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Research article

Updating the taxonomy of polymorphic plant taxa: six Atlantic Forest species segregated from the widely circumscribed *Oxalis polymorpha* Mart. ex Zucc. (Oxalidales, Oxalidaceae)

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Abstract. Widely circumscribed taxa are good candidates for in-depth taxonomic studies. The current taxonomy of *Oxalis* sect. *Polymorphae* includes 13 species mostly endemic to the Brazilian Atlantic Forest, in eastern Brazil. *Oxalis polymorpha* Mart. ex Zucc., the type-species of the section, exhibits a wide morphological variability and includes at least four recognized morphotypes. We propose the segregation of six species from this widely circumscribed *O. polymorpha* by combining morphological and molecular systematic data from the nuclear and plastid genomes. Thus, *Oxalis decipiens* Progel, previously treated under *O. polymorpha*, is accepted as a distinct species. The same is valid for *O. polymorpha* subsp. *tijucana* Lourteig, which is recognised at species level (*O. tijucana* (Lourteig) Fiaschi). Four additional new species are described based on material that were formerly placed under the wide circumscription of *O. polymorpha*: *O. amorimii* Fiaschi sp. nov., *O. animarum* Fiaschi sp. nov., *O. idimae* Fiaschi sp. nov., and *O. itatingae* Fiaschi sp. nov. We provide evidence that one of these species, *O. itatingae*, is phylogenetically closer to *O.* sect. *Holophyllum* than to other species of *O.* sect. *Polymorphae*, while the other species, excluding *O. tijucana*, emerged as non-sister taxa within the latter. Descriptions, illustrations, geographic distribution maps, preliminary conservation assessments, taxonomic notes, and an identification key to species of *Oxalis* sect. *Polymorphae* are provided.

Keywords. Nomenclature, phylogenetics, species circumscription, taxonomy.

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Introduction

Polymorphic taxa with wide circumscriptions and geographic distribution are good candidates for studies aimed at updating the taxonomic status of poorly studied plant groups (Nery & Fiaschi 2019; Nery *et al.* 2020; Anderson *et al.* 2023; Alencar *et al.* 2024). In regions with high degrees of species richness

and local endemism, such as the Brazilian Atlantic Forest, several recent studies have underscored the need to recognize a larger number of species than previously thought, due to intensified fieldwork in poorly collected areas (Fiaschi & Pirani 2005; Dias *et al.* 2014; Bacci *et al.* 2018), the use of combined sources of evidence (Nery & Fiaschi 2019; Nery *et al.* 2020; Pessoa *et al.* 2020), and the development of monographic studies, which involve the nomenclatural evaluation and circumscription of all names attributed to a species-group (Chautems *et al.* 2010; Mello-Silva & Cabral 2022; Fiaschi *et al.* 2024).

Monographic studies of South American *Oxalis* L. carried out by Lourteig (1994, 2000) paved the way for in depth studies of some sections, such as *Carnosae* Reiche, *Caesiae* R.Knuth and *Giganteae* Lourteig (Heibl 2005), *Thamnoxys* Endl. (Abreu 2011), *Palmatifoliae* DC. (Lopez *et al.* 2013), *Ripariae* Lourteig (Nurnberg-Silva & Fiaschi 2021), and *Holophyllum* Progel (Fiaschi *et al.* 2024), but there is yet much to be done in species circumscriptions from the Brazilian Cerrado and Atlantic Forest domains.

Oxalis sect. *Polymorphae* (Progel) Lourteig, a group that is almost restricted to the Atlantic Forest, but with a few species occurring in the Cerrado and Caatinga domains (Fiaschi 2014), counted eight species in Lourteig (1994), but this number has been updated and it now comprises 13 species (Fiaschi 2012, 2014; Vaio *et al.* 2018; Richetti *et al.* 2022). Among the species of this section, *O. polymorpha* Mart. ex Zucc., as the name suggests, is a very polymorphic taxon, whose wide variability has been recognized since its description, about two centuries ago (Zuccarini 1825), when six varieties (named as "a" to "f") were listed (Table 1). Zuccarini (1825) understood these varieties as representing a continuous series of interconnected forms, which he could not recognize at species level, likely due to the similar overall leaf morphology. In his treatment of Oxalidaceae R.Br. for *Flora brasiliensis*, Progel (1877) treated *O. polymorpha* var. *staphyleoides* Zucc. (Zuccarini's variety "a") at species level (as *O. staphyleoides* (Zucc.) Progel, instead of accepting *O. polymorpha*), but he based this name on the same specimen (*Martius s.n.*, M-0172333; Fig. 1) and plate (tab. III) that were listed by Zuccarini (1825) as original material associated with *O. polymorpha*. Progel (1877) also proposed *O. decipiens* Progel and included some of Zuccarini's varieties of *O. polymorpha* ("c", "d", and "e") under *O. rhombeo-ovata* A.St.-Hil.

More than one century later, Lourteig (1994) updated the taxonomy of *O. polymorpha* but followed the wide circumscription of Zuccarini (1825). Despite her effort to remove some taxa from the synonymy of *O. polymorpha*, such as *O. polymorpha* var. *dolichoides* Zucc. (here treated under *O. neuwiedii* Zucc.), and *O. polymorpha* var. *phaseoloides* Zucc. and *O. polymorpha* var. *violascens* Zucc. (here under *O. rhombeo-ovata*), which followed Progel (1877), she included *O. decipiens* as synonymous under *O. polymorpha* (Table 1). Moreover, Lourteig (1994) created *O. polymorpha* subsp. *tijucana* Lourteig, which was distinguished from the typical subspecies by the leaflet blades glabrous on both surfaces, and the canaliculate petioles, with the canal margin densely hirsute-ciliate.

Fiaschi (2014) followed the wide circumscription of *O. polymorpha* from Lourteig (1994) and described its geographic distribution as ranging from the state of Bahia, including Cruz das Almas (Recôncavo region) and the southern Bahian moist forests (Mori *et al.* 1983; Thomas & Barbosa 2008), to Espírito Santo, Rio de Janeiro, and eastern Minas Gerais states. However, he did not map the likely location where the type of *O. polymorpha* had been collected, which is an unknown locality in the Caatinga domain, close to São Francisco River, on the border between the states of Bahia and Minas Gerais.

Fig. 1 (on next page). Lectotype of *Oxalis polymorpha* Mart. ex Zucc. (*Martius s.n.*; M-0172333), showing a few morphological features. **A**. Dichasial branches with the flowers distally grouped. **B**. Young stem with very abundant, patent hairs (B1) and first flower with the pedicel articulated in the mid-portion (B2). **C**. Leaf blade venation conspicuous abaxially. **D**. Leaves distributed along the stem. **E**. Young fruit with the carpels only slightly prolonged apically. Modified from a high-resolution image provided by the Botanische Staatssammlung München.


Botanische Staatssammlung München
M-0172333
A
B
B2
B1
C
D
E
copyright reserved
Oxalis staphyleoides Pgl
Mart. fl. Bras.
vpt. Progel.
Typus
19210
Photogr.
Field Museum 1932
Oxalis Staphyleoides
polymorpha Zucc.
Habitat in sylvis Catingas
dictis ad fl. S. Francisci
Provinciae Bahiensis
Dr Martius Iter Brasil. Ord.
HERBARIUM REGIUM MONACENSE.
TYPE

Table 1. Comparison of species names accepted here (this study) with those recognized in three previous studies that investigated the taxonomy of taxa belonging to *Oxalis polymorpha* s. lat. (Zuccarini 1825; Progel 1877; and Lourteig 1994). Varieties by Zuccarini (1825) are listed from a) to f).

Zuccarini (1825)	Progel (1877)	Lourteig (1994)	This study
O. polymorpha	–	*O. polymorpha*	*O. polymorpha*
a) *O. polymorpha* var. *staphyleoides*	*O. staphyleoides*	*O. polymorpha*	*O. polymorpha*
b) *O. polymorpha* var. *dolichoides*	*O. roselata*	*O. neuwiedii*	*O. neuwiedii*
c) *O. polymorpha* var. *phaseoloides*	*O. rhombeo-ovata*	*O. rhombeo-ovata*	*O. rhombeo-ovata*
d) *O. polymorpha* var. *cauliflora*	*O. rhombeo-ovata*	*O. polymorpha*	*O. decipiens*
e) *O. polymorpha* var. *violascens*	*O. rhombeo-ovata*	*O. rhombeo-ovata*	*O. rhombeo-ovata*
f) *O. polymorpha* var. *polyantha*	*O. neuwiedii*	*O. neuwiedii*	unknown
–	*O. decipiens*	*O. polymorpha*	*O. decipiens*
–	*O. suffruticosa*	*O. polymorpha*	*O. puberula*
–	–	*O. polymorpha* subsp. *tijucana*	*O. tijucana*

Costa *et al.* (2019) confirmed the occurrence of *O. polymorpha* in the state of Rio de Janeiro, with the yellow-flowered *O. polymorpha* subsp. *tijucana* growing in humid forests of the surroundings of Rio de Janeiro city, and the white-flowered *O. polymorpha* subsp. *polymorpha*, based on specimens that are here treated at species level as *O. idimae* sp. nov., in seasonally dry forests from the northern part of the state.

Aiming to evaluate leaf morpho-anatomical variation among specimens that had been previously placed in *O. polymorpha*, Richetti *et al.* (2023) indicated four morphotypes that could be recognized at species level, one from the Recôncavo region of Bahia state (population CRA = Cruz das Almas), one from northern Rio de Janeiro state (CRM = Cardoso Moreira), one from the Rio Doce region (LIN = Linhares + MRL = Marliéria), and one from the surroundings of Rio de Janeiro city (TIJ = Tijuca forest). Besides their different geographic distributions, Richetti *et al.* (2023) observed differences among these morphotypes in venation patterns, leaf indumentum, midrib and pulvina vascular tissue, leaf arrangement and shape, inflorescence position, petal color, and fruit shape. Moreover, they suggested these morphotypes should be included in a broader phylogenetic sampling of *O.* sect. *Polymorphae* to check if they consist of separately evolving lineages (i.e., not a monophyletic group), thus strengthening their recognition as different species.

Oxalis sect. *Polymorphae* did not emerge as monophyletic in Cabral *et al.* (2024), who presented nuclear and plastid molecular data on two of the four morphotypes recognized by Richetti *et al.* (2023). These authors did not include the morphotypes LIN + MRL and TIJ, but showed that the morphotype CRM (there included as *O. polymorpha* var. *cauliflora* Zucc. (*Richetti 70*), but now *O. idimae* sp. nov.) was not sister to CRA (now *O. animarum* sp. nov.), which was included as *Oxalis* sp. nov. 5 (*Fiaschi 4591*) in a paraphyletic group basal to clade C, which recovered part of sect. *Polymorphae* + sect. *Phyllodoxys* Endl. (clade C1) as sister to C2: sect. *Holophyllum* + C3: sect. *Psoraleoideae* Lourteig (Cabral *et al.* 2024).

Despite the growing evidence suggesting that *O. polymorpha* is a complex of distinct morphotypes with unique combinations of morphological features and geographic distributions, the formal recognition of segregated taxa has not yet been attempted. In the present study we provide an updated (and narrower) circumscription of *O. polymorpha*, by elucidating its nomenclature, morphology, and phylogenetic relationships. We describe four new species from material that had been identified as *O. polymorpha* over the last decades, propose the recognition of *O. polymorpha* subsp. *tijucana* at species level, and accept *O. decipiens* as distinct from *O. polymorpha*. The phylogenetic relationships among taxa that belonged to this wide circumscription of *O. polymorpha* are also evaluated, to provide an independent source of information for their recognition at species level.

Material and methods

Phylogenetic investigation

We used DNA sequences from 22 specimens of *Oxalis* sect. *Polymorphae*, which represent 18 species of the section, including eight specimens (from six taxa) that belonged to *O. polymorpha* sensu Lourteig (1994) and Fiaschi (2014). We are unaware of any populations of *O. polymorpha* from the type locality or nearby areas, so we did not include sequences that could be confidently assigned to this taxon. However, three samples from coastal Bahia forests tentatively identified as *Oxalis* cf. *polymorpha* were added (*Fiaschi 4617*, *4618*, and *5415*) (Table 2). Thus, we sampled 17 from 19 species that are currently accepted in the section (except *O. artemioides* Fiaschi and *O. tijucana*), including those described for the first time here (*O. amorimii* sp. nov., *O. animarum* sp. nov., *O. idimae* sp. nov., and *O. itatingae* sp. nov.), and one likely undescribed species (*Oxalis* sp. aff. *umbraticola* A.St.-Hil., *Rhoden 19*) (Table 2). *Oxalis fruticosa* Raddi, an Atlantic Forest species which should be transferred from *O.* sect. *Phyllodoxys* to *O.* sect. *Polymorphae* following Cabral *et al.* (2024), was not sampled, nor the vicarious Amazonian *O. leptopodes* G.Don (Lourteig 1994). Fourteen species from six other sections of *Oxalis* subg. *Thamnoxys* were also included. *Oxalis sarmentosa* Zucc., from *O.* subg. *Oxalis*, was selected as the single outgroup taxon, following previous phylogenetic analyses (Cabral *et al.* 2024). All terminals sampled with voucher and GenBank accession numbers are listed in Table 2.

Total DNA was extracted from silica-dried leaf tissue using a CTAB protocol (Doyle & Doyle 1990). We used sequences from the nuclear ITS (internal transcribed spacer) and the plastidial *trn*L-*trn*F and *pet*A-*psb*J regions, which were either newly generated here or available on GenBank. Primer specifications and thermocycling conditions follow Fiaschi *et al.* (2024). PCR products were purified with polyethylene glycol (PEG) 20% and sequenced at GoGenetic (Curitiba, Paraná (PR), Brazil) or ACTGene (Alvorada, Rio Grande do Sul (RS), Brazil). Forward and reverse sequences were assembled and inspected using Geneious ver. 9.1 (https://www.geneious.com).

The three markers were individually aligned with MAFFT 7 (Katoh & Standley 2013) under default parameters, and manually adjusted to minimize the quantity and size of gaps. Three matrices were built and analyzed individually: (i) ITS (nuclear matrix), (ii) *trn*L-*trn*F + *pet*A-*psb*J concatenated (plastid matrix), and (iii) all markers concatenated (total matrix). The aligned sequences are available in FigShare (Fiaschi *et al.* 2024). The maximum likelihood (ML) analyses were performed using RAxML ver. 8.2.12 (Stamatakis 2014), with the rapid bootstrap algorithm with 1000 replicates and search of the best-scoring ML tree. The GTRCAT model was applied. The plastid and total matrices were partitioned in two and three partitions, respectively. Nucleotide substitution models were estimated for each marker using ModelTest-NG (Darriba *et al.* 2020) and selected according to the Akaike Information Criterion (AIC). The Bayesian inference (BI) was carried out through BEAST ver. 2.6.6 (Bouckaert *et al.* 2019) using the total matrix. Three partitions were set, each of them with the corresponding best substitution model. The priors chosen were the relaxed lognormal for the molecular clock and the Yule model for the tree. A run of 50 million generations was performed, sampling once every 1000th generation. Convergence and effective sample sizes (satisfactory if greater than 200) were verified on Tracer ver. 1.7 (Rambaut *et al.* 2018). The consensus tree and associated posterior probabilities were generated using a burn-in of 25% in TreeAnnotator (Drummond *et al.* 2012). Final trees and supports were visualized in FigTree ver. 1.4 (http://tree.bio.ed.ac.uk/software/figtree). RAxML, ModelTest-NG and BEAST were run on CIPRES (Miller *et al.* 2010).

Taxonomy

The protologues of all names that are relevant to the taxonomy of *O. polymorpha* sensu Lourteig (1994) as either accepted or synonymous taxa were obtained through the Biodiversity Heritage Library (BHL; https://www.biodiversitylibrary.org/) and the *Flora brasiliensis* online (http://florabrasiliensis.cria.org.br/).

Table 2. Species sampled in the phylogenetic analyses with their current infrageneric classification, voucher specimen, and GenBank accession numbers. Specimens in bold were traditionally included in the wide circumscription of *Oxalis polymorpha* Mart. ex Zucc. An asterisk (*) indicates new sequences generated during this work. En-dashes indicate missing molecular data.

Species	**Infrageneric classification**	**Voucher**	**ITS**	***pet*A-*psb*J**	***trn*L-*trn*F**
Oxalis alvimii	sect. *Holophyllum*	*Fiaschi 4597*	OQ310870	OQ295991	OQ296017
Oxalis amorimii sp. nov. *	sect. *Polymorphae*	*Fiaschi 5457*	PQ536092	PQ585589	PQ585606
Oxalis animarum sp. nov.	sect. *Polymorphae*	*Fiaschi 4591*	–	OR099855	OR099879
Oxalis barrelieri	sect. *Thamnoxys*	*Vaio 517*	KC602027	KC602052	KC602081
Oxalis blackii	sect. *Polymorphae*	*Costa 115*	MH705068	MH705089	MH705073
Oxalis caesariata	sect. *Foliosae*	*Fiaschi 5273*	PP175926	PP179507	PP179511
Oxalis alstonii subsp. *lutzii* *	sect. *Polymorphae*	*Melo 4829*	PQ536091	PQ585585	PQ585602
Oxalis* cf. *polymorpha *	sect. *Polymorphae*	*Fiaschi 4617*	PQ536093	PQ585595	–
Oxalis* cf. *polymorpha *	sect. *Polymorphae*	*Fiaschi 4618*	PQ536094	PQ585594	PQ585611
Oxalis* cf. *polymorpha *	sect. *Polymorphae*	*Fiaschi 5415*	PQ536095	PQ585593	PQ585610
Oxalis cipoensis *	sect. *Polymorphae*	*Costa 110*	PQ536096	PQ585587	PQ585604
Oxalis colatinensis	sect. *Polymorphae*	*Fiaschi 4625*	MH705069	MH705090	MH705074
Oxalis cornicarpa	sect. *Holophyllum*	*Fiaschi 5428*	OQ310886	OQ296007	OQ296034
Oxalis decipiens *	sect. *Polymorphae*	*Richetti 64*	PQ536097	PQ585588	PQ585605
Oxalis divaricata	sect. *Thamnoxys*	*Felix 13386*	KC602028	KC602055	KC602082
Oxalis frutescens	sect. *Thamnoxys*	*Vaio 426*	KC602026	KC602051	KC602080
Oxalis glaucescens	sect. *Pleiocarpa*	*Felix 13539*	KC602029	KC602053	KC602083
Oxalis hyalotricha subsp. *borealis*	sect. *Thamnoxys*	*Melo 4854*	OQ623648	OR099850	OR099875
Oxalis idimae sp. nov.	sect. *Polymorphae*	*Richetti 70*	OQ623652	OR099854	OR099878
Oxalis inopinata	sect. *Holophyllum*	*Fiaschi 5544*	OR964281	OR966574	OR966575
Oxalis itatingae sp. nov. *	sect. *Polymorphae*	*Fiaschi 4472*	PQ536098	PQ585599	PQ585615
Oxalis jacobinensis *	sect. *Thamnoxys*	*Cabral 226*	PQ536099	PQ585590	PQ585607
Oxalis kollmannii	sect. *Polymorphae*	*Fiaschi 4663*	OQ310872	OQ295993	OQ296019
Oxalis kollmannii *	sect. *Polymorphae*	*Vasques 53*	PQ536100	PQ585591	PQ585608
Oxalis monochasiata *	sect. *Polymorphae*	*Fiaschi 4585*	PQ536101	PQ585592	PQ585609
Oxalis neuwiedii	sect. *Polymorphae*	*Almeida 1336*	MH705072	MH705094	MH705078
Oxalis pardoensis	sect. *Polymorphae*	*Caxambu 5990*	OL998717	–	–
Oxalis physocalyx	sect. *Robustae*	*Melo 6953*	OQ310888	OQ296009	OQ296036
Oxalis psoraleoides subsp. *insipida*	sect. *Psoraleoidae*	*Vaio 431*	KC602030	KC602054	–
Oxalis puberula *	sect. *Polymorphae*	*Rhoden 7*	PQ536102	PQ585596	PQ585612
Oxalis rhombeo-ovata *	sect. *Psoraleoidae*	*Melo 4750*	PQ536103	PQ585597	PQ585613
Oxalis roselata *	sect. *Polymorphae*	*Rhoden 16*	PQ536104	PQ585586	PQ585603
Oxalis sarmentosa	subg. *Oxalis*	*Vaio 13*	KC602048	KC602048	KC602075
Oxalis sp. aff. *umbraticola* *	sect. *Polymorphae*	*Rhoden 19*	–	PQ585598	PQ585614
Oxalis suborbiculata	sect. *Thamnoxys*	*Cabral 110*	OQ623656	OR099861	OR099884
Oxalis umbraticola *	sect. *Polymorphae*	*Nery 91*	–	PQ585601	PQ585617
Oxalis umbraticola *	sect. *Polymorphae*	*Richetti 69*	PQ536105	PQ585600	PQ585616

Specimens deposited in national and international collections were consulted from loans and/or visits to the herbaria ALCB, BHCB, CEPEC, CVRD, FLOR, HUEFS, HURB, MBM, MBML, R, RB, SP, SPF, and VIES (acronyms following Thiers (continuously updated)) or from the online digitized collections JSTOR Global Plants (https://plants.jstor.org/), Specieslink (https://specieslink.net/), and Reflora (http://reflora.jbrj.gov.br/reflora/herbarioVirtual/). Material collected during fieldwork was processed following Mori (2011) for posterior inclusion at several national and international herbaria.

General morphological terminology followed Beentje (2016), while Radford *et al.* (1974) was adopted for plane and solid shapes, Ellis *et al.* (2009) for leaf venation, and Eiten (1963) to describe hair abundance classes. The description of the lateral leaflets base follows Fig. 2A, while the length of reproductive floral parts follows Fig. 2B, and the apical carpel prolongation in fruits follows Fig. 2C. Data on the habitat

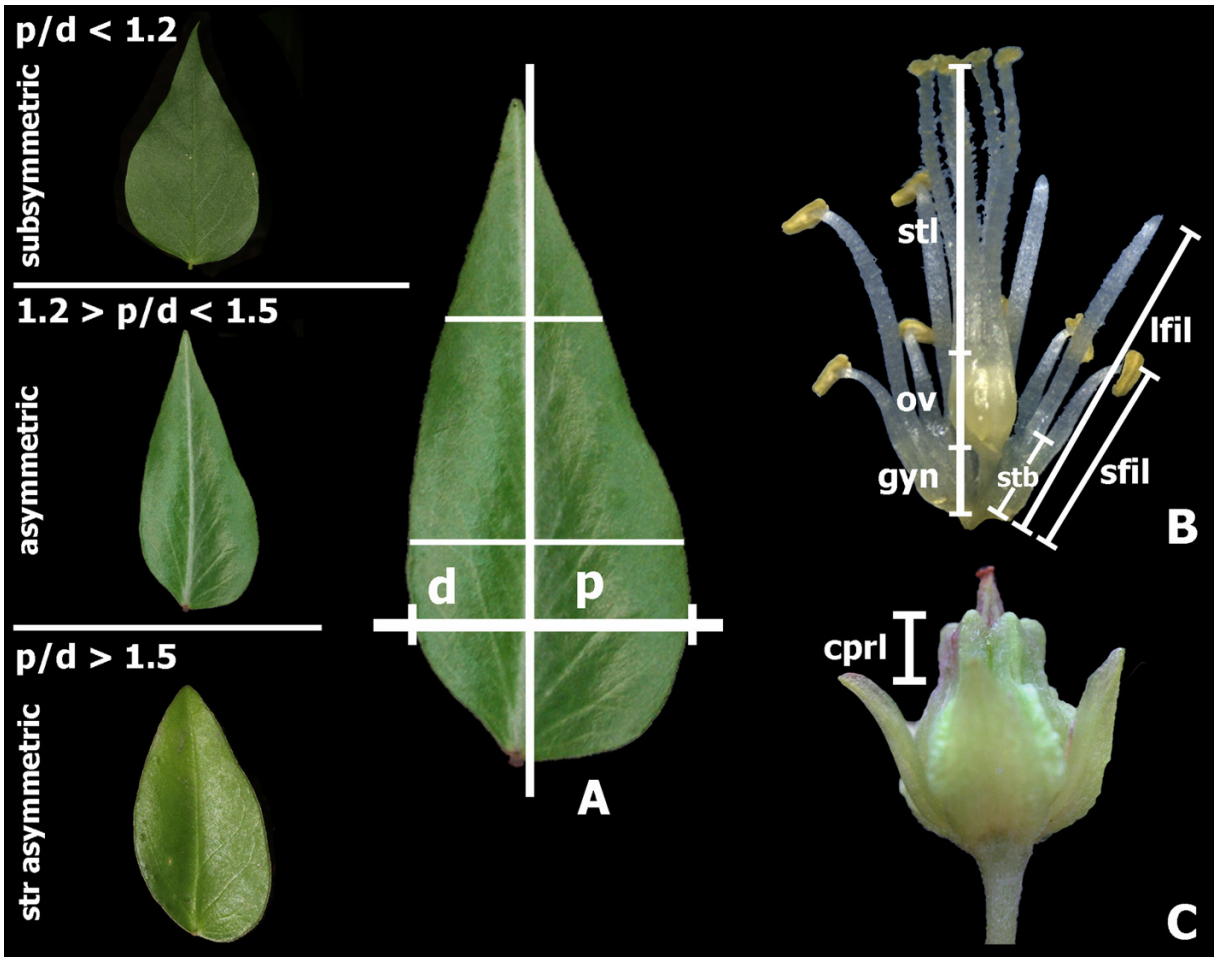


Fig. 2. Representation of some morphological measurements. **A**. Degree of lateral leaflet base asymmetry, based on the proximal (p)/distal (d) width ratio. Subsymmetric: p/d < 1.2 (*O. idimae* Fiaschi sp. nov., from *Vasques et al. 78*); asymmetric: 1.2 > p/d < 1.5 (*O. decipiens* Progel, from *P. Fiaschi & J.L. Costa Lima 4656*, FLOR); strongly asymmetric: p/d > 1.5 (*O. itatingae* Fiaschi sp. nov., from *P. Fiaschi et al. 4472*; holotype, FLOR). **B**. Pictorial view on how the lengths of reproductive floral parts were measured (based on *O. itatingae* long-styled morph, from *P. Fiaschi et al. 4472*; holotype, FLOR)): gyn = gynophore; lfil = longer filaments; ov = ovary; sfil = shorter filaments; stb = stamens base; stl = styles. **C**. Detail on how the fruit apical carpel prolongation (cprl) was measured (based on *O. decipiens*, from *P. Fiaschi & J.L. Costa Lima 4656*, FLOR). Photos: Pedro Fiaschi.

of each species were compiled from the NeoTropTree, an open online dataset of Neotropical forests (Oliveira-Filho 2017).

Preliminary conservation status assessments

Preliminary conservation assessments followed the IUCN guidelines (IUCN 2012) using the criterion B (geographic range as the form of extent of occurrence – EOO, and/or area of occupancy – AOO). The calculation of EOO and AOO were carried out using GeoCAT (Bachman *et al.* 2011). Information about threats and quality of habitat were obtained mainly from MapBiomas platform (Projeto MapBiomas 2024), a multi-institutional initiative to create and provide annual maps of land use and coverage in Brazil.

Results

Phylogenetic relationships among O. polymorpha s. lat. samples

Forty-eight new sequences were generated in this work (Table 2). The length of aligned matrices was 692, 645 and 824 base pairs respectively for ITS, *pet*A-*psb*J, and *trn*L-*trn*F; best nucleotide substitution models were GTR+I+G for ITS and GTR+G for both *pet*A-*psb*J and *trn*L-*trn*F. The nuclear and plastid trees showed no strongly supported differences regarding topology (Supp. file 1, Supp. file 2) and were then analyzed together in a total matrix. Maximum likelihood (ML) and Bayesian inference (BI) topologies recovered with the total matrix were highly congruent (Fig. 3). Further results and discussion are based on these trees.

Oxalis sect. *Polymorphae*, as it was treated previously, was recovered as polyphyletic by the inclusion of *O. itatingae* sp. nov. and *O. monochasiata* Fiaschi, which grouped with *O.* sect. *Holophyllum* and *O.* sect. *Thamnoxys*, respectively. Within *O.* sect. *Polymorphae*, as defined here, two sister subclades were evident: the first one (maximum likelihood bootstrap BS = 95, Bayesian inference posterior probabilities PP = 1) comprised ten species, while the second one had five species + an unnamed specimen (BS = 79, PP = 0.98). *Oxalis polymorpha* as traditionally widely circumscribed (s. lat.) was polyphyletic: three specimens (*O. amorimii* sp. nov., *O. idimae* sp. nov. and *O. decipiens*, as circumscribed here) appeared in the first subclade of *O.* sect. *Polymorphae*, along with specimens tentatively identified as the typical *O. polymorpha* (*Fiaschi 4617*, *4618*, *5415*), which, in turn, formed a monophyletic assemblage (BS = 100, PP = 1); one specimen (*O. animarum* sp. nov., as circumscribed here) joined the second subclade of *O.* sect. *Polymorphae*, in a sister relationship with *O. alstonii* Lourteig (BS = 87, PP = 0.47); while the last specimen (*O. itatingae*, as circumscribed here) is far more distantly related, grouping with species from the highly supported *O.* sect. *Holophyllum* (BS = 100, PP = 1), in a close relationship with *O. inopinata* Fiaschi & Bilk (BS = 100, PP = 1).

Taxonomic treatment

Class Embryopsida Engler ex Pirani & J.Prado
Order Oxalidales Heintze
Family Oxalidaceae R.Brown
Genus *Oxalis* L.

Oxalis polymorpha Mart. ex Zucc.
Figs 1, 5

Oxalis polymorpha Mart. ex Zucc. (Zuccarini 1825: 174). – *Oxalis polymorpha* Mart. ex Zucc. var. *staphyleoides* Zucc. (Zuccarini 1825: 175). – *Oxalis staphyleoides* (Zucc.) Progel (Progel 1877: 509). – **Type**: BRAZIL – "Provinciae Bahiensis" [**Bahia**] • habitat in sylvis Catingas dictis ad flumen St. Francisci; s.d. [Oct. 1818]; *C.F.P. von Martius s.n.*; lectotype: M [M-0172333], designated by Lourteig (1994: 150).

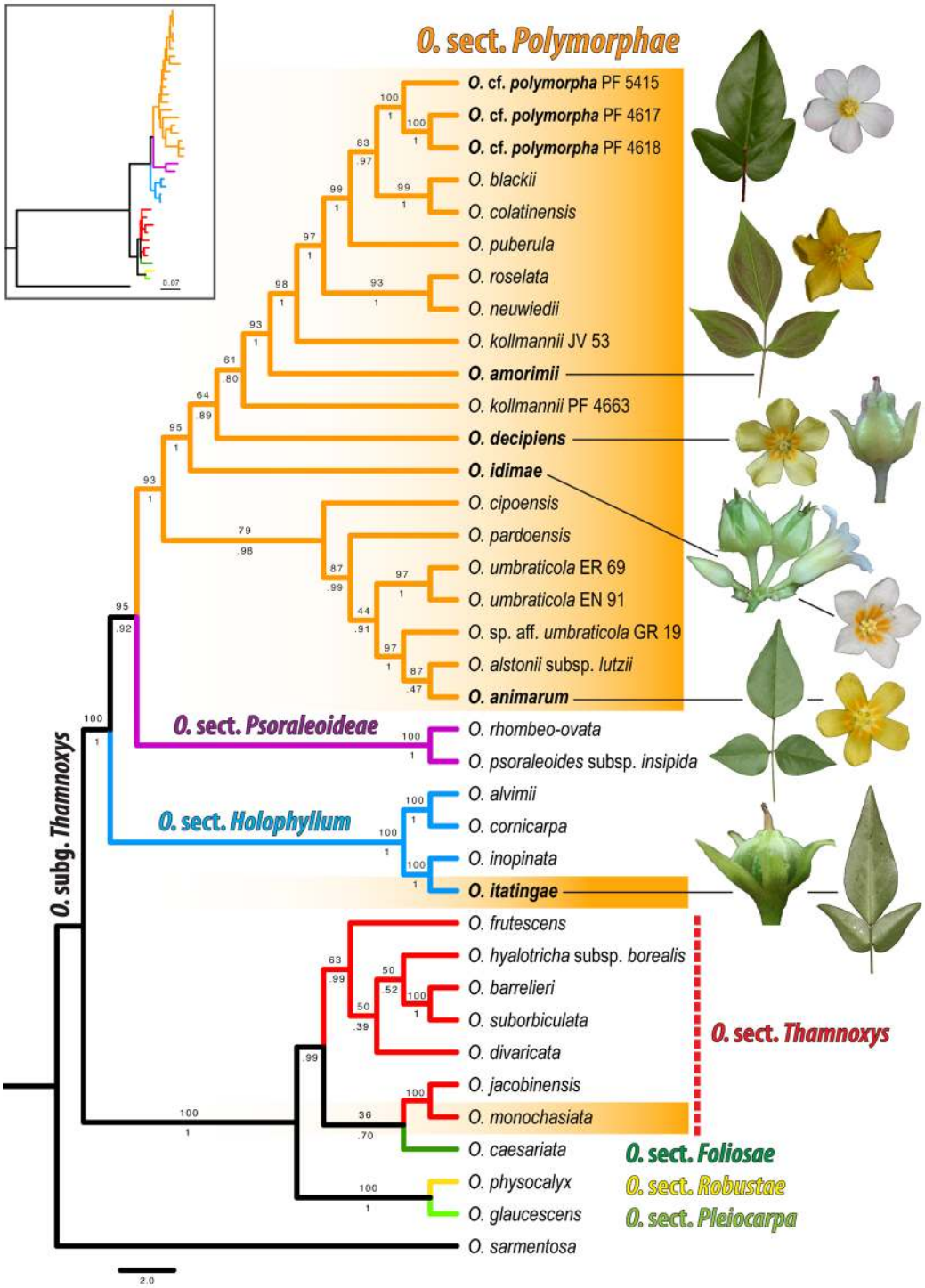


Fig. 3. Phylogenetic relationships among samples of *Oxalis polymorpha* Mart. ex Zucc. s. lat. (boldface terminals) based on combined ITS and plastid data. Branch support values are indicated above (maximum likelihood bootstrap, BS) and below (Bayesian inference posterior probabilities, PP) branches. The inset (upper left corner) shows the same topology with branch lengths. The orange gradients indicate species previously assigned to *O.* sect. *Polymorphae* (Progel) Lourteig (see text for details on *O. itatingae* Fiaschi sp. nov. and *O. monochasiata* Fiaschi). The illustrations on the right side represent (out of scale) the morphological variation of *O.* cf. *polymorpha* and five of six segregated species (*O. amorimii* Fiaschi sp. nov., *O. animarum* Fiaschi sp. nov., *O. decipiens* Progel, *O. idimae* Fiaschi sp. nov., and *O. itatingae*).

Other material examined

BRAZIL – **Bahia** • *Blanchet 5256*; P [photo] • Almadina, Faz. Beija-Flor, Serra da Pancadinha; 11 Aug. 1972; *Pinheiro 1902*; P [photo] • same data as for preceding; *Pinheiro 1904*; CEPEC, P [photo] • Almadina; 18 Jul. 1978; *Mori et al. 10261*; CEPEC • Almadina, Faz. Beija-Flor, ca 3 km al Sul de Almadina; 19 Jul. 1978; *Mori et al. 10298*; CEPEC, P [photo] • Ibicaraí, Itapé, lado sul; 3 Mar. 1971; *Pinheiro 1035*; P [photo] • same data as for preceding; *Pinheiro 1041*; P [photo] • Ibicaraí, Rod. BR-415, a 2 km W de Ibicaraí; 17 Mar. 1979; *Mori et al. 11602*; CEPEC, P [photo] • Ilhéus, Área do CEPEC; 2 Oct. 1979; *Mori 12486*; CEPEC, P [photo] • same data as for preceding; 14 Oct. 1981; *Hage & Brito 1471*; CEPEC, P [photo] • Itabuna; 16 Dec. 1966; *Emygdio et al. 2423*; R • Mucuri, Fazenda Afonsópolis; 7 Aug. 1965; *Lanna Sobrinho 1130*; P [photo] • Mucuri, "próx. à ponte sobre o Rio Mucuri" [close to bridge above Mucuri River]; 15 Sep. 1978; *Mori et al. 10535*; CEPEC, P [photo] • Porto Seguro, junto à fonte; 30 May 1962; *Duarte 6721*; P [photo] • Porto Seguro; 19 Oct. 1969; *Jesus 477*; CEPEC • Porto Seguro; 28 Nov. 1970; *Emygdio & Emmerich 3012*; P [photo] • Porto Seguro; 21 Mar. 1974; *Harley 17217a*; CEPEC, P [photo], RB • 9 Oct. 1969; *Jesus 478*; CEPEC • Porto Seguro, Km 16 de Porto Seguro-Eunápolis; 17 Jul. 1981; *Brito & da Vinha 41*; CEPEC • Porto Seguro; 13 Oct. 2006; *Amorim et al. 6447*; CEPEC, HUEFS • Prado, "Parque Nacional do Descobrimento" [Descobrimento National Park]; 17°11′ S, 39°20′ W; 3 Nov. 2009; *Matos et al. 1916*; CEPEC • Santa Cruz Cabrália; 21 Mar. 1978; *Mori et al. 9767*; CEPEC • Santa Cruz Cabrália; 18 Oct. 1978; *Mori et al. 10817*; CEPEC, P [photo] • Santa Cruz Cabrália, "Estação Ecológica do Pau-Brasil" [Pau-Brasil Ecological Station]; 3 Nov. 1978; *Euponino 350*; P [photo] • Santa Cruz Cabrália, "Estação Ecológica do Pau-Brasil" [Pau-Brasil Ecological Station]; 4 Mar. 1983; *Brito & da Vinha 184*; CEPEC • Santa Cruz Cabrália; 21 Nov. 1984; *Santos 456*; CEPEC.

Typification remarks

Zuccarini (1825) described *O. polymorpha* based on a material collected by von Martius while the Bavarian naturalist was traveling in the São Francisco River, presumably in the surrounding of Malhada or Carinhanha, in the state of Bahia, in October of 1818. This specimen was mounted in M (Fig. 1) and faithfully represented in the tab. III of Zuccarini (1825).

While describing *O. polymorpha*, Zuccarini (1825) proposed several varieties (a to f; Table 1), which, in his opinion, represented a morphological range of several other interconnected forms ("*polymorphae hujus specie varietates, plurimis allis formis inter se conuexae*"). The first of these varieties ("var. a) *staphyleoides*") was characterized as presenting "leaflets always subrhombic, acuminate, pubescent, and peduncles with simple or bifid divisions" (i.e., the dichasial branches). As interpreted by Lourteig (1994), this variety and the name that it received at species level, *O. staphyleoides* (Zucc.) Progel, were typified by the same specimen used to typify the species, i.e., the sample gathered by von Martius in the state of Bahia.

Another specimen also collected by Martius in a nearby location, but presumably on the other side of the São Francisco River, in the state of Minas Gerais, and housed at G (G00383166) (Fig. 4), was listed by Lourteig (1994) as an isotype of *O. polymorpha*. Despite the overall similarity of these two specimens (Figs 1, 4), we prefer not to treat this material as belonging to the same gathering, not only because it was collected on the other side of the river São Francisco, but also because it differs from the type by the more congested leaves in the stem distal end, the less pronounced indumentum on the distal end of stem, and the less pronounced leaf venation on the abaxial side of the leaflet blades (Fig. 4).

Fig. 4 (on next page). **A**. Specimen (G00383166) that was listed by Lourteig (1994) as an isotype of *Oxalis polymorpha* Mart. ex Zucc., but not accepted as type collection here (see Fig. 1 and discussion in "Typification remarks"). **B**. Detail of the inflorescence dichasial branches. Modified from a high-resolution image provided by the Conservatoire et Jardin botaniques de Genève.


A
B
Oxalis staphyleoides
Brésil.
Ysotypus!
M. Martius.
HERBARIUM GENAVENSE(G)
G00383166
TYPUS
Bearbeitet für das „Pflanzenreich".
O. staphyleoides Prog.
Determinavit :
1918.

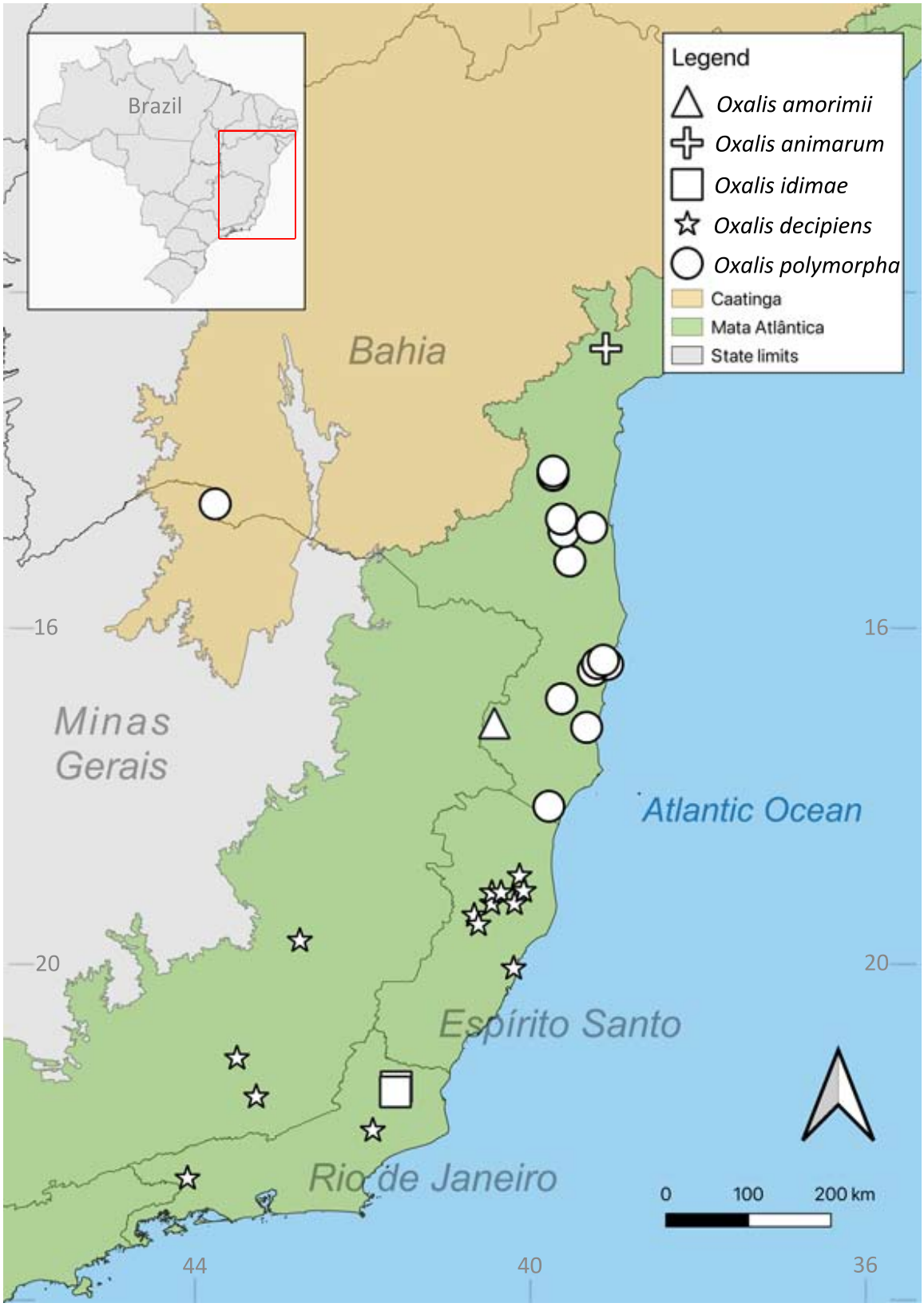


Fig. 5. Geographic distribution map of *Oxalis polymorpha* Mart. ex Zucc. (the single record in the Caatinga domain represents the type) and some of the segregated species recognized here, all of which are endemic to the Brazilian Atlantic Forest domain.

General remarks

Other than the type, which was likely collected in semideciduous forests along the São Francisco River, we are not convinced that other specimens can be unambiguously assigned to *O. polymorpha*; however, to help in the application of this name, we list above several specimens collected in the southern Bahia coastal rainforests (Fig. 5) that could also belong to this taxon in the narrower circumscription adopted here.

Oxalis polymorpha includes plants with the young stem with abundant to very abundant, curved or patent hairs, leaves either congested and almost forming one or more pseudo-whorls or more or less equally distributed along the stem, leaflet blades with moderate to abundant, appressed hairs, glabrescent in the adaxial surface, more densely arranged abaxially, apex usually acute to acuminate, lateral leaflets with a slightly to strongly asymmetric base, inflorescences with the dichasial branches usually elongated, having the flowers distally congested or, less commonly, distributed along the branches, pedicels lacking glandular hairs, corollas ranging from white to slightly pinkish (or even yellow, following the label from *Martius s.n.*, M-0172333), and capsules with short apical prolongations, up to ca 0.5 mm long (see Table 3 for a comparison with species segregated here).

Fiaschi (2014) adopted a very wide circumscription for *O. polymorpha*, as noted from the leaf morphological variation that was illustrated in his fig. 7G–H. Based on the updated circumscription presented here, the first four specimens of this illustration belong to *O. decipiens*, *Amorim 5549* (CEPEC) belong to a yet undescribed taxon, and the remaining specimens belong to *O. polymorpha* s. str. According to this same author, *O. polymorpha* is very similar to *O. puberula* Nees & Mart., and hardly distinguishable by the acute to acuminate (vs usually obtuse to rounded) leaflet apex. Moreover, despite *O. polymorpha* appears to differ consistently from *O. neuwiedii* by the pedicels lacking glandular hairs (Lourteig 1994; Fiaschi 2014), the distinction between these two species is sometimes confusing, and should be investigated with a more comprehensive sampling using morphometric and molecular data.

To adopt the narrower circumscription of *O. polymorpha* presented here, several taxa formerly placed as synonymous, treated at infraspecific level, or representing new species whose specimens were previously listed under this taxon are described below.

Oxalis amorimii Fiaschi sp. nov.
urn:lsid:ipni.org:names:77360846-1
Figs 5–6

Diagnosis

This new species differs from all other species of *O.* sect. *Polymorphae* by the presence of leaflets clearly three-nerved, suprabasal actinodromous (terminal blade) or basal actinodromous (lateral blades), characterized by having one basal pair of secondary veins almost as thick as the midrib, extending up to ca ⅔ of the blade length.

Etymology

The name of this species honors the Brazilian botanist and Malpighiaceae expert André M. Amorim, who dedicated a large part of his career to improving our knowledge of the southern Bahia forests. He was the collector of the type of this new species and has devoted himself to cultivate one of the specimens used for the photographic plate presented in Fig. 6.

Type material

BRAZIL – **Bahia** • Itanhém, Estrada Itanhém a Batinga, ca 16 km. "Ramal à direita, dando acesso a Faz. Pedra Grande, de Prop. de Etevaldo Rezende da Silva" [right branch, access to Faz. Pedra Grande, owned by Etevaldo Rezende da Silva]; 17°08′17″ S, 40°25′34″ W; 29 Dec. 2004; fl; *A.M. Amorim et al. 4614*; holotype: CEPEC.

Other material examined

BRAZIL – **Bahia** • Itanhém, "ca 16 km da estrada que ruma a oeste de Itanhém, Antiga Fazenda Pedra Grande (Mata do Otevaldo)" [ca 16 km from the road heading west from Itanhém, Former Fazenda Pedra Grande (Otevaldo's Forest)]; 17°07′58″ S, 40°25′18″ W; 27 Aug. 2022; st.; *P. Fiaschi et al. 5457*; FLOR.

Description

Unbranched or few-branched, erect subshrubs 20–40 cm tall; young stem with moderate, short, curved hairs, glabrescent towards the base; older stem brownish, terete, slightly striate longitudinally. *Leaves* pinnate-trifoliolate, distributed along the stem, mostly grouped at stem apex, but not forming a pseudo-whorl, the internodes 1–15 mm long; the petioles 35–80 × 0.4–0.8 mm, canaliculate adaxially, with moderate to abundant, curved to straight hairs, usually verruculose near the base, the base pulvinate, enlarged to ca 1.5 mm diam.; the rachis 9–20 mm long, similar to the petiole; petiolules ca 1 mm long, with abundant, appressed hairs; leaflet blades adaxially glabrescent, with occasional to sparse appressed hairs, especially along the midrib and along the margin; abaxially with abundant, appressed hairs, mostly along the midrib; membranous to chartaceous, adaxially green, abaxially green to slightly purplish. *Venation*: midrib impressed to canaliculate adaxially, prominent abaxially; clearly three-nerved, suprabasal actinodromous (terminal blade) or basal actinodromous (lateral blades), having one basal pair of secondary veins slightly thinner than the midrib (ca 1 mm vs ca 1.5 mm wide), decurrent, extending up to ca ⅔ of blade length, 3–4 distal secondary pairs thinner than the basal one, and one basal-most intramarginal secondary pair reaching up to ca ½ of the blade length; secondary veins slightly raised abaxially; intercostal tertiary vein fabric visible, irregular-reticulate, exterior tertiary course looped, quaternary vein fabric irregular-reticulate, areolation of good development, freely ending veinlets mostly one-branched. *Terminal blade* 50–74 × 22–31 mm, ovate to lanceolate or slightly rhombic, the apex acuminate to caudate, the base cuneate to attenuate. Lateral leaflets opposite, the blades 40–49 × 15–21 mm, ovate to lanceolate, the apex acuminate, the base subsymmetrical to asymmetrical, cuneate to obtuse, sometimes attenuate. *Dichasial cymes* axillary, shorter than the leaves; the peduncle 42–62 mm long, flattened to adaxially canaliculate, with moderate, short, patent or curved hairs; dichasial branches 2, up to ca 10 mm long, each with the flowers (or scars) densely grouped along the entire length; bracts 1–1.5 mm long, narrowly triangular, abaxially with abundant, appressed hairs; bracteoles up to ca 1 mm long, narrowly triangular, with abundant, appressed hairs. *Flower buds* ca 7 × 2.5 mm, lanceolate, acuminate. *Pedicel* 3–7 mm long, articulated at base, leaving a persistent foot up to ca 0.5 mm long; with moderate, ascending to curved hairs. *Sepals* light green, 5.5–7.5 × 1–1.8 mm, lanceolate, the exposed part with moderate, ascending to appressed hairs, the apex acuminate. *Corolla* yellow, ca 13.5 mm diam., petals 11.5–13 mm long, each with two orange maculae above the throat; short-styled morph: filaments connate for ca 0.5 mm of their length; shorter filaments ca 1.5 mm long, glabrous, each with a basal knob, longer filaments ca 4 mm long, non-appendiculate, distally hispidule; pistil: ovary ca 0.5 mm long; styles ca 0.5 mm long, recurved, hispidule; stigmas oblate, facing outwards; gynophore inconspicuous, ca 0.2 mm long; long-styled morph: filaments connate for ca 1 mm of their length; shorter filaments ca 1.5 mm long, glabrous, longer filaments ca 4 mm long, non-appendiculate, distally with occasional, short hairs; pistil: ovary ca 1 mm long; styles ca 4 mm long, erect, hispidule for the entire length; stigmas oblate; carpels uniovulate. *Capsules* unknown.

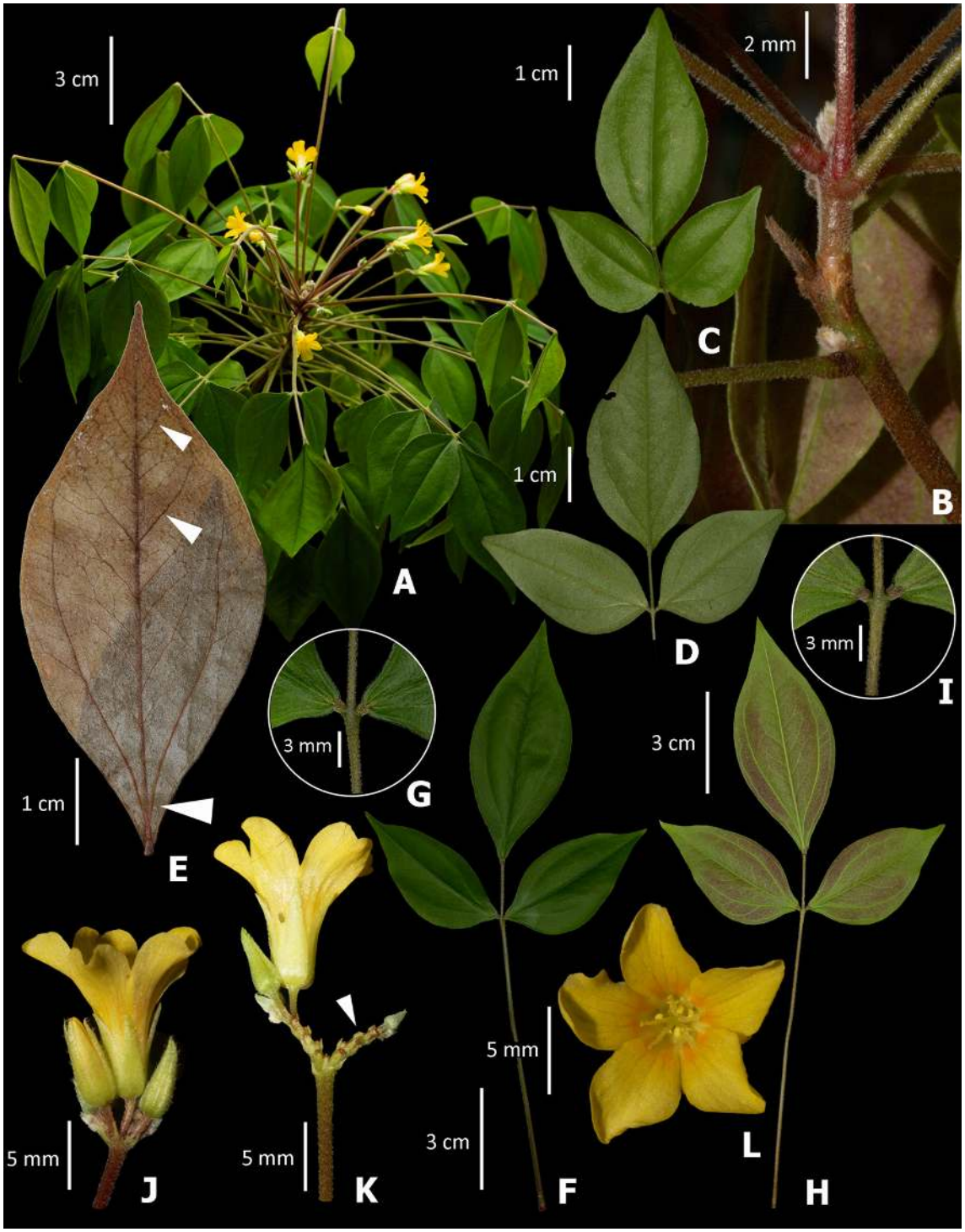


Fig. 6. *Oxalis amorimii* Fiaschi sp. nov. **A**. Habit. **B**. Detail of young stem with short, curved hairs. **C**. Leaf blade adaxial surface. **D**. Leaf blade abaxial surface. **E**. Detail of terminal leaflet venation abaxially, showing supra-basal secondary veins (large arrowhead) and distal secondaries (smaller arrowheads). **F**. Leaf adaxial surface, with detail of lateral leaflets insertion (**G**). **H**. Leaf abaxial surface, with detail of lateral leaflets insertion (**I**). **J**. Young inflorescence with terminal flower. **K**. Older inflorescence showing short persistent foot (arrowhead). **L**. Flower, frontal view. Photos: A, F–I: Carlos Ferreira; B–E, J–L: Pedro Fiaschi. All photos based on cultivated individuals of *P. Fiaschi et al. 5457*, FLOR, except E, based on *A.M. Amorim et al. 4614*, holotype, CEPEC.

Preliminary conservation status assessment

This species is so far known from a single patch of semideciduous forest in a private farmland situated in a very fragmented landscape at the border between the states of Bahia and Minas Gerais, where there are few remaining sites of forested areas. In a recent visit to this area, in August of 2022, we were able to locate less than 20 individuals of the species growing in 'cabruca', a system of cocoa cultivation under the canopy of native trees that was traditionally employed in the region, and which is known to provide shelter for the local biodiversity (Sambuichi & Haridasan 2007; Scroth *et al.* 2011). Since this species occurs in a single location (area of occupancy of 4 km^2), in an extremely fragmented landscape that suffered from both extent and quality loss, we recommend it to be assessed as Critically Endangered following the IUCN criteria CR B2ab(iii) (IUCN 2012).

Remarks

This species can be easily distinguished from the remaining species of *O.* sect. *Polymorphae* by the presence of three-nerved leaflets, which are unique to this species in the section. From other similar, yellow-flowered species of *O.* sect. *Polymorphae*, whose leaves are not congested in a terminal pseudo-whorl, it can also be distinguished from *O. decipiens* by the leaf terminal blades 50–74 mm long (vs 46–122 mm long), unbranched (vs usually bifid at base) dichasial branches, and flowers with the pedicel 3–7 mm long (vs 1.5–2 mm long), and from *O. animarum* sp. nov. by the leaf blades abaxial surface with abundant, appressed hairs (vs with moderate, patent to appressed hairs, mixed with shorter and thicker, darker hairs), the peduncles 42–62 mm long (vs 11–30 mm long), and the pedicels with moderate, ascending to curved hairs (vs with abundant, short, patent hairs, mixed with sparse to moderate, longer, glandular hairs).

Distribution and ecology

This species is only known from a small semideciduous forest fragment located in the municipality of Itanhém, close to the border between the states of Bahia and Minas Gerais (Fig. 5).

Oxalis animarum Fiaschi sp. nov.
urn:lsid:ipni.org:names:77360847-1
Figs 5, 7

Diagnosis

This new species differs from *O. decipiens* by the leaf blades with 4–7 (vs 7–12) pairs of secondary veins, abaxially with moderate, patent to appressed hairs, mixed with shorter and thicker, darker hairs (vs with abundant, appressed hairs), inflorescences with unbranched (vs usually bifid at base) dichasial branches, flowers with the pedicel 3–4.5 mm long (vs 1.5–2 mm long), bearing patent hairs, mixed with sparse to moderate, longer, glandular hairs (vs with appressed or curved hairs), and fruits shorter (vs longer) than the calyx lobes, with the carpels prolonged for ca 1 mm of their length (vs carpels prolonged for ca 2 mm of their length).

Etymology

The specific epithet '*animarum*' (latin: from the souls) refers to the city of Cruz das Almas. The word in Portuguese for 'soul' is 'alma'.

Type material

BRAZIL – **Bahia** • Cruz das Almas, Mata da Cazuzinha; 4 Nov. 2011; fl, fr; *G. Costa & S.F. Conceição 580*; holotype: HURB; isotype: HUEFS.

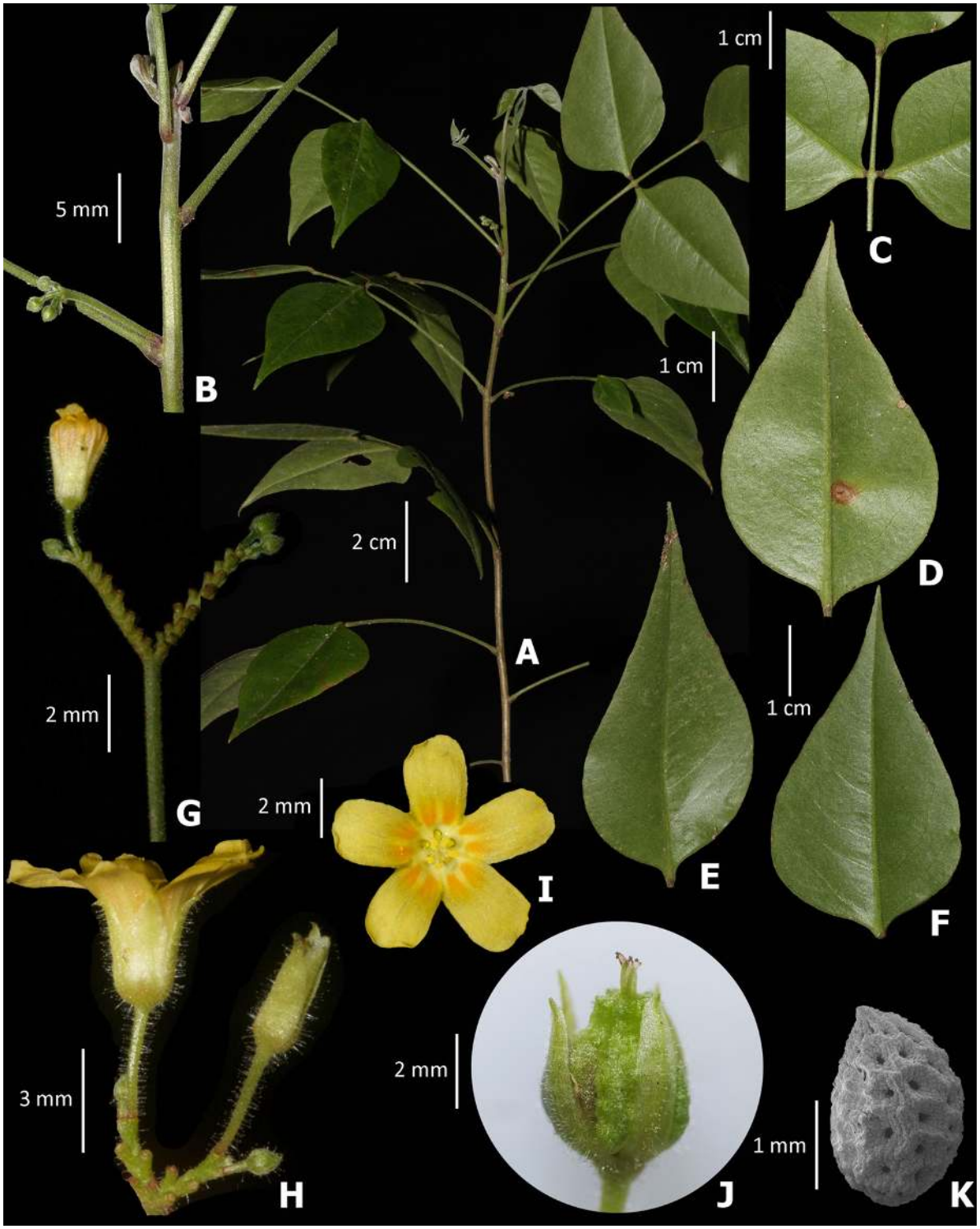


Fig. 7. *Oxalis animarum* Fiaschi sp. nov. **A**. Habit. **B**. Detail of young stem with short, curved hairs (note very short young inflorescence). **C**. Detail of leaflet blades insertion. **D**. Terminal leaflet abaxial surface. **E–F**. Lateral leaflets abaxial surface. **G**. Inflorescence with old flower (left) and young buds (right). **H**. Inflorescence detail showing flowers with glandular pedicel and sepals. **I**. Flower, frontal view. **J**. Fruit, lateral view. **K**. Seed, lateral view. Photos: A–F: Jhonathan Radavelli; G–J: Pedro Fiaschi; K: Gabriela Rhoden. A–F based on *F.S. Cabral et al. 275*, FLOR; G–J based on *P. Fiaschi et al. 5620*, FLOR; K based on *M.L.L. Martins & R. Alves 2455*, FLOR, HURB.

Other material examined

BRAZIL – **Bahia** • Cruz das Almas, Bosque do Instituto Bahiano de Fumo; 13 Sep. 1956; fl; *R.P. Lordelo 56-552*; ALCB • Cruz das Almas, Reserva Florestal do Instituto Baiano do Fumo (IBF); 12 Nov. 1983; *H.P. Bautista 1323*; ALCB, CEPEC, MBM, RB • Cruz das Almas, Mata da Cazuzinha; 11 Apr. 2011; fl; *J.C. Almeida et al. s.n.*; HURB • Cruz das Almas, Mata da Cazuzinha; 9 May 2011; fr; *S.S. Simões et al. 40*; HURB; • Cruz das Almas, Mata da Cazuzinha; 12°40′01″ S, 39°06′29″ W; 460 m a.s.l.; 27 Jan. 2016; fl; *P. Fiaschi & J.L. Costa-Lima 4591*; FLOR • Cruz das Almas, Mata da Cazuzinha, próximo a estrada da Praça da Ciência; 12°40′03″ S, 39°06′19.3″ W; 8 Dec. 2021; fr; *M.L.L. Martins & R. Alves 2455*; FLOR, HURB • Cruz das Almas, Mata da Cazuzinha; 12°39′55″ S, 39°06′22.2″ W; 12 Nov. 2022; *F.S. Cabral et al. 275*; FLOR • Cruz das Almas, Mata da Cazuzinha; 12°40′03″ S, 39°06′19″ W; 6 Mar. 2023; fl; *P. Fiaschi et al. 5620*; FLOR.

Description

Unbranched or few-branched, erect subshrubs, 30–100 cm tall; young stem with abundant to very abundant, short, curved hairs, more densely so at the distal end; older stem dark-brown, terete, slightly striate longitudinally. *Leaves* pinnate-trifoliolate, equally distributed along the stem, the internodes 10–24 mm long; the petioles 35–65 mm long, 0.5–0.7 mm diam., canaliculate adaxially, with abundant to very abundant, short, patent to curved hairs, curved along the channel, the base pulvinate, enlarged to ca 1.2 mm diam.; the rachis 8–20 mm long, similar to the petiole; petiolules ca 1 mm long, with abundant, appressed hairs; leaflet blades adaxially glabrescent, with short, curved hairs along the midrib and the margin, abaxially with moderate, patent to appressed hairs, mostly along the midrib, mixed with shorter and thicker, darker (yellow to brownish), mostly appressed hairs; membranous to chartaceous, adaxially dark green, abaxially lighter green. *Venation*: midrib impressed adaxially, prominent abaxially; secondary veins 4–7 pairs, inconspicuous, impressed on both surfaces, sometimes slightly raised abaxially; intercostal tertiary veins sometimes visible, irregular-reticulate, exterior tertiary course looped, quaternary veins fabric irregular-reticulate, areolation moderately developed, inconspicuous, free ending veinlets not seen. *Terminal blade* 32–80 × 16–27 mm, ovate to lanceolate, the apex acuminate to caudate, the base cuneate to attenuate. Lateral leaflets opposite, the blades 22–54 × 13–28 mm, ovate, the apex acuminate to caudate, the base subsymmetrical to asymmetrical, obtuse or cuneate to attenuate. *Dichasial cymes* axillary, much shorter than the leaves; the peduncle 11–30 mm long, slightly flattened laterally, with moderate to abundant, short, patent or curved hairs; dichasial branches 2, 1.5–4 mm long, each with the flowers (or scars) densely grouped along the entire length; bracts 0.5–1 mm long, triangular, abaxially with moderate to abundant, appressed hairs; bracteoles ca 0.5 mm long, triangular, with sparse to moderate, appressed hairs. *Flower buds* 4–4.5 × ca 2 mm, ovoid to ellipsoid, acute to acuminate. *Pedicel* 3–4.5 mm long, articulated at base, leaving a persistent foot up to ca 1 mm long; with abundant, short, patent hairs, mixed with sparse to moderate, longer, glandular hairs. *Sepals* greenish, ca 5 × 1.3–1.7 mm, lanceolate, the apex acuminate, the exposed part with moderate to abundant, short, patent hairs intermixed with longer glandular hairs. *Corolla* yellow, ca 10 mm diam., petals ca 8 mm long, each with two orange maculae above the throat; mid-styled morph: filaments connate for ca 0.7 mm of their length; shorter filaments ca 1.5 mm long, glabrous; longer filaments ca 4.5 mm long, appendiculate at ca 2 mm of their length, distally hispidule; pistil: ovary ca 1.2 mm long; styles ca 2 mm long, erect, hispidule for the entire length; stigmas oblate; gynophore ca 0.7 mm long. *Capsules* ca 4.5 × 4.5 mm, pyriform, with moderate, glandular and patent intermixed hairs, slightly shorter than the calyx lobes, the apex prolonged for ca 1 mm of their length; locules one-seeded, internally glabrous; seeds ca 2 × 1.5 mm, semi-obloid, with a honeycombed-foveolate surface.

Preliminary conservation status assessment

This species is only known from the Parque Florestal Mata de Cazuzinha, a small patch of semideciduous forest protected in the urban area of the municipality of Cruz das Almas, in the Recôncavo Baiano

region, which is heavily fragmented due to large, cultivated areas of tobacco, sugarcane, cassava, tropical fruits, and cattle farming. Despite 'Mata de Cazuzinha' being a protected area, the region where it is situated suffered from both extent and quality loss. The area of occupancy of the species is 4 km^2. We therefore recommend that it should be considered as Critically Endangered following the IUCN criteria CR B2ab(iii) (IUCN 2012).

Remarks

Fiaschi (2014) listed one specimen of *O. animarum* sp. nov. (*H.P Bautista 1323*, RB) under his wide circumscription of *O. polymorpha*. Among the main diagnostic features of this new species are the leaves distributed along the stem, the inflorescences with the peduncle much shorter than the petiole of the corresponding leaf, the flowers with glandular hairs on the pedicel and sepals, the leaf blades abaxially with patent to appressed hairs, mixed with shorter and thicker, darker (yellow to brownish) hairs, and the pyriform fruits shorter than the calyx lobes, with the carpels prolonged for ca 1 mm of their length.

Distribution and ecology

This new species is endemic to seasonally dry forests in the surroundings of Cruz das Almas (Fig. 4). It is only known from the 'Mata de Cazuzinha', a small urban remnant of the forests that once occurred in the region.

Oxalis decipiens Progel
Figs 5, 8

Oxalis decipiens Progel (Progel 1877: 507). – **Type**: BRAZIL – "Rio de Janeiro" [**Minas Gerais**] • "[Vila] Casal, près d'Uba (Ubá), sur la ligne du chemin de fer de D. Pedro 2°, avec Mr. Albuquerque" [Village Casal, near Ubá, along the railway line of Dom Pedro 2°, with Mr. Albuquerque]; 26 Feb. 1875; *A.F.M. Glaziou 7561*; lectotype: C [C10016336], designated by Lourteig (1994: 150); isolectotypes: P [P02440302], S [S-R-8335].

Oxalis polymorpha var. *cauliflora* Zucc. (Zuccarini 1825: 176). – **Type**: BRAZIL – "Rio de Janeiro" [**Espírito Santo**] • zwichen Villa Nova [now Nova Almeida] und Praya Molle; *M. Neuwied s.n.*; Apr. 1816 [presumably Dec. 1815, see Nomenclatural remarks]; lectotype: M [M-0121064, pro parte], designated by Lourteig (1994: 150) — only the left and central branches (see Fig. 9A); isolectotype: FI [FI005091].

Other material examined

BRAZIL – **Espírito Santo** • Colatina, Fazenda São Gabriel; 24 Mar. 1978; fl; *A. Lourteig 3217*; CEPEC, P [photo] • Colatina, Fazenda São Gabriel; ca 120 m a.s.l.; 24 Mar. 1978; fl; *A. Lourteig 3219*; P [photo] • Colatina, Santa Rosa da Graça Aranha; ca 120 m a.s.l.; 24 Mar. 1978; fl; *A. Lourteig 3221*; CEPEC, P [photo] • Governador Lindemberg, Pedra de Santa Luzia, prop. Firmino Sottele; 19°16′54″ S, 40°27′43″ W; 350–600 m a.s.l.; 26 Apr. 2007; fl, fr; *V. Demuner et al. 3890*; MBML, SPF • Governador Lindemberg, Morelo, propr. Fernando Nicolli; 19°08′55″ S, 40°27′28″ W; 13 Nov. 2006; *V. Demuner et al. 3043*; SPF • Linhares, Reserva Florestal de Linhares – Cia. Vale do Rio Doce, MME, talhão 89; 12 May 2000; fl; *P. Fiaschi et al. 240*; FLOR, SPF • Linhares, "Reserva Florestal da Companhia Vale do Rio Doce (CVRD), área experimental do MME" [Vale do Rio Doce Company Forest Reserve, experimental area of the MME], RFL 89; 19°07′57″ S, 40°04′58″ W; 75 m a.s.l.; 1 Feb. 2002; fl; *P. Fiaschi et al. 964*; FLOR, RB, SPF • Linhares,; "Reserva da Vale, nas proximidades do escritório" [Vale Reserve, near the office]; 19 Jan. 2011; fl; *P. Fiaschi et al. 3469*; FLOR, SPF • Linhares, "Reserva Natural Vale, proximidades do escritório" [Vale Natural Reserve, near the office]; 19°00′03″ S, 40°41′16″ W; 5 Feb. 2016; fl; *P. Fiaschi & J.L. Costa*

Lima 4656; FLOR • Linhares, Reserva Natural Vale, Estrada Aceiro; 3 Apr. 1993; fl; *G.L. Farias 605*; CVRD, FLOR, SPF • Linhares, Reserva Natural Vale, Estrada Municipal do MME, RFL-089/86; 4 Mar. 2008; fl, fr; *D.A. Folli 5877*; CVRD, FLOR, SPF • Linhares, Reserva Natural Vale, Estrada Peroba Amarela; 12 Mar. 1987; fl; *D.A. Folli 629*; CVRD, FLOR, SPF • Linhares, Reserva Natural Vale do Rio Doce (particular); 30 m a.s.l.; 26 Sep. 1978; fl; *A.M. Carvalho et al. 83*; FLOR, RB • Linhares, Reserva Florestal Vale do Rio Doce; 14 Oct. 1992; fl, fr; *G. Hatschbach et al. 58067*; MBM • Linhares, Reserva Natural da Vale, Trilha do Flamengo; 19°09′47.8″ S, 39°58′58″ W; ca 50 m a.s.l.; 12 May 2012; fl; *J.A. Lombardi et al. 9643*; CVRD [photo] • Linhares, Reserva Natural Vale do Rio Doce, Estrada da bomba d'água; 21 Apr. 1983; *A.L. Peixoto & H.C. de Lima 1778*; RB, SPF • Linhares, Reserva Natural da Vale, Estrada Guaribu Amarelo; 24.26936° S, 49.26981° W; 14 Apr. 2011; *J.C. Lopes et al. 161*; ESA, SPF • Linhares, Ponta de Ouro, "margens da Rodovia ES-358" [margins of Highway ES-358]; 19°12′29.9″ S, 40°10′01.7″ W; 80 m a.s.l.; 16 Nov. 2012; fl; *A.M. Assis & J. Freitas 3350*; MBML • Rio Bananal, "Estrada pavimentada para Novo Brasil" [Paved road to Novo Brasil]; 19°09′05.9″ S, 40°20′51.6″ W; 26 Jan. 2009; *C.P. Bruniera et al. 145*; SPF • Sooretama, Reserva Biológica de Sooretama, estrada Cupido; 19°03′42″ S, 40°08′18″ W; 30 m a.s.l.; 20 Feb. 2021; fl; *C.A.P. Toledo & H. Medeiros 578*; FLOR, RB • Sooretama, Reserva Natural da Vale (RNV); 19°09′03.4″ S, 40°04′15.1″ W; 59 m a.s.l.; 3 Feb. 2013; fl, fr; *M.G. Caxambu et al. 4564*; HCF [photo] • Sooretama, Reserva Natural da Companhia Vale do Rio Doce, MME; 19°08′03.2″ S, 40°05′02.2″ W; 74 m a.s.l.; 30 Apr. 2008; *M.M.M. Lopes et al. 1592*; SPF • Sooretama, "Reserva Biológica de Sooretama, entrada da picada em frente ao antigo posto de vigia" [Sooretama Biological Reserve, track entrance in front of old watch post]; 24 Aug. 2012; fl, fr; *T.B. Flores & G.O. Romão 1119*; MBML [photo], RB • Sooretama, Sooretama, Parque do Zooretama; 26 May 1965; fl; *A.J. Andrade & M. Emmerich 1981*; P • Sooretama, "Sooretama, do lado Norte da sede da Reserva de Sooretama" [Sooretama, on the north side of the Sooretama Reserve headquarters]; 11 Jul. 1969; *D. Sucre 5449*; RB • Serra, "a 1–3 km de Nova Almeida, em direção a Santa Cruz" [1–3 km from Nova Almeida, going to Santa Cruz]; 19 Jul. 1973; *D. Araujo & A.L. Peixoto 309*; RB, SPF. – **Minas Gerais** • Coronel Pacheco, Fazenda da Companhia; 2 Jun. 1945; fl; *E.P. Heringer 1921*; SP, SPF • Coronel Pacheco, Fazenda da Liberdade; 20 Feb. 1942; *E.P. Heringer 946*; SPF • Marliéria, "2 km após a entrada do Parque Estadual do Rio Doce, em direção à ponte Queimada e aos experimentos da Teresa Spósito (GEF)" [2 km beyond the Rio Doce State Park entrance, in direction to Queimada bridge and Teresa Spósito's experiments]; 19°42′12″ S, 43°30′52″ W; 29 Nov. 2000; fl; *A.A. Santos et al. 866*; CEN, FLOR • Marliéria, Pq. Estadual do Rio Doce, Mumbaça; 26 Mar. 2006; *J. Ordones et al. s.n.*; SPF 176576 •Marliéria, Parque Rio Doce, Trilha da Campolina; 19°41′55″ S, 42°30′23″ W; 24 Jan. 2018; fl; *E. Richetti et al. 64*; FLOR • Marliéria, Parque Florestal do Rio Doce; 15 Feb. 1973; *L.E. Mello-Filho et al. 3755*; R. – **Rio de Janeiro** • Cantagalo; s.d.; *Peckolt s.n.*; BR • Barra Mansa, ARIE Floresta da Cicuta; 22°32′54″ S, 44°05′18″ W; 2 Mar. 2024; *J.C. Vasques et al. 57*; FLOR, HUEFS, RB, SPF • Volta Redonda, Floresta da Cicuta; 12 Oct. 1985; *J.P.P. Carauta et al. 5095*; RB; • Volta Redonda; 21 Feb. 1987; *R.B. Pineschi 40*; RB • Volta Redonda; 21 Feb. 1987; *R.B. Pineschi 41*; RB; • Volta Redonda; 2 Jan. 1992; *M.R. Ascenção et al. 18*; RB.

Description

Unbranched, erect subshrubs, 15–60 cm tall; young stem with abundant to very abundant, curved hairs, more densely so at the distal end; older stem beige-cinereous to brownish, terete, slightly striate longitudinally. *Leaves* pinnate-trifoliolate, distributed along the stem, mostly grouped at stem apex, but not forming a pseudo-whorl, the internodes 3–22 mm long; the petioles 36–65 × 0.7–1.2 mm, canaliculate adaxially, with moderate to abundant, patent to curved hairs, curved along the channel, the base pulvinate, enlarged to ca 2 mm diam.; the rachis 8–20 mm long, similar to the petiole, sometimes slightly thinner, slightly enlarged distally; petiolules ca 1 mm long, with abundant, appressed to curved hairs; leaflet blades adaxially glabrous, ciliate along the margin, abaxially with abundant, appressed hairs; chartaceous, adaxially dark green, sometimes with a lighter shaded band along the midrib, abaxially lighter green, sometimes vinaceous. *Venation:* midrib canaliculate adaxially, raised abaxially; secondary veins 7–12

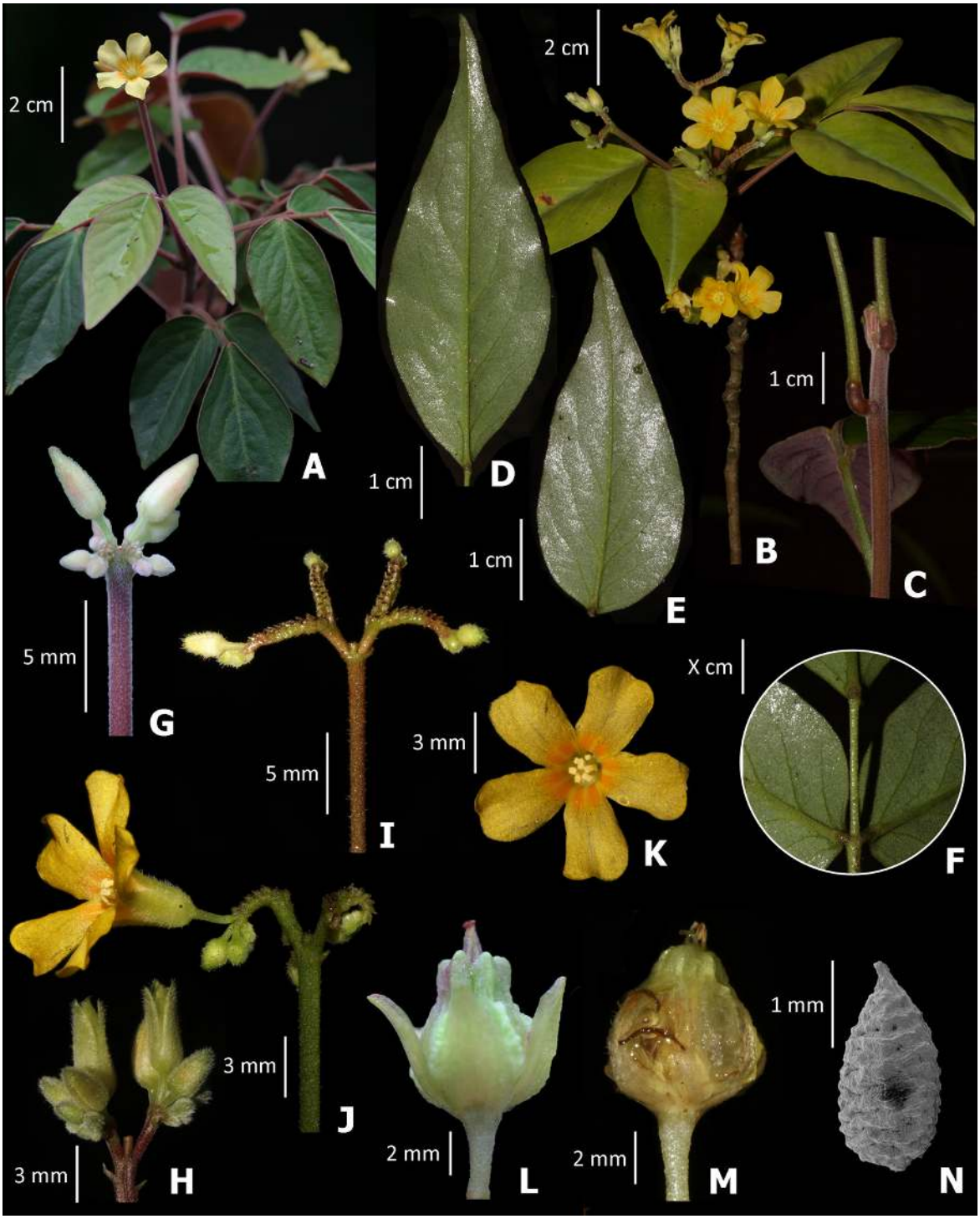


Fig. 8. *Oxalis decipiens* Progel. **A**–**B**. Habit (note cauliflorous and axillary inflorescences in B). **C**. Detail of young stem. **D**. Terminal leaflet, abaxial view. **E**. Lateral leaflet, abaxial view. **F**. Detail of leaflet blades insertion, abaxial surface. **G**–**H**. Detail of young inflorescences with flower buds. **I**. Older inflorescence with bifid dichasial branches. **J**. Inflorescence detail with flower and young buds. **K**. Flower, frontal view. **L**–**M**. Fruits, lateral view (note carpels prolonged for ca 2 mm of their length). **N**. Seed, lateral view (the central dark spot is likely due to incomplete SEM coating). Photos: A–M: Pedro Fiaschi; N: Gabriela Rhoden; A, C, G, N based on *E. Richetti et al. 64*, FLOR; B, L based on *P. Fiaschi & J.L. Costa Lima 4656*, FLOR; D–F, H–K, M based on *J.C. Vasques et al. 57*, FLOR, HUEFS, RB, SPF.

pairs, slightly visible or inconspicuous, impressed adaxially, slightly raised abaxially; intercostal tertiary veins sometimes visible, irregular-reticulate, exterior tertiary course looped, quaternary veins fabric irregular-reticulate, areolation moderately developed, inconspicuous, free ending veinlets not seen. *Terminal blade* 46–122 × 20–43 mm, ovate to lanceolate, the apex acuminate to slightly caudate, the base cuneate to obtuse. Lateral leaflets opposite, the blades 33–85 × 13–32 mm, ovate to lanceolate, the apex acuminate to slightly caudate, the base subsymmetrical to asymmetrical, obtuse to rounded. *Dichasial cymes* axillary and cauliflorous, except in young plants, which may lack cauliflorous inflorescences, shorter than the leaves; the peduncle 10–75 mm long, slightly flattened, with abundant, curved hairs; dichasial branches (1–)2(–3), usually bifid at the very base, and thus appearing as 4(–6), 1–7 mm long, each with the flowers (or scars) densely grouped along the entire length; bracts ca 1 mm long, triangular, abaxially with moderate to abundant, appressed hairs; bracteoles 0.5–0.7 mm long, triangular, with moderate to abundant, appressed hairs. *Flower buds* 4–4.5 × 1.4–2 mm, ovate-acuminate. *Pedicel* 1.5–3.5 mm long, articulated at base, leaving a persistent foot up to ca 0.5 mm long, with abundant, short, appressed or

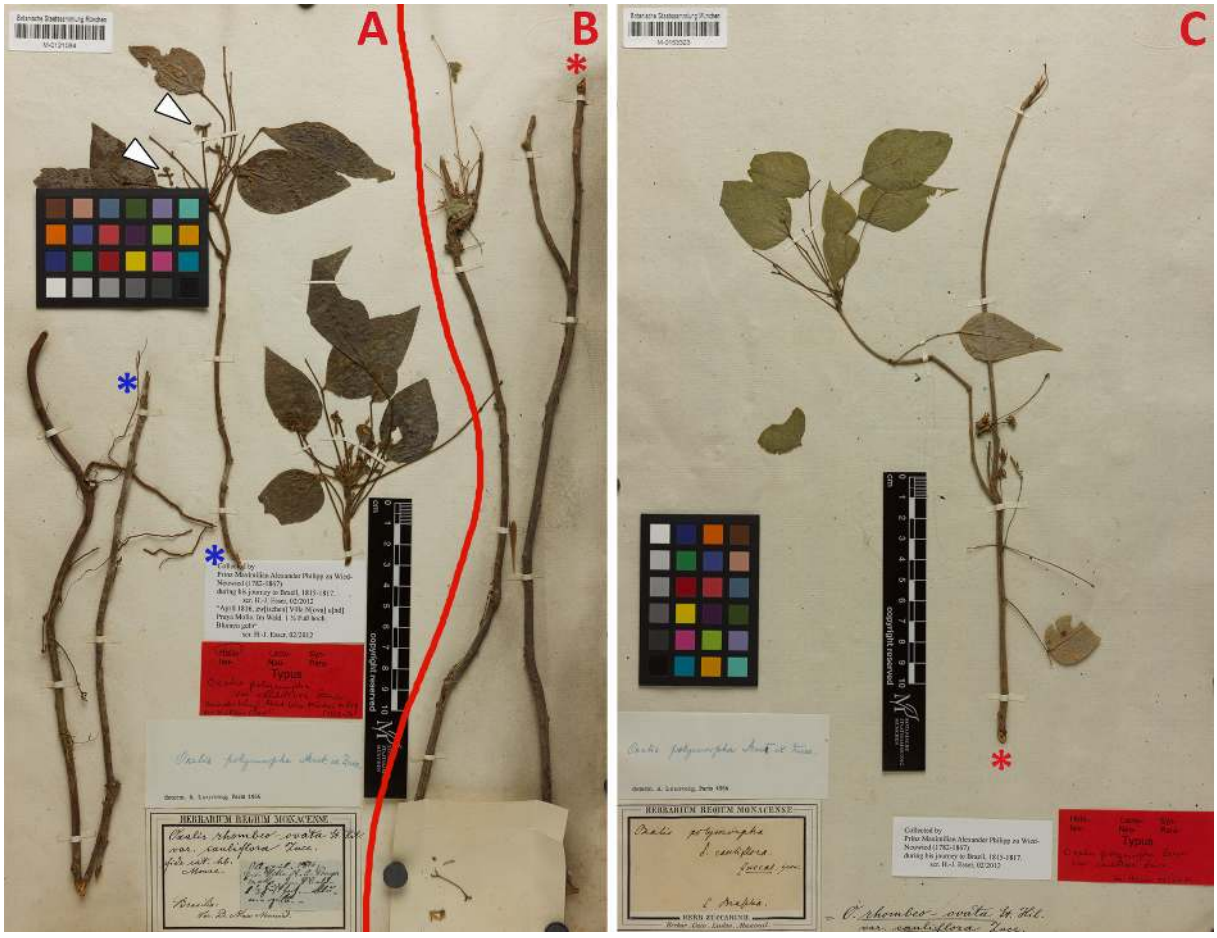


Fig. 9. A. Lectotype of *Oxalis polymorpha* var. *cauliflora* Zucc. (M-0121064, three pieces on the left), showing inflorescences with bifid dichasial branches (white arrowheads). Blue asterisks indicate the ends of the same broken branch. **B**. Pieces from a different gathering that do not belong to the type, but to the plant represented in C (M-0153323), which is here described as *O. idimae* Fiaschi sp. nov. Red asterisks indicate the ends of the same cut branch. Modified from high-resolution images provided by the Botanische Staatssammlung München.

curved hairs. *Sepals* greenish, 5–5.5 × 1–2.2 mm, oblong to lanceolate, the exposed part with abundant, curved hairs, the apex acuminate to obtuse. *Corolla* yellow, ca 9 mm diam., petals 8.5–9.5 mm long, each with two orange maculae above the throat; short-styled morph: filaments connate for ca 0.5 mm of their length; shorter filaments ca 3 mm long, glabrous, each with a basal knob, longer filaments ca 4.5 mm long, non-appendiculate, hispidule; pistil: ovary ca 0.8 mm long; styles ca 1 mm long, recurved, with a few setae; stigmas oblate; gynophore inconspicuous, up to ca 0.5 mm long; long-styled morph: filaments connate for 0.5–0.7 mm of their length; shorter filaments ca 1.2 mm long, glabrous, each with a basal knob, longer filaments 2.8–3.8 mm long, non-appendiculate or very slightly appendiculate at ca 1.5 mm long, hispidule or almost glabrous; pistil: ovary ca 0.8 mm long; styles ca 4 mm long, erect, hispidule for the entire length; stigmas oblate; gynophore 0.3–0.5 mm long. *Capsules* ca 5.5 × 5.5 mm, pyriform, glabrous, slightly longer than the calyx lobes, the apex prolonged for ca 2 mm of its length; locules one-seeded, internally glabrous; seeds ca 2.5 × 1.2 mm, ovoid, with a honeycombed-foveolate surface.

Preliminary conservation status assessment

Despite its widespread distribution (Fig. 5), *O. decipiens* occurs in a very fragmented area of lowland to submontane Atlantic forests in the states of Rio de Janeiro, Espírito Santo and Minas Gerais. The main threats to this species are the historical forest conversion into agricultural land for cattle grazing and eucalyptus reforestation for cellulose production. The region where this species occurs suffered from both extent and quality loss, but it is protected in large lowland Atlantic Forest remnants, such as the Rio Doce State Park, in Minas Gerais state, and the Reserva Natural Vale and Sooretama National Park, both in the state of Espírito Santo. *Oxalis decipiens* has an EOO of 81 772 km^2 and an AOO of 60 km^2, which could be expanded if additional populations are found. For these reasons we recommend that *O. decipiens* should be considered as Least Concern (LC) following IUCN (2012).

Nomenclatural remarks

Oxalis decipiens was described by Progel (1877) based on two syntypes: *Glaziou 7561*, from the surroundings of Ubá (Minas Gerais state) and *Peckolt s.n.* (BR529076 (bc) (photo)!), from Cantagalo (Rio de Janeiro state). Lourteig (1994) chose the specimen *Glaziou 7561* at C as the lectotype, as it bears an identification label handwritten by A. Progel.

Two specimens collected by Prince Max. Neuwied during his journey to Brazil from 1815 and 1817 are available at M and labeled as types of *O. polymorpha* var. *cauliflora*. The first (M-0121064) was collected "zw[ischen] Villa N[ova] u[nd] Praya Molle", between localities that, according to Moraes (2009) were visited between 20th and 21st December 1815, and which correspond to the current town of Nova Almeida and Praia Mole, at Espírito Santo state. This specimen was inadvertently chosen as the lectotype of *Oxalis polymorpha* var. *cauliflora* by Lourteig (1994), but it is a 'mixtum compositum', where the central leaf-bearing branches and the left stem with a few cauliflorous inflorescences correspond to this taxon (Fig. 9A), while the two pieces of stem on the right side likely belong to what we are describing here as *O. idimae* sp. nov. (Fig. 9B). The second specimen (M-053323, Fig. 9C) appears to belong to the same gathering of these two pieces of stem that were mounted on the right side in M-0121064. In support of this interpretation, the petioles, and peduncles from Fig. 9B are clearly thinner than those of Fig. 9A, and the single leaf blade of Fig. 9B dried greenish as those of Fig. 9C, contrasting to the brownish color of the leaves from Fig. 9A. Moreover, while the branches in Fig. 9A bear inflorescences with bifid dichasial branches, which are commonly observed in *O. decipiens* (Fig. 5I), those from Fig. 9C are not bifid, resembling what is observed in *O. idimae* (see Fig. 10F). The locality where M-053323 was collected is unknown, but it was very likely gathered during the part of Neuwied's expedition when he visited the northern part of Rio de Janeiro state, between September and November of 1815 (Moraes 2009), the region where *O. idimae* is presumably endemic (Fig. 5).

Taxonomic remarks

Oxalis decipiens can be distinguished from *O. polymorpha* by the usually cauliflorous (vs only axillary) inflorescences with bifid dichasial branches (appearing 4(–6) branched) (vs with single, unbranched dichasial branches), and by the pyriform capsules with the carpels apically prolonged for ca 2 mm long (vs carpels prolonged up to ca 0.5 mm long).

Distribution and ecology

This species mostly occurs in the Rio Doce valley rainforests in the northern part of the state of Espírito Santo and in the eastern part of Minas Gerais, especially in the large forest fragment protected in the Parque Estadual do Rio Doce. In addition to these areas, there are a few records in the surroundings of Vitória (Espírito Santo state) and in highland areas along the state of Rio de Janeiro, in the municipalities of Barra Mansa, Volta Redonda and Cantagalo, but no additional samples from this latter area are known to date.

Oxalis idimae Fiaschi sp. nov.
urn:lsid:ipni.org:names:77360848-1
Figs 5, 10

Diagnosis

Oxalis idimae sp. nov. differs from *O. decipiens* by the glabrescent young stem (vs with abundant to very abundant, curved hairs), leaf blades abaxially glabrous (vs with abundant, appressed hairs), sometimes with occasional hairs on the margin (vs with abundant hairs), venation with the midrib impressed (vs canaliculate) adaxially, conspicuous secondary veins (vs slightly visible or inconspicuous), and areolation of good (vs moderate) development, inflorescences with (1–)2 single branches (vs with (1–)2(–3) usually bifid branches), flowers with white (vs yellow) flowers, and broadly ovoid (vs pyriform) capsules with the carpels lacking apical prolongations or prolonged to only ca 0.5 mm of their length (vs with the carpels prolonged for ca 2 mm of their length).

Etymology

This new species honors the plant collector and amateur botanist Idimá Gonçalves Costa, who has recently discovered several new species of plants in the forest of northern Rio de Janeiro state, such as *Anthurium idimae* Theófilo & Nadruz (Valadares & Coelho 2017), *Besleria aurea* I.G.Costa & G.E.Ferreira (Ferreira *et al.* 2016), *Conchocarpus hendrixii* Groppo, I.G.Costa & Bruniera (Groppo *et al.* 2019), *Eugenia asema* I.G.Costa & M.C.Souza (Sobral *et al.* 2017), and *Hippeastrum idimae* Dutilh & R.S.Oliveira (Oliveira *et al.* 2017).

Type material

BRAZIL – **Rio de Janeiro** • Cardoso Moreira, localidade de Vinhático; 21°31′8.86″ S, 41°37′18.01″ W; 238 m a.s.l.; 6 Mar. 2017; *I.G. Costa 879*; holotype: FLOR [FLOR 66532]; isotypes: HUEFS, RB, SPF.

Other material examined

BRAZIL – **Rio de Janeiro** • Cardoso Moreira, "3 km após ponte via BR 356 sentido Campos dos Goytacazes, entrada à direita" [3 km after bridge, on road BR 356 to Campos dos Goytacazes, entrance to the right]; 21°30′58″ S, 41°36′27″ W; 27 Jan. 2018; fl, fr; *E. Richetti et al. 70*; FLOR • Cardoso Moreira; 5 Mar. 2024; *J.C. Vasques et al. 78*; FLOR, RB, SPF • Italva, "localidade de Quimbira, em escarpa de afloramento rochoso no interior da mata" [locality of Quimbira, on a rocky outcrop escarpment inside the forest]; 21°27′23″ S, 41°35′47″ W; 150 m a.s.l.; 11 Apr. 2014; fl; *I.G. Costa 400*; RB, SPF • Italva, Quimbira; 21°27′25″ S, 41°35′43.7″ W; 51 m a.s.l.; 18 Feb. 2017; fl; *T.S. Costa et al. 123*; FLOR • Italva; 5 Mar. 2024; *J.C. Vasques et al. 81*; FLOR, HUEFS, RB • Italva, Pão de Ló; 21°27′29″ S, 41°36′25″ W; 13 Dec. 2015; *J. Rossini & I.G. Costa 835*; R.

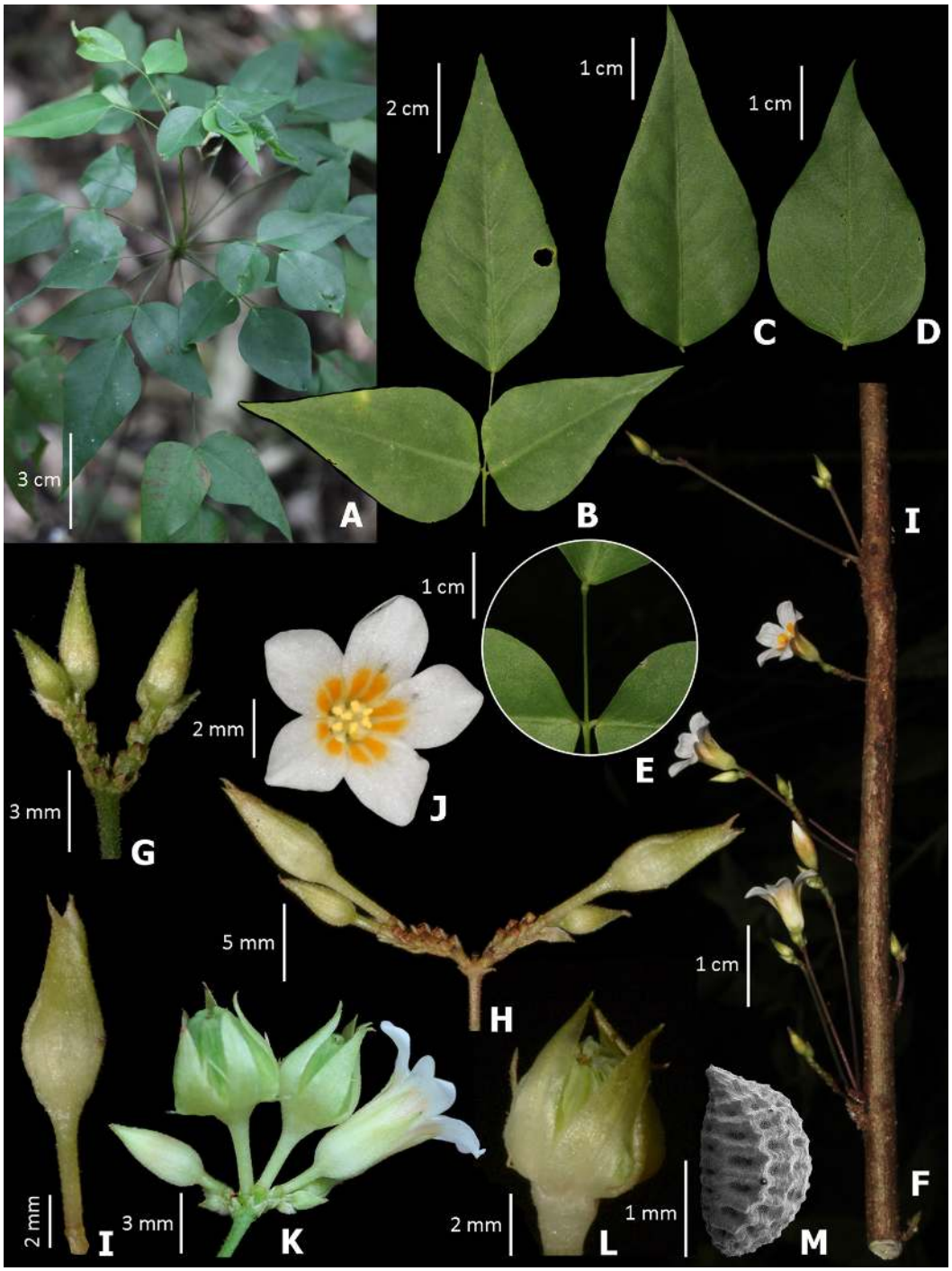


Fig. 10. *Oxalis idimae* Fiaschi sp. nov. **A**. Habit. **B**. Leaf, adaxial surface. **C**. Terminal leaflet detail, adaxial surface. **D**. Lateral leaflet, adaxial surface. **E**. Detail of leaflet blades insertion, adaxial surface. **F**. Stem with cauliflorous inflorescences bearing flowers and buds. **G**. Detail of young inflorescence with buds. **H**. Older inflorescence detail, showing densely grouped flowers (scars) along the entire length. **I**. Developing fruit in lateral view. **J**. Flower, frontal view. **K**. Young inflorescence with buds, flower (lateral view) and fruits. **L**. Fruit, lateral view. **M**. Seed, lateral view. Photos: A–L: Pedro Fiaschi; M: Gabriela Rhoden. A, J based on *J.C. Vasques et al. 81*, FLOR, HUEFS, RB; B–G based on *J.C. Vasques et al. 78*, FLOR, RB, SPF; H–I, K–L based on *T.S. Costa et al. 123*, FLOR; M based on *E. Richetti et al. 70*, FLOR.

Description

Unbranched or few-branched, erect subshrubs, 60–120 cm tall; young stem glabrescent, with occasional to sparse, curved to appressed hairs; older stem ochreous, terete, slightly striate longitudinally. *Leaves* pinnate-trifoliolate, arranged along the stem, densely grouped at stem apex, sometimes forming multiple pseudo-whorls, the internodes 5–40 mm long; the petioles 31–110 × 0.5–0.8 mm, slightly canaliculate adaxially, with occasional, appressed hairs, more densely in the proximal region, the base pulvinate, enlarged to ca 1.2 mm diam.; the rachis 10–28 mm long, similar to the petiole; petiolules ca 1 mm long, with sparse, appressed hairs; leaflet blades adaxially glabrous, abaxially glabrous, the margin sometimes with occasional hairs in the proximal part; membranous, adaxially green, abaxially lighter green. *Venation:* midrib impressed adaxially, impressed to slightly raised abaxially; secondary veins 5–8 pairs, conspicuous, impressed on both surfaces, sometimes very slightly raised abaxially, angle of divergence inconsistent; intercostal tertiary veins irregular-reticulate, exterior tertiary course looped, quaternary veins fabric irregular-reticulate, areolation of good development, free ending veinlets unbranched or with one branch. *Terminal blade* 54–110 × 24–48 mm, ovate to lanceolate, the apex acuminate, the base obtuse. Lateral leaflets opposite, the blades 31–73 × 15–33 mm, ovate to lanceolate, the apex acuminate, the base subsymmetrical to asymmetrical, rounded to almost truncate. *Dichasial cymes* cauliflorous, shorter than the leaves; the peduncle 6–65 mm long, slightly flattened laterally, with moderate, curved or appressed hairs; dichasial branches (1–)2, 0.5–8 mm long, each with the flowers (or scars) densely grouped along the entire length or with the proximal part elongated, and the scars far from the terminal flower; bracts 0.7–1.5 mm long, lanceolate to linear, abaxially with moderate to abundant, appressed hairs; bracteoles ca 0.5 mm long, triangular-ovate, with moderate, appressed hairs. *Flower buds* 4–4.5 × ca 1.5 mm, lanceolate, acuminate. *Pedicel* 3–6 mm long, articulated at base, leaving a persistent foot up to ca 0.5 mm long; with moderate to abundant, appressed hairs. *Sepals* greenish, ca 6 × 1.7–1.8 mm, lanceolate, the exposed part with sparse to moderate, appressed hairs, the apex acuminate. *Corolla* white, ca 10 mm diam., petals ca 10 mm long, each with two orange maculae above the throat; short-styled morph: filaments connate for ca 0.5 mm of their length; shorter filaments ca 3.5 mm long, glabrous, each with a basal knob, longer filaments ca 5 mm long, non-appendiculate, hispidule; pistil: ovary ca 0.7 mm long; styles ca 0.7 mm long, proximally hispidule; stigmas oblate; gynophore ca 0.5 mm long; long-styled morph: filaments connate for ca 0.5 mm of their length; shorter filaments ca 1.2 mm long, glabrous, each with a basal knob, longer filaments ca 3.5 mm long, non-appendiculate, hispidule in the distal ⅓; pistil: ovary ca 0.8 mm long; styles ca 3 mm long, erect, hispidule along the entire length; stigmas oblate; gynophore ca 0.3 mm long. *Capsules* ca 4.5 × 4.5 mm, broadly ovoid, glabrous, slightly shorter than the calyx lobes, the apex not prolonged or prolonged to ca 0.5 mm long; locules one-seeded, internally glabrous; seeds ca 2 × 1.2 mm, semi-obloid, with a honeycombed-foveolate surface.

Preliminary conservation status assessment

This species is only known from a few seasonally dry forest fragments in the northern part of Rio de Janeiro state, which has historically suffered from a steady conversion of forests in cultivated areas for agricultural activities or pastures for cattle farming. The species is not known from any protected area, and the only fragments where it occurs are privately-owned; thus, it may be suffering from both extent and quality loss. With an EOO of only 8.6 km^2, it is suggested that this species should be considered as Critically Endangered following the IUCN criteria CR B1ab(iii) (IUCN 2012).

Remarks

Costa *et al.* (2019) had access to one specimen of *O. idimae* sp. nov. (*I.G. Costa 400*, RB), but they decided to treat it under *O. polymorpha* subsp. *polymorpha*, which was distinguished from *O. polymorpha* subsp. *tijucana* by the leaves spacely distributed along the stem (vs grouped in a pseudo-whorl at stem apex).

Oxalis idimae sp. nov. can be distinguished from all other species that are here segregated from *O. polymorpha* by the following combination of character states: glabrescent young stem, glabrous leaf blades (the margin sometimes with occasional hairs), inflorescences mostly cauliflorous, with white flowers, and capsules with the carpels without apical prolongation or prolonged to only ca 0.5 mm long. Moreover, it can be distinguished from *O. decipiens*, which also sometimes bears cauliflorous inflorescences, by several additional features (see Table 3).

Distribution and ecology

This species is presumably endemic to the northern part of Rio de Janeiro state, where it is known only from seasonally dry forests.

Oxalis itatingae Fiaschi sp. nov.
urn:lsid:ipni.org:names:77360849-1
Figs 11–12

Diagnosis

This new species is very similar to *Oxalis tijucana*, from which it can be distinguished by the leaflet blades abaxially with abundant, short appressed hairs along the midrib (vs glabrous or with occasional hairs along the midrib); terminal blades ≥2 × longer (vs up to 1.5 × longer) than the lateral ones, with 5–7 (vs 8–12) pairs of secondary veins, and inflorescences with the peduncle 9–50 mm long (vs 82–110 mm long).

Etymology

The name of this species refers to the 'Padre Estadual da Pedra Branca' (Pedra Branca State Park, an important protection area where this species is known to occur (Fig. 12). In the tupi-guarani language, 'ita' means 'pedra' (the Portuguese word for rock) and 'tinga' means 'branca' (white, in Portuguese), thus the epithet '*itatingae*'.

Type material

BRAZIL – **Rio de Janeiro** • Rio de Janeiro, Prainha, "Área de Proteção Ambiental da Pedra Branca" [Pedra Branca Environmental Protected Area]; 23°02′16″ S, 43°30′25″ W; 23 Mar. 2015; *P. Fiaschi et al. 4472*; holotype: FLOR.

Other material examined

BRAZIL – **Rio de Janeiro** • Rio de Janeiro, "Área de Proteção Ambiental Prainha, Trilha para o Cruzeiro do Sul" [Prainha Environmental Protection Area, Trail to Cruzeiro do Sul]; 8 Apr. 2015; *D.R. Gonzaga & C. Martins 516*; RB • Rio de Janeiro, Camorim; 19 Dec. 1933; *Excursão O. Sampaio Freire, Peckolt e Oswaldo Costa s.n.*; R [70501] • Rio de Janeiro,; Camorim, Pedra da Rosilha, "acesso pela estrada da Boca do Mato - Vargem Pequena" [access via Boca do Mato - Vargem Pequena road]; 23 Jan. 2023; *P. Feliz 372*; RB • Rio de Janeiro,; Campo Grande, "Batalhão de Operações Especiais de Fuzileiros Navais (Batalhão Tonelero)" [Marine Special Operations Battalion (Tonelero Battalion)]; 22.8541° S, 43.5859° W; 25 Apr. 2017; *A.L. Scudeler et al. 443*; ESA, FLOR • Rio de Janeiro, Grumari; 2 Apr. 1984; *V.F. Ferreira 3344*; RB • Jacarepaguá, Vargem Grande, Mata de Lagôa; 150–350 m a.s.l.; 21 Apr. 1980; *T. Plowman 10108*; RB • Rio de Janeiro, Parque Municipal Ecológico da Prainha, "subida para o mirante Cruzeiro do Sul" [ascent to the Cruzeiro do Sul viewpoint]; ca 320 m a.s.l.; 13 Nov. 2003; fl; *J.M.A. Braga et al. 7256*; K n.v., MBM, NY n.v., RB • Rio de Janeiro, Parque Municipal Ecológico da Prainha, "subida para o mirante Cruzeiro do Sul" [ascent to the Cruzeiro do Sul viewpoint]; 7 Mar. 2024; st; *J.C. Vasques et al. 86*; FLOR • Rio de Janeiro, Restinga do Recreio dos Bandeirantes, Morro da Prainha; 4 Dec. 1978; *G. Martinelli 5551*; RB • Rio de Janeiro, Serra do Mendanha; ca 450 m a.s.l.; 27 Feb. 1969; *D. Sucre & P.I. Braga 6386*; RB.

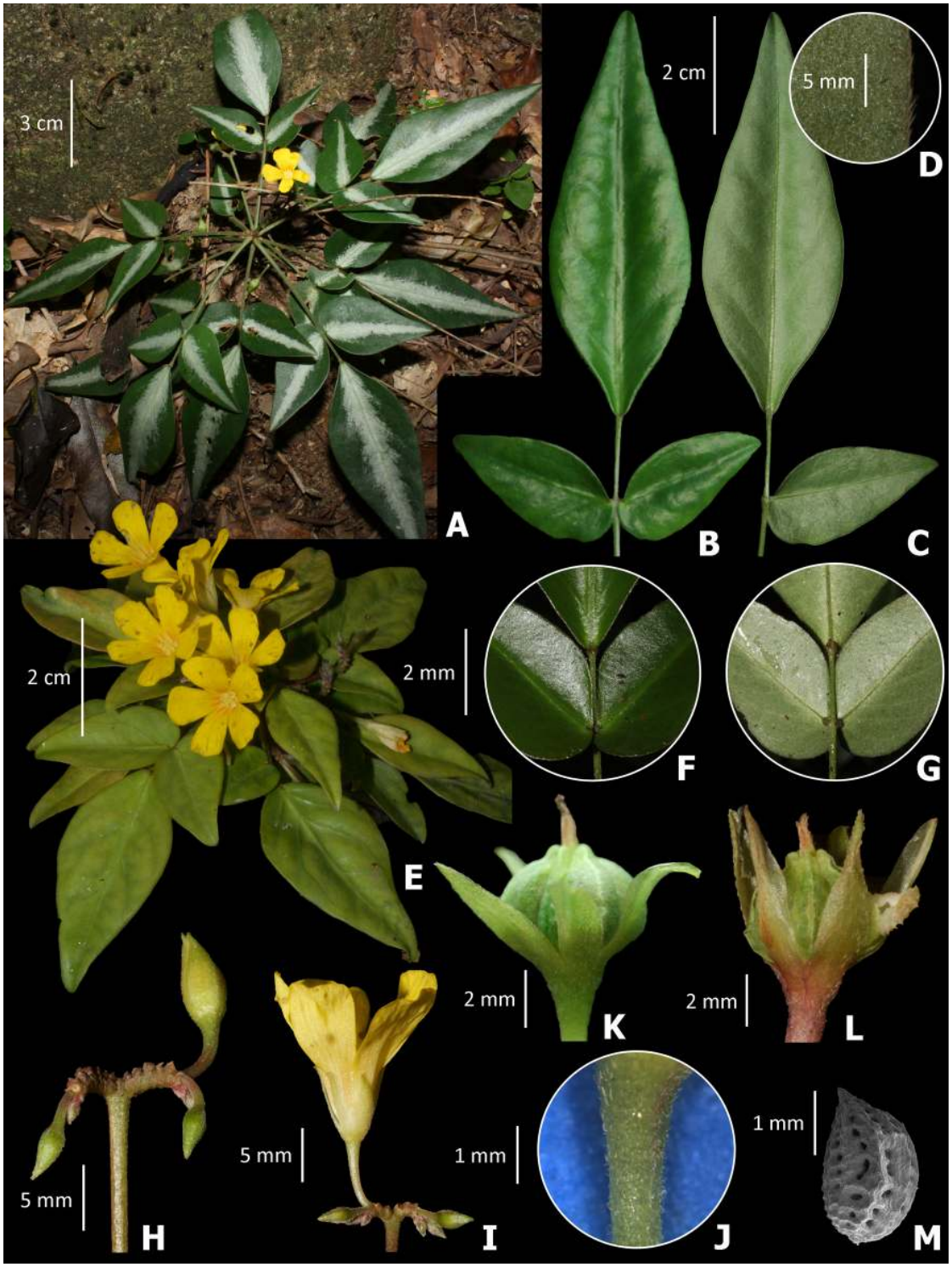


Fig. 11. *Oxalis itatingae* Fiaschi sp. nov. **A**. Habit. **B**. Leaf adaxial surface. **C**. Leaf abaxial surface (one lateral leaflet removed). **D**. Detail of leaflet ciliate margin. **E**. Habit (under cultivation). **F**. Detail of leaflet blades insertion, adaxial surface. **G**. Detail of leaflet blades insertion, abaxial surface **H**. Inflorescence with flower buds. **I**. Inflorescence with closing flower and young buds. **J**. Detail of hairs on the pedicel. **K**. Mature fruit, lateral view. **L**. Fruit after seeds ejected, lateral view. **M**. Seed, lateral view. Photos: A: Pablo Feliz; B-L: Pedro Fiaschi; M: Gabriela Rhoden. A based on *P. Feliz 372*, RB; B–C, E, H–M based on *P. Fiaschi et al. 4472*, holotype, FLOR; D, F–G based on *J.C. Vasques et al. 86*, FLOR.

Description

Unbranched or few-branched, erect subshrubs, 10–35 cm tall, with an elongated horizontal stem up to ca 30 cm long spreading under the leaf litter; young stem covered by scars of the fallen leaves and inflorescences; glabrescent, with sparse to moderate, short, curved or appressed hairs; older stem brownish, terete, smooth. *Leaves* pinnate-trifoliolate, densely grouped at stem apex, appearing arranged in a terminal pseudo-whorl, the internodes indistinct (< 0.5 mm long), sometimes up to ca 8 mm long; the petioles 14–68 × ca 0.5 mm, canaliculate adaxially or only slightly flattened, adaxially with abundant, curved hairs, abaxially with occasional to sparse hairs, the base pulvinate, enlarged to ca 1 mm diam., articulated at 0.5–2 mm long; the rachis 6–21 mm long, similar to the petiole; petiolules ca 0.5 mm long, with hairs slightly larger and thicker than the petiole ones; leaflet blades adaxially glabrous, with hairs restricted to the ciliate margin; abaxially with abundant, short appressed hairs along the midrib; membranous to chartaceous, abaxially lighter colored than adaxially. *Venation:* midrib impressed to slightly canaliculate adaxially, impressed to slightly raised in the proximal part abaxially; secondary veins 5–7 pairs, inconspicuous, impressed on both surfaces, angle of divergence increasing towards the apex; tertiary and quaternary veins inconspicuous (not described). *Terminal blade* 45–108 × 17–46 mm, lanceolate to almost narrowly trullate, the base cuneate to obtuse, the margin plane, ciliate, the apex acuminate. Lateral leaflets opposite, the blades 17–54 × 12–29 mm, ovate to widely ovate, the base asymmetrical to strongly asymmetrical, the proximal side > 1.5 wider than the distal one, rounded to almost truncate, the apex acuminate to obtuse. *Dichasial cymes* axillary, shorter than the leaves; the peduncle 9–50 mm long, slightly flattened, with sparse to moderate (abundant), curved or appressed hairs; dichasial branches 2, 1–7 mm long, each with the flowers (or scars) densely grouped along the entire length, sometimes recurving the branches; bracts ca 0.5 mm long, triangular, abaxially with abundant, appressed hairs; bracteoles ca 0.5 mm long, triangular, with abundant, appressed hairs. *Flower buds* ca 6.5 × 2.8 mm, ovate to lanceolate, acuminate. *Pedicel* 5–7 mm long, articulated at base, leaving a persistent

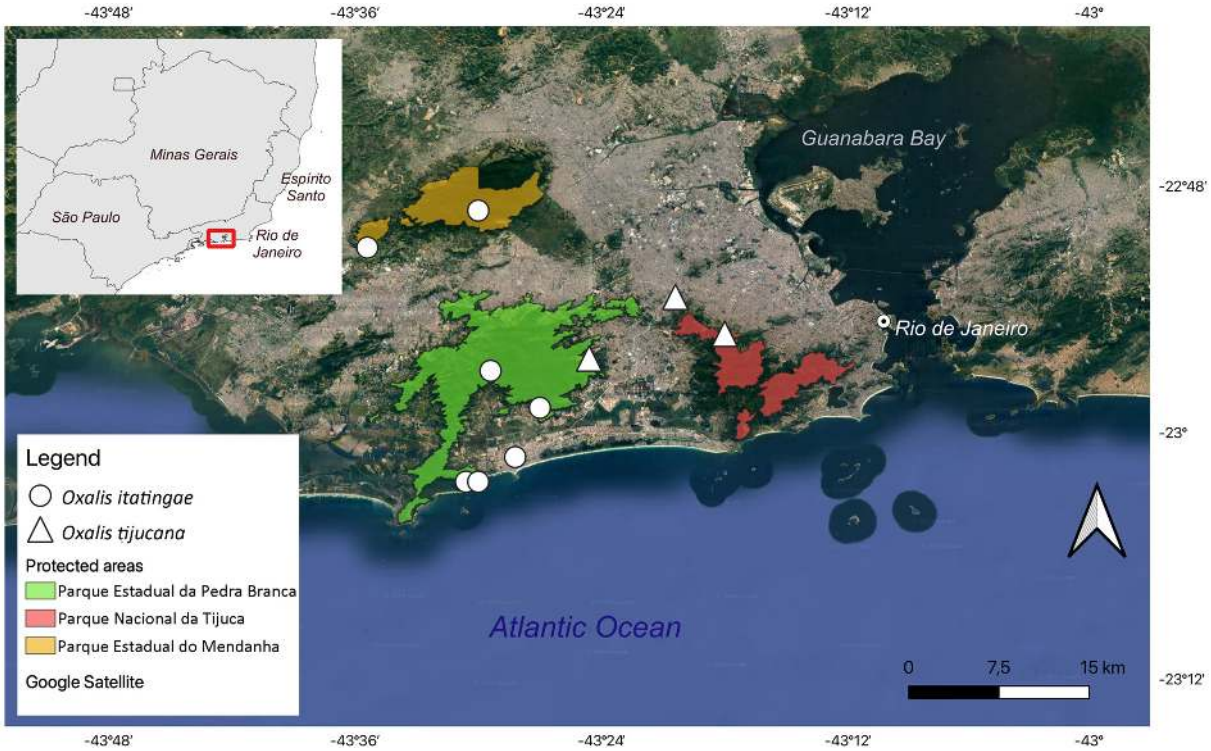


Fig. 12. Geographic distribution of *Oxalis itatingae* Fiaschi sp. nov. and *O. tijucana* (Lourteig) Fiaschi comb. et stat. nov. Inset shows southeastern Brazilian states.

foot up to ca 0.5 mm long; with abundant, short, patent to slightly retrorse hairs, sometimes distally mixed with antrorse, longer hairs. *Sepals* light green, ca 7 × 1.7–2 mm, narrowly elliptic or lanceolate, symmetric to slightly asymmetric, the apex acute to rounded, sometimes mucronate, the exposed part with moderate, appressed hairs. *Corolla* dark yellow, ca 16 mm diam., petals ca 15 mm long, each with two orange maculae above the throat; short-styled morph: filaments connate for ca 1 mm of their length; shorter filaments ca 2.5 mm long, glabrous; longer filaments ca 4.5 mm long, non-appendiculate, distally hispidule; pistil: ovary ca 1 mm long; styles ca 3.5 mm long, erect, hispidule for the entire length; stigmas oblate; gynopohore ca 1 mm long; long-styled morph: filaments connate for ca 1.2 mm of their length; shorter filaments ca 2.5 mm long, glabrous, longer filaments ca 4 mm long, non-appendiculate, distally hispidule; pistil: ovary ca 1.2 mm long; styles ca 2.8 mm long, erect, hispidule for the entire length; stigmas oblate; gynophore ca 1 mm long; carpels uniovulate. *Capsules* ca 4 × 5.5 mm, obloid, glabrous, shorter than the calyx lobes, the apex prolonged for ca 1 mm of its length; locules one-seeded, internally glabrous; seeds ca 3 × 1.7 mm, semi-obloid, with a honeycombed-foveolate surface.

Preliminary conservation status assessment

Oxalis itatingae sp. nov. is restricted to preserved forests in the western part of Rio de Janeiro municipality (Fig. 12), the second largest Brazilian city, which suffers from a continuous historic decline of habitat quality and extent. It is known to occur in some protected areas, such as Parque Municipal Ecológico da Prainha, but this protection may not be enough to safeguard it from further declines, as this region is still subjected to illegal squatting for real estate development. With an EOO of 190 km^2 and an AOO of 24 km^2, this species should be conservatively treated as Endangered following the IUCN criteria EN B2ab(iii) (IUCN 2012).

Remarks

Specimens belonging to this new species have been previously treated as *O. polymorpha* subsp. *tijucana* by Fiaschi (2014), Costa *et al.* (2019), and Richetti *et al.* (2023). However, during fieldwork in the municipality of Rio de Janeiro, we were able to locate one population of this latter taxon, which is here elevated to species level (as *O. tijucana* (Lourteig) Fiaschi). The main differences between *O. itatingae* sp. nov. and *O. tijucana* are presented in the diagnosis above (see also Table 3).

Distribution and ecology

This species is restricted to rainforests in the surroundings of Rio de Janeiro city, especially in Camorim, Campo Grande, and Jacarepaguá neighborhoods (Fig. 12), where it is only found in shady environments of preserved forests.

Oxalis tijucana (Lourteig) Fiaschi comb. et stat. nov.
urn:lsid:ipni.org:names:77360850-1
Figs 12–13

Type material

BRAZIL – **Rio de Janeiro** • Rio de Janeiro, Parque Nacional da Tijuca, Serra dos Pretos Forros, Represa dos Ciganos; 200–300 m a.s.l.; 30 Sep. 1977; fl, fr; *G. Martinelli et al. 3196*; holotype: P [P02440300]; isotypes: RB [RB00271307, RB00585541], SPF [SPF00197792].

Other material examined

BRAZIL – **Rio de Janeiro** • Rio de Janeiro, Cascadura, Serra da Bica; Nov. 1897; fl; *E. Ule 4537*; R • Rio de Janeiro, Serra da Bica, "par Ribeiro"; 21 Feb. 1883; *A.F.M. Glaziou 13648a*; P • Rio de Janeiro, Jacarepaguá, Curicica, FioCruz, "caminho da cachoeira" [waterfall path]; 22°56′37.17″ S, 43°24′51.72″ W; 13 Apr. 2015; fl; *J.P. Costa s.n.*; HUEFS [217077], RBR [37031] • same data as for preceding; 7 Mar. 2024; fl, fr; *J.C. Vasques et al. 85*; BAL, FLOR, RB, RBR, SPF.

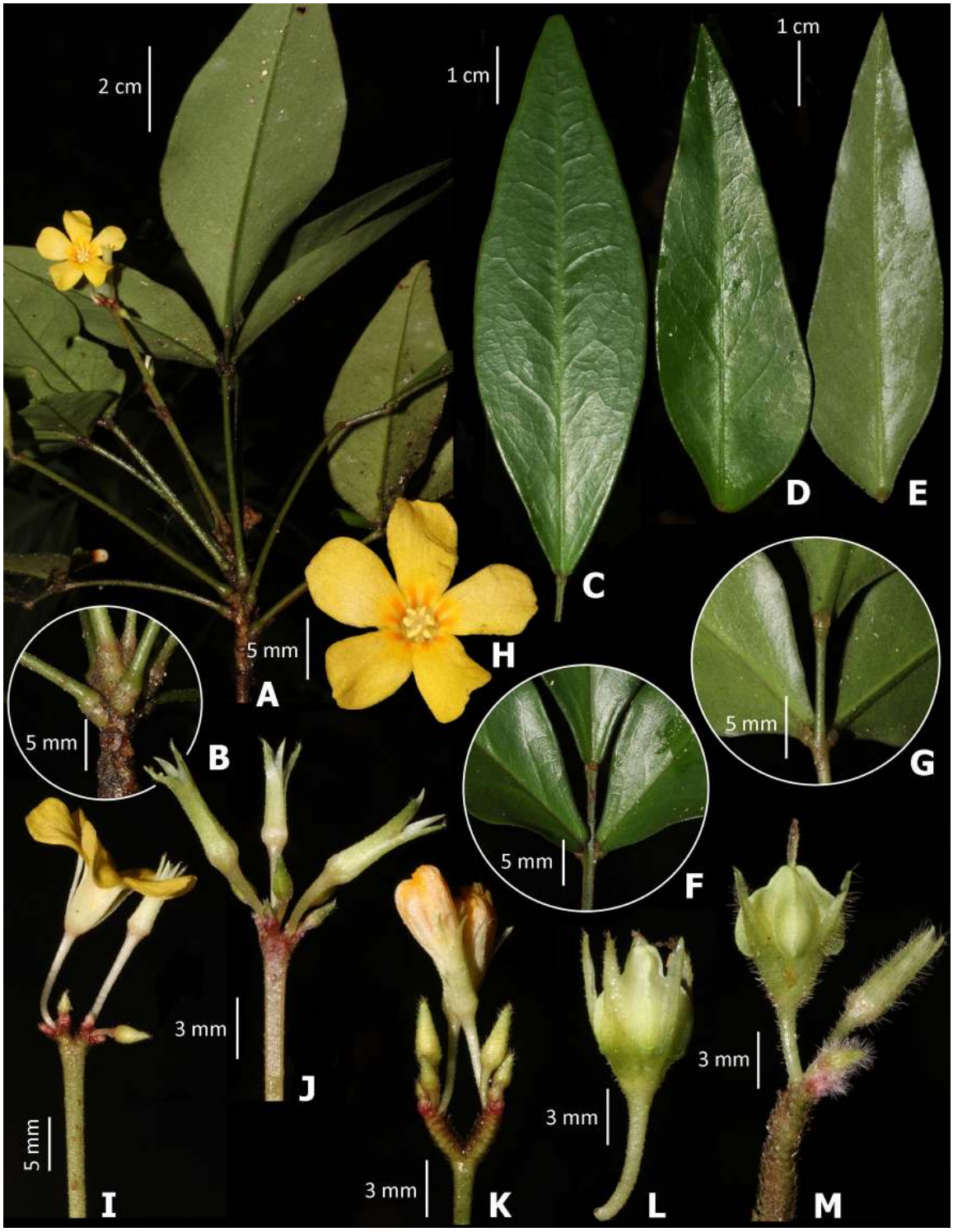


Fig. 13. *Oxalis tijucana* (Lourteig) Fiaschi comb. et stat. nov. **A**. Branch with inflorescence. **B**. Detail of the petioles swollen at base (pulvinae). **C**. Terminal leaflet adaxial surface. **D**. Lateral leaflet adaxial surface. **E**. Lateral leaflet abaxial surface. **F**. Detail of leaflet blades insertion, adaxial view. **G**. Detail of leaflet blades insertion, abaxial view. **H**. Flower, frontal view. **I**. Inflorescence with open flower. **J**. Inflorescence with old flowers. **K**. Older inflorescence with elongated dichasial branches. **L**. Fruit, lateral view. **M**. Distal part of dichasial branch with mature fruit. Photos: Pedro Fiaschi, all based on *J.C. Vasques et al. 85*.

Description

Unbranched, erect subshrubs, 25–30 cm tall, with the stem sometimes spreading under the leaf litter; young stem glabrescent, with sparse, appressed hairs; older stem brownish, terete, longitudinally striate. *Leaves* pinnate-trifoliolate, densely grouped at stem apex, appearing arranged in a terminal pseudo-whorl, but sometimes with a few leaves inserted below, the internodes 1–25 mm long; the petioles 49–105 × 0.5–1 mm, canaliculate and with abundant, curved hairs, along the margin adaxially, abaxially glabrous or with occasional hairs, the base pulvinate, enlarged to ca 2.5 mm diam., articulated at 1–2 mm of its length; the rachis 6–15 mm long, similar to the petiole; petiolules thick, 1–1.5 mm long, adaxially with hairs slightly larger and thicker than the petiole ones; leaflet blades adaxially glabrous; abaxially glabrous or with occasional hairs along the midrib and sparse hairs usually hiding under the revolute margin; membranous to chartaceous, abaxially lighter colored than adaxially. *Venation:* midrib canaliculate adaxially, at least in the proximal part, raised abaxially; secondary veins 8–12 pairs, conspicuous, impressed on both surfaces, angle of divergence increasing towards the apex; intercostal tertiary veins irregular-reticulate, exterior tertiary course looped, quaternary veins fabric irregular-reticulate, areolation moderately developed, free ending veinlets mostly with one branch. *Terminal blade* 100–160 × 29–48 mm, narrowly elliptic to lanceolate, the base attenuate to cuneate, the margin plane to revolute, the apex acute to acuminate. Lateral leaflets opposite, the blades 90–140 × 24–36 mm, lanceolate, the base asymmetrical to strongly asymmetrical, cuneate to obtuse, the apex acute to acuminate. *Dichasial cymes* axillary, shorter than the leaves; the peduncle 82–110 mm long, laterally flattened, with occasional to sparse, curved hairs; dichasial branches 2, up to ca 22 mm long, each with the flowers (or scars) densely grouped along the entire length; bracts ca 1 mm long, triangular, abaxially with abundant, appressed hairs; bracteoles ca 0.8 mm long, triangular, with abundant, appressed hairs. Flower buds ca 6.5 × 2.5 mm, lanceolate-acuminate. *Pedicel* 4.5–7 mm long, articulated at base, leaving a persistent, subsessile foot; with sparse to moderate, curved to appressed, antrorse hairs. *Sepals* light green, 7–10.5 × 1.5–2.4 mm, lanceolate to narrowly oblong, symmetric to slightly asymmetric, the apex acuminate to obtuse, sometimes mucronate, the exposed part with moderate, curved or straight hairs, sometimes with hairs ca 1 mm long. *Corolla* yellow, ca 18 mm diam., petals ca 13 mm long, each with two orange maculae above the throat; short-styled morph: filaments connate for ca 2 mm of their length; shorter filaments ca 5 mm long, glabrous; longer filaments ca 7 mm long, non-appendiculate, distally hispidule; pistil: ovary ca 1.2 mm long; styles ca 1.5 mm long, erect, glabrous; stigmas oblate; gynophore ca 1.5 mm long; long-styled morph: filaments connate for ca 1.5 mm of their length; shorter filaments ca 2.7 mm long, glabrous, longer filaments ca 4.5 mm long, non-appendiculate or very slightly appendiculate at ca 2 mm long, distally hispidule; pistil: ovary ca 1.2 mm long; styles ca 4 mm long, erect, hispidule for the entire length; stigmas oblate; gynophore ca 1.2 mm long; carpels uniovulate. *Capsules* ca 6 × 5.5 mm, obloid to broadly depressed ovoid or pyriform, glabrous, as long or slightly longer than the calyx lobes when fully developed, the apex prolonged for 1.5–2 mm of its length; locules one-seeded, internally glabrous; seeds 3.2–3.5 × 2–2.2 mm, semi-broadly ovoid, with a honeycombed-foveolate surface.

Preliminary conservation status assessment

Oxalis tijucana is restricted to preserved forests in the western part of Rio de Janeiro municipality, where it occurs in more urbanized areas than *O. itatingae* sp. nov. (Fig. 12); moreover, its EOO = 23 km^2 and AOO = 12 km^2 are much smaller than those of the latter species. It is very likely that this species no longer occurs in Serra da Bica, a locality where it was only collected in the late 19th century, and which is now an area dominated by criminal groups and only partially covered by degraded forests. The indication that *O. tijucana* has been suffering a continuous decline of habitat quality and extent suggests that it should be categorized as Critically Endangered following IUCN criteria CR B2ab(iii) (IUCN 2012).

Table 3 (continued on two next pages). Morphological comparison among species previously treated under *O. polymorpha* Mart. ex Zucc. and the new species that are described here (*).

Characters / taxa	***O. amorimii****	***O. animarum****	***O. decipiens***	***O. idimae****	***O. itatingae****	***O. polymorpha***	***O. tijucana***
Young stem (indumentum)	Moderate, curved hairs	Abundant to very abundant, curved hairs	Abundant to very abundant, curved hairs	Glabrescent, with occasional to sparse, curved to appressed hairs	Glabrescent, with sparse to moderate, curved to appressed hairs	Abundant to very abundant, curved or patent hairs	Glabrescent, with sparse, appressed hairs
Leaf arrangement	Along the stem, mostly grouped at stem apex	Along the stem	Along the stem, mostly grouped at stem apex	Along the stem, densely grouped at stem apex,sometimes forming multiple pseudo-whorls	Densely grouped at stem apex, appearing arranged in a terminal pseudo-whorl	Along the stem, mostly grouped at stem apex, sometimes almost forming one or more pseudo-whorls	Densely grouped at stem apex, appearing arranged in a terminal pseudo-whorl
Petiole (adaxial surface)	Canaliculate	Canaliculate	Canaliculate	Slightly canaliculate	Canaliculate or only slightly flattened	Canaliculate	Canaliculate
Petiole (indumentum)	Moderate to abundant, curved to straight hairs	Abundant to very abundant, short, patent to curved hairs	Moderate to abundant, patent to curved hairs	Occasional, appressed hairs, more densely in the proximal region	Adaxially with abundant, curved hairs, abaxially with occasional to sparse hairs	Moderate to abundant, patent to curved hairs	Adaxially with abundant, curved hairs along the margin, abaxially glabrous or with occasional hairs
Terminal leaflet shape	Ovate to lanceolate or slightly rhombic	Ovate to lanceolate	Ovate to lanceolate	Ovate to lanceolate	Lanceolate to almost narrowly trullate	Ovate to lanceolate	Narrowly elliptic to lanceolate
Terminal leaflet base	Cuneate to attenuate	Cuneate to attenuate	Cuneate to obtuse	Obtuse	Cuneate to obtuse	Attenuate to rounded	Cuneate to attenuate
Lateral leaflets degree of asymmetry (see Fig. 2A)	Subsymmetric to asymmetric	Subsymmetric to asymmetric	Subsymmetric to asymmetric	Subsymmetric to asymmetric	Asymmetric to strongly asymmetric	Subsymmetric to strongly asymmetric	Asymmetric to strongly asymmetric
Leaflet blades adaxial surface (indumentum)	Glabrescent, with appressed hairs along midrib	Glabrescent, with curved hairs along midrib	Glabrous	Glabrous	Glabrous	Moderate to abundant, appressed hairs, glabrescent	Glabrous
Leaflet blades abaxial surface (indumentum)	Abundant, appressed hairs, mostly along midrib	Moderate, patent to appressed hairs, mostly along midrib, mixed with shorter, thicker, appressed hairs	Abundant, appressed hairs	Glabrous	Abundant, appressed hairs along the midrib	Moderate to abundant, appressed hairs	Glabrous or with occasional hairs along the midrib

Table 3 (continued). Morphological comparison among species previously treated under *O. polymorpha* Mart. ex Zucc. and the new species that are described here (*).

Characters / taxa	***O. amorimii****	***O. animarum****	***O. decipiens***	***O. idimae****	***O. itatingae****	***O. polymorpha***	***O. tijucana***
Leaflet margin (indumentum)	Ciliate	Ciliate	Ciliate	Proximally with occasional hairs	Ciliate	Ciliate (similar to rest of abaxial surface)	Ciliate, with sparse hairs usually hiding under the margin
Midrib(adaxially / abaxially)	Impressed to canaliculate / raised	Impressed / raised	Canaliculate / raised	Impressed / impressed to slightly raised	Impressed to slightly canaliculate / impressed to slightly raised proximally	Impressed to slightly canaliculate / raised	Canaliculate / raised
Secondary veins (number of pairs)	One suprabal + 3–4 distal	4–7	7–12	5–8	5–7	5–11	8–12
Inflorescence position	Axillary	Axillary	Axillary and cauliflorous	Cauliflorous	Axillary	Axillary	Axillary
Inflorescence dichasial branches (branched or not)	Not branched	Not branched	Usually branched at base	Not branched	Not branched	Not branched or densely branched after the sterile, proximal part	Not branched
Pedicel length	3–7 mm	3–4.5 mm	1.5–3.5 mm	3–6 mm	5–7 mm	2.5–5 mm	4.5–7 mm
Pedicel indumentum	Moderate, ascending to curved hairs	Abundant, short, patent hairs, mixed with sparse to moderate, longer glandular hairs	Abundant, short, appressed to curved hairs	Moderate to abundant, appressed hairs	Abundant, short, patent to slightly retrorse hairs, sometimes distally mixed with antrorse, longer hairs	Abundant, appressed to curved, antrorse hairs	Sparse to moderate, curved to appressed, antrorse hairs
Corolla color	Yellow	Yellow	Yellow	White	Yellow	White to pinkish	Yellow
Longer stamens (appendiculate or not?)	Non-appendiculate	Appendiculate	Non-appendiculate (sometimes with an inconspicuous bulge)	Non-appendiculate	Non-appendiculate	Non-appendiculate	Non-appendiculate
Gynophore	Ca 0.2 mm long	Ca 0.7 mm long	0.3–0.5 mm long	Ca 0.2 mm long	Ca 1 mm long	Ca 0.5 mm long	1.2–1.5 mm long
Fruit shape (length / width)	Unknown	Pyriform (ca 4.5/4.5 mm)	Pyriform (ca 5.5/5.5 mm)	Broadly ovoid	Obloid (ca 4/5.5 mm)	Very broadly ovoid to broadly depressed ovoid (ca 3.3–4.5 mm)	Obloid to broadly depressed ovoid or pyriform (ca 6 × 5.5 mm)
Fruit (carpel prolongation)	–	Ca 1 mm long	Ca 2 mm long	Not prolonged or up to ca 0.5 mm long	Ca 1 mm long	Up to ca 0.5 mm long	1.5–2 mm long

Table 3 (continued). Morphological comparison among species previously treated under *O. polymorpha* Mart. ex Zucc. and the new species that are described here (*).

Characters / taxa	***O. amorimii****	***O. animarum****	***O. decipiens***	***O. idimae****	***O. itatingae****	***O. polymorpha***	***O. tijucana***
Fruit (indumentum)	–	Moderate, glandular, and patent intermixed hairs	Glabrous	Glabrous	Glabrous	Glabrous or distally with occasional, patent hairs	Glabrous
Geographic distribution (domain)	Bahia (Atlantic Forest)	Bahia (Atlantic Forest)	Rio de Janeiro to Minas Gerais (Atlantic Forest)	Northern Rio de Janeiro (Atlantic Forest)	Rio de Janeiro (Atlantic Forest)	Bahia (Caatinga / Atlantic Forest)	Rio de Janeiro (Atlantic Forest)
Habitat	Semideciduous forest	Semideciduous forest	Semideciduous / rainforest	Semideciduous forest	Rainforest	Deciduous / semideciduous / ain-forest	Rainforest

Remarks

This taxon was originally proposed as *Oxalis polymorpha* subsp. *tijucana* by Lourteig (1994) based on the presence of glabrous leaflets and canaliculate petioles, with the margin densely hirsute-ciliate. Other than these features, the species also differs from *O. polymorpha* by the leaves densely grouped at stem apex, forming a single terminal pseudo-whorl (vs leaves arranged along the stem), the pedicels with abundant, short, retrorse hairs (vs abundant, appressed to curved, antrorse hairs), and the obloid fruits with the carpels prolonged for ca 1 mm long (vs very broadly ovoid to broadly depressed ovoid fruits with the carpels prolonged for ca 0.5 mm long) (see Table 3).

Molecular phylogenetic evidence now available (Fig. 3) points to a sister-group relationship between a clade formed by *O. inopinata* plus *O. itatingae* sp. nov. and a larger clade that includes all remaining species of *O.* sect. *Holophyllum*. Due to its morphological similarity to *O. itatingae*, *O. tijucana* very likely also belongs to this first, smaller clade. Thus, its placement under *O. polymorpha* (and in *O.* sect. *Polymorphae*, Fig. 3) would not be supported, even though *O. tijucana* (and *O. itatingae*) have three-foliolate leaves, while *O. inopinata* and the remaining species of *O.* sect. *Holophyllum* are unifoliolate (Fiaschi *et al.* 2024). Among the morphological features that may support the placement of these two, three-foliolate species (*O. tijucana* and *O. itatingae*), together with *O. inopinata* (see fig. 11 in Fiaschi *et al.* 2024) are the canaliculate petioles with ciliate margin, the glabrous leaflet blades with conspicuously ciliate margins, and the inflorescences with dichasial branches bearing densely grouped bracteoles along the entire length (Fig. 13K).

Distribution and ecology

This species is restricted to rainforests in the surroundings of Rio de Janeiro city, especially in Cascadura, Curicica and Jacarepaguá neighborhoods, where it is commonly found in shady environments of preserved forests.

Identification key to species of Oxalis sect. Polymorphae

(species with * are here segregated from *O. polymopha* s. lat. but should be excluded from the section)

1. Leaves arranged along the stem (Fig. 7A), sometimes more densely so at stem apex, but not forming a single terminal pseudo-whorl 2
– Leaves densely grouped at stem apex, forming a single terminal pseudo-whorl (Fig. 14S, Y) or multiple pseudo-whorls 10

2. Pedicel and sepals with glandular hairs (Fig. 7H); sometimes rare and diminute 3
– Pedicel and sepals without glandular hairs 5

3. Leaflet blades with obtuse, rounded or slightly retuse apex .....***O. alstonii*** Lourteig
– Leaflet blades with acute, acuminate or caudate apex 4

4. Inflorescences longer than the petiole of adjacent leaves, dichasial branches > 5 mm long, with flowers arranged distally to a long sterile portion; leaflet blades glabrous, with occasional marginal hairs .. .. ***O. pardoensis*** (Lourteig) T.S.Costa & Fiaschi
– Inflorescences shorter than the petiole of adjacent leaves, dichasial branches 1.5–4 mm long, with flowers densely grouped along the entire length; leaflet blades glabrescent adaxially, with moderate, patent to appressed hairs abaxially ..... ***O. animarum*** Fiaschi sp. nov.

5. Inflorescences mostly cauliflorous (Fig. 10F), not observable in young plants with poorly developed stem 6
– Inflorescences mostly axillary (Fig. 6A), but sometimes with a few cauliflorous ones 7

6. Fruits with carpels distally prolonged ca 2 mm long, slightly longer than the sepals (Fig. 8L); leaf blades pubescent; flowers with yellow petals (Fig. 8K); inflorescences usually with bifid dichasial branches (Fig. 8I) ..... ***O. decipiens*** Progel
– Fruits with carpels not prolonged (Fig. 10K–L) or distally prolonged up to ca 0.5 mm of their length, shorter than the sepals; leaf blades glabrous; flowers with white petals (Fig. 10J); inflorescences with entire dichasial branches (Fig. 10H) ..... ***O. idimae*** Fiaschi sp. nov.

7. Leaflet blades with obtuse, rounded or slightly retuse apex ..... ***O. alstonii*** Lourteig
– Leaflet blades with acute, acuminate or caudate apex 8

8. Flowers with white to pinkish corolla lobes ..... ***O. polymorpha*** Mart. ex Zucc.
– Flowers with yellow corolla lobes 9

9. Trinerved leaflets (Fig. 6E); leaflet blades abaxially with abundant, appressed hairs; inflorescence dichasial branches with flowers congested from the base (Fig. 6K) ..... ***O. amorimii*** Fiaschi sp. nov.
– Pinnately-nerved leaflets (Fig. 1C); leaflet blades abaxially glabrous, with occasional hairs along the margin; inflorescence dichasial branches with flowers not congested or, if congested, after a sterile portion (Fig. 1A) ..... ***O. pardoensis*** (Lourteig) T.S.Costa & Fiaschi

10. Flower and fruit pedicel glabrous, sometimes with sparse, appressed hairs in bud 11
– Flower and fruit pedicel with sparse to very abundant, appressed, curved or patent hairs 14

11. Petioles with intermixed unicelular and pluricelular hairs; mature inflorescences with short dichasial branches (0.5–3 mm long) and flowers (or persistent floral bracts) distributed along the entire length ..... ***O. cipoensis*** T.S.Costa, Sakuragui & Fiaschi
– Petioles glabrous or only with unicelular hairs; mature inflorescences usually with elongated dichasial branches (3.5–17 mm long) and flowers (or persistent floral bracts) distally congested 12

12. Terminal leaflet blade 8–10.5 × ca 2 mm, narrowly elliptic to narrowly oblong or slightly oblanceolate; young stem glabrous; floral bracts glabrous; flowers with yellow corolla lobes .... ***O. artemioides*** Fiaschi
– Terminal leaflet blade 10–66 × 5–38 mm, ovate to lanceolate or elliptic to narrowly elliptic; young stem with moderate to very abundant, appressed or curved hairs; floral bracts with sparse, appressed hairs; flowers with white corolla lobes 13

13. Leaves grouped in a single, terminal pseudo-whorl; habit unbranched, 10–40 cm tall; terminal leaflet blade 20–66 × 17–38 mm, the base obtuse to rounded or slightly cordate ... ***O. colatinensis*** Fiaschi
– Leaves grouped in multiple pseudo-whorls; habit branched, (20–)50–200 cm tall; terminal leaflet blade 10–20(–30) × 5–13 mm, the base cuneate to obtuse ..... ***O. blackii*** Lourteig

14. Young stem with abundant to very abundant, appressed-retrorse hairs ..... ***O. umbraticola*** A.St.-Hil.
– Young stem with sparse to very abundant, appressed, curved or patent hairs, sometimes intermixed with glandular, pluricellular hairs, or glabrescent 15

15. Peduncle and/or pedicels with intermixed unicelular and glandular-pluricelular hairs, or only with glandular hairs 16
– Peduncle and pedicels usually only with unicelular hairs, sometimes with few intermixed glandular hairs 17

16. Lateral leaflets with symmetric to slightly asymmetric blades, similar to the terminal leaflet blade; petiole longer than the terminal leaflet blade ..... ***O. kollmannii*** Fiaschi
– Lateral leaflets with strongly asymmetric blades, diferente from the terminal leaflet blade; petiole usually shorter than the terminal leaflet blade ..... ***O. neuwiedii*** Zucc.

17. Leaflet blades glabrous or glabrescent on both surfaces 18
– Leaflet blades with sparse to abundant hairs abaxially, glabrescent or with sparse hairs adaxially 20

18. Petioles as long as or longer than terminal leaflet blade; leaflet blades with obtuse, rounded or slightly retuse apex; corolla ≤ 10 mm wide .....***O. alstonii*** Lourteig
– Petioles usually shorter than terminal leaflet blade; leaflet blades with acute to acuminate apex; corolla ≥15 mm wide 19

19. Terminal leaflet blade ≥2 × longer than the lateral blades (Fig. 11B), with 5 –7 pairs of secondary veins; blade margins plane, ciliate. Pedicels with abundant, short, retrorse hairs; peduncles 9–50 mm long ..... ***O. itatingae*** Fiaschi sp. nov. *
– Terminal leaflet blade up to ca 1.5 × longer than the lateral blades (Fig. 13C, D), with 9–12 pairs of secondary veins; blade margin plane to revolute, with the occasional hairs usually hiding under the margin. Pedicels with sparse to moderate, curved to appressed, antrorse hairs; peduncles 82–110 mm long .....***O. tijucana*** (Lourteig) Fiaschi comb. et stat. nov. *

20. Terminal leaflet apex acute or acuminate; lateral leaflets strongly asymmetric 21
– Terminal leaflet apex obtuse or rounded, sometimes acute; lateral leaflets symmetric or slightly asymmetric .....***O. puberula***

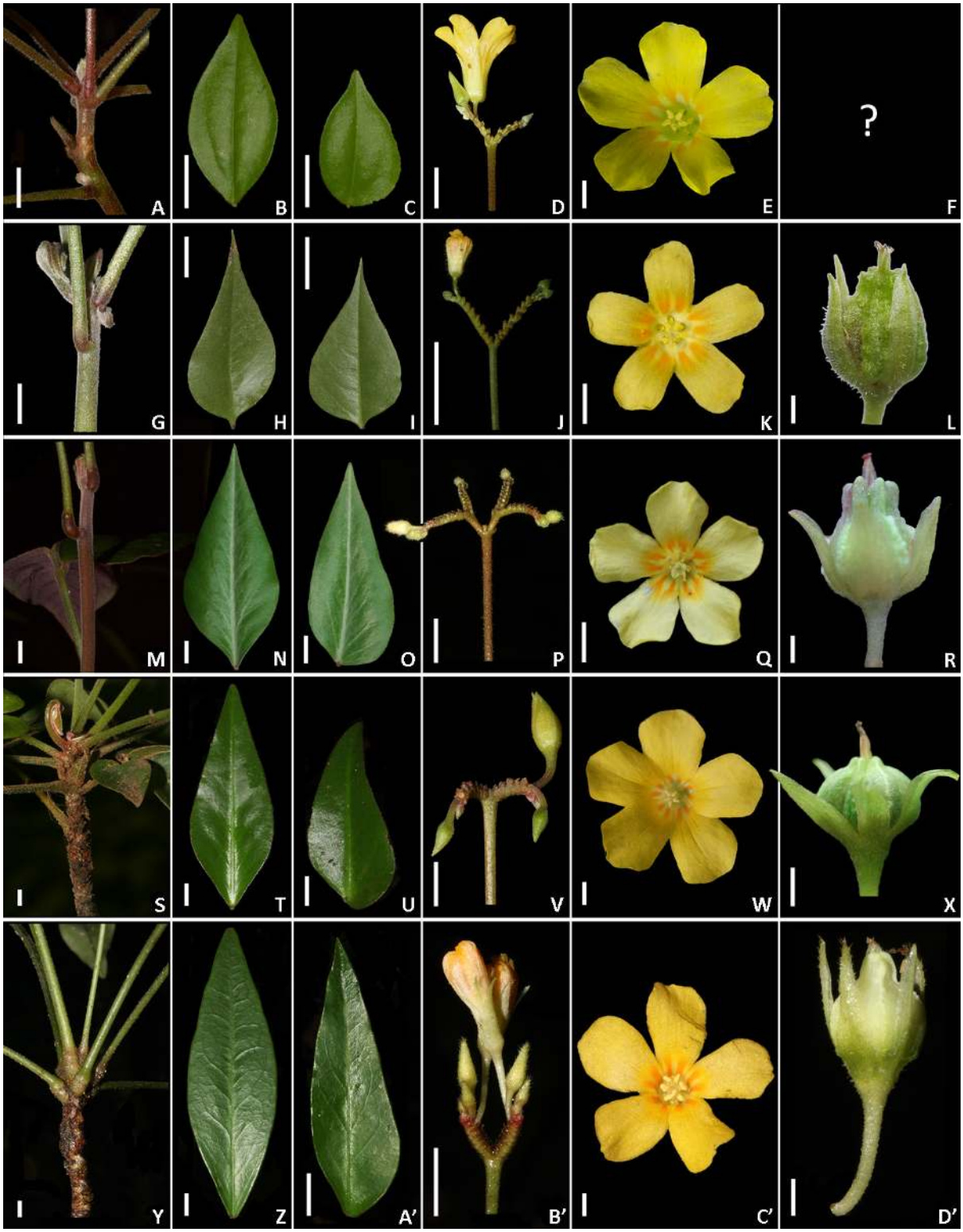
21. Flowers with white to pinkish corolla lobes; leaflet blades adaxial surface usually glabrescent .... ***O. polymorpha*** Mart. ex Zucc.
– Flowers with yellow corolla lobes; leaflet blades adaxial surface with moderate, appressed hairs ... .***O. roselata*** A.St.-Hil.

Discussion

Morphological comparison among *O. polymorpha* and its segregated taxa

Most of the species recognized here are segregated from the wide circumscription of *Oxalis polymorpha* proposed by Zuccarini (1825) about two centuries ago; until recently this taxon has retained a wide circumscription (Lourteig 1994; Fiaschi 2014), which was challenged by Richetti *et al.* (2022), who suggested the recognition of four morphotypes in *O. polymorpha* using leaf morpho-anatomical data combined with other morphological features. The morphotypes recognized by these authors (CRA, CRM, LIN+MRL, TIJ) respectively correspond to *Oxalis animarum* sp. nov., *O. idimae* sp. nov., *O. decipiens*, and *O. itatingae* sp. nov., the latter one then identified as *O. polymorpha* subsp. *tijucana*. Together with *O. amorimii* sp. nov. and *O. tijucana*, these taxa are compared to *O. polymorpha* s. str. in Table 3, and the yellow-flowered taxa segregated from *O. polymorpha* s. lat. can be differentiated among each other in Fig. 14.

Fig. 14 (on next page). Comparative figure among segregated, yellow-flowered species of the former *Oxalis polymorpha* Mart. ex Zucc. s. lat. (following Lourteig 1994 and Fiaschi 2014); A, G, M, S, Y = Stem apical portion; B, H, N, T, Z = Terminal leaflet; C, I, O, U, A' = Lateral leaflet; D, J, P, V, B' = Inflorescenca detail; E, K, Q, W, C' = Flower, frontal view; F, L, R, X, D' = Fruit, lateral view (unknown in *O. amorimii*, F). **A**–**F**. *Oxalis amorimii* Fiaschi sp. nov. **G**–**L**. *Oxalis animarum* Fiaschi sp. nov. **M**–**R**. *Oxalis decipiens* Progel. **S**–**X**. *Oxalis itatingae* Fiaschi sp. nov. **Y**–**D'**. *Oxalis tijucana* (Lourteig) Fiaschi. Scale bars: A, G, M, S, Y = 2 mm; B–C, H–I, N–O, T–U, Z–A' = 1 cm; D, J, P, V, B' = 5 mm; E, K, Q, W, C' = 2 mm; L, R, X, D' = 1 mm.


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As mentioned above, among the yellow-flowered taxa segregated from *O. polymorpha*, two species (*O. itatingae* sp. nov. and *O. tijucana*) are more closely related to *O. inopinata* (from *O.* sect. *Holophyllum*, Fiaschi *et al.* 2024) than to other species of *O.* sect. *Polymorphae* (Fig. 3). Both species (*O. itatingae* and *O. tijucana*) bear leaves densely grouped at the stem apex, almost forming a pseudo-whorl (Figs 13A, 14S, Y), and glabrous leaves, except along the margin (Fig. 11D) and the midrib undersurface, contrasting with the remaining species (*O. amorimii* sp. nov., *O. animarum* sp. nov., and *O. decipiens*), whose leaf blades bear moderate to abundant, appressed hairs abaxially, mostly along the midrib. Each of these three species can be distinguished from *O. polymorpha* by the features presented in Table 3 and Fig. 14, such as the presence of three-nerved leaves (in *O. amorimii*), glandular hairs (in *O. animarum*), and inflorescences with the dichasial branches bifid at base, and fruits with the carpels apically prolonged (in *O. decipiens*).

Oxalis idimae sp. nov. is the only of the species described here that shares with *O. polymorpha* s. str. flowers with a white corolla (Fig. 10J), but it differs, among other features (see Table 3), in the cauliflorous (vs axillary) inflorescences, and glabrous (vs with moderate to abundant, appressed hairs, glabrescent) leaflets. In the original description of *O. polymorpha*, Zuccarini (1825) indicated the presence of yellow flowers, but our current circumscription of this species includes mostly plants with white to slightly pinkish flowers, which are in large part distributed in southern Bahia moist rainforests (Fig. 5). As mentioned before, a comprehensive molecular and morphological study that evaluates the circumscription of *O. polymorpha* in comparison to *O. puberula* and *O. neuwiedii*, which are morphologically similar, white-flowered species of *O.* sect. *Polymorphae* (Fiaschi 2014), would be a necessary next step towards unraveling this species group.

Phylogenetic relationships among samples of *Oxalis polymorpha* s. lat.

Cabral *et al.* (2024) did not recover the monophyly of *O.* sect. *Polymorphae*, because this section included *O. fruticosa* (*O.* sect. *Phyllodoxys*) and because some of its samples emerged, albeit poorly supported, as successive sisters to the large clade that included remaining samples of sect. *Polymorphae* + (sect. *Holophyllum* and *Psoraleoideae*). These authors suggested the need for a further evaluation of the section monophyly. Our comprehensive sampling recovered *O.* sect. *Polymorphae* as monophyletic only if *O. itatingae* sp. nov. and *O. monochasiata* are excluded from this section. While the first species emerged as sister to *O. inopinata* in *O.* sect. *Holophyllum* (see below), the second was sister to *O. jacobinensis* Fiaschi & F.S.Cabral in *O.* sect. *Thamnoxys*, a relationship that had already been hinted at by Fiaschi *et al.* (2023), who pointed the similarity of these two species by sharing short glandular hairs on pedicel and sepals, and distally narrower capsules; moreover, these two species share with members of *O.* sect. *Thamnoxys* the nodding capsules that become erect only at maturity, and the usually more than one-seeded carpels (Lourteig 1994), while species of *O.* sect. *Polymorphae* share erect capsules with one-seeded locules.

Two well-supported sister subclades were recovered in *O.* sect. *Polymorphae*, but they do not show any evident morphological synapomorphies or coherent geographic distribution. The current, wide morphological circumscription of *Oxalis polymorpha* sensu Lourteig (1994) and Fiaschi (2014) is polyphyletic (Fig. 3): three specimens (*O. amorimii* sp. nov., *O. idimae* sp. nov. and *O. decipiens*) appeared in a clade that includes most species of the section, including *O. polymorpha* itself, while one specimen (*O. animarum* sp. nov.) was placed in a clade with other species usually bearing glandular hairs (except for *O. cipoensis* T.Costa, Sakur. & Fiaschi). The morphological differences among these samples are noteworthy, and it is surprising that these taxa remained so long treated under a single species (see Figs 3, 14). Thus, the phylogenetic investigation of morphologically variable species holding several infraspecific taxa and heterotypic synonyms could be a good way to support the update of taxonomically complex species groups (Anderson *et al.* 2023; Stoughton *et al.* 2017).

Flower color is a very useful feature to distinguish species of *Oxalis* subg. *Thamnoxys* (Lourteig 1994; Fiaschi 2014; Costa *et al.* 2019; Fiaschi *et al.* 2024), but the suggestion that a white-flowered clade of *O.* sect. *Polymorphae* is immersed in a yellow-flowered grade (Richetti *et al.* 2022) is not supported with the more comprehensive sampling used here. In the largest subclade of the section, flower color varies from yellow (in *O. amorimii* sp. nov., *O. decipiens*, *O. roselata* A.St.-Hil. and, sometimes, *O. kollmannii* Fiaschi) to white (all remaining species), while the clade that includes *O. animarum* sp. nov. has only yellow-flowered species.

Surprisingly, the included sample of *O. itatingae* sp. nov., which had been previously identified as belonging to *O. polymorpha* subsp. *tijucana* (see above), emerged as sister to *O. inopinata*, a species from *O.* sect. *Holophyllum* (Fiaschi *et al.* 2024). This section, which is geographically restricted to the Atlantic Forest, is characterized by unifoliolate leaves, usually congested at stem apex, and petioles and/or peduncles usually dorsiventrally flattened (Fiaschi *et al.* 2024). Despite having 3-foliolate (instead of unifoliolate) leaves, *O. itatingae* (and *O. tijucana*, which is a very morphologically similar species; not included in our phylogenetic sampling) share with *O. inopinata* the laterally flattened petioles, slightly to strongly canaliculate adaxially, peduncles only slightly flattened dorsiventrally, < 1 mm wide, and glabrous leaf blades, with hairs restricted to the margin. Moreover, karyotypic differences also distinguish most species of *O.* sect. *Holophyllum* from *O. inopinata* + *O. itatingae* (Guerra, unpublished data), so additional morphological data to support this distinction should be evaluated in the future.

Conclusion

In this study we present formal taxonomic recognition for six species whose specimens had been placed under *O. polymorpha*, but that should not be part of the circumscription of this taxon. Thus, we partly answer "what *O. polymorpha* is not?". As an important shortcoming of this attempt, we do not yet have the answer to the following open question: "What is, in fact, *Oxalis polymorpha*?". An intensive search for additional populations of *O. polymorpha* s. str. in the localities nearby the type-locality would be needed to evaluate if this species should include samples gathered along the southern Bahia coastal forests, as was done here, or if it should be circumscribed even more narrowly than in our current proposal.

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Supplementary files

Supp. file 1. Maximum likelihood tree based on the nuclear dataset (ITS).
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Supp. file 2. Maximum likelihood tree based on the plastid dataset (*trnL-trnF* + *petA-psbJ*).
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