

Taxonomic Notes on *Persicaria lapathifolia* (Polygonaceae/ Polygonaceae) Focusing on Türkiye

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What is already known on this topic?

- Persicaria lapathifolia* has infraspecific variation leading to different classifications by many taxonomists. According to recent records, *P. lapathifolia* is represented by subsp. *brittingeri*, subsp. *lapathifolia*, and subsp. *nodosa* in Türkiye. Previous studies often lack comprehensive phylogenetic analysis and morphological descriptions of subspecies in Türkiye.

What this study adds on this topic?

- This study focuses on clarifying the taxonomic status of the subspecies *Persicaria lapathifolia* in Türkiye using molecular and morphological data. All these results indicate that *P. lapathifolia* is represented by *P. lapathifolia* subsp. *lapathifolia* in Türkiye.

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ABSTRACT

Persicaria lapathifolia has exhibited significant variation in its external morphological characteristics (e.g., stem dotting, leaf shape, leaf and ocrea indumentum, perianth properties), leading to different classifications by many taxonomists. According to recent records, *P. lapathifolia* is represented by *P. lapathifolia* subsp. *brittingeri*, *P. lapathifolia* subsp. *lapathifolia*, and *P. lapathifolia* subsp. *nodosa* in Türkiye. In the present study, *P. lapathifolia* is evaluated, focusing on morphological and molecular evidence (internal transcribed spacer sequences) inferred from extensive examination of both authentic herbarium specimens (from national and international collections) and newly gathered field samples. Morphological observations revealed that members belonging to Turkish subspecies exhibited very similar characteristics that do not provide sufficiently diagnostic features to describe the infraspecific variation of *P. lapathifolia*. Also, phylogenetic analyses further support the morphological similarities, confirming the lack of clear genetic differentiation among the members of Turkish specimens. When the specimens belonging to subsp. *brittingeri* and subsp. *nodosa* collected from Türkiye were examined in detail, and it was determined that they clearly belong to subsp. *lapathifolia*. This morphological similarity is also highly supported by phylogenetic analyses based on internal transcribed spacer data. All these findings show that *P. lapathifolia* is represented by *P. lapathifolia* subsp. *lapathifolia* in Türkiye. Therefore, the extended description, chorology, and phylogenetic relationships of the *P. lapathifolia* subsp. *lapathifolia* are presented in detail for the first time in the present article.

Keywords: ITS, morphology, *Persicaria lapathifolia*, Türkiye

Introduction

The genus *Persicaria* Mill. (smartweeds) is often considered a member of the *Polygonum* L. (Ayman et al., 2024); however, recent morphological and molecular studies reveal that it is a distinct genus (Kim & Donoghue, 2008). The genus *Persicaria* comprises about 150 cosmopolitan species found in temperate regions and in subtropical regions of Africa, India, and South America (Ayman et al., 2024). They are mostly herbaceous plants characterized by swollen nodes, singular spikes or panicles, entire ocrea (–3), 4 or 5-parted perianth (Coode & Cullen, 1966; Li Anjen et al., 2003). Members of *Persicaria* exhibit a high morphological variation in leaf shape, indumentum, and perianth color (Parnell & Simpson, 1988) driven by extensive interspecific hybridization (Wilson, 1990; Kim et al., 2008).

Polygonum lapathifolium L. was described by Carl Linnaeus (1753) in *Species Plantarum*. Afterward, Delarbre (1800) transferred it to the genus *Persicaria* as *P. lapathifolia* (L.) Delarbre. However, Gray (1821) merged *Polygonum lapathifolium* and several previously described *Polygonum* taxa to *Persicaria lapathifolia* (L.) Gray. In the current literature, there are two distinct taxonomic concepts for the systematics of *Persicaria lapathifolia* based on narrow and broad species concepts advocated by Delarbre and Gray, respectively. The first revisional studies on *P. lapathifolia* were published by Wisskirchen (1995). In these articles, he listed four subspecies: subsp. *lapathifolia*, subsp. *pallida* (With.) A. Löve, subsp. *leptoclada* (Danser) Wissk., and subsp. *brittingeri* (Opiz) Sojak. According to GBIF (2025), *P. lapathifolia* (L.) Gray consisted of seven infraspecific taxa namely *P. lapathifolia* var. *salicifolia* (Sibth.) Miyabe, *P. lapathifolia* subsp. *brittingeri*, *P. lapathifolia* subsp. *incana* (Roth) H. Hara, *P. lapathifolia* subsp. *lapathifolia*, *P. lapathifolia* subsp. *leptoclada*, *P. lapathifolia* subsp. *mesomorpha* (Danser) Sojak, and *P. lapathifolia* subsp. *pallida*. Four of them (*P. lapathifolia* var. *salicifolia*, *P. lapathifolia* subsp. *brittingeri*, *P. lapathifolia* subsp. *leptoclada*, and *P. lapathifolia* subsp. *mesomorpha*) are listed as

heterotypic synonyms of *P. lapathifolia* according to the Plant of the World Online database (POWO, 2025).

P. lapathifolia is treated under the three subspecies in *Flora Hellenica* (Strid & Tan, 1997) and *Flora Iran* (Rechinger & Schiman-Czeika, 1968), two varieties in the *Flora of Pakistan* (Qaiser, 2001), two varieties in *Flora of Thailand* (Kantachot et al., 2010), three varieties in the *Flora of China* (Li Anjen et al., 2003), and without any infraspecies in Türkiye (Coode and Cullen, 1966; Leblebici 1990; Keskin, 2012). However, two subspecies, namely *P. lapathifolia* subsp. *brittingeri* and *P. lapathifolia* subsp. *nodosa* (Pers.) A. Löve, were recorded from Türkiye by Keskin & Severoğlu (2020, 2021).

The present study aims to contribute to the infraspecific taxonomy of *Persicaria lapathifolia* based on lots of herbarium and newly collected specimens and field observations focusing on Türkiye.

Material and Methods

Phenetic Studies

The current study was mainly performed using the authors' own specimens collected from 36 populations, as well as specimens stored in national and international herbaria. The *Flora of Turkey* and *The East Egean Islands* (Coode & Cullen, 1966) and other national floras (Webb & Chater, 1964; Rechinger & Schiman-Czeika, 1968; Strid & Tan, 1997; Qaiser, 2001; Li Anjen et al., 2003) were used for the identification of the examined samples. Important morphological characters such as stem, leaf, ocrea, glands, perianth, fruit, and ovary were photographed under a stereomicroscope.

Distribution Map

Distribution map was prepared through ArcGIS 10.5 (Esri, 2014) using the records of the *Flora of Turkey* and *The East Egean Islands* (Coode & Cullen, 1966), national or international herbarium records, and the specimens collected in the present study. The coordinates of old herbarium records for which global position information was not available were approximated and processed using Google Earth (URL-1, 2025).

Phylogenetic Studies

The genomic DNA of the specimens was extracted from herbarium material stored at the Herbarium of the Department of Biology, Recep Tayyip Erdogan University (RUB) following the modified extraction procedure of Doyle & Doyle (1987). In the modified protocol, fresh and mature leaf tissues were finely pulverized with a sterile razor blade. The resulting leaf powder was transferred into the extraction buffer, 0.02 g of PVPP (polyvinylpolypyrrolidone) was added, and the mixture was incubated at 65 °C for up to 4 hours. Chloroform was incorporated into the extraction steps to improve phase separation, and the incubation period was extended to ensure efficient nucleic acid release. During the precipitation phase, 7.5 M ammonium acetate and isopropanol were added to promote the selective precipitation of nucleic acids prior to purification. PCR amplification and sequencing of nrDNA ITS regions were carried out according to Gültepe et al. (2010). The ITS sequences were aligned using Muscle v.3.8.31 (Edgar, 2004), then edited in PhyDE v.0.9971 (Müller et al., 2010). The accessions used in the study were obtained from GenBank, following the work of Kundakçı et al. (2024). Briefly, the procedures outlined below represent a shortened version of the methodology presented by Kundakçı et al. (2024). Phylogenetic relationships were reconstructed using Maximum Parsimony (MP), Maximum Likelihood (ML), and Bayesian Inference (BI) analyses. MP analyses were run in PAUP* version 4.0b10. A majority-rule consensus tree was calculated from the most parsimonious trees. Bootstrap (BS)

support values for the nodes found in the MP analysis were calculated in PAUP* applying the optimal bootstrap parameters. Prior to BI analyses, the nucleotide substitution model that best fit the datasets was determined for ITS—using MrModeltest 2.3, following the Akaike Information Criterion. BI analyses in MrBayes 3.2 were performed with four simultaneous runs of Metropolis-coupled Markov Chains Monte Carlo, each with four parallel Markov chains. Finally, the ML tree was rooted with *Rumex* L.

Single nucleotide polymorphisms (SNPs) from 18 accessions representing seven investigated taxa were identified using MEGA X (Kumar et al., 2018) on the original aligned sequences of ITS regions. The nucleotides were subsequently incorporated manually into the Supplementary Table 1.

Results

Persicaria lapathifolia (L.) Gray subsp. *lapathifolia*. 2: 270. 1821 (Figures 1, 2, and 3).

Heterotypic synonyms: = *Persicaria lapathifolia* subsp. *nodosa* (Pers.) Å.Löve in Rit Landbúnaoörd. Atvinnud. Háskólans, B 3: 109 (1948); *Polygonum lapathifolium* subsp. *nodosum* (Pers.) Schübl. & G. Martens. Fl. Würtemberg: 257 (1834); *Polygonum lapathifolium* var. *nodosum* (Pers.) Wimm. & Grab. Fl. Siles, 1: 378 (1827).

Annual herbs. Stems erect or ascending, 40–90 cm, branched, glabrous or subglabrous, often reddish and/or red dotted. Leaf blade narrowly elliptic, lanceolate or ovate, 2.6–5.9 × 0.3–0.8 cm, adaxial surface glabrous or sparsely hairy, with a large blackish spot, abaxial surface glabrous, densely lanate or sublanate, pellucid or yellowish–brownish glands, margin plane–undulate and ciliate, apex acuminate or acute, base cuneate, petiole 0.2–0.5 cm and hispidulous. Ocrea brownish, tubular, 7–12 mm, glabrous or densely lanate, surface nerve 13–17, apex truncate, not ciliate or rarely shortly ciliate. Inflorescence terminal or axillary, spicate, erect or nodding, densely flowered, pedicel 1.35–1.70 mm; peduncles yellow glandular. Bracts lanceolate, margin sparsely shortly ciliate. Perianth greenish–white or pinkish, 4(or 5)–parted; tepals ovate, 1.50–2.80 × 0.55–0.90 (–1.38) mm, veins strongly forked, apex obtuse, base fused, surface yellow glands. Stamens 6 (4+2), 0.45–0.90 mm, glands present at the base. Styles 2, connate at base. Fruit broadly ovoid, biconcave, shiny, 2.0–2.3 × 1.6–1.9 mm, brown–dark brown, included in persistent perianth.

Phenology: Flowering in June–August, fruiting in August–October

Habitat: Forest clearings, damp places, marshes and near streams, roadside

Phytogeographic Region: Europe–Siberian, Mediterranean, Irano–Turanian (Figure 4)

Vernacular Name: Tırşon (Güner et al., 2012)

Examined specimens: **A1 (A) Balıkesir:** Around Lake Manyas, 1981, L. Ergün (ISTO 25960); **A1 (E) Edirne:** Büyükdöllük Village, Lake Göl Baba, 40 m, 26.vi.1984, Ö. Seçme–E. Leblebici 4536 (B); **A1 Kırklareli:** between Demirköy–Yenice, roadside, 719 m, N 41° 45' 56,6", E 027° 41' 03,3", 14. ix. 2019, Makbul & Kundakçı 115b (RUB); Pınarhisar, 01.viii.1990, A. Baytop (ISTE 62397); Vize, Hamidiye Village, stream edge, 290 m, 25.vi.2002, Ş. Kültür, N. Sadıkoğlu (ISTE 80924);

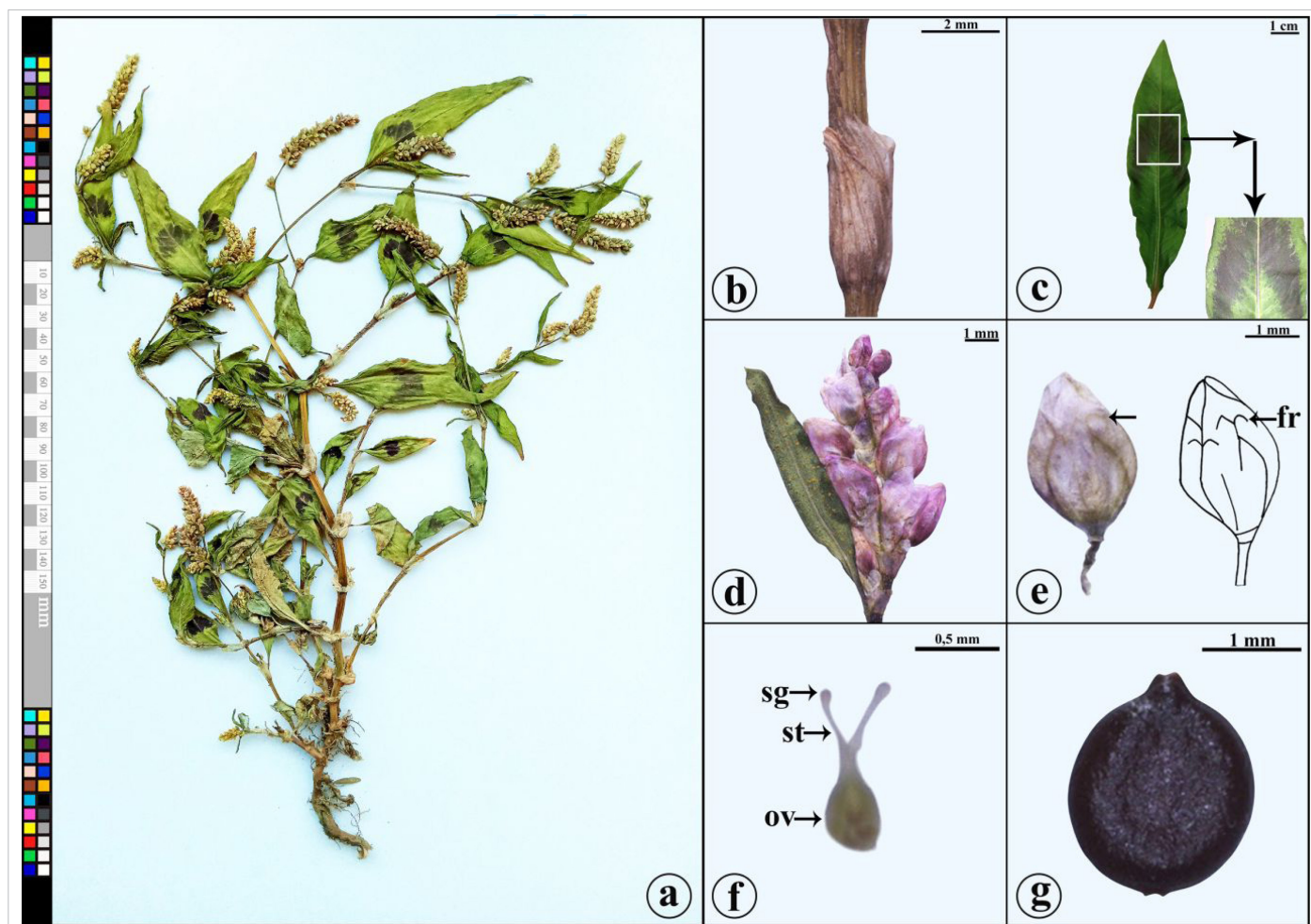


Figure 1.
Persicaria lapathifolia subsp. *lapathifolia* (Makbul & Kundakçı 70): a, Herbarium Specimens; b, Ocrea; c, Leaf; d, Inflorescence; e, Perianth; f, Gynoecium; g, Fruit. Fr, Forked; Sg, Stigma; St, Style; Ov, Ovary.

A1 (E) Tekirdağ: Tekirdağ, Karahisarlı Village, 23.vii.1992, E. Akalın (ISTE 64698); **A2 (A) Balıkesir:** Kuş Cenneti, Lake Manyas shore, 16.x.1970, A. Baytop (ANK 18725); **A2 (E) İstanbul:** Belgrad Forest, lake edge damp area, 68 m, N 41° 10' 48,0", E 028° 57' 35,2", 13.x.2022, Makbul & Kundakçı 607 (RUB); Belenköy-Küçükçekmece, Post, B.V.D (E); Büyükdere to Sultan, 21.x.1906, Azn. (G); Gaziosmanpaşa, Tayakadın, stream, 29.vii.1942, B. Kasaplıgil (ISTF 1959); Gaziosmanpaşa, Arnavutköy, 08 ix.1942 (ISTF 2114); Terkos gölü, x. 2011, A. Bakacak (ISTF 40953); **A3 Düzce:** Akçakoca, Melenagzı Village, along the Melen stream, marsh, meadow, 1–25 m, 30.vi.2002, A. Doğru Koca 1738 (HUB); **A3 Karabük:** Keltepe ski center, alpine open area, 1467 m, N 41° 03' 30,3", E 032° 28' 00,8", 15.x.2022, Makbul & Kundakçı 635 (RUB); **A3 Sakarya:** Hendek, Beştepeler, cultivated, 09.ix.1992, S. Kuş (ISTF 36070); **A4 Ankara:** Gündül district, Yeşilöz town, Kirmir stream valley, ağlamera, steppe in rocky valley, 760 m, 07.ix.2002, B. Tankahya 1917 (HUB); Kızılcahamam, 3 km north of Kızılcahamam, edge of rice field, 1000 m, 26.vii.1988, R. M. Nesbitt-D. Samuel (GAZI 1914); Beypazarı, Eğrisu, in the stream, *P. silvestris* açıklığı, 1650 m, 08.ix.1971, Y. Akman (ANK 973, G! 973); Kayaş, Hatip stream, T. Uslu- M. Kılınç (ANK 36); **A4 Bolu:** Karacasu, 700 m, 06.1954, O. Alpay (ANK 239); Lake Yeniçağa, 1000 m, 07.viii.1982, Th. Raus (B 6935); **A4 Kastamonu:** Cide, Kızılcaasu, 900 m, 07.x.1980, O. Ketenoğlu (ANK 1414); **A5 Kastamonu:** Abana, Kastamonu, Harmuson stream damp stony places, 20 m, 13.viii.2000,

E. Kanoğlu (KATO 14420); **A6 Samsun:** 19 Mayıs, Kumcağız, sandy shores, 0 m, 41° 29' 42", 36° 7' 3", 28. viii. 2018, Makbul 450 (RUB); Ladik, lake edge, 876 m, N 40° 54' 09,1", E 035° 59' 41,2", 11.viii.2021, Makbul & Kundakçı 323c (RUB); Bafra, Doğanca Village, cultivated wetlands, 0 m, N 41° 37' 19,4", E 036° 00' 30,0", 10.viii.2021, Makbul & Kundakçı 319 (RUB); **A7 Giresun:** Tamdere, between Tamdere-Kümbet, 49 km to Dereli, under mixed forest, 1631 m, N 40° 29' 54,5", E 38° 47' 53,6", Güzel 936c (RUB); Bulancak, rubble areas, 15 m, N 40° 56' 46,2", E 038° 10' 09,0", 09.viii.2021, Makbul & Kundakçı 313 (RUB); Espiye, Karaduğa Döresi, 180 m, 22.viii.1975, A. Uruçelik (KATO 1856); **A7 Trabzon:** Araklı, 15 m, N 40° 54' 34,5", E 40° 02' 31,3", 14. ix. 2018, Makbul & Kundakçı 64 (RUB); Araklı-Bayburt road, Kaya içi neighbourhood, 2 km to, road-sides, 540 m, N 40° 40' 33,7", E 39° 54' 02,0", 14. ix. 2018, Makbul & Kundakçı 70 (RUB); **A8 Erzurum:** Pasinler entry, riverbed, 1690 m, N 39° 58' 38,7", E 041° 38' 30,8", 17.viii.2021, Makbul & Kundakçı 337-338 (RUB); **A8 Rize:** Ardeşen Fırtına Deresi entry, damp area by the stream, 20 m, N 41° 10' 31,8", E 40° 58' 12,5", 12. ix. 2018, Makbul & Kundakçı 9 (RUB); İkizdere-Ispir road, roadsides, 570 m, N 40° 46' 18,4", E 40° 33' 41,3", 13. ix. 2018, Makbul & Kundakçı 42 (RUB); İkizdere, Çamlık Village, roadsides, 1530 m, N 40° 42' 07,5", E 40° 40' 00,5", 13. ix. 2018, Makbul & Kundakçı 52 (RUB); İkizdere, Çamlık Village, 2640 m, N 40° 42' 04,8", E 40° 40' 09,9", 13. ix. 2018, Makbul & Kundakçı 54 (RUB); **A8 Trabzon:** Çaykara district, Kabataş Village, 23.viii.1983, S. Ayaz 1013 (HUB 04598);

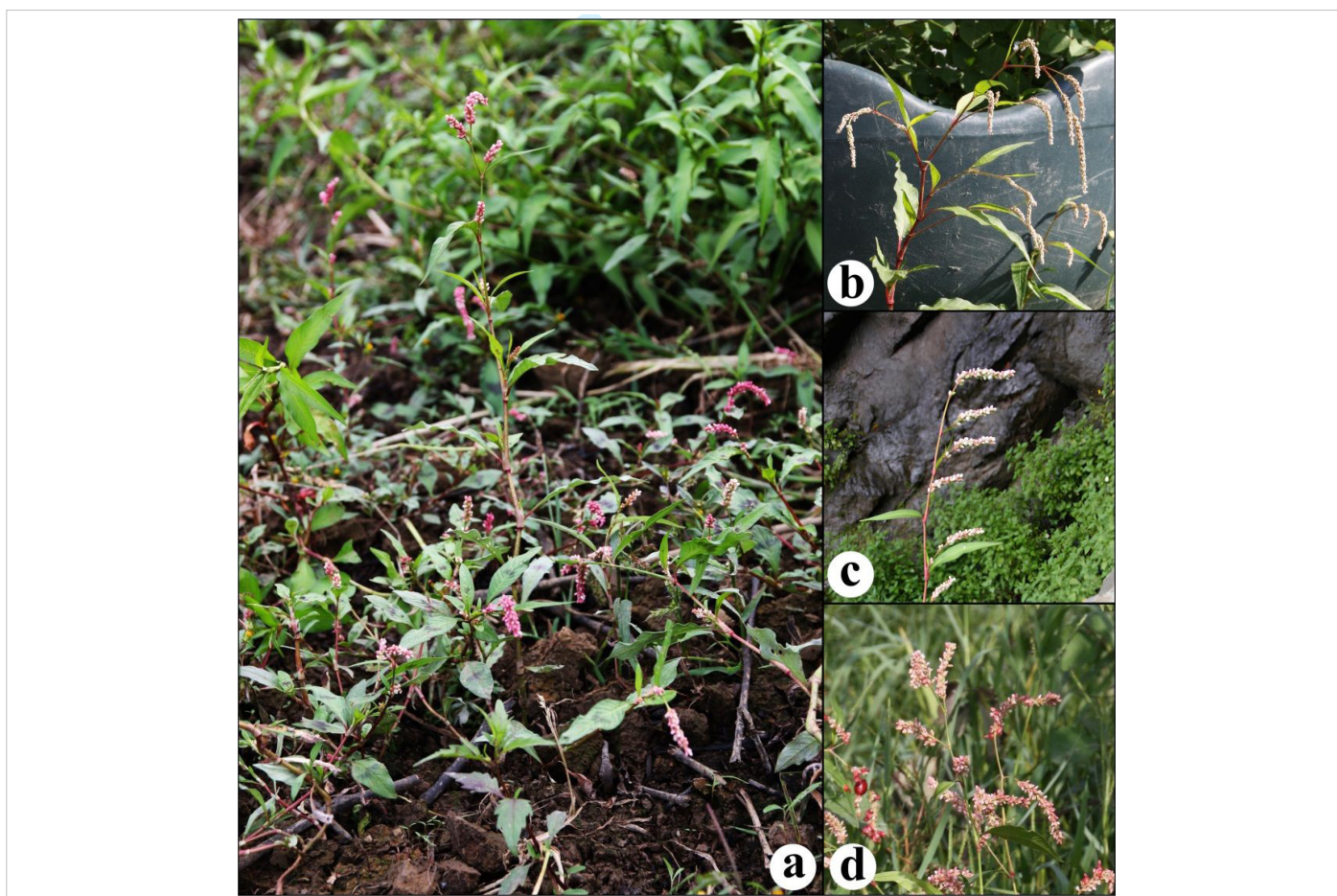


Figure 2.
Persicaria lapathifolia subsp. *lapathifolia*. a, Habitus (M&K 468); b–d, Inflorescence (b, M&K 462; c, M&K 407; d, M&K 464).

A9 Ardahan: between Ilgar Passage-Posof, roadsides, 1848 m, N 41° 28' 20,5", E 042° 42' 31,7", 15.ix.2021, Makbul & Kundakçı 441 (RUB); near the Türkgözü border crossing, roadside damp area, 1268 m, N 41° 34' 52,2", E 042° 49' 00,1", 15.ix.2021, Makbul & Kundakçı 449 (RUB); **A9 Artvin:** Şavşat, Yavuzköy upper, Sahara exit, in forest, 1687 m, N 41° 13' 53,5", E 042° 26' 13,6", 15.ix.2021, Makbul & Kundakçı 435 (RUB); Şavşat, Demirkapı-Akdamlı road, stream edge, 1650 m, N 41° 07' 03,9", E 042° 05' 31,8", 16.ix.2021, Makbul & Kundakçı 455 (RUB); between Hopa-Kemalpaşa, roadsides, 7 m, N 41° 25' 49,5", E 041° 26' 53,0", 30.x.2022, Makbul & Kundakçı 680 (RUB); **A9 Kars:** Akyaka-Cebeci road, damp places, 1503 m, N 40° 45' 21,7", E 043° 37' 27,6", 12.vii.2021, Makbul & Kundakçı 262 (RUB); between Arpaçay-Tomarlı Village, meadow edge, stony, wet places, 1700 m, 24.vii.1984, H. Ocakverdi 2003 (GAZI); **B1 Ödemiş:** Bozdağ, 1000 m, 01.x.1935, Gassner (ANK 52); **B1 Çanakkale:** Kocaçeşme Village coast, sandy shores, 5 m, N 40° 39' 54,0", E 026° 48' 22,5", 13. ix. 2019, Makbul & Kundakçı 112 (RUB); **B2 İzmir:** between Torbalı-Selçuk, humid areas, 53 m, N 38° 22' 53,6", E 027° 21' 28,2", 30.viii.2021, Makbul & Kundakçı 380 b (RUB); B2 Kütahya: Emet, South of Eğrigöz Village, 750 m, 25.ix.1981, G. Görk G-858 (EGE 37803); **B5 Aksaray:** Kızılkaya Village, Aşıklı Höyük (Melendiz), 1110 m, 24.viii.1994, Füsün Ertuğ 181 (GAZI); **B5 Kayseri:** Felahiye, Kermelik Bridge, 22.viii.1999, S. Erik 6182 (HUB); **B5 Nevşehir:** Ürgüp-Mustafapaşa, channel edges, humid areas, 1100 m, 10.viii.1989, M. Vural-Ö. Eyüboğlu (GAZI 5578); **B6 Yozgat:** Çayıralan, between Çat-Ezikli, stream edge, 1450 m, 18.vii.1980, T. Ekim (ANK 4606); **B7 Erzincan:** Erzincan-Tercan road, to Tercan'a 7-8 km, cultivated land, 1390 m, N 39° 45' 30,5", E

040° 17' 30,0", 11.vii.2021, Makbul & Kundakçı 245 (RUB); **B8 Bingöl:** Karlıova, Selekan Village, roadsides, 1904 m, N 39° 06' 23,3", E 041° 13' 25,3", 21.viii.2021, Makbul & Kundakçı 375 (RUB); **B9 Ağrı:** between Tutak-Hamur 5. km, stream edge, gravelly-sandy area, 1590 m, N 39° 32' 07,4", E 042° 49' 21,0", 17.viii.2021, Makbul & Kundakçı 341c (RUB); **B9 Muş:** Hasköy exit, inside the water edge arc, 1280 m, N 38° 40' 43,6", E 041° 42' 53,0", 23. viii. 2020, Makbul & Kundakçı 144a (RUB); **B9 Van:** Erçiş, between Taşkapı- Hasanabdal 5. km, roadsides, 1935 m, N 39° 14' 08,6", E 043° 23' 53,9", 18.viii.2021, Makbul & Kundakçı 346a (RUB); **C2 Antalya:** Karagöl plateau, 1000 m, 07.viii.1947, P. H. Davis (EGE 13914); Karagöl, near Tuva, 1000 m, Davis (ANK 13914); **C3 Antalya:** around Aksu, roadsides, 107 m, N 36° 56' 21,2", E 030° 52' 19,7", 31.vii.2021, Makbul & Kundakçı 282c (RUB); Serik, roadsides, 6 m, N 36° 56' 03,8", E 030° 56' 13,3", 31.vii.2021, Makbul & Kundakçı 286 (RUB); **C2 Kahramanmaraş:** between Göksun-Değirmendere, Ağapınar location, stream edge, 1421 m, N 37° 55' 46,4", E 036° 28' 45,4", 20. viii. 2019, Makbul & Kundakçı 83 (RUB); Çamlıbel bridge, Süleymanlı road, damp places, 647 m, N 37° 48' 33,5", E 036° 47' 30,9", 25.viii.2022, Makbul & Kundakçı 587 (RUB); **C2 Muğla:** Fethiye, near Kale, 24.iv.1964, Dr. Regel-E. Leblebici (EGE 16672); **C5 Konya:** Ereğli, Mountain Aydos, Halkapınarı dam surroundings, streamside, 1400 m, 17.vii.1978, S. Erik 2964 (HUB 04606); Ereğli, 200 m, 21.vi.1968, Y. Akman (PP05174488!); **C6 Hatay:** Çevlik, Samandağ coast, sandy shores, 18 m, N 36° 06' 53,9", E 035° 55' 33,5", 24.viii.2022, Makbul & Kundakçı 581 (RUB); Yayladağı, damp places, 07.ix.1997, M. Keskin 1426 (ISTE 78252).

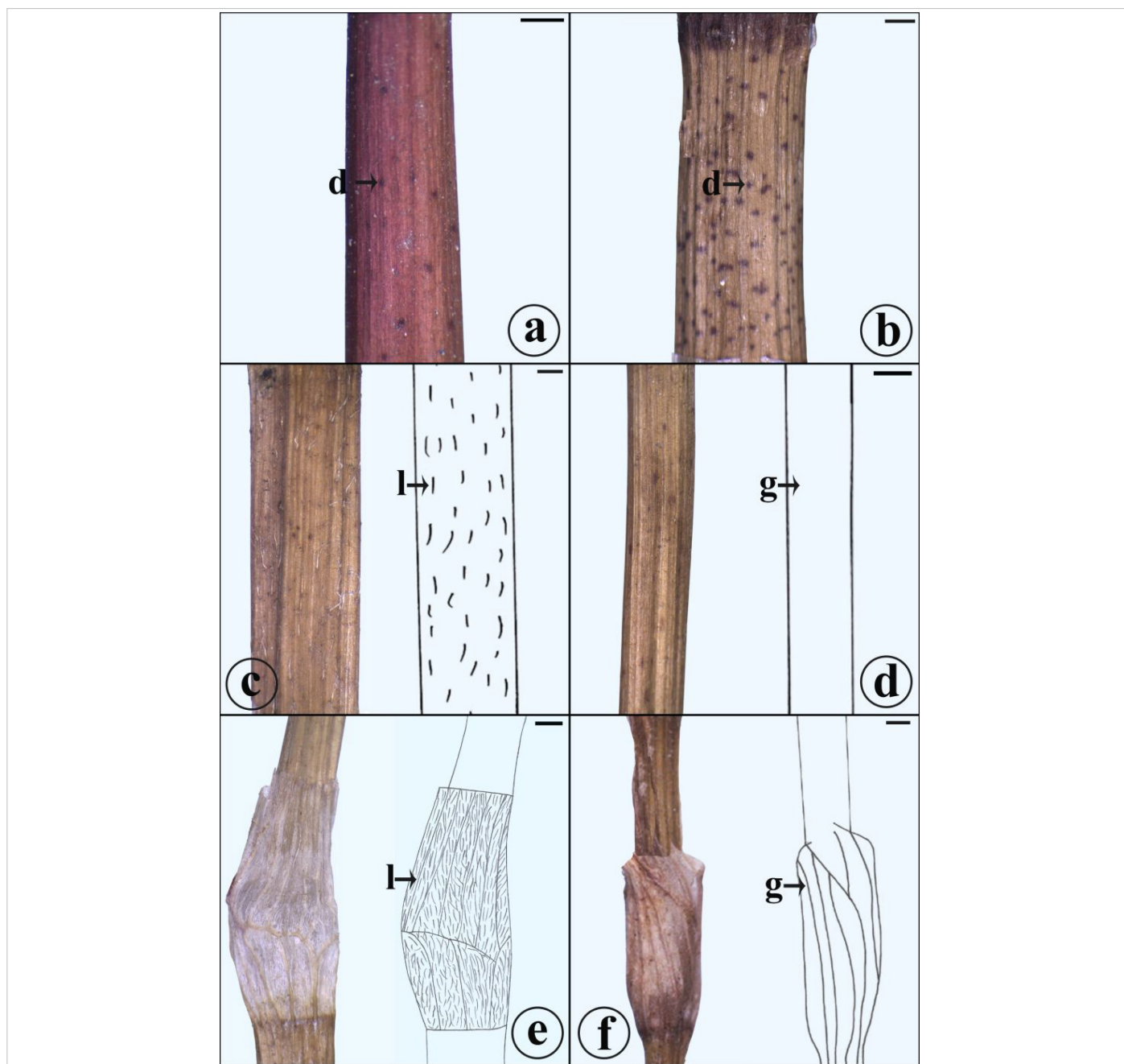


Figure 3.
Stem and Ocrea Characteristics of *Persicaria lapathifolia* subsp. *lapathifolia*. a–b, Stem Dotting; c–d, Stem Indumentum; e–f, Ocrea Indumentum. d, Dotted; g, Glabrous; l, Lanate; Scale Bars, 1 mm.

Phylogenetic Relationships

The MP, ML, and BI analyses based on ITS sequence data yielded trees with nearly identical topologies. Therefore, the ML tree was selected, and support values from the other analyses (MP and BI) were mapped onto this tree (Figure 5). Several members of the subfamily Polygonioideae, namely *Atraphaxis* L., *Bistorta* (L.) Scop., *Emex* Neck. ex Campdera, *Fallopia* Adans., *Koenigia* L., *Polygonella* Michx., *Polygonum* L., *Reynoutria* Houtt., and *Rumex* were selected as distant outgroups to provide a more robust phylogeny in the phylogenetic analyses (Figure 5). The dataset included 172 individuals with outgroup taxa marked by dark triangles and comprised 51 *Persicaria* accessions (ten individuals of *P. hydropiper* are highlighted with dark triangles). According to the phylogenetic

trees, the monophyly of *Persicaria* is corroborated with strong support values (ITS: ML=99, MP=100, and PP=1.0). In the phylogenetic trees derived from ITS data, the accessions of *P. lapathifolia* from GenBank and newly generated sequences clustered together with strong support values (ML=100, MP=100, and PP=1.0). *P. lapathifolia* was divided into two subclades with a moderately supported value (Figure 5; subclade P4b2). As shown in Figure 5 (ML=77, MP=100, and PP=1.0), the accessions of *P. lapathifolia* subsp. *lapathifolia* from Türkiye were grouped into two subclades; one of these had high support values, and the other one had low support values (Figure 5; ML=77, MP=100, and PP=1.0). The SNP sites of accessions belonging to the *Persicaria lapathifolia* and some *Persicaria* species are given in Supplementary Material; Supplementary

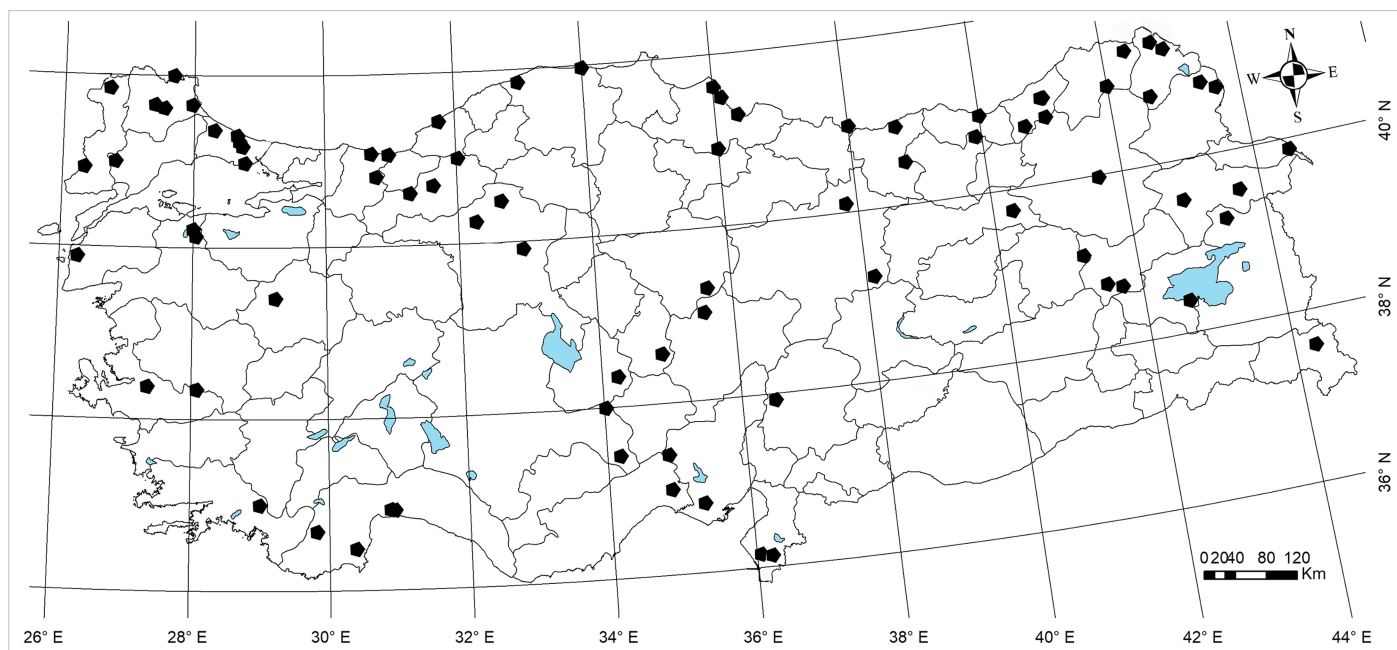


Figure 4.
 Distribution of *Persicaria lapathifolia* subsp. *lapathifolia* in Türkiye.

Table 1. According to ITS data, the accession of *P. lapathifolia* obtained from GenBank and the new sequences, twelve (99, 167, 267, 420, 421, 493, 498, 543, 549, 551, 573, 580) polymorphic sites were determined (Supplementary Material; Supplementary Table 1).

Discussion

Persicaria lapathifolia is a morphologically variable species including several infraspecific taxa (Timson, 1963; Webb & Chater, 1964; Wilson, 1990; Wilcox, 2021). Delarbre (1800) treated *P. lapathifolia* without any infraspecific taxa, while Gray (1821) dividing it into seven subspecies. However, the character used for delimitation of infraspecific taxa of *P. lapathifolia* mostly overlaps; therefore, it is not always possible to classify *P. lapathifolia* as a subspecies or variety based on these traits (Table 1, Figure 3).

Persicaria lapathifolia subsp. *brittingeri* was recorded based on specimens of M. Keskin 7889 and M. Keskin 8019 collected from two localities in İstanbul (Türkiye) by Keskin & Severoğlu (2020). Keskin & Severoğlu (2020) indicated that *P. lapathifolia* subsp. *brittingeri* differed from the other two subspecies by the lanate hairs of the leaf abaxial surfaces when young. Although the specimens of M. Keskin 7889 and 8019 could not be examined in any national herbaria, the present authors collected a specimen (Makbul & Kundakçı 462) from Keskin's locality in 2021. As a result of the examination of this specimen, it was found that the abaxial surfaces of the leaf were clearly glabrous (Figure 6) contrary to Keskin & Severoğlu (2020). According to Wilson (1990), the leaf abaxial surfaces of *Persicaria* taxa are densely lanate in young individuals whereas these hairs are shed with maturity. Wilson (1990) also reported that in *P. lapathifolia*, even in a single individual, the abaxial surfaces of the leaf can vary from glabrous to lanate hairs. Similarly, Shirahama et al. (2017) reported that the leaf abaxial surfaces of *Persicaria lapathifolia* var. *lapathifolia* (= *Persicaria lapathifolia*) collected from the same location were hairy in some individuals and glabrous in others. These variations reported by Timson (1963), Wilson (1990) and Wilcox (2021)

in the pubescence of the abaxial surface of the leaf were also observed in the sample of Makbul & Kundakçı 462 as well as in the samples collected from other locations in Türkiye (Figure 6). Furthermore, Keskin & Severoğlu (2021) noted that *P. lapathifolia* subsp. *brittingeri* differed from *P. lapathifolia* subsp. *nodosa* by the absence of reddish-purplish dots on the stem. However, the specimens of Makbul & Kundakçı 462 collected from the same locality have dense reddish-purple dots on the stem. Additionally, examination of herbarium samples belonging to *P. lapathifolia* subsp. *brittingeri* (= *Polygonum brittingeri*) stored at BGBM (B100612548 photo!, B100612955 photo!, B101273185 photo!), JE (00026219 photo!, 00026220 photo!, 00026221 photo!), and WU (0061137 photo!, 0072194 photo!, 0108307 photo!, 0134120 photo!, 0148628 photo!, 0147023 photo!, 0147026 photo!, 0147040 photo!, 0148211 photo!) showed that the leaf blade was glabrous, lanate, or sublanate. All these observations indicate that *Persicaria lapathifolia* subsp. *brittingeri* is not presented in Türkiye.

Persicaria lapathifolia subsp. *nodosa* was recorded based on specimens of M. Keskin 7861, 8032, 8062, 8071! collected from four localities in İstanbul (Türkiye) by Keskin and Severoğlu (2021). They reported that *P. lapathifolia* subsp. *nodosa* differed from the other two subspecies in Türkiye by a long and rough stem with red-purple dots in the upper part, and a dark pink perianth (Keskin & Severoğlu, 2021). However, further observation and examination of the specimen of *P. lapathifolia* subsp. *nodosa* stored at NGBB (Keskin 8071!) and the specimens (Makbul & Kundakçı 464 and 468) collected from the same localities as Keskin & Severoğlu (2021) revealed that stems were covered completely with red dots or red dots of varying intensity (Figure 3). Additionally, the examination of herbarium samples belonging to *P. lapathifolia* subsp. *nodosa* (= *P. nodosum*) stored at E photo!, K photo!, NGBBI, and P photo! shows that in the specimens at these herbaria, it was seen that the dots on the stem varied from sparsely to densely. It has been reported that stem dots and gland (color and density) characteristics are unreliable characters in the definition of *Persicaria* taxa, and that the density of glands varies in different populations (Timson, 1963). Wilcox (2021)

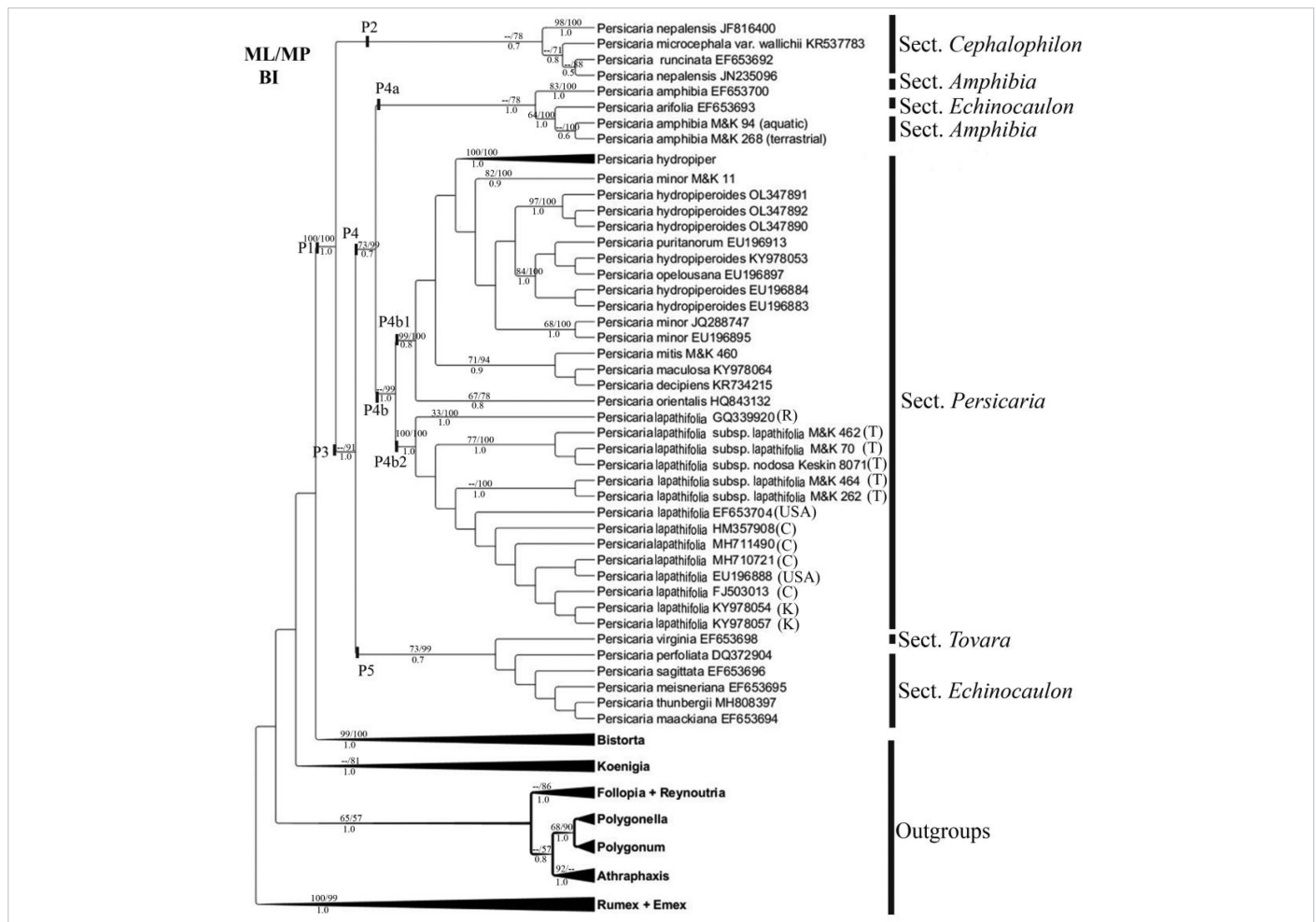


Figure 5.
 Majority-Rule Consensus Phylogram of Persicarieae from the ML Analysis Based on the ITS Dataset (Support Values: First-Line ML Bootstrap, and MP Bootstrap, Second-Line BI Posterior Probability). C: China, K: Korea, R: Russia, T: Türkiye, USA: United States of America.

reported that the stems of the *P. lapathifolia* typically exhibited red and/or red-dotted coloration due to their anthocyanin content. Similarly, in the *Flora of Europe* (Webb & Chater, 1964) and *Flora Hellenica* (Strid & Tan, 1997), the stem of the *P. lapathifolia* taxon is described as being red or having red dots. All these observations indicate that *Persicaria lapathifolia* subsp. *nodosa*, which is a heterotypic synonym, belongs to the taxon *P. lapathifolia* subsp. *lapathifolia*.

Recent molecular studies on *Persicaria* using nucleotide sequence data (Kim & Donoghue, 2008; Kim et al., 2008) have shown that the genus is largely monophyletic. Examination of the phylogenetic tree in Figure 5 indicates that the sections *Cephalophylon* (Meisner) H. Gross, *Echinocaulon* (Meisner) H. Gross, *Persicaria* (Mill.) H. Gross, *Tovara* (Adanson) H. Gross, *Amphibia* Tzvelev, and *Truelloides* Tzvelev previously proposed based on molecular and morphological evidence are generally supported. However, *P. arifolia* (L.) Haraldson (EF653693), which is morphologically assigned to section *Echinocaulon*, clustered with *P. amphibia* (L.) Delarbre from section *Amphibia*. This unexpected placement is likely due to nucleotide ambiguities, insertions/deletions, or other sequence irregularities present in the GenBank *P. arifolia* sequence (Figure 5).

Similarly, the phylogenetic tree shows that species belonging to section *Persicaria*, including *P. lapathifolia*, are clearly separated from the other

sections. *P. lapathifolia* and *P. maculosa* Gray are morphologically similar taxa (Coode & Cullen, 1966; Li Anjen et al., 2003), yet in the ITS-based phylogenetic tree (Figure 5), they are placed in distinct clades. Overall, the ITS data provide clear molecular support for distinguishing these morphologically similar taxa, corroborating the molecular distinction between *P. lapathifolia* and *P. maculosa*.

According to the phylogenetic tree, members of *P. lapathifolia* are clustered with strong support values (Figure 5). In the phylogram, specimens belonging to *P. lapathifolia* subsp. *lapathifolia* (M&K 462) and *P. lapathifolia* subsp. *lapathifolia* (M&K 464, Keskin 8071), which represent new records from the country, were grouped in the same clade together with the GenBank samples (Figure 5, subclade P4b2). Twelve polymorphic sites were identified in the SNP regions of accessions in all *P. lapathifolia* taxa examined (Supplementary Material; Supplementary Table 1). *P. lapathifolia* subsp. *brittingeri* has 'A' at position 99, 'C' at position 167, 'A' at the position 493. However, these nucleotide positions are similar to those of *P. lapathifolia* (M&K 70, GQ339920) and *P. lapathifolia* subsp. *nodosa* (Keskin 8071). *P. lapathifolia* subsp. *nodosa* (Keskin 8071) has 'A' at position 99, 'T' at position 167, 'A' at the position 493, 'T' at position 498 (Supplementary Material; Supplementary Table 1). The findings indicate that the *P. lapathifolia* species, exhibiting significant variety in phenetic characteristics, may potentially possess genetic

Table 1.
 Comparison of the Intraspecies of *Pericaria lapathifolia* Taxon

Taxa	Stem	Leaf Shape	Leaf Indumentum	Perianth Color	Inflorescence	
					Properties	Indumentum
<i>Pericaria lapathifolia</i> subsp. <i>brittingeri</i> (Opiz) Sojak	Not dotted ¹⁶ , purplish ¹⁰	Broadly obovate to elliptic ¹⁰ , ovate ^{6,8} , ovale ⁸ , elliptic ⁷	Almost glabrous ⁵ , leaf abaxial surface grey hairy ^{6,8} , densely tomentosa to velutinous ¹⁵ , densely lanate when young ^{10,16} and glandular ¹⁰ , densely woolly or tomentose ⁷	Pinkish ^{15,16} , greenish-white to pink ¹⁰ , reddish ⁸	—	Glandular ¹⁰
<i>Pericaria lapathifolia</i> subsp. <i>incana</i> (Roth) H. Hara	—	—	Leaf abaxial surface gray ⁹	Whitish-yellowish ⁹	—	—
<i>Pericaria lapathifolia</i> subsp. <i>Lapathifolia</i> (= <i>Pericaria lapathifolia</i> subsp. <i>nodosa</i> (Pers.) A. Löve)	Dotted ^{4,5} , red-purplish dotted in upper part ^{9,15,17}	Ovate-lanceolate ^{3,4,7} , ovate-elliptic ¹² , narrowly lanceolate ^{11,12,17} , lanceolate ^{8,10,11} , elliptic ^{10,17} ovate to linear-lanceolate ¹³	Glabrous ^{7,9,11} or lax pilose ^{2,9} , leaf abaxial surface glabrous ^{10,13} , densely tomentose ¹³ , sparsely hairy ¹⁰ and pellucid ^{11,13} yellowish ^{11,15,13} or red dotted ¹⁵	Purple ^{1,2,3} , pink ¹¹ , pink or pink-whitish ^{9,17} , pink to reddish ¹⁰ , greenish-white or red ¹²	Dense ^{11,12,13}	Glandular ¹⁰
<i>Pericaria lapathifolia</i> subsp. <i>leptoclada</i> (Danser) Wisk.	—	Lanceolate ¹⁴	—	Largely or completely green ¹⁴	Dense ¹⁴	—
<i>Pericaria lapathifolia</i> subsp. <i>mesomorpha</i> (Danser) Sojak	—	—	—	Pale green ¹⁴	Lax ¹⁴	—
<i>Pericaria lapathifolia</i> subsp. <i>pallida</i> (With.) A. Löve	Usually not red dotted ¹⁰	Linear-lanceolate ⁷	Leaf abaxial surface densely tomentosa ⁷ or densely grayish hairy ¹⁰	Greenish-white to pink ¹⁰	—	Densely glandular ¹⁰
<i>Pericaria lapathifolia</i> var. <i>salicifolia</i> (Sibth.) Miyabe	—	—	—	—	—	—
<i>Pericaria lapathifolia</i> subsp. <i>nodosa</i>	With red-purplish dots on the upper parts ¹⁷	Narrowly lanceolate or elliptic ¹⁷	Glabrous ¹⁷	Pinkish or pinkish-white ¹⁷	Densely	Glandular ¹⁷
<i>Pericaria lapathifolia</i> subsp. <i>brittingeri</i>	Not dotted ¹⁶	Broadly ovate-lanceolate ¹⁶	Lanate at the bottom at least when young, green at upper but sparsely hairy ¹⁶	Pinkish ¹⁶	Densely ¹⁶	Glandular ¹⁶
<i>P. lapathifolia</i> subsp. <i>lapathifolia</i>	Dotted (sparse or dense) or reddish-purplish ¹⁸	Narrowly elliptic, lanceolate or ovate ¹⁸	Glabrous, hairy or sub-hairy ¹⁸	Greenish-white or pinkish ¹⁸	Densely or lax ¹⁸	Glandular ¹⁸

¹Linnaeus, 1753; ²Delarbie, 1800; ³Gray, 1821; ⁴Persoon, 1805; ⁵Opiz, 1852; ⁶Opiz, 1824; ⁷Rechinger & Schiman-Czeika, 1968; ⁸Opiz, 1854; ⁹Schübler & G.M. von Martens, 1834; ¹⁰Strid & Tan, 1997; ¹¹Coode & Cullen, 1966; ¹²Boissier, 1867; ¹³Webb & Chater, 1964; ¹⁴Danser, 1921; ¹⁵Mozaffarian, 2012; ¹⁶Keskin & Severoglu, 2020; ¹⁷Keskin & Severoglu, 2020; ¹⁸Present study (Superscripts indicate the sources of the contacts).

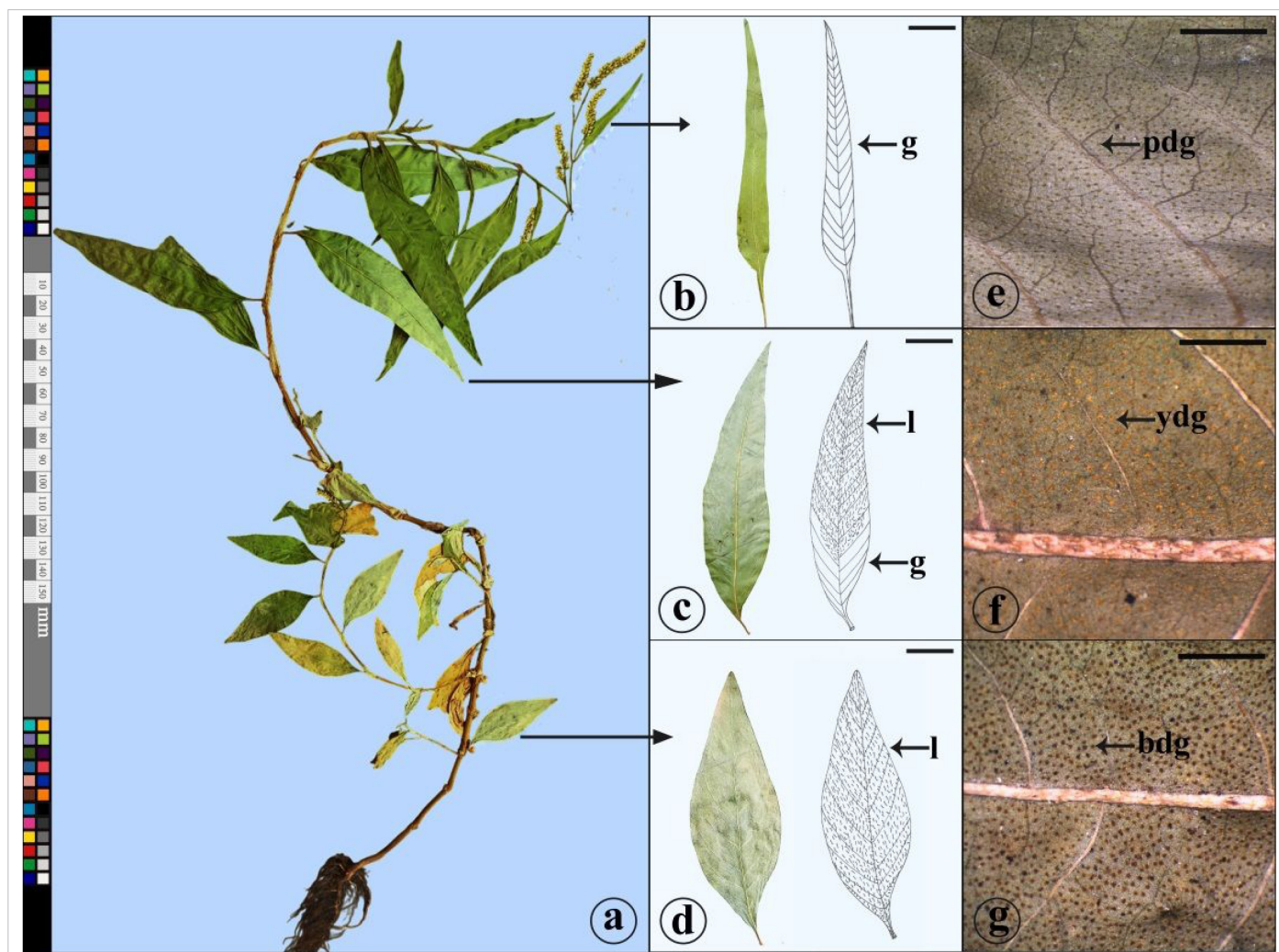


Figure 6. Leaf Characters of *Persicaria lapathifolia* subsp. *lapathifolia*. a, General View; b–d, Leaf Indumentum; e–g, Leaf Dots. g, Glabrous; l, Lanate; bdg, Brown Dotting Glands; pdg, Pellucid Dotting Glands; ydg, Yellow Dotting Glands; Scale Bars, 1 mm.

variations (Timson, 1963; Webb & Chater, 1964; Wilson, 1990; Wilcox, 2021).

Conclusion and Recommendations

In conclusion, *P. lapathifolia* was examined in detail for the first time in terms of its chorology, morphology, and molecular characteristics in Türkiye. Furthermore, specimens of *P. lapathifolia* stored in national and international herbaria, as well as those collected by the authors, were re-examined, and the distribution of species was updated. It was observed that certain morphological characteristics, such as the indumentum on the abaxial surfaces of the leaf and shape, reddish dots on the stem, and the perianth properties, which are used to distinguish between subspecies, exhibited variation even within the same individual plants.

When the specimens subsp. *brittingeri* and subsp. *nodosa*, which were given as a new record from the country, were examined, and it was determined that they had similar morphological characteristics to subsp. *lapathifolia* specimens. This morphological similarity is highly supported by phylogenetic analyses based on ITS data. This situation shows that the samples given as subsp. *brittingeri* and subsp. *nodosa*

in the country belong to subsp. *lapathifolia*. The *P. lapathifolia* subsp. *brittingeri* and *P. lapathifolia* subsp. *nodosa* are listed as heterotypic synonyms of *P. lapathifolia* in databases such as Plants of the World Online (POWO, 2025). The results from this study, based on morphological and molecular data, supported the classification of *P. lapathifolia* at the subspecies level, specifically *P. lapathifolia* subsp. *lapathifolia*.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Artificial Intelligence Usage Statement: The authors declared that no Artificial Intelligence tool was used in the preparation of the manuscript.

Peer-review: Externally peer-reviewed.

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