



Novelties in *Persicaria* (Polygonaceae): description of a narrowly endemic new species from southern Brazil, and typification of the name *Polygonum minus*

LUÍS A. FUNEZ^{1,3*} & GUSTAVO HASSEMER^{2,4}

¹Departamento de Botânica, Universidade Federal de Santa Catarina, CEP 88040-900, Florianópolis, SC, Brazil

²Universidade Federal do Mato Grosso do Sul, Câmpus de Três Lagoas, CEP 79613-000, Três Lagoas, MS, Brazil

³✉ lfunezz@gmail.com; <https://orcid.org/0000-0002-0008-1061>

⁴✉ g.hassemer@ufms.br; <https://orcid.org/0000-0003-4365-6934>

*Author for correspondence

Abstract

A new species of *Persicaria*, *P. humboldtiana*, endemic to a narrow area of waterfalls in Corupá, southern Brazil, is described in the present paper. The *locus classicus* of the new species is well-known for plant endemisms. A complete morphological description, original pictures, a distribution map, and a morphological comparison with the similar Eurasian species *P. minor* (\equiv *Polygonum minus*) are given. The name *Polygonum minus* is lecto- and epitypified on, respectively, a Morison's illustration and a specimen preserved at BM.

Key words: Caryophyllales; *Persicaria minor*; Santa Catarina; typification

Introduction

Persicaria Miller (1754: unpaginated) (Polygonaceae Juss., Persicarieae Dumort.) is a genus that includes *ca.* 150 species distributed in the North Temperate Zone of the world, the Caribbean, and South America (Brandbyge 1993). We here accept the recognition of *Persicaria* as a separate genus from *Polygonum* Linnaeus (1753: 359) according to several authors (*e.g.* Decraene & Akeroyd 1988, Hong *et al.* 1998, Decraene *et al.* 2000, Keskin & Severođlu 2020, and for molecular data, Frye & Kron 2003, Kim & Donoghue 2008, Galasso *et al.* 2009, Sanchez *et al.* 2009, 2011, Burke *et al.* 2010, Schuster *et al.* 2011). In fact, most recent studies classify these two genera as belonging to different tribes: *Persicaria* is part of tribe Persicarieae Dumort., while *Polygonum* is included in tribe Polygoneae (Decraene & Akeroyd 1988, Hong *et al.* 1998, Decraene *et al.* 2000, Kim & Donoghue 2008, Galasso *et al.* 2009, Sanchez *et al.* 2011, Schuster *et al.* 2011). Several recent contributions are presenting new combinations in *Persicaria* for the remainder of the taxa originally in *Polygonum* that still awaited formal generic transfer (*e.g.* Galasso *et al.* 2009, Akeroyd 2013, Li *et al.* 2013, Doweld 2017, Funez & Hassemer 2018), and new species are being described following the updated generic circumscription (*e.g.* Funez & Hassemer 2018). The recognition of *Persicaria* is bolstering further study of groups within the genus (*e.g.* Kong & Hong 2018a, 2018b, 2019, Mosaferi *et al.* 2018). At the same time, the circumscription of genera in the tribe Polygoneae continues to be refined, with *e.g.* the subsuming of *Polygonella* Michaux (1803b: 240–241) under *Polygonum* (Schuster *et al.* 2011), and the expansion of *Atraphaxis* Linnaeus (1753: 333), which we accept as including *Bactria* Yurtseva & Mavrodiev in Yurtseva *et al.* (2016: 42–43), *Persepolium* Yurtseva & Mavrodiev in Yurtseva *et al.* (2017: 185) and *Caelestium* Yurtseva & Mavrodiev (2019: 73), as per Tavakkoli *et al.* (2015).

The genus *Persicaria* is insufficiently studied in Brazil. Prior to the present study, there were 16 species of this genus recognised in the country (see Funez & Hassemer 2018). In Funez & Hassemer (2018), a new, hitherto overlooked species from southern Brazil was described, *viz.* *P. sylvestris* Funez & Hassemer (2018: 2–6). Conversely, the online database *Flora do Brasil 2020* (de Melo 2020) does not recognise this new species (it is indicated there as a synonym of *Polygonum acuminatum* Kunth in von Humboldt *et al.* [1818: 178]). Furthermore, de Melo (2020) does not accept the genus *Persicaria*, so that the Brazilian species of *Persicaria* are treated in the genus *Polygonum*.

We argue that insufficient floristic sampling in many areas of Brazil, in addition to the continued use of an evidently erroneous, non-monophyletic generic classification system for the Polygonaceae by the official database *Flora do Brasil 2020*, result in hindrances to the advancement of the taxonomic knowledge of *Persicaria* in Brazil.

Further field work in southern Brazil, coupled with study of herbarium specimens and nomenclatural studies has evidenced a new species of *Persicaria* from southern Brazil. In this contribution we describe this new species, which, according to the best of evidence, is endemic to a narrow area of waterfalls in Corupá, Santa Catarina state, southern Brazil. This area is well-known for plant endemisms (Hassemer & Rønsted 2016, Funez *et al.* 2020). We present a complete morphological description, field pictures, a distribution map, and we discuss the morphological affinities of the new species. The most similar species is the Eurasian *P. minor* (Huds.) Opiz (1852: 72), whose basionym (*Polygonum minus* Hudson [1762: 148]) is here typified.

Materials & Methods

We studied directly specimens kept at the ASE, C, CGMS, EFC, FI, FLOR, FT, FURB, HBR, HTL, JOI and MBM herbaria, and images of specimens were studied (from the following herbaria: B, BM, ESA, F, G, GH, HAL, K, MEXU, MO, NY, P, RB and US) (herbarium codes according to Thiers 2021 [continuously updated]). Pertinent literature were analysed and, in addition to the works cited in the Introduction, we revised further relevant literature on *Persicaria* and *Polygonum* in South America (e.g. Pilz & Pereira 1987, Cialdella 1989, Arambarri & Bayón 1995, Cialdella & Cocucci 1998, Pereira 2014, Cantero *et al.* 2017). The assessment of conservation status follows the IUCN's (2019) criteria. The distribution map was prepared using QGIS Desktop (<https://qgis.org>). Diagnoses are presented for all species treated, as per the recommendations in Hassemer *et al.* (2020). The nomenclature presented here follows the Shenzhen Code (Turland *et al.* 2018—hereafter ICN). Full references to protologues are provided in the text (as per the *Phytotaxa* guidelines), whereas standard authorship and protologue citations are provided in the taxonomic treatment. Field work was conducted in Santa Catarina state, southern Brazil, from 2008 to 2020.

Taxonomic treatment

Description of a new species from southern Brazil

Persicaria humboldtiana Funez & Hassemer, *sp. nov.*

Type:—BRAZIL. Santa Catarina: Corupá: RPPN Emilio Fiorentino Battistella, 12 January 2020, *L.A. Funez 9599* (holotype FURB! [Figure 1]).

Diagnosis:—Differs from *Persicaria minor* (Huds.) Opiz by petiolate broad-lanceolate leaves and tepals up to 1.1 mm long, with marked venation.

Description (Figure 1):—Herbs perennial. Stems 15–40 cm long, erect to ascending, usually branched near the base, rooting at basal nodes, glabrous, 0.7–1.8 mm diam., internodes 20–35 mm long. Ochrea brownish hyaline, cylindrical, 4–8 mm long, membranaceous, base inflated, margins truncate, with bristles 2–3 mm long, surface scarcely strigose, trichomes *ca.* 1 mm long, eglandular; petiole 3–6 mm long, adnate to the lower half of ochrea, antrosely pubescent; blade, broadly lanceolate, 3.3–6.5 × 1.2–2.3 cm, base long-attenuate, apex acute to acuminate, margins antrosely appressed-pubescent, adaxial and abaxial surface appressed-pubescent along midvein and glabrous on lamina. Inflorescences terminal, or also axillary, erect to apically curved, uninterrupted, 3.2–5.6 × 0.3 cm, pedunculated, peduncle to 1.4 cm long, glabrous; ochreolae 1.0–1.8 × 0.3–0.5 mm, glabrous, margins ciliate with 1–4 bristles 0.1–1.0 mm long. Pedicels ascending, *ca.* 0.5 mm long. Flowers bisexual, 2–3 per ochreate fascicle, homostylous; perianth white, not glandular-punctate, membranaceous with conspicuous venation; tepals 5, connate 1/3–1/4 of their length, obovate, 0.8–1.1 × 0.3–0.6 mm, margins entire, apex obtuse to rounded; stamens 6, included, filaments 0.6–0.7 mm long, adnate to petals at base; anthers white, elliptic to ovate, *ca.* 0.1 mm long; styles 2, *ca.* 0.5 mm long, included, connate 1/3 of its length, stigma capitate. Ovary conic, 0.6 × 0.4 mm. Fructiferous perianth greenish, 1.7–2.0 × 1.0–1.1 mm. Achenes dark brownish, trigonous, 1.8–1.9 × 0.9–1.0 mm, with an apical portion 0.2–0.3 mm long, shiny, smooth.



FIGURE 1. Field photographs of *Persicaria humboldtiana*. **A.** Habit. **B.** Flower and ochreolae in lateral view. **C.** Flower in frontal view. **D.** Ochrea and stem. **E.** Leaf blade, abaxial surface. **F.** Leaf blades, adaxial surface. **G.** Inflorescence. Photographs by L.A. Funez.

Etymology:—The specific epithet is a tribute to the German explorer, geographer and naturalist Friedrich Wilhelm Heinrich Alexander von Humboldt (1769–1859), who was originally honoured by the name Hansa Humboldt, the original name of Corupá, the Brazilian municipality where the new species, according to the best of evidence, is restricted to. The village of Hansa Humboldt was founded by German immigrants in 1897, and had its original name forcibly changed to Corupá in 1944 as part of Getúlio Vargas’ policy of persecution of the German-speaking population in Brazil.

Phenology:—Confirmed flowering and fruiting: January. This species was seen alive during the late autumn and winter, but not fertile. Thus, it is probably that species blooms along the summer and parts of spring and autumn, as most of the Brazilian species.

Distribution:—The new species is only known from the type locality, in Salto Grande waterfall, in the Emílio Fiorentino Battistella Natural Heritage Particular Reserve, in Corupá municipality, northern Santa Catarina, southern Brazil (Figure 2).

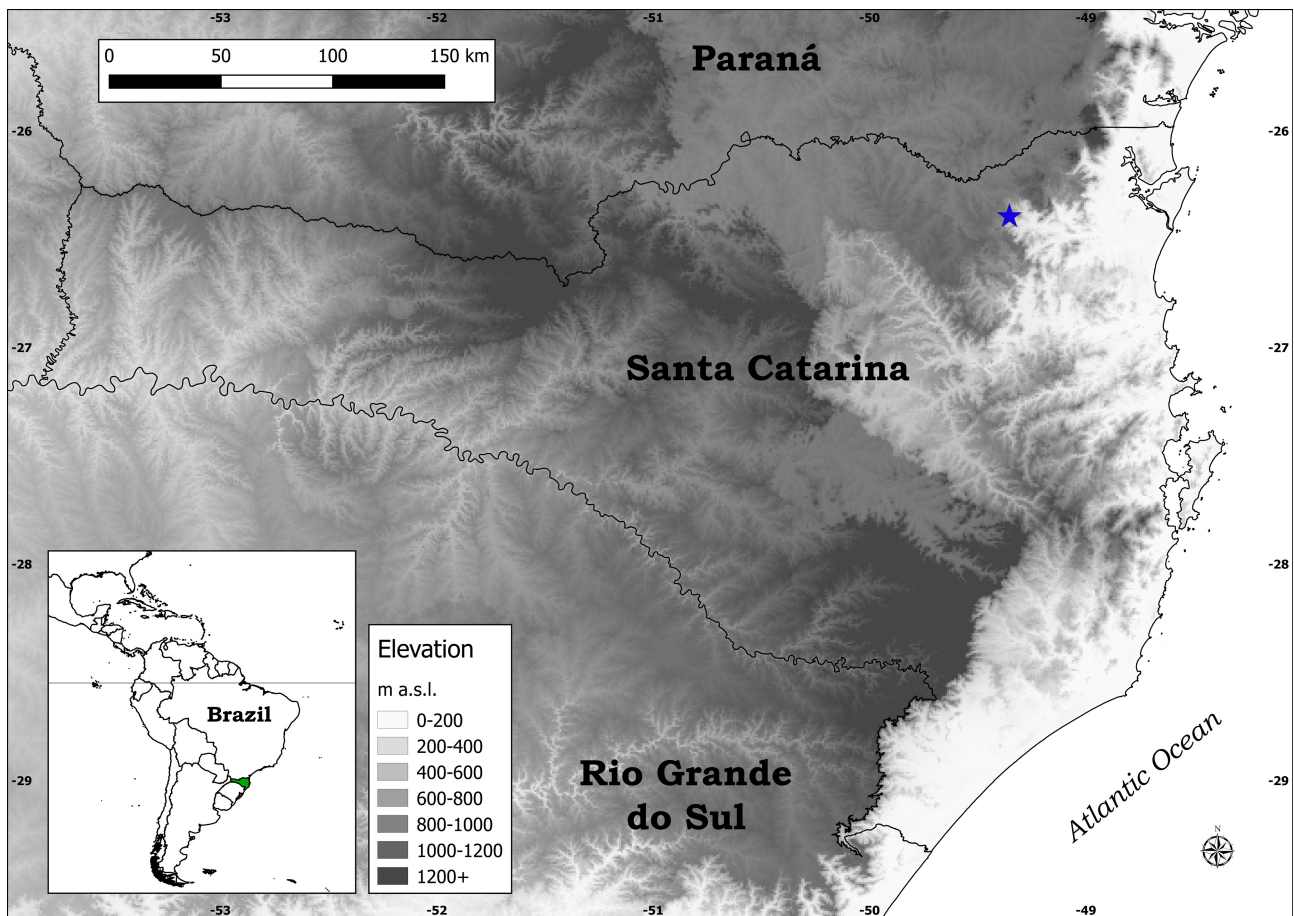


FIGURE 2. Distribution map of *Persicaria humboldtiana*.

Habitat:—*Persicaria humboldtiana* inhabits humid rocks along the riverbanks, at permanently humid spots due to constant splashing, and is susceptible (and seemingly resistant) to occasional flooding. The new species occurs in the same locality and environment as the narrowly endemics *Plantago humboldtiana* Hassemer in Hassemer & Rønsted (2016: 4–9) and *Ludwigia humboldtiana* Funez *et al.* (2020: 80–87), what demonstrates the high importance of this habitat for biodiversity conservation.

Conservation status:—*Persicaria humboldtiana* is here assessed as Critically endangered CR according to the criterion B2a,b(iii) of IUCN (2019). The area of occupancy (AOO) of less than 2 km², with only one population known. This population is located within an environmentally protected area (Emílio Fiorentino Battistella Natural Heritage Particular Reserve); nevertheless, the species unfortunately cannot be considered satisfactorily safe, because of the ongoing trend of reduction of environment protection areas in the region, due to the pressure caused by the agricultural advance in Santa Catarina state (Hassemer *et al.* 2015) and in Brazil as a whole, leading to the conversion of natural environments in agricultural and silvicultural lands.

Notes:—This species is most similar to *Persicaria minor*, a cosmopolitan species common in Eurasia and North America, with only one record in South America, in Argentina (Cialdella 1989). Despite the similarities due the small size of the vegetative and reproductive characters of both species, *P. humboldtiana* is easily differentiated due its petiolate, broadly lanceolate leaves (vs. sessile, linear lanceolate leaves in *P. minor*). Another very useful characteristic to distinguish these species is the size of the tepals, much smaller in *P. humboldtiana*, 0.8–1.1 mm long, with prominent veins (vs. 2.5–3.0 mm long, with inconspicuous venation in *P. minor*) (see Table 1).

Other species similar to *Persicaria humboldtiana* are *P. hydropiperoides* (Michaux 1803a: 239) Small (1903: 378–379, 1330), *P. maculosa* Gray (1821: 269) and *P. setacea* (Baldwin in Elliott [1817: 455]) Small (1903: 379, 1330), but the size of the tepals are conspicuously bigger than in *P. humboldtiana*; all these species has flowers with tepals longer than 2.5 mm long and sessile leaves, whereas *P. humboldtiana* tepals are 0.8–1.1 mm long and its leaves are petiolate.

TABLE 1. Morphological comparison between *Persicaria humboldtiana* and *P. minor*.

	<i>Persicaria humboldtiana</i>	<i>Persicaria minor</i>
Ochrea	4–8 mm long, membranaceous, base not inflated, margins truncate, with bristles 2–3 mm long, surface scarcely strigose, trichomes <i>ca.</i> 1 mm long, not glandular	3–10 mm, chartaceous, base not inflated, margins truncate, ciliate with bristles (0.3–)1–3(–5) mm, surface glabrous or strigose, not glandular-punctate
Petioles	conspicuously petiolate, petioles 3–6 mm long	sessile to 10–20 mm
Leaves	broadly lanceolate, 3.3–6.5 × 1.2–2.3 cm, base long-attenuate, apex acute to acuminate, margins antrorsely appressed-pubescent, adaxial and abaxial surface appressed-pubescent along midvein and glabrous on lamina, white glandular dots sometimes frequent, more visible abaxially	linear to linear-lanceolate, (1–)2.0–7.5(–10) × (0.2–)0.4–1.0(–2.3) cm, base tapered to cuneate, margins antrorsely scabrous, apex acute to acuminate, faces glabrous or sparingly strigose, especially along midveins, not glandular-punctate
Inflorescence size (mm)	3.2–5.6	3–50 × 2–4
Perianth colour	white	roseate to red, rarely white
Flowers per fascicule	2–3	3–4
Tepals	0.8–1.1 × 0.3–0.6 mm long, veins prominent	2.5–3.0 mm, veins not prominent
Number of stamens	6	5, 6 or 8
Filament length (mm)	0.6–0.7	0.5
Anther	<i>ca.</i> 0.1 mm long, white	<i>ca.</i> 0.5 mm long, yellow to pink
Styles	2, connate ½ of the length	styles 2(–3), connate at bases
Achenes	trigonous, 1.8–1.9 × 0.9–1.0 mm	biconvex or rarely 3-gonous, (1.5–)1.8–2.3(–2.7) × (1.1–)1.3–1.5(–1.8) mm

Typification of the name Polygonum minus

Persicaria minor (Huds.) Opiz, Seznam Rostlin Květeny České: 72. 1852

≡ *Polygonum minus* Huds., Fl. Angl.: 148. 1762

≡ *Peutalis minor* (Huds.) Raf., Fl. Tellur. 3: 14. 1837

Lectotype (designated here):—(illustration) figure on the lower-left (“*Persicaria minor*”) of plate 29 of section 5 in Morison (1680).

Epitype (designated here):—UNITED KINGDOM. Surrey, ditch near Ockham Court, 14 September 1935, *E.C. Wallace s.n.* (BM barcode BM001072687! [Figure 3]).

Diagnosis:—Annual, decumbent to ascending, absence of rhizomes or stolons, stems unarmed, leaves linear to linear-lanceolate, petioles not winged, not auriculate, ochreae chartaceous, brownish, the margins ciliate with bristles, inflorescences spike-like, uninterrupted, perianth 5-lobed, campanulate, perianth and peduncles eglandular, styles exserted.

Photographs:—Figure 4.



FIGURE 3. Epitype of *Polygonum minus* (E.C. Wallace s.n., BM barcode BM001072687). Copyright: Natural History Museum, London.



FIGURE 4. Field photographs of *Persicaria minor*. **A.** Inflorescence. **B.** Fertile stem. **C.** Habit (dense population). **D.** Ochrea and stem. **E.** Habit (isolate plant). Photographs by Richard V. Lansdown.

Notes:—*Persicaria minor* is a species native to Eurasia (Komarov & Grigoriev 1936, Webb & Chater 1964, Villar 1990), and naturalised in eastern North America and Argentina (Fernald 1917, Cialdella 1989). Molecular phylogenetic evidence presented by Bunawan *et al.* (2011) suggests that the current circumscription of *P. minor* is not monophyletic, so that the Southeast Asian populations referred to the species could perhaps constitute a separate entity. This very interesting question demands further studies for its resolution.

The protologue of *Polygonum minus* (Hudson 1762: 148) informed no gatherings, but gave provenance as “*Anglis*” and “*In the meadows beyond Peterborough-house, and in Tothil-fields, Westminster*”. Moreover, the protologue gave two pre-Linnean synonyms: “*Persicaria pusilla repens*”, for which “*Ger. Em. 446. Park. 857. R. Syn. 145.*” (*i.e.*, Johnson 1633, Parkinson 1640, Ray 1724) were given as references, and “*Persicaria minor*”, for which “*Bauh. pin. 101. Hib. Ox. II. s. 5. t. 29. f.*” (*i.e.*, Bauhin 1623, Morison 1680) were given as references. The following three illustrations were directly or indirectly cited, and thus comprise original material: figure on the left (“*Persicaria pusilla repens*”) on page 446 in Johnson (1633); figure on the lower-left (“*Persicaria pusilla repens*”) on page 857 in Parkinson (1640); and figure on the lower-left (“*Persicaria minor*”) of plate 29 of section 5 in Morison (1680).

No original specimens could be located for the name *P. minus*; the majority of William Hudson’s herbarium was destroyed by fire prior to his death (Fred Rumsey, pers. comm., 19 August 2020), and the remainder of his specimens are kept at BM and LINN (Lanjouw & Stafleu 1957). Thus, in accordance with Arts. 9.3 and 9.4 of the ICN, we designate here as lectotype the best among the original illustrations, *viz.* the figure on the lower-left (“*Persicaria minor*”) of plate 29 of section 5 in Morison (1680).

Illustrations alone could be insufficient for the accurate application of species names in genera with complicated taxonomy, such as is the case for *Persicaria*. In fact, Morison’s illustration is not sufficient for the unambiguous application of the name *Polygonum minus*. Therefore, in accordance with Art. 9.9 of the ICN, we designate here as epitype a complete and well-preserved specimen, *viz.* BM barcode BM001072687.

Acknowledgements

We are grateful to F. Rumsey (Natural History Museum, London) for searching for specimens and providing important information on the name *Polygonum minus*; to R. Langa for the authorisation to collect plants in the Emílio Fiorentino Battistella Natural Heritage Particular Reserve; to R.V. Lansdown (Ardeola Environmental Services & Royal Botanic Gardens, Kew) for kindly providing field photographs of *Persicaria minor* from Britain; and to anonymous reviewers for contributing to improve this work. LAF thank to CNPq/Capes/FAPs/BC-Fundo Newton/PELD nº 15/2016 and FAPESC/2018TR0928 for the scholarship granted.

References

- Akeroyd, J.R. (2013) New nomenclatural combinations in *Persicaria* (L.) Miller and a new hybrid name in *Rumex* L. (Polygonaceae). *Contribuții Botanice* 48: 15–21.
- Arambarri, A.M. & Bayón, N.D. (1995) Flora del Valle de Lerma: Polygonaceae Juss. *Aportes Botánicos de Salta Serie Flora* 3 (3): 1–53.
- Bauhin, G. (1623) *Pinax Theatri Botanici*. L. Regis, Basel, 522 pp.
- Brandbyge, J. (1993) Polygonaceae. In: Kubitzki, K., Rohwer, J.G. & Bittrich, V. (Eds.) *The Families and Genera of Vascular Plants*, vol. 2. Springer, Berlin, pp. 531–544.
- Bunawan, H., Choong, C.Y., Md-Zain, B.M., Baharum, S.N. & Noor, N.M. (2011) Molecular systematics of *Polygonum minus* Huds. based on ITS sequences. *International Journal Of Molecular Sciences* 12: 7626–7634.
<https://doi.org/10.3390/ijms12117626>
- Burke, J.M., Sanchez, A., Kron, K. & Luckow, M. (2010) Placing the woody tropical genera of Polygonaceae: a hypothesis of character evolution and phylogeny. *American Journal of Botany* 97: 1377–1390.
<https://doi.org/10.3732/ajb.1000022>
- Cantero, J.J., Núñez, C.O. & Barboza, G.E. (2017) *Persicaria capitata* (Polygonaceae) naturalizada en la República Argentina. *Darwiniana, nueva serie* 5: 138–145.
<https://doi.org/10.14522/darwiniana.2017.52.769>

- Cialdella, A.M. (1989) Revisión de las especies argentinas de *Polygonum s.l.* (Polygonaceae). *Darwiniana* 29: 179–246.
- Cialdella, A.M. & Cocucci, A.E. (1998) Polygonaceae. In: *Flora Fanerogámica Argentina*, vol. 43. Consejo Nacional de Investigaciones Científicas y Técnicas, Buenos Aires, 44 pp.
- Decraene, L.P.R. & Akeroyd, J.R. (1988) Generic limits in *Polygonum* and related genera (Polygonaceae) on the basis of floral characters. *Botanical Journal of the Linnean Society* 98: 321–371.
<https://doi.org/10.1111/j.1095-8339.1988.tb01706.x>
- Decraene, L.P.R., Hong, S.P. & Smets, E. (2000) Systematic significance of fruit morphology and anatomy in tribes Persicarieae and Polygoneae (Polygonaceae). *Botanical Journal of the Linnean Society* 134: 301–337.
<https://doi.org/10.1111/j.1095-8339.2000.tb02356.x>
- Doweld, A.B. (2017) New names in *Fallopia*, *Persicarioipollis*, *Polygonum* and *Reynoutria* (Polygonaceae), living and fossil. *Phytotaxa* 308: 66–79.
<https://doi.org/10.11646/phytotaxa.308.1.5>
- Elliott, S. (1817) *Sketch of the Botany of South-Carolina and Georgia*, part 1 (5). J.R. Schenck, Charleston, 606 pp., 6 plates.
<https://doi.org/10.5962/bhl.title.9508>
- Fernald, M.L. (1917) Contributions from the Gray Herbarium of Harvard University.—New Series, no. L. *Rhodora* 19: 133–155.
- Frye, A.S.L. & Kron, K.A. (2003) *rbcL* phylogeny and character evolution in Polygonaceae. *Systematic Botany* 28: 326–332.
<https://doi.org/10.1043/0363-6445-28.2.326>
- Funez, L.A. & Hassemer, G. (2018) Novelties in the genus *Persicaria* (Polygonaceae) in Brazil: a new species, a new combination, and a diagnostic key to all species. *Nordic Journal of Botany* 36: e01631.
<https://doi.org/10.1111/njb.01631>
- Funez, L.A., Farias, D.M., Hassemer, G. & de Gasper, A.L. (2020) *Ludwigia humboldtiana* (Onagraceae), a narrowly endemic new species from the subtropical Atlantic Forest, southern Brazil. *Phytotaxa* 470: 77–89.
<https://doi.org/10.11646/phytotaxa.470.1.3>
- Galasso, G., Banfi, E., De Mattia, F., Grassi, F., Sgorbati, S. & Labra, M. (2009) Molecular phylogeny of *Polygonum* L. s.l. (Polygonoideae, Polygonaceae), focusing on European taxa: preliminary results and systematic considerations based on *rbcL* plastidial sequence data. *Atti della Società Italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano* 150: 113–148.
- Gray, S.F. (1821) *A Natural Arrangement of British Plants*, vol. 2. Baldwin, Gradock, and Joy, London, 757 pp.
- Hassemer, G., Ferreira, P.M.A. & Trevisan, R. (2015) A review of vascular plant endemisms in Santa Catarina, southern Brazil, highlights critical knowledge gaps and urgent need of conservation efforts. *Journal of the Torrey Botanical Society* 142: 78–95.
<http://dx.doi.org/10.3159/torrey-d-14-00033.1>
- Hassemer, G. & Rønsted, N.A.H. (2016) Yet another new species from one of the best-studied neotropical areas: *Plantago humboldtiana* (Plantaginaceae), an extremely narrow endemic new species from a waterfall in southern Brazil. *PeerJ* 4: e2050.
<http://dx.doi.org/10.7717/peerj.2050>
- Hassemer, G., Prado, J. & Baldini, R.M. (2020) Diagnoses and descriptions in Plant Taxonomy: are we making proper use of them? *Taxon* 69: 1–4.
<https://doi.org/10.1002/tax.12200>
- Hong, S.P., Decraene, L.R. & Smets, E. (1998) Systematic significance of tepal surface morphology in tribes Persicarieae and Polygoneae (Polygonaceae). *Botanical Journal of the Linnean Society* 127: 91–116.
<https://doi.org/10.1111/j.1095-8339.1998.tb02091.x>
- Hudson, W. (1762) *Flora Anglica*. Printed by the author, London, 506 pp.
- von Humboldt, F.W.H.A., Bonpland, A.J.A. & Kunth, K.S. (1818) *Nova Genera et Species Plantarum*, vol 2. Librairie Grecque-Latine-Allemande, Paris, 406 pp., plates 97–192.
<https://doi.org/10.5962/bhl.title.640>
- IUCN [International Union for Conservation of Nature] (2019) *Guidelines for Using the IUCN Red List Categories and Criteria*. Version 14. IUCN, Gland, 113 pp.
- Johnson, T. (1633) *The Herball, very much enlarged and amended*. A. Islip, J. Norton & R. Whitakers, London, 1630 pp.
<https://doi.org/10.5962/bhl.title.121658>
- Kim, S.T. & Donoghue, M.J. (2008) Molecular phylogeny of *Persicaria* (Persicarieae, Polygonaceae). *Systematic Botany* 33: 77–86.
<https://doi.org/10.1600/036364408783887302>
- Keskin, M. & Severođlu, Z. (2020) The genus *Persicaria* (Polygonaceae) in Turkey with a new taxon record. *EMU Journal of Pharmaceutical Sciences* 3: 97–105.
- Komarov, V.L. & Grigoriev, Yu.S. (1936) Горец—*Polygonum*. In: Komarov, V.L. (Ed.) *Флора СССР*, vol. 5. Издательство Академии Наук СССР, Moscow and Saint Petersburg, pp. 594–701.

- Kong, M.-J. & Hong, S.-P. (2018a) Comparative achene morphology of *Persicaria* sect. *Cephalophilon* and related taxa (Polygonaceae). *Korean Journal of Plant Taxonomy* 48: 134–142.
<https://doi.org/10.11110/kjpt.2018.48.2.134>
- Kong, M.-J. & Hong, S.-P. (2018b) The taxonomic consideration of floral morphology in the *Persicaria* sect. *Cephalophilon* (Polygonaceae). *Korean Journal of Plant Taxonomy* 48: 185–194.
<https://doi.org/10.11110/kjpt.2018.48.3.185>
- Kong, M.-J. & Hong, S.-P. (2019) Leaf micromorphology of the *Persicaria* sect. *Cephalophilon* (Polygonaceae) and its systematic re-evaluation. *Phytotaxa* 391: 167–184.
<https://doi.org/10.11646/phytotaxa.391.3.1>
- Lanjouw, J. & Stafleu, F.A. (1957) *Index Herbariorum*, part II (2). International Association for Plant Taxonomy, Utrecht, 121 pp.
- Li, B., Fan, D., Lei, S. & Zhang, Z. (2013) New combinations in *Persicaria* (Polygonaceae: Persicarieae) for the Flora of China. *Phytotaxa* 91: 24–26.
<http://dx.doi.org/10.11646/phytotaxa.91.1.2>
- Linnaeus, C. (1753) *Species Plantarum*, vol. 1. L. Salvius, Stockholm, pp. 1–560.
<http://dx.doi.org/10.5962/bhl.title.669>
- de Melo, E. (2020) Polygonaceae. In: *Flora do Brasil 2020*. Jardim Botânico do Rio de Janeiro. Available from: <http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB13718> (accessed 22 December 2020)
- Michaux, A. (1803a) *Flora Boreali-Americana*, vol. 1. C. Crapelet, Paris and Straßburg, 330 pp., plates 1–29.
<https://doi.org/10.5962/bhl.title.330>
- Michaux, A. (1803b) *Flora Boreali-Americana*, vol. 2. C. Crapelet, Paris and Straßburg, 340 pp., plates 30–51.
<https://doi.org/10.5962/bhl.title.330>
- Miller, P. (1754) *The Gardeners Dictionary*, 4th ed., vol. 3. Printed for the author, London, unpaginated.
<https://doi.org/10.5962/bhl.title.79061>
- Morison, R. (1680) *Plantarum Historiæ Universalis Oxoniensis*, vol. 2. Theatro Sheldoniano, Oxford, 617 pp. + 126 plates.
- Mosaferi, S., Sheidai, M., Keshavarzi, M. & Noormohammadi, Z. (2018) Species differentiation in annual *Persicaria* based on different markers. *Acta Botanica Hungarica* 60: 401–417.
<https://doi.org/10.1556/034.60.2018.3-4.10>
- Opiz, F.M. (1852) *Seznam Rostlin Květeny České*. Fr. Řivnáce, Prague, 216 pp.
- Parkinson, J. (1640) *Theatrum Botanicum*. Th. Cotes, London, 1755 pp.
<https://doi.org/10.5962/bhl.title.152383>
- Pereira, P.E.E. (2014) *Estudo do gênero Polygonum L. (Polygonaceae) em áreas úmidas do extremo sul do Brasil*. M.Sc. dissertation. Universidade Federal do Rio Grande, Rio Grande, 63 pp.
- Pilz, A.B.F. & Pereira, A.B. (1987) *Polygonum* L. no Rio Grande do Sul. *Pesquisas, Botânica* 38: 43–71.
- Ray, J. (1724) *Synopsis Methodica Stirpium Britannicarum*, 3rd ed. W. & J. Innys, London, 482 pp.
- Sanchez, A., Schuster, T.M. & Kron, K.A. (2009) A large-scale phylogeny of Polygonaceae based on molecular data. *International Journal of Plant Sciences* 170: 1044–1055.
<https://doi.org/10.1086/605121>
- Sanchez, A., Schuster, T.M., Burke, J.M. & Kron, K.A. (2011) Taxonomy of Polygonoideae (Polygonaceae): a new tribal classification. *Taxon* 60: 151–160.
<https://doi.org/10.1002/tax.601013>
- Schuster, T.M., Reveal, J.L. & Kron, K.A. (2011) Phylogeny of Polygoneae (Polygonaceae: Polygonoideae). *Taxon* 60: 1653–1666.
<https://doi.org/10.1002/tax.606010>
- Small, J.K. (1903) *Flora of the Southeastern United States*. Published by the author, New York, 1370 pp.
<https://doi.org/10.5962/bhl.title.133>
- Tavakkoli, S., Osaloo, S.K., Mozaffarian, V. & Maassoumi, A.A. (2015) Molecular phylogeny of *Atraphaxis* and the woody *Polygonum* species (Polygonaceae): taxonomic implications based on molecular and morphological evidence. *Plant Systematics and Evolution* 301: 1157–1170.
<https://doi.org/10.1007/s00606-014-1140-7>
- Thiers, B. (2021 [continuously updated]) *Index Herbariorum: a global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. Available from: <http://sweetgum.nybg.org/science/ih> (accessed 22 December 2020)
- Turland, N.J., Wiersema, J.H., Barrie, F.R., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Kusber, W.-H., Li, D.-Z., Marhold, K., May, T.W., McNeill, J., Monro, A.M., Prado, J., Price, M.J. & Smith, G.F. (Eds.) (2018) *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017*. Regnum Vegetabile 159. Koeltz Botanical Books, Glashütten, 254 pp.

<https://doi.org/10.12705/code.2018>

- Villar, L. (1990) *Polygonum* L. In: Castroviejo, S., Lainz, M., López, G., Montserrat, P., Muñoz, F., Paiva, J. & Villar, L. (Eds.) *Flora Iberica*, vol. 2. Real Jardín Botánico, Madrid, pp. 571–586.
- Webb, D.A. & Chater, A.O. (1964) *Polygonum* L. In: Tutin, T.G., Heywood, V.H., Burges, N.A., Valentine, D.H., Walters, S.M. & Webb, D.A. (Eds.) *Flora Europaea*, vol. 1. University Press, Cambridge, pp. 76–80.
- Yurtseva, O.V., Kuznetsova, O.I., Mavrodieva, M.E. & Mavrodiev, E.V. (2016) What is *Atraphaxis* L. (Polygonaceae, Polygoneae): cryptic taxa and resolved taxonomic complexity instead of the formal lumping and the lack of morphological synapomorphies. *PeerJ* 4: e1977.
<https://doi.org/10.7717/peerj.1977>
- Yurtseva, O.V., Severova, E.E. & Mavrodiev, E.V. (2017) *Persepolium* (Polygoneae): a new genus in Polygonaceae based on conventional maximum parsimony and three-taxon statement analyses of a comprehensive morphological dataset. *Phytotaxa* 314: 151–194.
<https://doi.org/10.11646/phytotaxa.314.2.1>
- Yurtseva, O.V. & Mavrodiev, E.V. (2019) *Caelestium*, genus novum (Polygonaceae, Polygoneae): evidence based on the results of molecular phylogenetic analyses of tribe Polygoneae, established with consideration of the secondary structure of the ITS rDNA regions. *Новости Систематики Высших Растений* 50: 47–79.
<https://doi.org/10.31111/novitates/2019.50.47>