

Fast, linked, and open – the future of taxonomic publishing for plants: launching the journal PhytoKeys

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Received 12 September 2010 | Accepted 9 October 2010 | Published 1 November 2010

Citation: Penev L, Kress WJ, Knapp S, Li D-Z, Renner S (2010) Fast, linked, and open – the future of taxonomic publishing for plants: launching the journal PhytoKeys. *PhytoKeys* 1: 1–14. doi: 10.3897/phytokeys.1.642

Abstract

The paper describes the focus, scope and the rationale of PhytoKeys, a newly established, peer-reviewed, open-access journal in plant systematics. PhytoKeys is launched to respond to four main challenges of our time: (1) Appearance of electronic publications as amendments or even alternatives to paper publications; (2) Open Access (OA) as a new publishing model; (3) Linkage of electronic registers, indices and aggregators that summarize information on biological species through taxonomic names or their persistent identifiers (Globally Unique Identifiers or GUIDs; currently Life Science Identifiers or LSIDs); (4) Web 2.0 technologies that permit the semantic markup of, and semantic enhancements to, published biological texts. The journal will pursue cutting-edge technologies in publication and dissemination of biodiversity information while strictly following the requirements of the current International Code of Botanical Nomenclature (ICBN).

Keywords

E-publications, open access, semantic tagging, semantic enhancements, plant systematics

Introduction

Exciting and novel advances in the publishing and dissemination of taxonomic information are changing the field. The appearance of electronic media as conduits of scientific communication and the adaptation of the Internet as a medium of transmission

and dissemination means that taxonomists, publishers, and indexing and aggregation services have the chance to use these new tools to accelerate biodiversity research and understanding. Accompanying these changes has been the development of methods to increase the speed and efficiency of sampling of biological materials and discovery of new taxa, thanks to the development of new methods, especially the application of DNA sequencing to taxonomic work.

The challenges are indeed daunting in scale. From the viewpoint of biodiversity publishing, these challenges could be summarized in four main groups: (1) Appearance of electronic publications as amendments or even alternatives to paper publications; (2) Open Access (OA) as a new publishing model; (3) Linkage of electronic registers, indices and aggregators that summarize information on biological species through taxonomic names or their persistent identifiers (GUIDs, currently LSIDs, Life Science Identifiers); and (4) Web 2.0 technologies that permit the semantic markup of, and semantic enhancements to, published biological texts.

In response to these publication challenges, we are here establishing a new journal in plant systematics, called *PhytoKeys*. *PhytoKeys* (<http://www.phytokeys.com>) builds on existing experience and innovations accumulated during the successful launch of its partner journal *ZooKeys* (<http://www.zookeys.org>). *PhytoKeys* aims to set new standards in taxonomic publishing and especially dissemination, in full compliance with the current International Code of Botanical Nomenclature (ICBN).

E-publish or perish? Print and electronic publications of nomenclatural acts and biological Codes

The future of biodiversity publishing in the digital era has provoked lively discussions in the last few years, most of them focusing on the permissibility of electronic publication of nomenclatural activities, such as new species descriptions or lectotypifications. Were electronic publication to be allowed, the biological Codes would need revision. Both, the International Code of Botanical Nomenclature, ICBN (Article 29, Recommendation 30A), and the International Code of Zoological Nomenclature, ICZN (Articles 8 and 9), currently do not allow strictly e-only publications of nomenclatural acts (for the ICZN, see details in Knapp and Wright 2010).

Effective publication under the ICBN is currently defined “*only by distribution of printed matter (through sale, exchange, or gift) to the general public or at least to botanical institutions with libraries accessible to botanists generally*” (Article 29). At the International Botanical Congress in Vienna in 2005, Recommendation 29A laid out a preliminary set of ideas about the relationships between print and electronic versions of an article:

“Publication of nomenclatural novelties in periodicals that distribute an electronic version as well as a printed version, should only be in those with the following features:

- 1. The printed and electronic versions are identical in content and pagination;*
- 2. The electronic version is in a platform-independent and printable format;*
- 3. The electronic version is publicly available via the World Wide Web or its successors;*
- 4. The presence of nomenclatural novelties is prominently indicated in the work”*

(Recommendation 29A, ICBN)

In our view, best practice for any journal currently publishing nomenclatural information electronically should consider the following criteria to ensure effective publication:

1. Maintenance of a printed version registered under print ISSN (P-ISSN), different from the ISSN of the electronic version (E-ISSN);
2. Production of the print version simultaneously with the electronic version;
3. The printed version to be identical (including resolution and color) to the electronic (normally PDF) version;
4. Maintenance of a stock of the printed version that may be requested and delivered on purchase, exchange or gift;
5. Publication of the electronic version on the World Wide Web.

Descriptions of new taxa are already being published in e-only journals and authors and publishers have carefully followed the current requirements of the Codes. New plant taxa published recently in an entirely electronic journal, PLoS One (Knapp 2010) accomplished effective publication of the names therein by the authors themselves taking care to print the articles and send them to various libraries to provide paper archiving. It is obvious that such a policy intended to satisfy the Codes is not sustainable on the long term and makes changes and amendments to both Codes like those that have been suggested recently more topical and urgent (Knapp et al. 2007, Knapp and Wright 2010, Knapp et al. 2010, Wheeler and Krell 2007). Amendments to the Codes are currently under active discussion in both the zoological and botanical/mycological communities (e.g., Availability & electronic publication 2010, Chapman et al. in press).

The policy of PhytoKeys regarding electronic publication is very clearly defined. We shall strictly follow the requirements of the current International Code of Botanical Nomenclature (Vienna Code), adopted by the Seventeenth International Botanical Congress Vienna, Austria, July 2005 (<http://ibot.sav.sk/icbn/main.htm>). The journal will be published simultaneously in online and print formats. The high-resolution, full-color print version is identical to the online PDF version. In addition, the entire content of the journal is published open access, free to anyone to download, archive, print and distribute.

Publish for free or read for free? Open access in biodiversity publishing

PhytoKeys is established as an entirely open access journals and adheres strictly to the principles of free exchange of knowledge, which means a direct, barrier-free, online dissemination of scientific results at no charge to the reader (see the Berlin (2003) and Bethesda (2003) Declarations on Open Access). Under the open access model and according to the Creative Commons Attribution License (CC-BY) used by PhytoKeys, authors retain the rights for their articles, which may however be copied, downloaded, and used for text- and data-mining purposes, provided that such uses are fully attributed to the author(s) and source of publication.

By publishing open access, authors benefit from a higher visibility and increased citation rate of their papers; analyses of articles published between 2001 and mid-2009 (Wagner 2010) found 39 cases of an open access citation advantage (OACA) and 7 showing either no OACA effect or ascribing OACA to factors unrelated to OA publication. Open access articles are downloaded more than articles for which subscriptions fees must be paid; Wagner (2010) concluded that *“studies typically show a 25–250 % OACA or more. The higher end of that range might prove illusionary. However, even if the true OACA turns out to be only 10–15%, this would still be a major incentive for scholars to choose an open access publishing option.”*

Another important advantage to open access publishing is that it permits immediate, often automated, distribution of the published contents to bibliographic databases, e-archives, indexers and aggregators [e.g., Encyclopedia of Life (EOL), Global Biodiversity Information facility (GBIF), PubMedCentral, Wikispecies, Wikipedia, Wikimedia, Plazi, and many others). Furthermore, the published text can be “atomized” and disseminated in fragments associated with bibliographic metadata. For instance, taxon descriptions and associated discussions can be automatically supplied through the Species Profile Model (SPM) to EOL (<http://wiki.tdwg.org/twiki/bin/view/SPM/PlaziEOLProject>) and locality data supplied to GBIF through the Integrated Publishers Toolkit (IPT) (Chavan and Ingwersen 2009, Penev et al. 2009b).

As a business model, open access (“author pays but everyone can read at no charge”) is often opposed to conventional publishing model (“publisher pays but everyone has to pay to read”) (Suber 2003, 2007). Publication fees in open access journals ensure a barrier-free distribution of the contents and include costs involved in processing, formatting, publishing, indexing, and archiving of the published materials. It is expected that authors cover the open access fee from institutional funds or from grants from funding agencies. The current policy of funding bodies in many developed countries is to provide grant money for open access publishing in their budgets. For instance, such major funding bodies as the European Union’s Framework Program Seven (FP7), National Institutes of Health (NIH) of the USA, and Wellcome Trust in UK already demand open access of the published scientific results they fund (see for instance the Open Access Pilot in FP7 (2009) or SPARC Europe News (2007).

Unfortunately, some authors of worthy manuscripts may be constrained in their ability to pay open access fees, e.g., students, scientists from developing countries, or

retired scientists. In PhytoKeys, such authors will have the option of discounted fees or a complete waiver. Discounts or waivers will also be offered to scientists who actively participate in the review and editorial process. We hope with these incentives to give all botanists the opportunity to experience the pleasure and benefits derived from open access publishing.

Although open access is not yet entirely accepted in taxonomy publishing due to several constraints (Agosti and Johnson 2006), its value is clear and the proportion of electronically published taxonomic work is rapidly increasing. In addition, there is a growing demand that at least descriptions of taxa should be placed firmly in the public domain (Agosti and Egloff 2009). The revolutionary changes occurring in the transition to Web 2.0, whereby all publications can be linked to form one virtual entity (rather than thousands of individual entities – see Agosti et al. 2007) will greatly increase the importance of open access publications. The mission of PhytoKeys is to further progress in this direction.

Publish “indivisible” entities or “atomize” content? Semantic markup of and semantic enhancements to taxonomy publications

Scientific publishing for over 500 years has developed around two basic models: (i) the large scientific monograph and (ii) the scientific article within a periodical (journal). Both models have traditionally been seen as producing “indivisible” entities of published information, identified, described and cited through their bibliographic descriptions (today called “metadata”). Division, separation and analysis of the body texts of scientific publications have been possible only through reading on paper by humans.

The Internet and especially Web 2.0 technologies, also known as the Semantic Web (<http://en.wikipedia.org/wiki/SemanticWeb>), have stimulated the development of radically new models of publication, dissemination, reading and analysis of scientific content. These innovations have occurred with unprecedented speed and scale, and have already visibly impacted taxonomic publishing (for a review, see Penev et al. 2010a). We are on the verge of being able to have scientific texts read, harvested, and sorted out in databases entirely by computers. A key requirement for the success of these models is standardized methods and protocols for text processing and their implementation in routine editorial practices. Semantic mark up, or tagging, is a method that assigns markers, or tags, to text strings such as taxonomic names, gene sequences, localities, designations of nomenclatural novelties and so on. Tags “translate” the meaning of the respective strings into machine-readable languages like XML (eXtensible Markup Language). Semantic tagging allows not only computerized methods of archiving and data mining from articles but it also provides the basis for so-called “semantic enhancements”, defined as “anything that enhances the meaning of a published journal article, facilitates its automated discovery, permits its linking to semantically related articles, provides access to data within the article in actionable form, or facilitates integration of data between articles” (Shotton et al. 2009). Semantic Web

technologies represent a vast and dynamic area of development, and we do not aim to discuss them in detail here. Recently, the concept of semantic tagging and its potential for semantic enhancements to taxonomic papers have been reviewed and illustrated by working examples in a special issue of *ZooKeys* (Penev et al. 2010b). *PhytoKeys* will build on and further develop technologies described and implemented in *ZooKeys*.

PhytoKeys uses the Pensoft Mark Up Tool (PMT) as the basic software tool for XML mark up implemented within the editorial process. PMT is based on the Tax-Pub XML schema, an extension to the Document Type Definitions (DTD) of the US National Library of Medicine Journal Archiving and Interchange Tag Suite (NLM; <http://sourceforge.net/projects/taxpub>). PMT provides highly automated, fine granularity mark up, for example, denoting each separate taxon treatment within a paper, or tagging of all taxon names, literature references, gene sequences, etc. The final XML output of the paper is validated against the National Library of Medicine (NLM) document type definition (DTD) and could be archived in PubMedCentral upon approval of the latter. The taxon treatments (including descriptions of new taxa) are exported through XML to Encyclopedia of Life (EOL), Plazi and other interested aggregators of information. The PDF file of a paper will be identical to the printed version and will be stored for browsing or searching through the Biodiversity Heritage Library (BHL). Papers will also be published as semantically enhanced HTMLs, allowing interactive reading and use by methods such as: (i) visualisation of main tag elements within the text (e.g., taxon names, taxon treatments, localities, etc.); (ii) internal cross-linking between paper sections, citations, references, tables, and figures; (iii) mapping of localities listed in the whole paper or within separate taxon treatments; (iv) autotagging of taxon names, with dynamic links to a wider array of large international biodiversity databases through the Pensoft Taxon Profile (PTP) (see next section for details), (v) autotagging of GenBank and Barcode of Life Database (BOLD) accession numbers and linking to NCBI and BOLD, respectively; (vi) linking of taxon names to relevant references in PubMed, Google Scholar, Biodiversity Heritage Library, and other databases.

A substantial feature of the semantic Web is open data publishing, where not only analysed results, but original datasets can be published as citeable items. The incentives for authors and institutions to publish in *PhytoKeys* can be summarised as follows (Costello 2009, Smith 2009, Chavan and Ingwersen 2009, Penev et al. 2009a, Kühn et al. 2010):

- 1) Data produced and collected using public funds can be published, cited, used and re-used in the future, either as separate datasets or collated with other data;
- 2) Data can be indexed and made discoverable, browsable and searchable through biodiversity infrastructures (GBIF and others);
- 3) Data can be integrated with other dataset across space, time and taxonomic groups, bringing in this way recognition and new opportunities for collaboration to the authors;
- 4) Collection managers can trace usage and citations of digitized data from their collections;

- 5) By publishing data, authors and institutions are credited for their work to create and maintain datasets through:
 - a) Registering of priority and authorship in a conventional journal publication;
 - b) Indexing, discovery and citation in the same way as a standard research paper, to benefit authors in recognition and career building;
- 6) Datasets, metadata and respective data papers are inter-linked to expedite and mutually extend the dissemination, to the benefit of the authors and society.

PhytoKeys will support various methods for data publication. For instance, occurrence data sets can be published as downloadable files under a separate DOI number linked to the respective paper such as a taxonomic revision or floristic catalogue (for examples see Miller et al. 2009, Rasmussen and Asenjo 2009, Penev et al. 2009a). Identification keys can be published in several formats, from plain text formats for dichotomous keys, to HTML versions of the same key cross-linked to figures, references and individual couplets or DELTA, Lucid or MX interactive keys, published as downloadable primary files. The last option will allow future researchers to download and then modify keys by adding or removing taxa or diagnostic characters to adapt keys for local users (Sharkey et al. 2009, Penev et al. 2009b, Stoev et al. 2010).

A special feature of PhytoKeys will be the opportunity to publish data papers for datasets already uploaded and indexed by the authors to GBIF. Such data papers can be automatically extracted from the GBIF metadata catalogue, generated in a form of XML-tagged manuscripts through the GBIF's Integrated Publishers Toolkit (IPT) and then submitted to PhytoKeys for regular review and editorial processing (<http://data.gbif.org>, see also Chavan and Ingversen 2009, <http://www.cbd.int/gti/doc/gbif-IPT-en.pdf>).

A challenging new approach that will be implemented in PhytoKeys is to streamline taxonomic publishing by handling manuscripts generated from authors' databases or community websites, such as Scratchpads and LifeDesks. This process was recently prototyped and implemented in our sister journal ZooKeys (Blagoderov et al. 2010).

Semantic mark up and enhancements are expected to greatly extend and accelerate the way in which taxonomic information is published, disseminated and used. The mission of PhytoKeys is to launch a venue for botanists to use and enjoy these exciting opportunities in the rapidly changing world of publishing.

Link yourself or perish: Electronic registers, indexers ad aggregators, or how to get linked to all?

The Semantic Web could also be called a "linked Web" because most semantic enhancements are provided through various kinds of links to external resources. Standard hyperlinks to resources such as DOI numbers for publications or GenBank accession numbers are already usual components of advanced journal publishing. There is, how-

ever, still much to be done in this direction, and the vision of *PhytoKeys* is to develop and implement new ways of cross-linking with specialized biodiversity resources. The external linking will be provided in-house, within the editorial process, so that the authors are not bothered with these sometimes quite cumbersome processes (Fig. 1).

The results of these linkages will be visualized in the HTML versions of the published papers through various cross-links within the text and more particularly through the *Pensoft Taxon Profile* (PTP) (<http://ptp.pensoft.eu>), a web-based harvester that

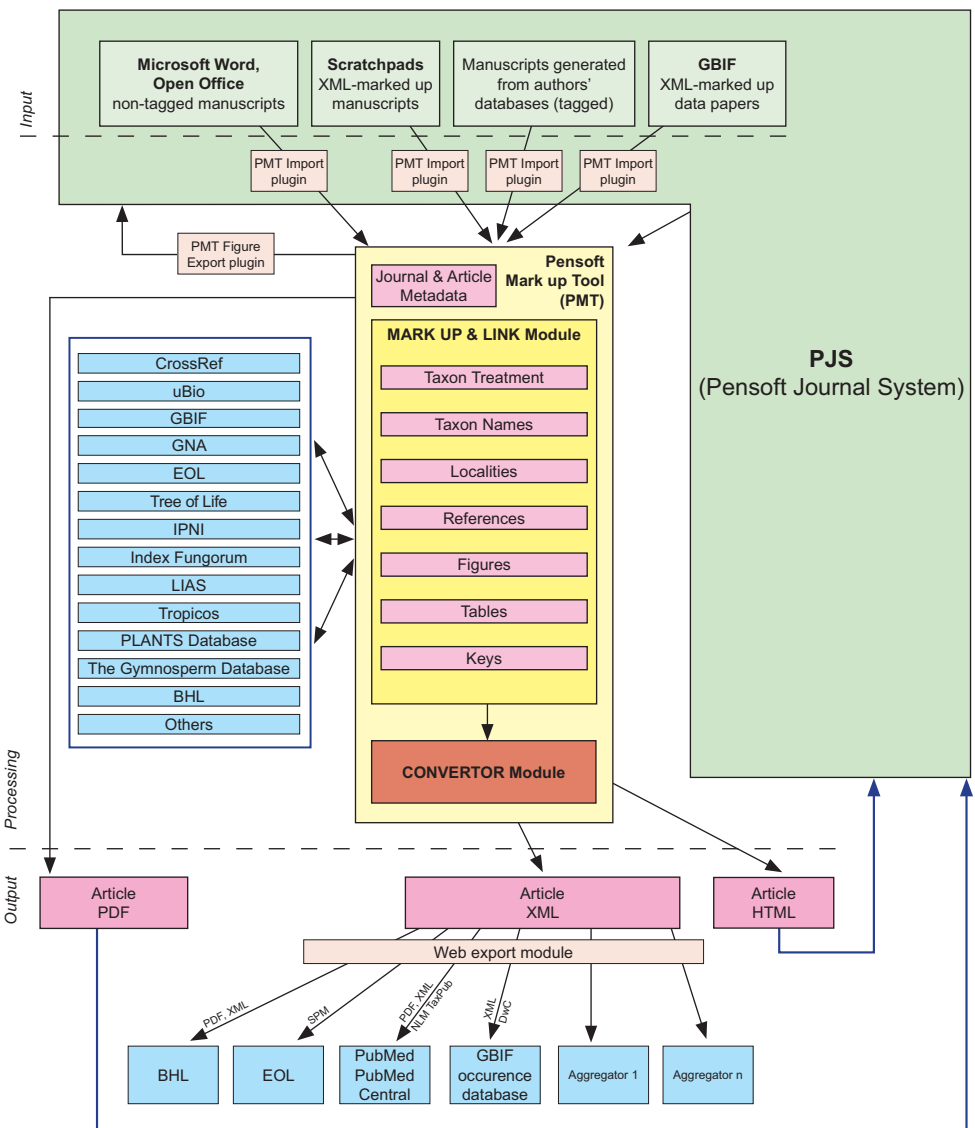


Figure 1. Editorial process in *PhytoKeys* based on XML mark up workflow and extensive internal and external cross-linking to taxon databases, leading biodiversity platforms, indexers and aggregators.

automatically links any taxon name mentioned within a text to external sources and creates a dynamic web page for that taxon. PTP saves readers a great amount of time and effort by gathering for them the relevant information on a taxon from leading biodiversity sources in real time (Table 1). The PTP does not distinguish between names used in botany, mycology and zoology, so information on an animal name cited within a botanical paper is linked as well as vice versa. The PTP may be also used for names not cited within a paper and functions as a focused harvester without any charges or barriers to the readers.

The mission of PhytoKeys is to constantly extend its cross-linking and linkout programs with the main aim being to harvest as many data as possible from biodiversity sources and thereby serving in this way our authors, reviewers, editors and readers.

Table 1. External web resources currently linked to taxon names cited within PhytoKeys papers, provided through the Pensoft Taxon Profile (PTP) (www.ptp.pensoft.eu) (see also Penev et al. 2010a).

Source name	Web address
General sources	
Global Biodiversity Information Facility	www.gbif.org
Encyclopedia of Life	www.eol.org
Catalogue of Life	www.catalogueoflife.org
ITIS	www.itis.gov
uBio	www.ubio.org
WoRMS – World register of Marine Species	www.marinespecies.org
BioLib	www.biolib.cz
Plazi	www.plazi.org
IUCN – International Union for Conservation of Nature	www.iucn.org
Wikipedia	www.wikipedia.org
Wikispecies	www.species.wikimedia.org
Taxon-oriented sources	
International Plant Name Index	www.ipni.org
Tropicos	www.tropicos.org
PLANTS Database	www.plants.usda.gov
The Gymnosperm Database	www.conifers.org
Gene sequences	
NCBI - National Center for Biodiversity Information	www.ncbi.nlm.nih.gov
Barcode of Life Data Systems	www.boldsystems.org
Images	
Morphbank	www.morphbank.net
Wikimedia	www.wikimedia.org
Yahoo	www.images.search.yahoo.com
Literature references	
Google Scholar	www.scholar.google.com
PubMed	www.ncbi.nlm.nih.gov/pubmed
BHL - Biodiversity Heritage Library	www.biodiversitylibrary.org

General

Global Biodiversity Information Facility

Encyclopedia of Life

Catalogue of Life

Integrated Taxonomic Information System

World Register of Marine Species

Wikipedia

Wikispecies

IUCN

BioLib

Taxonomy

International Plant Name Index

Tropicos

PLANTS Database

Gene Sequences

National Center for Biotechnology Information

Barcode of Life

Images

Morphbank

Wikimedia

Yahoo

Literature

Google Scholar

PubMed

Biodiversity Heritage Library

Disclaimer

Some of the searched sites, particularly taxon-oriented databases, do not provide either "AND" or "Exact phrase" search functions, or Application Programming Interface (API). This may lead to the listing of various homonyms, e.g., the taxon profile of spruce (*Picea abies*) will also display the chilopod species *Lithobius obscurus picea Matic*, 1957 in *Chilobagge* and the fly *Tachinops picea Walker*, 1833- 393 in *diptera.org*

Quercus robur

Create your own taxon profile

Global Biodiversity Information Facility

Specimen and observational data for **Quercus robur** from the Global Biodiversity Information Facility Network

Click here to go to the GBIF search results for this taxon

Gene Sequences and PubMed links

Inherited blast name: Plants

Rank: species

Lineage:
cellular organisms; Eukaryota; Viridiplantae; Streptophyta; Streptophytina; Embryophyta; Tracheophyta; Euphyllophyta; Spermatophyta; Magnoliophyta; eudicotyledons; core eudicotyledons; rosids; fabids; Fagales; Fagaceae; Quercus

Entrez records

Database name

Subtree links

PubMed Central

144

Nucleotide

227

Protein

52

Taxonomy

4

PopSet

10

Related links found in database

Effects of a low severity prescribed fire on water-soluble elements in ash from a Cork Oak (*Quercus...*

Online coupling of thin layer chromatography with matrix-assisted laser desorption/ionization...

Can we predict indirect interactions from quantitative food webs? - an experimental approach.

Velocity and pattern of ice propagation and deep supercooling in woody stems of *Castanea sativa*,...

Population differentiation of sessile oak at the altitudinal front of migration in the French...

To get a complete list click here.

Disclaimer: The NCBI taxonomy database is not an authoritative source for nomenclature or classification - please consult the relevant scientific literature for the most reliable information.

Images from Wikimedia

Biodiversity Heritage Library

Bibliography for *Quercus robur*

1997 IUCN red list of threatened plants

1997: 223

Abhandlungen der Königlich Akademie der Wissenschaften zu Berlin.

1879: 184

Abhandlungen herausgegeben vom Naturwissenschaftlichen Verein zu Bremen.

18: 204- 249

Acadian geology :

16

Acta Societatis pro Fauna et Flora Fennica.

v. 43 (1915): 183

Actes de la Société Linnéenne de Bordeaux

t.42 (1868): 308

To get a complete list click here

Figure 2. Dynamic webpage (taxon profile) of the the English oak (*Quercus robur* L.) generated “on the fly” by the Pensoft Taxon Profile tool (PTP, <http://ptp.pensoft.eu>)

Editorial policies, focus and scope

The editorial policy of PhytoKeys will be based on the following principles:

- High quality of published papers, controlled by an eminent editorial board and rigorous peer-review process;
- Open access to all published content ensuring the widest possible barrier-free distribution of works at no charge for readers;
- Author copyright and distribution under the Creative Commons Attribution 3.0 license;
- Quick turn-around time, ranging between 3–6 weeks for review and 1–2 weeks for publication, after manuscript acceptance;
- Online submission and editorial management system, professional review and editorial assistance, typesetting, proofreading and publication;
- No limit in manuscript length; large revisionary works, checklists, catalogues, etc. will be published as special journal issues in the form of separate monographs with assigned ISBN numbers as well as the standard ISSN of the journal;
- Publication in four different formats: (1) high-resolution, full-colour print version (2) PDF identical to the printed version; (3) HTML to provide links to external resources and semantic enhancements to published texts for interactive reading, and (4) XML version for archiving in PubMedCentral thus providing a machine-readable copy of the content to facilitate future data mining;
- Continuous development and implementation of cutting-edge publishing technologies: XML-based editorial work flow and mark up process, data publication and various semantic Web 2.0 enhancements, such as linking of all taxon names to external sources (e.g., GBIF, EOL, IPNI, etc.), as well as linking references to the Biodiversity Heritage Library (BHL) and other bibliographic sources, gene sequences to Genbank and so on;
- Submission of all new taxa to the International Plant Name Index (IPNI) within a few days of publication;
- Automatically generated dynamic web pages for all taxonomic names mentioned within a publication, by linkout to a wide array of leading biodiversity sites, through the Pensoft Taxon Profile (PTP) tool;
- Publishing of species-by-occurrence datasets under separate DOI numbers and indexing of published datasets with GBIF, simultaneous with the publication process;
- Data section providing automated generation and mark up of manuscripts from the metadata catalogue of the Global Biodiversity Information Facilities (GBIF);
- Acceptance of manuscripts automatically generated in XML files from databases, e.g., Scratchpads and LifeDesks web platforms;
- Immediate Alert Service through Email and RSS feeds to inform interested colleagues and organisations about your publication;

- Immediate distribution and dissemination of your publication to scientific databases, indices and search engines (ISI Web of Knowledge, Google Scholar, CABI Abstracts, DOAJ, and others);
- Archiving of your publication, electronically and in print, in trusted (e-) archives and libraries, in the first case PubMedCentral.

One of the highest priority objectives of PhytoKeys will be quick coverage by ISI Web of Science and the assignment of an impact factor by the end of the second year of existence. The accumulated experience with ZooKeys gives us confidence that this goal is definitely achievable.

PhytoKeys will consider for publication works in taxonomy, systematics, biogeography, evolution, and phylogeny in the widest possible sense. Examples of such papers are new descriptions of taxa, if they are accompanied by proper diagnoses, keys and/or distinction from at least the related or similar species; taxonomic revisions of extant (or ‘recent’) and fossil plant groups; checklists and catalogues; phylogenetic and evolutionary analyses; plant DNA barcode analyses; papers in descriptive and/or historical biogeography; methodology papers; data mining and literature surveys; monographs, conspectus, and atlases; collections of papers, Festschrift volumes, and conference proceedings.

Ecological papers will be considered if they treat specific taxa or as part of special issues on a certain topic, region or taxon.

The following categories of papers will also be considered for publishing: original research articles; reviews as longer articles offering a comprehensive overview, historical analysis or/and future perspectives of a topic; monographs and collections of papers with no limit in size, published as “special issues”; data papers; short communications; letters and discussion papers; book reviews.

Authors and editors publishing large revisions or surveys, collection of papers, conference proceedings, Festschrift volumes, checklists, catalogues, etc. will benefit from being assigned ISBN numbers to their works, providing in this way additional dissemination and promotion through the book industry framework.

We are convinced that PhytoKeys will establish a new model of publishing and dissemination of information in botany taking advantage of the exciting possibilities in the application of the semantic Web. New technologies implemented in PhytoKeys will permit taxonomists, ecologists, conservationists and any reader anywhere to harvest within seconds the most essential information on a taxon, locality, or even a specimen, such as descriptions, images, maps, keys, gene sequences and references. A significant impediment to the acceleration of knowledge about the diversity of our planet is access to all the information accumulated during the long history of scientific discoveries; information published in PhytoKeys will be free and open access for anyone to read and use. We are committed to enhancing access to and speeding up the dissemination of taxonomic knowledge, and all efforts of PhytoKeys will be directed to advance knowledge about plant life on Earth.

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Larsenianthus, a new Asian genus of Gingers (Zingiberaceae) with four species

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Academic editor: Sandra Knapp | Received 4 August 2010 | Accepted 14 October 2010 | Published 1 November 2010

Citation: Kress WJ, Mood JD, Sabu M, Prince LM, Dey S, Sanoj E (2010) *Larsenianthus*, a new Asian genus of Gingers (Zingiberaceae) with four species. *PhytoKeys* 1: 15–32. doi: 10.3897/phytokeys.1.658

Abstract

Larsenianthus W.J.Kress & Mood, **gen. nov.** is described with one new combination and three new species. *Larsenianthus careyanus* (Benth.) W.J.Kress & Mood, **comb. nov.**, is widespread in India and present-day Bangladesh; *L. wardianus* W.J.Kress, Thet Htun & Bordelon, **sp. nov.**, is from upper Myanmar in Kachin State; *L. assamensis* S.Dey, Mood, & S.Choudhury, **sp. nov.**, is restricted to Assam, India; and *L. arunachalensis* M.Sabu, Sanoj & T.Rajesh Kumar, **sp. nov.**, has only been found in Arunachal Pradesh, India. A phylogenetic analysis using the plastid *trnK* intron and nuclear ITS DNA sequence data indicates that the four species of *Larsenianthus* form a monophyletic lineage that is sister to *Hedychium*, a geographically widespread genus of about 50 species in tribe Zingibereae of subfamily Zingiberoideae. A dichotomous key and three-locus DNA barcodes are provided as aids for the identification of the four species of *Larsenianthus*.

Keywords

Bangladesh, conservation status, DNA barcodes, *Hitchenia*, India, Myanmar, phylogeny, taxonomy

Introduction

The classification of the family Zingiberaceae continues to be refined (Kress et al. 2002, 2007, Harris et al. 2006) and new taxa are still being discovered and described (e.g., Ly et al. 2010). Recent field work in South Asia has not only uncovered taxa new to science, but also provided new insights into our understanding of generic boundaries and species definitions (Sabu 2006). Here we clarify the generic placement of a species first recognized over 125 years ago and describe a new genus of gingers with three additional new species.

In 1835 Nathaniel Wallich applied the name *Hitchenia glauca* to a ginger that he had listed earlier in his catalogue (Wallich 1832) as *Curcuma glaucophylla* Wall. (no. 6594). Another species listed in his catalogue as *Curcuma careyana* Wall. (no. 6595) was later moved to the genus *Hitchenia* by Bentham, who neither described its morphology nor provided any reason for the new generic placement (Bentham and Hooker 1883). A third species, which had previously been listed as *Curcuma caulina* J.Graham (Graham 1839), was added to the genus *Hitchenia* as *H. caulina* (J.Graham) Baker (Baker 1892). In that publication Baker circumscribed the genus *Hitchenia* and provided more detailed descriptions of the other two species, *H. glauca* and *H. careyana*. However, he realized the taxonomic problems that existed and stated that the latter species “..resembles *H. glauca* in habit, but differs so much in structure that probably it should form a different genus...” (Baker 1892).

In Wallich's 1835 original application of the generic name, the genus honored Mr. Thomas Hitchin of Norwich, England, who was a gardener and distributor of rare plants in the 1810–1830s (Noltie 2005). Unfortunately Wallich misspelled Thomas Hitchin's name when he published the new genus as *Hitchenia*. Horaninow (1862) changed the name back to *Hitchinia* to correct Wallich's mistake, but this nomenclatural revision was not recognized by later botanists. In fact Bentham and Hooker (1883) mentioned Horaninow's corrected generic spelling as an error and preferred to use *Hitchenia*.

Since the time of Baker, little progress has been made in understanding the taxonomic status of *Hitchenia* until the publication of a new classification of the Zingiberaceae by Kress et al. (2002). *Hitchenia glauca*, which had been once more discovered in Myanmar after many years of obscurity, was included in the molecular phylogenetic study of the family and shown to be closely related to several species of *Curcuma*. It was tentatively placed in Curcuma Group I (Kress et al. 2002). At about the same time as the publication of the new classification of the family, living specimens of *Hitchenia careyana* (Plate 1B) were collected near the type locality of Sylhet (formerly Silhet) in Bangladesh (M. Collins, pers. com.). From a comparison by the authors of these living collections to material of *Hitchenia glauca*, it became clear that these two taxa were only superficially similar and probably not at all closely related to each other. For this reason it appeared that a new generic name was needed for *H. careyana*.

In 2002, as part of a survey of the gingers of Myanmar, one of us (WJK) collected specimens of an unknown ginger near Myitkyina, in Kachin State, which closely re-

sembled *H. careyana*, but were distinctive in the inflorescence color and orientation (Plate 1A). In 2008 another of us (SD) discovered an unusual ginger during field work in southern Assam. Surprisingly, the flowers closely resembled those of both the former *H. careyana* and the newly collected material from Myanmar (Plate 1A-C). Finally, only a few weeks later, a fourth species of ginger with the same distinctive inflorescence and floral morphology was recognized by the third author (MS) of this paper whose botanical team had just returned from a survey of plants in northeast India (Plate 1D).

After studying both living specimens and preserved collections of all four taxa, the accumulated research data were sufficient to warrant the circumscription of a new genus. The long exserted and arched style (with included filament) of the flower resembles a similar floral structure found in genera such as *Hedychium*, *Globba*, and *Pommereschea*. In order to obtain evidence of the origin of this floral characteristic in the new genus, to provide an independent test of the evolutionary relatedness of these four species, and to determine their position in the evolution of the family Zingiberaceae a molecular phylogenetic investigation was undertaken (see below). All data suggested that these four species should be placed in a new genus, which we have named *Larsenianthus*, allied to *Hedychium*.

With regards to the remaining species in the genus *Hitchenia*, Leong-Škorničková et al. (2007) in a study of chromosome number and genome size variation in the gingers demonstrated that one species, *H. caulina*, would be better placed in the genus *Curcuma* as initially proposed by Graham (1839). Eventually some taxonomists may prefer to subsume both species of *Hitchenia* into *Curcuma*.

Below we provide descriptions of the new genus and the four included species. Plant measurements were for the most part recorded from living material. Methods and results of the molecular phylogenetic analysis, GenBank accession numbers for a three-locus DNA barcode for each species, and assessments of the conservation status of all species of *Larsenianthus* are also provided.

Phylogenetic evidence and DNA barcode markers

Materials and methods

DNA extraction, amplification, and sequencing. Total genomic DNAs were extracted for a representative sample of each species of *Larsenianthus* described herein (Table 1) using a modified CTAB protocol. Nucleic acid fragments for *trnK* and ITS as phylogenetic markers were amplified using custom primers and Promega Go Taq Flexi under standard cycling conditions, and cleaned using an abbreviated PEG/NaCl procedure as described in Kress et al. (2002). Amplification of *rbcL* and the *trnH-psbA* spacer region as DNA barcoding loci used published primers under standard conditions (Kress and Erickson 2007). The *matK* DNA barcode locus was isolated from the *trnK* intron sequences that were generated for the phylogenetic analyses. Fragments were fluorescently labeled using Applied Biosystems (Foster City, California, USA) Big-Dye v3.1 (1/8

concentration) chemistry Terminator Cycle Sequencing Ready Reaction Kit following AB protocol for a 3130xl Automated DNA Sequencer. DNA fragments were compiled and edited in Sequencher 4.9 (Gene Codes Corp., Ann Arbor, Michigan, USA).

Phylogenetic analyses. Newly generated sequences of the *trnK* intron and ITS were added to a reduced taxon version of the Kress et al. (2002) data matrix, which included representatives of all subfamilies of the Zingiberaceae. *Siphonochilus* was designated as the outgroup based on results of the prior study (Kress et al. 2002). The data matrix was realigned using MUSCLE (Edgar 2004) as implemented in Geneious Pro v4.8.5 (Biomatters Ltd., Auckland, New Zealand; www.geneious.com) followed by minor manual adjustment with indels treated as missing data.

Maximum Parsimony. Separate and combined Fitch parsimony analyses of one thousand random sequence addition replicates with tree bisection and reconstruction (TBR) branch swapping, holding four trees, saving all shortest trees were conducted in PAUP *4.0b10 (Swofford 2002). Branch support was calculated based on 1,000 bootstrap pseudoreplicates (BS) of 100 random addition replicates (holding four trees, TBR branch swapping, saving 10 trees per replicate) to maximize the accuracy of the estimation while minimizing analysis time.

Likelihood. Bayesian analyses were conducted in MrBayes (Huelsenbeck and Ronquist 2001, Ronquist and Huelsenbeck 2003) to estimate branch support using three replicates of five million generations (sampling every 100 generations), running four chains. The *trnK* dataset was partitioned into three regions (*trnK*5' IGS, *matK*, and *trnK*3'IGS) and the combined dataset was partitioned into four regions (*trnK* as described above, plus ITS). Appropriate burn-in (number of generations discarded prior to calculation of posterior probability [PP]) for each analysis was determined based on a standard deviation of split frequencies (discarding all trees prior to stabilization below a standard deviation >0.01). Burn-in times for each data matrix are available from the senior author.

Results

ITS. Analyses of the ITS data matrix produced 23 shortest trees of 1,011 steps based on 268 parsimony informative characters (results not shown). Trees fell into three distinct tree islands, one of 21 trees, and two of one tree only. Differences between these three tree islands were minor. In all shortest trees, the four species of *Larsenianthus* form a monophyletic clade with moderate to strong support (BS=89%; PP=1.00), and are sister to a monophyletic clade of *Hedychium* (BS=100%; PP=1.00). The sister relationship is also supported although less strongly than the reciprocal monophyly of the genera if only parsimony is considered (BS=68%; PP=1.00).

***trnK* intron.** *trnK* intron analyses produced over 100,000 shortest trees of 552 steps based on 328 parsimony informative characters (results not shown). Relationships were generally less well resolved and less strongly supported than with the ITS data, however there were missing data for part of the 5' *trnK* sequences for two of

the *Larsenianthus* samples. Monophyly of *Hedychium* was moderately supported by parsimony (BS=84%) and strongly supported by Bayesian methods (PP=1.00). The majority rule consensus tree recovered a monophyletic *Larsenianthus*, but not the strict consensus tree. Three of the four species of *Larsenianthus* formed a monophyletic group with low to moderate support (BS=65%; PP=0.96). Similarly, a sister relationship between the two genera was not recovered.

Combined ITS & trnK. The combined data analyses produced 18 shortest trees of length 1,590 steps (Figure 1). Analyses utilized 585 parsimony informative characters. *Larsenianthus* and *Hedychium* were both monophyletic with strong branch support (*Hedychium*: BS=100%; PP=1.00; *Larsenianthus*: BS=96%; PP=0.98); the sister relationship between the two genera was confirmed with moderate support (BS=83%; PP=0.92; Fig. 1).

DNA barcodes. The DNA barcodes that were generated for the three barcode loci, *rbcLa*, *matK* and *trnH-psbA*, (Kress and Erickson 2007, CBOL Plant Working Group 2009) provide unique genetic identifiers for each of the four species of *Larsenianthus*. GenBank accession numbers for sequences of each DNA barcode locus for each species are provided (Table 1).

Conservation status

The overall distribution of the genus covers a large area of sub-Himalayan forests in northeastern Bangladesh, the Indian states of Meghalaya and Assam, the northern border of Arunachal Pradesh, and into upper Myanmar. *Larsenianthus careyanus* is the most widespread of the species and by IUCN guidelines (IUCN Standards and Petitions Subcommittee 2010) we categorize it as *Near Threatened* (NT) because of the gradual decline of the habitats it occupies and the small number of recent collections.

Table 1. List of species of *Larsenianthus* with vouchers (herbarium location) and GenBank accession numbers for DNA barcodes and gene sequences used in the phylogenetic analyses.

Taxon	Voucher	ITS	<i>trnK</i> (including <i>matK</i>)	<i>rbcLa</i>	<i>trnH-psbA</i>
<i>L. wardianus</i>	W. J. Kress 10-8750 (US)	HM771392	HM771404	HM771400	HM771396
<i>L. careyanus</i>	W. J. Kress 03-7403 (US)	HM771393	HM771405	HM771401	HM771397
<i>L. assamensis</i>	S. Dey 1012 (CAL)	HM771395	HM771407	HM771403	HM771399
<i>L. arunachalensis</i>	Sanoj & Rajesh Kumar 105640 (CAL)	HM771394	HM771406	HM771402	HM771398

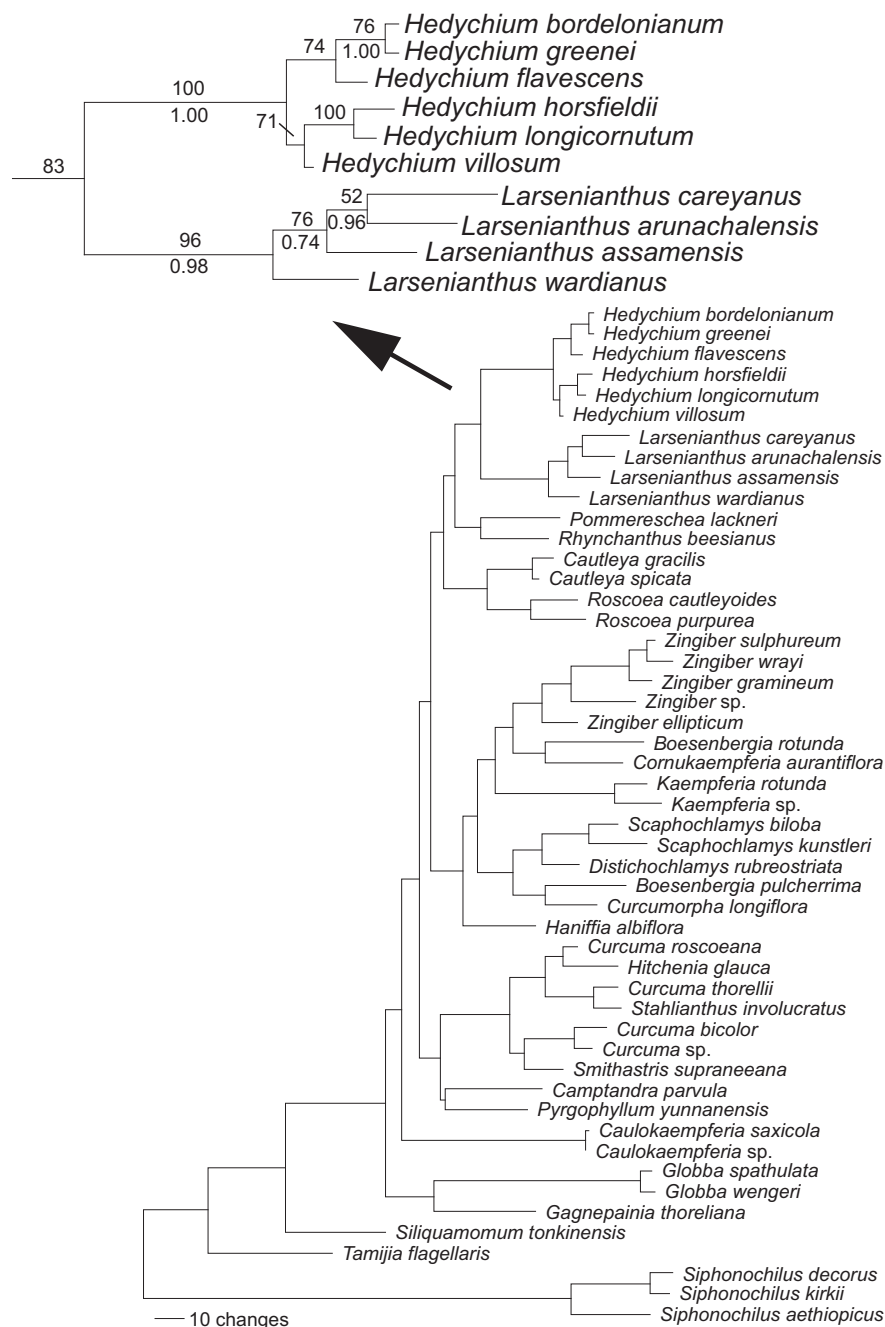


Figure 1. Molecular phylogeny of the Zingiberaceae indicating the placement of *Larsenianthus* within the Zingiberoideae in the combined ITS/*trnK* analysis. Tree length (excluding uninformative characters) = 1,590 steps, Consistency Index = 0.5314, Retention Index = 0.6809, Rescaled Consistency Index = 0.3619. Bootstrap numbers are provided above the branch, Posterior Probabilities below.

The other three new species are only known from their type localities. Until more collections are made of these three species, we estimate a provisional conservation status of *Critically Endangered* (CR: B1ab(iii) + B2ab(iii)).

Taxonomy

***Larsenianthus* W.J.Kress & Mood, gen. nov.**

urn:lsid:ipni.org:names:77107682-1

Figs. 2–4; Plate 1A–D

Zingiberacearum tribus Zingiberearum genus novum Hedychio J.Koenig affine, a quo staminodiis lateralibus parvis auriculatis, labello angusto elongato marginibus incrassatis carinaque centrali et filamento valde arcuato differt.

Type. *Larsenianthus careyanus* (Benth.) W.J.Kress & Mood, comb. nov., *Hitchenia careyana* Benth., Gen. Pl. 3: 643. 1883.

Description. Evergreen, rhizomatous, terrestrial herbs, clumping with 10–20 shoots per plant, 1–2.5 m tall, plane of distichy of leaves parallel to rhizome, 2–12 leaves per shoot, alternate, sessile to petiolate. Inflorescence terminal on leafy shoot or basal on leafless shoot, pedunculate; bracts basally attached, reflexed or adpressed, spirally arranged and imbricate, 35–80 per inflorescence, not pouched, adventitious plantlets sometimes produced in sterile bracts at base of inflorescence; flowers mature from base to apex of inflorescence. Bracteoles variable in size, the inner one largest, not tubular. Flowers conspicuous, in cincinni of 2–6 flowers or rarely reduced to one flower; calyx tubular, tri-dentate, shorter than the corolla; floral tube long and curved, exserted well beyond the bract, corolla lobes subequal with dorsal lobe slightly larger than laterals, apex opening oblong, bordered on the two lateral sides with a thickened and rounded margin formed by the base of the lateral staminodes and the labellum; lateral staminodes small, bowl-shaped, reflexed; labellum narrow at the base, widening towards the apex, elongate, oblanceolate or spatulate, basal margins thickened, raised with center channeled or ‘v’ in cross-section, apex dentate or entire; fertile stamen long and arched over the labellum, anther oblong, without a crest, thecae dehiscent for full length; epigynous glands linear; style with stigma protruding beyond anther thecae; ovary trilocular, fruit an oblong capsule, two-layered with the outer splitting into three coiled sections, the inner forming an arillate membrane covering the 1–10 seeds.

Discussion. *Larsenianthus* is a distinctive genus in the tribe Zingibereae. Some similarities exist with the genera *Hedychium*, *Globba* and *Pommerschea* in the vegetative parts, the bract orientation, and the long filament. The uniqueness of the genus and its close relationship to *Hedychium* is confirmed by phylogenetic analyses of DNA sequence data (Fig. 1). However, the combination of unique features including the narrow, elongate labellum with slightly thicken edges and a deeply channeled center combined with the small, cup-shaped lateral staminodes and strongly arched filament clearly distinguish this genus from others in the tribe. Two additional traits that char-



Figure 2. *Larsenianthus wardianus* W.J.Kress, Thet Htun & Bordelon. **A** overall habit **B** leaf base with petiole and ligule **C** inflorescence **D** inflorescence bract **E** bracteole **F** calyx, spread open **G** flower, lateral view **H** flower, front view **I** flower, semi-lateral view with corolla tube cut away to show epigynous nectaries and style **J** base of flower, cut-way view to show style, and ovary **K** anther with slightly protruding stigma **L** ovary, transverse section. Line drawing by Alice Tangerini from plants in cultivation; Botany Research Greenhouse Accession #02-7054 and US National Herbarium voucher W. J. Kress 10-8750.

acterize at least two of the four species in the genus (*L. assamensis* and *L. careyanus*) are the unusual white capsular fruit with a gelatinous fused arillate structure that encases the seeds and the multiple adventitious plantlets that form in the axils of the sterile bracts at the base of the inflorescence.

Etymology. This new genus honors Dr. Kai Larsen, Professor of Botany Emeritus, Aarhus University, Denmark, for his many years of dedicated efforts in the education of botanists worldwide and for his profound achievements in the taxonomy of the family Zingiberaceae, especially in the flora of Thailand.

Key to species of *Larsenianthus*

- 1a. Inflorescence on a basal leafless shoot..... *L. wardianus*
- 1b. Inflorescence terminal on a leafy shoot..... 2
- 2a. Inflorescence bracts green and white, 4–6 flowers per bract..... *L. careyanus*
- 2b. Inflorescence bracts red, 1–3 flowers per bract 3
- 3a. Margins of inflorescence bracts corrugate and denticulate, 1 flower per bract *L. assamensis*
- 3b. Margins of inflorescence bracts entire and smooth, 2–3 flowers per bract *L. arunachalensis*

Larsenianthus wardianus W.J.Kress, Thet Htun & Bordelon, sp. nov.

urn:lsid:ipni.org:names:77107683-1

Fig. 2; Plate 1A

Nova species L. careyano affinis, a quo minore statura, congestis foliis, inflorescentia radicali in bractea sine foliis, cum paucis floribus in unaquisque bractea differt.

Type. Myanmar: Kachin State: Myitkyina Township, NW section of Pidaung Wildlife Sanctuary, approx. 15 km. from Myitkyina, 25°34'52" N, 97°14'56" E, understory of evergreen forest. 22 February 2002. W. J. Kress, Thet Htun, M. Bordelon, and Khin Maung Ha 02-7054 (living plant only for cultivation). Plants of #02-7054 cultivated at the Smithsonian Botany Research Greenhouses. 14 April 2010. W. J. Kress 10-8750 (holotype: US!; isotypes RAF!, E!).

Description. *Evergreen herb*, medium-size to 125 cm tall; rhizome to 2.0 cm in diameter, fibrous, aromatic, inner color white; tubers present. *Leafy shoots* 10–20 per plant, erect, densely clumped. *Leaves* 4–5 per shoot, to 118 cm in total length; basal leaf sheaths reddish and glabrous, ca. 30 cm in length × 5 cm in width; sheathing petioles to 52 cm in length × 1.5 cm in diameter, glabrous, green and clasping stem, margin slightly revolute; ligule small, 10 mm in length × 1 mm in width, not lobed, truncate on petiole, papery and ephemeral disappearing in mature leaves; lamina 67 cm in length × 14 cm in width, ovate, green and glabrous above, lower midrib green and glabrous, base long attenuate onto petiole, slightly subequal, apex acuminate, adaxial surface dark green. *Inflorescence* basal on leafless shoot, erect to 33 cm in height; peduncle 20 cm in length × 1.0–1.5 cm in diameter, glabrous, lower sheaths

red, upper sheaths green; spike ovoid, 6–10 cm in length $\times$ 4–5 cm in diameter; rachis straight; inflorescence bracts about 40 per inflorescence, 1–2 lower bracts sterile, bracts 3.7 cm in length $\times$ 2.4 cm in width at base of inflorescence, 2.0 cm in length $\times$ 1.8 cm in width distally, spirally arranged and imbricate, not pouched, held at 40° from vertical axis, glabrous, bright green with reddish apex, margins smooth; bracteoles not tubular, 2.1 cm in length $\times$ 1.6 cm in width, glabrous, pale white with reddish apex. *Flowers* conspicuous, 3–4 per bract; calyx tubular, 1.5 cm long, tri-lobed with central lobe shortest, pale yellow to pink; floral tube 3.2 cm in length $\times$ 2.0 mm in diameter, reddish pink, externally glabrous with scattered unicellular papillate hairs inside, lobed with each lobe 1.4 cm in length, reflexed; lateral staminodes 3.0 mm in length $\times$ 2.0 mm in width, cup-shaped, glabrous, red; labellum 2.2 cm in length $\times$ 3.0 mm in width at apex, linear to spatulate, not lobed, red basally with yellow apex, glabrous; fertile stamen with filament 2.1 cm long, red at throat of corolla becoming yellow distally, glabrous; anther 3.0 mm in length $\times$ 2.0 mm in width, without a crest; pollen pale yellow; epigynous glands two, linear; stigma minute, <1 mm across, white, extending slightly beyond anther; ovary trilocular, 2.0 mm in length $\times$ 2.0 mm in width, pubescent, white to cream colored. *Fruits* and seeds unknown.

Distribution. Known only from the type locality in Kachin State, upper Myanmar.

Ecology. This species is found in the understory of evergreen forests dominated by members of the family Dipterocarpaceae in the foothills of the Himalayas.

Etymology. Named for Francis Kingdon-Ward, the British plant collector who extensively explored Upper Burma in the first half of the twentieth century and who inspired the authors of this species in their work in Myanmar (Kress et al. 2003, Kress 2009).

Other specimens examined. Known from the type collection in Padaung National Park west of Myitkyina, Kachin State, Myanmar, as well as cultivated material (Smithsonian Botany Research Greenhouse GH-2002-050) collected at the type locality.

***Larsenianthus careyanus* (Benth.) W.J.Kress & Mood, comb. nov.**

urn:lsid:ipni.org:names:77107684-1

Plate 1B

Basionym: *Hitchenia careyana* Benth. (Gen. Pl. 3: 643, 1883).

Type. India: “Mts Sillet, Francis de Silva and William Gomez”, 1832. Wallich Cat. Herb. Ind., 6595 (as *Curcuma careyana* in Wallich [1832]; lectotype [designated here]: K!; isoelectotypes: E!, BM!).

Description. *Evergreen herb*, medium-sized to 215 cm tall; rhizome to 2.5 cm in diameter, fibrous, fragrant, inner color with an outer white layer and inner dull white layer, roots 5 mm in diameter, yellow; tubers absent. *Leafy shoots* 10–30, densely clumped, stems 3–4 cm in diameter at base. *Leaves* 7–9 per stem, increasing in size upward, to 40 cm in total length; basal leaf sheaths 3, glossy, dark green with sparse hairs, turning brown; petiole 0–2 mm in length; ligule 7–8 cm in length $\times$ 4 cm in width, semi-transparent, green turning brown, densely pubescent with short hairs,

apex rounded to truncate; lamina 36–60 cm in length $\times$ 18–19 cm in width, ovate to elliptic, surface broadly corrugate with prominent veins, dark green, glossy, glabrous, abaxial side dull green, glabrous, midrib with few hairs, margin hyaline, ciliate, base acute, apex acuminate. *Inflorescence* terminal on leafy shoot, erect to 35 cm in height, apical part of peduncle 11–12 cm in length $\times$ 1.2–1.8 cm in width clasped by the top two leaf sheaths, light yellow-green, glabrous; spike cylindric, 22–25 cm in length $\times$ 6–7 cm in diameter; inflorescence bracts up to 60 per inflorescence, 3–4 lower bracts sterile, individual bracts ovate, 3.5 cm in length $\times$ 3 cm in width, green with a broad white edge, glabrous, striate, inside smooth with copious, sticky mucilage, apex mucronate reflexed 90°, margin hyaline; 1–3 adventitious plantlets produced in sterile bracts at base of old inflorescence; cincinnus 1 per bract; flowers mature from base to apex of inflorescence. Bracteoles lanceolate, cymbiform, not tubular, keeled with uneven sides, 25–28 mm in length $\times$ 5–15 mm in width, striate, yellow-tan, apex truncate to slightly acute. *Flowers* conspicuous, 4–6 per bract; calyx tubular, 10–18 mm in length, trilobed, white, transparent, glabrous; floral tube 45–52 in length $\times$ 1–2 mm in diameter, white, glabrous, deflexing 45° toward rachis in last 10 mm, lobes 3, linear-lanceolate, 15 mm in length $\times$ 10 mm in width, greenish-white with pink apex, dorsal lobe recurved 180° against corolla tube, ventral lobes deflexed downward, twisted, almost parallel with labellum; lateral staminodes 2 mm in length $\times$ 2 mm in width, suborbicular, white, iridescent, reflexed, apex truncate, pink, glabrous; labellum 24 mm in length $\times$ 6 mm at the widest, elongate, oblanceolate, white to light purple-pink, iridescent with reflective cells giving a sparkle effect, apex truncate, bidentate at center; fertile stamen with filament 2.3 cm long, forming a 180° arc, ending c. 1 cm above labellum, white; anther 5 mm in length $\times$ 3 mm in width, oblong, pollen white; epigynous glands two, cuneate, 5 mm in length $\times$ 1 mm in diameter, yellowish; stigma, c. 1 mm long, apical opening with hairs, white, extending 2 mm beyond thecae; ovary trilocular. *Fruits* 2.0 cm in length $\times$ 1.0 cm in diameter, capsular, dehiscing into three separate coiled sections; seeds 8–10, 5 mm in length $\times$ 3 mm in width, shiny green, enclosed in a thin, tripartite, cocoon-like fused aril.

Distribution. Bangladesh and northeastern India (Assam, Meghalaya, Arunachal Pradesh, Manipur).

Ecology. *Larsenianthus careyanus* is found in tropical semi-evergreen forest.

Etymology. This species was originally named by Wallich for the botanist Dr. William Carey (1761–1834).

Specimens examined. **India:** Arunachal Pradesh: Lohit Dist., 15 September 1969, A.S. Rao 47859 (CAL!); Tirap F. D., 10 November 1959, R. Seshagiri Rao 20004 (CAL!). Assam: Dulong Reserve Forest, 21 November 1957, G. Panigrahi 11283 (CAL!); Kabakhal Reserve Forest, 9 January 1957, R. Seshagiri Rao 9077 (CAL!); Kakoi Reserve Forest, N. Lakhimpur, 13 May 1966, D.M. Verma s.n. (ASSAM!). Manipur: Thirighat, February 1906, A. Meebold 10817 (CAL!); Thirighat, November 1907, A. Meebold 6237 (CAL!). **Bangladesh:** (India, East Bengal), no date, Griffith 5627 (CAL!); near Sylhet, from material collected by M. Collins and cultivated in the US Botany Research Greenhouses (#02146), 29 July 2003, W. J. Kress 03-7403 (US!).

***Larsenianthus assamensis* S.Dey, Mood, & S.Choudhury, sp. nov.**

urn:lsid:ipni.org:names:77107685-1

Fig. 3; Plate 1C

Species nova L. careyano *affinis*, a quo *planta minore semidecumbenti*, *inflorescentia minore* (circa 8×4 cm) *ovoidea bracteis coccineis ad margines dentatis*, *ad bracteam quamque flore fertili solitari et labello angustiore magis roseo differt*.

Type. India: Assam: Cachar Dist., Bhaluknala, Barail Wildlife Sanctuary, narrow sub-stream of Lakhicherra, $24^{\circ}58'50.7''$ N, $92^{\circ}46'30.8''$ E. Cachar tropical semi-evergreen forest, 26 m elevation, August 2007, S. Dey 1012 (holotype: CAL!; isotype: ASSAM!).

Description. *Evergreen herb*, medium-sized to 144 cm tall, rhizome fibrous, elongate in distinct sections, bulbous, white-colored internally; tubers absent. *Leafy shoots* 7–17 per plant, erect or slightly decumbent, base bulbous. *Leaves* 7–12 per shoot, to 35 cm in total length; basal leaf sheaths 3–5, light pink, drying brown, deciduous; petiole 0–7 mm in length; ligule 7 mm in length $\times$ 5 mm in width, bilobed, apices rounded; lamina 24–34 cm in length $\times$ 5.4–8.5 cm in width, elliptic, dark green and glabrous above, base aequilateral, tip acuminate, midrib and veins depressed, abaxial surface dull green and glaucous. *Inflorescence* terminal on leafy shoot, erect to 14 cm in height; apical part of peduncle 3–5 cm in length $\times$ 3–5 mm in diameter, light green-brown, glabrous; involucre bract 4.2 cm in length $\times$ 1 cm in width, green, red striated, apex cirrose; 1 adventitious plantlet produced in sterile bracts at base of old inflorescence; spike ovoid to ellipsoid, 5.5–8.5 cm in length $\times$ 3.8–4 cm in diameter; inflorescence bracts c. 35 per inflorescence, 2.1–2.8 cm in length $\times$ 1–1.3 cm in width, ovate-oblong, concave, loosely clasping, red-veined, margin corrugate and denticulate, apex mucronate, revolute with long hairs, apical bracts smaller, sterile; one cincinnus per bract; bracteole lanceolate, cymbiform, 27 mm in length $\times$ 19 mm in width, semi-transparent, white, apex tapered, red. *Flowers* conspicuous, 1–4 per bract (usually only a single flower fertile); calyx tubular, 8–14 mm in length $\times$ 5 mm in diameter, trilobed, white, apex pink; floral tube 19–27 mm in length $\times$ 2–2.5 mm in diameter, pink-red, glabrous, corolla lobes linear-lanceolate, dorsal lobe 13 mm in length $\times$ 2 mm in width and reflexed 90° , ventral lobes 11 mm in length $\times$ 2 mm in width and deflexed and parallel to floral tube, orange-red with darker apex; lateral staminodes ovate, 6 mm in length $\times$ 3 mm in width, light orange with translucent dots, apex irregular, reflexed; labellum 22–25 mm in length $\times$ 2–3 mm in width, elongate, oblong, 'v' in cross-section, basal margins thickened, light orange, apex slightly trilobed, outer lobes 1 mm in length, rounded, curved upward toward apex, purplish-white; fertile stamen with filament c. 18 mm in length, arched, greenish purple at base, light orange-white distally, oblong, anther 3 mm in length $\times$ 0.5 mm in width, thecae glossy purple; pollen white; epigynous glands two, unequal, largest 3 mm in length $\times$ 0.5 mm in width and linear, smallest 2 mm in length $\times$ 0.5 mm in width and cylindric, dark purple; stigma 0.5 mm in length, extending 5 mm beyond anther, purplish; ovary trilobular, 2 mm in length $\times$ 1 mm in width, obovoid-oblong, unequally 3-lobed, pubescent, purplish. *Fruits* 8–9 mm in length $\times$ 4–4.5 mm in width, oblong to ellipsoid, white, capsular,

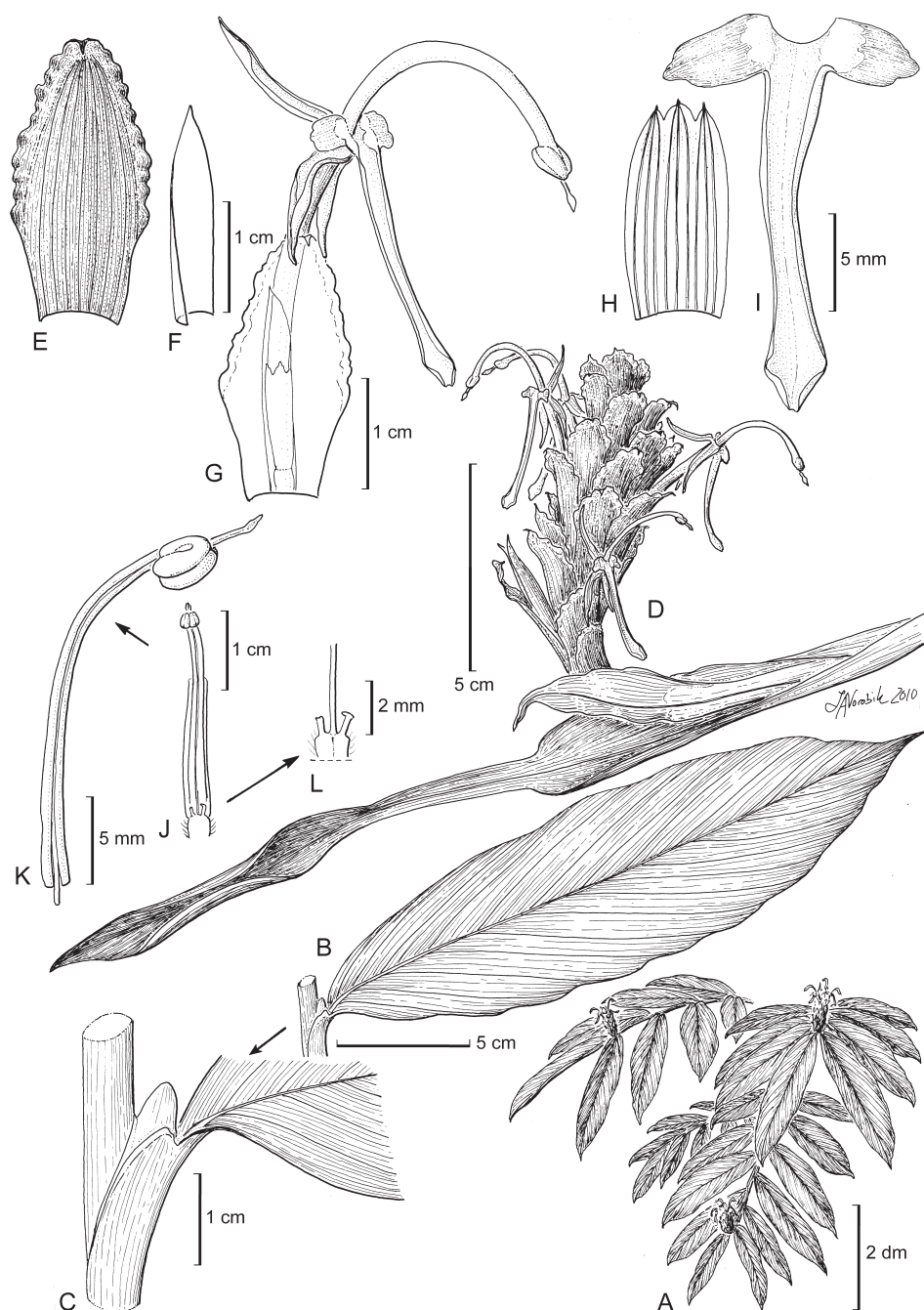


Figure 3. *Larsenianthus assamensis* S.Dey, Mood, & S.Choudhury. **A** overall habit **B** leaf, entire **C** leaf base with petiole and ligule **D** inflorescence **E** inflorescence bract **F** bracteole **G** bract and flower, semi-lateral view **H** calyx, spread open **I** labellum with attached lateral staminodes **J** stamen showing base of floral tube and the epigynous nectaries **K** filament and anther with protruding stigma **L** epigynous nectaries and style. Line drawing by Linda Van Vorobik from plants in cultivation; voucher S. Dey 1012.

dehiscing into three separate coiled sections, seeds 1–4, c. 3 mm in length $\times$ 2 mm in width, obovoid, seeds light to dark violet, enclosed in a cocoon-like arillate membrane.

Distribution. Known only from two locations in the Barail Wildlife Sanctuary. *Larsenianthus careyanus* is also frequently found in this same region.

Ecology. This species occurs in the understory of tropical semi-evergreen forest in very moist conditions along streams (rainfall 350–400 cm/yr) at 25–150 m in elevation. Associated plants are species of *Musa*, *Curculigo*, *Begonia*, *Albizzia*, *Ampelocissus*, *Dysoxylum*, *Laportea*, *Uncaria*, and ferns.

Etymology. Named for the Indian state of Assam where this species is endemic.

Specimens examined. **India:** Assam: Cachar Dist., Lakhicherra, Barail Wildlife Sanctuary, 24°59.053' N, 92°46.525' E. ca. 150 m. elevation, 30 August 2007, S. Dey s.n. (living material only).

***Larsenianthus arunachalensis* M.Sabu, Sanoj & T.Rajesh Kumar, sp. nov.**

urn:lsid:ipni.org:names:77107686-1

Fig. 4; Plate 1D

Species nova L. careyano affinis, a quo inflorescentia centrali in caule bifoliato portata et ad bracteam quamque floribus fertilibus 2–3 differt.

Type. **India:** Arunachal Pradesh: Lohit Dt.: Lalpani, Hayuliang Road, N 27°56'28.2", E 096°22'21.9", 6 August 2009, E.Sanoj & T.Rajesh Kumar 105640 (holotype: CAL!; isotypes: CAL!, ASSAM!).

Description. *Evergreen herb*, medium-sized to 150 cm tall; rhizome 1.9 cm in diameter, hard, fibrous, slightly aromatic, inner color pale brown; tubers absent. *Leafy shoot* erect; base 2.5–3 cm in diameter. *Leaves* two per flowering shoot, to 120 cm in total length; basal leaf sheaths 4–6, red and green, densely pubescent towards apex; petiole 19.5–31 cm in length, cross section U-shaped, pubescent, green; ligule 9.5–14 cm in length $\times$ 2.4–2.7 cm in width, lanceolate, apex attenuate, pubescent abaxially, becoming dry and brown; lamina 56–88 cm in length $\times$ 19–25 cm in width, abaxially pale green and densely pubescent with silvery hairs, elliptic, dark green, and glabrous above, veins raised 4–6 mm, margins entire, undulate, hyaline, white tinged, base attenuate, apex long acute, slightly twisted. *Inflorescence* terminal on leafy shoot, erect to 90 cm in height; apical part of peduncle 25–75 cm in length, c. 1.2 cm in diameter, pubescent, pale green; spike elliptic, 14–19 cm in height $\times$ 3–3.4 cm in diameter; inflorescence bracts 60–80 per inflorescence, bracts 2.4–2.9 cm in length $\times$ 2.6–2.8 cm in width, spirally arranged and tightly imbricate, orbicular to broadly elliptic, cymbiform, free to the base, coriaceous, deep red, base white tinged, margin entire and smooth, glabrous, apex acute to rounded, surfaces pubescent, dense brown hairs toward apex; one cincinnus per bract; bracteoles tubular, longer than bracts, 2.8–3.3 cm in length, unilaterally split 1 cm, apex acute to rounded, deep red, white tinged towards base, densely pubescent with short brown hairs towards apex. *Flowers* conspicuous, 2–4 per bract, 2–8 flowers open simultaneously on inflorescence; calyx tubular, 16–17 mm in length $\times$ c. 3 mm in width, apex trilobed, unilaterally split 5–6 mm, pale red, white

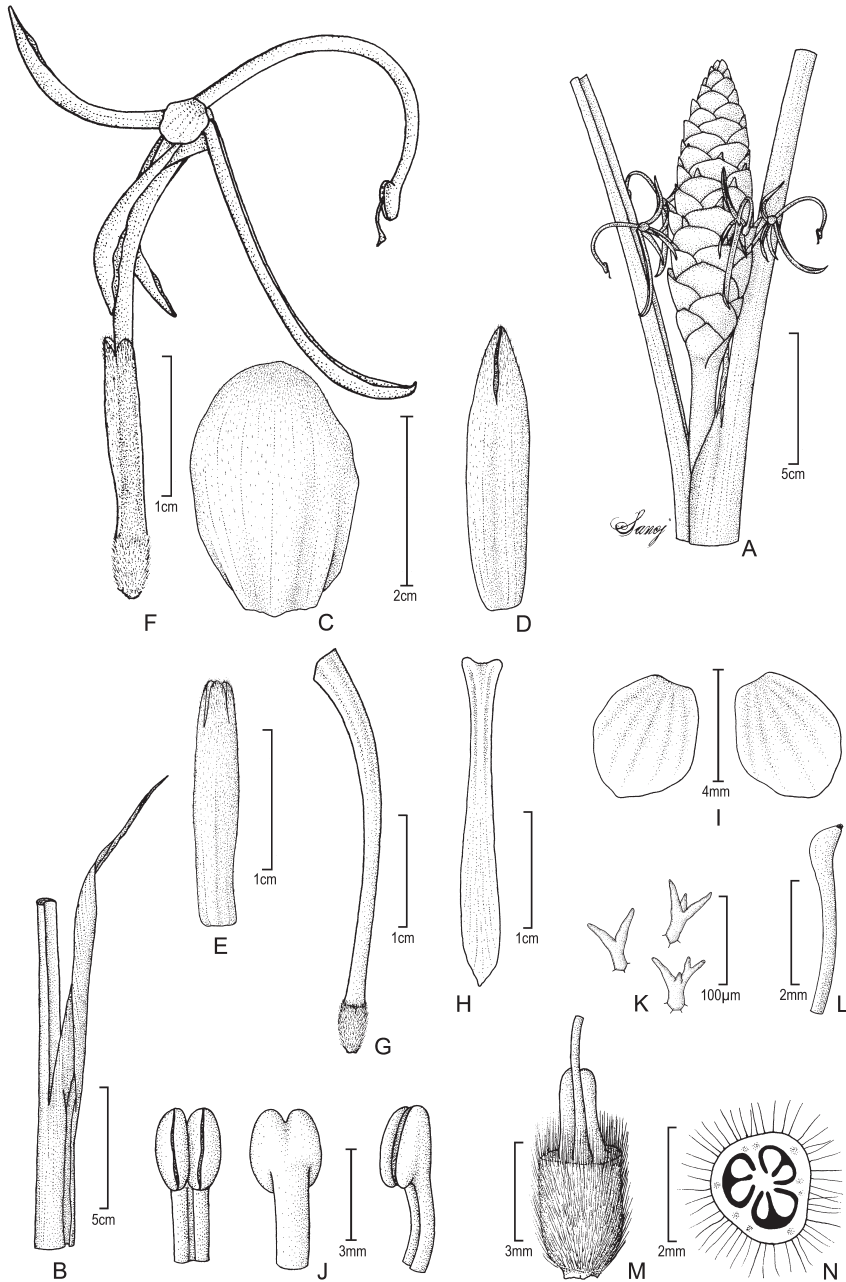


Figure 4. *Larsenianthus arunachalensis* M.Sabu, Sanoj & T.Rajesh Kumar. **A** inflorescence **B** apical part of leaf sheath with ligule and petiole **C** inflorescence bract **D** bracteole **E** calyx **F** flower, lateral view **G** floral tube **H** labellum **I** lateral staminodes **J** anther, front, back and lateral views **K** unicellular branched hairs inside corolla tube **L** stigma and upper portion of style **M** base of flower, cut-way view to show style and epigynous nectaries **N** ovary, transverse section. Line drawing by E. Sanoj from plants in cultivation; voucher Sanoj & Rajesh Kumar 105640.

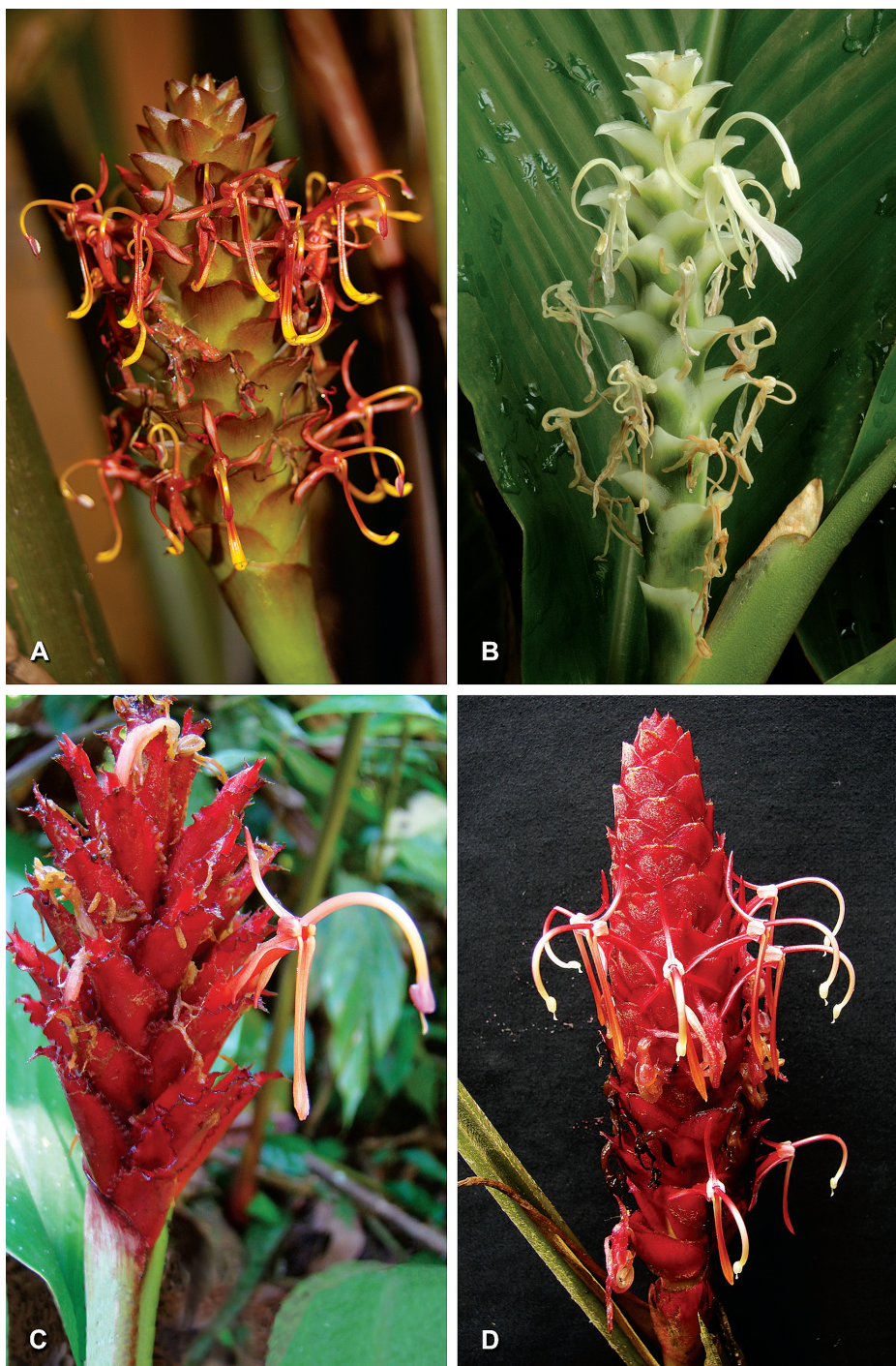


Plate I. Inflorescences with flowers of **A** *Larsenianthus wardianus* W.J.Kress, Thet Htun & Bordelon **B** *L. careyanus* (Benth.) W.J.Kress & Mood **C** *L. assamensis* S.Dey, Mood, & S.Choudhury **D** *L. arunachalensis* M.Sabu, Sanoj & T.Rajesh Kumar. All photos by the authors.

towards base, pubescent with denser hairs towards apex, membranous, translucent; floral tube 3.2–3.3 cm in length $\times$ c. 3.5 mm in diameter at opening, red, lobed with each lobe 15–17 mm in length, oblanceolate, dorsal lobe reflex, sparsely pubescent externally with scattered unicellular branched hairs inside, lateral lobes glabrous; lateral staminodes c. 4 mm in length $\times$ 3.5 mm in width, orbicular to broadly elliptic, white with pale red tinge, revolute; labellum 25–28 mm in length $\times$ 2.5–3 mm in width, narrowly oblong in first two-thirds and oblanceolate distal third, semi-spathulate, red to creamy yellow towards base and orange-yellow towards acute, beak-like apex; fertile stamen with filament 2.4–2.6 cm in length, red becoming creamy-yellow near anther, arching like a fish-hook; anther c. 3 mm in length $\times$ 2 mm in width, creamy yellow, glabrous; epigynous glands two, oblong, white, 2.5–3.0 mm in length; stigma c. 0.5 mm wide, white, bulbous, margins ciliate, exerted 2–2.5 mm from the middle of the anther; ovary trilocular, c. 3 mm in length $\times$ 2.5 mm in diameter, tomentose, pale red. *Fruits* and seeds unknown.

Distribution. *Larsenianthus arunachalensis* is narrowly endemic in Arunachal Pradesh, India, and is known only from the type locality. It is highly endangered due to various anthropogenic activities.

Ecology. This species grows in sandy soil above 1,400 m in elevation amidst thick clumps of wild species of *Musa*.

Etymology. The specific epithet “*arunachalaensis*” is derived from the name of the state in northeast India from where the type specimen was collected.

Specimens examined. Known only from the type specimen.

Acknowledgements

We would like to acknowledge Mark Collins, Mike Bordelon, Linda Van Vorobik, Alice Tangerini, Ida Lopez, Jana Leong-Škorníčková and Mark Newman for helpful discussion and assistance in preparing the manuscript; colleagues in Myanmar, India, and Bangladesh, especially Mr. Rajesh Kumar, Mr. Satyanarayananji, and U Thet Htun, for assistance in the field; Dr. Philip Oswald and Dr. Alain Touwaide for the Latin diagnoses; and especially Prof. Kai Larsen for his many contributions to our understanding of the taxonomy of the family Zingiberaceae.

Funding support was provided by a research grant from the Department of Science and Technology, Govt. of India, New Delhi (SP/SO/PS/115/2009), a Senior Research Fellowship awarded by the Council of Scientific and Industrial Research (CSIR), New Delhi, (9/43(0138)2K9-EMR I), and the Smithsonian Institution. All are gratefully acknowledged.

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New species of *Solanum* (Solanaceae) from Peru and Ecuador

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Academic editor: W. John Kress | Received 26 August 2010 | Accepted 13 October 2010 | Published 1 November 2010

Citation: Knapp S (2010) New species of *Solanum* (Solanaceae) from Peru and Ecuador. PhytoKeys 1: 33–51. doi: 10.3897/phytokeys.1.659

Abstract

Three new species of “non-spiny” *Solanum* are described from Peru and Ecuador, and a revised description for *Solanum verecundum* M.Nee is presented. *Solanum kulliwaita* S.Knapp, **sp. nov.** (Dulcamaroid clade) is endemic to the Department of Cuzco in southern Peru, and is most similar to the recently described *Solanum sanchez-vegae* S.Knapp of northern Peru. *Solanum dillonii* S.Knapp, **sp. nov.** (Brevantherum clade) is found in southern Ecuador and northern Peru in the Amotape-Huancabamba phytogeographic zone, and is morphologically similar to the widespread *Solanum riparium* Ruiz & Pav. *Solanum oxapampense* S.Knapp, **sp. nov.**, (also of the Brevantherum clade) is endemic to the Oxapampa region (Department of Pasco) of central Peru, and is similar to and segregated from *Solanum verecundum* M.Nee of Peru and Ecuador. Complete descriptions, distributions and preliminary conservation assessments of all new species are given.

Keywords

Amotape-Huancabamba zone, Andes, Ecuador, endemism, conservation, nightshades, Peru, *Solanum*

Introduction

Solanum L., with ca. 1500 species, is the largest genus in the Solanaceae and one of the ten most species-rich genera of flowering plants (Frodin 2004). The highest species diversity in the genus occurs in South America, and is concentrated in the Andes (Knapp 2002). As part of the collaborative project PBI *Solanum*: a world--wide treatment (see Knapp et al. 2004, <http://www.solanaceaesource.org>), descriptions of all

species of *Solanum* are being provided on-line. This intensity of work in the genus by a large number of collaborators, along with the massive increase in specimens available from the Andean regions of South America and intensive work in the undetermined collections of herbaria worldwide has meant that species limits are being re-evaluated using modern methods (e.g., Spooner et al. 2008, Ames and Spooner 2010) and many new taxa are being discovered, both in the field and in herbaria (see Chiarini 2004, Knapp 2005, Peralta et al. 2005, Anderson et al. 2006, Granados-Tochey and Orozco 2006, Nee et al. 2006, Granados-Tochey et al. 2007, Knapp 2007, 2008, Knapp and Nee 2009, Stern and Bohs 2009, Tepe and Bohs 2009, Knapp 2010). In addition, the intensive global monographic project, in conjunction with a commitment by the botanical community to achieving Targets 1 (a global plant species checklist) and 2 (preliminary conservation assessments for all known plant species) of the *Global Strategy for Plant Conservation* (GSPC; Secretariat of the CBD 2002), means that recognition and description of endemic or near endemic taxa or those facing a significant conservation threat is particularly timely.

Recent intensive collecting in Peru, coupled with targeted collecting by members of the PBI project team and work in many herbaria has uncovered several new species from Peru and adjacent Ecuador and necessitated the revision of the circumscription of *Solanum verecundum* M.Nee from which one of these new taxa is segregated. Two of these are endemic to Peru and one to the recently defined highly diverse Amotape-Huancabamba phytogeographic zone (Weigend 2002, Stern et al. 2009) straddling the border of Peru and Ecuador. All of these taxa have been assessed for conservation status using the ArcGIS software described in Moat (2007) which uses a combination of extent of occurrence (EOO), a measure of geographic spread as a polygon, and AOO (area of occurrence), a measure of distribution based on number of occurrences. For calculation of the AOO I have used both a cell size of 0.04 km² as recommended by Moat (2007) and of 2 km² as recommended by IUCN (2001). Coordinates are presented in square brackets if calculated from maps; otherwise they are given as written on specimen labels.

Taxonomic treatments

Dulcamaroid clade

Members of the Dulcamaroid clade (sensu Bohs 2005, Weese and Bohs 2007) have terminal and usually highly branched inflorescences, pedicels arising from small pegs on the inflorescence rachis and a vine-like habit. The clade is sister to the black night-shades (Morelloids, including members of *Solanum* section *Solanum*), and contains 50 species of woody and semi-woody vines and lax shrubs. Four of these species are from Eurasia (including the widespread weed *Solanum dulcamara* L.), four are from North America (including Mexico) and the rest are from Central and South America, with centers of diversity in the Andes and southeastern Brazil.

***Solanum kulliwaita* S.Knapp, sp. nov.**

urn:lsid:ipni.org:names:77107687-1

Fig. 1

Species nova Solano sanchez-vegae *mihi similis, sed foliis ad apicem acuminatis, inflorescentibus et floribus glandularibus, trichomatibus uniseriatis simplicibus differt.*

Type. Peru: Cusco: Prov. La Convención, Dist. Ocobamba, Mesa Pelada, 12°54'13"S, 72°37'06", 2613 m, 23 March 2004, L. Valenzuela, E. Suclli & G. Calatayud 3163 (holotype: USM!; isotypes: AMAZ, CUZ, MO!, MOL, NY! [NY00824906]).

Description. Woody vine or scandent shrub, height unknown, the branches arching. Stems sparsely pubescent with simple uniseriate multicellular trichomes 0.5–1 mm long, glabrescent, slightly winged from the decurrent leaf bases; new growth pubescent with simple or occasionally branched uniseriate trichomes 0.5–1 mm. Bark of older stems dark reddish brown, shiny. Sympodial units plurifoliate. Leaves simple, (2-)3.5–8.5 cm long, 1–3 cm wide, narrowly elliptic to lanceolate, slightly fleshy, the upper surfaces sparsely pubescent with simple or occasionally furcate or branched trichomes on the lamina, more densely pubescent on the midvein, the lower surfaces glabrous or with a few scattered simple uniseriate trichomes along the midvein; primary veins 7–9 pairs, often drying blackish brown; base acute to attenuate; margins entire, sometimes revolute, densely pubescent in the basal quarter to third with simple trichomes extending from the petiole; apex acute; petioles 0.7–2 cm long, densely pubescent along the adaxial groove with golden simple or occasionally furcate uniseriate trichomes, not apparently twining. Inflorescences terminal or appearing lateral, 9–11 cm long, 3–5 times branched, with 10–20 flowers, densely pubescent with simple uniseriate trichomes mostly 0.3–0.5 mm long, some longer and to 1 mm, purple in live plants and retaining pigmentation in dried material, the cells of the trichomes small and weak-walled, usually collapsing and tangled, the lateral cell walls dark-pigmented, the terminal cells spheroidal and apparently glandular; peduncle 1.5–3.5 cm long; pedicels 1–1.2 cm long, ca. 0.5 mm in diameter at the base, ca. 1 mm in diameter at the apex, slender, erect to nodding, densely pubescent like the inflorescence axes, articulated at the base and inserted into a short sleeve or above the base and leaving a peg ca. 2 mm long; pedicel scars irregularly spaced 0.5–5 mm apart, usually grouped. Buds ellipsoid, the corolla strongly exserted from the calyx tube before anthesis. Flowers all perfect, 5-merous. Calyx tube 2–2.5 mm long, cup-shaped, narrowing gradually to the pedicel, the lobes 2.5–3.5 mm long, the lower portion broadly deltate, the distal part an apiculate tip to 2 mm long, densely pubescent with simple uniseriate trichomes like those of the inflorescence axes abaxially, these apparently glandular, the adaxial surface glabrous. Corolla 2.3–2.5 cm in diameter, purple, stellate, lobed 2/3 to 3/4 of the way to the base, the lobes 9–12 mm long, 4–5 mm wide, spreading, the tips and margins densely pubescent on the abaxial surface with weak, collapsing simple uniseriate trichomes like those of the inflorescence, but smaller and not apparently glandular. Filament tube minute, the free portion of the filaments 1–2 mm long,



Figure 1. Isotype specimen of *Solanum kulliwaita* S.Knapp. (Valenzuela et al. 3163, NY [NY00824906]). Specimen image reproduced with the permission of The C. V. Starr Virtual Herbarium of The New York Botanical Garden (<http://sciweb.nybg.org/science2/VirtualHerbarium.asp>).

glabrous; anthers 3.5–4.5 mm long, 1–1.5 mm wide, ellipsoidal, loosely connivent, yellow, poricidal at the tips, the pores lengthening to slits with age. Ovary glabrous; style 7–8 mm long, glabrous; stigma capitate, the surface minutely papillose. Fruit a globose berry, ca. 1 cm in diameter (immature?), black when ripe, the pericarp thin, not shiny, glabrous; fruiting pedicels 1.5–1.7 cm long, ca. 1.5 mm in diameter at the base, woody, more or less nodding. Seeds not known.

Distribution. Endemic to the valley of the Río Urubamba in the Department of Cusco in southern Peru (Fig. 2).

Ecology. Both collections are from montane cloud forests of the eastern slopes downriver from Machu Picchu in a locality broadly known as Mesa Pelada, from 2400–2600 m.

Etymology. Named for the flower and trichome colour – kulli = purple; waita = flower in Quechua.

Preliminary conservation status. Known only from two collections in a very narrow geographical area outside any protected area, *Solanum kulliwaita* is assessed as Data Deficient for EOO and AOO (due to there not being 3 collection points with which to calculate the polygon: Moat, 2007); using the cell size of 2 km², however, is assessed as Critically Endangered (IUCN 2001) with an AOO of 8.

Specimen examined. Peru: Cusco: Prov. La Convención, Dist. Maranura, Mesapelada, 12°54'33"S, 72°37'06"W m, 2450 m, 19 April 2004, W. Galiano, E. Suclli, P. Núñez, A. Rodríguez & V. Chama 6137 (CUZ, MO, NY! [NY00824933], USM).

Discussion. *Solanum kulliwaita* is most similar morphologically to *S. sanchez-vegae* S.Knapp from northern Peru; both species have large, purple flowers and simple leaves. It can be distinguished from the latter species by its leaves that are glabrous beneath and with a dense covering of uniseriate trichomes on the adaxial surface of the petiole, the ciliate lower leaf margins and the distinctive uniseriate glandular trichomes of the inflorescence. *Solanum sanchez-vegae* has larger, fleshier leaves with loose dendritic trichomes and the trichomes of the inflorescence are both non-glandular and dendritic. The inflorescence trichomes of *S. kulliwaita* are unusual in members of the Dulcamaroid clade in having three globular cells at the apex and in drying purple (and being purple in live plants, fide Valenzuela et al. 3163). Trichomes on the rest of the plant (i.e., leaves and stems) are not glandular.

Brevantherum clade

Members of the Brevantherum clade (sensu Bohs 2005, Weese and Bohs 2007) are trees, shrubs and herbs with stellate or modified stellate (see Roe 1971, Stern and Bohs 2009) trichomes and oblong to ellipsoid (never tapered) anthers. The two new species described here belong to the group previously recognised as section *Brevantherum* Seithe (Roe 1967, 1972), distinguished by plurifoliate, dichasial sympodial units and erect, terminal, many-branched inflorescences.

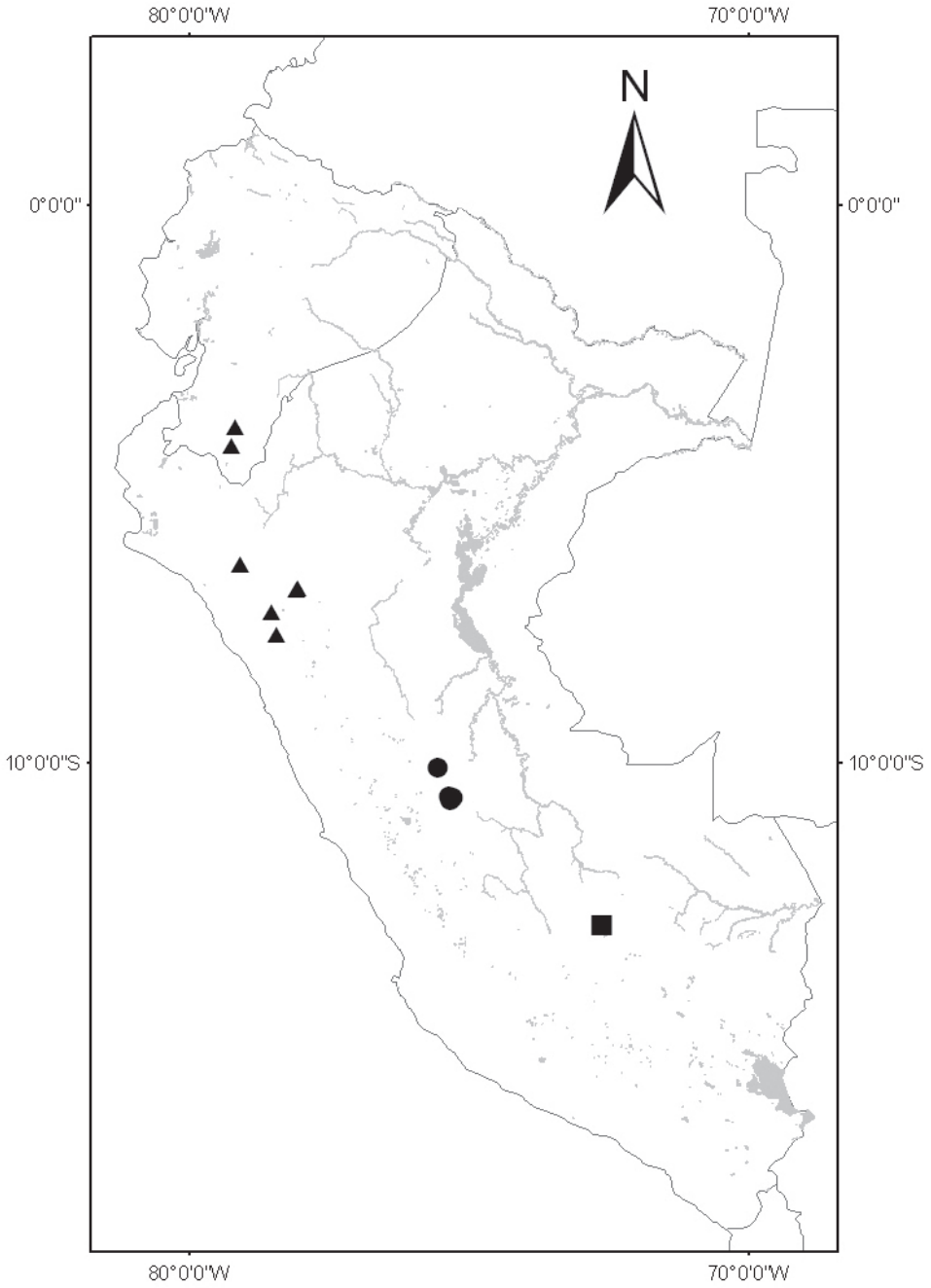


Figure 2. Distribution of *Solanum kulliwaita* (circles), *S. dillonii* (triangles) and *S. oxapampense* (squares).

***Solanum dillonii* S.Knapp, sp. nov.**

urn:lsid:ipni.org:names:77107688-1

Fig. 3

Species nova Solano ripario Ruiz & Pav. *similis, sed trichomatibus multangulatis vel echinatis longistipitatis, foliis ad basibus acutis, floribus violaceis, differt.*

Type. Peru: Cajamarca: Prov. Celendin, on road from Celendin to Balsas, east of pass on descent to Balsas, 2002 m, 6°52'13"S, 78°30'91"W, 12 December 2007, S. Stern, E. Tepe, S. Leiva & M. Zapata 119 (holotype: USM!; isotypes: BM! [BM001016881], HAO†, NY! [NY 00986687], UT!).

Description. Shrub or small tree, 4–8 m tall, branching in the upper part of the stems. Stems densely pubescent with multangulate to echinoid trichomes on multiseriate stalks 0.5–1 mm long, the rays > 12, 0.2–0.3 mm long, glabrescent; new growth densely pubescent with multangulate to echinoid trichomes on multiseriate stalks 0.5–1 mm long like those of the stems, greyish white. Bark of older stems reddish brown. Sympodial units plurifoliate, the branching dichasial. Leaves simple, 12–30 cm long, 4.5–16 cm wide, elliptic to broadly elliptic, discolorous, the upper surfaces evenly and moderately pubescent with 1–3-rayed sessile stellate trichomes, the rays 0.3–1 mm long, the trichome bases bulbous, the lamina clearly visible, the lower surfaces densely pubescent with of multangulate to echinoid trichomes on multiseriate stalks 0.5–1.5 mm long, the rays 10–16, to 1 mm long, these mixed with porrect-stellate trichomes with 8–10 rays on multiseriate stalks to 1 mm long, and sessile echinoid trichomes with weak rays to 0.3 mm long, the lamina not visible; primary veins 9–11 pairs, the veins drying yellowish green above, not visible beneath; base acute; margins entire, plane; apex acute; petioles 1.5–3 cm long, densely pubescent with multangulate to echinoid trichomes like those of the stems and leaf undersurfaces. Inflorescences terminal, 15–20 cm long, many times branched, with 100+ flowers, densely pubescent with multangulate trichomes of many sizes, the largest to 0.18 mm in diameter, on multiseriate stalks to 1.5 mm, some smaller and sessile; peduncle 7–10 cm long; pedicels 7–9 mm long, ca. 2 mm in diameter at the base, 2.5–3 mm in diameter at the apex, stout, nodding at anthesis, densely pubescent like the inflorescence axes, articulated at the base; pedicel scars closely spaced ca. 1 mm apart. Buds globose, the corolla scarcely exerted from the calyx tube before anthesis. Flowers all perfect, 5-merous. Calyx tube 3–3.5 mm long, cup-shaped, narrowing gradually to the pedicel, the lobes 2.5–3 mm long, deltate, densely pubescent abaxially with multangulate to echinoid trichomes like those of the inflorescence rhachis, these more sessile distally, the adaxial surface sparsely pubescent with sessile echinoid trichomes. Corolla 1.3–1.5 cm in diameter, purple, stellate, lobed ca. $\frac{3}{4}$ of the way to the base, the lobes 6–7 mm long, 3.5–4.5 mm wide, reflexed or spreading at anthesis, the tips and margins densely pubescent on the abaxial surface with sessile or short-stalked multangulate to echinoid trichomes with >10 rays like those of the inflorescence, the adaxial surface glabrous or with a few echinoid trichomes near the apex on the midvein. Filament tube minute, the free portion of the filaments 2.5–3 mm long, glabrous; anthers 3–3.5 mm long, ca. 1 mm



Figure 3. Isotype specimen of *Solanum dillonii* S.Knapp. (Stern et al. 119, NY [NY00986687]). Specimen image reproduced with the permission of The C. V. Starr Virtual Herbarium of The New York Botanical Garden (<http://sciweb.nybg.org/science2/VirtualHerbarium.asp>).

wide, ellipsoidal, loosely connivent, yellow, poricidal at the tips, the pores lengthening to slits with age. Ovary densely pubescent with multangulate trichomes; style 9–9.5 mm long, sparsely pubescent along its entire length with multangulate trichomes with 4–8 rays; stigma clavate, the surface minutely papillose. Fruit a globose berry, 1–1.5 cm in diameter, dark green when ripe, the pericarp thin, not shiny, unevenly pubescent with sessile or short-stalked multangulate trichomes with rays of many varying lengths, the longest rays ca. 1 mm long; fruiting pedicels 1.2–1.5 cm long, ca. 3 mm in diameter at the base, woody, more or less erect. Seeds >200 per berry, 1.5–2 mm long, 1–1.5 mm wide, flattened-reniform, reddish or golden brown, the surfaces minutely pitted.

Distribution. Southern Ecuador (Prov. Loja) and northern Peru (Dept. Cajamarca), in the Amotape-Huancabamba phytogeographic zone (see Weigend 2002, 2004) (Fig. 2).

Ecology. Tropical moist forest along the western slopes of the Andes and the valley of the Río Marañón, from 1500–2200 m. Often found along roads and small streams in secondary situations.

Etymology. Named in honor of Michael O. Dillon, recently retired from the Field Museum of Natural History in Chicago, who has devoted much time and energy to the understanding of the flora of northern Peru and whose efforts collecting in the Monteseco region helped define the extent of this species' distribution.

Preliminary conservation status. *Solanum dillonii* is relatively widely distributed in the Amotape-Huancabamba region, and has an EOO of 22,492 km², giving a status of possible Near Threatened, and an AOO (with cell size of 0.04 km²) of 10,541 km², giving a status of Least Concern (IUCN 2001). Using a cell size of 2 km² gives an AOO of 28 km², resulting in an assessment of Endangered. Given that the species is of a partially secondary nature, growing in disturbed areas and along roads, I feel the status of possibly Near Threatened is the most realistic assessment for *S. dillonii*, but more collecting with population assessment will help refine this.

Specimens examined. **Ecuador:** Loja: Vilcabamba-Yangana road km 1–3, 1500–1600 m, 4°18'S, 79°14'W, 29 October 1984, P.M. Jørgensen 56267 (AAU, BM [BM001012348], QCA); ca. 7 km E of Catamayo on the road to Loja, ca. 1700 m, 3°28'S, 79°10'W, 6 February 1984, S. Knapp & J. Mallet 6258 (BH, QCA, NY [NY00829072], US). **Peru:** Cajamarca: Prov. Santa Cruz, Dist. Catache, upper Río Zaña valley, ca. 5 km above Monte Seco on path to Chorro Blanco, 1500–2000 m, [6°52'S, 79°05' W], 16–18 March 1986, M.O. Dillon, A. Sagástegui A., D. Dillon, P. Alcorn, J. Santisteban, S. Leiva, C. Téllez & M. Guzmán 4379 (BM [BM000849416], F [F-1993682], NY [NY00829133]); Prov. Santa Cruz, ca. 3 km por aire ENE Monteseco, 1800 m, [6°52'S, 79°05' W], 31 May 1987, J. Santisteban C. & J. Guevara B. 125 (BM, NY [NY00829131]); Prov. Celendin, Marañón River valley, Chachapoyas-Cajamarca road, 1900–2100 m, [6°51'S, 78°04'W], 28 May 1984, D.N. Smith & J. Cabanillas 7257 (MO [MO-5294201], NY [NY00829129]); Prov. Cajamarca, Dist. San Juan, 2 km before town of San Juan, on road from Casamayo to Cajamarca, km 139 about 143 km southeast of Cajamarca, 2215 m, 7°17'08"S, 78°30'91"W, S. Stern, E. Tepe, S. Leiva & M. Zapata 109 (BM [BM001016880], HAO†, NY [NY00986682], USM, UT). La Libertad: Prov. Otuzco, alrededores de Huaranchal,

2140 m, [7°41'21"S, 78°26'51"W], 6 February 1999, A. Sagástegui, S. Leiva & V. Quipuscoa 11608 (BM [BM000935134]).

Discussion. *Solanum dillonii* is superficially similar to the widespread *S. riparium* Ruiz & Pav. and to the more southerly *S. conglobatum* Dunal. It differs from *S. riparium* in its violet flowers, acute leaf bases and pubescence; both stem and leaf trichomes of *S. dillonii* are very long-stalked and multangulate, while those of *S. riparium* are sessile and tend to have more rays (tending to echinoid sensu Roe 1971). Both species have some porrect-stellate trichomes on the lower leaf surfaces. *Solanum riparium* occurs in a wide variety of tropical and premontane forests of the eastern Andean slopes, and *S. dillonii*, while to some extent (in the Río Marañón valley) sympatric with it, is a plant of the moist to dry forests of the western Andean slopes and inter-Andean valleys in the Amotape-Huancabamba phytogeographic zone (Weigend 2002, 2004). *Solanum dillonii* is the species referred to as "*S. erianthum* vel. aff." in the checklist of the Monte Seco forest fragment (Sagástegui and Dillon 1991). *Solanum dillonii* has also been misidentified as *S. conglobatum*, a species of dry forests from southern Peru and Bolivia. It is similar to *S. conglobatum*, with few-rayed trichomes on the upper leaf surfaces and dense abaxial leaf pubescence, but differs from that species in having multangulate rather than porrect-stellate trichomes abaxially and in not having an accrescent calyx in fruit.

Solanum dillonii is another species endemic to the Amotape-Huancabamba phytogeographic zone (Weigend 2002, 2004); this region has been highlighted as a center of species richness and endemism in the Geminata clade (see Knapp 2002, Stern et al. 2009) of *Solanum*. The area is not only home to many endemics, such as *S. dillonii*, but is a zone of considerable overlap between northern and southern taxa.

***Solanum oxapampense* S.Knapp. sp.nov.**

urn:lsid:ipni.org:names:77107689-1

Fig. 4

Species nova Solano verecundo *M.Nee similis, sed foliis coriaceis superne nitidibus, subtus valde pubescentibus, trichomatibus peltatis, differt.*

Type. Peru: Pasco: Prov. Oxapampa, Oxapampa-Villa Rica road, 7 km from road head, 2120 m, 10°36'S, 75°20'W, 4 January 1984, D.N. Smith & J. Albán 5558 (holotype: USM! [USM-123391]; isotypes: MO! [MO- 5784802], NY! [NY00723838]).

Description. Treelet to small tree, 2.5–9 (–18) m tall, branching in the upper part of the stems. Stems densely pubescent with persistent short-stalked peltate trichomes 0.2–0.4 mm in diameter, the rays 20–30, fused for almost their entire length, the mid-point absent, the trichome center dark reddish brown; new growth densely pubescent with peltate trichomes like those of the stems, drying pale beige. Bark of older stems pale brownish tan from the persistent trichomes. Sympodial units plurifoliate, the branching dichasial. Leaves simple, 6.5–16 cm long, 2–5 cm wide, narrowly elliptic, coriaceous, strongly discoloured, the upper surfaces glabrous and shiny, dark green when fresh, drying dark olive green, the lower surfaces densely pubescent with short-stalked peltate



Figure 4. Isotype specimen of *Solanum oxapampense* S.Knapp. (Smith & Albán 5558 NY [NY00723838]). Specimen image reproduced with the permission of The C. V. Starr Virtual Herbarium of The New York Botanical Garden (<http://sciweb.nybg.org/science2/VirtualHerbarium.asp>).

trichomes to 0.5 mm in diameter with >20 rays, subtended by a dense layer of tangled sessile echinoid trichomes ca. 0.1 mm long, the lamina not visible; primary veins 16–20 pairs, deeply impressed above, densely covered by pubescence beneath; base acute; margins entire, revolute; apex acute to acuminate; petioles 0.6–2 cm long, densely pubescent with peltate trichomes like those of the stems and leaf undersurfaces. Inflorescences terminal, 8–15 cm long, many times branched, with 60+ flowers, densely pubescent with peltate trichomes like those of the stems; peduncle 3–6 cm long; pedicels 5–8 mm long, ca. 1.5 mm in diameter at the base, ca. 2 mm in diameter at the apex, stout, nodding at anthesis, densely pubescent like the inflorescence axes, articulated at the base; pedicel scars closely and more or less regularly spaced ca. 1 mm apart. Buds globose, the corolla exerted about halfway from the calyx tube just before anthesis. Flowers all perfect, 5-merous. Calyx tube 1.5–2 mm long, cup-shaped, narrowing gradually to the pedicel, the lobes 1.5–2 mm long, deltate, densely pubescent abaxially with peltate trichomes like those of the inflorescence rhachis, the adaxial surface sparsely pubescent with sessile echinoid trichomes. Corolla 1.2–1.5 cm in diameter, white, stellate, lobed ca. $\frac{3}{4}$ of the way to the base, the lobes 6–7 mm long, 4–4.5 mm wide, reflexed at anthesis, the tips and margins densely pubescent on the abaxial surface with peltate trichomes with >20 rays like those of the inflorescence, the adaxial surface glabrous, the tips and margins with a few sessile echinoid trichomes. Filament tube 0.5–1 mm long, the free portion of the filaments 1–1.5 mm long, glabrous, with tiny projections ca. 0.5 mm long on edge of tube between each filament; anthers 3–4 mm long, 1–1.5 mm wide, ellipsoidal, loosely connivent, yellow, poricidal at the tips, the pores lengthening to slits with age. Ovary densely pubescent with multangulate to echinoid trichomes; style 9–9.5 mm long, densely pubescent along its entire length with multangulate to echinoid trichomes with 4–30 rays ca. 0.2 mm long; stigma capitate, the surface minutely papillose, bright green in fresh plants. Fruit a globose berry, 0.6–0.7 cm in diameter, green when ripe, the pericarp thin, not shiny, unevenly pubescent with multangulate or echinoid trichomes with rays of many varying lengths, appearing scurfy; fruiting pedicels 1–1.1 cm long, ca. 1.5 mm in diameter at the base, woody, more or less erect. Seeds 40–50 per berry, 0.9–1 mm long, 0.9–1 mm wide, flattened-reniform, reddish or golden brown, the surfaces minutely pitted, the testal cells elongate.

Distribution. Endemic to the valley of the Río Huancabamba (Río Pozuzo) in central Peru; found within the Parque Nacional Yanachaga-Chemillen (Fig. 2).

Ecology. Montane forests from 1500 to 2500 m elevation; as with many members of the *Brevantherum* group, often found along roadsides and in open areas.

Etymology. Named for the valley of Oxapampa, where this species is endemic.

Preliminary conservation status. *Solanum oxapampense* is known from only 4 localities, has an EOO of 198 km² and AOO (using a cell size of 0.04) of 195 km²; giving it a status of Endangered (IUCN 2001). If the IUCN (2001) recommended cell size is applied the AOO is reduced to 16 km²; the status remains Endangered.

Specimens examined. **Peru:** Pasco: Prov. Oxapampa, Dist. Huancabamba, camino a Pozuzo, 1200–1400 m, 10°04'02"S, 75°32'59"W, 2 June 2004, R. Rojas, M. Huaman, A. Peña & J. Mateo 2490 (MO, NY [NY00824860], USM); Prov. Oxapam-

pa, Dist. Oxapampa, Parque Nacional Yanachaga-Chemillen, Sector Chacos, 2471, 10°37'S, 75°17'W, 24 January 2004, R. Vasquez, A. Monteagudo, A. Peña & R. Francis 28939 (MO, NY[NY00829065], USM); Prov. Oxapampa, Dist. Oxapampa, Oxapampa-Villa Rica road, 2300 m, 10°39'59"S, 75°19'33"W, 22 November 2007, E. Tepe, S. Stern, J. Mateo, M.P. Moreno, R. Rojas 2227 (BM [BM001017349], USM, UT).

Discussion. *Solanum oxapampense* is a very distinctive species with its coriaceous and strongly discoloured leaves, with the upper surfaces dark green and shiny and the veins deeply impressed, and the lower surfaces densely pubescent with pale tan peltate trichomes. It is similar to *S. verecundum* M.Nee with which it is broadly sympatric, but does not apparently co-occur. *Solanum verecundum* is found along the eastern slopes of the Andes from Ecuador to southern Peru, *S. oxapampense* is possibly derived from it. The two species share trichomes that are peltate to some degree, small white flowers and small fruits (orange in *S. verecundum*, apparently green at maturity in *S. oxapampense*). *Solanum oxapampense* differs from *S. verecundum* in its coriaceous, narrower leaves and in its pubescence, which is composed of truly peltate trichomes whose rays are fused for more than half their length and that lack midpoints. Trichomes of *S. verecundum* have rays that are only fused in the central half, near the midpoint; midpoints are always present, even if sometimes very small and nub-like.

In the original description of *S. verecundum* (Nee 2000), the plant illustrated in Figure 1 is Smith & Albán 5558 the type specimen selected here for *S. oxapampense*, not Jaramillo et al. 13285, the type specimen of *S. verecundum* as indicated in the text of Nee (2000). Smith and Albán 5558 is the only specimen of the species here recognised as *S. oxapampense* to have been included in the original circumscription of *S. verecundum*; an emended description of that species excluding this element is presented below and diagnostic characters separating the two are presented above.

Neither *Solanum oxapampense* nor *S. verecundum* would have been included in section *Brevantherum* by Roe (1972) due to their possession of peltate trichomes, despite the overall habit and inflorescence morphology. Nee (2000) mentioned this in the original description of *S. verecundum* (see below). Molecular data show these groups (the traditional sections *Brevantherum* and *Lepidota* (Dunal) Seithe) to be members of the same clade, defined by having ellipsoid anthers and variations on stellate trichomes (some of which have lost the rays altogether, e.g., section *Gonatotrichum* Bitter, see Stern and Bohs 2009).

***Solanum verecundum* M.Nee**, Kurtziana 28: 137, 2000.

urn:lsid:ipni.org:names:1016242-1

Fig. 5

Type. Ecuador: Sucumbios: El Salado, colecciones en el sendero a la finca del Sr. Segundo Pacheco, 1400 m, 13 October 1990, J. Jaramillo, E. Grijalva & M. Grijalva 13285 (holotype: QCA; isotype: NY! [NY00381798]).

Description. Shrub to small tree, 4–14 m tall. Stems densely pubescent with persistent short-stalked porrect–stellate to somewhat peltate trichomes 0.2–0.3 mm in



Figure 5. Isotype specimen of *Solanum verecundum* M. Nee. (Jaramillo et al. 13258, NY [NY00381798]). Specimen image reproduced with the permission of The C. V. Starr Virtual Herbarium of The New York Botanical Garden (<http://sciweb.nybg.org/science2/VirtualHerbarium.asp>).

diameter, the rays 10–12, fused for less than half their length, the midpoint sometimes a short stub to 0.5 mm long; new growth densely pubescent with porrect-stellate trichomes like those of the stems, these drying pale golden-brown. Bark of older stems reddish gold from the persistent trichomes. Sympodial units plurifoliate, the branching dichasial. Leaves simple, 6–19 cm long, 2–10 cm wide, elliptic or narrowly elliptic, membranous or chartaceous, discolourous ("silvery beneath" fide Bohs 3361), the upper surfaces moderately and evenly pubescent with sessile and short-stalked porrect-stellate trichomes with up to 15 rays, the rays fused only in their lower part near the midpoint, the midpoint to 0.2 mm long, the lamina visible, the lower surfaces densely pubescent with short-stalked porrect-stellate trichomes to 0.4 mm in diameter with up to 16 rays, the rays fused only in the center, the midpoint to 0.05 mm long, the lamina not visible; primary veins 12–15 pairs, not markedly impressed above, densely covered by pubescence beneath; base acute to somewhat attenuate onto the petiole; margins entire, plane; apex acute to acuminate; petioles 1–1.3(–4) cm long, densely pubescent with porrect-stellate to peltate trichomes like those of the stems. Inflorescences terminal, 7–10 cm long, many times branched, with 100+ flowers, densely pubescent with porrect-stellate to peltate trichomes like those of the stems; peduncle 2–5 cm long; pedicels 5–6 mm long, 1–1.5 mm in diameter at the base, ca. 1.5 mm in diameter at the apex, stout, nodding at anthesis, densely pubescent like the inflorescence axes, articulated at the base; pedicel scars closely and more or less regularly spaced ca. 1 mm apart. Buds globose, the corolla strongly exerted from the calyx tube just before anthesis. Flowers all perfect, 5-merous. Calyx tube 1–1.5 mm long, cup-shaped, narrowing gradually to the pedicel, the lobes 1–1.5 mm long, deltate, abaxially densely pubescent with porrect-stellate to slightly peltate trichomes like those of the inflorescence, the adaxial surface sparsely pubescent with sessile porrect-stellate trichomes. Corolla 1–1.2 cm in diameter, white, stellate, lobed ca. $\frac{3}{4}$ of the way to the base, the lobes 4–5 mm long, 2–2.5 mm wide, reflexed at anthesis, the tips and margins densely pubescent on the abaxial surface with porrect-stellate trichomes with ca. 10 rays like those of the inflorescence, the adaxial surface glabrous, the tips and margins with a few sessile porrect-stellate trichomes. Filament tube minute, the free portion of the filaments ca. 1 mm long, glabrous; anthers 2.5–3 mm long, ca. 1 mm wide, ellipsoidal, loosely connivent, yellow, poricidal at the tips, the pores lengthening to slits with age. Ovary densely pubescent with multangulate to porrect-stellate trichomes; style 6–6.5 mm long, densely pubescent along its entire length with porrect-stellate 4–6-rayed trichomes ca. 0.2 mm long, the midpoints elongate and equal to the rays; stigma capitate, the surface minutely papillose. Fruit a globose berry, 0.5–1 cm in diameter, bright orange when ripe, the pericarp thin, not shiny, unevenly pubescent with multangulate trichomes with rays of many varying lengths, appearing scurfy; fruiting pedicels 0.9–1 cm long, 1.5–2 mm in diameter at the base, woody, erect. Seeds >100 per berry, 1–1.5 mm long, 1–1.5 mm wide, flattened-reniform, pale golden-yellow, the surfaces minutely pitted, the testal cells square.

Distribution. Along the eastern slopes of the Andes from northern Ecuador to southern Peru (to the Department of Cuzco; see Nee, 2000 for a distribution map).

Ecology. *Solanum verecundum* occurs in premontane and montane forests, primarily in secondary growth ("purma") and along roads, from 1200–2000 m.

Preliminary conservation status. *Solanum verecundum* is a relatively common species with a broad distribution along the eastern slopes of the Andes and can be considered of Least Concern (IUCN 2001).

Specimens examined. **Ecuador:** Napo: road Baeza-Tena, 8 km from Baeza, towards Río Cosanga, 1800–1900 m, 0°31'S, 77°50'W, 28 October 1976, H. Balslev & E. Madsen 10400 (BM [BM000935121]). Zamora-Chinchipe: road between El Progreso and Guaramizal, ca. halfway to Guaramizal, 1430 m, 4°48'23"S, 79°07'26"W, 28 March 2005, L. Bohs, J.L. Clark, J.R. Bennett, N. León et al. 3324 (BM [BM000846206]); Cantón Chinchipe, Parroquia Zumba, trail from Guaramizal to cabin of Sandy León, W of Escuela Byron Jiménez, just S of Las Pircas, 1600 m, 4°46'21"S, 79°10'36"W, 30 March 2005, L. Bohs, J.L. Clark, J.R. Bennett, N. León et al. 3361 (BM [BM000846204]); Cantón Valladolid, Parroquia Valladolid, road between Valladolid and El Porvenir del Carmen, close to Tapala, 1600–1680 m, 4°32'45"S, 79°06'08"W, 1 April 2005, L. Bohs, J.L. Clark, J.R. Bennett & N. León 3381 (BM [BM000846226]); Palanda, region de la Cordillera del Condor, Parroquia San Francisco de Vergel, riberas del Río Vergel, entre Santa Rosa y La Canela, 1200 m, 4°39'07"S, 79°01'41"W, 6 March 2007, W. Quizhpe & A. Wisum 2492 (BM [BM000943415]). Peru. Cajamarca: Prov. San Ignacio, San José de Lourdes, entre Camaná y Santo Tomás, 1800–1870 m, 5°01'00"S, 78°52'W, 8 April 1997, J. Campos & S. Corrales 3801 (BM [BM000846199]); Prov. San Ignacio, San José de Lourdes, caserio Rumichina, 1679 m, 5°49'09"S, 78°17'04"W, 30 June 2006, J. Perea & V. Flores 2508 (BM [BM000943431]). Huánuco: Prov. Ambo, 38 km from Tingo Maria, between Tingo Maria and Pucallpa, 1680 m, 4 August 1978, J. Aronson & P. Berry 618 (BM [BM000795484]).

Discussion. As mentioned above, the original description of *S. verecundum* (Nee 2000) included one specimen here segregated as *S. oxapampense*. The taxa differ in a suite of characters, detailed above in the discussion of *S. oxapampense*, but are easy to distinguish by leaf morphology; the leaves of *S. oxapampense* are coriaceous and shiny above while those of *S. verecundum* are membranous or chartaceous and pubescent above. These stellate trichomes cause the leaves to be asperous to the touch on dry specimens. The stellate trichomes of *S. verecundum*, while somewhat peltate like those of *S. oxapampense*, never have the rays fused for more than half their length, and always bear midpoints, even if these are quite tiny. Nee (2000) pointed out the morphological similarity between *S. verecundum* and the similarly widespread *S. lepidotum* Dunal and *S. schlechtendalianum* Walp. The latter two taxa have more lateral inflorescences that are not borne on erect peduncles. *Solanum lepidotum* and *S. schlechtendalianum* show a similar pattern of hair diversity to *S. verecundum* and *S. oxapampense*; each species pair has one member with porrect-stellate trichomes with the rays not fused (*S. schlechtendalianum* and *S. verecundum*) and one with peltate trichomes (*S. lepidotum* and *S. oxapampense*). Taxonomists working with primarily morphological data have traditionally recognised different sub-groupings for taxa with stellate and peltate trichomes (Seithe

1962, Carvahlo 1996, Nee 1999), but molecular data (Bohs 2005, Weese and Bohs 2007) suggest a more complex situation.

Acknowledgments

I thank the C. V. Starr Virtual Herbarium of The New York Botanical Garden (<http://sciweb.nybg.org/science2/VirtualHerbarium.asp>) for permission to use images of specimens in their care; Kim Watson (NY) for scanning images of NY sheets; Guy Atchison (BM) for the map and for performing the conservation assessments; Michael Nee (NY) and Lynn Bohs (UT) for many long discussions about *Solanum* taxonomy; Nroman Robson (BM) for help with Latin; Eric Rodriguez (HUT), Asunción Cano and Maria Isabel Torre (both USM) for checking the holdings of herbaria in Peru; and the curators of the herbaria mentioned in the text for permission to examine specimens in their care; this work was funded by the National Science Foundation's Planetary Biodiversity Inventory (PBI) Program (DEB-0316614).

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Two new species of *Solanum* (Solanaceae) from the Amotape-Huancabamba Zone of southern Ecuador and northern Peru

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Academic editor: *Sandra Knapp* | Received 31 August 2010 | Accepted 8 October 2010 | Published 1 November 2010

Citation: Stern S, Bohs L (2010) Two new species of *Solanum* (Solanaceae) from the Amotape-Huancabamba Zone of southern Ecuador and northern Peru. *PhytoKeys* 1: 53–65. doi: 10.3897/phytokeys.1.660

Abstract

Two new species of *Solanum* subgenus *Leptostemonum* from southern Ecuador and northern Peru are described here. *Solanum rubicaule* S.Stern, **sp. nov.**, is a member of sect. *Torva* and is characterized by a festooning, scandent growth form and fruits held horizontally on recurved pedicels. *Solanum achorum* S.Stern, **sp. nov.**, is a member of sect. *Erythrotrichum* and is characterized by 4–12-flowered inflorescences, small seeds, and a small calyx. Both species are distributed in the Amotape-Huancabamba Zone of the Andes in northern Peru and southern Ecuador.

Resumen

Se describen aquí dos especies nuevas de *Solanum* subgenero *Leptostemonum* del sur de Ecuador y el norte de Peru. *Solanum rubicaule* S.Stern, **sp. nov.**, es un miembro de la sección *Torva* y se la caracteriza por su hábito escandente y frutos sostenidos laterales por pedicelos recurvados. *Solanum achorum* S.Stern, **sp. nov.**, es un miembro de la sección *Erythrotrichum* y se la distingue por inflorescencias con pocas flores, semillas pequeñas, y un cáliz pequeño. Ambas especies ocurren en la zona Amotape-Huancabamba en los Andes del norte de Peru y el sur de Ecuador.

Keywords

Amotape-Huancabamba Zone, Andes, Ecuador, Huancabamba Depression, new species, Peru, *Solanum*

Introduction

The Amotape-Huancabamba Zone of northern Peru and adjacent southern Ecuador, also known as the Huancabamba Depression due to the low summits of the Andes in this area, is one of the most biodiverse regions of the neotropics (Berry 1982, Ayers 1999, Weigend 2002, 2004, Stern et al. 2008). Its diversity can be attributed to a number of factors including the heterogeneity of its topography, vegetation, geological substrate, and climate. The complex topography, resulting from the Andes dissected by the Huancabamba, Marañón, and Utcubamba rivers, is likely the most important factor influencing its biodiversity, with the mountains and rivers creating a mosaic of isolated valleys and habitat fragments that promotes speciation (Panero 1992, Weigend 2002). This region is a hotspot of endemism for selected groups of *Solanum* (Knapp 2002a). Recent collecting trips to this area have yielded a vast number of *Solanum* specimens including the two species described here.

Both of these new species belong to *Solanum* subgenus *Leptostemonum* (Dunal) Bitter, a group characterized by long, attenuate anthers, stellate hairs, and epidermal prickles. An extensive phylogenetic study of this group resolved subgenus *Leptostemonum* as monophyletic and delimits 12 to 15 major subclades (Levin et al. 2006, Weese and Bohs 2007). The two species described here are both difficult to place within the subgenus using morphological features because they share characteristics with multiple groups. Therefore, DNA sequences were obtained from these two species and analyzed using the methods and framework phylogeny of Levin et al. (2006) to confirm their relationship to other members of *Solanum* subgenus *Leptostemonum*. One of the species described here, *Solanum rubicaule* S.Stern, has morphological and molecular characters that place it in *Solanum* section *Torva* Nees. This group contains approximately 40–50 species of erect or scandent shrubs or small trees typically with branched inflorescences, straight or recurved spines, and triangular corolla lobes with abundant tissue between the petals (interpetalal tissue).

The second new species, *Solanum achorum* S.Stern, belongs to *Solanum* section *Erythrotrichum* Child. This group has approximately 23 species and is characterized by plurifoliate sympodial units (see Knapp 2002b for description of sympodial units in *Solanum*), recurved prickles, a ferruginous to reddish tomentum with stellate-glandular hairs, and large berries with a pubescent exocarp (Agra 2008).

Morphological and molecular work has revealed *S. rubicaule* and *S. achorum* to be distinct species within in their respective clades. (S. Stern and L. Bohs, unpubl. data).

Taxonomic treatments

Solanum section *Torva*

Solanum rubicaule S.Stern, sp. nov.

urn:lsid:ipni.org:names:77107690-1

Figs. 1–2

Solano subinermi Jacq. et *S. asperolanato* Ruiz & Pav. *similis sed a S. subinermi pedicellis fructiferis curvatis, a S. asperolanato habitu scandenti differt.*

Type. Peru: Cajamarca: Prov. San Ignacio, road from San Ignacio to El Chaupe, 2–3 km hike in from trailhead to El Chaupe, 5°11'56"S, 79°03'51"W, 1775 m, 17 December 2007 (fl, fr), S.Stern et al. 181 (holotype: USM!; isotypes: BM001016784!, HAO [destroyed], NY00986627!, NY00986637!, UT!).

Description. Scandent shrub, often festooning over other plants, 1–3 m tall. Stems armed with recurved, tan to orange roseline prickles to 3 mm in length, the base 2–3 × 0.5–1 mm, moderately to densely pubescent with tan to rusty, porrect-stellate hairs, the stalks 0.5–1 mm, multiseriate, the rays 5–10, 0.1–0.2 mm, unicellular to multicellular, the midpoints nearly absent, the lateral rays often partially proximally fused (see Roe 1971 for hair terminology). Flowering portions of stem consisting of difoliate sympodial units, the leaves usually geminate, those of a pair often slightly unequal. Leaves simple, the blades 10–13 × 5–8 cm, elliptic to ovate, chartaceous to coriaceous, discolorous, adaxially reddish brown, abaxially whitish green, the adaxial surface densely pubescent with multicellular, uniseriate glandular hairs 0.3–0.6 mm long, and stellate hairs like those of the stem but with the stalks ca. 0.2–0.6 mm, the rays 3–8, ca. 0.2–0.4 mm long, the abaxial surface densely stellate-pubescent with hairs like those of the stem but with the stalks 0.1–0.3 mm, the rays 8–12, ca. 0.2–0.4 mm long; venation pinnate, the secondary veins 5–7 on both sides of the midvein, the midrib abaxially occasionally with a few recurved spines like those of the stem; base obtuse, often asymmetrical; margin entire; apex acute; leaves subsessile to shortly petiolate (to 2 cm), the petiole moderately to densely pubescent with hairs like those of the stem, occasionally sparsely armed with recurved spines like those of the stem. Inflorescences to 12 cm, extra-axillary or subopposite the leaves, unbranched to twice branched, with 2–8 flowers, the plants andromonoecious, with male flowers on young plants and hermaphroditic flowers on older plants, the axes moderately to densely pubescent with hairs like those of the stem, unarmed; peduncle 0.5–3 cm; rachis 2–8 mm; pedicels 7–11 mm in flower, 10–20 mm in fruit, distally swollen, spaced 2–4 mm apart, articulated at the base. Flowers 5-merous. Calyx 1.2–2 cm long, the tube 2–3 mm, the lobes 12–18 × 3–6 mm, triangular, densely pubescent abaxially with hairs like those of the stem; fruiting calyx slightly accrescent, incompletely covering the fruit. Corolla 3–4 cm in diameter, chartaceous, white, stellate with moderate interpetalar tissue, lobed nearly to the base, the lobes 12–16 × 4–8 mm, narrowly triangular-ovate, slightly reflexed at an-



Figure 1. Isotype of *Solanum rubicaule* S.Stern [Stern et al. 181 (UT)].

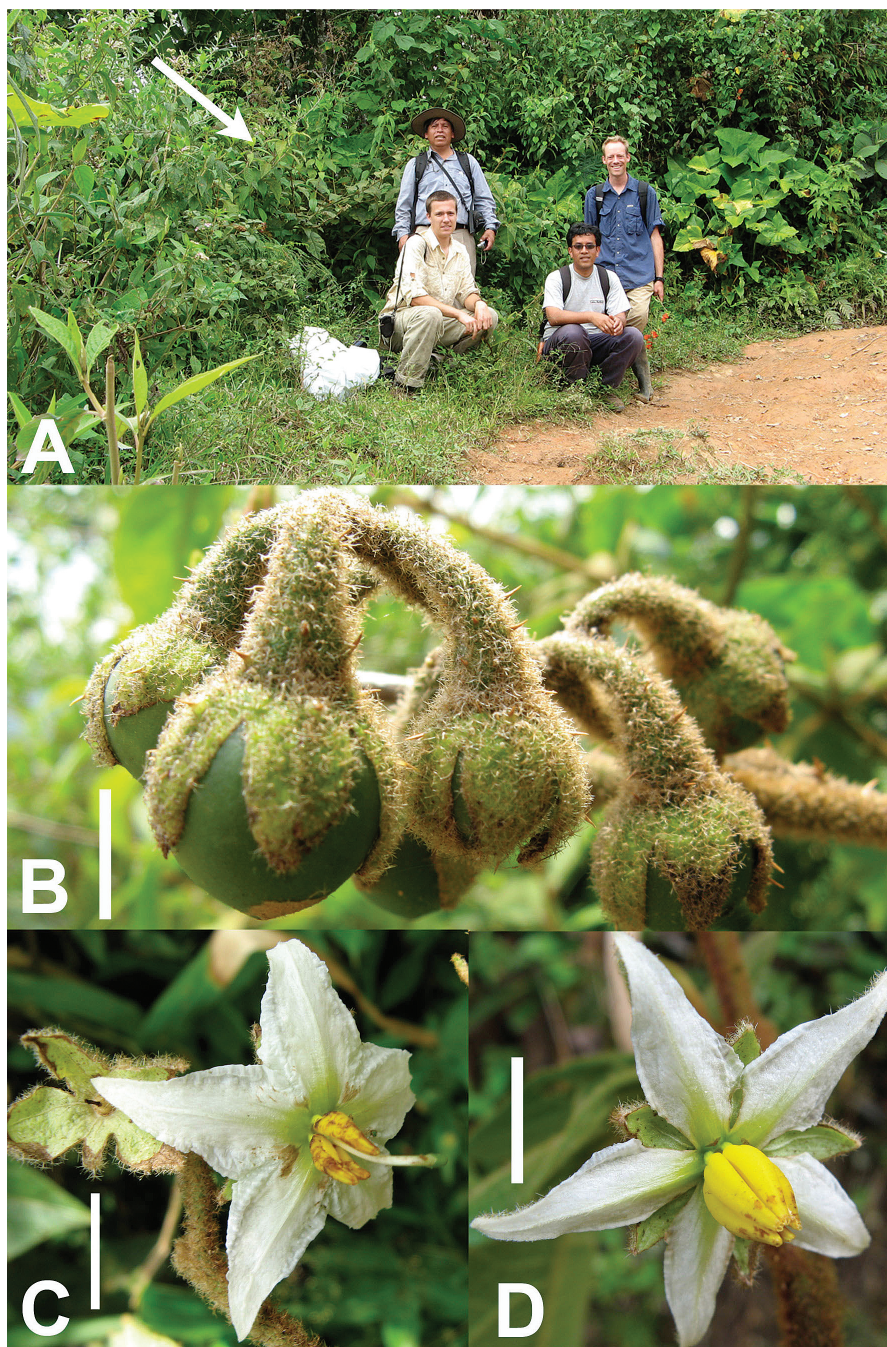


Figure 2. Photos of type collection of *Solanum rubicaule* S. Stern. **A** Collecting party in front of type collection, indicated by arrow, at trailside habitat in San Ignacio, Dept. Cajamarca, Peru (from left to right: Segundo Leiva, Stephen Stern, Mario Zapata, and Eric Tepe). **B** Fruiting inflorescence; note recurved pedicels. **C** Hermaphroditic flower. **D** Functionally male flower; note the absence of exserted style. Scale bars = 1 cm.

thesis, densely pubescent abaxially on midvein with hairs like those of the abaxial leaf surface, adaxially glabrous. Stamens 8–12 mm; filaments 1–2 mm long, glabrous; anthers 7–10 × 1–2 mm, attenuate, connivent, yellow, linear-lanceolate, tapering, the base cordate, the apex acute, with pores directed slightly introrsely, not opening into longitudinal slits. Ovary moderately stellate-pubescent with white hairs like those of the stem; style in functionally male flowers 4–7 × 0.5–1.5 mm, not exerted beyond stamens, cylindrical, glabrous; style in hermaphroditic flowers 10–14 × 0.5–1.5 mm, exerted beyond stamens, cylindrical, glabrous; stigma to 1.5 mm wide, capitate. Fruit a berry, 1–2 cm in diameter, globose with a small acute protrusion at the apex, green, hard at maturity, glabrous, the pedicels recurved down in fruit positioning the fruits horizontal to the rachis. Seeds 25–50 per fruit, reniform, brown, rugose, ca. 3 × 2.5 mm, flattened, with a small notch where connected to placenta.

Distribution. Known only from northern Peru in Dept. Cajamarca and southern Ecuador in Prov. Zamora-Chinchipe in open places in disturbed montane tropical forest, 1650–2200 m in elevation.

Ecology. The flowering specimen was collected in December. Fruiting specimens were collected in December–January and March–April.

Etymology. The name *Solanum rubicaule* is derived from the festooning growth form, reminiscent of the genus *Rubus* L. and the Latin “*caulis*” for stem.

Conservation status. According to the IUCN Red List Categories (IUCN 2010) *S. rubicaule* is classified as VU-B1a+B2a+B2biii; D2 (Vulnerable). The extent of occupancy is estimated to be approximately 10,000 km² and less than five collected locations. This area of the Amotape-Huancabamba Zone has been underexplored, but collections have increased in recent years, largely due to efforts by MO in southern Ecuador and HAO in northern Peru. As this collecting continues and more specimens are determined in herbaria the number of locations should rise. Additionally, although there is continuing decline in forest habitat in this region due to deforestation for the establishment of settlements and farming, the effects of this on *S. rubicaule* are difficult to assess because it occurs in disturbed edges of forest and roadsides.

Specimens examined. **Ecuador:** Zamora-Chinchipe: Cantón Chinchipe, Parroquia Zumba, trail from Guaramizal to cabin of Sandy León, W of Escuela Byron Jiménez, just S of Las Pircas, 4°46'60"S, 79°12'18"W, 2100 m, 28 March 2005 (fr), L.Bohs et al. 3336 (QCNE, UT); same locality, same date (fr) L.Bohs et al. 3338 (QCNE, LOJA, UT); same locality, 4°46'50"S, 79°12'33"W, 2000 m, 29 March 2005 (fr), L.Bohs et al. 3357 (QCNE, UT); Fundación Arco Iris, between Loja and Zamora, trail from field station to Río San Francisco, 3°59'20"S, 79°05'35"W, 2200 m, 5 April 2005 (fr), L.Bohs et al. 3425 (LOJA, QCNE, UT). **Peru:** Cajamarca: Prov. San Ignacio, above San Francisco (ca. a El Chaupe), 1650 m, 5 January 1995 (fr), S.Leiva et al. 1621 (HAO [destroyed], NY).

Discussion. *Solanum rubicaule* has a festooning growth form, meaning that it is often arched and draping over other vegetation. This growth form is similar to mem-

bers of *Solanum* sect. *Micracantha* Dunal, a group of vining species from the New World tropics that climb using recurved prickles. This superficial similarity explains why specimens of *S. rubicaule* are often annotated as "*Solanum* sect. *Micracantha*." However, other morphological and molecular characters place *S. rubicaule* in *Solanum* sect. *Torva*, including flowers with triangular corolla lobes with abundant interpetalar tissue and typically branched inflorescences. Parsimony analyses of sequence data from three molecular markers (nuclear ITS and *waxy* or GBSSI and chloroplast *trnT-F*) also place *Solanum rubicaule* in sect. *Torva*; however, the relationships within the section are not well-resolved and require further study (S. Stern and L. Bohs, unpub. data).

Following the definition of Walker and Whelan (1991), the breeding system of *S. rubicaule* is andromonoecious, meaning that there are staminate and hermaphroditic flowers on the same plant. However, a more specific description of the breeding system might be "temporally andromonoecious" since the first-formed inflorescences on a plant appear to be composed entirely of male flowers. Inflorescences on older plants are composed of hermaphroditic flowers.

Within sect. *Torva*, *S. rubicaule* is similar to *S. subinerme* Jacq., a species found throughout northern South America from the Guianas to central Peru, both of which have a scandent growth form and few-branched inflorescences. However, *S. rubicaule* has a distinctive infructescence with fruits held horizontal to the rachis due to pedicels that curve downward (see Fig. 2b) while *S. subinerme* has fruits held upright on erect pedicels. The adaxial leaf surface of *S. rubicaule* is unarmed, while the adaxial leaf surface of *S. subinerme* often has straight prickles to 1.5 cm long. Both species have multiseriate stalked hairs on the adaxial leaf surface but those *S. subinerme* are nearly sessile to short stalked (to ca. 0.4 mm) and very thin (ca. 0.1 mm in diameter) while those of *S. rubicaule* reach 0.6 mm with greatly thickened stalks (to 0.3 mm in diameter). Herbarium specimens of *S. rubicaule* and *S. asperolanatum* Ruiz & Pav. are very similar with regard to pubescence and flower appearance, but the latter species has upright inflorescences that are more than twice branched, typically has >12 flowers, is a large shrub or small tree and does not have the festooning growth form of *S. rubicaule*.

Solanum section *Erythrotrichum*

The second new species, *Solanum achorum*, has morphological and molecular characters that place it in *Solanum* sect. *Erythrotrichum* (S. Stern and L. Bohs, in prep). Morphologically, this species shares the plurifoliate sympodial units, recurved prickles, ferruginous tomentum with stellate-glandular hairs, and berries 1.5–2.5 cm in diameter with a pubescent exocarp typical of other members of sect. *Erythrotrichum*. This group appears to have three distinct centers of diversity, in Central America, northeastern Brazil, and the Andes of Peru and Ecuador (Agra 2008).

***Solanum achorum* S.Stern, sp. nov.**

urn:lsid:ipni.org:names:77107691-1

Figs. 3–4

Solano megaspermo *Agra* et *S. velutino* Dunal *affinis sed a S. megaspermo inflorescentiis paucifloribus et seminibus parvioris, a S. velutino calycibus parvioris differt.*

Type. Peru: Amazonas: Prov. Chachapoyas, road from Leimebamba to Chachapoyas, about 15 km N of Leimebamba along Río Utcubamba, 6°37'39"S, 77°48'44"W, 2050 m, 13 December 2007 (fl, fr), S.Stern et al. 129 (holotype: USM!; isotypes: BM001016783!, HAO! [destroyed], NY00986767!, UT!).

Description. Erect to scandent shrub, 1–3 m tall. Stems armed with recurved, tan to orange rosellike prickles to 2.5 mm in length, the base 2–3 × 0.5–1 mm, sparsely to moderately pubescent with rusty, porrect-stellate hairs, the stalks nearly absent to 0.2 mm, multiseriate, the rays 5–10, 0.2–0.3 mm, unicellular to multicellular, the midpoints nearly absent. Flowering portions of stem consisting of plurifoliate sympodial units, the leaves apparently not geminate. Leaves simple, the blades 6–20 × 2.5–11 cm, elliptic to ovate, chartaceous, discolorous, adaxially dark green, abaxially whitish green, the adaxial surface sparsely stellate-pubescent with hairs like those of the stem, the abaxial surface moderately to densely stellate-pubescent with hairs like those of the stem but white and with midpoints often gland-tipped, these mixed with multicellular, uniseriate glandular hairs 0.3–0.6 mm long; venation pinnate, the secondary veins 4–5 on both sides of the midvein, the midrib abaxially occasionally with sparse recurved spines like those of the stem; base obtuse, often asymmetrical; margin entire; apex acute; petioles 0.5–3 cm, moderately pubescent with hairs like those of the stem, occasionally armed with sparse recurved spines. Inflorescences 2–15 (20) cm, 2–5-branched, with 4–12 flowers, the plants andromonoecious, specifically androgynocious (Walker and Whelan 1991), with hermaphroditic flowers at the base of the inflorescence and occasionally with staminate flowers at the tip, the axes moderately to densely pubescent with hairs like those of the stem; peduncle 1–3 cm; rachis 3–5 cm; pedicels 4–15 mm in flower, 10–25 mm in fruit, erect, spaced 3–5 mm apart, articulated at the base. Calyx 3–6 mm long, the tube 1–3 mm, the lobes 2–4 × 1–2.5 mm, triangular, moderately to densely pubescent with hairs like those of the stem; fruiting calyx not accrescent, not completely covering the fruit. Corolla 2–3.5 cm in diameter, stellate with little to no interpetalar tissue, chartaceous to membranaceous, white, the tube 2–4 mm long, the lobes 10–15 × 3–5 mm, narrowly triangular-ovate, often reflexed, acute at apices, densely pubescent abaxially with white stellate hairs like those of the stem, glabrous to sparsely pubescent adaxially. Stamens 6–10 mm; filaments to 1 mm long, glabrous; anthers 6–10 mm × 1–2 mm, attenuate, connivent, yellow, the base cordate to obtuse, the apex acute to obtuse, the pores apical, not opening into slits. Ovary moderately pubescent with stellate hairs; style in functionally male flowers 3–6 × 0.5–1.5 mm, not exerted beyond stamens; style in hermaphroditic flowers 8–12 × 0.5–1.5 mm, exerted beyond stamens, cylindrical, moderately pubescent with stellate hairs; stigma 1.5–2 mm wide, capitate. Fruit a berry, 1.5–2 cm in diameter, glo-



Figure 3. Isotype of *Solanum achorum* S. Stern [Stern et al. 129 (UT)].

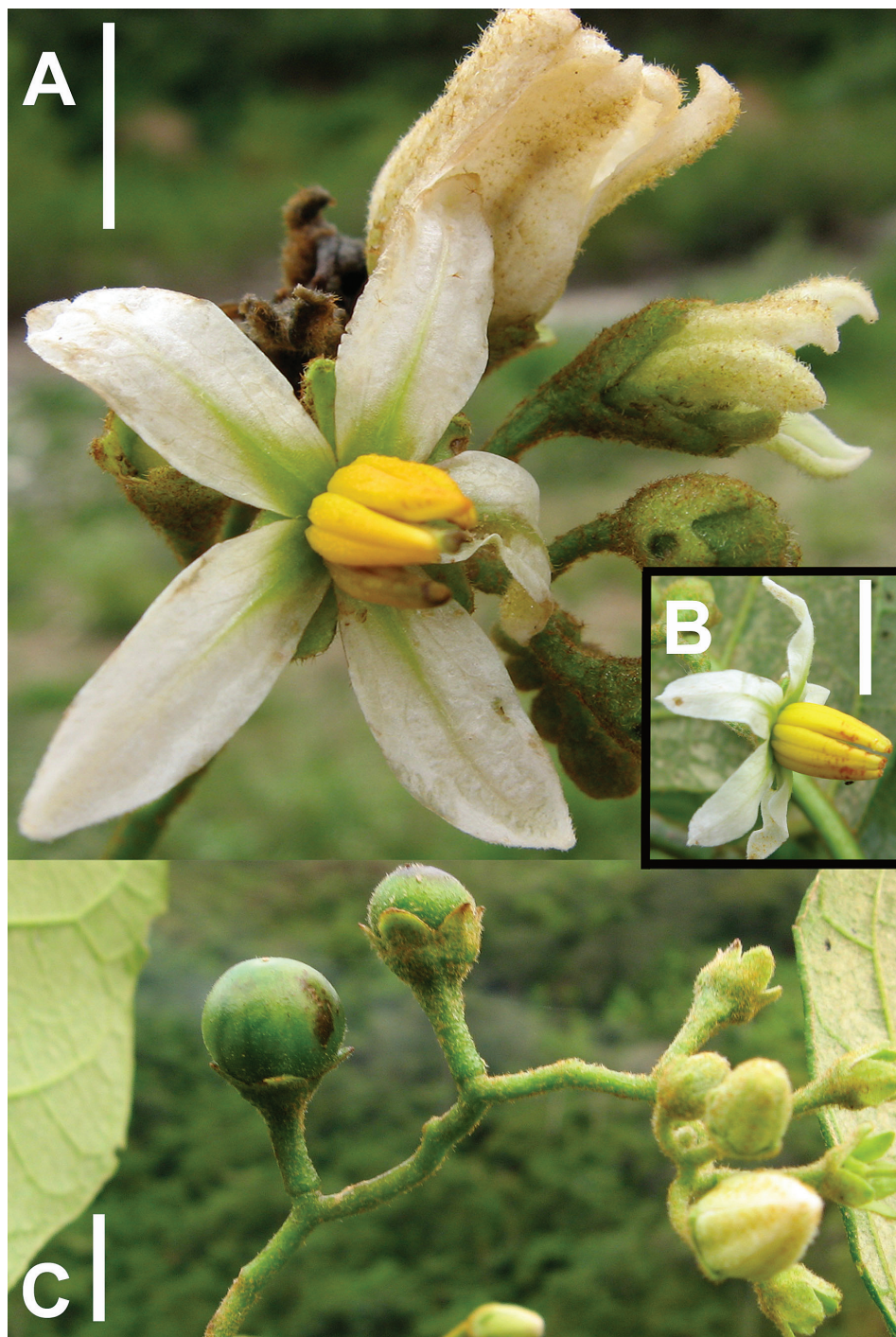


Figure 4. Photos of type collection of *Solanum achorum* S.Stern. **A** Hermaphroditic flower and buds. **B** Functionally male flower; note the absence of exerted style. **C** Inflorescence and immature fruits. Scale bars = 1 cm.

bose, obtuse at apex, green and often mottled with white, often turning brown while still on plant, drying brown, moderately pubescent when young with gland-tipped stellate hairs like those of the stem but with rays often fused, these mixed with short simple glandular hairs, becoming glabrous to sparsely pubescent when mature. Seeds 25–50 per fruit, reniform, brown, rugose, $3\text{--}5 \times 1.5\text{--}3.5$ mm, the margin flattened with a swollen center.

Distribution. Known from northern Peru in Depts. Amazonas and Cajamarca and southern Ecuador in Prov. Zamora-Chinchipe in disturbed open places in montane tropical forest, 700–2100 m in elevation.

Ecology. Flowering specimens were collected in December; fruiting specimens were collected in July, October, and December.

Etymology. The name *Solanum achorum* is derived from the Greek “*achoros*” meaning “homeless.” This name was chosen because of disagreement as to which group within *Solanum* subg. *Leptostemonum* this species belongs.

Conservation status. According to the IUCN Red List Categories (IUCN 2010) *S. achorum* is classified as VU- B2a+B2biii; D2 (Vulnerable). The extent of occupancy is estimated to be approximately 30,000 km² with less than 10 collected locations. The conservation status of *S. achorum* is similar to that of *S. rubicaule* with respect to the potential of more unidentified specimens in herbaria, more specimens as a result of increased collecting efforts, and the difficulty of assessing future habitat as deforestation continues.

Specimens examined. **Ecuador:** Zamora-Chinchipe: Cantón Chinchipe, Parroquia Zumba, Quebrada Tarrangamí, near cabin of Sandy León, W of Escuela Byron Jiménez, just S of Las Pircas, region of Guaramizal, 4°46'50"S, 79°12'33"W, 2000 m, 29 March 2005 (fr), L.Bohs et al. 3356 (LOJA, QCA, QCNE, UT); same locality, same date (fr), L.Bohs et al. 3358 (QCNE, UT); Cantón Valladolid, Parroquia Valladolid, road between Valladolid and El Porvenir del Carmen, ca. 3 km from Valladolid en route to Tapala, 1600–1650 m, 4°33'27"S, 79°07'50"W, 1 April 2005 (fl), L.Bohs et al. 3380 (QCNE, UT); road between Zumba and Amaluza, 8–10 km W of Zumba, 1500–1700 m, 4°50'07"S, 79°09'50"W, 31 March 2005 (fl, fr), L.Bohs et al. 3367 (QCNE, LOJA, UT); along road between Zumba and Vilcabamba, 57.9 km N of Zumba, 9.2 km S of Santa Ana, 6.3 km N of Palanda, 4°36'39"S, 79°07'42"W, 1243 m, 28 July 2004 (fr), T.Croat 92480 (BM). **Peru:** Cajamarca: Prov. San Ignacio, Dist. San José de Lourdes, caserio Rumichina, límite con caserio Naranjos, 5°54'04"S, 78°36'09"W, 1811 m, 24 June 2006 (fr), J.Perea & V.Flores 2407 (BM); Prov. San Ignacio, Dist. San José de Lourdes, bosque alrededor de la comunidad, 5°06'16"S, 78°51'11"W, 1860 m, 10 October 2006 (fr), J.Perea & V.Flores 2799 (BM); Prov. San Ignacio, approximately km 115 on road from Jaen to San Ignacio, east side of hills dividing San Ignacio and Rio Chinchipe, 5°06'53"S, 78°59'16"W, 711 m, 17 December 2007 (fl, fr), S.Stern et al. 177 (BM, NY, USM, UT).

Discussion. The plurifoliate sympodial units, ferruginous to reddish tomentum with stellate-glandular hairs, and large berries with large seeds and a pubescent exocarp identify *Solanum achorum* as a member of *Solanum* sect. *Erythrotrichum*. Additionally,

parsimony analyses of sequence data from three molecular markers (nuclear ITS and *waxy* or GBSSI and chloroplast *trnT-F*) place *S. achorum* in this section; however, the relationships within the group are incompletely resolved due to a lack of taxon sampling and require further study (S. Stern and L. Bohs, unpub. data). The inflorescence structure of *S. achorum*, being branched with both hermaphroditic and staminate flowers, would place it in Agra's (2008) subsect. *Rhytidoandrum* Agra; however, this relationship has not been tested phylogenetically using molecular data.

Of the 23 species of sect. *Erythrotrichum* that Agra (2008) recognized, only three occur in Peru, with one species, *S. urubambaense* Agra, endemic to southern Peru in the area around Cuzco. *Solanum achorum* can be distinguished from the two members of sect. *Erythrotrichum* occurring in northern Peru and southern Ecuador by a number of characters. It shares a similar vegetative appearance with *S. megaspermum* Agra, especially regarding habit, pubescence, and leaf shape; however, *S. megaspermum* has more robust inflorescences (> 30 flowers vs. 4–12 flowers in *S. achorum*) and larger seeds (5–5.5 × 2–3 mm vs. 3–5 × 1.5–3.5 mm in *S. achorum*). *Solanum achorum* also shares many characteristics with *S. velutinum* Dunal, including a scandent habit, similar pubescence, and similar-sized white corollas, but *S. achorum* has a branched inflorescence that can reach 20 cm versus inflorescences to 6 cm long in *S. velutinum*. The calyx lobes in *S. achorum* are 2–4 mm in length and not foliaceous while those of *S. velutinum* are commonly over 10 mm long and foliaceous.

Acknowledgments

We thank E. Tepe, S. Leiva, and M. Zapata for field assistance; S. Knapp for discussion about the new species; S. Knapp and two anonymous reviewers whose comments greatly improved this manuscript; and the following herbaria for loans of specimens: BM, HAO, LOJA, QCA, QCNE, NY, and USM. This work was supported by NSF grant DEB-0316614 (PBI *Solanum*: A worldwide treatment) to LB.

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Two new South American species of *Solanum* section *Crinitum* (Solanaceae)

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Academic editor: Sandra Knapp | Received 31 August 2010 | Accepted 25 October 2010 | Published 1 November 2010

Citation: Farruggia FT, Bohs L (2010) Two new South American species of *Solanum* section *Crinitum* (Solanaceae). *PhytoKeys* 1: 67–77. doi: 10.3897/phytokeys.1.661

Abstract

Two new species of *Solanum* section *Crinitum* are described here. *Solanum falciforme* Farruggia, **sp. nov.**, closely resembles *S. crinitum* and *S. lycocarpum*, but differs by the presence of falcate trichomes on the young growth. It is endemic to the cerrado and adjacent woodlands of Distrito Federal, Bahia, Goiás and Minas Gerais, Brazil. The other species, *Solanum pseudosycophanta* Farruggia, **sp. nov.**, has close affinities to *S. sycophanta* but differs from the latter in having prominent long-stalked stellate hairs along the stem, calyx, petiole and the adaxial surface of the leaf, in contrast to *S. sycophanta* which is glabrous or pubescent with sessile to short-stalked multangulate hairs. This species is narrowly distributed in tropical montane forests of northern Peru and southern Ecuador.

Resumen

Se describen aquí dos especies nuevas de *Solanum* sección *Crinitum*. *Solanum falciforme* Farruggia, **sp. nov.**, se asemeja a *S. crinitum* y *S. lycocarpum*, pero difiere de las otras dos por la presencia de tricomas falcadas en las partes jóvenes de la planta. La nueva especie es endémica al cerrado y bosques adyacentes de Distrito Federal, Bahía, Goiás y Minas Gerais, Brasil. La otra especie, *Solanum pseudosycophanta* Farruggia, **sp. nov.**, tiene estrechas afinidades con *S. sycophanta* pero difiere de ésta por tener pelos estrellados con tallos largos en las ramas, cálices, pecíolos y en la superficie adaxial de la hoja; al contraste, *S. sycophanta* está glabra o pubescente con pelos multangulados sesiles o con tallos cortos. Esta especie está estrechamente distribuida en los bosques tropicales montaños del norte de Perú y sur del Ecuador.

Keywords

Andes, Brazil, cerrado, Ecuador, new species, Peru, *Solanum*, *Solanum falciforme*, *Solanum pseudosycophanta*

Introduction

The economically important genus *Solanum* L., which includes tomato (*S. lycopersicum* L.), potato (*S. tuberosum* L.), and eggplant (*S. melongena* L.), is currently the focus of an initiative to provide online descriptions and taxonomic information for all *Solanum* species (the PBI *Solanum* project; www.solanaceaesource.org). Detailed taxonomic study of *Solanum* section *Crinitum* Whalen ex A. Child has revealed undescribed species within the section, two of which are treated below.

Solanum section *Crinitum* is comprised of large trees and shrubs, 2–30 m tall, with large, 3 to 8.5 cm diameter, purple flowers fading to white in some taxa. The fruits are some of the largest known in the genus, ranging in size from 1 cm up to 15 cm in diameter, and have a swollen to knobby calyx at maturity. The group as circumscribed by Whalen (1984) and Nee (1999) includes about 14 species. One of these, *S. mitlense* Dunal, is endemic to Mexico, while the rest are restricted to tropical South America, with highest diversity along the eastern slopes of the Andes from Colombia to Bolivia.

Taxonomic treatments

Solanum falciforme Farruggia, sp. nov.

urn:lsid:ipni.org:names:77107761-1

Figs. 1–2

Frutex vel arbuscula, 1–3 (–4) m × ca. 2–5 cm diametro, flores magnae, corollis 3.5–4.5 cm diametro, rotato-stellatis, fructus globosus, puberulus vel glabrisculus, 5–7.5 cm diametro. Solano crinito et S. lycocarp affinis sed pilis falcatis longistipitatis stellatis caulium differt.

Type. Brazil: Distrito Federal: Brasília, on road to Gama, DF16, 3–7 km from junction with BR040, 15°58' S, 48°02' W, 1100 m, 10 Jul 1984, S.A. Mori et al. 16658 (holotype: NY!; isotype: MO-3580598!).

Description. Shrub or small tree 1–3 (–4) m × ca. 2–5 cm dbh. Trunk with sharp, stout broad-based prickles, the bark grey-brown to reddish-dark brown, smooth to slightly roughened; flowering stems armed with broad-based prickles, very densely pubescent with sessile to short-stalked light tan multangulate-stellate hairs, the apex 0.1–0.3 mm in diameter, the rays 7–10+, moderately to densely pubescent with falcate long-stalked stellate hairs, the stalks ca. 4–6.2 mm, multiseriate, the apex 0.1–0.3 mm in diameter, the rays 5–7. Sympodial units difoliate, geminate. Leaves simple, the blades ca. 19–25 × 7–17 cm or more, ca. 2.5 times as long as wide, lanceolate, coriaceous, slightly discoloured, the fresh and dried leaves light green adaxially, lighter green abaxially, the adaxial surface very densely pubescent when young with stalked stellate hairs, these nearly absent on older plants, the stalks ca. 0.1–0.3 mm, multiseriate at the base, the rays 7–8, the midpoints ca. 0.1 mm, these mixed with abundant short simple glandular hairs beneath the stellate pubescence, the abaxial surface very densely pubescent with golden-tan multiseriate-stalked porrect-stellate hairs, the stalks 0.2–0.4 mm, the

rays 7–10, the midpoints absent; major veins 5–6 on either side of midvein, abundantly armed with broad-based prickles and falcate long-stalked stellate hairs; base cordate to oblique; margin entire to deeply repand; apex acute to obtuse; petioles (1–) 3–5 cm, densely pubescent with hairs like those of the young stems. Inflorescences 3–9.5 cm, extraaxillary, unbranched, with 8–15 flowers, the plants strongly andromonoecious, with one to few hermaphroditic flower(s) at the base of the inflorescence and all other flowers functionally staminate, the axes densely stellate-pubescent with hairs like those of the stems, armed or unarmed; peduncle 18–22 mm; rachis 2–8 cm; pedicels 4–10 mm in flower and fruit, densely congested, spaced 1–4 mm apart, articulated at base. Flowers 5-merous. Calyx ca. 2.5 cm long, the tube at anthesis 2–3 mm, the lobes ca. 20 × 2 mm, the apex acute, the abaxial surface densely pubescent with short-stalked to sessile porrect-stellate hairs and falcate long-stalked stellate hairs, armed or unarmed; fruiting calyx tube becoming slightly thickened and accrescent with maturity, the lobes 7–15 × 3–8 mm, slightly reflexed, subtending but not enclosing the fruit. Corolla 3.5–4.5 cm in diameter, 16–23 mm long, stellate to rotate-stellate with abundant interpetalar tissue, lobed for more than half of its length, membranaceous, violet to blue, the tube 6–8.2 mm, the lobes 16–19 × 3.5–4 mm, deltate, moderately pubescent adaxially with sessile to short-stalked multangulate or porrect-stellate hairs, the rays 5–10, the midpoints often pronounced, ca. 0.1–0.2 mm long, densely pubescent abaxially with sessile to short-stalked porrect-stellate and falcate long-stalked stellate hairs. Stamens equal, the filament tube 0–0.1 mm, the free part of the filaments 1.5–1.8 mm, glabrous; anthers ca. 13 × 2.8 mm, tapered, connivent, yellow, the pores directed distally, opening into longitudinal slits with age, the connective stellate-pubescent. Ovary densely pubescent with sessile stellate hairs; style in hermaphroditic flowers 14–15 × 0.2–0.5 mm, cylindrical, curved at apex, glabrous or sparsely pubescent in lower half with sessile stellate or short-stalked unbranched glandular hairs; style in staminate flowers vestigial; stigma capitate, slightly bilobed. Fruit a berry, 5–7.5 cm in diameter, globose, likely green at maturity, powdery pubescent with stellate hairs. Seeds unknown.

Distribution. Endemic to Brazil. Found in cerrado and along roadsides, 380–1300 m in elevation, common in States of Goiás and Distrito Federal, but also occurring in Bahia and Minas Gerais.

Ecology. Flowering specimens were collected in January–December. Fruiting specimens were collected in January, March, June and July.

Etymology. The name is derived from the Latin “falcatus” describing the sickle-shaped long hairs characteristic of this species.

Conservation status. According to the IUCN Red List Categories (IUCN 2010), *S. falciforme* is classified as VU-B1a+biii; A2c (Vulnerable). Populations of this species are located near expanding population centers leading to highly fragmented populations. The extent of occupancy is estimated to be less than 20,000 km². There is also a continuing decline in suitable habitat in these regions due to deforestation and the establishment of new settlements.

Local names. Brazil: Lobeiro (Costich 1017); fruto do lobo (Macedo 3245, Heringer 10718).



Figure 1. *Solanum falciforme* Farruggia. Image of Isotype [S.A. Mori et al. 16658 (MO)]. Detail of falcate hairs (inset).

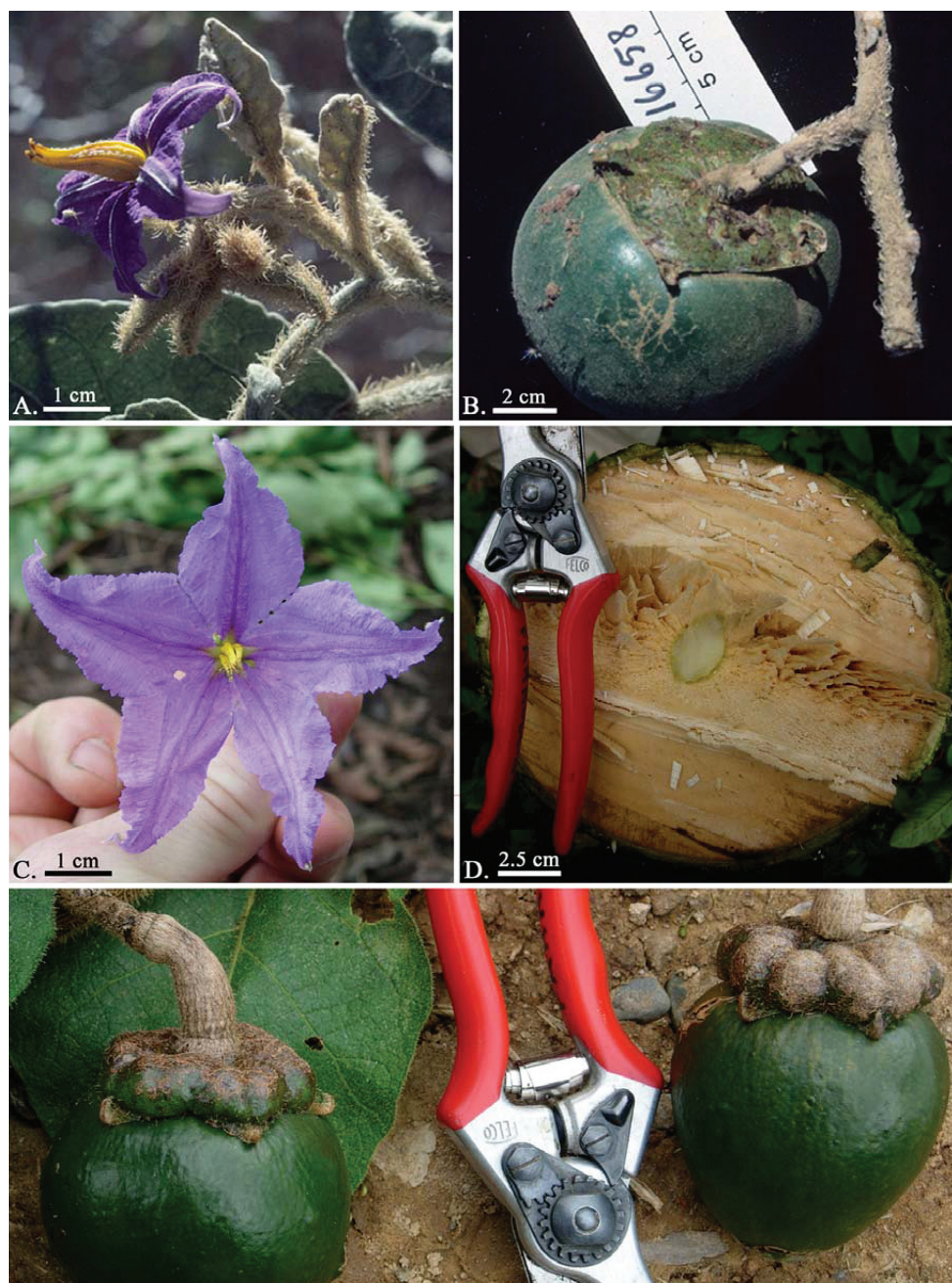


Figure 2. **A-B** *Solanum falciforme* Farruggia. Images of type collection [S. Mori et al. 16658] **A** Staminate flower with pubescent anthers and falcate hairs on axes **B** Mature fruit showing powdery pubescence and expanded calyx tube. Photos by S. Mori **C-E** *Solanum pseudosycophanta* Farruggia [L. Bohs et al. 3784]. **C** Staminate flower **D** Cross-section of trunk showing abundant secondary xylem and spongy pith **E** Mature fruits showing knobby calyx with thickened lobes reduced to points. Photos by F.T. Farruggia.

Representative specimens. Brazil: sin loc, 1821, L. Riedel 3013 (MO, NY, US). Bahia: Barreiras, estrada para o Aeroporto de Barreiras, entre 5 a 15 km a partir da sede do município, 11 Jun 1992, A.M.V. de Carvalho et al. 4028 (NY). Distrito Federal: Chapada da Contagem, Vegetação de Transição, 6 Oct 1981, A.L.V. Atta 6 (F); estrada que vai de Brasília ao Gama, próximo ao balão que vai para Taguatinga, 11 Nov 1981, R. Batista 10 (F); Rodovia Brasília-Uruaçu, 15 Dec 1964, R.P. Belém & J.M. Mendes 31 (F, US); região da Palma, beira da estrada, 1980, V. de Carvallho dos Anjos 15 (F); Chapada de Contagem, 15°37'S, 47°58'W, 6 Oct 1981, E.A. Costa 10 (F); Parque Nacional, 8 Nov 1981, D. Costich 1017 (F); Brasília, Planaltina, EMBRAPA-CPAC Reserve, 1000 m, 22 Jul 1982, D. Costich 1091 (F, NY); Brasília, Planaltina, EMBRAPA-CPAC Reserve, 1000 m, 23 Jul 1982, D. Costich 1092 (F, NY); Região da Palma, campo sujo, 15°34'S, 48°02'W, 1300 m, 3 Jun 1981, R.S. Ganem & C.M.S. Mello 20 (F); Brasília, no Centro Olímpico da UnB, 2 Jun 1980, A.E. Heringer Salles et al. 164 (NY); Brasília, 9 Oct 1979, E.P. Heringer et al. 2288 (MO, NY); Brasília, proximidades de Santo Antônio do Descoberto – Goiás, 25 Oct 1979, E.P. Heringer et al. 2607 (MO); Brasília, bacia do Rio São Bartolomeu, 10 Apr 1980, E.P. Heringer et al. 4301 (NY, US); Brasília, Cabeça do Viado, 3 Mar 1961, E.P. Heringer 8060 (US); Brasília, Sobradinho, 8 Jan 1965, E.P. Heringer 10180 (NY); Brasília, 21 May 1978, E.P. Heringer 16747 (F, MO); Brasília, João Pinheiro, 20 Aug 1981, E.P. Heringer 18078 (F, US); Brasília, ca. 25 km S. of Brasília on road to Belo Horizonte, 700 m, 26 Aug 1964, H.S. Irwin & T.R. Soderstrom 5610 (F, NY, US); CAESB, 4.4 km NNE do centro de Brasília, G.S. Koury 23 (F); CAESB, 4.4 km NNE do centro de Brasília, 30 May 1979, S. Kunzler 23 (F); Corrêgo Capão da Erva, 10 Nov 1981, M.F. Luz 13 (F); vicinity of Universidade de Brasília, 29 Jul 1965, R.T. Martin 486 (GH); região da Palma, 15°34'S, 48°02'W, 9 Jun 1981, T.L.F. Martins 18 (F); região da Palma, 15°34'S, 48°02'W, 9 Jun 1981, M.L.P. Matricuela 17 (F); região da Palma, 15°34'S, 48°02'W, 1200 m, 9 Jun 1981, R. Matrícula de Oliveira L. 11 (F); Brasília, campo sujo, próximo á estrada, 15°34'S, 48°02'W, 1000 m, C.M.S. Mello & R.S. Ganem 24 (F); Córrego Capão da Mata, 15°45'S, 47°43'W, 1000 m, 10 Nov 1981, A.G. Miranda 20 (F); região da Palma, 15°34'S, 48°02'W, 9 Jun 1981, A.G. Moreira 15 (F); Brasília, University Campus, along road parallel to Lago Paranoá, 6 Oct 1975, F.H. Oldenburger & V.V. Mecenas 1698 (NY); campos campestres, Córrego Capão da Erva, 15°45'S, 47°43'W, 1000 m, 10 Nov 1981, M.A.F. de Oliveira 20 (F); Brasília, 13 Nov 1958, Edm. Pereira 4612 (US); Brasília, Fazenda Agua Limpa, University of Brasília field station, near Vargem Bonita, c. 18 km. SSW of Brasília TV tower, 9 Jun 1976, J.A. Ratter et al. R3134 (NY); Brasília, Entrada da Fazenda Sucupira – CPAC, 1100 m, 17 Nov 1987, L.A. Skorupa & W.L. Werneck 53 (MO, NY); Brasília, campus of the Universidade de Brasília, 1050 m, May 1973, Taxonomy class of the University of Brasília 129 (MO, US); Brasília, Chapada da Contagem, 6 Oct 1981, M.P. Valle & M.L. Batista 6 (F, NY); Brasília, próximo ao setor de clubes, 1100 m, 19 Apr 1982, E.M.X. Vieira 1 (NY); Brasília, próximo ao lago Paranoá, UnB. Centro Olímpico, 1100 m, 26 Jun 1982, E.M.X. Vieira 20 (F); Brasília, Fazenda Chapadinhoa em Jose Pires, Apa da Cafuringa, 1000 m, 25 Sep 1990, R.F. Vieira et al. 517 (NY). Goiás: cerrado and rocky hillside ca. 25 km by road SW of Monte

Alegre de Goiás, northern spur of Serra Atalaia, 600 m, 13 Mar 1973, W.R. Anderson 6999 (F, MO, NY, US); Chapada dos Veadeiros, 13 km by road S of Terezina, 1000 m, 19 Mar 1973, W.R. Anderson 7501 (F, MO, NY, US); Serra do Caiapó, ca. 16 km (straight line) S of Caiapônia, 800 m, 1 May 1973, W.R. Anderson 9549 (F, MO, NY, US); Verrado do Loteamento Santa Maria próximo a quadra 19, 23 May 1981, A.C.S. Berçot 35 (F); Hidrolândia, Morro Feio, 5 km N Hidrolândia, 950 m, 7 Apr 1988, R.R. Brooks et al. BRASPEX #1 (NY); Niquelândia, nas margens do Rio Tocantinzinho, 450 m, 22 Jul 1995, T.B. Cavalcanti et al. 1603 (NY); region of the Chapada dos Veadeiros, 20 km N of São João da Aliança, 14°30'S, 47°30'W, 16 Apr 1956, E.Y. Dawson 14283 (US); Município de Jataí, 10 km north of Jataí, ca. 900 m, 15 Oct 1968, G. Eiten & L.T. Eiten 9331 (NY); Alto Paraíso de Goiás, Fazenda Santo Antônio, 15 Nov 1997, J.M. Felfli 371 (NY); Planaltina, Rod. GO-118, 45 km S de São Gabriel de Goiás, 8 May 2000, G. Hatschbach et al. 70610 (NY); Santo Antônio do Descoberto, 26 Feb 1980, E.P. Heringer et al. 3492 (NY); Santo Antônio do Descoberto, 26 Feb 1980, E.P. Heringer et al. 3494 (NY, US); Formosa, 20 Oct 1966, E.P. Heringer 10718 (US); Formosa, 16 Oct 1965, E.P. Heringer 10720 (NY); Cristalina, ca. 6 km S of Cristalina, Serra dos Cristais, 1175 m, 3 Nov 1965, H.S. Irwin et al. 9892 (F, NY, US); Cristalina, ca. 5 km S of Cristalina, Serra dos Cristais, 1200 m, 2 Mar 1966, H.S. Irwin et al. 13285 (F, NY, US); 75 km N of Corumbá de Goiás on road to Niquelândia, Goiás in valley of Rio Maranhão, 700 m, 22 Jan 1968, H.S. Irwin et al. 18982 (GH, F, US); Alto Paraíso de Goiás, ca. 10 km S of Alto do Paraíso, 1000 m, 22 Mar 1969, H.S. Irwin et al. 24919 (F, NY); Alto Paraíso de Goiás, ca. 20 km N of Alto do Paraíso, 1250 m, 23 Mar 1971, H.S. Irwin et al. 33066 (NY); Niquelândia, ca. 8 km S of Niquelândia, 23 Jan 1972, H.S. Irwin et al. 34878 (F, NY); Goiânia, 3 Jul 1951, A. Macedo 3245 (MO, US); Serra dos Pirineus, 75 km N of Corumbá de Goiás on road to Niquelândia, in valley of Rio Maranhão, 700 m, 22 Jan 1968, H. Maxwell 18982 (MO, NY); Niquelândia, margem direita do Rio Bagagem, próximo a Barra do Baga Gem/Tocantins (Maranhão), região da Serra Negra, 380 m, 26 Jul 1995, B. Walter et al. 2521 (MO). Minas Gerais: Parque Nacional Grande Sertão Veredas, 30 Apr 1999, R. Rodrigues-da Silva et al. 281 (NY).

Discussion. Within *Solanum* section *Crinitum*, *S. falciforme* most closely resembles *S. lycocarpum* A. St.-Hil., *S. gomphodes* Dunal and *S. crinitum* Lam. All four species have pubescence of sessile to short-stalked porrect-stellate hairs and distributions centered in eastern Brazil. *Solanum gomphodes* can be easily distinguished from *S. falciforme* by its sessile leaves (vs. petioles usually 3–5 cm long in *S. falciforme*) and exclusively short-stalked stellate hairs. *Solanum lycocarpum* and *S. crinitum* are sympatric with *S. falciforme*, but the former two species have much broader distributions throughout South America. *Solanum falciforme* is easily distinguished from *S. lycocarpum* and *S. crinitum* by the presence of macroscopic falcate (sickle-shaped) long-stalked bristly hairs on the young stems as well as the inflorescence and calyx. Collections of *S. crinitum* often have similar long-stalked trichomes on the young stems, inflorescence and calyx; however the stalks of these hairs are straight. *Solanum lycocarpum* is similar to the other three taxa in its abundant pubescence of short-stalked stellate hairs, but the distinctive long-stalked hairs found in *S. falciforme* are noticeably absent.

***Solanum pseudosycophanta* Farruggia, sp. nov.**

urn:lsid:ipni.org:names:77107762-1

Figs. 2–3

Arbor, (5–) 10–20 (–30) m × 7–40 cm diametro, truncus aculeis crassis armatus, flores magnae, corollis 5–8.5 cm diametro, stellatis ad rotato-stellatis, fructus ellipticus, glaber, 6–10 cm diametro. Solano sycophantae affinis sed pilis longistipitatis stellatis superficialium foliorum caulium et calycium differt.

Type. Peru: Cajamarca: Provincia San Ignacio, road to El Chaupe north of San Ignacio, 3 km north of town of Marizaua, 5°08'57"S, 79°01'36"W, 1591 m, 17 Dec 2007, S. Stern et al. 178 (holotype: USM!; isotypes: NY!, UT!).

Description. Tree (5–) 10–20 (–30) m × 7–40 cm dbh. Trunk with sharp, stout broad-based prickles, the bark light brown to reddish, thin with shallow fissures; flowering stems often unarmed, nearly glabrous to densely pubescent with stalked reddish-tan multangulate-stellate hairs, the apex 0.7–0.9 mm in diameter, the rays 8–10. Sympodial units difoliate, geminate. Leaves simple, the blades 10–40 (–50) × 7–25 (–30) cm or more, length to width ratio ca. 1.5–1.7:1, elliptical, ovate to lanceolate, chartaceous, discolorous, the fresh and dried leaves dark green adaxially, light green to whitish- or yellowish-green abaxially, the adaxial surface moderately pubescent with simple glandular hairs and stalked porrect-stellate hairs, the stalks 0.5–3 (–5) mm, multiseriate, the rays 4–8, the midpoints 0.1–0.3 mm, eglandular, the abaxial surface densely pubescent with whitish-golden stalked porrect-stellate hairs, the stalks 1–1.5 mm, the rays 4–6, the midpoints ca. 0.5 mm; major veins 6–8 on either side of midvein, unarmed; base cordate to oblique; margin entire to shallowly lobed, the apex of lobes broadly rounded to acute; apex acute to acuminate; petioles 5–6 (–9) cm, densely pubescent with hairs like those of the young stems. Inflorescences 2–10 cm, extra-axillary, branched, with 10+ flowers, the plants strongly andromonoecious, with one to few hermaphroditic flower(s) near the base of the inflorescence and all other flowers functionally staminate, the axes densely stellate-pubescent with hairs like those of the stems, unarmed; peduncle 10–55 mm; rachis 2.5–8 cm; pedicels 8–25 mm in flower and fruit, densely congested, spaced 1–2 (–5) mm apart, articulated at base. Flowers 5-merous. Calyx 10–20 mm long, the tube at anthesis 2–3 mm, the lobes ca. 11 × 4 mm, the apex acute to acuminate, the abaxial surface densely stellate-pubescent with hairs like those of the stems, unarmed; fruiting calyx becoming inflated, knobby and woody, the lobes remaining as thick points, subtending the fruit. Corolla 5–8.5 cm in diameter, stellate to rotate-stellate with moderate interpetalal tissue, lobed for more than half of its length, membranaceous, light purple to violet, the tube 12–20 mm, the lobes 20–35 × 3.5–5 mm, lanceolate, sparsely pubescent adaxially with sessile multangulate stellate hairs, the rays 1–10, densely pubescent abaxially along central portion of lobes with sessile porrect-stellate hairs. Stamens slightly unequal, the filament tube ca. 2.2 mm, the free part of the filaments ca. 2 mm, glabrous; anthers 11–16 × ca. 1.5 mm, tapered, connivent, yellow, the pores directed distally, opening into longitudinal slits at maturity. Ovary slightly pubescent with simple glandular and porrect-stellate



Figure 3. *Solanum pseudosycophanta* Farruggia. Image of isotype [S. Stern et al. 178 (NY)].

hairs, becoming glabrous with age; style in hermaphroditic flowers 16–18 × ca. 1.1 mm, cylindrical, strongly curved at apex, slightly to moderately pubescent at base with hairs similar to those of the ovary; style in staminate flowers 4–4.4 × ca. 0.2 mm, cylindrical, straight at apex, slightly to moderately pubescent at base with hairs similar to those of the ovary; stigma capitate, slightly bilobed. Fruit a berry, 6–10 cm in diameter, ellipsoidal to turbinate, green and juicy at maturity, glabrous, the pericarp thick with sclerified inclusions. Seeds 4–6.5 × 3.5–4 mm, strongly flattened, reniform, reddish brown to light brown, rugose.

Distribution. Restricted to northern Peru and southern Ecuador in clearings and open places in disturbed, transitional and montane tropical forest, 900–1900 m in elevation.

Ecology. Flowering specimens were collected in May, and October–December. Fruiting specimens were collected in May, and November–December.

Etymology. The name *S. pseudosycophanta* was chosen because of the similarity of this taxon to *S. sycophanta*.

Conservation status. According to the IUCN Red List Categories (IUCN 2010), *S. pseudosycophanta* is classified as VU-B1a+biii; A2c; D1 (Vulnerable). Populations of this species are located near expanding population centers leading to highly fragmented populations. The extent of occupancy is estimated to be less than 20,000 km², less than 10 locations, and there are estimated to be less than 1,000 mature individuals across its range. There is also a continuing decline in suitable habitat in these regions due to deforestation and the establishment of new settlements.

Local names. Peru: Lucuma de oso (Bohs et al. 3784).

Uses. Used for firewood (Bohs et al. 3784).

Representative specimens. **Ecuador:** Zamora Chinchipe: road between El Progreso and Guaramizal, ca. 3 km after turnoff from Vilcabamba-Zumba road at El Progreso, 4°48'23"S, 79°07'26"W, 1430 m, 28 Mar 2005, L. Bohs et al. 3322 (NY, UT); Palanda, región de la Cordillera del Cóndor, parroquia San Francisco de Vergel, riberas del Río Vergel, entre Santa Rosa y La Canela, 04°49'07"S, 79°01'41"W, 1200 m, 6 Mar 2007, W. Quizhpe & A. Wisum 2491 (MO, NY). **Peru:** Amazonas: Bongará, Shillac, N by trail from Pedro Ruíz, 5°49'S, 78°01'W, 2300 m, 31 Aug – 2 Sep 1983, D.N. Smith & S. Vasquez S. 4890 (MO, NY); Bongará, road from Pedro Ruiz to Moyobamba, 15 km east of Pedro Ruiz just before town of Carrera, 5°52'35"S, 77°55'45"W, 1780 m, 14 Dec 2007, S. Stern et al. 137 (NY, USM, UT); Bongará, Shillac, 1900 m, 8 May 1991, K. Young & M. Eisenberg 417 (MO, NY). Cajamarca: San Ignacio, San Ignacio, El Chaupe, 5°10'50.1"S, 79°03'25.0"W, 1800 m, 10 Oct 2010, F.T. Farruggia et al. 2711 (HAO, MO, NY, PLAT, USM, UT); San Ignacio, San Ignacio, La Mora, 5°05'S, 79°03'W, 1800 m, 6 Feb 1996, J. Campos & O. Díaz 2450 (USM); San Ignacio, Santuario Nacional Tabaconas-Namballe, pampa Limón, zona de amortiguamiento, 5°17'29"S, 79°16'32"W, 1980 m, 23 Nov 1998, C. Díaz et al. 10125 (MO, NY, USM); San Ignacio, San José de Lourdes, Santo Tomás, NE del Maraón RENOM, 04°55'S, 78°50'W, 1950 m, 1 Nov 1995, V. Quipuscoa S. 418 (MO, NY); San Ignacio, Dist. San José de Lourdes, Villa Rica, 4°55'S, 78°50'W, 1750

m, 27 Oct 1995, R. Vasquez et al. 20426 (MO, NY); San Ignacio, San José de Lourdes, Villa Rica, 5°03'42"S, 78°53'32"W, 1550 m, 27 May 2010, L. Bohs et al. 3784 (UT); San Ignacio, San José de Lourdes, Villa Rica, 5°03'39.8"S, 78°53'26.1"W, 1625 m, 11 Oct 2010, F.T. Farruggia et al. 2736 (HAO, MO, NY, PLAT, USM, UT); San Ignacio, San José de Lourdes, Buenos Aires del Parco, 5°04'07"S, 78°32'35"W, 1700 m, 16 Jul 2001, E. Vicuña et al. 465 (USM).

Discussion. Within *Solanum* section *Crinitum*, *S. pseudosycophanta* most closely resembles *S. sycophanta* Dunal. The distribution of these taxa overlaps in Peru and Ecuador; however, *S. sycophanta* is more widespread throughout the Andes, while *S. pseudosycophanta* is restricted to northern Peru and southern Ecuador. These two species have large (4–8 cm) elliptical to round, glabrous fruits, more or less spiny trunks, and predominantly entire leaves at maturity. *Solanum pseudosycophanta* differs from *S. sycophanta* in having prominent long-stalked stellate hairs on the stem, inflorescence, and adaxial surface of the leaf. In *S. sycophanta* the stems and petioles lack long-stalked stellate hairs, and are glabrous or pubescent with sessile to short-stalked multangulate hairs. The calyx also differs between these two taxa; *S. pseudosycophanta* has calyx lobes with acute apices that cover most of the corolla in bud, while *S. sycophanta* has a calyx with shorter truncate calyx lobes that only partially cover the petals in bud. Furthermore, *S. pseudosycophanta* in fruit has a knobby calyx with thick pointed lobes, whereas *S. sycophanta* has a smaller rounded calyx without the pointed lobes.

Acknowledgments

We thank Eric Tepe and Stephen Stern for their help with fieldwork in Ecuador and Peru and their consultation during this project, and Segundo Leiva and Mario Zapata for their assistance with planning and carrying out fieldwork in northern Peru. Scott Mori provided photos of *S. falciforme*. The following herbaria provided access to their collections: F, GH, HAO, MO, NY, US, USM. This work was supported by NSF through the PBI *Solanum* grant, DEB-0316614, to LB.

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