**RESEARCH ARTICLE** 



## Evolutionary relationships and taxonomy of Microtea (Microteaceae), a basal lineage in the core Caryophyllales

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#### Abstract

The basal position of the small American genus *Microtea* within the core Caryophyllales was suggested only recently in accordance with molecular phylogeny. However, the specific relationships within the genus were not traced. The results of our phylogenetic analysis based on the *mat*K chloroplast gene suggest the monophyly of *Microtea*, and *Ancistrocarpus* and other related genera should be included in it. *Microtea* is divided into two major sister clades: clade A consisting of *M. glochidiata*, *M. maypurensis* and *M. tenuifolia*, and clade B comprising *M. debilis*, *M. sulcicaulis*, *M. scabrida*, *M. celosioides*, and *M. papillosa*. The nrDNA dataset (ITS), although containing only a limited number of accessions, shows the same species number in clade A, and the remaining species studied (*M. debilis*, *M. scabrida* and *M. celosioides*) form clade B. Subgeneric status is assigned to clades A and B corresponding with the names *Microtea* subgen. *Ancistrocarpus* subgen. nov. and *Microtea* subgen. *Microtea*, respectively. The diagnostic characters at the subgeneric level are as follows: length of pedicels, number of flowers at each node, number of stamens and styles. A multivariate analysis of 13 distinguishing morphological characters supports the results of phylogenetic analysis. All species have similar pericarp and seed ultrasculpture and anatomy, and they share the reticulate pericarp surface (independent of presence or absence of finger-shaped outgrowths on its surface) and rugose or slightly alveolate seed ultrasculpture. On the basis of morphological characters, we

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accept 10 *Microtea* species. A checklist includes a new diagnostic key, morphological descriptions and distribution patterns of each species. *Galenia celosioides* is the oldest legitimate name available for the plants previously known as *Microtea paniculata*, for which the combination *Microtea celosioides* is validated here. The neotypes of *Galenia celosioides* and *Microtea sprengelii* were designated from the collections of Prinz Wied at BR. The name *M. foliosa* is discussed and finally synonymized with *M. scabrida*. The lectotypes of *Ancistrocarpus maypurensis* ( $\equiv$ *Microtea maypurensis*), *Microtea debilis* var. *ovata* (=*M. debilis*), *M. glochidiata*, *M. maypurensis* var. *angustifolia* (=*M. tenuifolia*), *M. glochidiata* f. *lanceolata* (=*M. maypurensis*), *M. congebracteata* (=*M. celosioides*), *M. paniculata* var. *latifolia* (=*M. scabrida*), *M. portoricensis*, *M. scabrida*, *M. sulcicaulis*, and *Potamophila parviflora* (=*M. maypurensis*) are designated. *Microtea sulcicaulis* is reported for the first time as native to Bolivia, and *M. maypurensis* is reported from Indonesia (Java), where it is found as an alien plant with an unclear invasion status.

#### **Keywords**

Caryophyllales, Microtea, molecular phylogeny, reproductive characters, taxonomy

#### Introduction

The genus Microtea Sw. was described by Swartz (1788) with one species, M. debilis Sw., native to the Lesser Antilles (the Caribbean). The author placed it within the group "Pentandria-Digynia" due to the pentaphyllous perianth, five stamens, and two styles. A pericarp with distinct echinate outgrowths was reported as another indicative character of Microtea (Swartz 1788). Kunth (1817) described a related genus Ancistrocarpus Kunth with the type species A. maypurensis Kunth, and he pointed out that the main differences between Microtea and Ancistrocarpus belong to the reproductive characters such as the different numbers of stamens (five vs eight, respectively) and styles (two vs four or five) and the shape of the pericarp outgrowths (echinate vs apically hooked). Further new generic and species names were mostly based on the same reproductive characters (Roemer and Schultes 1820, Schrank 1821, Link 1821), but none of the genera allied to Microtea have been commonly accepted, and currently Microtea has been considered a single genus that includes all closely related taxa (e.g., Steudel 1841, Moquin-Tandon 1849, Urban 1885, Walter 1909, Rohwer 1993, Marchioretto and de Siqueira 1998). According to the latest studies (Marchioretto and de Siqueira 1998, Hernández-Ledesma et al. 2015), Microtea comprises 10-12 species distributed in Central and South America. They can be distinguished and classified by life history, presence of bracteoles by each flower, and morphology of the pericarp (e.g., Walter 1909, Marchioretto and de Siqueira 1998). However, many important reproductive traits are still poorly studied in this genus, including the fruit and seed anatomy that has been depicted schematically only for *M. debilis* (Melikian 1993).

Traditionally, *Microtea* occupied a provisional position within the core Caryophyllales and has been considered as part of the Chenopodiaceae (Kunth 1817, Walter 1906, Takhtajan 2009), Petiveriaceae (Brown and Varadarajan 1985) or Phytolaccaceae (Moquin-Tandon 1849, Walter 1909, Hutchinson 1926, Nowicke 1968, Behnke 1993, Rohwer 1993, Atha 2004, Zhu and Sanderson 2017). Friedrich (1956) suggested that *Microtea* may be a connecting link between the Phytolaccaceae and Chenopodiaceae. Also, Behnke (1993) and Behnke and Mabry (1994) reported that the structures of sieve-element plastids and of the pollen grains deviate from those of the other Phytolaccaceae. The recently combined molecular phylogeny based on the *petD* and *matK* regions revealed a distant position of *Microtea* from both Chenopodiaceae and Phytolaccaceae (Schäferhoff et al. 2009). However, only two *Microtea* species – *M. debilis* and *M. scabrida* Urb. – were included in this molecular analysis (Schäferhoff et al. 2009). Currently, the monophyly of *Microtea* and the relationships between its species have not been confirmed.

The aims of the present paper are (1) to include more species of *Microtea* in the molecular analysis in order to clarify the relationships between the species of the genus and to confirm the monophyly of *Microtea*, (2) to provide new data on the carpological characters as the most diverse and taxonomically important traits, and (3) to provide a new taxonomic description of the genus and better determination of the range of each species.

#### Methods

Field studies and revision of the herbarium material

Field work was done by the first author (AS) in Grenada in November 2016 (Main Island, Carriacou, and Petit Martinique) and in March 2018 in the Dutch Caribbean (Curaçao); however, no *Microtea* species were found. The field investigations in Brazil were provided by Maria Salete Marchioretto. The revision of herbarium specimens was undertaken in B, BM, BR, E, G, H, K, L (incl. U & WAG), LE, LY, M, MEXU, MHA, MSB, MW, P, and PACA. The Virtual database of the Brazilian herbaria (http://reflora.jbrj.gov.br/reflora/PrincipalUC/PrincipalUC.do), National Herbarium of Colombia (http://ciencias.bogota.unal.edu.co/icn/colecciones-cientificas/herbario/) and the Tropicos database (http://tropicos.org/Name/24800059?tab=specimens) were used as references for some specimens kept in ASE, CEN, COL, FURB, GB, HUFS, NY, NYBG, RB, SJRP, and US if their identification was possible using the digital images.

#### Carpological studies

Several fruits of all species were taken from the herbaria vouchers deposited in herbaria with the permission of the curators. Seed ornamentation was examined using a scanning electron microscope (SEM) JSM–6380 (JEOL Ltd., Japan) at 15 kV after sputter coating with gold-palladium in the laboratory of Electron Microscopy at the Lomonosov Moscow State University. To restore the soft pericarp tissue prior to scanning electron microscopy, the fruits were dehydrated in aqueous ethyl alcohol solutions of increasing concentration, followed by alcohol-acetone solutions and pure acetone. The seeds did not require a complicated treatment prior to SEM due to the presence of the

hard seed coat. The cross-sections of the fruits and seeds were prepared using a rotary microtome Microm HM 355S (Thermo Fisher Scientific, USA). Before sectioning, the seeds were soaked in water:alcohol:glycerin (1:1:1) solution, dehydrated in an ethanol dilution series and embedded in Technovit 7100 resin (Heraeus Kulzer, Germany). The cross-sections were observed using a Nikon Eclipse Ci microscope and photographed with a Nikon DS-Vi1 camera (Nikon Corporation, Japan) at the Department of Higher Plants (Moscow State University).

#### Phylogenetic analysis

The list of vouchers and their accession numbers is provided in Table 1.

**Table 1.** Voucher information and GenBank accession numbers for *Microtea* species and outgroups included in the phylogenetic analysis. Sample codes are provided only for the newly sequenced samples.

Sample	Species	Voucher -	GenBank accession number			
code			matK	ITS		
Mi02	Microtea debilis	French Guiana, Eau Claire, 15 Aug 1993, <i>S. Mori et al.</i> 23295 (P05197089)	MH678599	-		
_	M. debilis	USA, California, cultivated, Yuncker et al. (UC851834)	_	JX232577		
Mi14	M. celosioides	Brazil, Bahia, Milagres, 6 Mar 1977, <i>R.M. Harley</i> <i>19451</i> (U 1473444)	MH678600	MH726167		
Mi07	M. celosioides	Brazil, Piaui, Caracol, 25 Feb 2011, <i>Melo et al. 9216</i> (PACA 115982, sub <i>M. longebracteata</i> )	MH678601	-		
Mi06	M. glochidiata	Brazil, Tucano Mun., 20 Feb 1992, A.M. de Carvalho & D.J.N. Hind 3841 (G)	MH678602	MH726168		
Mi10	M. maypurensis	Brazil, Bahia, Rio Jacurici, 16 Jan 1997, <i>M.M. Arbo et al. 7276</i> (G)	MH678603	MH726169		
Mi22	M. papillosa	Brazil, Minas Gerais, Diamantina, 11 May 1982, <i>L. Rossi et al. 76279</i> (PACA 76279)	MH678604	-		
Mi19	M. scabrida	Paraguay, Concepcion, Paso Horqueta, 18 Nov 1993, E. Zardini & T. Tilleria 37460 (MW0581802)	MH678605	-		
Mi26	M. scabrida	Paraguay, Cordillera Dept., Cerro Tobati, 28 Oct1987, <i>R. Degun &amp; E. Zardini 447</i> (G)	MH678606	MH726170		
Mi27	M. scabrida	Paraguay, Guaira, Melgarejo, 13 Mar 1989, <i>E. Zardini</i> & C. Velasquez 11391 (MW)	MH678607	MH726171		
Mi28	M. scabrida	Paraguay, National Park Ybicu'i, 11 Nov 1989, <i>E. Zardini &amp; U. Velásquez s.n.</i> (G)	MH678608	_		
Mi47	M. sulcicaulis	Paraguay, dept. Cordillera, Colonia Rosado, 26 Oct 1986, <i>A. Schinini &amp; E. Bordas 24850</i> (G)	MH678609	-		
Mi34	M. tenuifolia	Brazil, Bahia, 23 Mar 1974, <i>Belmonte 17305</i> (U1473428)	MH678610	MH726172		
Mi36	Griselinia littoralis	Switzerland, Botanical Garden of Geneva, Sep 2017, A. Konstantinova (living collection)	MH678611	MH726173		
Mi41	G. scandens	Chile, Santiago, 1925, A. Marillo 923 (LE)	MH678612	MH726174		
_	Macarthuria australis	Australia, <i>Lepschi &amp; Brims 1943</i> (K)	FN825765	_		
_	M. neocambrica	Australia, Coveny & Wilson 11674 (K)	FN825766	_		
-	Stegnosperma halimifolium	no data	HQ878442	_		
-	Simmondsia chinensis	no data	AF204863	-		

#### DNA extraction and PCR amplification

The nuclear (ITS) and chloroplast (matK) regions of genomic DNA were used for the phylogenetic analysis. Total DNA was isolated from dried leaves using Invisorb<sup>®</sup> Spin Plant Mini Kit (Stratec Molecular GmbH, Berlin, Germany). ITS-A (Blattner and Kadereit 1999) and ITS4 (White et al. 1990) primers were used for ITS region amplification, and MatK-1RKIM-f and MatK-3FKIM-r were used for matK region (http://botany.si.edu/projects/dnabarcode/matK PCR & Sequencing Protocols.pdf). PCRs were performed using 0.75 units of MyTaq Red DNA polymerase (Bioline, London, UK) in 15  $\mu$ l of original buffer containing MgCl, and dNTPs, with 0.3  $\mu$ M of each primer and 1 µl of unquantified DNA template. Thermocycling was carried out in TProfessional Basic Thermocycler (Biometra, Göttingen, Germany) using the thermal and cycling conditions as described in Shaw et al. (2007): initial denaturation at 80 °C for 5 min; 30 cycles of 95 °C for 1 min, 50 °C for 1 min, a ramp of 0.3 °C/s to 65 °C and incubation at 65 °C for 4 min, with a final extension step of 65 °C for 5 min. A clean-up reaction with exonuclease I and alkaline phosphatase (Thermo Fisher Scientific, Waltham, Massachusetts, USA) was used to remove unincorporated primers and nucleotides before sequencing. The PCR products were sent to Macrogen Europe (Netherlands) for automated sequencing. The primers used for amplification were also used for the sequencing reactions.

#### Sequence alignment and phylogenetic reconstruction

Data files were assembled, edited and evaluated using Geneious 8.1 software (Biomatters Ltd, Auckland, New Zealand). Regions of ambiguous alignment were excluded from all analyses. After exclusion of these regions we used 754 characters in the nuclear (ITS) and 828 characters in the chloroplast (*mat*K) analysis. The nuclear and chloroplast data were analyzed separately with MEGA7 software (Kumar et al. 2016) which delivered a maximum likelihood (ML) tree based on the Kimura 2-parameter model (Kimura 1980) with support for nodes measured by bootstrap percentages (N70% considered significant). The percentage of trees in which the associated taxa clustered together is shown next to the branches. Initial tree(s) for the heuristic search were obtained automatically by applying Neighbor-Join and BioNJ algorithms to a matrix of pairwise distances estimated using the Maximum Composite Likelihood (MCL) approach, and then selecting the topology with superior log likelihood value. The tree is drawn to scale, with branch lengths measured in the number of substitutions per site. Evolutionary analyses were conducted in MEGA7 (Kumar et al. 2016).

#### Multivariate analysis

Different *Microtea* species were classified by group average linkage algorithm of cluster analysis constructed on a Gower similarity matrix (Gower 1971) based on thirteen characters including general morphology (life history, pubescence, leaves) and reproductive

traits. This approach recognizes the species grouping based on similar characters, but does not provide a true phylogenetic context. The reliability of grouping was assessed at the level *p*<0.05 using SIMPROF algorithm (Clarke 1993, Clarke and Warwick 2001). Calculations were performed using PRIMER 6.1.6 statistical software (Clarke and Gorley 2006).

### Results

#### Phylogenetic analysis of matK region

The most representative phylogenetic analysis based on cpDNA (*mat*K) dataset shows the monophyly of the genus *Microtea*, which is divided into two well-supported clades (Fig. 1): clade A consisting of *M. glochidiata* + *M. maypurensis* / *M. tenuifolia*, and clade B comprising the remaining species included in the analysis (*M. debilis*, *M. celosioides*, *M. scabrida*, *M. sulcicaulis*, and *M. papillosa*). In clade B, *M. debilis* is a sister to the remaining species. The position of all *Microtea* species is considered to be close to *Macarthuria* (core Caryophyllales). Three clades – *Macarthuria*, *Stegnosperma* and *Microtea*, even if not fully represented in the trees based on different phylogenetic markers – occupy a



**Figure 1.** The phylogenetic tree from maximum likelihood analysis of *mat*K region sequences. The tree with the highest log likelihood (-2983.53) is shown. The analysis involved 18 nucleotide sequences. Codon positions included were  $1^{st}+2^{nd}+3^{rd}+N$  oncoding. There were a total of 828 positions in the final dataset.



**Figure 2.** The phylogenetic tree from maximum likelihood analysis of ITS region sequences. The tree with the highest log likelihood (-2848.78) is shown. The analysis involved 9 nucleotide sequences. There were a total of 754 positions in the final dataset.

basal position within the core Caryophyllales (Brockington et al. 2009, Schäferhoff et al. 2009, Sukhorukov et al. 2015). The tree based on the *mat*K region that includes these three basal lineages suggests the monophyly of *Microtea* (Fig. 1).

#### Phylogenetic analysis of ITS region

Based on the nrDNA tree (Fig. 2), the clade A (*M. glochidiata* + *M. maypurensis* / *M. tenuifolia*) is a sister to the clade B comprising the rest of the species studied (*M. debilis* + *M. celosioides* / *M. scabrida*) with good statistical support. However, only a limited number of species were included in the ITS dataset.

Based on both matK and ITS phylogenetic analyses, subgeneric status was assigned to two major clades: clade A (*M. glochidiata* + *M. maypurensis* / *M. tenuifolia*) represents *M.* subgen. *Ancistrocarpus* stat. nov., and clade B represents the type subgenus (*M.* subgen. *Microtea*).

#### Carpological investigations

In all the species studied the fruit is one-seeded (Fig. 3), and the pericarp surface is reticulate (Figs 4–8, A, B, E, F). The finger-shaped (echinate) outgrowths over the



**Figure 3.** Cross-section of the fruit of *Microtea glochidiata*, showing the embryo and perisperm covered by the tegmen (Brazil, Bahia, Tucano Mun., 20 Feb 1992, *A.M. de Carvalho & D.J.N. Hind 3841*, PACA). Abbreviations: P – pericarp with plumose outgrowths, T – testa of the seed coat (tegmen covers perisperm and embryo), PE – perisperm, E – embryo. Magnification – 50×.

entire fruit surface are present in almost all species (Figs 3; 4A, B; 5–6A, B, E, F; 7E, F; 8 A, B) except *M. portoricensis* (Fig. 7A–B), but they are usually scattered or even obscure in *M. tenuifolia* (Fig. 8E–F) and in some specimens of *M. celosioides* (Fig. 4E–F). In *M. glochidiata* they can reach 0.65 mm in length (Fig. 7E–F). The echinate outgrowths may be covered by large horizontal unicellular papillae (plumose outgrowths: *M. glochidiata*, Fig. 7E–F), or each outgrowth is terminated by a group of 2–4 recurved (hooked) hairs (*M. maypurensis*, Fig. 8A–B). Such plumose or hooked outgrowths clearly assist epizoochorous dispersal. Two thick styles are characteristic for the species forming clade B (*M. bahiensis*, *M. celosioides*, *M. debilis*, *M. papillosa*, *M. portoricensis*, *M. scabrida*, *M. sulcicaulis*), and those in the remainder of the genus (clade A: *M. glochidiata*, M. maypurensis, M. tenuifolia) possess three to five thin styles. The pericarp consists of several layers; the cells of the innermost layers are usually filled with tannins (Fig. 9 A, B). The pericarp outgrowths emerge from the mesophyll and consist of several prosenchymatous cell layers.

The seeds are spherical and black, with a rugose (Figs 4–8C, D, G, H) or slightly alveolate (*M. sulcicaulis*: Fig. 6D) surface, and are basally inserted on the fruit wall. The seed coat of all species consists of a thick (40–50  $\mu$ m) exotestal layer, with outer cell



**Figure 4.** Fruits and seeds of *Microtea debilis* and *M. celosioides*: **A, B** fruit of *M. debilis*, enclosed in the perianth (St. Lucia, Soufrière, 1958, *G.R. Proctor 17789*, BM000019256) **C, D** seed of *M. debilis* (Honduras, nr Cangrejal river, foothills of Ceiba, 29 Jul 1938, *T.G. Yuncker et al.* 8674, G) **E, F** fruit of *M. celosioides* (Retiro das Pedras, Brumadinho, 14 Dec 1998, *J.R. Stehmann & C.E.S. Ferreira 2399*, PACA) **G, H** seed of *M. celosioides* (Retiro das Pedras, Brumadinho, 14 Dec 1998, *J.R. Stehmann & C.E.S. Ferreira 2399*, PACA). Magnification: **A, E** – 30×, **B, F** – 100×, **C, G** – 50×, **D, H** – 300×.



Figure 5. Fruits and seeds of *Microtea papillosa* and *M. scabrida*: A, B fruit of *M. papillosa*, enclosed in the perianth (Diamantina Mun., Estrada Conselheiro Mata, 11 Apr 1982, *L. Rossi et al. 3322*, PACA)
C, D seed of *M. papillosa* (Diamantina Mun., Estrada Conselheiro Mata, 11 Apr 1982, *L. Rossi et al. 3322*, PACA)
E, F fruit of *M. scabrida*, enclosed in the perianth (Paraguay, Alto Paraná, 1909, *K. Fiebrig 5468*, M). Magnification: A, E – 30×, B, F – 100×, C, G – 50×, D, H – 300×.



**Figure 6.** Fruits and seeds of *Microtea sulcicaulis* and *M. bahiensis*: **A, B** fruit of *M. sulcicaulis*, enclosed in the perianth (Paraguay, Caazapá Dept., Tavai, 7 Dec 1988, *F. Mereles 2122*, G) **C, D** seed of *M. sulcicaulis* (Paraguay, Caazapá Dept., Tavai, 7 Dec 1988, *F. Mereles 2122*, G) **E, F** fruit of *M. bahiensis* (Brazil, Bahia state, Salvador, Dunas de Itapuã, nr Hotel Stella Maris, N from Condomínio Alamedas da Praia, 8 Jun 1993, *P. de Queiroz 3211*, PACA) **G, H** seed of *M. bahiensis* (Brazil, Bahia state, Salvador, Dunas de Itapuã, nr Hotel Stella Maris, N from Condomínio Alamedas da Praia, 8 Jun 1993, *P. de Queiroz 3211*, PACA). Magnification: **A, E** – 30×, **B, F** – 100×, **C, G** – 50×, **D, H** – 300×.



Figure 7. Fruits and seeds of *Microtea portoricensis* and *M. glochidiata*: A, B fruit of *M. portoricensis*, enclosed in the perianth (Puerto Rico, Cabo Rojo, 1864, *Grosourdy 13*, P04598159) C, D seed of *M. portoricensis* (Puerto Rico, Cabo Rojo, 1864, *Grosourdy 13*, P04598159) E, F fruit of *M. glochidiata* (Brazil, Maranhão, Barao do Grajau, 21 Jan 2012, *R.M. Harley et al. 56455*, K) G, H seed of *M. glochidiata* (Brazil, Maranhão, Barao do Grajau, 21 Jan 2012, *R.M. Harley et al. 56455*, K). Magnification: A, E – 30×, B, F – 100×, C, G – 50×, D, H – 300×.



Figure 8. Fruits and seeds of *Microtea maypurensis* and *M. tenuifolia*: A, B fruit of *M. maypurensis*, enclosed in the perianth (Bolivia, La Paz Dept., Beni river, Jul 1886, *H.H. Rusby 1379*, LE) C, D seed of *M. maypurensis* (Bolivia, La Paz Dept., Beni river, Jul 1886, *H.H. Rusby 1379*, LE) E, F fruit of *M. tenuifolia* enclosed in the perianth (Brazil, Minas Gerais, Serrra das Vertentes, Jun 1893, *A. Glaziou 20437*, B) G, H seed of *M. tenuifolia* (Brazil, Jacobina Mountains in Bahia, 1836, *Blanchet 2588*, P00798998). Magnification: A, E – 30×, B, F – 100×, C, G – 50×, D, H – 300×.



**Figure 9.** Cross-section of *Microtea glochidiata* fruit (Brazil, Bahia, Tucano Mun., 20 Feb 1992, *A.M. de Carvalho & D.J.N. Hind 3841*, PACA). **A** image of the cross-section **B** schematic representation. Abbreviations: P – pericarp; T – testa; TE – tegmen.

walls much thicker than the arch-like protoplast (Figs 3; 9), and 1–2 barely visible layers of tegmen with bar-thickenings of its cell walls. The cells of the exotesta (Fig. 9) are dark brown due to the presence of unstructured tannin-like substances, but without additional stalactite-shaped deposits (vertical or oblique depositions of tannins originating from the outer cell walls). The annular embryo occupies a peripheral position in the seed, and is located vertically. The perisperm is abundant.

All *Microtea* species share the reticulate pericarp surface (regardless of the presence or absence of echinate outgrowths) and the rugose or slightly alveolate seed surface. The fruit and seed structure of *Microtea*, namely the homocellular pericarp consisting of several layers, seed coat with much thicker testa and barely noticeable tegmen with barthickenings of the cell walls, vertical embryo position in one-seeded fruits, and abundant perisperm, is typical for the core Caryophyllales (Sukhorukov et al. 2015, 2018).

#### Diagnostic characters in Microtea and multivariate analysis

All characters discovered in *Microtea* species are summarized in Table 2.

The results of cluster analysis of the characters suggest the existence of five significantly different groups within the *Microtea*, these branches being highlighted in black colour (Fig. 10): (1) *M. glochidiata–M. maypurensis–M. tenuifolia*, (2) *M. debilis–M. portoricensis*, (3) *M. scabrida–M. sulcicaulis*, (4) *M. celosioides–M. bahiensis*, and (5)



**Figure 10.** Classification of *Microtea* species by group average linkage algorithm of cluster analysis based on 13 characters. Black branches connect significantly (P < 0.05) different groups, red branches – insignificantly different groups.

*M. papillosa*. The groups are significantly (p<0.05) distinguished on different levels of Gower's index. Clusters (2–5) correspond with clade B in the phylogenetic analysis. The most prominent distinctions are observed between three major clusters consisting of (1) *M. glochidiata*, *M. maypurensis*, *M. tenuifolia*; (2) *M. debilis–M. portoricensis*; and (3) *M. papillosa*, *M. bahiensis–M. celosioides*, *M. scabrida–M.sulcicaulis*. Cluster (1) corresponds with clade A in the phylogenetic analyses (Figs 1, 2), and this group is clearly distant from the remaining species due to character sets 4, 5, 9 and 10. Cluster (2) comprises the species without bracteoles (character 3, state 0), and cluster 3 unites the rest of the genus with the similar sets of characters 3, 4, 5, 8, 9, 10, and 12.

Table 2. Characters of *Microtea* species.

	Species/character	M. bahiensis	M. debilis	M. celosioides	M. glochidiata	M. maypurensis	M. papillosa	M. portoricensis	M. scabrida	M. sulcicaulis	M. tenuifolia
1	Life history: 0 – annual or rarely biennial; 1 – upright perennials with a taproot	1	0	0	0	0	1	0	2	1	0
	or caudex; 2 – perennial lianas										
2	Pubescence: 0 – (almost) glabrous; 1 – papillate	0	0	0	0	0	1	0	0	0	0
3	Bracteoles. 0: absent; 1: present	1	0	1	1	1	1	0	1	1	1
4	Flower arrangement. 0: solitary (inflorescence is a spike); 1: two or three in	0	0	0	1	0	0	0	0	0	0
	clusters (thyrsoid inflorescence)										
5	Presence of pedicel. 0: flowers sessile or subsessile (pedicel up to 1.3 mm); 1:	0	0	0	1	1	0	0	0	0	1
	pedicel 1.35–3.0 mm										
6	Perianth segments. 0: oblong or ovoid; 1: roundish	0	0	0	1	0	0	0	0	0	0
7	Number of perianth segments. 0: always five; 1: four or five (varying)	0	0	0	0	0	0	1	0	0	0
8	Number of stamens. 0: four or five; 1: more than five (usually seven or eight)	1	0	1	1	1	1	0	1	1	1
9	Number of stigmas. 0: two, rarely three; 1: three to five	0	0	0	1	1	0	0	0	0	1
10	Shape of stigmas. 0: thick; 1: filiform	0	0	0	1	1	0	0	0	0	1
11	Diameter of fruit body (without stigmas and outgrowths if the latter are	1	1	1	0	0	1	0	2	2	0
	present). 0: 0.9–1.1 mm; 1: 1.1–1.3 mm; 2: 1.4–2.0 mm										
12	Fruit/perianth ratio. 0: fruit longer than perianth (protruding); 1: fruit equal to	0	0	0	0	0	0	0	0	0	1
	perianth (fruit not protruding)										
13	Pericarp. 0: without any projections, reticulate; 1: with scattered, thick and	1	2	1	3	4	1	0	1	1	0
	simple outgrowths; 2: with abundant thick outgrowths; 3: with fimbriate										
	(plumose) projections; 4: with projections terminating in hooks										

### Taxonomy

### Artificial key to the Microtea species

1	Leaning or twining perennial herb up to 150 cm; leaf blades basally truncate
_	Smaller herbs or dwarf subshrubs up to 100 cm; leaves cuneate2
2	Stems decumbent; each flower supported by a bract; bracteoles not present;
	stamens 4–5; annuals with obovate leaves
_	Stems usually erect; each flower supported by a bract and two transverse brac-
	teoles; stamens 5-8; annuals or perennials with leaves not obovate4
3	Pericarp with echinate (finger-shaped) outgrowths1. M. debilis
_	Pericarp not echinate (its surface reticulate)
4(2)	Perennials or annuals with shortly but densely papillate stem and leaves
_	Perennials or annuals with glabrous stems, or with leaves papillate at margins
	and mid-ribs
5	Perennial herb or dwarf subshrub with well-expressed caudex and rosulate
	leaves; cauline leaves short (up to 2.0 cm) 6. M. bahiensis
_	Annuals or perennial herbs (in latter case without a caudex); cauline leaves
	usually larger (2.5–12.0 cm)

6	Flowers 1-6 per node; pericarp outgrowths plumose 8. M. glochidiata
_	Flowers 1(2) per node; pericarp outgrowths (if present) glabrous or hooked at
	apices7
7	Flowers 1(2) per node; pericarp outgrowths hooked at apices
_	Flowers always one per node; pericarp outgrowths (if present) not hooked8
8	Perennial herb; leaves lanceolate or narrowly oblong, usually appressed to the
	stem, stiff; fruit 1.75-2.0 mm long5. M. sulcicaulis
_	Annuals, biennials; leaves filiform to oblong, not appressed to the stem, not
	stiff; fruit less than 1.5 mm long9
9	Pedicels 1.35–1.7(2.5) mm long; fruit not protruding or slightly protruding
	from the perianth; pericarp smooth, verrucous or with barely visible out-
	growths; leaves usually filiform or lanceolate 10. M. tenuifolia
_	Pedicels up to 1 mm long; fruit twice the length of the perianth; pericarp with
	short finger-shaped outgrowths; leaves narrowly lanceolate to oblong (rarely
	ovoid)

#### Gen. Microtea Sw., Prodr. [O.P.Swartz]: 53 (1788).

Microtea debilis Sw. (type species)

- =Schollera Rohr, Skr. Naturhist.-Selsk. 2: 210 (1792), nom. illegit., non Roth (1788).
- *≡Microtea* subgen. *Schollera* (Rohr) H.Walter, Pflanzenr. (Engler) 39: 127 (1909), nom. inval. (Art. 22.2). Type species: *M. debilis* Sw. Note: Vahl (1792) established that a new generic name, *Schollera* was based on the plant that he considered conspecific with *Microtea debilis*. The type of *Schollera* Rohr is therefore that of *Microtea debilis* (Turland et al. 2018: Art. 10.2).
- =Ancistrocarpus Kunth, Nov. Gen. Sp. [quarto] 2: 186 (1817). Type species: A. maypurensis Kunth (=Microtea maypurensis (Kunth) G.Don).
- *=Potamophila* Schrank, Pl. Rar. Hort. Monac. 2: tab. 63 (1821) nom. illegit., non R.Br. (1810). Type species: *P. parviflora* Schrank (*=Microtea maypurensis* (Kunth) G.Don).
- =Ceratococca Willd. ex Roem. & Schult., Syst. Veg., ed. 15, 6: LXX (1820). Type species: C. maypurensis Humb. & Bonpl. ex Roem. & Schult. (=Microtea maypurensis (Kunth) G.Don).
- =Aphananthe Link, Enum. Hort. Berol. Alt. 1: 383 (1821), nom. rej. Type species: A. celosioides (Spreng.) Link (≡Microtea celosioides (Spreng.) Moq. ex Sennikov & Sukhor.). Note: The generic name Aphananthe Link is rejected in favour of its later homonym, Aphananthe Planch. (Cannabaceae).

**Description of the genus.** Annuals, perennial herbs, rarely dwarf subshrubs; stems angulate, glabrous or papillate; leaves alternate, sessile or pedunculate, entire, filiform to ovate or obovate, cuneate or truncate, apically mostly acuminate, a persistent leaf rosette usually present, cauline leaves resembling the rosulate leaves or much shorter;

inflorescence a spike or thyrsoid; pedicel inconspicuous or up to 3 mm long; flowers actinomorphic, bisexual, subtended by a hyaline bract and two similar bracteoles, sometimes bracteoles absent; perianth of (4)5 glabrous segments or lobes, green, white or yellowish; stamens (4)5 in alternisepalous position, or 6–8 (in both antesepalous and alternisepalous positions), anthers 0.15–0.30 mm, introrse, thecae globose, pollen grains pantoporate; ovary roundish; style not present or very short, stigmas 2–5; fruit nut-like, single-seeded, dry; pericarp projections (if present) not evident in flowering condition, pericarp at fruiting stage reticulate, mostly having finger-shaped outgrowths (emergences) that can be plumose (with additional smaller hair-like projections) or hooked at their apices; seeds spherical, black, with rugose or alveolate surface, with annular embryo located vertically and abundant perisperm.

Ten species distributed in the (sub)tropics of the Americas; two -M. *debilis* and *M. maypurensis* – are considered as aliens in the humid tropics of Africa (Cameroon) and Asia (Indonesia), respectively.

#### Taxonomic synopsis of Microtea

#### Microtea subgen. Microtea

*Microtea* subgen. *Moquinia* Nowicke in Ann. Missouri Bot. Gard. 55: 349 (1968). Type: *M. paniculata* Moq. (*M. celosioides* (Spreng.) Moq. ex Sennikov & Sukhor.).

**Description of the subgenus.** Annuals, perennial herbs or dwarf subshrubs; bracteoles present or absent; pedicels inconspicuous or very short (up to 1.3 mm long); flowers single per node (inflorescence a spike); stigmas 2(3), thick. The species are distributed across the (sub)tropical South America, in Central America and Antilles.

#### 1. M. debilis Sw., Prodr. [O.P.Swartz]: 53 (1788).

- =M. debilis Sw. var. ovata Delile ex Moq. in DC., Prodr. 13(2): 17 (1849). Lectotype (Sukhorukov, designated here): Overseas territories of France. Guadeloupe, herb. Desfontaines (P00798994!).
- =M. debilis var. rhombifolia Moq. in DC., Prodr. 13(2): 17 (1849). Holotype: [with-out locality data] "Herb. Poiret in Herb. Moquin-Tandon" (P00798997!). Note: One specimen at K contains both varieties (*M. debilis* var. ovata and *M. debilis* var. rhombifolia) mounted on one sheet and identified as such by Moquin-Tandon. It contains several plant fragments with different labels. The varieties can barely be distinguished from one another.

Lectotype. (designated by Howard and Howard 1982: 76): OVERSEAS TERRI-TORIES OF THE NETHERLANDS. St. Eustatius, *F. Masson s.n.* in Herb. Banks (BM000019252!). Note. The species was described from the West Indies, and Saint Christopher Island (also known as Saint Kitts Island, St. Kitts & Nevis) was reported as the only locality in the protologue. Although the personal herbarium of Swartz is incorporated in S, he noted for some species in his book (Swartz 1788) that in such cases he used the herbarium collections in Banks's possession (Stearn 1961, Howard and Howard 1982). The collections used by Swartz (1788) are listed in Swartz's subsequent publication, *Flora Indiae Occidentalis*, in which the original locality of *M. debilis* was stated more accurately as the island of "St. Eustathii", and "Masson" was indicated as the collector (Swartz 1797: 543). This specimen is the only element associated with the taxon by the original author, and consequently it was designated as the lectotype of the name (Howard and Howard 1982: 76). Although this was not indicated in the protologue, probably a further collection was available to Swartz by that time: a specimen of *M. debilis* collected by H. de Ponthieu (reportedly in Grenada) was acquired by Swartz from Banks and subsequently given to L.J. Montin, a Swedish collector of herbarium material, whose private herbarium became part of S along with that of Swartz himself (Lindman 1916).

**Description.** Annuals, glabrous; stems decumbent, up to 30 cm (Fig. 11A); rosulate leaves up to 9 (10–12) cm, long-petiolate, obovate or oblong, mostly persistent; cauline leaves rhombic or ovate, cuneate; inflorescence a spike (Fig. 11B); flowers sessile or very shortly pedicellate (pedicels at fruiting ~1 mm); bracteoles absent; perianth segments 5, greenish, lanceolate or oblong; stamens (4)5; stigmas 2, thick; fruit roundish, 1.1–1.25 mm long and 1.0–1.2 mm wide (Fig. 4A, B), with finger-shaped outgrowths (up to 0.4 mm long); seed ~1.0 mm, with rough surface (Fig. 4D).

**Habitat.** Sands, forest margins, or as a weed; altitudes up to 1000(1200) m a.s.l. **Distribution.** Native to American tropics (Fig. 12).



**Figure 11.** *Microtea debilis*: **A** general view of the plants (La Selva Biological Station, Costa Rica, 2001) **B** close-up of the inflorescence (La Selva Biological Station, Costa Rica, 2001). Photographs by Orlando Vargas Ramírez. See also https://sura.ots.ac.cr/florula4/find\_sp3.php?key\_species\_code=LS001515.



Figure 12. Distribution map of *Microtea debilis* in its native range.

**Specimens examined. ANTIGUA & BARBUDA:** Dimsdale, 29 Aug 1937, *H.E. Box 1005* (BM000019212); **BELIZE:** Manatee Lagoon, 1905, *M.E. Peck 42* (K); 22 mile of Stann Creek river, 250 ft, 3 July 1932, *W.A. Schipp 286* (K); Bright Lookout Bank, Sibun river, 12 Jan 1935, *P.H. Gentle 1487* (K); Toledo distr., 28 Oct 2005, *C. Whitefoord & V. Quiroz 106292* (BM000895516); **BOLIVIA:** La Paz, Upper Rio Beni, Dec 1906, *J.W. Evans 54* (BM); Rio Acre, Jan 1912, *E. Ule 9363* (G, K); Beni Dept., provinces Ballivián & Yacuma, 27 May 1985, *I. Guareco 477* (M); Beni Dept., provinces Ballivian & Yacuma, comunidad Charaton, 11 Mar 1995, *E. Rivero 293* (M); **BRAZIL:** Acre: Sena Madureira Mun., 10 Oct 1968, *G.T. Prance & al. 7958* (P05197144, U1473418); Serra do Moa, 24 Apr 1971, *G.T. Prance et al. 12403* (K); Sena Madureira to Rio Branco, 10 Oct 1968, *G.T. Prance et al. 7958* (K); Cruzeiro do Sul, 18 Nov 2001, *T.B. Croat 85419* (NY01187675 – image!); Amazonas: Barra do Rio Negro [Manaus], 1850, *R. Spruce 1078* (BM000019274, M); Mun. Boca do Acre, Rio Acre, Jan 1912, *E. Ule 9363* (L1673158); Barcelos, 9 Sep 1962, *A.P. Duarte 7284* (RB00272328 – image!); Manaus, 20 Oct 1971, *P.J.M. Maas & H. Maas 498* 

(U1473424); Manaus Mun., Rio Cuieiras, 50 km upstream, farm of Sr. Nemerio, 2 Apr 1974, J.C. Ongley & J.F. Ramos P21790 (K, U1473416); Rio Mapari, ca 30 km E of Borba, 24 Jun 1983, C. Todzia et al. 2246 (K); Maués Mun., ca. 20 km E of Maués, 23 Jul 1983, S.R. Hill 13146 (K); Maranhão: Rio Perizes, 12 Dec 1976, B.G.S. Ribeiro & G.S. Pinheiro 1752 (IAN154119 - image!); Parà: 1908, C.F. Baker 29 (K, M); Rio Tapajos, 29 Feb 1920, anonym 14684 (RB00272338 - image!); Belém, 10 Nov 1942, W.A. Archer 7794 (K); Pernambuco: Aliança, Rio Branco, Apr 1913, J.G. Kuhlmann 3139 (RB00272342 - image!); Rio Grande do Sul: Porto Alegre, Jan 1898, Reinedly s.n. (E). Note: The isolated record from Rio Grande do Sul may be locally alien, since the specimen was collected near the port. COLOMBIA: Cundinamarca Dept.: Bogotá, 1851–1857, J. Triana 5260 (P04598044); Guainía Dept.: Rio Negro, San Felipe, 28 Sep1921, Ph.v. Luetzelburg 22249 (M); Magdalena Dept.: Santa Marta, 1898-1901, H.H. Smith 1246 (BM000019264, G, E, K, L1673160, LE, P04598033); Antioquia Dept.: Vuelta de Acuña, 14 Jan 1918, F.W. Pennell 3815 (K); Bolivar Dept.: nr Turbaco, 9 Nov 1926, E.P. Killip & A.C. Smith 14359 (LE); Amazonas Dept.: Rio Putumayo, Sep/Oct 1930, G. Klug 1647 (BM000019246, K); Rio Igara Paraná, Puerto Buenaventura, 12 Oct 1973, C. Sastre 2484 (P04448856); Santander Dept.: Puerto Berrio, 6 Jun 1935, O. Haught 1752 (BR, BM000019237); nr Barrancabermeja, 5 Mar 1967, J. de Bruijin 1593 (WAG1166513); Tolima Dept.: San Sebastián de Mariquita, 25 Sep 2001, G.C. Bernal et al. 1096 (COL000007803 - image!); COSTA RICA: Talamanca, Mar 1894, A. Tonduz 8712 (BM000019277, P03321182); Sipurio, Apr 1894, H. Pittier & Th. Durand 8712 (M, P04598123); Alajuela prov., Los Chiles, 4 Aug 1949, R.W. Holm & H.H. Iltis 933 (G, P04598124); Limón prov., Cordillera de Talamanca, 9°40'25"N, 83°01'35"W, 24 Feb 1989, G. Herrera 2439 (BM000019239); DOMINICA: 1838, Murray 344 (K); Oct 1881, H. Eggers 563 (BR, G, L1673154, LE, LY, M, P04597992); Dubuc, 21 Jul 1983, Assi & Portecop 16503 (P06806988); St. Patrick, 8 Feb 1986, C. Whitefoord 5386 (BM000019281); DOMINICAN REPUB-LIC: Higüey, Nov 1946, R.A. Howard & E.S. Howard 9731 (P04598162); ECUA-**DOR: Esmeraldas prov.**: Timbre, 2 Jun 1955, *E. Asplund 16558* (B, G, K, P04598007); Guayas prov.: Balao, [without date] Hamilton 373 (K, BM000019242); Balao, Dec 1891, Eggers 14122 (B); Guayaquil, 1846–1849, W. Jameson 373 (BM); nr Naranjito, Jun 1945, W.H. Camp 3575 (P04598008); Los Ríos prov.: Clementina on Rio Pita, 12 Mar 1939, E. Asplund 5253 (BR, G, K, P04598009); Manabi prov.: El Recreo, 1897, H. Eggers 14927 (LE); Naranjapata, 21 Nov 1933, H.J.F. Schimpff 505 (G, M); Napo prov.: Puerto Misahualli, May 1983, W. Palacios et al. 366 (K); FRENCH GUI-ANA: St Georges, 14 May 1983, M.F. Prévost 1356 (P04598030); Eau Claire, 3°37'N, 53°12'W, 15 Aug 1993, S. Mori et al. 23295 (P05197089); Elahé, Abati Ti Wan, 6 Mar 1999, M. Pignal 927 (P00176753); Cayenne, 15 May 1999, M.-F. Prévost 3657 (P5197094, U1473414); GRENADA [Main Island]: 1844, J. Goudots.n. (P04598036); Victoria [city], 20 Nov 1957, G.R. Proctor 17140 (BM000019255); St. George's, 11 May 1905, Broadway 4366 (BR); GUADELOUPE (selected specimens): see type of M. debilis var. ovata; [without exact location and date] Bertero, herb. J. Gay 1820 (K); [without exact location and date] coll. Bertero s.n. [herb. De Candolle] (G00676754);

[without exact location] 1907, P. Duss 41 (LY); Rivage de Capesterre, 1 Apr 1943, Ouestel 5064 (P04597987); GUATEMALA: Izabal, Aug 1870, G. Bernoulli 877 (G. K); GUYANA (selected specimens): [without location] 1868, Schomburgk 229 (BR, L1673157, P04598083); Mazaruni river, Sep 1880, G.S. Jenman 748 (K); Mazaruni river, Aug 1889, Jenman 5277 (BM000019244, K); Rockstone, Sep 1905, A. W. Bartlett 8559 (K); Aruka, NW district, Nov 1915, C.K. Bancroft & N. Persaud s.n. (K); Tumatumari village, Jun 1921, H.A. Gleason 18 (K); Amakura river, Northwest district, 8°10'N, 60°W, Mar 1923, J.S. de la Cruz 3548 (K); Pomeroon district, Moruka river, Jul 1927, J.S. de la Cruz 4601 (K); Cuyuni river, near Lower Camaria landing, 23 Nov 1929, N.Y. Sadwith 666 (K); Mabaruma compound, 11 Jul 1934, W.A. Archer 2256 (K); Waranama ranch, intermediate Savannahs, Berbice river, 9 Jun 1958, Harrison 1073 (K); Potaro river, near Amatuk, 2000 ft, 10 Sep 1959, B.A. Whitton 344 (K); [West Demerara Region] Essequibo, Henrietta, 4 Feb 1960, J.A. Harris 143 (MHA); Royal Island, 5 May 1985, C. Feuillet 2181 (B, P04598031); Cuyuni-Mazaruni Region, near Eping river, 5°58'N, 60°13'W, 396 m, 10 Feb 1991, T. McDowell 3985 (K, U1473392); Pomeroon-Supenaam Region, Kabakaburi river, 8 Sep 1992, B. Hofmann & L. Roberts 2443 (U1473417); Rupununi distr., Manari, 2 Aug 1995, M.J. Jansen-Jacobs et al. 4733 (U1473413); North-West distr., Moruka river, 9 Oct 1997, T. van Andel 1959 (U1473415); HAITI: Ile La Tortue [Tortuga Island], La Vallée, 21 May 1925, E.L. Ekman 4063 (G, K); HONDURAS: Roatan Island, Aug 1886, G.F. Gaumer 27 (K); Santa Barbara Dept., San Pedro Sula, May 1888, C. Thieme 5427 (K); nr Cangrejal river, foothills of Ceiba, 29 Jul 1938, T.G. Yuncker et al. 8674 (BM00019283, G,K); Gracias a Dios dept., Cocobila, 10 Feb 1981, G.R. Proctor 38968 (BM000019258); Gracias a Dios dept., Rio Platano Biosphere Reserve, 30 May 1985, S.G. Knees 2821 (BM000019248); Atlántida, La Ceiba, 26 Sep 1991, M. Chorley 439 (BM); Gracias a Dios dept., Tawahka Asangni Biosphere Reserve, 1994, P. House 99 (BM000833935); JAMAICA: Negril, 9 Mar 1908, W. Harris 10214 (BM000019231, K, P04598156); MARTINIQUE: [year] 1833, Sieber 93 (BM000019251, BR, G, M, P04597991); [without exact location] 1839, *Rivoire s.n.* (P04597989); [without exact location] 1868-1869, Hahn 1026 (B); nr St Pierre, Jun 1879, Cosson 811 (K); June 1913, M. Mouret 128 (P04597990); Tivoli, 12 Dec 1944, H. Stehle 5552 (U1473388); MONT-SERRAT: Plymouth, 5 Feb 1959, G.R. Proctor 19021 (BM000019257); NETHER-LANDS ANTILLES: St. Eustatius Island, [without exact location] 1908, I. Boldingh 89 (U1473381); Saba Island, Bottom city, 29 Aug 1947, F. Arnoldo 892 (U1473385); St. Martin: Filipsburg to Belvedere, 18 Aug 1908, I. Boldingh 2588 (U1473387); NIC-ARAGUA: Omotepe Island, Oct 1869, P. Lévy 241 (G, P04598125); Puerto Cabezas, 5 Oct 1978, W.D. Stevens 10563 (MO-20480120 - image!); Wiwili Mun., 20 Jan 2006, I. Coronado et al. 30888 (MEXU); PANAMÁ: Isthmus of Panama, Feb 1850, A. Fendler 109 (K); [no exact location] Jul 1861, J. Hayn 196 (BM000019238, K); Isla Brava, 8 Jun 1909, E. André 350 (K); El Real, 16 Jun 1959, W.L. Stern et al. 621 (LE); Fort San Lorenzo, 17 Dec 1966, D. Burch et al. 1025 (K); Ailigandi, 8 Oct 1978, B. Hammel 5041 (MEXU); PERU: Huánuco Region: Prov. Pachitea, Dept. Huanuco, Bosque National de Iparia, 6 Dec 1966, J. Schunke 1322 (G); Panguana, Nov/Dec

2008, G. Gerlach 136 (M); Puno Region: [San] Gaban, Aug 1854, R.F. Hohenacker 2443 (G, M); Loreto Region: Maucallacta, Rio Paranapura, Jan 1935, G. Klug 3959 (BM000019247, K); Loreto prov., 30 Oct 1940, E. Asplund 14151 (G, K); Loreto dept., Rio Nanya, 7 Aug 1972, T.B. Croat 18874 (E); Dept. Iquitos, Maynas, 19 May 1986, M. Rimachi 8194 (BR); San Martín Region: Prov. Mariscal Cáceres, Dept. Tocache Nuevo, 6 Nov 1969, J. Schunke 3585 (G); PUERTO RICO: nr Dorado, Mar 1922, N.L. Britton et al. 6650 (NY00992870 - image!); Yabacoa, 11 Oct 1968, R.J. Wagner 1687 (U1473389); Mun. de Patillas, 15 May 1988, C.M. Taylor & J. Druitt 8097 (NY00992874 - image!); ST. KITTS & NEVIS: St. Kitts, nr Canada Estate, Sep/ Oct 1901, N.L. Britton & J.F. Cowell 275 (NY01509872 - image!); ST. LUCIA: St Lucia, Jun 1879, H.B. Murray s.n. (K); Soufrière, 1958, G.R. Proctor 17789 (BM000019256); Anse Mamin, 21 Nov 1938, H.E. Box 1999 (BM); ST. VINCENT & GRENADINES: St. Vincent [Island], 1822, L. Guilding s.n. (K); St. Vincent Island, 1826, Lambert s.n. (BR); [St. Vincent Island] pastures at Petit Bordell estate, 14 Oct 1949, I. Velez 3341 (K); St. Vincent Island, [without date and collector] 178 (BM000019219); SURINAME (selected specimens): 1843, Hostmann s.n. (K); Paramaribo, 1851, Wullschlaegel 445 (BR); Groningen, 10 May 1916, J.A. Samuels 115 (K, L1673164, P04598019); Corantijnpolder nr Nieuw Nickerie, 27 Aug 1933, J. Lanjouw 634 (K); Landsboerderij, 11 Feb 1955, J.C. Lindeman 521 (U1473398); Zuid river, 3°20'N, 56°49'W, 30 Sep 1963, H.S. Irwin et al. 57701 (M, P04598018); distr. Suriname, Kalpoeweg, 13 Apr 1981, Ch. Kalpoe 16588 (U1473404); Marowijne, Bigiston, 13 Apr 2006, T.R. van Andel & L. McIntosh 5180 (L0842725); TRINIDAD & TOBAGO (selected specimens): Trinidad [Island], 1826, Sieber 134 (L1673148, LE, M, P04598179); Tobago [Island], Nov 1889, H. Eggers 5826 (P04597985); Tobago, Roxborough, 16 Oct 1912, W.E. Broadway 4642 (G, K); Tobago, 15 May 1913, anonym s.n. (P04597986); Trinidad, Imperial College of Tropical Agriculture [St Augustine], New Farm, 80 ft, 20 Feb 1958, J.W. Purseglove 6112 (K); Trinidad, Curepe, 8 miles E of Port-of-Spain, 25 May 1975, A. Raynal 15549 (K); Tobago, Castara, 18 Jul 1910, W.R. Broadway 4068 (E); VENEZUELA (selected specimens): Amazonas: Dept. Casiquiare, Maroa, 25 Aug 1978, O. Huber 2571 (K); Alto Orinoco Mun., 1 May 2005, A. Fernández et al. 21234 (NYBG03142590 - image!); Aragua State: Maracay, [without date] P.C. Vogl 20 (BR, M); Barinas State: Barinas to San Cristobal, 13 Mar 1964, F.J. Breteler 3692 (WAG1166512); Capital District: Caracas, 1864, Grosourdy 19 (P04598045); Cordillera de la Costa, 19 Aug 2000, W. Meier et al. 7418 (M); Cordillera de la Costa, 1 May 2002, W. Meier et al. 8153 (G); Carabobo State: Companero, 1843, J. Linden 1338 (LE, P04598050); San Esteban, 1893-1894, Mocquerys s.n. (H1332163); Chirgua, 700 m, 1 Jan 1939, A.H.G. Alston 5960 (BM000019204, LE, U1473454); Distr. Bejuma, 16 Apr 2000, W. Meier & N. Flauger 6878 (G); Delta Amacuro State: Delta of Orinoco, San Antonio, 16 Feb 1911, F.E. Bond et al. 140 (K); Falcón State: Rio Tucuyo, 26 Jan 1966, J.A. Steyermark & A. Braun 94504 (M); Mérida State: El Vigia, [without date] Mocquerys 981 (P05197141); Monagas State: Lower Orinoco, Sacupana, Apr 1896, H.H. Rusby & R.W. Squires 77 (E, G, K, M); Sucre State: Cumaná, 1893–1894, Mocquerys 814 (K, P04598035); Trujillo State:



Figure 13. Records of Microtea debilis as an alien plant in Africa.

Trujillo city, 22 May 1971, *C. Emilin & B. de Rojas 964* (U1473456); **Vargas State:** road from La Suagra to Macuto, Apr 1854, *anonym s.n.* (K); **Yaracuy State:** Chivacoa, 6 Mar 2004, *W. Meier & S. Nehlin 10101* (G); San Felipe distr., 23 Mar 2004, *W. Meier & J.L. Escalona 10219* (B 10 0455316); **Zulia State:** Maracaibo, 1826, *Plée s.n.* (P04598048); [without exact location] 1893–1894, *Mocquerys 931* (P04598034); **VIRGIN ISLANDS** (US): St Croix, Jolly Hill, 20 Jan 1906, *C. Raunkier s.n.* (BR, P04598163); St. Thomas, Charlotte Amalie, 9 Feb 1913, *N.L. Britton et al. 470* (NYBG01509850 – image!); Note: Data were not available on the presence of the species in Cuba, in agreement with the recent treatment of *Microtea* in this country (Greuter 2002). As alien found in tropical Africa (Bamps 1974; see also Fig. 13): **CAME-ROON**: Douala, sea shore, Oct 1938, *H. Jacques-Félix 2203* (P04621264); Douala, 50 m, 21 Mar 1967, *A. Meurillon 661* (K); Douala, 8 Oct 1969, *anonym 1721* (P04621263, WAG1166511); West province, Moliwe, 3 miles N of Victoria, 400 ft, 16 Aug 1969, *H. Chuml 301* (K); South-West Province, NE of Muyuka, at foot of Cameroon Mt., 26 Aug 1983, *D. Thomas 2538* (K, P05156267, P05156282, WAG1166510).

# **2.** *M. celosioides* (Spreng.) Moq. ex Sennikov & Sukhor., comb. nov. urn:lsid:ipni.org:names:77193071-1

≡Galenia celosioides Spreng., Nov. Prov.: 18 (1818). ≡Aphananthe celosioides (Spreng.) Link, Enum. Hort. Berol. Alt. 1: 383 (1821). Neotype (designated here by Sennikov & Sukhorukov): BRAZIL. Bahia, Mucuri, März [March] 1816, Maximilian, Prinz zu Wied 53 (BR0000005575398! Fig. 14). Notes. Although Galenia celosioides was synonymized with Microtea maypurensis (Moquin-Tandon 1849,

Schmidt 1872, Walter 1909, Nowicke 1968) or M. debilis (Steudel 1841), the protologue (Sprengel 1818) contains the phrases "flosculi ... brevissime pedicellati... styli duo" [flowers very shortly pedicellate, styles two], the characters found in M. celosioides. The description did not include reference to the presence of hooked outgrowths, a peculiar feature of *M. maypurensis*, and the short pedicels and two styles also exclude this species. Nevertheless, Moquin-Tandon (1849) reported his former intention to transfer Sprengel's name to Microtea, apparently on the basis of his analysis of its protologue. He changed his mind probably because he did not examine the original material of the name. Galenia celosioides was introduced anonymously to the Berlin Botanical Garden, from which it was described as new to science by the end of 1818 (Sprengel 1818). Although the source of introduction was not recorded, among European plant collectors in Brazil it was only Alexander Philipp Maximilian, Prince of Wied-Neuwied (1782-1867), who collected specimens early enough to bring the material to Berlin before the protologue of G. celosioides had been published. Prince Maximilian travelled in Brazil during 1815–1817, in the States of Rio de Janeiro, Bahia and Espírito Santo, mostly along the coast. He left for Europe in May 1817 and arrived at Lisbon on 1st July. Very shortly after the arrival he started to distribute dried specimens, seeds and even living collections which he donated to botanical experts and gardens in Germany and Belgium. Large amounts of seeds were sent to Ghent, Antwerp and Enghien, but it is unknown which seeds were sent to Germany (Moraes 2009). A herbarium voucher of *M. paniculata* numbered 53 by C.G.D. Nees von Esenbeck, a German botanist who received a large set of specimens from Prince Maximilian for collaborative work, can be found in the Nees herbarium at BR. This number was cited by Walter (1909) as referable to *M. paniculata* (specimen destroyed at B). Along with the characters stated in the protologue of G. celosioides, this fact provides indirect evidence that Prince Maximilian's collections were the likely source of the introduction of G. celosioides to the Botanical Garden in Berlin. There are no specimens of the original material of *G. celosioides* in existence, which probably was acquired by B and then destroyed (Stafleu and Cowan 1985). Since the characters of the Prince Maximilian's specimen at BR are in good agreement with the protologue of G. *celosioides*, we designate this specimen as a neotype of the species name. This name is therefore the earliest one available for the species also known as *M. paniculata*.

- *M. paniculata* Moq. in DC., Prodr. 13(2): 18 (1849), **syn. nov.** Lectotype (designated by Nowicke 1968: 350): BRAZIL. Bahia, "Serra Jacobina" [Villa do Barra, according to Moquin-Tandon (1849)], [1837], *Blanchet 2709* (K000601204! isolectotype P00743956!).
- *M. longebracteata* H.Walter, Pflanzenr. (Engler) 39: 129 (1909), syn. nov. Lectotype (Sennikov & Sukhorukov, designated here): BRAZIL. Prov. Bahia, zwischen den Campos und Vittoria, [1815], *Sellow 359* (B 10 0250568! isolectotypes B 10 0250569! B 10 0250570!). Note: The main character distinguishing *M. longebracteata* from *M. paniculata* is the length of the bracts that is equal to those of the flowers (Walter 1909). However, the length of the bracts in both taxa is equal to that of the flower buds, and the length of fully opened flowers is greater than the length of the subtending bract.



Figure 14. Neotype of *Galenia celosioides* (BR0000005575398).

**Description.** Annuals or biennials; stems erect, up to 100 cm; leaves petiolate (petioles up to 2.0 cm), blades 3.0-10.0(12.0) cm long, 0.2-2.0 cm wide, cuneate, lanceolate to oblong, rarely ovate, glabrous or their margins and mid-rib below covered with papillae; inflorescence a spike, long and spreading, whip-like; flowers with a bract and two filiform bracteoles (often not well-visible), bracts longer than flowers at the beginning, then equal to the perianth segments; pedicels up to 1.0 mm at fruiting, perianth segments 5, oblong or ovoid; stamens 5–8; stigmas 2, thick; fruit with scattered short outgrowths, fruit body  $(1.0)1.1-1.4 \times 0.9-1.1$  mm, 1.5-2 times as long as the perianth (Fig. 4E, F); pericarp readily scraped off the seed; seed ~1.0 mm, with rough surface (Fig. 4H).

Habitat. Forest margins, roadsides, river banks, on sandy and rocky substrates; altitudes up to 1000 m a.s.l.

Distribution. (Fig. 15) Eastern South America.

**Specimens examined. BRAZIL** (selected specimens): **Alagoas:** Maceió, 4 Sep 1987, *S. Tsugaru & Y. Sano B-1470* (NYBG01014516 – image!); **Bahia**: Gloria Mun., Barra do Tarrachil, 17 Jul 1962, *G. Eiten & L. T. Eiten 4966* (K); Victoria da Conquista, 17 Jan 1965, *E. Pereira & G. Pabst 34875* (M); Rio Cumbuca, Mucugê, 4 Feb 1974, *R.M. Harley 15971* (K, P04598066, U1473440); Serra de Itiuba, Itiuba, 19 Feb 1974, *R.M. Harley 16204* 



Figure 15. Distribution map of Microtea celosioides.

(P04598067, U1473439); Milagres, 6 Mar 1977, R.M. Harley 19451 (U1473444); Morro do Chapéu Mun., 980 m, 1 Jun 1980, R.M. Harley 22970 (E, K, U1473442); Cachoeira do ferro Doido, Morro do Chapéu, 30 Nov 1980, A. Furlan & al. s.n. (PACA 76292); Ceará: Cedro, May 1933, Ph. von Luetzelburg 26522 (M); Jaguaribe Mun., Maciço do Pereiro, 12 Apr 2011, A.M. Miranda & K. Manso 6327 (HUEFS178925 - image!); Distr. Federal: Brasilia, 27 Oct 1965, H.S. Irwin et al. 9600 (LE); Paranoá, 13 Dec 1965, H.S. Irwin & al. 11258 (IAN122990 - image!); Espírito Santo: Linhares, 20 Apr 2011, J. Meirelles et al. 624 (HUEFS193997 - image!); Goiás: Serra Dourada, 19 Jan 1966, H.S. Irwin & al. 11812 (NYBG00864091 - image!); Maranhão: Loreto Mun., Loreto city, 11 Feb 1970, G. Eiten & L.T. Eiten 10581 (K); Carolina Mun., Rodovia, 24 Apr 2008, G. Pereira-Silva et al. 13260 (CEN00091428 - image!); Mato Grosso: Barra do Garças, 17 Jun 1966, D.R. Hunt 6050 (K); Vale dos Sonhos, Barra do Garças Mun., 93 km S of Xavantina, 9 Nov 1968, R.M. Harley & al. 10980 (K); Mato Grosso do Sul: Estrada Forte Coimbra, Lagoa do Jacadigo, Corumbá, 1 May 1989, A. Pott et al. 4744 (PACA); Faz. Retirinho, Aquiduana, 23 Nov 1989, A. Pott et al. 5433 (PACA); Maracaju Mun., Serra de Maracaju, 12 Nov 1993, G. Hatschbach et al. 58937 (H1679509, K); Minas Gerais: Serra de Belo Horizonte, Belo Horizonte, 10 Feb 1927, W. Hoehne s.n. (PACA 76836); Diamantina, 3 Jun 1955, E. Pereira 1680 (PACA); Estrada Diamantina-Milho Verde, 33 km from Diamantina, 3 Dec 1981, N. Hensold et al. s.n. (PACA 76282); Caeté Mun., Serra da Piedade, 10 Jan 1982, N. Hensold et al. s.n. (PACA 76294); Subida ao Pico do Itambé, Santo Antonio do Itambé, 5 Apr 1982, A. Furlan et al. s.n. (PACA 76296); Tiradentes, 6 Jun 1984 (PACA 76835); São Thomé das Letras, 30 Oct 1984, I. Cordeiro et al. s.n. (PACA 76291); Serra do Cabral, Joaquim Felício, 21 Nov 1984, R.M. Harley et al. s.n. (PACA 76295); N of Grão Mogol, 27 Nov 1984, R.M. Harley et al. s.n. (PACA 76283); Estrada Serra-Diamantina, Trinta Réis, 27 Jan 1986, N.L. Monezes et al. s.n. (PACA 76284); Itacambira, Rodovia to Juramento, 14 Feb 1988, J.R. Pirani et al. 2272 (PACA); Caeté Mun., Morro da Piedade, Serra da Moenda, 24 Apr 1990, J.A. Paula & S.B. Velten s.n. (PACA 76847); Pico de Itabirito, Itabirito, 21 May 1994, W.A. Teixeira s.n. (PACA 76841); Retiro das Pedras, Brumadinho, 14 Dec 1998, J. R. Stehmann & C.E.S. Ferreira 2399 (PACA); Faz. Santana, Salto da Divisa, 21 Aug 2003, J.A. Lombardi et al. 5333 (PACA); Vilarejo do Funil, Rio Preto, 21 May 2004, F.R.G. Salimena et al. 1284 (PACA); Parque Estadual de Grão Mogol, Grão Mogol, 13 Jun 2006, C.V. Vidal 187 (PACA); Lima Duarte, 20 Nov 2006, F.M. Ferreira et al. 1139 (K); Santana do Riacho Mun., Cachoeira Véu de Noiva, 15 Mar 2007, M.S. Marchioretto 353 (PACA); Serra de Antônio Pereira, Samarco, Ouro Preto, 4 May 2007, M. Messias et al. 1296 (PACA); Serra do Lenheiro, São João Del Rei, 25 Dec 2012, M. Sobral 15294 (PACA); Paraíba: Paraiba do Norte, Serra Borborema, 20 Mar 1913, Ph. v. Luetzelburg 12490 (M); Varzea, 23 Mar 1936, Luetzelburg 27000 (M); Areia, 17 Jun 1953, J.C. de Moraes 973 (IAN082599 - image!); Alagoa Nova Mun., Brejo Paraibano Reg., 5 Mar 2012, E. Melo et al. 10917 (PACA); Pernambuco: Floresta, 26 Aug 1994, M. Sales 319 (K); Buíque, 20 May 1995, K. Andrade et al. 62 (K); Piaui: São Raimundo Nonato, 1 May 1978, E. Laure 195 (P06806987); Serra Branca, São Raimundo Nonato, 7 Feb 1986, L. Emperaire 2817 (P05197106); São Joao do Piaui Mun., Porfirio,

Aug 1995, F.G. Alcoforado Folho 480 (K); Caracol, 25 Feb 2011, Melo et al. 9216 (PACA 115982) as M. longebracteata; Caracol Mun., Serra das Confusões, Serra Grande, 18 Jul 2011, A.A. Conceição et al. 4037 (PACA); Rio de Janeiro: Rio de Janeiro [city], 1879, A. Glaziou 11440 (LE); Guanabara, 7 Feb 1964, W. Hoehne 5581 (P05197105); Corcovado, 5 Feb 1940, B. Rambo 3581 (PACA); Próximo de Recreio dos Bandeirantes, Guanabara, 4 Apr 1964, W. Hoehne 5708 (PACA); Est. da Guanabara, Pedra de Estauna, 31 Jan 1965, Newton Santos 5409 (M); Rio Grande do Norte: Grossos, Salina Salmar, 27 Jun 2007, A.A. Roque 137 (UFRN00004903 - image!); Nísia Floresta, Sete Lagoas, 18 Aug 2016, V.F. Sousa 456 (UFRN00022373 - image!); Sergipe: Canindé de São Francisco, 9 Sep 2014, K.M. Pimenta 589 (RB00956693 - image!); Pirambú Mun., [without date] M. Ramos & E. Santos 98 (ASE0017438 - image!); Tocantins: Goias, Araguaina, 9 Mar 1982, A. Krapovickas et al. 37841 (G); Rodovia, 1 Feb 2012, R.M. Harley et al. 56656 (K); PARAGUAY: Valenzuela, 18 Mar 1884, B. Balansa 4571 (B, P04598095); Tobati, [without date] E. Hassler 3981 (P03321381); Dept. Cordillera, Cordillera de Altos, 6 Mar 1984, A. Schinini 23957 (G); Dept. Cordillera, Tobati, 8 Feb 1991, E. Zardini & C. Velázquez 26244 (B); Paraguay, Concepcion, Paso Horqueta, 18 Nov 1993, E. Zardini & T. Tilleria 37460 (MW0581802).

# 3. *M. papillosa* M.S.Marchioretto & J.C.de Siqueira, Pesquisas, Botânica 48: 30 (1998).

Holotype. BRAZIL. Minas Gerais, Estrada Conselheiro Mata, a 2 km do asfalto, Diamantina, 11 April 1982, *L. Rossi, A. Furlan, N.L. Menezes, N. Hensold, H.L. Wagner & E.M. Isejima 3317* (PACA!).

**Description.** Perennial with a taproot or rarely annual (?) herb with caudex; stems erect, densely covered with short papillae; leaves papillate, oblong or lanceolate, appressed or somewhat spreading, cuneate, 2.0–4.0 cm long and 0.2–0.7 cm wide; inflorescence a spike; flowers subsessile, with the pedicels 0.25–0.5 mm long, with a bract and two bracteoles; perianth segments 5, oblong, greenish; stamens 6–8; stigmas 2, thick; fruit  $1.1-1.25 \times 0.9-1.1$  mm, with short finger-shaped outgrowths (Fig. 5A, B); seed 0.9–1.0 mm, with rough surface (Fig. 5D). Morphologically, this species is most similar to *M. celosioides* and is distinguished by the papillate stems and leaves.

Habitat. Sandy substrates at altitudes 500–1400 m a.s.l.

Distribution. (Fig. 16) Endemic to Minas Gerais (Diamantina Mun.), Brazil.

Specimens examined. BRAZIL. Minas Gerais: Diamantina Mun., Estrada Conselheiro Mata, a 2 km do asfalto, 11 Apr 1982, *L. Rossi et al. 3322* (PACA); N of Grão Mogol, 900–1000 m, 27 Nov 1984, *R.M. Harley et al. 36121 & 37090* (K); 15 km from Diamantina towards Mendanha, 2 Dec 1984, *B. Stannard et al. 36280* (K); Itacambira, 1220 m, 11 Nov 1988, *J.R. Pirani et al. 2272* (K); 5 km W de Diamantina, 1200 m, 16 Feb 1991, *M.M. Arbo et al. 5220* (K); Diamantina Mun., 14 km from Diamantina, 30 Jan 2000, *R.C. Forzza & R. Mello-Silva 1486* (G, K).



Figure 16. Distribution map of Microtea papillosa.

#### 4. M. scabrida Urb., Ber. Deutsch. Bot. Ges. 3: 325 (1885).

- $\equiv M.$  paniculata Moq. var. scabrida (Urb.) Kuntze, Revis. Gen. Pl. 3(3): 268 (1898). Lectotype (Sennikov & Sukhorukov, designated here): BRAZIL. [Without exact location and date] *F. Sellow s.n.* (F0BN005735, image!). Note: The lectotype is chosen according to the protologue (Urban 1885). Urban's collections of *M. scabrida* in B have probably been missing since 1945.
- =M. paniculata var. latifolia Kuntze, Revis. Gen. Pl. 3(3): 268 (1898). Lectotype (Sennikov & Sukhorukov, designated here): BOLIVIA. Rio Yapacani, June 1892, O. Kuntze s.n. (B!).
- *M. foliosa* Chodat, Bull. Herb. Boissier, ser. 2, 3: 418 (1903). Lectotype (designated by Nowicke 1968: 351): PARAGUAY. In regione collium "Cerros de Tobaty", September 1900, *E. Hassler 6254* (MO216419, image! isolectotypes P00743942! K000601209!). Note: This species was synonymized with *M. paniculata* (*=M. celosioides*) by Marchioretto and de Siqueira (1998). We have seen the original specimens cited in the protologue (Chodat and Hassler 1903): the specimens with the numbers 6254 (MO216419 image! K000601209! P00743942!), 1649 (P03321197), 1988 (P00743946!) and 1988b (B! P00743944!) are *M. scabrida*, and the specimens with the number 7605 (K000601208! P00743941!) belong to *M. sulcicaulis*, a species described in the same article by Chodat and Hassler (1903). The authors mentioned in the publication three *Microtea* species:

*M. foliosa*, *M. paniculata* and *M. sulcicaulis* (Chodat and Hassler 1903), and *M. scabrida* was omitted in the species list. The protologue of *M. foliosa* combines the characters of both *M. scabrida* and *M. sulcicaulis*, but the epithet "foliosa" belongs to *M. scabrida* with inflorescence leafy in its lower part. Based on the typification made by Nowicke (1968), and in agreement with Walter (1909), we synonymize *M. foliosa* with *M. scabrida*.

=M. scandens Rusby, Mem. New York Bot. Gard. 7: 239 (1927). Holotype: BO-LIVIA. La Paz, Iturralde, Ixiamas, alt. 244 m, 18 Dec 1921, M. Cárdenas 1942 (NYBG01163848, image!).

**Description.** Leaning or twining perennial herb up to 150 cm, glabrous or slightly scabrid; leaves ovate or oblong (Fig. 17A), long-petiolate (petioles 1.0–4.0 cm), blades 5.0–10.0 cm long and 2.0–4.0 cm wide, basally truncate, apically acuminate; inflorescence lax, a spike (Fig. 17B); flowers almost sessile (pedicels up to 1.0 mm), with a bract and two bracteoles; perianth segments 5, whitish or green, oblong or ovoid, stamens 6–7, stigmas 2–3; fruit 1.75–2.0 mm long and 1.6 mm wide, with finger-shaped outgrowths, some of them basally concrescent (Fig. 5E, F); seed 1.3–1.5 mm, with verrucous surface (Fig. 5H).

Habitat. Forests, shrub thickets; alt. up to 1000 m.



Figure 17. *Microtea scabrida:* A a fragment of the shoot (São Bento do Sul, Santa Catarina, Brazil, 23 Sep 2016)B inflorescence (São Bento do Sul, Santa Catarina, Brazil, 14 Dec 2013). Photographs by Paulo Schwirkowski.



Figure 18. Distribution map of Microtea scabrida.

Distribution. (Sub)tropical parts of South America (Fig. 18).

Specimens examined. ARGENTINA: Chaco prov.: Isla del Cerrito, 11 Dec 1971, A.G. Schulz 17927 (G); Corrientes prov.: Itati, 6 Feb 1964, T.M. Pedersen 68 (P04598111); Santo Tome Dep., Potrero Luna, 8 Dec 1981, S.G. Tressens et al. 1612 (G); Ituzaingö Dept., Puerto Mora, 11 Dec 1973, A. Krapovickas et al. 24329 (RB00272365 - image!); Entre Rios prov.: Concepción del Uruguay, Dec 1917, L. Hauman s.n. (BR); Dep. Uruguay, 31 Mar 1967, T.M. Pedersen 8202 (E00621962, P04598112); Concordia Dept., Nueva Escócia, 24 Nov 1988, N.M. Bacigalupo et al. 863 (B); Misiones prov.: Dept. San Ignacio, El Colorado, 24 Jun 1946, G.J. Schwarz 2845 (L1678246); Dep. San Pedro, El Alcazar, 30 Mar 1949, E. Schwindt 1428 (BR); Cainguás Dept., Oro Verde, 29 Apr 1949, G.J. Schwarz 7789 (G); Candelaria Dept., Santa Ana, 10 Mar 1951, J.E. Montes 15101 (P05197102); Leandro N. Alem Dept., Paso Carreta, 9 Mar 1969, A. Krapovickas et al. 15003 (G); BOLIVIA: see lectotype of M. paniculata var. latifolia (B); San Rafael, 27 Mar 1902, R.S. Williams 222 (BM000019282, K); La Paz, Upper Rio Beni, Dec 1906, J.W. Evans 53 (BM000019216); Santa Cruz Dept., Rio Yapacani, 8 Mar 1926, J. Steinbach 7498 (BM000019275, E, K, U1473457); Prov. Sara, Dept. Santa Cruz, Rio Yapacani, 8 Mar 1926, J. Steinbach 7498 (G); La Paz, Ixiamas, 18 Dec 1921, M. Cárdenas 1942

(NYBG – image!); BRAZIL: Acre: Santa Rosa Mun., Rio Chambuiacu, 14 Mar 2002, D.C. Daly et al. 11320 (NY00865147 - image!); Amazonas: Seringal São Francisco, Aug 1911, E. Ule 9361 (G, K, L1678244); Bahia: [without exact location and year] Blanchet s.n. (LE); Rio Grongogy, Nov 1915, H.M. Curran 148 (US01344703 - image!); Milagres, 6 Mar 1977, R.M. Harley 19451 (E); Abaira Mun., 31 Jan 1992, J.R. *Pirani et al. 51372* (E00324053); Minas Gerais: [without exact location] 1816–1821, A. Saint-Hilaire 43 (P04598127); Paraná: Tomazina, Barra Grande, 29 Jan 1911, P. Dusén 11265 (K); Cerre Azul Mun., Ribeirao do Veado, 9 Feb 1960, G. Hatschbach 6725 (L1678240); Foz do Iguaçu Mun., Parque Nacional, 18 Feb 1963, G. Hatschbach 9737 (U1473447); Xambre Mun., 10 Dec 1965, G. Hatschbach 13304 (B, P04598113); Icaraima & Porto Camargo, 20 Jan 1967, G. Hatschbach et al. 4285 (U1473449); Icaraima Mun., Porto Camargo, 20 Jan 1967, G. Hatschbach 15765 (B, P04598114); Altônia Mun., Porto Byington, 23 Jan 1967, J.C. Lindeman & J.Y. de Haas 4396 (K); Cerro Azul Mun., Cabeceiras do Riberao do Tigre, 16 Dec 1992, G. Hatschbach & O.S. Ribas 58457 (G); Cerro Azul Mun., Rua Serra da Paranapiacaba, 16 May 1997, G. Hatschbach et al. 66536 (SJRP00009310 - image!); Paraíba: Areia, 15 May 1944, I.M. Vasconcellos 240 (RB00272395 - image!); Pernambuco: [without exact location] 1838, M. Gardner 1738 (G); Recife Mun., Caxangá, 29 Jul 1887, Ridley et al. s.n. (BM000019259); Recife, Mar 1936, S. Vasconcellos 4097 (US01344756 - image!); Rio de Janeiro: [without exact location] 1816-1821, A. Saint-Hilaire 376 (P04598132); Maricá Mun., Itaipuacu, 27 Jan 1935, Brade 29310 (B); Niterói, 6 Mar 1998, M.C.F. dos Santos 153 (RB00766894 - image!); Rio Grande do Sul: [without exact location] 1816–1821, A. Saint-Hilaire 2711 (P04598128); Iraí, Nov 1949, K. Emrich s.n. (PACA 48169); Santa Catarina: [without exact location] Jul 1840, F. Müller 460 (K); Itapiranga ad fl. Uruguai superius, 16 Feb 1934, B. Rambo 1788 (PACA), Sao Bento do Sul, Rio Natal, 14 Dec 2013, P. Schwirkowski 128 (FURB36981 - image!); São Paulo: [without exact location] 25 Feb 1874, A. Glaziou 2007 (P04598040); Serra de São Pedro, São Pedro, 22 Dec 1965, J. Mattos & N. Mattos 13028 (PACA); PARAGUAY: Asunción: 13 Sep 1874, B. Balansa 1988 (G, K, P04459470); Caaguazú: Caaguazú city, Nov 1874, B. Balansa 1988b (B, P00743944); Caazapá: San Juan Nepomuceno, 12 Dec 1989, I. Basualdo 2794 (G); National Park Caaguazu, 24 Nov 1997, E.M. Zardini & A. Benitez 47391 (P05197101); Cordillera: Tobati, 10 Jan 1903, K. Fiebrig 677 (E, G, L, M); Tobati, 14 Jan 1903, F. Fiebrig 737 (E, G, K, L1678243, LY, M) sub M. foliosa; Cerro Tobati, 28 Oct 1987, R. Degun & E. Zardini 447 (G); Cerro Ybitu Silla, Tobati, 28 May 1988, E. Zardini 4319 (G); Guairá: Villarica, 13 Sep 1874, B. Balansa 1988 (P00743946); Villarica, 13 Nov 1945, G.W. Teague 444 (BM000019276); Colonia Indepedencia, 30 Mar 1972, T.M. Pedersen 10122 (K, P04598115); Tebicuary, 17 Nov 1978, L. Bernardi 18685 (G); Melgarejo, 13 Mar 1989, E. Zardini & C. Velásquez 11391 (E00047207, K); Cordillera de Ybytyruzu, 28 May 1989, E. Zardini & U. Velásquez 12354 (G); Paraguarí: 15 Dec 1875, B. Balansa 1988 (P04598096); prope Sapucay, 1885-1895, E. Drake 1649 (P03321197); Sapucay, Jul 1913, E. Hassler 11878 (BM000019235, E, G); La Rosada, 12 Dec 1979, G. Schmeda 234 (G); Ybicui National Park, La Posada, 3 Feb 1992, *E. Zardini & P. Aquino 30230* (G); Estero del Ypoá, Trinchera Cué, 5 Aug 1993, *E.M. Zardini & T. Tilleria 36838* (B); Alto Paraná: [without exact location] 1909, *K. Fiebrig 5468* (BM000019222, E, G, L1678245, LY, M); PERU: reported for the Dept. Madre de Dios (Brako and Zarucchi 1993); URUGUAY: [without exact location and year] *J. Tweedie s.n.* (BM).

#### 5. M. sulcicaulis Chodat, Bull. Herb. Boissier, ser. 2, 3: 419 (1903).

Lectotype. (designated by Nowicke 1968: 351, first-step lectotype; Sennikov & Sukhorukov, second-step lectotype designated here): PARAGUAY. In regione fluminis Tapiraguay, Aug.[ust] [without year], *E. Hassler 4328* (K000601203! isolectotypes B! G! P00743937! P00634433!). Note: This species was synonymized with *M. celosioides* by Marchioretto and de Siqueira (1998, sub *M. paniculata*). We reinstate *M. sulcicaulis* to specific rank due to (1) strongly perennial life history, (2) stiff (not spreading) inflorescences, (3) larger fruit diameter, (4) alveolate seed surface (in *M. celosioides* it is rough but without alveolae), and (5) predominant distribution in subtropical South America (Paraguay, South Brazil, and SE Bolivia).

**Description.** Perennial herb with a taproot; stems up to 60 cm, sparsely branched, glabrous; rosulate leaves at least partially persistent, appressed to the stem, lanceolate to narrowly oblong,  $3.0-8.0 \times 0.5-1.0$  cm, tapering into the short petiole; cauline leaves numerous, continuously decreasing in size towards the inflorescence, sessile; inflorescence a spike, branched, with lateral shoots directed upwards and not spreading or whip-like; pedicels up to 0.5 mm, flowers with a bract and two bracteoles; perianth segments 5, greenish with white margin or yellowish, ovoid; stamens 5–8; stigmas 2, thick; fruit  $1.5-2.0 \times 1.30-1.50$  mm (Fig. 6A); pericarp readily scraped off the seed, with small finger-shaped outgrowths up to 0.3 mm (Fig. 6B); seed 1.3-1.5 mm, with alveolate surface (Fig. 6D).

Habitat. Rocky and sandy substrates at altitudes up to 1500 m a.s.l.

Distribution. Subtropical South America (Fig. 19).

Specimens examined. BOLIVIA (the first record for the country): Santa Cruz Dept., Fortin Suarez Arana, 19 Oct 1977, *C. Evrard 8203* (BR) as *Microtea* sp. Previously not reported for this country (Jørgensen et al. 2015); BRAZIL:Bahia: Rio de Contas Mun., Pico das Almas, 6 Nov 1988, *R.M. Harley et al.* 25939 (K); Agua Quente Mun., Pico das Almas, 1400 m, 13 Dec 1988, *R.M. Harley & D.J.N. Hind 27232*(K); Mun. de Abaira, 13 Dec 1993, *W. Ganev 2615*(K); Mato Grosso do Sul: Pacuri, 12 Dec 1982, *G. Hatschbach 45918* (G); Rio de Janeiro: 1857, *A. Glaziou 16311* (BR); PARAGUAY: Alto Paraguay Dept.: Fuerte Olimpo, 24 Oct 1946, *T. Rojas 13637* (E); Amambay Dept.: Pedro Juan Caballero, Bela Vista, 23 Nov 1963, *J. Correa Gomes 1465* (G); Pedro Juan Caballero, 19 Oct 1986, *T.M. Pedersen 14669* (G); Estancia 5 Hermanos, 2 Nov 1997, *I. Basualdo 6437* (G); National Park Cerro Corá, Cerrado, 350 m, 10 Nov 1999, *E.M. Zardini & P. Baéz 52218* (P05197108); Caazapá Dept.: Tavai, 7 Dec 1988, *F. Mereles 2122* (G); Canindeyú Dept.: Nanduro Kai, 1 Nov 1978, *L. Bernandi* 



Figure 19. Distribution map of *Microtea sulcicaulis* (circles) and *M. bahiensis* (star).

18347 (G); Lagunita, 23 Sep 1988, T.N. Pedersen 15089 (G); [without exact location]
11 Oct 1996, B. Jiménez & G. Marin 1616 (BM000527219); Mbaracayú Natural Reserve, 31 Oct 1998, E.M. Zardini & I. Chaparro 49429 (B 10 0058099); Central Dept.: Ypacarai Lake, Dec 1913, E. Hassler 12395 (BM000019236, E, G, L1678248, LY); Concepción.: nr Concepción, Oct 1901, E. Hassler 7605 (G, K000601208, LY, sub M. foliosa); Cordillera Dept.: Piribebuy, 11 Jan 1877, B. Balansa 2576 (P04598143); Colonia Rosado, 26 Oct 1986, A. Schinini & E. Bordas 24850 (G); San Pedro Dept.: Yaguareté forest, 24 Aug 1995, E. Zardini & A. Vargas 43638 (MW).

# 6. *M. bahiensis* M.S.Marchioretto & J.C.de Siqueira, Pesquisas, Botânica 48: 11 (1998).

**Holotype.** BRAZIL. Estado Bahia, Munícipio de Salvador, ca. 30 km a N do Centro de Salvador, Estrada para o aeroporto, arredores de Itapuá, dunas [Bahia State, Salvador Municipality, ca. 30 km N from Salvador city, on the way to the airport, surroundings of Itapuá, dunes], 23 May 1981, *Carvalho, Mori & Boom 706* (CEPEC! isotypes – ALCB, NY). **Description.** Perennial herb or dwarf subshrub, glabrous, up to 30 cm tall; caudex well-developed; stems erect or ascending; rosulate leaves up to 9.0(10.0-12.0) cm, obovate or oblong, mostly persistent at fruiting; cauline leaves rhombic, ovate or obvate, cuneate and shorter (up to 2.0 cm) than the rosulate leaves; inflorescence a spike, mostly one-sided; flowers sessile or very shortly pedicellate (pedicels up to 0.5 mm); bracteoles present, very short, perianth segments 5, greenish with white margins, oblong or ovoid; stamens 8; stigmas 2, thick; fruit roundish,  $1.1-1.3 \times 1.0-1.2$  mm, with short finger-shaped outgrowths (Fig. 6E, F); seed 1.1-1.3 mm, with rough surface (Fig. 6H). Note: We were unsuccessful in extracting DNA from the available specimens. However, the characters of this species indicate its position within the type subgenus.

Habitat. Sand dunes at altitudes up to 500 m a.s.l.

Distribution. Endemic to Bahia state, Brazil (Fig. 19).

**Specimens examined. BRAZIL**. Bahia State, Salvador Mun., Itapuá, 27 Feb 1983, *P. de Queiroz 496* (ALCB); Itapuá, 20 Apr 1983, *P. de Queiroz 544* (HUEFS, PACA); Bahia [state], Salvador, Dunas de Itapuá, nr Hotel Stella Maris, N from Condomínio Alamedas da Praia, 8 Jun 1993, *P. de Queiroz 3211* (K, PACA).

#### 7. M. portoricensis Urb., Ber. Deutsch. Bot. Ges. 3: 324 (1885).

Lectotype. (designated by Nowicke 1968: 348, first-step lectotype; Sennikov & Sukhorukov, second-step lectotype designated here): PUERTO RICO. Cabo Rojo, in campis, 20 January 1885, *P. Sintenis 717* (S-R-3531 – image! isolectotypes P00743938! B 10 0296282! B 10 0296820! BM000019288! G! K000601210! P00743938! P00743939! L1678241! L1678242! LE!).

**Description.** Annual, glabrous, stems decumbent, up to 30 cm; rosulate leaves up to 8.0 cm, long-petiolate (petioles up to 3.0 cm), obovate or oblong, mostly persistent at fruiting; cauline leaves rhombic or ovate, cuneate; inflorescence a spike, one-sided, flowers sessile or very shortly pedicellate (pedicels at fruiting ~1.0 mm); bracteoles mostly absent or tiny; perianth segments 4–5, greenish, lanceolate or oblong; stamens 4–5; stigmas 2, thick; fruit almost orbicular or broadly ovate, 0.9–1.1 × 0.9–1.0 mm, reticulate, without any projections (Fig. 7A, B); seed 0.9–1.0 mm, with rough surface (Fig. 7D). Note: This species is assigned here to the type subgenus, although it was not included in the molecular analysis. Morphologically, it is closely related to *M. debilis*.

Distribution. Endemic to the Greater Antilles (Fig. 20).

Specimens examined. DOMINICAN REPUBLIC: reported by Moscoso (1943) and Nowicke (1968 ["herbarium S"] (n.v.); HAITI: reported by Nowicke (1968), herbarium S (n.v.); CUBA: Santiago de las Vegas, 10 May 1904, *H.A. van Hermann 121* (BM00019279, P04598109); Ramón de la Sagra, [without date] *A. Jamain s.n.* (P04598110); Limonar, 1864, *Angel 771* (LE); Havana, 3 Nov 1921, *E.L. Ekman 13408* (G); PUERTO RICO: see type specimens; Cabo Rojo, 1864, *Grosourdy 13* (P04598159); Laguna Derrumadero, nr Bayaguana, 7 Sep 1981, *T. Zanoni & M. Mejia 16407* (NY01509884 – image!).


Figure 20. Distribution map of Microtea portoricensis.

*Microtea* subgen. *Ancistrocarpus* (Kunth) Sukhor. & Sennikov, comb. & stat. nov. urn:lsid:ipni.org:names:77193077-1

*≡Ancistrocarpus* Kunth, Nov. Gen. Sp. [quarto] 2: 186 (1817). *≡Microtea* subgen. *Eumicrotea* H.Walter, Pflanzenr. (Engler) 39: 127 (1909), nom. inval. (Art. 21.3). Type: *M. maypurensis* (Kunth) G.Don.

**Description of the subgenus.** Annuals; bracteoles present; pedicels conspicuous (1.35–3.0 mm long); flowers single or clustered (2–6 per node); stigmas 3–5, thin. The species are mostly distributed in Brazil, with irradiations to the neighbouring countries.

# 8. M. glochidiata Moq. in DC., Prodr. 13(2): 18 (1849).

**Lectotype.** (Sukhorukov & Sennikov, designated here): BRAZIL. Piauhy [Piauí], near Boa Esperança [-6.809768, -41.380520], February 1839, *Gardner 2311* (K000601202! isolectotypes B! P00743948! P00743949! P00743950!). Notes: The lectotype specimen, *Gardner 2311*, was collected when G. Gardner used the hospitality of Rev. Marcos de Araújo Costa (Gardner 1846), who was a land-owner, amateur botanist and educator in the province of Piauí, Brazil. The other collections cited in the protologue (Moquin-Tandon 1849), *Blanchet 2680* from Villa di Barra, belong to *M. maypurensis* (P00798999) and *M. celosioides* (BM000019298).

**Description.** Annual, glabrous, up to 40 cm; stem erect, usually branched from the base with mostly persistent rosulate leaves; leaves linear to oblong, cuneate, 1.0–



Figure 21. Distribution map of Microtea glochidiata.

3.0 cm long, 0.1–0.4 cm wide; inflorescence thyrsoid, flowers 1–6 at each node, pedicels at fruiting 1.5–2.5(3.0) mm long; each flower with a bract and two bracteoles; perianth segments 5, white or yellowish, broadly ovoid or suborbicular, 0.8–1.0 mm long, imbricate; stamens 5–8; stigmas 3–5, filiform; fruit orbicular, its body 1.0–1.2 mm, covered with plumose outgrowths 0.4–0.7 mm long (Fig. 7E, F); pericarp easily scraped off the seed; seed ~1.0 mm, with slightly alveolate surface (Fig. 7H).

**Habitat.** Forest margins, roadsides, ruderal sites, on sandy substrates at altitudes up to 500 m a.s.l.

Distribution. (Fig. 21) Eastern tropical Brazil.

Specimens examined. BRAZIL: Bahia: Jacobina, [without date] *Blanchet 2630* (P04598062); Nova da Rainha, [without date] *Martius 304/18* (M); Gentio do Ouro, 22 Feb 1977, *R.M. Harley 18907* (E, K, M, P05197098, U1473427); Gentio do Ouro Mun., nr Santo Inácio, 26 Feb 1977, *R.M. Harley 19120* (E, P05197099, U1473426); Upper São Francisco river, Caldeirão Grande, 500 m, 18 Apr 1980, *R.M. Harley 21511* (K); Riacho Grande, 4–5 km NE from Itatim, Santa Terezinha, 16 May 1983, *L. Noblick et al. 3243* (PACA); Tucano Mun., 20 Feb 1992, *A.M. de Carvalho & D.J.N. Hind 3841* (G, K, PACA); Paramirim Mun., Lago do Leito, 17 Jan 1997, *G. Hatschbach et al. 65893* (H1693402); Rio de Contas Mun., 5 Feb 1997, *M.L. Guedes* 

et al. 5118 (K); Remanso, 27 Feb 2000, M.R. Fonseca et al. 46314 (K, P000868555); Remanso, 10 Mar 2005, L.P. Queiroz et al. 10070 (HUEFS093066 – image!); Ceará: Sobral, 8 Apr 1984, A. Fernandes 12451 (ASE0023720 – image!); Espírito Santo: between Colatina & Patrimônio, 4 Dec 1971, A.P. Duarte 13986 (PACA); Maranhão: Sao Raimundo das Mangabeiras Mun., 15 Mar 1962, G. Eiten & L.T. Eiten 3674 (K); Barao do Grajau, 21 Jan 2012, R.M. Harley et al. 56455 (K); Pernambuco: Petrolina, 22 Jan 1970, P. Carauta 1008 (RB169035 – image!); Piauí: see lectotype and isolectotypes of M. glochidiata; Caracol, 25 Feb 2011, E. Melo et al. 9216 (PACA); Rio Grande do Norte: Jucurutu, 1 Jun 2008, A.A. Roque 570 (HUEFS164628 – image!).

#### 9. M. maypurensis (Kunth) G.Don, Hort. Brit. [Loudon]: 98 (1830).

- ≡Ancistrocarpus maypurensis Kunth, Nov. Gen. Sp. [quarto] 2: 186 (1817). Lectotype (Sennikov & Sukhorukov, designated here): COLOMBIA. "In pratis Maypure", ex herb. Bonpland, ex herb. Kunth s.n. (B 10 0296283!). Note: Kunth, who revised the main set of Humboldt's and Bonpland's collections at P, acquired a large part of this herbarium. After his death, the collections were transferred to the Botanical Museum in Berlin (Urban 1881), where they partly survived.
- *Ceratococca maypurensis* Humb. & Bonpl. ex Roem. & Schult., Syst. Veg., ed. 15, 6: 800 (1820). Holotype: COLOMBIA. Maypure, Cataracta, Orinoco, A.J.A. Bonpland & F.W.H.A. von Humboldt s.n. (B-W 06266-01!). Notes: Ceratococca maypurensis was apparently based on a duplicate of the collection on which Ancistrocarpus maypurensis was described earlier by Kunth. However, a specimen in the Herbarium of Willdenow was not accessible to Kunth at the time when the protologue was prepared (McVaugh 1955).
- *=Potamophila parviflora* Schrank, Pl. Rar. Horti Monac. 2: tab. 63 (1821), nom. illegit., non R.Br. 1810.
- ≡Ancistrocarpus schrankii Ledeb., Index Seminum Horti Academici Dorpatensis 1821 (Appendix I): 21 (1821). Described on the basis of plants cultivated in the Botanical Garden in Munich. Lectotype (Sennikov & Sukhorukov, designated here): [icon] fig. 63 in Schrank (1821). (Fig. 22). Note: von Ledebour (1821) intended (Art. 6.11) to introduce his new species name as a replacement name for the later homonym published by Schrank, and both names are therefore necessarily homotypic. Schrank (1821) published his new species names based on seeds sent or brought from Brazil by C.F. von Martius. Original herbarium collections of Potamophila parviflora Schrank were not found at M and most likely had never been prepared (H.-J. Esser, pers. comm. 2018), and the illustration published as part of the protologue is the only original element available for lectotypification (Art. 9.4). The protologue of Potamophila parviflora indicates that the new species has five styles (although only three are visible in the accompanying illustration) and a pericarp with setae. Coupled with pedicellate flowers and petiolate leaves, easily recognizable in the illustration, these characters are indicative of Microtea may-

*purensis*, of which *P. parviflora* (*Ancistrocarpus schrankii*) is a later synonym. This agrees with the conclusions of Moquin-Tandon (1849), Walter (1909) and Nowicke (1968). Schrank (1821) stated that the new species was collected in "Brasilia prope sinum Omnium Sanctorum ad flumina locis umbrosis". There is a gathering, Herb. Martius *2198* (M 0274659, M 0274661, M 0274662), which was collected by Martius in Bahia, Cachoeira, along the Paraguaçu River at the distance of ca. 35 km from Baía de Todos os Santos (Bay of All Saints), in December 1818 (see the route of Martius' expedition in Tiefenbacher (1983)). This is the likely type locality of *P. parviflora*, and the gathering may be the voucher for the seed collection sent by Martius to the Munich Botanical Garden. The plants of this gathering are unmistakeably referable to *M. maypurensis*. Two other specimens, Herb. Martius 2309 (M 0274665, M 0274666), collected by Martius in Bahia, Monte Santo, in April 1819, were mistakingly labelled as *P. parviflora*. They clearly disagree with the protologue and belong to *M. celosioides*. This curatorial mislabelling probably occurred because of the confusingly similar localities on its label and in the protologue.

- =M. sprengelii Moq. in DC., Prodr. 13(2): 19 (1849). Neotype (Sennikov & Sukhorukov, designated here): BRAZIL. Bahia, Rio Belmonte, [Aug. 1816], Maximilian, Prinz zu Wied 53 (BR000005537679, image!). Note: Moquin-Tandon (1849) based the protologue of Microtea sprengelii entirely on the description of M. maypurensis in Sprengel (1820). He stressed the diagnostic character of opposite leaves, which is almost impossible in Microtea. However, Sprengel's description closely matches the characters of M. maypurensis except for the opposite leaves, and unlikely belongs to any other species. Moquin-Tandon (1849) assumed a technical error in Sprengel (1820), with which we agree. Sprengel noted specifically that he based the description on plants from Brazil. No relevant specimens survived. As a neotype, we designate a specimen of M. maypurensis collected in Brazil by Prinz Maximilian, a contemporary collection that may have been available to Sprengel.
- =M. glochidiata f. lanceolata Chodat & Hassler, Bull. Herb. Boiss., ser. 2, 3: 418 (1903). Lectotype (Sennikov & Sukhorukov, designated here): PARAGUAY. Ad marginem silvae [prope] Caraguatay, Aug.[ust] [1897], E. Hassler 3126 (P00743952! isolectotypes P00743951! P00743953!). Note: Our synonymy confirms the opinion of Heimerl (1912).

**Description.** Annual or biennial, glabrous; stems erect, up to 60 cm, branched; rosulate leaves oblong, usually withered, lower leaves oblong or spatulate, cuneate, petiolate (petioles up to 2.5 cm), 3.0–8.0 cm long and (0.2–0.4)0.5–2.0 cm wide (sometimes narrower), acuminate; inflorescences a spike, not one-sided, often spreading; flowers solitary (rarely two per node), with a bract and two bracteoles, pedicellate (pedicels 1.5–3.0 mm), perianth segments 5, oblong to ovoid, white or yellowish; stamens 5–8, stigmas 3–5, filiform; fruit slightly protruding from the perianth or up to twice its length, fruit body 1.0–1.1 mm across, with outgrowths 0.2–0.5 mm long terminating in a group of 2–4 hooked hairs (Fig. 8A, B); pericarp readily scraped off the seed; seed ~1mm, with rough surface (Fig. 8D).

Potamophila parviflora 63.

**Figure 22.** Lectotype of *Ancistrocarpus schrankii* (fig. 63 in Schrank, 1821). Image provided by the library of Biological Faculty, Lomonosov Moscow State University.



Figure 23. Distribution map of Microtea maypurensis in its native range.

Habitat. Forests or ruderal sites; 0–1500 m.

**Distribution.** Tropical South America (Fig. 23).

**Specimens examined. BOLIVIA: La Paz Dept.**: Beni river, Jul 1886, *H.H. Rusby* 1379 (BM000019263, E, G, LE, P04598104); nr Guanay, 1892, *M. Bang 1589* (B, BM000019206, E, G, K); Tipuani, Hacienda Simaco, 1400 m, Jan 1920, *O. Buchtien* 5404 (K, M); Tipuani, 1400 m, 29 Mar 1923, *O. Buchtien 7290* (E, G); Mapiri, 850 m, 29 Nov 1926, *O. Buchtien 694* (M); **Santa Cruz Dept.**: Nuflo de Chávez prov., Pascana Ministro, 12 Jun 1995, *J.R. Abbott 16976* (K); Nuflo de Chávez prov., Lomerio, 14 Apr 1995, *F. Mamani & M. Saucedo 817* (MEXU); **BRAZIL: Amazonas:** Rio Juruá, Juruá Miry, May 1901, *E. Ule 5503* (G, L1678235); Rio Branco, Nov 1913, *J.G. Kuhlmann 120* (RB00272533 – image!); Rio Negro between Ilha Uabetuba & Ilha da Silva, 14 Oct 1971, *G.T. Prance et al. 15235* (NY00779040 – image!); Rio Jutai, 17 Nov 1975, *N.A. Rosa & L. Coelho 563* (IAN151165 – image!); **Bahia**: [without exact location] 1834, *Blanchet s.n.* [herb. De Candolle] (G00687542); Jacobina, [without date] *Blanchet 2588* (P00743954, a plant in the middle]; Andaraí, 500–600 m, 13 Feb 1977, *R.M. Harley 18632* (E, K, P05197100); Iaçu Mun., Lagedo Alto, 25 Sep 1984, *L.R. Noblick & M.J. Lemos 3407* (PACA); Ilheus Mun., Rodovia, 10 Apr



Figure 24. The record of *Microtea maypurensis* as an alien plant in Indonesia.

1986, J.L. Hage s.n. (G); Dom Basilio Mun., 28 Dec 1989, A. de Carvalho et al. 2679 (G, PACA); Jacobina Mun., 30 Nov 1992, M.M. Arbo et al. 5450 (K); Iaçu Mun., Rio Paraguacu, 10 Apr 1992, G. Hatschbach et al. 56968 (G, K); Rio Jecuriçá, 16 Jan 1997, M.M. Arbo et al. 7276 (G, K); Maranhão: Carolina Mun., National Park Chapada das Mesas, 9 Apr 2016, A.C. Sevilha et al. 5723 (CEN00097885 - image!); Minas Gerais: Pedra Azul, 12 Dec 1984, A.M. Giulietti et al. 36297 (K); towards Jequitinhonha, Pedra Azul, 20 Oct 1988, R.M. Harley et al. 25232 (K, PACA); Pará: Marabá to Altamira, 16 Jan 1976, P. Bamps 5170 (BR); Paraíba: Esperança, 14 Sep 1958, J.C. de Moraes 1936 (RB00272388 - image!); Paraná: Londrina, 17 Nov 1969, G. Hatschbach 22898 (NYBG00779051 - image!); Pernambuco: [without exact location] 1838, Gardner 1138 (P04598076); Petrolina Mun., Tapera, Aug 1930, D.B. Pickel 50 (B, BM000019250); Rio de Janeiro: Rio de Janeiro [city], 1883, A. Glaziou 15355 (LE); Roraima: Rio Ajarani, 29 Apr 1974, J.M. Pires et al. 14408 (IAN144038 - image!); São Paulo: Rio Negro, between Ilha Uabetuba & Ilha da Silva, 14 Oct 1971, G.T. Prance et al. 15235 (G, K, M, P04598013, U1473419); Sergipe: Cristinapolis Mun., 2 Apr 1976, G. Davidse et al. 11810 (U1473430); Tocantins: Darcinopolis Mun., Rio Tocantins, 16 Apr 2008, G. Pereira-Silva et al. 12933 (CEN00091111 – image!); CO-LOMBIA: Rio Vaupés, 1852, R. Spruce 2546 (E, K); ECUADOR: El Oro, 18 km on road Huaquillas-Arenillas, [without date] Harling & Andersson 18835 (GB - image!); GUIANA: [without exact location] 1868, Schomburgk 835 (B, E, K, P04598085); Pirara, 1841, Schomburgk 325 (BM000019270); Region Upper Takutu, Essequibo,

1 Jun 1996, *D. Clarke 1874* (U1473431); **PARAGUAY**: **Amambay Dept**.: between Rio Apa & Rio Aquidabán, 13 Feb 1908, *K. Fiebrig 4928* (BM000019221, G, E, K, L); **Cordillera Dept**.: see lectotype of *M. glochidiata* f. *lanceolata*; Caraguatay, Aug 1900, *E. Hassler 3126* (B, BM000019232, G, P00743953, P00743951, P00743952); **San Pedro Dept**.: [without exact location] 26 Oct 1953, *A.L. Woolston 210* (K); **PERU**: **Cusco Region**: Paucartambo prov., Cusco dept., Pillcopata, 20 Jun 1959, *J. Infantes 5913* (B); **Puno Region**: Carabaya prov., San Gaban distr., [without date] ex herb. Steudel 2288 (G, P04598108); **SURINAME**: nr Paramaribo, 12 Feb 1904, *van Hell 150* (U1473435); Paramaribo, 10 April 1916, *J.A. Samuels 8* (K); Paramaribo, 12 Apr 1916, *J.A. Samuels 65* (BM000019265, L1678237, P04598014); Found as alien in Southeast Asia (Fig. 24): **INDONESIA**: Java, Pasuruan, 1924, *anonymous s.n.* (L1678238). Previously not reported from this region (Backer 1954).

#### 10. M. tenuifolia Moq. in DC., Prodr. 13(2): 18 (1849).

=M. maypurensis var. angustifolia Moq. in DC., Prodr. 13(2): 18 (1849). Lectotype (Sennikov & Sukhorukov, designated here): BRAZIL. Jacobina Mountains in Bahia, 1836, Blanchet 2588 (P00798998!).

Lectotype. (designated by Nowicke 1968: 352): BRAZIL. Espírito Santo State, Pico d'Habira [Pico do Itabira], 1843, *Claussen 392* (P00743993!).

**Description.** Annual or short-lived perennial herb with several or numerous stems 10–40 cm high; leaves sessile (sometimes rosulate leaves shortly pedunculate), cuneate, 10–30 mm long and 0.3-3.0(5.0) mm wide; inflorescence a spike; pedicels 1.35-1.7(2.5) mm; flowers with a bract and two bracteoles, perianth segments 5, white, oblong; stamens 6–8, stigmas 3–5, thin; fruit  $0.9-1.1 \times 1.0-1.1$  mm (Fig. 8E), equal to perianth or slightly protruding; pericarp smooth or with small and scattered tubercles (Fig. 8F), more or less reticulate, readily scraped off the seed; seed 0.9-1.1 mm, with rough surface (Fig. 8H).

We report for the first time that the perianth/fruit ratio is a useful distinguishing character for this species. Also, the number of stigmas can be useful in delimiting *M. tenuifolia* and similar forms of *M. celosioides* with narrower leaves. The character set of *M. tenuifolia* supports its close relationship to *M. maypurensis*, especially the forms with reduced pericarp outgrowths. Remarkably, Moquin-Tandon (1849) described a new variety of *M. maypurensis* (var. *angustifolia* Moq.) represented by two specimens of *M. tenuifolia* (P00743955! and P00798998!) and one specimen containing two individuals, *M. tenuifolia* and a narrow-leaved *M. maypurensis* (leg. *Blanchet 2588*, P00743954!). The figure of *M. tenuifolia* in Calió and Pirani (2006) showing the tuberculate perianth is rather an exception, and the individuals with pericarp lacking the outgrowths have so far been collected more frequently.

Habitat. Forest margins, rocky places; 0–1000 m.



Figure 25. Distribution map of Microtea tenuifolia.

**Distribution.** Endemic to Eastern Brazil, found only in Bahia, Espírito Santo, Minas Gerais and Rio de Janeiro States (Fig. 25).

Specimens examined. BRAZIL: Bahia: 4 km SW of Belmonte, 23 Mar 1974, *R.M. Harley 17305* (K, P04598081, U17305, U1473428); see lectotype of *M. maypurensis* var. *angustifolia*; Jacobina, [without date], *Blanchet 153* (BM000019209); Morro do Chapeu, 1000 m, 1 Jun 1980, *R.M. Harley 22924* (U1473452); Espírito Santo: see lectotype of *M. tenuifolia*; Minas Gerais: [without exact location] Feb 1839, *Riedel 48* (P007990000); [without exact location] 1841, *Claussen 4* (P00743934); [without exact location] 1845, *Widgren s.n.* (M); Caldas, 5 May 1870, *A. Glaziou 11* (P04598116); Caldas, 15 May 1870, *A. T. Regnell s.n.* (B); Serrra das Vertentes, Jun 1893, *A. Glaziou 20437* (B, K, P04598119); Turvo, 24 Apr 1926, *W. Hohne & A. Gehrt s.n.* (PACA 76840); Buenópolis Mun., Curimatai, [without date] *A. Glaziou 19399* (P04598074); Serra do Espinhaco, 15 Feb 1969, *H.S. Irwin et al. 23315* (G); Bacia do Córrego Escurona, Grão Mogol, 2 Nov 1987, *M. C. Assis & al. s.n.* (PACA 76297); Vale do Rio Itacambiruçu, Grão Mogol, 10 Dec 1989, *A. Freire-Fierres et al. s.n.* (PACA 76298); Vale do Córrgo Escurona, Grão Mogol, 13 Jun 1990, A.A. Oliveira et al. s.n. (PACA 76299); Serra dos Inconfidentes, Pico do Itabirito, Itabirito, 4 Jan 1994, W.A. Teixeira s.n. (PACA); Estação Ecológica da Mata do Cedro, Carmópolis, 13 Jul 2004, L. Echternacht & T. Dornas 573 (PACA); Estação Ecológica da Mata do Cedro, Carmópolis, 23 Jan 2005, L. Echternacht & T. Dornas 830 (PACA); Grão Mogol Mun., Parque Estadual de Grão Mogol, 13 Apr 2006, C.V. Vidal 177 (PACA); Santana do Riacho Mun., Entre a Rodovia BR 251 e Grão Mogol, Cachoeira Véu de Noiva, 15 Mar 2007, M.S. Marchioretto 352 & 355 (PACA); Rio de Janeiro: nr Rio de Janeiro, Feb 1882, A. Glaziou 13127 (G, K); Rio de Janeiro, 1887, A. Glaziou 17748 (LE).

#### Species excluded

All species cited below under *Microtea* belong to the South African genus *Lophiocarpus* Turcz., with a distinct position within Caryophyllales (Cuénoud et al. 2002, Schäferhoff et al. 2009) and with a different seed anatomy (Sukhorukov et al. 2015). The transfers of *Lophiocarpus* to *Microtea* were undertaken due to the morphological similarity of their members (Brown 1909), which is a case of homoplasy between phylogenetically distant Caryophyllales genera (Schäferhoff et al. 2009, Brockington et al. 2009).

- Microtea burchellii (Hook.f.) N.E.Br., Bull. Misc. Inf. Kew 1909(3): 135 [1909]
   ≡ Lophiocarpus burchelii Hook.f. in Bentham & Hooker f., Gen. Pl. 3(1): 50 (1880);
- Microtea gracilis A.W.Hill, Bull. Misc. Inf. Kew 1910(2): 56 [1910]
   = Lophiocarpus polystachyus Turcz., Bull. Soc. Imp. Naturalistes Moscou 16: 56 (1843);
- Microtea polystachya (Turcz.) N.E.Br., Bull. Misc. Inf. Kew 1909(3): 135 [1909]
   ≡ Lophiocarpus polystachyus Turcz., Bull. Soc. Imp. Naturalistes Moscou 16: 56 (1843);
- *Microtea tenuissima* (Hook.f.) N.E.Br., Bull. Misc. Inf. Kew 1909(3): 134 [1909] ≡ *Lophiocarpus tenuissimus* Hook.f., Hooker's Icon. Pl. 15: 50, tab. 1463 (1883).

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**RESEARCH ARTICLE** 



# Camelina neglecta (Brassicaceae, Camelineae), a new diploid species from Europe

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#### Abstract

*Camelina neglecta* is described as a new diploid species and its relationship to the other diploids of the genus and to the somewhat superficially similar tetraploid *C. rumelica* and hexaploid *C. microcarpa*, are discussed. SEM of seed and stem trichomes of the new species are presented.

#### **Keywords**

Brassicaceae, Camelina, Camelineae, chromosome numbers, Cruciferae

# Introduction

The Brassicaceae (Cruciferae) is an economically important family with ca. 4050 species and 348 genera (BrassiBase 2018, Kiefer et al. 2014, Koch et al. 2018, DA German and MA Koch pers. com.). It includes many crops such as broccoli, Brussels sprouts, cabbage, cauliflower, canola, turnip (*Brassica* L.), radish (*Raphanus sativus* L.), arugula (*Eruca vesicaria* subsp. *sativa* (Mill.) Thell.), horseradish (*Amoracia rusticana* Gaetnr., Mey., & Scherb.), wasabi (*Eutrema japonicum* (Miq.) Koidz.) and watercress (*Nasturtium officinale* W.T.Aiton), as well as *Arabidopsis thaliana* (L.) Heynh., the model organism in modern biology. *Camelina* Crantz, a small genus of seven or eight Eurasian species, has become increasingly interesting due to ongoing research in developing *C. sativa* (L.) Crantz as a high-yielding crop for oilseed and aviation biofuel. Wild populations of *Camelina* species may harbour agronomically important traits for introgression and crop improvement and attention to these has heightened in recent decades. Several *Camelina* species occur as cosmopolitan weeds (*C. sativa*, *C. microcarpa* Andrz. and *C. rumelica* Velen.), whereas others have restricted ranges in the Irano-Turanian floristic region, predominantly Turkey.

One of the authors (JRB) studied the *Camelina* accessions in the United States Department of Agriculture's (USDA) Germplasm Resource Information Network collection and, based on flow cytometry, he noticed that accession 650135 had a small genome size, consistent with diploidy. Both Galasso et al. (2015) and Martin et al. (2017) showed that plants of that accession are diploid with 2n = 12, whereas Martin et al. (2018) found the existence of sexual incompatibility between plants of that accession and the morphologically similar hexaploid *C. microcarpa*. In light of these findings and based on a critical evaluation of morphology of plants of *C. microcarpa* and *C. rumelica*, we recognise plants of that accession as the following new species.

#### Taxonomy

*Camelina neglecta* J.Brock, Mandáková, Lysak & Al-Shehbaz, sp. nov. urn:lsid:ipni.org:names:77193889-1 Figs 1–4

**Type.** France, Lozere, Causse Méjean, corn field, September 1996, 44°16'N, 2°33'E, *Henri Besancon s.n.* (holotype: MO-6869197; isotype: MO-6869196).

**Description.** Annual herbs. Stems 50–60 cm tall, simple at base, branched about middle or above, densely pilose above base with exclusively simple, crisped trichomes 1–3 mm long, glabrous at middle and above. Basal leaves withered by anthesis; cauline leaves oblong-lanceolate, middle ones  $4-5.5 \times 0.5-1$  cm, gradually reduced in size upwards and becoming narrowly lanceolate, sparsely hirsute with simple trichomes, ciliate with antrorse subsetose trichomes 0.1-1 mm long, base sagittate, margin entire, apex acute. Racemes 30-75-flowered, becoming lax, elongated considerably and 18-24 cm long in fruit; fruiting pedicels 0.9-2 cm long, divaricate-ascending, glabrous. Sepals oblong, 2-2.5 mm long; petals pale yellow, narrowly oblanceolate,  $2.5-4.5 \times 0.8-1$  mm; median filaments ca. 2 mm long; anthers ovate, ca. 0.2 mm long; ovules 30-34(-36) per ovary. Fruit pyriform,  $7-7.5 \times 4-4.5$  mm; valves not veined, margin strongly carinate, winged, apex acuminate, extending 0.9-1.1 mm on to stylar area; style 1.3-1.6 mm long, free portion only ca. 0.5 mm long. Seeds brown, oblong,  $0.9-1.1 \times 0.5-0.6$  mm; seed coat minutely papillate, copiously mucilaginous when wetted.



Figure 1. Holotype of Camelina neglecta. Besancon s.n. (MO-6869197).



**Figure 2.** Mitotic chromosomes of *Camelina neglecta*. Greenhouse-grown plants from seeds of *Besancon s.n.* (USDA accession 650135). Scale bar: 10 µm.

The origin of the type material is a seed collection deposited at the USDA and no original voucher is known anywhere, including BORD, long suspected to house it. As a result, a greenhouse-grown plant from the USDA seeds was pressed as the voucher and therefore is recognised as the holotype.

*Camelina neglecta* is a diploid species most closely resembling the hexaploid (2n =40) *C. microcarpa* DC. and the tetraploid (2n = 26) *C. rumelica*. Deviant counts for *C*. microcarpa are almost certainly based on misidentifications of plants of other species. For example, counts of 2n = 26 for *C. microcarpa* from France, Morocco and Spain (see Warwick and Al-Shehbaz 2006, BrassiBase) most likely belong to C. rumelica, a species two of the authors (MAL and TM) found to consistently have 2n = 26. Furthermore, diploid (2n = 12) counts for *C. rumelica*, from Hungary (Baksay 1957) and United States (Brooks 1985), are most likely based on plants of C. neglecta or another diploid species yet to be described. Critical verifications of the vouchers of these previous counts are needed to establish their identity beyond any doubt. One of the authors (IAS) examined the voucher cited in Brooks (erroneously reported as McGregor 35289 instead of 35290; Freeman, pers. com.) and it fits quite well in C. neglecta, based on trichome morphology and ovule number. Our count of 2n = 12 in *C. neglecta* (Fig. 2) agrees with this and is based on the same seed accession as that of Martin et al. (2017), misidentified as C. microcarpa. The present isolated occurrence of C. neglecta in France might appear to be odd, but with the availability of resources, a thorough search for it in eastern Europe and Southwest Asia should be made.

In addition to differences in ploidy level and chromosome numbers, *Camelina ne*glecta differs from both *C. microcarpa* and *C. rumelica* by having lower stems soft pilose



**Figure 3.** Trichomes of lowermost part of stem in *Camelina neglecta*. Greenhouse-grown plants from seeds of *Besancon s.n.* (USDA accession 650135). Scale bar: 400 µm.

(vs. hirsute) with crisped (vs. straight) trichomes not mixed (vs. mixed) with forked ones (Fig. 3), as well as by having 30-34(-36) [vs. (16-)20-24(-26)] ovules per ovary. It further differs from the yellow-flowered *C. microcarpa* by having petals 2.5–4.5 (vs. 3.8–6) mm long petals and fruit 7–7.5 (vs. 4–5.5) mm long. From *C. rumelica, C. neglecta* also differs by the smaller yellow (vs. white) petals 2.5–4.5 (vs. (5-)6-9) mm long and pilose (vs. hirsute) lower stems.

There are two other Southwest Asian diploid species in the genus, of which *Camelina laxa* C.A.Mey. (2n = 12) is distributed in Armenia, Azerbaijan, Georgia, Iran and Turkey and it is unique in the genus in having strongly flexuous infructescences. The other is *C. hispida* Boiss. (2n = 14), a species of Iran, Iraq, Israel, Jordan, Lebanon, Syria and Turkey. The latter differs from all other species of the genus by having pubescent (vs. glabrous) middle stems and inflorescences.

The papillate seeds of *Camelina neglecta* (Fig. 4) are copiously mucilaginous and the seed epidermis exudes the mucilage within a few seconds after soaking.

The native ranges of five *Camelina* species (*C. hispida*, *C. laxa*, *C. microcarpa*, *C. rumelica* and *C. sativa*) are widespread in south-eastern Europe and/or Southwest Asia (especially Turkey). Other species, *C. anomala* Boiss. & Hausskn. and *C. stiefelhagenii* Bornm., are rare in Turkey but appeared in areas outside of their known native range, with a collection of *C. anomala* from Beqaa, Lebanon (1961) and *C. stiefelhagenii* from



**Figure 4.** SEM image of *Camelina neglecta* seed. Greenhouse-grown plants from seeds of *Besancon s.n.* (USDA accession 650135). Scale bar: 1 mm.

Dresden, Germany (1941) and Gothenburg, Sweden (1952). It is quite possible that *C. neglecta* is more widespread in Europe and SW Asia that we currently know.

Due to the allohexaploid nature of *Camelina sativa*, there is much interest in discovering its putative diploid parents. The phylogenetic treatment of the genus (Brock et al. 2018) showed the relationships of diploid *Camelina* species relative to *C. sativa* and indicated a potentially shared hybridisation and polyploidisation history of the weedy *C. microcarpa* and its domesticated *C. sativa*. It is essential to identify the wild *Camelina* diploids to facilitate reconstruction of the evolutionary history of *C. sativa* and allow the potential for re-synthesis of the crop as has been done in *Brassica napus* L. (Chen et al. 1988).

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Lestourneaud (BORD) for their help in searching for a voucher of *Camelina neglecta*, as well as to Craig C. Freeman (KANU) for the loan of *C. rumelica* specimens and for confirming the voucher number cited in Brooks (1985). JRB thanks the William H. Danforth Fellowship that supported parts of this research.

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**RESEARCH ARTICLE** 



# Taxonomic reconsideration of Prunus veitchii (Rosaceae)

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#### Abstract

Prunus veitchii was published in 1912 and was treated as a synonym of *P. serrulata* var. *pubescens*. The information about this taxon is relatively scarce. When consulting specimens of *Prunus* L., type materials of *Prunus veitchii* were found to belong to three taxa and *P. veitchii*, *P. concinna*, *P. japonica* var. *zhejiangensis*, *C. jingningensis* and *C. xueluoensis* were found to be conspecific. The taxonomic status of *P. veitchii* is reconsidered in the present paper. Morphometric analyses were performed to evaluate the significance of differences between *P. veitchii* and *P. serrulata* var. *pubescens*. The results show that the leaves of *P. veitchii* are significantly smaller and narrower than the leaves of *P. serrulata* var. *pubescens* and the peduncle and pedicels are shorter. According to the results of morphometric analyses, *P. veitchii* should be treated as a separate species. To address these results, a lectotype of *P. veitchii* is designated here and *P. concinna*, *Cerasus jingningensis* and *C. xueluoensis* are here designated as synonyms of *P. veitchii*.

#### Keywords

Prunus, Prunus serrulata var. pubescens, typification, synonyms, China

# Introduction

*Cerasus* A. Gray, the taxon that includes species commonly known as cherries, is a group that is famous for germplasm resources of edible fruits and flowering trees and shrubs. Historically, *Cerasus* has been treated either as a subgenus of *Prunus* L. or as a separate genus (Wen et al. 2008). In the past twenty years, molecular phylogenetic analyses (Bortiri et al. 2001; Lee and Wen 2001; Wen et al. 2008; Shi et al. 2013; Chin et al. 2014) have supported recognition of *Prunus sensu lato*, including *Cerasus*,

as a single genus and have also shown that, with the removal of the species in sect. *Microcerasus*, a monophyletic *Cerasus* can be recognised. Although the inclusion of *Cerasus* within *Prunus* is no longer as controversial as it used to be, there are still many problems with the taxonomy of this clade (Wu et al. 2018).

*Prunus veitchii* Koehne (Koehne 1912) is a species of shrub cherry that occurs at altitudes above 1000 m in western Hubei Province, China. It was treated as a synonym of *P. serrulata* var. *pubescens* Wilson by Wilson (1916), a treatment followed by "Flora Reipublicae Popularis Sinicae" (Yü and Li 1986) and "Flora of China" (Li and Bartholomew 2003) and also by Koehne (1917), albeit with reservation. We found that the type materials of *P. veitchii* actually belonged to three taxa and that the voucher of Wilson's treatment is not the same plant as the specimen on which Koehne's description was based. This means that the taxonomic status of *P. veitchii* needs to be redefined.

Meanwhile, we also found that *P. veitchii*, *P. concinna*, *P. japonica* var. *zhejiangensis*, *Cerasus jingningensis* and *C. xueluoensis* should all be conspecific due to their similarities in morphology and habitat. The histories of all of these taxa are relevant and are described below.

First, along with the publication of *P. veitchii*, Koehne (1912) described another shrub cherry, *P. concinna*, from a similar habitat. Due to the lack of materials, Koehne was uncertain about its status and the name is still unresolved today. Second, Chang (1992) described *P. japonica* var. *zhejiangensis* based on Zhang Fanggang & Li Zhiyun 5309, which was collected from southern Zhejiang Province. This variety (Figure 1) was thought to be different from the typical variety in its persistent ovate stipules and black fruit (Chang 1992). However, it is strange that Chang did not include this variety in "Flora of Zhejiang" (Editorial Board 1993), which was published in the following year and for which Chang was involved in compiling most of the content for Rosaceae, including Prunus L. Although the taxon was later included in "Flora of China" (Li and Bartholomew 2003), it was overlooked in later publications (Wang 2014, Yan et al. 2017). Third, Xu et al. (2012) described a new species of cherry, C. jingningensis (Fig. 1), based on specimens collected from southern Zhejiang Province. Recently, P. japonica var. zhejiangensis was treated as a synonym of C. jingningensis by Liu et al. (2017). Finally, C. xueluoensis was published by Nan et al. (2013) based on Cheng-Hui Nan 040301, which was collected from western Hubei Province.

Here, we use morphometric analyses to test the distinct nature of *P. veitchii* and *P. serrulata* var. *pubescens* and conclude that the former should be recognised as a separate species. We designate a lectotype for *P. veitchii* and reduce *P. concinna*, *Cerasus jingningensis* and *C. xueluoensis* to its synonymy.

#### Materials and methods

Herbarium specimens from A, AU, CSFI, DAV, E, GH, HBG, HHBG, HX, IBK, IBSC, IFP, JJF, JXU, K, KUN, LBG, MO, NAS, NF, NY, PE, UC, US, ZJFC and



Figure 1. Holotypes of *Prunus japonica* var. *zhejiangensis* (left, photograph by Fanggang Zhang) and *Cerasus jingningensis* (right).

ZM (Chinese Academy of Sciences 2018, Thiers, [continuously updated].) were examined by visiting the herbaria or through the Chinese Virtual Herbarium (Chinese Academy of Sciences 2018) and Global Plant database (JSTOR 2018). To evaluate the differences between *P. veitchii* and *P. serrulata* var. *pubescens*, specimens from different origins were selected to gather morphological data and which were subjected to morphometric analyses. Seven floral characters and eight leaf characters (Table 1) were selected for analyses, following Chang et al. (2007), though some characters used by Chang et al. (2007) were discarded because it was not possible to collect enough relevant data from the available specimens. A total of 26 specimens for floral characters and 44 specimens for vegetative characters were measured (see Appendix 1). Measurements were made manually with rulers for borrowed specimens or performed using Digimizer version 4.6.0 (MedCalc Software 2018) for online images.

A non-parametric Kruskal-Wallis ANOVA was conducted to evaluate the significance of the difference in measured characters between *P. veitchii* and *P. serrulata* var. *pubescens* in each character, as not all characters follow a normal distribution. Box plots were created to illustrate the differences. Data analyses were performed in R version 3.5.1 (R Core Team 2011) and diagrams were created by using ggplot2 package (Wickham 2016).

Code	Floral Character	Code	Vegetative Characters
А	Peduncle length (cm)	Н	Petiole length (cm)
В	Pedicel length (cm)	Ι	Leaf length (cm)
С	Length of calyx tube (cm)	J	Leaf width (cm)
D	Diameter of calyx tube top (cm)	Κ	Angle of leaf base (°)
Е	Length of calyx lobe (cm)	L	Angle of leaf apex (°)
F	Width of calyx lobe (cm)	М	Length of leaf apex (cm)
G	Ratio of length and width of calyx lobe	Ν	Ratio of leaf length and petiole length
		0	Ratio of length and width of leaf

Table 1. Floral characters and vegetative characters used in morphometric analyses.

#### Results

After examining the type specimens, other collections, relevant literature and plants in the field, we determined that *P. veitchii*, *P. concinna*, *P. japonica* var. *zhejiangensis*, *C. jingningensis* and *C. xueluoensis* must be conspecific. Their original descriptions are not essentially different (Table 2). Although the type specimens of these taxa cannot all be compared directly because they were collected in different seasons and stages of development, it was clear that they are conspecific after consulting specimens collected from the type localities in different seasons.

The result of basic statistics and Kruskal-Wallis ANOVA are summarised in Table 3. The box plots (Figure 2) show that there is no significant overlap between *P. veitchii* and *P. serrulata* var. *pubescens* for most of the measured characters. Moreover, ANOVA showed that the means of almost all measured characters differ significantly, except width of the calyx lobes.

#### Discussion

*Prunus veitchii* was treated as a synonym of *P. serrulata* var. *pubescens* by Wilson, a treatment that was followed by Koehne with reservation (Koehne 1917). Koehne (1917) mentioned that the sepals of *P. veitchii* are ovate and shorter and the leaflets are smaller than those of *P. serrulata* var. *pubescens*. Consistent with Koehne's observation, our morphometric analyses show that the leaves of *P. veitchii* are smaller, while the sepals are shorter and wider. The leaves of *P. veitchii* are also obviously narrower than the leaves of *P. serrulata* var. *pubscens*, while the calyx tubes are longer and the peduncles and pedicels are shorter. These results indicate that *P. veitchii* should not be treated as a synonym of *P. serrulata* var. *pubescens*.

The short peduncle was thought to be an important feature that distinguished *P. sargentii* Rehder from members of the *P. serrulata* complex (Chang et al. 2007). According to the key to classify the *P. serrulata* complex and its related species published by Chang et al. (2007), *P. veitchii* is similar to *P. sargentii*, having an umbellate or subumbellate inflorescence, sessile or short-pedunculate, consisting of 1–4 flowers

**Table 2.** Characteristic description of *Prunus veitchii*, *P. concinna*, *P. japonica* var. *zhejiangensis*, *Cerasus jingningensis* and *C. xueluoensis*, from the original literature (the description of *P. concinna* contains Koehne's description (Koehne 1912) in the original literature and Rehder's description (Rehder 1940) is based on the individuals introduced in Harvard Arnold Arboretum).

	P. veitchii	P. concinna	P. japonica var. zhejiangensis	C. jingningensis	C. xueluoensis
Life Form	Shrub	Shrub	Shrub	Shrub	Shrub, small tree
Lamina	-	narrow-elliptic to oblong- ovate, oblong-obovate	_	ovate, ovate- elliptic, obovate- elliptic	elliptic, obovate-elliptic
Leaf Length	-	3–6 (8) cm	-	3–6 cm	3–7 cm
Leaf Width	-	-	-	1.5–3 cm	1.5–3 cm
Leaf Margin	Incisively serrate	Sharply and rather finely serrate, doubly serrate	_	Acuminately serrate, biserrate	Serrate, biserrate
Leaf Apex	_	-	_	Acuminate, cuspidate	Acuminate, caudate
Leaf Base	_	Cuneate, rounded	_	Cuneate, rounded	Subrounded to broadly cuneate
Petiole	-	3–8 mm	-	4–10 mm	5–9 mm
Inflorescence	Umbellate, 1–3 flowered	Umbellate (Koehne, 1912), 1–4 flowered (Rehder, 1940), 1–2 flowered (Koehne, 1912)	-	Umbellate, subumbellate, 1–3 flowered	Umbellate, 2–4 flowered
Peduncle	No	No	-	Very short or no peduncle	Inconspicuous
Bract	Leaf like	-	-	Leaf like, subovate, ovate- oblong	Obovate, spatulate, fan- shaped, lobate
Pedicel	0.8–1.3 cm	0.8–1.5 cm (Rehder 1940), 0.8–0.9 cm (Koehne 1912)	_	0.8–1.8 cm	0.6–2.5 cm
Calyx Tube	Tubular with acute base, obconical, 8–10 mm long	Tubular (Rehder, 1940), obconically-tubular (Koehne, 1912), 9 mm long	-	Tubular- campanulate	Narrow tubular, apical enlarged, 6–10 mm long
Sepal	Ovate, oblong, entire	Ovate to ovate-oblong (Rehder 1940), ovate- triangular (Koehne 1912), entire	-	Ovate-triangular, entire	Ovate-triangular, entire
Published year	1912	1912	1992	2012	2013

with tubular hypanthia, triangular-lanceolate sepals with entire margins and white to reddish petals. Nonetheless, *P. veitchii* is definitely different from *P. sargentii*, which has small and elliptic or obovate-elliptic shaped leaves and short petioles, as opposed to the leaves of *P. sargentii* are elliptic-obovate or oblong-obovate and the length of leaves and petioles can reach 12 cm and 3 cm long (Rehder 1940). In addition, the distribution of *P. veitchii* is significantly different from that of *P. sargentii*. The former is mainly distributed around central and eastern China, while the latter is mainly distributed in northern Japan, the Korean peninsula and far eastern Russia (Chang et al. 2007). Therefore, we think that it is better treated as an separate species, based on current evidence.



**Figure 2.** Univariate statistics with the minimum and maximum values for discriminating characters of *Prunus veitchii* and *P. serrulata* var. *pubescens*. PS, *P. serrulata* var. *pubescens*. PV, *P. veitchii*. A, Peduncle length (cm). B, Pedicel length (cm). C, Length of calyx tube (cm). D, Diameter of calyx tube top (cm). E, Length of calyx lobe (cm). F, Width of calyx lobe (cm). G, Ratio of length and width of calyx lobe. H, Petiole length (cm). I, Leaf length (cm). J, Leaf width (cm). K, Angle of leaf base (°). L, Angle of leaf apex (°). M, Length of leaf apex (cm). N, Ratio of length and petiole length. O, Ratio of length and width of leaf.

E. H. Wilson 66 (Veitch Expedition) collected in April 1900, was cited as the voucher when Koehne described *P. veitchii*. However, this collection number is a source of some confusion. Number "66" was re-used by Wilson for a specimen collected in 1907 during his expedition for Arnold Arboretum, which was determined by Koehne (1912) as a certain form of *P. triflora*. Another number "66a", also collected in April 1900, was cited as *P. tenuiflora* by Koehne in "Plantae Wilsonianae" (Koehne 1912). There are 7 sheets (Table 4) designated as Wilson 66, collected in April 1900, in the Global Plant database (JSTOR 2018), three of which are not congruent with the original description. Amongst these three specimens, one of them, A00241703, contains Wilson's handwriting, which says '*Prunus serrulata* var. *pubescens*', indicating it is the voucher for Wilson's treatment of *P. veitchii* as a synonym of *P. serrulata* var. *pubescens*. It is reasonable to infer that the mixed collection led Wilson to propose a taxonomic treatment, different from Koehne.

As for why this species was published again several times, we believe that there are several reasons besides the confusing voucher. First, the vouchers of this species are deposited in different herbaria in different countries, so it would have been dif**Table 3.** Arithmetic average ±standard deviation and Kruskal-Wallis ANOVA for measured morphological characters. A, Peduncle length (cm). B, Pedicel length (cm). C, Length of calyx tube (cm). D, Diameter of calyx tube top (cm). E, Length of calyx lobe (cm). F, Width of calyx lobe (cm). G, Ratio of length and width of calyx lobe. H, Petiole length (cm). I, Leaf length (cm). J, Leaf width (cm). K, Angle of leaf base (°). L, Angle of leaf apex (°). M, Length of leaf apex (cm). N, Ratio of leaf length and petiole length. O, Ratio of length and width of leaf.

Variates	Prunus veitchii	P. serrulata var. pubescens	Chi-Square value (ANOVA)	P value (ANOVA)
A	$0.34 \pm 0.24$	$0.96 \pm 0.44$	12.639	< 0.001
В	$1.09 \pm 0.37$	$1.79 \pm 0.45$	9.536	< 0.01
С	$0.77 \pm 0.08$	$0.61 \pm 0.07$	14.158	< 0.001
D	$0.34 \pm 0.04$	$0.28 {\pm}~0.04$	7.424	< 0.01
E	$0.38 \pm 0.04$	$0.45 \pm 0.06$	6.869	< 0.01
F	$0.2 \pm 0.02$	$0.18 \pm 0.03$	0.925	0.364
G	$1.95 \pm 0.22$	$2.5\pm0.38$	12.639	< 0.001
Н	$0.74 \pm 0.16$	$1.88 \pm 0.31$	30.6	< 0.001
Ι	6.18±1.23	8.65±0.96	25.988	< 0.001
J	2.71±0.59	$4.62 \pm 0.67$	29.021	< 0.001
Κ	115.53±20.7	162.63±38.39	15.341	< 0.001
L	$75.9 \pm 8.61$	94.39±13.18	19.991	< 0.001
М	$0.61 \pm 0.21$	$1.1 \pm 0.24$	22.205	< 0.001
Ν	8.55±1.89	$4.68 \pm 0.71$	30.069	< 0.001
0	2.29±0.11	$1.89 \pm 0.19$	24.535	< 0.001

ficult to consult all of them in the past. Second, few sources, especially those easily accessible to Chinese plant taxonomists, record this species. *P. veitchii* is not included in "Flora Hubeiensis" (Fu 2002) and it is listed as one of the synonyms of *P. serrulata* var. *pubescens* in "Flora Reipublicae Popularis Sinicae" (Yü and Li 1986) and "Flora of China" (Li and Bartholomew 2003), which makes it easy to be ignored. And neither "Flora Hubeiensis" (Fu 2002) nor "Reipublicae Popularis Sinicae" (Yü and Li 1986) record *P. concinna*, which is only listed as a species that could not be treated in "Flora of China" (Li and Bartholomew 2003) because the authors had not seen the type specimens. Third, this species sometimes has three winter buds growing side by side, which has led some authors to treat it mistakenly as a member of section *Microcerasus* (Nan et al. 2013, Wang 2014, Liu et al. 2017). However, this trait is quite unstable. From observations of herbarium specimens and plants in the field, we found that the number of buds varies from one to three or four and mostly only one bud can be found (Figure 3).

According to the International Code of Nomenclature (ICN) (McNeill et al. 2012), it is necessary to designate a lectotype of *P. veitchii*, since the voucher points to more than one taxon. We choose the barcoded sheet US00130697 as the lectotype, since a label with Koehne's handwriting, '*Prunus veitchii* Koehne' is affixed to it.

Specimen	Туре	Collecting	Identification
-		locality	
E. H. Wilson 66 - E00417568	Original material	W. Hubei	P. veitchii
E. H. Wilson 66 – HBG511147	Original material	W. Hubei	P. veitchii
E. H. Wilson 66 - Y00415930	Original material	W. Hubei	P. veitchii
E. H. Wilson 66 – US00130697	Original material (lectotype designated in this paper)	W. Hubei	P. veitchii
E. H. Wilson 66 – A00032230	_	W. Hubei	A small branch is <i>P. veitchii</i> , the other 3 branches are <i>P. pseudocerasus</i>
E. H. Wilson 66 – A00241703	_	W. Hubei	P. tenuiflora (P. serrulata var. pubescence)
E. H. Wilson 66 – K000737109	_	W. Hubei	P. tenuiflora (P. serrulata var. pubescence)
E. H. Wilson 2825	Type of P. concinna	W. Hubei	P. veitchii
Zhang Fanggang & Li Zhiyun 5309	Type of <i>P. japonica</i> var. <i>zhejiangensis</i>	S. Zhejiang	P. veitchii
Y.K.Xu, C.G.Zhao etc. JN1205001	Type of C. jingningensis	S. Zhejiang	P. veitchii
Cheng-Hui Nan 040301	Type of C. xueluoensis	W. Hubei	P. veitchii

**Table 4.** Type and original materials of *Prunus veitchii*, *P. concinna*, *P. japonica* var. *zhejiangensis*, *Cerasus jingningensis* and *C. xueluoensis*.

### **Taxonomic treatment**

#### *Prunus veitchii* Koehne, Pl. Wilson. (Sargent) 1(2): 257. 1912 Figure 3

- Type: China, western Hubei, April 1900, E.H. Wilson 66 (lectotype, designated here: US! [US00130697]; isolectotypes E! [E00417568], HBG! [HBG511147], NY! [NY00415930], A! [A00032230 in part]).
- Prunus concinna Koehne, Pl. Wilson. (Sargent) 1(2): 210. 1912, syn. nov. Type: China, western Hubei, 7 April 1907, E.H. Wilson 2825 (holotype: K! [K000737137]).
- Prunus japonica Thunb. var. zhejiangensis Y. B. Chang, Bull. Bot. Res. 12(3): 271–274, 1992. Type: China, Zhejiang, Suichang, Daixikeng, Tieluyang, 26 May 1986, F. G. Zhang & Z. Y. Li 5309 (holotype: ZM!).
- Cerasus jingningensis Z. H. Chen, G.Y. Li & Y. K. Xu, Jour. of Zhejiang For. Sci. & Tech. 32(4): 81–83, 2012, syn. nov. Type: China, Zhejiang, Jingning She Autonomous County, Dayanghu, 22 May 2012, Y. K. Xu, C. G. Zhao et al. JN1205001 (holotype: ZJFC!).
- Cerasus xueluoensis C. H. Nan & X. R. Wang, Ann. Bot. Fennici 50: 79–82, 2013, syn. nov. Type: China, Hubei, Enshi Tujia and Miao Autonomous Prefecture, Xuanen County, Xueluozhai, 3 April 2009 C. H. Nan 040301 (holotype: NF!).

**Description.** Small trees, sometimes shrubs, deciduous, up to 3 m tall. Winter buds ovoid, apex acute, 1-3(4). Stipules lanceolate, sometimes ovate and lobed. Leaves elliptic to obovate-elliptic,  $3-8 \times 1.5-3.5$  cm, apex acuminate, base subrounded to broadly



Figure 3. P. veitchii. A. Flower branch. B. Fruit Branch. C. Individual. D. Variation of the winter buds.

cuneate, abaxially pale green and glabrous, sparsely pilose or sometimes pilose when young, adaxially green and glabrous or sparsely pubescent, margin serrate or biserrate. Petiole 4–10 mm, glabrous or sparsely pilose, apex with 2 nectaries or not. Inflorescence umbellate or sometimes corymbose, peduncle short or inconspicuous, 1–4-flowered, involucral bracts spatulate or obovate-elliptic, bracts ovate, obovate or spatulate, margin serrate. Pedicel 6–25 mm, glabrous or sparsely pilose. Hypanthium tubular,  $6-10 \times 1.5-3$  mm, reddish-green to purplish, glabrous or sparsely pubescent. Sepals ovate-triangular to triangular-lanceolate, 3–5 mm, margin entire. Petals white or pinkish, obovate, apex emarginate, ca. 10 mm long. Stamens ca. 30–40. Style glabrous. Drupe ovoid or globose, ca. 8–10 mm in diam., glabrous, black when ripe. Flowering March-April, fruiting May-June.

**Distribution and habitat.** Anhui, Fujian, Hubei, Hunan, Jiangxi, Zhejiang Provinces, usually occurs in mountain-top thickets at elevations of 800 to 1700 m (Figure 4).

**Specimens examined. Fruit or leaf branch,** JianJun Zhou 16050702, Xunlin Yu & Hui Zhou 14051515 (CSFI); Fusong Peng 728, 551, Anonymous 23060, Anonymous



Figure 4. Distribution and habitat of *P. veitchii*. A. Distribution. B. Habitat.

& Qibai Xiang 844, Laiguan Lin 5976, Linhan Liu 1838, Xianyu He 21316, C. Y. Wu L72, Jiangxidiaochadui 348, Jiangxidui 1242 (PE); Anonymous 11758 (NAS); Choufen Liang 34522; 34484, 34442 (IBK); Xianyu He 23025, Wukaodui 2386 (IBSC); Yaoguo Xiong 07753, 08772 (LBG); Changming Xie et al. L8633-304, Jianshe Fang et al. L8635-320, Maochun Liu 840044, Chensen Ding & Xianglin Shen 5234, 5342, 5215 (ZJFC). **Flower branch,** H. H. Chung s. n. (AU); Xu Zhang 2015033003, Xunlin Yu, Fan Zhang, Ronghui Tu 16040517, Xunlin Yu, Si Feng, Fanxun Zhang 16040506 (CSFI); HZ017025 (HZ); Lai & Shan 647, Niemin Xiang 92022 (NAS); Anonymous 4218, Jiangxidui 81 (PE); Chensen Ding et al. 5008, Liang Chen 0219 (ZJFC).

#### Acknowledgements

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# Appendix

P. serrulata var. pubescens

Flower

China: Anonymous 118 (IFP), E. H. Wilson 20 (A00241699), E. H. Wilson 20 (A00241700), E. H. Wilson 13, 66, 69 (A), Anonymous s. n. (NAS00358158), H. F. Chow 40129 (PE), Z. Wang 2283 (PE).

North Korea: C. S. Chang & S. A. Ryue sky 0038 (PE).

Leaf

E. H. Wilson 20 (A00241699), E. H. Wilson 20 (A00241700), E. H. Wilson 13, 51, 51a, 69 (A), H. H. Chung s. n. (AU034505), Wilson 5833 (GH), Anonymous 3038 (NAS00358152), X. Y. He 21994 (NAS), M. B. Deng 4136 (NAS), T. Y. Zhou 1101 (NAS), K. Nakashima s. n. (NAS00358168), M. B. Deng 5498 (NAS), S. X. Li 592 (PE), T. Tang 1948 (PE).

P. serrulata var. pubescens determined as P. leveilleana

Flower

Japan S. Tsugaru 14295, 16109 (

S. Tsugaru 14295, 16109 (MO), S. Tsugaru et al. 32548 (MO), T. Sawada 895(MO),
 T. Sawada et al. 287 (MO), K. Seto 28312 (MO),

Leaf

Japan: C. Howick et al. HMT2688, HMT2689 (MO), S. Tsugaru 14326 (MO), S. Tsugaru et al. 18429 (MO), S. Tsugaru et al. 692 (MO), S. Tsugaru et al. 27511, 27680, 29096 (MO), S. Tsugaru & T. Takahashi 14586 (MO), T. Takahashi & G. Murata 2913 (MO), T. Sawada 895 (MO).

# Flower

China: E. H. Wilson 66 (HBG511147, NY00415930, US00130697), H. H. Chung s. n. (AU039954), Q. Z. Lin 054029 (CSFI), X. L. Yu et al. 16040517 (CSFI044820, CSFI044821, CSFI044822), S. Feng & G. X. Feng 16040517 (CSFI), X. Zhang 2015033004 (CSFI), Anonymous 547 (HHBG\_ HZ017025).

Leaf

China: G. Yao & R. P. Jiang 11758 (NAS), Anonymous 660465 (LBG00010741), Y. G. Xiong 07753, 08772 (LBG), X. L. Yu & H. Zhou 14051515(CSFI), H. Zhou 16050702 (CSFI), C. F. Liang 34442, 34484, 34522 (IBK), Wukaodui 2386 (IBSC), X. G. Li 203583 (IBSC), X. Y. He 23025 (IBSC), F. S. Peng 728 (PE), Jiangxidui 348 (PE), Jiangxidiaochadui 348, 1242 (PE), Y. K. Xu, C. G. Zhao et al. JN1205001 (ZJFC).
**RESEARCH ARTICLE** 



# A remarkable new species of *Pamianthe* (Amaryllidaceae) from the Department of Cauca, Colombia

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#### Abstract

A new saxicolous species of Amaryllidaceae tentatively assigned to the tribe Clinantheae, *Pamianthe ecollis* Silverst., Meerow & Sánchez-Taborda, is described from the western slope of the Cordillera Occidental in the department of Cauca, Colombia. The new species differs from the two hitherto known species of *Pamianthe* in its yellow flowers and in its nearly obsolete perianth tube. The near loss of the perianth tube may be correlated with a change in pollinator. The new species lacks a bulb; it produces a large number of winged seeds that are wind-dispersed. A key to the species of *Pamianthe* is provided. This is the first record of the genus *Pamianthe* for Colombia. The phylogenetic position of the genus *Pamianthe* is discussed.

#### Keywords

Amaryllidaceae, biodiversity, Cauca, Clinantheae, Colombia, Pamianthe, Andes

#### Resumen

Se describe una nueva especie de Amaryllidaceae tentativamente perteneciente a la tribu Clinantheae, *Pamianthe ecollis* Silverst., Meerow & Sánchez-Taborda, procedente de la vertiente occidental de la cordillera Occidental en el departamento del Cauca, Colombia. La nueva especie difiere de las dos especies conocidas de *Pamianthe* por su perianto amarillo que tiene un tubo casi ausente. La reducción del tubo del perianto probablemente tiene correlación con un cambio en el polinizador. La nueva especie carece de un bulbo, y produce numerosas semillas aladas que se dispersan por el viento. Se provee una clave a las especies de *Pamianthe*. Este es el primer registro del género *Pamianthe* para Colombia. Se discute la posición filogenética del género *Pamianthe*.

#### Introduction

Amaryllidaceae J. St.-Hil. is a cosmopolitan family represented in Colombia by nine native genera and 26 native species, including a monotypic endemic genus, *Plagiolirion* Baker (Meerow and Silverstone-Sopkin 1995). Some of the Colombian species have restricted ranges and are in danger of extinction or may already be extinct (Silverstone-Sopkin 2011). Recent field work in the Cordillera Occidental of the Andes, in the department of Cauca, has resulted in the discovery of a new species of Amaryllidaceae that also seems to be narrowly distributed. Vegetative and floral morphology and nrDNA ITS sequences indicate that this species represents a novelty in the genus *Pamianthe* Stapf.

Stapf (1933a, 1933b) published the genus *Pamianthe* in honor of Major Albert Pam, who cultivated bulbs in England that he received from Peru in 1928. There are five published species names that have been assigned to this genus: *P. andreana* (Baker) Stapf, *P. cardenasii* Traub, *P. parviflora* Meerow, *P. peruviana* Stapf, and *P. quitoensis* (Herb.) Stapf. *Pamianthe quitoensis* was transferred to the genus *Leptochiton* Sealy, as *L. quitoensis* (Herb.) Sealy, and *P. andreana* is considered a synonym of this species. *Pamianthe cardenasii* has been placed in the synonymy of *P. peruviana* (Meerow 1984). Thus, the genus *Pamianthe*, as previously recognized, includes only two species, *P. parviflora*, known only from Ecuador (Meerow 1984), and *P. peruviana* (the type species), known from Perú and Bolivia. The new species described in this paper is the third species of the genus and the first record from Colombia. It is also the first species of the tribe Clinantheae, to which *Pamianthe* has been assigned (Meerow et al. 2000; Leiva and Meerow 2016), discovered north of Ecuador.

#### Methods

Photographs of the flower in alcohol and seeds of *Pamianthe ecollis* were taken with a Nikon model DS-Ri1U3 digital camera, using a Nikon model SMZ-1500 stereo dissecting microscope at the Laboratorio de Imágenes del Postgrado en Ciencias-Biología de la Universidad del Valle; floral and seed measurements were made with NIS Elements Br, version 4.20 software.

DNA extraction, amplification and sequencing protocols were as described in Meerow et al. (2000, 2006). The ITS sequence of *P. ecollis* was aligned with a previous ITS alignment of the tribe Clinantheae (Meerow et al. 2000; Meerow 2010) using the program MAFFT (Katoh and Standley 2013). A branch and bound parsimony analysis was run using PAUP v. 4.10 (Swofford 2002), followed by generation of Jackknife support percentages. The ITS sequence of *P. ecollis* is deposited in GenBank (Genbank Acc. MH979036).

#### Results

Taxonomic treatment

# Pamianthe ecollis Silverst., Meerow & Sánchez-Taborda, sp. nov.

urn:lsid:ipni.org:names:77193890-1 Figs 1, 2

**Diagnosis.** This species differs from both *Pamianthe parviflora* Meerow and *P. peruviana* Stapf in having a yellow perianth and staminal cup (versus white) and in nearly lacking a perianth tube. Additionally, it differs from *P. parviflora* in having shorter pedicels, a longer ovary, and more numerous ovules, and from *P. peruviana* in having much longer pedicels, more flowers per umbel, much shorter tepals, a shorter staminal cup that is not exserted from the perianth, and a smaller fruit.

**Type.** COLOMBIA. Cauca: Municipio Argelia, road between Nuevo Horizonte and La Montaña, north of the Serranía El Pinche, Cordillera Occidental, western slope (Fig. 3), 2839 m, 4 Feb 2018, *J. A. Sánchez-Taborda 2870* (holotype: CUVC 67719!, 67720!, mounted on two sheets; isotype: CAUP). GPS coordinates are withheld to discourage poaching; they are available to bonafide researchers upon request.

Description. Terrestrial saxicolous herbs (Fig. 1A); bulb absent, roots emerge from base of pseudostem, and are thick, possibly with a velamen layer (Fig. 1B). Leaves (Fig. 1C) sessile, attached alternately to an elongate pseudostem; lamina lorate, 82.7–104.5 × 5.5–6.3 cm, margin entire, glabrous, narrowing distally (but not acuminate), apex acute, with a conspicuous midrib. Scape cylindrical, 45-46 cm long; intact bracts not seen (bracts withered and damaged in dried specimens); inflorescence pseudoumbellate, flowers oriented at right angles from apex of pedicels. Flowers (Fig. 1D-F) 9-10, of which 3-4 are at anthesis simultaneously; pedicels in flowers at anthesis 7–9 cm long; perianth tube nearly obsolete (ca. 1.8 mm long); limb crateriform, ca. 3.3 cm in diam; tepals 6, yellow, glabrous; outer tepals with green tips and very narrow green abaxial mid-longitudinal stripe, valvate, elliptical, ca.  $3.2 \times 1.4$ –1.5 cm, apiculate, apex thickened, ca. 2.3 mm long, with salient adaxial apiculum (Fig. 2B) ca.  $1.3 \times 1.4$  mm, which is densely glandular-papillate (Fig. 2C); inner tepals imbricate at base, ovate, broader than outer tepals, ca.  $2.8 \times$ 2.1 cm, apex rounded, thickened and papillate on adaxial surface, but not apiculate and lacking adaxial protuberance. Stamens 6, basally connate into immaculate yellow staminal cup attached to the adaxial base of inner tepals (Fig. 2A), ca. 5 mm long (measured from base to tip of tooth), not exserted, with 2 deltoid to rounded teeth between each 2 free filaments; free filaments yellow, ca. 5 mm long, attached to border of staminal cup, included, strongly incurved; anthers grouped in center of flower (but not connivent), brown with yellow borders, ca. 7.1 mm long, linear, dorsifixed, versatile, longitudinally dehiscent; pollen yellow. Style (in the only flower preserved in ethanol) apparently immature (flower protandrous), curved, ca. 10 mm long, included (hidden below the grouped anthers), stigma 3-lobed, lobes papillate;



Figure 1. Pamianthe ecollis. A Pamianthe ecollis growing in its native habitat, on a steep, rocky bank B Base of plant C Habit D Inflorescence E Flower, lateral view F Flower, front view A photo by Fredy Gómez-Ortiz
B photo by Laura Clavijo C-F type collection, photographs taken in the field by Jhon A. Sánchez-Taborda.

ovary green, 3-angled, oblong, ca.  $40 \times 9$  mm, 3-loculed, placentation axile, ovules oblong, ca.  $1.6 \times 0.5$  mm, ca. 100 per locule (Fig. 2D), biseriate, ovules of each row alternating with those of the other row. Fruit (Fig. 2E): unopened fruit not available for measurement; dehiscent fruit 3-valved, valves broad-elliptic to obovate, base obtuse, apex short-beaked, dry, smooth, glabrous, ca.  $38 \times 29$  mm. Seeds (Fig. 2E, F) as many as 233 in one capsule, alate, glabrous, seed body dark brown, wing light brown, flat, thin, membranous, shape of entire seed (including wing) narrowly to broadly falcate, (12-) 15–18 × 5–9 mm.



Figure 2. *Pamianthe ecollis*. A Androecium, with staminal cup B Tip of outer tepal, showing apex and adaxial protuberance C Adaxial protuberance, showing glandular papillae D Opened ovary with ovules (ovules in two locules are visible) E Infructescence of living plant F Seeds, showing variation in shape
A–D, F photographs by Juan Felipe Ortega-Giraldo, Laboratorio de Imágenes del Postgrado en Ciencias-Biología, Universidad del Valle, Cali, Colombia E photo by Laura Clavijo.

**Distribution and ecology.** *Pamianthe ecollis* is known only from the type locality (Fig. 3). The general habitat is cloud forest. The forest at this site includes the following genera: trees: *Clusia* L., *Hedyosmum* Sw., *Ocotea* Aubl.; shrubs: *Miconia* Ruiz & Pav., *Palicourea* Aubl.; herbs: *Anthurium* Schott, *Besleria* L., *Kohleria* Regel, *Peperomia* 



Figure 3. Map of Colombia showing the distribution of Pamianthe ecollis (black circle).

Ruiz & Pav., and *Sphaeradenia* Harling. Epiphytes were predominantly bromeliads and orchids. The new species is common at this site (Fredy Gómez-Ortiz pers. com.). However, this species does not grow within closed forest. The seeds of *P. ecollis*, which are adapted for anemochory, and a photograph of the population at the type locality (Fig. 1A), indicate that this species inhabits open areas on steep banks near creeks. Plants from the type collection were growing near a waterfall. Plants from a later collection, from which herbarium specimens were not prepared, were growing on an apparently disturbed, open slope on rocky substrate. The roots of the plants are superficial, immersed in a thick layer of moss, and grasp the surface of the rock. Thus, this species is a lithophyte.

Phenology. Plants were collected in flower in February and in fruit in August.

**Etymology.** The specific epithet is from Latin, *e* (without), *collum* (neck), adjectival form *collis*, referring to the almost absent perianth tube of this species.

**Preliminary conservation status.** Since nothing is known of the distribution of this species apart from the type locality, it is best to place it in the category Data Deficient (IUCN 2012, 2017).

### Discussion

A strict consensus tree cladogram (Fig. 4) based on ITS sequences of the tribe Clinantheae places the new species of *Pamianthe* as sister to *P. peruviana* with 92% jackknife support, in a subclade that is sister to a second subclade comprising *Clinanthus* Herb. and *Paramongaia* Velarde. However, with ITS there is no support for *Pamianthe* as part of Clinantheae (jackknife support = 42%; Fig. 4). Preliminary super matrix trees from sequence capture with anchored bait enrichment (Meerow, unpublished data) suggest that *Pamianthe* is in fact sister to the tribes Clinantheae, Eucharideae, and Hymenocallideae, rather than the first branch in Clinantheae.

*Pamianthe ecollis* resembles the two other species of *Pamianthe* in its staminal cup morphology, with the free portion of the staminal filaments attached to the rim of the cup (not below the rim), two lobes or teeth between each two staminal filaments, and the staminal filaments strongly curved inward, as well as numerous, biseriate, winged, wind-dispersed seeds. Leaf width and the conspicuous midvein are similar to that of *P. peruviana*. It differs from both of the two hitherto known species in having a yellow perianth and staminal cup (versus white in the other two species) and in its nearly obsolete perianth tube. Moreover, *P. parviflora* has a shorter ovary (10 mm versus 40 mm in *P. ecollis*) and fewer ovules per locule (about 20 versus about 100 in *P. ecollis*). *Pamianthe peruviana* additionally differs in having fewer flowers (2–4, usually 2, versus 9–10 in *P. ecollis*), shorter pedicels (1.5–3 cm long versus 7–9 cm long in *P. ecollis*), free tepals much longer (outer tepals 10–12 cm long, inner tepals 9–11 cm long, versus 3.2 and 2.8 cm long in *P. ecollis*), staminal cup 8 cm long and long-exserted (versus ca. 0.5 cm long and included in *P. ecollis*).

The elongate (12–25 cm long) perianth tube in *P. peruviana*, which contains three nectar-bearing internal channels (Traub 1972), may be correlated with pollination by sphingid moths. The nearly obsolete perianth tube of *P. ecollis* may be associated with a change in pollinators; in a tubeless perianth, nectar would be available to short-tongued insects, such as bees. No flower visitors have been observed.

The glandular papillae (Fig. 2C) on the adaxial protuberance of the outer tepals apparently have a secretory function. They probably play a role in pollinator attraction; they may produce a substance that is gathered by insect visitors, or they may function as osmophores. Possible osmophores have been reported in the Chilean allioid amaryllid *Gilliesia* Lindl. (Rudall et al. 2002). The flat, alate seeds are most likely wind-dispersed, suggesting that these plants inhabit open areas within the cloud forest vegetation; seeds of Amaryllidaceae of closed lowland tropical forest, such as *Eucharis* Planch. & Lind., are relatively few per locule, subglobose, and wingless, and probably are bird-dispersed, and in one case possibly water-dispersed (Silverstone-Sopkin 2011).

The Clinantheae, which is sister to the tribe Hymenocallideae (Meerow et al. 2000), was not previously known to extend to Colombia. We hypothesize that the three rare species of *Pamianthe* may represent the remnants of a once more broadly distributed epiphytic and lithophytic lineage in the tribe that were isolated as the Andes



**Figure 4.** Strict branch and bound parsimony consensus tree of the Clinantheae, based on ITS sequences, with jackknife support values.

rose to their present position, and moist forests contracted on the western slopes. We are confident that rigorous analysis of our next generation sequence data will successfully resolve the current ambiguous phylogenetic position of the genus.

#### Key to the species of the genus Pamianthe

1	Perianth and staminal cup yellow, perianth tube nearly obsolete
_	Perianth and staminal cup white, perianth with a well-developed tube2
2	Pedicels 5-6 cm long; perianth tube less than 2 cm long; outer tepals less than
	3 cm long; staminal cup less than 2 cm long Pamianthe parviflora Meerow
_	Pedicels 1.5-3 cm long; perianth tube more than 11 cm long; outer tepals
	more than 8 cm long; staminal cup more than 7 cm long

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**REVIEW ARTICLE** 



# Trollius austrosibiricus (Ranunculaceae), a new species from South Siberia

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#### Abstract

*Trollius austrosibiricus* Erst & Luferov, **sp. nov.**, a new species from Russian South Siberia is described and illustrated. This new species is endemic to Western and Central Siberia. Morphologically, it is close to the East Asian species *T. chinensis* and *T. macropetalus*. However, it differs from the aforementioned species due to the morphology of the rhizomes, aerial shoots, sepals and petals. This species is also distinguished from *T. asiaticus*, which is widespread in Russia (Western and Eastern Siberia), Mongolia, China, northeastern Kazakhstan and in the northeast of the European part of Russia, in having a smaller number of sepals, longer persistent styles and petals longer than sepals. In addition, an identification key for all Russian species is given and all species have been discussed.

#### Keywords

Ranunculaceae, Trollius, new species, South Siberia, Russia

#### Introduction

Trollius L. (Ranunculaceae) is distributed in temperate to arctic regions of the Northern Hemisphere and has two centres of diversity in SW China and the area ranging from Siberia, the Pamirs and Kashmir (Doroczewska 1974). The genus is characterised by conspicuous orange- or yellow-coloured flowers, similarly coloured petals, subscapose habit and ternate or deeply 3-lobed leaves (Kadota 1987). Trollius is distinguished by an unusual floral structure with petals divided into blade, pit (nectarostigma) and claw (Wang et al. 2010). Length ratio of nectaries to stamens has been considered to be one of the most important morphological characters for species delimitation (Schipczinsky 1937, Siplivinsky 1972, Kadota 1987, Tamura 1995, Luferov et al. 2018). Species belonging to the T. sect. Longipetala Dorosz. are characterised by linear, flat, thin petals, which are longer than the sepals or nearly equal to them. All representatives belonging to this group, except *T. asiaticus*, are common to the Far East part of Asia. All Siberian species are characterised by petals shorter or equal to sepals. When carrying out a revision of the genus for Russia, we focused on specimens whose petals are much longer than the sepals. Further revision of the herbarium material allowed us to describe a new species of Trollius from South Siberia.

#### Methods

The revision of herbarium material was undertaken in the herbaria LE, MHA, ALTB, NS and NSK (Thiers 2017). The drawings of *Trollius austrosibiricus* are based on the images of the type specimens (NS-0013097). The photographs in the field were taken by a Nikon D90 camera. The morphological characters were measured using AxioVision 4.8. The flowering and fruiting periods and habitats are given as cited on the collector's labels. The IUCN Red List Categories and Criteria (IUCN 2016) were applied to assess the conservation status. All revised localities of *Trollius austrosibiricus* mentioned in the paper are shown on a map (Fig. 1) made with SimpleMappr (http://www.simplemappr.net).

#### Taxonomy

*Trollius austrosibiricus* Erst & Luferov, sp. nov. urn:lsid:ipni.org:names:77194177-1

Figs 2, 3

**Type.** RUSSIA. Tuva Republic: Mongun-Tayga region, Tsagan-Shibetu ridge, the upper Barlyk river, valley of the right tributary, the lower part of the south-eastern slope (5°), forb-grass-sedge steppe meadow, 2350 m alt., flowering, 22 Jul 1980,



Figure 1. Distribution map of Trollius austrosibiricus.

V. Khanminchun, M. Danilov & P. Enns without collector number (holotype: NS barcode 0013097!).

**Diagnosis.** *Trollius austrosibiricus* is morphologically close to *T. chinensis* Bunge and *T. macropetalus* (Regel) Fr.Schmidt. It differs from these species in simple rhizomes, shorter aerial shoots, smaller flowers and shorter persistent styles. The new species is distinguished from *T. asiaticus* L. by a smaller number of sepals, longer persistent styles and petals longer than sepals.

**Description.** *Herbs* perennial, (20-)40-70 cm high. *Rhizomes* simple or slightly branching, short, erect or arched, with a bundle of adventitious roots. *Stems* straight, simple, less often weakly branched, slightly grooved. *Basal leaves* (1-)2-4, spirally-alternate, congested in a basal rosette; petioles 10-25(-35) cm long; blades  $4-7 \times 5-8$  cm, rhomboid, 3-5(-7)-lobed, segments dissected almost to the midrib into lobes, ending sharply with edges dentate. *Cauline leaves* 2-5(-7), opposite, with short petioles or sessile, gradually smaller towards the apex. *Inflorescence* terminal, 1(-2)-flowered. *Flowers* 3.5-4.5(-5.5) cm diam.; pedicels 5-12 cm long, elongating in fruit up to 8-15 cm long; sepals 8-10(-14),  $1.3-2.4 \times 0.8-1.5$  cm, rhombic-ovate or broadly elliptic, reddish-orange or yellow-orange; petals 9-18,  $2-2.8 \times 0.2-0.3$  cm, oblong-lanceolate, slightly wider at middle, base narrow cuneate, apex acute, orange- or reddish-orange coloured, nectarostigma 2.5-3 mm from base; stamens more than (9)10, filaments 7-11mm long, anthers 1.5-2(-2.5) mm long, linear; *Fruits* aggregate, with 9-14(17) follicles, 10-15 mm long, persistent style 1.5-3.0 mm long, slightly incurved.

**Specimens seen (paratypes). Russia. Tuva Republic:** Western Sayan, Kurtushibinskiy ridge, the upper Mynas river, right tributary of the Hut river, forb-grass meadow, 1080 m alt., 6 Jul 1989, D. Shaulo & I. Kovaleva 4695 (NS barcode 0013098!); Mongun-Tayga region, valley of Tolayty river, yernik-sedge wetland meadow, 2500 m alt., 26



**Figure 2.** Photograph of *Trollius austrosibiricus*. **A** Flowering plant **B** Flower **C** Leaf laminae (Photographs by E. Balde and A. Erst).

Jul 1980, M. Danilov & A. Krytsin 932 (NS barcode 0013096!); the northern slope of the East Tannu-Ola ridge, the average flow of Elegest river, floodplain, No., 22 Jul 1973, V. Khanminchun & V. Dyukov 2270 (NS barcode 0013095!); **Kemerovo Oblast**: Tashtagol region, the village of Ust-Kabyrza 4 km above Pysas river, 52°48'N, 88°28'E, 450 m alt., grass meadow, haymaking, 11 Sep 2000, I. M. Krasnoborov, A. I. Shmakov, D. Germann, S. Kostyukov, E. Antonuk, P. Kosachev & A. Vashchenko 207 (NS barcode 0013094!); **Krasnoyarsk Krai**: Abansky region, near Ustyanskoye village, the upper part of the eastern slope, upland meadow, 6 Jul 1956 T. Vagina (NS barcode 0013093!); Ermakovsky district, valley of the US river, elevation 852 m alt., 52.2847°N, 93.2517°E, 03 Jul 2010, I.V. Khan & E.A. Balde 152 (NSK barcode 0028601!); **Khakassia Republic**: Abansky ridge, near Biskamzha station, southern slope, burning, 53.25 N, 089.30E, 700 m alt., 4 Jun 1991, E. Ankipovich (NS barcode 0013092!).

Affinities. Trollius austrosibiricus is morphologically close to T. chinensis Bunge and T. macropetalus (Regel) Fr.Schmidt. It is well distinguished by simple rhizomes (rather than by the multi-headed basal part of the plant, as in T. chinensis and T. macropetalus), shorter aerial shoots, smaller flowers and shorter persistent styles (Table 1). Trollius chinensis is an East Asian species occurring in Russia (Primorsky



Figure 3. *Trollius austrosibiricus*. A General view B Sepal C Petal D Stamen E Fruit F Follicle. Scale bar: 1 cm (A–F).

Characters	T. austrosibiricus	T. chinensis	T. macropetalus	T. asiaticus
Stem height, cm	(20)40-70	70–150 (180)	70–150 (180)	20-75
Underground organs	simple rhizomes	multi-headed basal part	multi-headed basal part	multi-headed basal part
Length/width of the basal leaf blade	47/58	6-15/7-25	6-15/7-25	4-7/5-8
Number of flowers on shoot	1(2)	2–7(1)	2–7(1)	1–2(3)
Flower diameter, cm	3.5-4.5(5.5)	4-5(6)	(4)5-7(8)	3-4(5)
Number of sepals	8-10(14)	8-12	5-7	10-20
Petal length, mm	20-28	25-35	30-35 (40)	14-22
Petal apex	Acute, narrowed smoothly from the middle part of the petal	Acute, narrowed abruptly upwards	Acuminate, narrowed smoothly upwards	Rounded
Distance from nectary pit to petal base, mm	2.5–3	3.5–4	3.5–4.5	1.5–2
Sepals/Petals length ratio	<1	<1	<1	≥1
Petal/Stamen length ratio	2-3.5/1	2-3/1	3.5-5/1	1.5-2/1
Follicle length, mm	10-15	14-18	14-22	8-12
Style length, mm	1.5–3	3–4	3.5–5	0.5-1(2)
Persistent style shape	Almost erect at the base, above: bent arc-like inwards	Bent outwards at the base, above: bent slightly arc-like towards the centre of the flower	Bent outwards at the base, above: bent slightly arc-like towards the centre of the flower	Bent sharply arc-like towards the centre of the flower

Table 1. Morphological comparison between *Trollius austrosibiricus* and related species.

and Khabarovsk territories, Sakhalin), in the north and northeast of China and on the Korean peninsula (Schipczinsky 1937, Siplivinsky 1972, Doroczewska 1974, Kitagawa 1979, Woroshilov 1982, Luferov 1991, 2004).

This new species is distinguished from *T. asiaticus* L. by a smaller number of sepals, longer persistent styles and petals longer than sepals (Table 1). *Trollius asiaticus* grows mainly in extra-tropical Asia (Western and Eastern Siberia, Mongolia, northeast Kazakhstan and China), as well as in the northeast of European Russia (Schipczinsky 1937, Siplivinsky 1972, Doroczewska 1974, Borodina-Grabovskaya 2001, Friesen 2003).

Phenology. Flowering from April–early May; fruiting in May.

**Distribution.** *Trollius austrosibiricus* is endemic to mountainous areas of the southern part of Western and Central Siberia. Russia: Tuva Republic, Kemerovo district, Krasnoyarsk territory, Khakassia (Figure 1).

Habitat and ecology. *Trollius austrosibiricus* grows in subalpine and forest zones, in moist valleys at 350–2400 m elevation. It occurs in forest glades and fringes, in mixed-grass and mixed-grass-cereal dry and swampy meadows, along the banks of rivers, streams and small ponds with fresh water.

**Etymology.** The specific epithet of the new species is derived from the type locality, South Siberia, Russia.

**Preliminary conservation assessment.** No appropriate data on abundance and/ or distribution of the taxon are available. It can be included in the Not Evaluated (NE) category of IUCN Red List Categories (IUCN 2016) as it lacks adequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.

#### Discussion

According to our data, 16 species of Trollius occur in Russia. The "Flora of the USSR" includes 11 species of Trollius, one of which is not found in Russia: T. dschungaricus Regel is confined to the east of Central Asia and China (Schipczinsky 1937). The greatest species diversity is observed in Siberia (12 species: our data); 11 species of Trollius (Friesen 2003) were previously indicated for this region, of which we recognise 9 and T. sayanensis (Malyschev) Sipl. and T. vicarius Sipl. are synonyms to T. asiaticus L and T. uniflorus Sipliv. Nine species grow in the Far East (Luferov et al. 2018), 5 species of Trollius are found in the European part of Russia (Tzvelev 2001) and 1 species occurs in the Caucasus (Borodina-Grabovskaya 2012). Many species that have been described recently from Russia require more detailed investigation and evidence of species independence (Luferov et al. 2018). Many taxa of the genus have intermediate characteristics of the groups described by A. Doroczewska (1974) as sections. The groups considered in this monograph require verification, since many species exhibit intermediate features between sections. Molecular phylogeny has not yet been developed, but there are some works related to a small number of species that do not consider the classification of groups (Despres et al. 2003, Wang et al. 2010). Representatives of the Trollius section occur in Russia (petals 6-14 mm long, linear, apex rounded or spatulate, with no groove at the base; plants of Asia, Europe and the Caucasus): T. europaeus, T. altaicus and T. ranunculinus; the Longipetala sections (petals 7-40 mm long, oblong, narrow, flat, thin, not thickened and dull, similar to sepals and usually orange): T. macropetalus, T. ledebourii, T. austrosibiricus, T. asiaticus, T. kytmanovii and T. apertus; the Insulaetrollius sections: (petals 2-12 mm long, linear, extended or pyriform, grooved at the base; plants of the Okhotsk-Japan-Kamchatka region): T. riederianus, T. sibiricus, T. uniflorus, T. japonicus, T. miyabei, T. membranostylis and T. chartosepalus. It should be noted that many morphological characters used to distinguish between species and groups of species are not fully developed, do not cover the entire morphological diversity of the genus Trollius and are very variable (many hybridogenic taxa have not yet been described, many species ecomorphs are not yet known). For proper identification, classification and understanding of groups in the genus Trollius, complex studies are needed, including micro- and macro-morphological, molecular phylogenetic, cytogenetic etc. This paper presents the results of taxonomic studies that enabled development of the key to identification of the Trollius species, based on the novel morphological and rhythmological features: for example, indication of the falling (in T. chartosepalus) and non-falling sepals (in other species), shape, the size of sepals, petals, persistent styles, their size ratio, the colour of the flower elements, leaflets and stigmas.

According the most recent data, the key for *Trollius* identification (from Russia) is provided by us.

# Key to identification species of the genus Trollius from Russia

1	Flowers globular, closed due to overlapping sepal edges; petals, stamens and pistils pot visible during flowering
_	Flowers bowl-shaped, saucer-shaped or, if globular, always open: sepal edges
	do not overlap; petals, stamens and pistils visible during flowering2
2	Petals longer than sepals and protrude from the flower
-	Petals equal to sepals or shorter4
3	Sepals 5–7. Petals 30–40 mm long, 1.5–2 times longer than sepals. Persistent
	styles 3.5–5 mm long T. macropetalus
-	Sepals 8–14. Petals 20–28 mm long, 1.2–1.5 times longer than sepals. Persis-
	tent styles 1.5–3 mm long T. austrosibiricus
4	Petals 1.5–2 times longer than stamens
_	Petals shorter
5	Persistent styles and stigmas purplish-black or often blackening. Persistent
	styles 2.5-3 mm long (Plants from the Altai Republic) T. altaicus
-	Persistent styles and stigmas light green or yellow-green. Persistent styles less
	than 2 mm long
6	Plants 80–100 cm high. Sepals 5–9 (12) T. ledebourii
_	Plants 20–75 cm high. Sepals 10–207
7	Sepals reddish-orange. Persistent styles 0.5–1 mm long
-	Sepals yellow-orange or yellow. Persistent styles 1.5–2 mm long
0	Diente ble en griegete la ferregenieg. Segula en ite en gele energe ferrele der
0	Plants bloom prior to lear expansion. Sepais white of pale cream, finely den-
	tate along the edge, do not fall long after flowering. Leaflets up to 25 mm
	long. Persistent styles 8–18 mm long, equal to or longer than the ovary, thin,
	straight or slightly curved
-	Plants bloom with leaves developed. Sepals from pale yellow to orange, typi-
	cally smooth-edged, fall at the end of flowering. Leaflets up to 15 (18) mm
	long. Persistent styles not more than 5 mm long, several times shorter than the ovary more or less thickened incurved
9	Persistent styles 4–5 mm long 3 times shorter than leaflets. Senals golden-
/	vellow T ranunculinus
	Persistent styles less than 3 mm long 5 7 times shorter than leaflets 10
10	Petals equal to stamens 1, 3 mm longer or shorter
10	Portals 2, 2,5 times shorter than stamons
_ 11	Petals 2–2.) times shorter than stamens
11	Separs 5-/12
-	Separs 9–12
12	Petals oblong-obovate, apex cuneate. Persistent styles 0.4–1.2 mm long
	T. apertus
-	Petals obovate or spatulate, apex rounded. Persistent styles not less than
	2 mm long13

13	Leaf blades round-pentagonal, 4–8 cm long, 5–10 cm wide, dentate with triangular acute and sharp teeth. Flowers 3–4 cm in diameter. Sepals yellow-
	orange or yellow. Petals are reddish-orange, equal to stamens or 1-3 mm
	longer. Leaflets with arcuate, unbreakable persistent styles 2–3 mm long
	T. riederianus
_	Leaf blades are rounded- reniform, 8–14 cm long, 10–24 cm wide, dentate
	with narrow-triangular acute and sharp teeth. Flowers $2.5-3.5$ cm in diam-
	eter Sepals nale vellow or vellow-orange Petals orange 1–3 mm shorter than
	stamens. Leaflets straight or slightly accuse with longer (3-45 mm long)
	thin brittle persistent style
1 /	Diagto un to 40 and high Store since a might a flarence Secolo and a sub-
14	Plants up to 40 cm nign. Stem simple, with 1 flower. Sepais grey-yellow. Pet-
	als narrow-linear, acute, yellow-orange, 1–3 mm longer than stamens. Pedi-
	cels up to 10 cm long with fruits up to 20 cm. Leaflets are light green. (Plants
	from Siberia and the mainland of the Far East)
_	Plants 70–120 cm high. Stems branched, with 2–5 flowers, less often simple.
	Sepals yellow-orange or golden-yellow. Petals obovate or spatulate, blunt, or-
	ange, equal to stamens in length. Pedicles 2-5 cm long with fruits up to 10
	cm. Leaflets reddish-brown later blackening. (Plants from Sakhalin Island)
	T. mivabei
15	Sepals 5_6 Persistent styles up to 1.4 mm long subulate straight or slightly
1)	Curved
	Sanala 0, 12 Demistrant and a shared 2 merel and a million of the d
_	Separs $9-12$ . refinitely using about 2 mm long, with nattened edges, webbed,
	arcnedI. membranostylis

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**RESEARCH ARTICLE** 



# Perrottetia wichmaniorum (Dipentodontaceae), a new species from Kauaʻi, Hawaiian Islands

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#### Abstract

*Perrottetia wichmaniorum* Lorence & W. L. Wagner, **sp. nov**. is described as endemic to Kaua'i. It differs from its Hawaiian congener *P. sandwicensis* by its larger, thicker, more densely hirtellous-villosulous rugose leaves with a smaller length:width ratio [1.5–1.7:1], larger inflorescences with usually four degrees of branching with moderately to densely hirtellous axes, and flowers with glabrous petals. This new species falls into the Endangered (EN) category when evaluated using the IUCN Red List criteria for endangerment based on its small area of occupancy, a decline in the extent and quality of its habitat, and number of mature individuals.

#### **Keywords**

Dipentodontaceae, Perrottetia, Hawaiian Islands, Kaua'i, conservation, IUCN Red List, endangered

# Introduction

*Perrottetia* Kunth is a genus of 16–17 species of shrubs or small trees distributed from China, Malesia, Australia, and the Pacific to Central and South America, with a center of diversity in Colombia (Ding 1962; Lundell 1985; Mabberley 2017; Sánchez Montano and Fernández Alonso 2000). Formerly *Perrottetia* was often included in Celastraceae (e.g., Ding Hou 1962; Matthews and Endress 2005). However, recent molecular evidence places it in Dipentodontaceae in the small order Huerteales (Zhang and Simmons 2006; Worberg et al. 2009). In their treatment of *Perrottetia* in the Hawaiian

Islands, Wagner et al. (1990, 1999) recognized a single species, *P. sandwicensis* A. Gray, occurring on all the main islands except Ni'ihau and Kaho'olawe. Subsequent field studies and examination of herbarium specimens from Kaua'i revealed the presence of a second previously undescribed species. We here describe *Perrottetia wichmaniorum* Lorence & W. L. Wagner, which differs from *P. sandwicensis* by its larger, thicker, more pubescent and rugose leaves with a smaller length:width ratio [1.5–1.7:1], larger inflorescences with up to four degrees of branching and moderately to densely hirtellous axes, and flowers with glabrous petals. This new species is known only from wet forests in the Hanalei District of northern Kaua'i, where it sometimes grows sympatrically with *P. sandwicensis* and apparently occasionally hybridizes with it. We found the characters separating the two species to be well differentiated in all populations, in addition to their growing sympatrically in some areas. However in both species, smaller plants or branches with smaller leaves may have correspondingly smaller inflorescences that are less highly branched.

The affinities of *Perrottetia* species in the Hawaiian Islands are obscure and would benefit from molecular studies to resolve phylogenetic relationships. Also, the breeding systems of both species should be studied in more detail in the field. The breeding system of *P. sandwicensis* was first described as being polygamodioecious by Gray (1854). That of *P. wichmaniorum* as being dioecious is based on our own observations. The breeding system for both species is characterized based on morphology and not experimental results that should be considered in future work.

#### Key to the Hawaiian Species of Perrottetia

Leaves with blade broadly elliptic, broadly ovate, or suborbicular, 7–18.5 cm long, 4.5–10.5 cm wide [length:width 1.5–1.7:1], stiffly chartaceous to subcoriaceous, rugose with venation depressed adaxially and prominulous abaxially; inflorescences with usually four degrees of branching, the axes moderately to densely hirtellous; petals glabrous ..... 1. Perrottetia wichmaniorum
 Leaves with blade ovate, elliptic, or oblong-elliptic, rarely obovate or broadly elliptic (Maui), 7–19 cm long, 2.5–9.5 cm wide [length:width 1.8–2.7:1], chartaceous, smooth, the venation not depressed adaxially nor prominulous abaxially; inflorescences with up to three (rarely to four on Kaua'i) degrees of branching, the axes glabrate to densely brown villosulous; petals with ciliolate margins......2. Perrottetia sandwicensis

# 1. Perrottetia wichmaniorum Lorence & W. L. Wagner, sp. nov.

urn:lsid:ipni.org:names:77194235-1 Figs 1, 2A–C

**Diagnosis.** *Perrottetia wichmaniorum* is similar to *P. sandwicensis* from which it differs by its larger, thicker, more pubescent and rugose leaves with a smaller length:width ratio

[1.5–1.7:1], larger inflorescences with usually four degrees of branching with moderately to densely hirtellous axes, the staminate inflorescences 12.5–14 cm long, 10–13 cm wide, the pistillate inflorescences 9–13 cm long, 6–13 cm wide, and flowers of both sexes with glabrous petals.

**Type. Hawaiian Islands: Kaua'i:** Hanalei District, Nā Pali-Kona Forest Reserve; upper Hanakoa Valley north of Pihea Peak, 3900–4000 ft, 21 Dec. 1988 (pistillate), *T. Flynn & D. H. Lorence 3246* (Holotype: PTBG-014949!; Isotypes AD!, F!, MO!, MU!, SING!, US!).

Description. Sprawling dioecious small tree 1.5-3 m tall with a dense crown or sometimes a shrub; branches when fresh green or sometimes purple or maroon-tinged, densely villous-hirtellous with pale brown hairs 0.2-0.5 mm long. Leaves spirally arranged, dark green except petioles and veins usually purple or maroon-tinged when fresh; blade thickly chartaceous to subcoriaceous, broadly elliptic, broadly ovate, or suborbicular, 7–18.5 cm long, 4.5–10.5 cm wide [length:width 1.5–1.7:1], adaxially glabrous, rugose with secondary, tertiary, and quaternary venation depressed, abaxially with venation prominulous, densely hirtellous-villosulous along costa and on veins, the hairs rufous, 0.2-0.6 mm long, the secondary veins 9-12 on each side, the axils occasionally with hair tufts, the tertiary veins conspicuously anastomosing, base broadly cuneate to obtuse or truncate, apex acute to rounded, the tip short acuminate, margin serrate-dentate, the teeth 0.5-1 mm long, tips indurated; petiole 1.5-5 cm long, brown villosulous or glabrate; stipules linear-oblong, 2-2.4 mm long, glabrous, deciduous. Inflorescences of both sexes axillary or occasionally infrafoliar, paniculate cymes with usually four degrees of branching, pyramidal, purple or maroon-tinged, the staminate 12.5-14 cm long, 10-13 cm wide, the pistillate 9–13 cm long, 6–13 cm wide, both with the peduncle 2–4 cm; axes densely rufous hirtellous, the hairs 0.2-0.3 mm long, bracts glabrous, ovate-elliptic or subulate, those on primary branches 1.8-2.0 mm long, those on secondary branches 1.2–1.5 mm long, those on tertiary branches 1–1.2 mm long, pedicels with 1–3 glabrous linear-oblong to subulate bracts 0.5-1.5 mm long; flowers on glabrous pedicels 0.5-1 mm long, hirtellous below articulation with ultimate axis. Staminate flowers with sepals and petals 5, spreading at anthesis, sepals purplish green, ovate, 1.0-1.2 mm long, apex acute to acuminate, glabrous, margins entire, petals white, ovate, similar to sepals in size but thinner, glabrous, margins entire; stamens on filaments 2-2.5 mm long, anthers transverse-ellipsoid, 0.5-0.6 mm long, 0.6-0.7 mm wide; pistillode 0.8-1.0 mm. Pistillate flowers with sepals and petals 5, glabrous, subequal, not spreading at anthesis, sepals reddish purple, ovate-deltate, 1-1.4 mm long, apex acute, petals white, ovate, similar in size to sepals but thinner; pistil conical, 1.2–1.5 mm long, stigma lobes 2(3), papillose; staminodes 5, 0.3-0.4 mm long. Infructescence 8-14.5 cm long, 6-14 cm wide. Fruit a globose berry 2.5-4 mm in diameter, ripening red or purple tinged, glabrous. Seeds (2-)4, subglobose, tan, 1.2-1.5 mm long, with thin aril, the testa rugose-reticulate.

**Distribution.** Hawaiian Islands, northern Kaua'i, known only from the Hanalei District, growing along streams or on windward upper valley slopes and summit areas above the valleys at c. 740–1280 m (Fig 3). Collections are known from the upper Waioli Valley in the east and along the Nā Pali Coast to Awa'awapuhi Valley in the west, although they likely also occur in intervening areas with suitable habitat.



**Figure I.** *Perrottetia wichmaniorum* Lorence & W. L. Wagner **A** Habit, branch with pistillate inflorescences **B** Staminate flower **C** Pistillate flower. **A**, **C** drawn from holotype *T. Flynn & D. H. Lorence 3246* (PTBG), **B** from *T. Flynn & L. Hume 3292* (PTBG).



Figure 2. Perrottetia wichmaniorum (A–C) A Abaxial leaf surface B Adaxial leaf surface C inset of abaxial leaf surface. Drawn from isotype and field images of *T. Flynn & D. H. Lorence 3246* (US), and *W. L. Wagner et al. 6265* (US). Perrottetia sandwicensis A. Gray (D–F) D Abaxial leaf surface E Adaxial leaf surface F inset of abaxial leaf surface. Drawn from D. Herbst 871 (US). Field images from Forest and Kim Starr [http://www.starrenvironmental.com/resources/] were used to augment illustration, especially colors: Koʻolau Gap, Maui [#110713-7251 (25006081321\_ac9bdd7fdb\_o), #110713-7252 (24731716429\_d7c44c451a\_o), and #110713-7253 (25006085211\_f687c67af8\_o)]; Road to Lower Kula Pipeline Haiku Uka, Maui [#170520-0692 (34385766464\_bb0d9bc7d0\_o), #170520-0693 (34385767704\_f28a1b34d7\_o)].

Habitat and ecology. This new species grows in diverse wet forest with species of *Metrosideros* Banks ex Gaertn. dominant, associated with species of *Cheirodendron* Nutt. ex Seemann, *Syzygium* Gaertn., *Psychotria* L., *Melicope* J. R. Forst. & G. Forst., *Broussaisia* Gaud., *Dubautia* Gaud., *Smilax* Tourn. ex L., *Astelia* Banks & Sol. ex R. Br., and diverse ferns including *Dicranopteris linearis* (Burm. f.) Underw., *Cibotium* Kaulf., *Sadleria* Kaulf., and *Diplazium* Sw. Flowering was observed from November to June and fruiting from January to August.

**Threats.** Threats to this species include invasive alien plant species, primarily Axonopus fissifolius (Raddi) Kuhlm., Buddleja asiatica Lour., Clidemia hirta (L.) D. Don var. hirta, Erigeron karvinskianus DC., Hedychium gardnerianum Sheppard ex Ker Gawl., Juncus planifolius R. Br., Rubus argutus Link, and R. rosifolius Sm. Habitat modification by introduced pigs (Sus scrofa), blacktail deer (Odocoileus hemionus), and goats (Capra hircus) also negatively impact this species. Although recorded as first naturalized on Kaua'i as recently as 2004, Buddleja asiatica is rapidly becoming a very serious invasive species in the same wet drainages and riparian zones in which Perrottetia wichmaniorum occurs.

**Conservation status.** When evaluated using the World Conservation Union's IUCN Red List criteria for endangerment (IUCN 2012), *Perrottetia wichmaniorum* falls into the Endangered (EN) category, a designation recommended for taxa facing a very high risk of extinction in the wild. The species merits this designation by having a very small Extent of Occurrence (EOO) of ca. 35 km<sup>2</sup>, along with a small Area of Occupancy (AOO) of ca. 10 km<sup>2</sup>, and an estimated population of ca. 7200 individuals (K. R. Wood, pers. comm.). The formal IUCN coding system for our evaluation is EN, B1ab(i,ii,iii,v)+2ab(i,ii,iii,v), which indicates that *P. wichmaniorum* is subject to an inferred decline in its area of occupancy, in addition to a decline in the extent and quality of its habitat and number of mature individuals.

**Etymology.** We take pleasure in naming this new species for Charles R. "Chipper" Wichman, Jr., who has served as Director and CEO of the National Tropical Botanical Garden (NTBG) since 2005, and his wife Hau'oli Wichman, who has served alongside Chipper throughout his directorship, for both their service on behalf of the Garden and especially for their efforts to conserve the Hawaiian Flora. Chipper has also served as Director of NTBG's Kahanu Garden on Maui and Limahuli Garden on Kaua'i, where the new species occurs in the Upper Limahuli Preserve.

Specimens examined (paratypes). Hawaiian Islands. Kaua'i: Hanalei District. Nā Pali-Kona Forest Reserve, upper Hanakoa Valley north of Pihea peak, *T. Flynn et al.* 2937 (AD, F, PTBG), *T. Flynn & D. H. Lorence 3247* (BISH, PTBG, US); Kōke'e State Park, Hwy 550 at mile 19 [southern rim of Kalalau Valley], along north side of road, *T. Flynn et al. 3257* (PTBG); Kōke'e State Park, Awa'awapuhi Valley west and below Hwy 550, *T. Flynn & D. H. Lorence 3260* (PTBG); Kōke'e State Park, along Hwy 550 near mile 19 on edge of Kalalau Valley, *T. Flynn & L. Hume 3292* (PTBG); upper Hanakoa Valley just E of Kalalau Valley rim, *D. H. Lorence et al. 6312* (BISH, PTBG, US); upper Waioli Stream Valley, main waterfall, hanging valley between upper and lower falls on N face of Nāmolokama Mt., *D. H. Lorence et al. 7295* (PTBG); Kalalau rim, north, below



Figure 3. Distribution map showing known locations of Perrottetia wichmaniorum on Kaua'i.

Pu'u o Kila, *K. R. Wood 1047* (PTBG); Kalalau rim, NW facing aspect, below Pihea Peak, *K. R. Wood 1132* (BISH, PTBG, US); upper Hanakoa valley from Pihea peak, southwest facing cliffs, *K. R. Wood et al. 2218* (PTBG); upper Hanakāpī'ai drainage and the North Bog area along Wainiha Rim (ridge to Hono o nā pali), below in Hanakāpī'ai head-water, east drainage, *K. R. Wood 5272* (PTBG); upper Hanakoa drainage north of Pihea peak, west of Moa'alele, *K. R. Wood 5272* (PTBG); upper Hanakoa drainage north of Pihea peak, west of Moa'alele, *K. R. Wood & S. Perlman 7453-A* (PTBG, US); Limahuli, upper south-east corner below Pali Ele'ele, *K. R. Wood 7508* (PTBG); below Pihea Peak in Upper Hanakoa Valley, *W. L. Wagner et al. 6265* (PTBG, US).

**Discussion.** This new species sometimes grows sympatrically with *P. sandwicensis* with which it occasionally hybridizes. Two examples of putative hybrids were recognizable by their intermediate leaf morphology and inflorescence structure, if fertile.

**Putative hybrids. Hawaiian Islands.** Kaua'i: Hanalei District. Kōke'e State Park, mile 19 of Highway 550 just below Pu'u o Kila lookout on southern rim of Kalalau Valey, *D. H. Lorence et al. 6001* (BISH, MO, NY, PTBG, US), Highway 550, mile 19 [southern rim of Kalalau Valley], *T. Flynn et al. 3256* (PTBG).

# **2.** *Perrottetia sandwicensis* **A.** Gray, U. S. Expl. Exped., Phan. 291. 1854. Fig 2D–F

**Type.** Hawaiian Islands: O'ahu. On mts. behind Honolulu. 1840. U. S. Expl. Exped. s.n. (Lectotype: US-16429!; Isolectotype: GH [GH-00050026!]), designated by St. John, Rhodora 87: 570. 1985.

**Note.** Gray also cited a Gaudichaud collection from the same locality, as well as "also Hawai'i; along the margin of forests." The US sheet does not have a specific locality.

*Perrottetia sandwicensis* A. Gray var. *tomentosa* O. Deg. & Greenwell, Rev. S. Am. Bot. 10(1): 25 1951.

**Type.** Hawaiian Islands: Maui. Mauka of Nawini, S slope of Haleakalā, in gulch in decadent forest, 24 November 1950, *O. Degener*, *A. B. Greenwell, W. H. Hatheway, Miller, Silva 21119* (Holotype: NY [NY-00337484!]; Isotype: BISH-501715!).

**Description.** Polygamodioecious shrub or small slender tree 2–6(–8) m tall; branches when fresh red to green, usually glabrous or glabrate, sometimes strigulose or villous-tomentose with light brown hairs 0.1-0.4 mm long. Leaves spirally arranged, shiny, dark green except veins and petioles usually pink, red, or reddish orange; blade chartaceous, ovate, elliptic, or oblong-elliptic, rarely obovate or broadly elliptic (Maui), 7–19 cm long, 2.5–9.5 cm wide [length:width 1.8–2.7:1], adaxially relatively smooth, glabrous, abaxially somewhat paler and glabrate to moderately villosulous (Maui), especially along veins and on young leaves, the hairs yellowish brown, 0.4-0.8 mm long, the secondary veins 8–11 on each side, usually with hair tufts in secondary and tertiary vein axils, the tertiary and quaternary veins usually not prominulous below, apex longto short-acuminate or sometimes rounded or obtuse (Maui), base cuneate to obtuse or rounded, margin serrate, the teeth 0.3-1 mm long, tips indurated; petiole 1.5-5 cm long, sparsely to moderately pale brown villosulous-hirsute or glabrate; stipules linear-oblong, 1-1.5 mm long, glabrous or puberulent, deciduous. Inflorescences of both sexes axillary or occasionally infrafoliar, paniculate cymes, pyramidal, with two to three (rarely to four on Kaua'i) degrees of branching, the peduncle (0.5-) 1–4 cm, the staminate 4-7(-12) cm long, 2-6 cm wide, the pistillate 3-5 cm long, 2-3 cm wide; axes glabrate to densely brown villosulous, the hairs 0.1–0.4 mm long, bracts glabrous, triangular-subulate, those on primary branches 0.4–1.0 mm long, those on secondary branches 0.5-1.0 mm long, pedicels with 1-3 bracts 0.5-0.8 mm long; flowers on glabrous or puberulent, articulate pedicels 1–3.5 mm long. Staminate flowers with sepals and petals 5, calyx greenish orange, sometimes red-margined, sepals deltate, 0.5–0.7 mm long, margins entire, petals similar in color and shape to sepals but thinner, 0.6–0.8 mm long, 1–1.2 mm wide, margins ciliate; stamens with filaments 1.5–1.9 mm long,

anthers transverse ellipsoid, 0.5–0.6 mm long, 0.6–0.7 mm wide; pistillode 0.5–0.7 mm. Pistillate flowers with sepals and petals 5, bracteolate, with calyx greenish orange to red, sepals deltate, 0.6–1.5 mm long, 0.5–0.7 mm wide, petals similar in color and shape but thinner, deltate, 0.6–1.1 mm long, margins ciliate; pistil ovoid, 1.0–1.5 mm long, stigma lobes 2, papillose; staminodes 5, 0.3–0.4 mm long. *Infructescence* 5–10 cm long, 3.5–7 cm wide. *Fruit* a depressed-globose berry (2–)4–6 mm in diameter, reddish-green, ripening bright red, or white and red-tinged, glabrous. *Seeds* (2–)4, triangular-globose, 1.3–1.5 mm long, with thin aril, the testa rugose-reticulate, or sometimes only with transverse wavy lines.

**Distribution.** Hawaiian Islands, endemic to Kaua'i, O'ahu, Moloka'i, Lana'i, Maui, and Hawai'i. In mesic and wet forests, c. 300–1250 (–1830 on Maui) m elevation. Flowering was observed from November through July and fruiting from November through August.

Common names. Olomea, Pua'a olomea, Waimea (Maui).

**Discussion.** Some collections from East Maui have loosely villosulous stems and lower leaf surface with curling hairs, including the type of *Perrottetia sandwicensis* var. *tomentosa*, but these otherwise correspond to typical *P. sandwicensis*. Since the degree of pubescence intergrades with typical sparsely puberulent or glabrate forms, this variety was not recognized by Wagner et al. 1990, 1999. Pubescence in *P. wichmaniorum* is usually spreading hirtellous with straight hairs and is especially dense on the inflorescence axes and young stems and leaves.

Representative specimens examined. Hawaiian Islands: Kaua'i. Hanalei District, Koke'e State Park. Hwy 550 at mile 19, along north side of road, T. Flynn et al. 3255 (PTBG); Nā Pali-Kona Forest Reserve, upper Hanakoa Valley north of Pihea peak, T. Flynn & D. H. Lorence 3244 (PTBG, US); Koloa District, Kahili Ridge, W. L. Stern et al. 3114 (NY, US); Waimea District: Mohihi Valley, E. H. Bryan 1451 (BISH, US); Kaunuohua Ridge between Kilohana Lookout at Pu'u o Kila and Pihea, W. L. Stern & S. Carlquist 1242 (US); Makaha, north facing slopes below and west of Kokio keokeo, K. R. Wood & M. Query 15806 (PTBG, US). O'ahu. Kona District, Wa'ahila Ridge, on Koʻolau summit ridge past Mount Olympus summit, J. W. Adams & M. Bond 95 (PTBG); ridge E. Nu'uanu Valley, C. N. Forbes 1434 (BISH, US); Ko'olauloa District, Punalu'u, Castle trail, B. C. Stone 1158 (US), Waikane-Schofield trail, Waikane side, T. G. Yuncker 3197 (US); 'Ewa District, Kipapa Gulch, S ridge, E. Y. Hosaka 711 (BISH, US); Wai'anae District, Mt. Ka'ala, near road, O. Degener & I. Degener 28015 (US), below summit ridge of head of Makua Valley, O. Degener & W. Hatheway 21166 (BISH, US); Pu'u Kalena, W. R. Donaghho s.n. (US). Lana'i. Munro Trail, ca. 1/2 mile from fog drip station, in bottom of feeder valley to Maunalei Gulch, T. Flynn & D. Palumbo 255 (PTBG); Pu'u Kole, 14 Jan 1964, O. Degener & I. Degener 30159 (BISH, US), Haʻaleiepaʻakai, Kaohai, H. St. John & A. J. Eames 18788 (BISH, US). Molokaʻi. upper end of Hanalilolilo pipe-line, O. Degener 8971 (BISH, US); west ridge of Honomuni, H. St. John 25194 (BISH, US). Maui. W. Maui; Wailuku District, Kahakuloa Drainage, K. R. Wood 3144 (AD, NY, PTBG); near last ditchman's house on way to Mt. Eke, O. Degener & H. Wiebke 2561 (US); Lahina District, Honokahau Drainage

Basin, C. N. Forbes 496.M (US); ravine back of Lahaina, A. S. Hitchcock 14882 (US);
E. Maui, Makawao District, Ahupua'a of Kalialinui, upper Ko'olau Gap, 1.5 mi east of Hosmer's Grove, P. K. Higashino 780 (BISH, US); Haleakala, Ko'olau Gap, valley on west side, 2 mi N of Holua Cave, H. St. John & A. L. Mitchell 21281 (BISH, US), Hana District, Kaeanae Gap, crater of Haleakalā, C. N. Forbes 1071.M (US). Hawai'i. N. Hilo District, Laupāhoehoe Natural Area Reserve, follow Kīlau Stream, K. R. Wood et al. 3184 (MO, NY, PTBG, WU); S. Hilo District, 'Õla'a State Forest Preserve, 14 Aug 1975, S. P. Darwin 1218 (PTBG, US); N side of Stainback Hwy. 10 mi. above junction with Hwy. 11, 31 Jan 1968, D. Herbst 871 (BISH, US); Ka'ū District, Route 148a, NE of Kilauea, 11 Jul 1961, O. Degener & I. Degener 28197 (BISH, US).

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