# Phylogeny and circumscription of Antillean Anemotrochus, gen. nov., and Tylodontia (Apocynaceae: Asclepiadoideae: Gonolobinae) 

Authors: Mangelsdorff, Ralph D., Meve, Ulrich, and Liede-Schumann, Sigrid

Source: Willdenowia, 46(3) : 443-474
Published By: Botanic Garden and Botanical Museum Berlin (BGBM)
URL: https://doi.org/10.3372/wi.46.46311

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

[^0]$\left\lvert\, \begin{aligned} & \text { Botanisches Museum } \\ & \text { Berlin }\end{aligned}\right.$

# Phylogeny and circumscription of Antillean Anemotrochus, gen. nov., and Tylodontia (Apocynaceae: Asclepiadoideae: Gonolobinae) 

Version of record first published online on 30 November 2016 ahead of inclusion in December 2016 issue.


#### Abstract

Combined molecular and morphological analyses demonstrate that a number of small-flowered Caribbean Asclepiadoideae of hitherto uncertain affiliation form two independent lineages in Asclepiadeae-Gonolobinae, and not, as previously assumed, in the Metastelmatinae. One lineage is described as the new genus Anemotrochus, which includes the widespread Caribbean A. eggersii, a species originally described under Metastelma; A. yamanigueyensis, a new species discovered by the authors in E Cuba; and A. viridivenius, a plant from Hispaniola formerly assigned to Matelea. The second lineage, Tylodontia, is a small genus restricted to Cuba. Besides its type species, T. cubensis, the genus comprises T. fuscula, a species formerly assigned to Metastelma; T. stipitata, a new species described here; and T. urceolata, a species formerly assigned to Astephanus. Anemotrochus and Tylodontia belong to the wider Matelea alliance, but they form endemic Antillean, mainly Cuban lineages independent from Matelea. All species, except for A. viridivenius, are fully described and illustrated, and distribution maps are provided. The names Metastelma eggersii and Astephanus schlechterianus (a synonym of T. fuscula) are lectotypified here.


Key words: Apocynaceae, Asclepiadoideae, Asclepiadeae, Gonolobinae, Metastelmatinae, Anemotrochus, Matelea, Tylodontia, Caribbean, Antilles, Cuba, endemism, molecular phylogeny, taxonomic revision

Article history: Received 29 June 2016; peer-review completed 8 September 2016; received in revised form 7 October 2016; accepted for publication 17 October 2016.

Citation: Mangelsdorff R. D., Meve U. \& Liede-Schumann S. 2016: Phylogeny and circumscription of Antillean Anemotrochus, gen. nov., and Tylodontia (Apocynaceae: Asclepiadoideae: Gonolobinae). - Willdenowia 46: 443-474. doi: http://dx.doi.org/10.3372/wi.46.46311

## Introduction

The Gonolobinae are a subtribe of the Asclepiadeae (As-clepiadoideae-Apocynaceae), comprising c. 400 species with almost exclusively American distribution (Kings \& Morillo 2015). A single species, Gonolobus rostratus (Vahl) R. Br. ex Schult. has been introduced recently in W Africa (D. Goyder, according to Krings 2008). Woodson (1941) reduced the 46 genera described in this subtribe to three genera, Fischeria DC., Gonolobus Michx. and Matelea Aubl. Krings \& al. (2008) demonstrated that this subtribe falls into two lineages, of which one comprises

Gonolobus, while the other one includes numerous genera synonymized under Fischeria and Matelea by Woodson (1941). Current publications tend to reassess several of these genera or even describe new ones (e.g. Stevens 2001; Goyder 2006; Stevens \& Morales 2009; Morillo 2012, 2013; Morillo \& Krings 2014). A recent phylogemetic study in Metastelma R. Br. (Metastelmatinae; LiedeSchumann \& al. 2014) showed that the Caribbean species M. eggersii Schltr. falls into the Gonolobinae.

Grisebach (1866: 175) described Tylodontia Griseb., based on T. cubensis Griseb., as "juxta Microloma inserendum" with shoots possessing recurved eglandular

[^1]trichomes, an urceolate corolla, with the gynostegium inserted at the base and the small corona lobes in the middle of the tube. Bentham (1876) treated Tylodontia as a synonym of Astephanus R. Br. without making the necessary combination for the described species. Schumann (1895) also listed Tylodontia as a synonym of Astephanus without putting the combination into effect. Following Schumann (1895), Astephanus was defined by a gynostegium lacking a corona, whereas Grisebach (1866: 175) stated that Tylodontia has a "Corona parva, 5phylla". This would have excluded Tylodontia from Astephanus. Gómez de la Maza (1895) combined T. cubensis into Astephanus with a new epithet, as A. grisebachii, because the name A. cubensis was blocked by Kunth (1819: 206), a taxon placed in Metastelma by Liede \& Meve (1997). Based on the free anthers and the odd inflorescence, Schlechter (1899: 237) kept Tylodontia separate from Astephanus. Woodson (1941) combined Tylodontia into Cynanchum L. at the rank of a subgenus. He stated that the presence of a corona excluded it from Astephanus. Liede (1997: 176) included Tylodontia and Astephanus urceolatus in Cynanchum sect. Macbridea (Raf.) Liede. The characters she gave for this section are: "Plants herbaceous, twining, leaves lanceolate to linear, inflorescences extraaxillary, sciadioidal (umbel-shaped panicle; Liede \& Weberling 1995), corolla abaxially glabrous, corona absent or consisting of basally fused staminal and interstaminal parts, with only staminal lobes differentiated, but these exceeding the gynostegium...". However, as $T$. cubensis and $A$. urceolatus have thyrsoidal inflorescences, coronas consisting (also) of differentiated interstaminal parts and apically flattened style-heads, they cannot be included in C. sect. Macbridea. Further, Liede (1997: 176) noted that these taxa cannot be included in Metastelma: "...and all species lack the most reliable character of Metastelma, the bearded corolla lobes". As T. cubensis has adaxially densely bearded corollas, this feature does not suit for excluding it from Metastelma, but the possession of interstaminal corona elements and furrowed pollinia, as well as the shoots, which are uniformly and densely covered with recurved trichomes, separate the species well from Metastelma. Later, Liede \& Meve (2003: 587) tentatively included $T$. cubensis and A. urceolatus in "Cynanchum" with an ambiguous position until more material would become available, but remarking that Tylodontia might be resurrected. Their main arguments were that the Astephaninae are confined to the Old World and that Schlechter (1899: 240) argued "Die Gestalt der Corolla erinnert an Tylodontia cubensis Griseb." (the shape of the corolla [of A. urceolatus] is reminiscent of T. cubensis). Considering the historically uncertain position of these taxa, in addition to recent morphological evidence that the mainly Cuban alliance of the Metastelma-like species Astephanus urceolatus Griseb., Metastelma eggersii, M. fusculum C. Wright, and Tylodontia cubensis Griseb. display characters typical of Gonolobinae (Mangelsdorff 2004), the present study aims to take a closer look at the Carib-
bean small-flowered Metastelma-like taxa in order to (1) clarify their systematic position, (2) test their monophyly and (3) revise these groups taxonomically, taking into account the results of the phylogenetic study.

## Material and methods

## Phylogeny

Taxon sampling - The datasets of Rapini \& al. (2007) and Krings \& al. (2008) were used as a starting point, because these two datasets combine a broad general sampling in New World Asclepiadeae (Rapini \& al. 2007) with the largest sampling so far available in Gonolobinae (Krings \& al. 2008). In both datasets, samples completely lacking one of the regions studied (trnT-F, rps16 or $L E A F Y$ ) were pruned. Finally, representatives of all hitherto known Caribbean (mainly Cuban) small-flowered Metastelma-like taxa were added, resulting in eleven samples representing seven species.

Duplicate samples were added for three Cuban species of Matelea, namely M. bicolor (Britton \& P. Wilson) Woodson (Liede \& Meve LM 3583), M. nipensis (Urb.) Woodson (Mangelsdorff RMC 318) and M. tamnifolia (Griseb.) Woodson (Mangelsdorff RMC 125), and the Central American Gonolobus ophioglossa Woodson (Mangelsdorff RMP 1286). For three species of Gonolobinae (G. barbatus Kunth, G. suberosus (L.) R. Br. and M. cyclophylla (Standl.) Woodson) not all partial sequences could be obtained from the same specimen, so that the sequences of two different accessions had to be combined (see Appendix for all vouchers under their names as accepted here, including GenBank accession numbers). Preliminary analysis adding the eleven smallflowered Metastelma-like taxa to the complete dataset of Rapini \& al. (2007) had placed all samples with full support in the New World Clade of Asclepiadeae. Therefore, only samples of the New World Asclepiadeae subtribes Diplolepinae, Gonolobinae, Metastelmatinae, Orthosiinae, Oxypetalinae, Pentacyphinae and Tassadiinae were included in the main analysis (see Appendix). The two samples of Pentacyphus were considered as the outgroup following Liede-Schumann \& al. (2014). The total matrix comprises 156 accessions, 67 of which are considered as Gonolobinae.

DNA extraction, amplification and sequencing - DNA was extracted from silica-gel-dried leaves (vouchers deposited at FR or UBT). Total DNA was extracted using the DNeasy Plant Mini Kit (Qiagen, Hilden, Germany) following the manufacturer's instructions. PCR primers and protocols for the plastid $\operatorname{trn} T-\operatorname{trn} L$ and $\operatorname{trnL} L-\operatorname{trn} F$ spacers and the $\operatorname{trn} L$ intron are those described in Taberlet $\&$ al. (1991). The $\operatorname{trn} L$ intron and $\operatorname{trnL}$-trnF intergenic spacer were amplified either as one fragment, using primers c and f , or as two separate fragments, using primers c and $d$, and e and f, respectively. The two segments were kept

Table 1. Sequence characteristics ( 156 terminals).

|  | trnT-L | trnL | trnL-F | rps16 | LEAFY |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Length (bp) | 763-1027 | 489-547 | 197-387 | 812-849 | $\begin{gathered} \text { 79-138 (intron) } \\ 404-475 \\ \text { (intron+exon) } \end{gathered}$ |
| Median length (bp) | 798 | 513 | 370 | 833 | 103.5 (intron) 464 (intron+exon) |
| Aligned length (bp) | 1264 | 592 | 455 | 944 | 545 |
| New sequences | 13 | 13 | 13 | 13 | 16 |
| Missing partial sequences | 46 | 46 | 0 | 1 | 93 |
| Missing data cells (total) | 58537 (29.7 \%) | 27370 (29.6\%) | 381 (0.5\%) | 1610 (1.1\%) | 68030 (80.0 \%) |
| Missing data cells (in available partial sequences) | 393 (0.3\%) | 138 (0.2\%) | 381 (0.5\%) | 666 (0.5 \%) | 17345 (50.5\%) |
| Variable characters | 221 | 82 | 118 | 273 | 145 |
| Parsimony-informative characters | 109 | 30 | 42 | 153 | 70 |

separate for alignment because most of the samples were amplified separately and the matrix of Krings contains only the trnL-trnF intergenic spacer. The rps16 intron was amplified as in Liede-Schumann \& al. (2005) using the primer pair $r p s 16-1 \mathrm{~F}$ and $r p s 16-2 \mathrm{R}$. LEAFY was amplified using the primers and PCR conditions described in Krings \& al. (2008). All accessions were sequenced directly from the PCR product. In cases in which PCR yielded more than one band, the major band was excised, purified with the QIAquick gel extraction kit (Qiagen) and then sequenced directly. For one accession of the Caribbean small-flowered Metastelma-like taxa (Liede \& Meve 3593), no PCR product for $L E A F Y$ could be obtained (see Appendix). For seven species of Gonolobinae, Krings \& al. (2008) had recovered 2-7 LEAFY sequences by cloning. In these cases, the majority rule consensus of all sequences of the same species was calculated using CodonCode Aligner, v.3.0.3 (CodonCode Corp., Dedham, Massachusetts, U.S.A.), and inserted in the final matrix.

For all five markers, forward and reverse sequences were aligned with CodonCode Aligner, v.3.0.3, and the consensus was exported in fasta format. The fasta files of all markers except $L E A F Y$ were aligned manually in Mesquite (Maddison \& Maddison 2011). For LEAFY, the fasta files were prealigned with the OPAL package inside Mesquite (Wheeler \& Kececioglu 2007) and the resulting alignment was corrected manually. A total of 67 partial sequences was obtained newly for this study. Because the two datasets integrated here are only partially congruent in terms of marker selection, the matrix has a high number of missing partial sequences (see Table 1 and Appendix).

Phylogenetic analysis - Congruency of the partitions was assessed using the ILD (Incongruence Length Difference; Farris \& al. 1994) test as implemented in PAUP 4.0b10 (Swofford 2003). We conducted 1000 replicates using random addition ( 10 addition sequences), keeping a maximum of 100 trees in each repetition. Taxa miss-
ing a partial sequence in the set under investigation were excluded. Only values of $p<0.01$ were considered as significantly incongruent (Cunningham 1997).

Following the recommendation by Huelsenbeck \& Rannala (2004), the most complex model GTR + G + I was implemented for each partition and model parameters were allowed to be optimized independently. Test runs implementing the models of Krings \& al. (2008) did not result in a different tree topology (results not shown).

For Maximum Likelihood (ML) reconstructions, all analyses were implemented in GARLI 2.0 (Zwickl 2006), with general settings left at default. Five independent runs were conducted to find the best tree. Support for individual relationships was evaluated using likelihood bootstrap, 100 replicates and two search replicates each, and the resulting trees summarized with sumtrees (Sukumaran \& Holder 2010).

Bayesian inference (BI) relied on MrBayes 3.2 (Huelsenbeck \& Ronquist 2001; Ronquist \& Huelsenbeck 2003). The five partitions ( $\operatorname{trn} T-L$, $\operatorname{trn} L$, $\operatorname{trn} L-F$, rps6, and $L E A F Y$ ) were considered unlinked, parameters estimated independently, and four simultaneous independent runs were conducted with default temperatures and prior distributions, saving one tree every 1000 generations. The analysis was run for 4 million generations, when constancy was reached at an average standard deviation of split frequencies $\leq 0.015$. Burn-in and run convergence were assessed by examination of the split frequencies diagnostic and the first $50 \%$ of the trees were excluded from the construction of the $50 \%$ majority rule consensus tree. All matrices and trees are available in Treebase (Piel \& al. 2002; study number 16299).

## Taxonomic revision

The treatment is based on the critical study of c. 150 herbarium specimens obtained from A, B, GH, GOET, HAC, HAJB, HBG, JBSD, JE, NY, P, S and US (herbarium codes follow Thiers [continuously updated]). The abbreviation "HFC" is used throughout for the collections of
the "Herbario de la Flora de Cuba" in addition to the individually named collectors. Additional material was provided by fieldwork conducted by R.D.M. during three excursions to Cuba in collaboration with Dr Jorge Gutiérrez (HAJB) and the late Dr Armando J. Urquiola (Pinar del Río) and by S.L.-S. and U.M. on one excursion to Cuba.

## Results

## Phylogeny

Partition homogeneity tests resulted in $p$ values of 0.59 for $\operatorname{trnL-F} / \operatorname{LEAFY}, 0.23$ for rps 16 / LEAFY and 0.35 for $\operatorname{trnL} L-F / r p s 16$. All $p$ values were above the threshold at which phylogenetic accuracy has been shown to suffer by combining gene partitions (i.e. $p<0.01$; Cunningham 1997). Therefore, only the combined dataset was considered further.

All analyses recover a very highly supported $\left(\mathrm{BS}_{\mathrm{ML}}\right.$ $=\mathrm{mm} 0.92, \mathrm{PP}=1.0)$ monophyletic Gonolobinae (Fig. 1). In Gonolobinae, however, basal resolution is low, only a few clades are well supported. These are the Fischeria clade $\left(\mathrm{BS}_{\mathrm{ML}}=\mathrm{mm} 0.73, \mathrm{PP}=0.99\right)$, the Macroscepis Kunth-Schubertia Mart. clade $\left(\mathrm{BS}_{\mathrm{ML}}=\mathrm{mm} 0.92\right.$, PP $=1.0)$, the core Gonolobus clade $\left(\mathrm{BS}_{\mathrm{ML}}=\mathrm{mm} 0.6\right.$, PP $=1.0$ ) and a small Caribbean (incl. Cuba) clade comprising Matelea correllii Spellman, M. nipensis, M. oblongata (Griseb.) Woodson and M. phainops Krings, while a clade comprising Central American species of Matelea is only poorly supported ( $\mathrm{PP} \mathrm{mm}=\mathrm{mm} 0.81$ ).

In all analyses, the small-flowered Metastelma-like taxa fall into two separate, well-supported clades (labelled Anemotrochus and Tylodontia, Fig. 1). One clade $\left(\mathrm{BS}_{\mathrm{ML}}=1.0, \mathrm{PP}=1.0\right)$ comprises taxa hitherto known as Metastelma eggersii Schltr. [Liede \& Meve 3592, Mangelsdorff RMC 387, Neil 270], Matelea viridivenia Alain [Clase \& al 5609, Veloz \& al. 836], and a so-far undescribed species [Mangelsdorff RMC 222a, 222b, RMC 357]. Matelea viridivenia from Hispaniola is sister to the widespread Metastelma eggersii and the undescribed species from Cuba. This clade is sister to a clade comprising Cuban Matelea species, M. bicolor and M. ekmanii (Urb.) Woodson, albeit with no support in the ML analysis and little support in the Bayesian analysis ( $\mathrm{PP}=$ 0.93). In Metastelma eggersii, the sample from the Caicos Islands is sister to the two Cuban samples.

The other clade $\left(\mathrm{BS}_{\mathrm{ML}}=0.52, \mathrm{PP}=0.97\right)$ comprises Tylodontia cf. cubensis [Liede \& Meve LM 3593], as well as taxa hitherto known as Astephanus urceolatus [Mangelsdorff RMC 233], Metastelma fusculum [RMC 327], and a so-far undescribed species [Mangelsdorff RMC 332, RMC 333]. This clade is sister to the Cuban Matelea tamnifolia, the type of Poicilla Griseb., but the relationship receives support only in the Bayesian analysis (PP $=0.96$ ).

Based on the results of the phylogenetic analysis detailed here, we propose to recognize the clade including

Metastelma eggersii, Matelea viridivenia and a hitherto undescribed species (Mangelsdorff RMC 222a, 222b, RMC 357) as a new genus: Anemotrochus Mangelsdorff, Meve \& Liede. For the clade including Astephanus urceolatus, Metastelma fusculum, Tylodontia cf. cubensis and a hitherto undescribed species (Mangelsdorff RMC 332, RMC 333), we propose to reinstall Tylodontia Griseb.

## Macro- and micromorphology

Morphological circumscription of Anemotrochus and Tylodontia - All seven taxa accepted share a dense indumentum of shoots, petioles, peduncles, and pedicels consisting of eglandular, retrorse, antrorse or spreading multicellular trichomes. Tylodontia has ovate to ovate-lanceolate leaf blades with obtuse to slightly cordate bases, acute apices, and straight margins, while Anemotrochus has much smaller, usually ovate to broadly lanceolate leaf blades with rounded or cuneate bases, rounded, often minutely apiculate apices and more or less revolute margins.

The corollas of Tylodontia and most species of Anemotrochus and are fused for more than half the total length with a tubular to urceolate basic shape (Fig. 2). Only in A. viridivenius is the corolla radiate and only basally fused. The corolla lobes are pronouncedly dextrorsely imbricate in bud and asymmetric in outline when unfolded. Anemotrochus possesses papillose or pilose corolla lobes with the right side of the lobes being completely glabrous, laminar-solid staminal corona lobes, reduced or absent interstaminal corona elements, and an expanded basal mouth of the anther wings.

All currently known species of Tylodontia have a non-annular corolline corona (cf. also Kunze 1995) consisting of a complicated system of ridges and bulges (Fig. 3A, 3B, 8F), whereas Anemotrochus lacks such corolline outgrowths. The anther wings of Tylodontia consist of two separate structures, the basal one almost as long ( $T$. cubensis) or longer than the apical one, with more or less expanded margins and the upper one being the structure where the pollinia are inserted (Fig. 9C, 10H), Anemotrochus lacks a longer expanded basal part (Fig. 3A). All species of Tylodontia have more or less pronounced interstaminal coronal elements (Fig. 10H), whereas in Anemotrochus only an almost invisible ridge connects the staminal lobes at their bases (Fig. 3A).

Morphological characteristics grouping Anemotrochus and Tylodontia in the Gonolobinae - Because character evolution in Gonolobinae has not yet been studied in detail and is beyond the scope of the present analysis, an evaluation of a particular character as apomorphic or as plesiomorphic is still not possible. Of the characters listed as typical for the subtribe (Liede 1997, following, e.g., Stevens 1988, Kunze 1995 and Swarupanandan \& al. 1996), all species possess the broad, flat style-head and strongly divergent pollen sacs. Tylodontia furthermore possesses the annular corona [sensu Kunze


Fig. 1. Maximum Likelihood tree showing position of Tylodontia and Anemotrochus in Gonolobinae. Distribution plotted on tree using "Trace all characters" function of Mesquite (Maddison \& Maddison 2011). Numbers indicate Maximum Likelihood bootstrap support $\left(\mathrm{BS}_{\mathrm{ML}}\right) /$ Bayesian Posterior Probability $(\mathrm{PP}) ; \mathrm{BS}_{\mathrm{ML}}=100$ and $\mathrm{PP}=1.0$ indicated by asterisks.


Fig. 2. A: Charrascales E of Yamanigüey, type locality of Anemotrochus yamanigueyensis; B: A. yamanigueyensis climbing at type locality, 6 Mar 2006; C: A. yamanigueyensis flowering in cultivation; D: Tylodontia fuscula above banks of Río Palmarito, Piedra la Vela, Guantánamo, 29 Mar 2003; E: T. fuscula inflorescence in cultivation; F: T. stipitata climbing on Cyathea sp. close to entrance of Parque Nacional Alejandro de Humboldt, 3 Mar 2006; G: T. stipitata flower, frontside of corolla removed, note prominent corolline corona on left side of corolla, stipitate gynostegium and ringlike corona of fused interstaminal and staminal parts; H: T. urceolata inflorescence in cultivation; I: T. urceolata flower, frontside of corolla removed, note prominent lower anther wings and conniventerect connective appendages; scale bar $=1 \mathrm{~mm} .-$ Origin: A, C: RMC 222; B: Liede \& Meve 3569; D, E: RMC 327; F, G: Liede \& Meve 3568; H, I: RMC 233. - Photographs: all by R. Mangelsdorff except B, F by U. Meve.
(1995); but here, sensu Endress \& Bruyns (2000), named corolline corona], which, in Asclepiadeae, is found only in Gonolobinae (Liede \& Kunze 1993), though not in all members of the subtribe, including Anemotrochus. Tylodontia urceolata, in addition, possesses "dorsal anther appendages" (sensu Kunze 1995), an additional appendage exactly on the back of the fertile parts of the anther (cf. Fig. 10H) but not below as is typical for staminal corona formations. The pollinia conform to the definition of Woodson (Woodson 1941: 198) that "the faces of
the pollinium are more or less dissimilar: one convex or rounded and the other flattened or somewhat excavated", and "in some cases both sides are deeply furrowed or excavated". In both genera, the anther wings possess additional guiding structures (sensu Kunze 1995). Neither genus possesses glandular hairs, but the shoots of all species are covered over the whole surface by an indumentum composed of multicellular, eglandular, whitish to slightly coloured trichomes, a character frequently found in Gonolobinae (and Oxypetalinae).


Fig. 3. A: Anemotrochus yamanigueyensis, flower with parts of the corolla removed to expose gynostegium with its 5 flattened ovoid corona lobes (note corolla lobe indumentum restricted to right half of lobes); B: A. yamanigueyensis, inner side of anther wing with bristles on guide rail section, a : distal, b : proximal ridge; C : Tylodontia urceolata, anther wing including guide rail section without bristles, a: distal, b: proximal ridge. - Scale bars: $\mathrm{A}=1 \mathrm{~mm} ; \mathrm{B}=100 \mu \mathrm{~m} ; \mathrm{C}=200 \mu \mathrm{~m} .-\mathrm{A}, \mathrm{B}: ~ R M C 222 ; \mathrm{C}: R M C$ 233. - SEM photographs: R. Mangelsdorff \& M. Ruppel, Goethe-Universität Frankfurt am Main.

Delimitation of Anemotrochus and Tylodontia from Matelea s.str. - The two genera delimited here can be distinguished from Matelea s.str. by a number of characters. Pubescence is ubiquitous on the stems in all species, in contrast to being mostly in one or two lines in Matelea s.str. Furthermore, indumentum consists only of nonglandular trichomes of more or less equal length, while Matelea s.str. is characterized by a mixed indumentum comprising long and short eglandular trichomes as well as glandular ones. Leaf shape (see above) distinguishes both Anemotrochus and Tylodontia from Matelea s.str., which is characterized by much larger, narrowly elliptic to lanceolate leaves with cuneate to rounded bases (Krings \& Morillo 2015). Anemotrochus has distinct laminar-solid staminal coronas, whereas evident interstaminal corona elements are absent. Distinct staminal corona elements are also found in T. cubensis; they are more reduced in T. fuscula, separating the latter and Anemotrochus from Matelea s.str. as currently circumscribed by Morillo (2012) and Morillo \& Krings (2014). Further characters possibly segregating the new genera from Matelea s.str. are the serrate seed margins and the absence of a coma, but as fruits and seeds are not known from all species, these characters might not hold up to future inquisition.

Tylodontia stipitata possesses, next to a complicated system of corolline corona structures, a gynostegial corona
composed of dominant interstaminal and minor staminal parts that encircle the stipe of the gynostegium, resulting in a structure superficially similar to Matelea annulata Alain, where instead the ring-like corona is formed by complete fusion of staminal and interstaminal elements with ligules in the interstaminal position. Tylodontia urceolata has a lobulate interstaminal corona and a vestigial corona in staminal position, a combination of structures also not found in Matelea s.str. Below the guiding structure into which the pollinium is to be inserted, another significant structure is present in Tylodontia consisting of bead-like swollen anther wing margins that are almost as long or longer and more prominent than the guide rails themselves (Fig. 10H; cf. also Kunze 1994). These structures presumably function as nectar-exuding structures. Similar structures, but less prominent, can also be found in Anemotrochus. Krings (2011) named them "hooked" anther wings when describing Anemotrochus (Matelea) viridivenius. Within the Gonolobinae, dorsal anther appendages are known only in Fischeria and Gonolobus (Krings \& al. 2008). While Fischeria possesses vesicular dorsal appendages, those of Gonolobus are laminar (Krings \& al. 2008). The architecture of the solid bifurcate dorsal appendage of T. urceolata is unique within this subtribe. Finally, nectar chambers that are not known in Matelea s.str. can be observed in Anemotrochus eggersii and A. yamanigueyensis.

## Discussion

The present study was conducted to clarify the position of several unusual Caribbean taxa and had therefore restricted sampling of the species-rich Gonolobinae as a whole (South American taxa especially are widely missing). Nevertheless, our phylogenetic tree, which is largely in agreement with the one shown by Krings \& al. (2008), allows some preliminary conclusions. Similar to Metastelma (Liede-Schumann \& al. 2014), Gonolobinae show a strong geographical pattern. Both Central America and the Caribbean (including Cuba) apparently have been settled more than once, leading to the extreme species richness observed today. In contrast to the results of Krings \& al. (2008), the species-poor genus Fischeria is retrieved in the ML analysis as unsupported sister to all other Gonolobinae, but Macroscepis and Schubertia are retrieved amid Matelea s.l. Core Gonolobus remains monophyletic with high support, corroborating the results of Krings \& al. (2008). While Anemotrochus is very well supported, support for Tylodontia is lower. However, this is most likely the result of the missing LEAFY sequence of the first-branching $T$. cubensis.

According to Krings (2011), the Gonolobinae comprise at least two major lineages, the one including Gonolobus s.l., the other one Fischeria DC., and a diverse array of taxa largely synonymized with Matelea by Woodson (1941). Matelea sensu Woodson comprises at least 260 species, and several attempts have been made to describe smaller natural genera (e.g. Stevens 2001; Morillo 2012, 2013, 2015; Morillo \& Krings 2014). However, as Krings (2011:730) stated, "The synorganization of androecium and gynoecium appears to have facilitated such a myriad of gynostegial structural variation ... that it is at times difficult to discern relationships, much less morphological synapomorphies, in the absence of a resolved phylogeny". Ibatia Decne. and Chloropetalum Morillo are well separated from the rest of "Matelea", which falls into a number of well-supported clades whose relationships among each other are not yet understood, a result corresponding to the findings of Krings \& al. (2008) and Morillo (2015). The small-flowered Caribbean taxa studied here form two such clades, opening two possibilities for integrating these taxa into the existing Asclepiadoideae systematics. First, these species could be treated as Matelea s.l., adding floral types not yet found in the genus, no matter how widely it is understood. To add Anemotrochus and Tylodontia to Matelea s.l. would most likely also necessitate the inclusion of Gonolobus, Macroscepis and Schubertia in order to establish a monophyletic unit, based on the position of the type species, $M$. palustris Aubl., in Krings \& al. (2008), even though this was based only on a single partial sequence (trnL-F, 370 $b p)$. The other option is to circumscribe the two lineages as independent genera, following the pattern started by Stevens (2001), and continued by Morillo (2012, 2013, 2015) and Morillo \& Krings (2014), who separated sev-
eral genera from the large pool of Matelea mostly based on morphological criteria. While the recognition of small segregate genera in Matelea counters the general trend in Asclepiadoideae to amalgamate small genera into large ones (Goyder 2004; Liede-Schumann \& al. 2012; LiedeSchumann \& Meve 2015; Khanum \& al. 2016), the two genera proposed here are well supported, Tylodontia by both morphological and molecular data, and Anemotrochus by molecular data and vegetative morphological characters.

The overall similarity between flowers of Tylodontia and two of the three Anemotrochus species presumably constitutes a parallelism due to adaptation to similar habitats and pollination syndromes, as can be inferred from the phylogenetic analysis. This corresponds with the floral similarity of the two genera with several species of Metastelma occurring in the Caribbean, which has caused such taxonomic confusion (this paper; LiedeSchumann \& al. 2014; Liede-Schumann \& Meve 2015). An apparent problem seems to be that often non-homologous structures have been compared, whereas additional important structures were not investigated thoroughly enough. Longitudinal sections through flowers seem especially promising for character analysis. Also, thorough comparison of vegetative characteristics can lead to natural groupings in Gonolobinae; in particular, details of leaf shape and indumentum structure are promising candidates.

Molecular analysis suggests that Anemotrochus eggersii and A. yamanigueyensis, both with urceolate to tubular flowers, form a clade with A. viridivenius (Matelea viridivenia) with rotate, adaxially pubescent flowers of whitish basic colour patterned with green. No flowers could be investigated by ourselves, so that all data are derived from Krings \& al. (2008) and Krings (2011). The gynostegium of A. viridivenius has a basally ligulate laminar staminal corona, almost completely reduced interstaminal corona parts, an expanded basal part of the anther wings, as known from Tylodontia, and shares a similar growth form with A. eggersii and A. yamanigueyensis.

Krings (2011) states that Matelea alainii Woodson, a Cuban endemic, is more similar to $M$. viridivenia than to any other species of Matelea s.l., considering the small leaves, indumentum type, gynostegial and follicle morphology. Unfortunately, despite considerable efforts, no material of M. alainii was available for our molecular study; the only extant material are the type (with several isotypes), and one additional poor specimen, all dating from 1956. While a transfer of M. alainii to Anemotrochus seems not advisable under these conditions, the delimitation of the genus is not affected. If M. alainii is really the closest relative of $A$. viridivenius, it will either be retrieved as sister to it or it will be inserted between $A$. viridvenius and the A. eggersii-A. yamanigueyensis clade. In either case, M. alainii can be included in Anemotrochus. The decision not to describe a separate genus for $M$. viridivenius (and M. alainii) is independent of the
number of species possibly contained in the group and is a consequence of recent results in Asclepiadoideae, which have shown that open and closed flower types, while conspicuously different, have obviously arisen several times inside well-supported lineages; e.g. Bruyns \& al. (2015), who have shown that the open-flowered genus Brachystelma Sims has evolved several times from inside Ceropegia L. with tubular flowers. Therefore, we weigh the full molecular support for the genus and the vegetative similarities of the species higher than the more obvious character of open versus closed flowers.

## Taxonomic treatment

Preliminary key to the genera of the Gonolobinae in the Antilles (by Gilberto Morillo)

1. Stems, leaves and inflorescences sparsely to $\pm$ densely indumented with whitish multicellular eglandular trichomes, no glandular capitate trichomes present, or these few and inconspicuous $\qquad$

- Stems, leaves and/or inflorescences sparsely to $\pm$ densely indumented with whitish, yellowish or light brown multicellular eglandular and glandular capitate trichomes 6

2. Leaf blades oblong-lanceolate, basally sagittate; staminal corona segments prominent-convex and cucullate (hooded), not ligulate (Cuba)

Poicilla (P. tamnifolia)

- Leaf blades ovate, oblong-ovate to narrowly elliptic, basally cuneate, rounded, obtuse, truncate or slightly cordate (in Tylodontia cubensis and T. urceolata); staminal corona segments not cucullate, ligulate or


3. Corolla campanulate, lobes glabrous, basally incurved with an ocellus-like concavity, and with a large white ocellus at apex; staminal corona a costate ridge adnate to stipe in most of its length, apically ligulate; follicles ovoid, 5-ridged (Jamaica)

Jacaima

- Corolla rotate-subcampanulate or urceolate, lobes pubescent at least on adaxial face, spreading or somewhat curved, without a basal concavity and without ocelli; staminal corona laminate or thick-laminate, adnate to stipe only at base, not ligulate; follicles fusiform, 10-ridged, smooth or with some isolated protuberances, strongly beaked in some species . . . . . . 4

4. Corolla rotate, lobes reticulate, pubescent on both faces; staminal corona lobes oblong, extending c. 0.5 mm beyond style-head; corolline corona a protuberance at base of staminal corona; follicles oblong-fusiform, with coarse and prominent protuberances (Hispaniola) . . .

Anemotrochus (A. viridivenius)

- Corolla urceolate, lobes not reticulate, abaxially glabrous; staminal corona lobes well differentiated, or part of a highly complex system of fused staminalinterstaminal coronas which are folded into corolline
corona, shorter or as long as gynostegium, sometimes apparently absent; corolline corona absent or forming a complicated system of ridges and bulges mostly in fused part of corolla; follicles smooth or with some isolated protuberances 5

5. Leaf blades tapering and without colleters at base; corolline corona absent; follicles fusiform, with some isolated protuberances, and with sparse trichomes (West Indies)

Anemotrochus

- Leaf blades basally rounded or slightly cordate, with $2-4$ colleters at base; corolline corona part of a complicated system of ridges and bulges mostly in fused part of corolla, or apparently absent or reduced; follicles, as far as known, smooth and glabrous (Cuba)

Tylodontia
6. Mature leaf blades $2-6 \times 1-3 \mathrm{~cm}$, basally rounded, obtuse or truncate, with glabrous or nearly glabrous surface, pubescent on veins
.7

- Mature leaf blades usually from 6-20 $\times 4-15 \mathrm{~cm}$ or larger, basally cordate or subcordate (truncate to cuneate in few Gonolobus species, where dorsal laminar anther appendages and corolline coronas occur), usually with pubescent surface and veins . 8

7. Corolla lobes ovate, adaxially pubescent; staminal corona lobes obovate to suborbicular, rounded to emarginate at apex, with a small internal ligule, as long as gynostegium; style-head flat, anther wings thick, slightly incurved; follicles subcylindric-fusiform, not winged (Cuba).

Poicillopsis (P. ovatifolia)

- Corolla lobes linear-lanceolate, glabrous; staminal corona lobes swollen at base, subtriangular in front view, ridged, rising vertically and then connecting to stipe below anthers, shorter than gynostegium; style-head conical or convex with a slightly raised protuberance; anther wings thin, with divergent apices; follicles fusiform, with 5 undulating wings (follicles unknown for one species) (Hispaniola)

Ptycanthera
8. Mature stems with thick fissured cork in lower internodes; latex with unpleasant smell; pollinia pendent from caudicles

9

- Mature stems lenticellate or with thin layer of cork in lower internodes; latex with or without an unpleasant smell; pollinia horizontal or slightly bent down from caudicles 10

9. Inflorescence an umbelliform cyme; corolla urceolate or tubular; gynostegium generally included; staminal corona segments fleshy, basally adnate to corolla tube over at least $1 / 2$ of its length, free at apex and frequently concealing corolla throat; corolline corona present; follicles (5-)7-winged, 2 wings incomplete (Neotropics)

Macroscepis

- Inflorescence a racemiform cyme; corolla subcampanulate or campanulate, gynostegium generally exserted; staminal corona segments usually laminar, adnate to base of corolla tube, not concealing corolla throat; corolline corona absent; follicles muricate (Neotropics)

Ibatia
10. Mature stems $5-10 \mathrm{~mm}$ thick or thicker, with light brown pubescence of eglandular spreading long trichomes ( $1.5-6 \mathrm{~mm}$ ) and glandular capitate trichomes ( $0.15-0.4 \mathrm{~mm}$ ), these turning black when dried; corolla lobes conspicuously crisped in one or both margins; gynostegial corona usually forming an annular structure adnate to stipe, apically 5-lobed in some species; anthers inflated dorsally, vesicular, frequently pear-shaped; corolline corona absent; follicles broadly ovoid to fusiform, smooth or with some small protuberances, neither muricate nor winged (Neotropics)

Fischeria

- Mature stems generally $1.5-4(-5) \mathrm{mm}$ thick, usually with withish or yellowish pubescence, eglandular trichomes spreading or retrorse ( $0.4-2(-2.5) \mathrm{mm}$ ), glandular capitate trichomes ( $0.1-0.4 \mathrm{~mm}$ ) translucent to light brown when dried; corolla lobes planar, sometimes somewhat concave or marginally undulate, but not crisped; gynostegial corona of staminal and interstaminal segments; staminal corona lobes adnate to base of corolla tube, usually ridge-like and raised, not ligulate, interstaminal segments flabellate, oblongsulcate or cup-like; corolline corona present, annular but sometimes interrupted or discontinuous, or represented by pubescent mounts of tissue subopposite to anthers; laminar dorsal anther appendages present or absent; follicles $3-5$-winged, wings sometimes discontinuous or reduced, absent in one species . ... $\mathbf{1 1}$

11. Laminar dorsal anther appendages present; mature stems conspicuously lenticellate (Neotropics and temperate North America)

Gonolobus

- Laminar dorsal anther appendages absent; mature stems with a thinly suberized layer, not lenticellate (Neotropics) . . . Chloropetalum (C. denticulatum)

1. Anemotrochus Mangelsdorff, Meve \& Liede, gen. nov.
Type: Anemotrochus eggersii (Schltr.) Mangelsdorff, Meve \& Liede

Diagnosis - Differing from Matelea by shoots densely covered throughout with eglandular, retrorse, and multicellular trichomes, small subsessile to very shortly petiolate leaves with tapering bases, a gynostegium with prominent staminal corona parts, and only slightly furrowed pollinia.

Description - Prostrate to ascending vines with white latex. Shoots often differentiated in long and short shoots, often intertwining, surfaces densely and uniformly indumented with eglandular, multicellular, whitish, retrorse trichomes. Bark on older shoots light brown to beige, slightly corky. Leaves opposite, small, not exceeding $15 \times 5 \mathrm{~mm}$, subsessile or shortly petiolate; blade ovate or ovate-lanceolate, rarely widely circular, elliptic-lanceolate or obovate, membranous, bases rounded, obtuse to cuneate, margins entire, often revolute. Inflorescences
extra-axillary, mostly on short shoots with up to 6 flowers, subsessile. Flowers small (corolla lobes 2-4.5 mm long), on pedicels to 6 mm long. Corolla broadly urceolate fused for $c .1 / 2$ of total length, or basally subcampanulate with expanded lobes, white, cream, yellowish-greenish, and whitish with greenish reticulation intensifying to centre; lobes ovate to linear, often twisted, adaxially on left side pubescent with needle-like or short and blunt trichomes (exact pattern for A. viridivenius not known). Corolline corona a protuberance at base of staminal corona (A. viridivenius) or absent (A. eggersii and A. yamanigueyensis). Staminal corona laminar to rather solid, c. $1 / 2$ as long to as long as gynostegium. Interstaminal corona appearing as inconspicuous sinus between staminal corona segments (A. viridivenius) to almost invisible. Anther wings separated in a basal, basally centripetal part and an apical, basally centrifugal part (Fig. 4E). Pollinar$i a$ with pendulous, slightly furrowed pollinia. Follicles 1 or 2 per flower, fusiform with protuberances on surface, with c. 15 seeds (A. eggersii). Seeds ovate to obovate, winged, comose.

Number of species - Three. One species widely distributed in mainly littoral habitats in the Bahamas, Cuba, Jamaica, Hispaniola and numerous small islands, one species a Cuban endemic and one a Hispaniolan endemic. Matelea alainii Woodson, also from Cuba, is vegetatively very similar, while the flowers possess no evident staminal corona lobes. However, in the absence of molecular data, it seems premature to transfer this taxon to Anemotrochus.

Etymology - The name is derived from Greek $\dot{\alpha} v \varepsilon \mu \circ \varsigma$ (ánemos, wind) and $\tau \rho 0 \chi$ ós (trochós, wheel), i.e. a windmill, after the appearance of the corolla when viewed from the top.

## Key to the species of Anemotrochus

1. Corolla rotate to subcampanulate, whitish, with reticulate greenish pattern (Hispaniola) .

## 3. A. viridivenius

- Corolla subglobose to urceolate, white, cream, yel-lowish-greenish or brownish, occasionally with reddish tinge, but without pattern


2. Corolla adaxially strigose; staminal corona laminar, lobes basally connate (Caribbean) . . . 1. A. eggersii

- Corolla adaxially with short papillose emergences; staminal corona solid, lobes separated (E Cuba) ...

2. A. yamanigueyensis
3. Anemotrochus eggersii (Schltr.) Mangelsdorff, Meve \& Liede, comb. nov. $\equiv$ Metastelma eggersii Schltr. in Urban, Symb. Antill. 1: $258.1899 \equiv$ Cynanchum eggersii (Schltr.) Alain in Mem. Soc. Cub. Hist. Nat. "Felipe Poey" 22: 119. 1955. - Holotype: Bahamas, Fortune Island, Feb 1888, H. F. A. Eggers 3869 (B [destroyed];
lectotype, designated here: HBG 117/1921!; isolectotypes: G 00176944!, GOET 19/2002/8!, HBG 125/1921!, K 000196954!, MPU 019147 [photo!], NY 00111026!, P $00190920!$, WU [n.v.]). - Fig. 4.
= Metastelma jamaicense Schltr. in Urban, Symb. Antill. 5: 469. $1908 \equiv$ Cynanchum rendlei Stearn in Phytologia 21: 138. 1971 [non Cynanchum jamaicense (Griseb.) Woodson in Ann. Missouri Bot. Gard. 28: 210. 1941]. - Holotype: Jamaica, in Long Mountain, West near Kingston, 260 m, 7 Nov 1904, W. Harris 8866 (NY 00111034!; isotypes: BM 000952916!, NY 00111035!, P!, S [photo!]).

Description - Plants herbaceous, ascending, to 2 m high, pronouncedly differentiated in long- and short shoots. Long shoots sparsely and irregularly branched, short shoots mostly from both sides of a node. Shoots perennial, $\pm$ lignified, basally corky, bark light brownish or greyish, densely covered over whole surface with multicellular, recurved, 20-300(-500) $\mu \mathrm{m}$-long trichomes. Internodes of long shoots $0.5-2.5 \mathrm{~cm}$ long, $0.6-1 \mathrm{~mm}$ in diam., short shoots extremely condensed, $1.4-3.2 \mathrm{~mm}$ in diam. Leaves with $0.2-1.2 \mathrm{~mm}$-long petiole; blade $1.5-12(-15) \times 1.2-3(-5) \mathrm{mm}$ (largest on Bahamas), broadly circular, elliptic-lanceolate or obovate, basally rounded to cuneate, without colleters, apically mostly emarginate, apiculus $0.2-0.3 \mathrm{~mm}$ long, marginally slightly revolute and thickened, adaxially glabrous, abaxially occasionally on veins, margins and apex with scattered recurved trichomes $100-200(-300) \mu \mathrm{m}$ long. Inflorescences normally on short shoots, $1-3$-flowered. Inflorescence bracts ovate-lanceolate, $0.3-0.6 \times 0.2-0.3 \mathrm{~mm}$, pilose. Pedicels $0.8-1.8 \mathrm{~mm}$ long, sparsely to densely pilose over whole surface or along a single line with recurved, $100-300 \mu \mathrm{~m}$-long trichomes. Floral buds elongated conical, c. $4 \times 2 \mathrm{~mm}$, with imbricate, contorted aestivation. Flowers fragrant (fide Gillis \& al. 12196, Proctor \& al. 33196). Calyx free to basally fused, abaxially glabrous or with some trichomes at central base, lobes ovate-lanceolate, $1-1.4 \times 0.6-0.8 \mathrm{~mm}$, apically obtuse to acuminate. Corolla broadly urceolate, fused for c. $1 / 2$ of total length, $2.5-3.5 \mathrm{~mm}$ long, white, cream, yellowish-greenish or brownish (darkening with age); lobes oblong, 1-1.6× $0.5-1 \mathrm{~mm}$, apically obtuse, reflexed expanded, slightly contorted, adaxially on left side of lobes and on mouth of tube villose with needle-like, 200-400 $\mu \mathrm{m}$-long trichomes. Gynostegial corona with staminal and interstaminal parts, shorter or equalling gynostegium, staminal parts laminar, broadly deltate, $0.3-0.55 \times 0.25-0.5 \mathrm{~mm}$, erect, margins occasionally slightly revolute, sometimes slightly tuberculate; interstaminal parts consisting of inconspicuous ridges connecting basal margins of staminal corona. Gynostegium $0.5-0.6 \mathrm{~mm}$ long, c. 1 mm in diam., sessile. Anthers broader than long, trapezoidal. Anther wings spreading at an angle of $60-70^{\circ}$ relative to flower axis, $0.3-0.6 \mathrm{~mm}$ long, basally forming a distinct mouth projecting out of plane of gynostegium. Connective append-
ages ovate, c. $0.25 \times 0.2 \mathrm{~mm}$, adnate to top of style-head, narrower than stamen. Pollinarium: Pollinia apically attached to caudicle, liberated at an angle of $45^{\circ}$ relative to corpuscular axis, c. $0.15 \times 0.6-0.7 \mathrm{~mm}$, narrowly ellipsoid, flattened in cross-section, with a distinct fold relative to corpusculum on inner side; caudicles c. $40 \mu \mathrm{~m}$ long, toward corpusculum more cylindric, toward pollinium more flattened; corpusculum narrowly ovoid, c. $150 \times$ $70 \mu \mathrm{~m}$. Style-head $0.2-0.25 \mathrm{~mm}$ long, $0.6-0.7 \mathrm{~mm}$ in diam., green, with mushroom-shaped upper part forming an inconspicuous ring-like structure above corpusculi ("noses" above corpusculi inconspicuous). Follicles (seen only on material from the Bahamas) 1 or 2 per flower, angle between them $180^{\circ}$ or more, $25-35 \times 4-6 \mathrm{~mm}$, obclavate, beaked, light to dark brown, occasionally with isolated, $0.4-1.4 \mathrm{~mm}$-long protuberances, with scattered trichomes. Seeds c. 15 per follicle, ovoid to obscurely pyriform, 2.8-3.2 $\times 1.6-1.7 \mathrm{~mm}$, seta side tuberculate, aseta side smooth; marginally with $0.16-0.32 \mathrm{~mm}$-wide wing with dentate margins; coma 19-22 mm long, white.

Phenology - Flowering presumably over the whole year; flowering specimens were collected in January, March-July, August and October-December.

Distribution - Bahamas, Cuba, Jamaica, Hispaniola (one sterile specimen seen) and numerous small islands (Fig. 6).

Ecology - Coastal habitats on sand and boulders.

Conservation status - As this taxon has a wide distribution and occurs in localities that are of low value for land utilization, the category Least Concern (LC) is appropriate (IUCN 2012, 2016).

Etymology - Named after Henrik Fr. A. Baron von Eggers (1844-1903), Danish soldier and botanist.

Remarks - In overall appearance, the specimens from the Bahamas are more coarse than the ones from Cuba. This might be the result of collection artifacts, as the Cuban specimens were fewer and less well preserved.

Additional specimens investigated - Baнamas: 29 Feb. 1980, L. J. K. Brace 344 (NY); Andros: North Andros, beach area on Evans Bay, 13 Dec 1974, D. S. Correll \& D. Evans 43938 (NY); Atwood Cay: 3 Dec 1907, P. Wilson 7399 (NY); Berry Islands [N Andros]: Whale Cay, on sand, 29 Jan 1905, N. L. Britton \& C. F. Millspaugh 2191 (NY); Castle Island: 22 Dec 1907, P. Wilson 7799 (NY); Cat Island: the Bight and vicinity, rocky rail, 6 Mar 1907, N. L. Britton \& C. F. Millspaugh 5879 (NY); Crooked Island: Pitts Town, 9 Jan 1906, L. J. K. Brace 4613 (NY); Long Cay (formerly Fortune Island): between Long Cay Village and boat landing, in whitelands along road, 7 Jun 1977, D. S. Correll \& G. R. Proctor 48839 (NY); Fortune


Fig. 4. Anemotrochus eggersii - A: section of mature plant with long and short shoots; B : flower; C : corolla, top view; D: flower, longitudinal section; E: gynostegium; F: pollinarium (broken); G: style-head, carpels. - Scale bars: A = $1 \mathrm{~cm} ; \mathrm{B}-\mathrm{E}, \mathrm{G}=1 \mathrm{~mm} ; \mathrm{F}$ $=0.1 \mathrm{~mm}$. - Origin: A: Ekman 15757; B, C, G: Ekman 15759; D, F: Harris 8866 (type of Metastelma jamaicense). - Drawn by R. D. Mangelsdorff.

Island: 5 Feb 1888, H. F. A. Eggers 3869 (B, GOET, HBG [ 2 sheets] NY); Eleuthera: rock sound and vicinity, shell point opposite settlement, 21 Feb 1907, N. L. Britton \& C. F. Millspaugh 5552 (NY); Inagua: Tenados, 14 Oct 1904, G. V. Nash \& N. Taylor 1031 (NY [2 sheets]); Tenados, 28 Oct 1904, G. V. Nash \& N. Taylor 1349 (NY); South Beach, in sandy thickets, 14 Feb 1973, G. R. Proctor \& W.
T. Gillis 33272 (A); Great Inagua, across causeway along South Side Road, about 2 miles E of Matthew Town, in dry coppice, 1 Mar 1974, D. S. Correll 41697 (NY); Mariguana: 10 miles W of Abraham Bay, 5-6 Dec 1907, P. Wilson 7433 (GH, NY); Mayaguana, Pirates Well Up-theBay, dunes and whitelands, 9 Feb 1973, W. T. Gillis \& G. R. Proctor 11598 (A, B); Mayaguana, East of Pirate

Wells, 9 Feb 1973, G. R. Proctor \& W. T. Gillis 33196 (A); Ragged Island: along dirt road near Duncan Town airstrip, in open coppice, 16 Apr 1977, D. S. Correll 48349 (NY); Great Ragged Island, 24 Dec 1907, P. Wilson 7808 (NY). - Cuba: Prov. Guantánamo: Baracoa, Llano de Maisi, 30 Dec 1959, Hno. Alain, Al. Lopez-Figueiras 7068 (HAC); Guantánamo Bay, coastal cliffs, 17-30 Mar 1909, N. L. Britton 2195 (NY); Guantánamo, Cainanero, in wild cliffs facing sea, 23 Nov 1922, E. L. Ekman 15757 (S); Guantánamo, in wild cliffs facing sea, 23 Nov 1922, E. L. Ekman 15755 (NY); Guantánamo-Baitiquirí, 18 Jan 1981, P. Herrera \& al. 0036109 (HAC); Guantánamo-Manigua, costera cerca de Playa Baitiguiri, May 1968, J. Bisse \& E. Köhler HFC 8309 (HAJB, JE [2 sheets]); GuantánamoCerca de Playa Baitiguiri, 8 Feb 1972, J. Bisse HFC 21394 (HAJB [2 sheets], JE); Guantánamo alrededores de Tortuguilla, 12 Apr 1972, J. Bisse \& R. Berazaín HFC 21826 (HAJB [3 sheets], JE). Prov. Holguín: Bahía de Naranjo, 5 Apr. 2003, Mangelsdorff RMC 387 (FR). Prov. Las Villas: Villa Clara, Corralillo, Motembo, cuabales 3 km al suroeste del pueblo, 28 Jan 1981, R. Berazaín \& al. HFC 43624 (HAJB). Prov. Pinar del Río: Pan de Guijabón, 19 Mar 2006, Liede \& Meve 3592 (UTB). - Turks and Caicos Islands: Caicos Islands: Providenciales, at S tip of Five Cays, 16 Dec 1975, D. S. Correll 46424 (NY); Pine Cay, 25 Aug 1974, D. S. Correll 43128 (NY); North Caicos, open area behind dune near Whitby, 10 Jun 1974, W. T. Gillis \& G. R. Proctor 12196 (A); North Caicos, Whitby, in coastal coppice, 12 Feb 1978, D. S. Correll \& al. 49477 (NY); in sandy pine yard, 4 Mar 1911, C. F. Millspaugh \& C. M. Millspaugh 9212 (GH, NY); South Caicos, 14 Dec 1907, P. Wilson 7670 (NY). - Turks IsLands: Grand Turk, 27 Aug 1905, G. V. Nash \& N. Taylor 3765 (NY); Long Cay [additional no. 9367 mounted on sheet, same locality but different collection date: 22 Mar 1911], rocky plain, 20 Mar 1911, C. F. Millspaugh \& C. M. Millspaugh 9350 (GH, NY); Eastern Cay [additional no. 9350 mounted on sheet, same collector but different collection date: 20 Mar 1911], Whitelands, 22 Mar 1911, C. F. Millspaugh \& C. M. Millspaugh 9367 (GH, NY). Haiti: Presqu'̂̂le du Nord-Ouest, Jean Robel, first terrace, east of Bord-de Mer, 7 Jul 1925, E. L. Ekman 4011 (B).
2. Anemotrochus yamanigueyensis Mangelsdorff, Meve \& Liede, sp. nov. - Fig. 2B, C, 3A, B, 5.
Holotype: Cuba, Prov. Holguín, Yamanigüey, 20 m , in low and dry Charrascales, 6 Mar 2006, Liede \& Meve 3569 (FR!; isotypes: HAJB!, UTB! [in alcohol]).

Diagnosis - Differing from Anemotrochus eggersii by the more slender and tender habit, always remaining climbing, instead of the more robust and slightly shrubby habit of A. eggersii, only rarely forming short shoots, flowers formed only on long shoots; by corolla lobes that possess short and warty trichomes instead of long, acicular ones as in A. eggersii and solid staminal corona lobes instead of laminar ones with revolute margin as in A. eggersii.

Description - Plants herbaceous, basally lignified with age, prostrate or twining to c. 1.5 m high, irregularly branched, partially creeping over ground and sending off runners, which emerge some distance from mother plant. Shoots perennial, basally corky, bark light brownish, densely covered over whole surface with multicellular, recurved, $150-750 \mu \mathrm{~m}$-long trichomes. Internodes $1.5-5 \mathrm{~cm}$ long, $0.75-2 \mathrm{~mm}$ in diam., slightly thinner and less densely pubescent than nodes. Leaves with 1.2-1.4 mm-long petiole on slightly raised bases; blade $7-8 \times$ c. 4.8 mm , slightly coriaceous, ovate, basally cuneate, without colleters, apically acuminate, apiculus $0.2-0.4 \mathrm{~mm}$ long, marginally slightly revolute, thickened, adaxially sparsely covered with recurved, $120-260 \mu \mathrm{~m}$-long trichomes sitting on slightly lifted pads, abaxially isolatedly covered with recurved, c. $200 \mu \mathrm{~m}$-long trichomes. Inflorescences on long shoots only, sessile, $\pm$ horizontal when in anthesis, sciadioidal, up to 6 -flowered, up to 3 flowers open synchronously. Inflorescence bracts caducous, narrowly triangular to linear, $0.35-0.9 \times$ c. 0.18 mm , ciliate. Pedicels $10-16 \mathrm{~mm}$ long, densely covered over whole surface with recurved, $100-300 \mu \mathrm{~m}$-long trichomes on slightly lifted pads. Floral buds elongated conical, c. $5.5 \times 2.5 \mathrm{~mm}$, with basally imbricate to apically contorted aestivation. Flowers spreading to pendulous, heavily and sweetly fragrant, nectariferous. Calyx basally fused, abaxial bases with trichomes; lobes triangular to narrowly deltate, c. $2 \times 0.6 \mathrm{~mm}$, apically acute to acuminate, occasionally ciliate. Corolla urceolate to tubular, slightly thick, whitish-greenish to cream, occasionally with reddish tinge; lobes linear-oblong, 4-4.5 $\times$ $0.7-0.8 \mathrm{~mm}$, acute, recurved toward tip, slightly twisted, pronouncedly overlapping, basally and on mouth of tube papillate and with 5 more densely pigmented nerves, apically slightly rugose to warty, adaxially pilose only on left side with warty, $70-520 \mu \mathrm{~m}$-long trichomes. Gynostegial corona of staminal parts attached directly underneath anthers, shorter than gynostegium, yellowish green; lobes flattened ovoid, c. 0.4 mm long (measured from point at which lobe is adaxially fused with stamen), c. 0.6 mm long, erect to inflexed. Gynostegium c. 0.9 mm long in total (from mouth of guide rails to top of gynostegium c. 0.5 mm ), c. 1 mm in diam., atop a bulge c. 0.4 mm long (this is region below mouth of guide rails). Anthers about as long as broad, pentagonal to hexagonal, abaxially convex. Anther wings of adjacent anthers separated into 3 different parts, basal part ("pseudostipe") c. 0.11 mm long, guide rail part centrifugal, spreading at an angle of $\mathrm{c} .45^{\circ}$ relative to flower axis, $0.23-0.25 \mathrm{~mm}$ long with an additional basal guiding structure almost in same plane as anther and widening at base into a presumable nectar-exuding part; guide rails differentiated into a distal and proximal ridge, which is bristly in between (Fig 3B). Connective appendages ovate (with acuminate apices), c. $0.35 \times 0.2 \mathrm{~mm}$, slightly inflexed and adnate to top of style-head. Pollinarium: pollinia apically attached to caudicle, c. $320 \times 120 \mu \mathrm{~m}$, clavate, ovate in cross-section, caudicles c. $200 \mu \mathrm{~m}$ long, cylindric, slightly convexly recurved; corpusculum elliptic,


Fig. 5. Anemotrochus yamanigueyensis - A: flowering shoot; B: trichomes on shoot; C: flower, top view; D: flower, side view; E: gynostegium; F : flower, longitudinal section; G : pollinarium. - Scale bars: $\mathrm{A}, \mathrm{C}-\mathrm{F}=1 \mathrm{~mm} ; \mathrm{B}, \mathrm{G}=0.5 \mathrm{~mm}$. - Origin: $\mathrm{A}-\mathrm{G}$ : $R M C$ 222. - Drawn by R. D. Mangelsdorff.
basally spreading into arm-like structures, c. $170 \mu \mathrm{~m}$ long. Style-head c. 0.65 mm long, c. 0.55 mm in diam., white, with depressed-conical upper part with prominent central depression. Fruits and seeds unknown.

Phenology - The type specimen flowered in March. One plant in cultivation (in Germany) flowered regularly from September to January.

## Distribution - E Cuba: Holguín Province (Fig. 6).

Ecology - Coastal habitats on ultramafic soil (Fig. 2A). In microphyllous evergreen shrubwoods with bixeric tropical climate (Borhidi 1991).

Conservation status - This taxon, so far as is known, has a very local distribution in an area of low value for


Fig. 6. Distribution of the species of Anemotrochus - A. eggersii $(\boldsymbol{\bullet})$; A. viridivenius $(\bullet)$; A. yamanigueyensis $(\star)$.
land utilization, but it grows on ultramafic soils that might be of interest for mining in the future. The category Vulnerable VU B1ab(iii) is appropriate (IUCN 2012, 2016).

Etymology — Named after the type locality, Yamanigüey Cuba.

Remarks - The bristly zone between distal and proximal ridge of guide rail was observed only in this species. Possibly it occurs in Anemotrochus eggersii as well, but the material analysed was too badly preserved for thorough study.

Additional specimens investigated (paratypes) Cuba: Prov. Holguín: Minoraea Moa, E of Yamanigüey, $74^{\circ} 44^{\prime} 477^{\prime \prime} \mathrm{W}, 20^{\circ} 34^{\prime} 23^{\prime \prime N}$ N, $0-10 \mathrm{~m}$, Charrascales (shrub vegetation) on serpentine, near coastline, 5 Mar 2002, R. Mangelsdorff RMC 222 ( FR , specimen prepared from cultivated material, Bot. Gard. Frankfurt am Main, 11 Dec 2003); Moa, Breñales de Playa Vaca, 9 Nov 1945, J. Acuña 13316 (HAC).
3. Anemotrochus viridivenius (Alain) Mangelsdorff, Meve \& Liede, comb. nov. $\equiv$ Matelea viridivenia Alain
in Phytologia 22: 169. 1971. - Holotype: Dominican Republic, Prov. Pedernales, Cabo Rojo, 4 Nov 1969 (fl.), A. Liogier 16637 (NY [photo!]).

Description and illustration — See Krings (2011).
Phenology - Fide Krings (2011) flowering specimens were collected in April, November and December.

Distribution and ecology - Endemic to Hispaniola, xerophytic thickets in the south, from sea level to c. 150 m (Fig. 6).

Etymology - The epithet is derived from Latin viridis (green) and vena (vein), because of the green-veined corolla.

Additional specimen investigated - Dominican RepubLIC: Prov. Independencia: Municipio Duverge, La Zursa, part above seabath on hillside, 2036097 N, 022897 E, 15 m , dry spiny forest, very arid, accompanied by Capparis sp., Croton sp., Maytenus buxifolia (A. Rich.) Griseb., Melocactus lemairei (Monv. ex Lem.) Miq. ex Lem. and Prosopis juliflora (Sw.) DC., 6 Jun 2009, T. Clase \& al. (JBSD [sub no. 5609]).
2. Tylodontia Griseb., Cat. Pl. Cub.: 175. 1866. - Type: Tylodontia cubensis Griseb.

Description - Plants climbing to c. 3 m high, sparsely and irregularly branched, with white latex. Shoots, petioles, peduncles and pedicels $\pm$ densely covered by eglandular, retrorse multicellular, basally slightly thickened and variably sized trichomes to 2 mm long; unicellular or glandular trichomes sbsent. Stipules present. Leaf blade ovate-lanceolate, basally rounded or slightly cordate. Inflorescences extra-axillary, bostrychoid with mostly geminiflorous partial inflorescences, sciadioidal-thyrsoidal, or, more commonly, with $\mathrm{a} \pm$ lengthened rachis that can form flowers for an extended period. Corolla $\pm$ white, fused for at least $1 / 2$ of total length, subglobose-urceolate, adaxially pilose or glabrous. Corolla lobes carnose, dextrorsely imbricate in bud, pronouncedly asymmetric with left side basally extended and covering neighbouring lobe, basally often grooved, margins of grooves often continued as ridges in tube. Corolline corona $\mathrm{a} \pm$ prominent system of epipetal elevations or lobe-like structures at base or in middle of tube. Gynostegial corona consisting of staminal and interstaminal parts. Outer corona with interstaminal parts often larger (pseudolobes), inserted at base of gynostegium, mostly apically and laterally involute. Staminal (inner) corona elements mostly inconspicuous (laminar in T. cubensis). Anther wings separated in 2 different structures, basal one conspicuous, mostly longer and more prominent than upper one, vertically oriented, upper one (where pollinia are inserted) almost horizontal (basally centrifugal) and seemingly an extension of hyaline membrane covering pollinia. Zone between distal and proximal ridge of guide rail not bristly (Fig. 3C). Connective appendages laminar, $\pm$ appressed to style-head (linear and erect in T. urceolata). Gynostegium $\pm$ stipitate (subsessile in T. cubensis). Pollinarium: Pollinia pendulous, flattened in cross-section, obliquely ovate-kidney-shaped with a more flattened zone at upper median margin relative to anther; caudicles basally inserted, cylindric, distally flattened, geniculate; corpusculum ovate-elliptic. Style-head roughly mushroomshaped, broader than long, centrally pitted. Follicles 1 per flower, fusiform to obclavate, 6-7 cm long, rostrate.

Number of species - Four. Endemic in Cuba, rare.
Etymology - The name is derived from Greek tú $\lambda \mathrm{o}$ (týlos, wheal or callosity) and ooov́s (odoús, genitive oסóvtos, odóntos, tooth), presumably because of the swollen, short anthers.

Remarks - The four species are highly variable with regard to their gynostegial corona structures. Tylodontia cubensis has broad staminal corona lobes that are basally adjacent but more or less free. In contrast, T. urceolata has free interstaminal corona lobes, no visible staminal corona lobes, but bifurcate dorsal anther appendages. Tylodontia fuscula has a highly complex system of fused staminal and
interstaminal coronal parts that are folded into the corolline corona lobes, while $T$. stipitata has a ring-like corona consisting of fused staminal and interstaminal parts.

From Matelea s.l., Tylodontia is easily distinguished by the tiny flowers with an urceolate whitish corolla, more or less laminar (or collar-like) staminal and often rather prominent interstaminal corona parts and anther wings that are separated into two different structures, of which the basal one is much more prominent than the apical one.

## Key to the species of Tylodontia

1. Corolla to 1.8 mm long, lobes reflexed to touching tube; basal anther wings inconspicuous (W Cuba) . .

## . 1. T. cubensis

- Corolla 2.3-6 mm long, lobes not reflexed; basal anther wings conspicuous with vaulted margins ( E Cuba)
. 2

2. Corolla adaxially densely tomentose ... 2. T. fuscula

- Corolla adaxially glabrous to isolatedly pilose ... 3

3. Corolla $2.4-2.6 \mathrm{~mm}$ long, stipe distinctly narrower than gynostegium, connective appendages inconspicuous, inflexed, laminar
4. T. stipitata

- Corolla 3-6 mm long, stipe of approximately same width as gynostegium; connective appendages conspicuous, erect, solid, plano-convex in cross-section

4. T. urceolata
5. Tylodontia cubensis Griseb., Cat. Pl. Cub.: 175. 1866 $\equiv$ Astephanus grisebachii M. Gómez in Anales Soc. Esp. Hist. Nat. 23: 276. 1895 [non Astephanus cubensis Kunth in Humboldt \& al., Nov. Gen. Sp. 3: 206. 1819] $\equiv$ Cynanchum grisebachii (M. Gómez) Woodson in Ann. Missouri Bot. Gard. 28: 214.1941 [non Cynanchum cubense (A. Rich.) Woodson in Ann. Missouri Bot. Gard. 28: 213. 1941]. - Holotype: Cuba, Pinar del Río, "Vuelta abajo", tobacco area from Artemisa to Pinar del Río and south, 1 Aug 1862 [cf. Howard 1988: App. 1 \& 9], C. Wright 2964 (GOET 19/2007/7!; isotypes: GH 00076855!, K 000196685!, P 00106955!, YU 001845!). - Fig. 7.

Description - Plants ascending twining, to c. 2 m high, sparsely and irregularly branched. Shoots herbaceous, basally slightly lignified, densely covered with multicellular, recurved, $70-650 \mu \mathrm{~m}$-long trichomes. Internodes in fertile part 3-10.5 cm long, $0.7-1 \mathrm{~mm}$ in diam. Stipules narrowly triangular, c. $0.14 \times 0.06 \mathrm{~mm}$. Leaves with $9-15 \mathrm{~mm}-$ long petiole; blade $18-35 \times 8-25 \mathrm{~mm}$, ovate, basally rounded to obtuse to cordate, with 2-4 colleters at adaxial base, apically acuminate, apiculus $0.4-0.7 \mathrm{~mm}$ long, adaxially on veins and margins sparsely and on blade and toward margin isolatedly covered with multicellular, recurved, 70-300 $\mu \mathrm{m}$-long trichomes, abaxially mainly on veins and margins sparsely covered with recurved (on living plants presumably erect), $70-500 \mu \mathrm{~m}$-long trichomes; marginally sparsely covered with appressed to recurved, $120-500 \mu \mathrm{~m}$-long trichomes. Inflorescences presumably


Fig. 7. Tylodontia cubensis - A: flowering stem; B: inflorescence; C: flower, side view; D: longitudinal section of flower; E: gynostegium, front of staminal corona removed; F: gynostegium; G: pollinium; H: pollinarium; I: style-head, carpels. - Scale bars: A, $\mathrm{B}=1 \mathrm{~cm} ; \mathrm{C}-\mathrm{F}, \mathrm{I}=1 \mathrm{~mm} ; \mathrm{G}, \mathrm{H}=0.1 \mathrm{~mm} .-$ Origin: A, F, H: HFC 32315; B, C, E, G, I: Wright 2964; D: HFC 10895. - Drawn by R. D. Mangelsdorff.
pendent, thyrsoidal, $>70$-flowered, up to 17 flowers open synchronously. Peduncles $2-10 \mathrm{~mm}$ long, densely covered with recurved, 70-300 $\mu \mathrm{m}$-long trichomes. Rhachis straight, to 28 mm long. Floral bracts lanceolate to linear, $0.25-1 \times 0.06-0.25 \mathrm{~mm}$, with trichomes on surface. Pedicels $2.5-4 \mathrm{~mm}$ long, very densely covered with recurved, $50-220 \mu \mathrm{~m}$-long trichomes. Floral buds globose to conical, $1.2-1.6 \times$ c. 1.2 mm , with imbricate aestivation. Flowers presumably erect. Calyx free to basally fused; lobes ovate to deltate, $0.8-1.1 \times 0.45-0.72 \mathrm{~mm}$, apically obtuse to acute, abaxially pubescent. Corolla subglobose, fused for c. $3 / 4$ of total length, basal $1 / 4$ adnate to gynostegium, $1.4-1.8 \mathrm{~mm}$ long ( -2.5 mm , HFC 32515 ); lobes lanceolate to ovate, $0.35-0.45 \mathrm{~mm}$ wide, apically obtuse, recurved to declinate, twisted, basally asymmetric with left side extended and covering $1 / 2$ of neighbouring lobe, on adaxial surface basally grooved with ridge into fused part down to base of interstaminal parts of gynostegium (corolline corona), verrucose, usually with sparse, verrucose, 45-95 $\mu$ m-long trichomes on inner margins, rarely glabrous (HFC 32415); corolla cells with radial cuticular ridges, resulting in an intensely verrucose surface. Corolline corona system of V-shaped bulges on bases of corolla lobes. Gynostegial corona of basally fused lobes differentiated in staminal position, rounded to transversely rectangular, $0.4-0.7 \mathrm{~mm}$ long, c. 0.8 mm wide, apically laciniate with up to 7 blunt indentations, appressed to back of anther, shorter (HFC 32515) to slightly longer than gynostegium, then apically inflexed (Wright 2964, HFC 10895). Gynostegium c. 0.3 mm long, c. 0.95 mm in diam., sessile to atop a bulge c. 0.15 mm long. Anthers slightly wider than long, pentagonal, abaxially convex; anther wings extending along whole length of anther, separated into basal part (sensu Kunze 1995), c. 0.15 mm long, centripetal, and upper part (guide rail), c. 0.12 mm long, centrifugal, consisting of distal ridge alone, wings smooth. Connective appendages ovate, c. 0.08 mm long, appressed to top of style-head, margins revolute, flanking corpusculi. Pollinaria: pollinia apically attached to caudicles, $140-270 \times 100-160 \mu \mathrm{~m}$, ovoid, obliquely elliptic in cross-section, with proximal sterile, hyaline region; caudicles inserted at base of corpusculum at an angle of c. $140^{\circ}$ to corpuscular axis, c. 38-75 $\mu \mathrm{m}$ long, triangular in outline; corpusculum narrowly ellipsoid, 140-270 $\times$ $40-90 \mu \mathrm{~m}$. Style-head c. 0.75 mm long, c. 0.15 mm in diam., colour unknown, pentagonal, flat, centrally umbonate. Fruits and seeds unknown.

Phenology - Flowering specimens were collected in October and November.

Distribution - W Cuba: Pinar del Río Province (Fig. 11A).

Ecology — Fide Bisse \& Lippold HFC 10895: "pinares".
Conservation status - This taxon has a local distribu-
tion in areas of low value for land utilization and seems to be extremely rare there. The category Vulnerable VU B2ab(ii,iii) is appropriate (IUCN 2012, 2016).

Etymology — Named after Cuba.
Remarks - Wright 2964 (GOET) was identified by Howard (1988, App. 1: 159) as the holotype of T. cubensis, although Grisebach did not clearly designate this specimen in the protologue. However, Howard is undoubtedly right as Grisebach was domiciled in Göttingen and this sample is the only one annotated by Grisebach.

Because rarely collected and with small, often badly preserved flowers, Tylodontia cubensis is one of the enigmatic Cuban Asclepiadeae. The flimsy flowers are easily damaged when prepared, as the anthers dislocate. The axes of symmetry are difficult to understand because the corolla lobes overlap each other for almost one-half and are partially twisted.

Pollinaria sizes are rather variable in this species, with the smallest sizes measured in Wright 2964 and the largest ones in HFC 32515. As can be noted from the description, the specimen from the Pan de Guajaibón (HFC 32515) deviates in several aspects from the type. More material is necessary to decide whether these characteristics are of taxonomic value.

Additional specimens investigated - Cuba: Prov. Pinar del Río: Viñales, pinares al sur del pueblo, Nov 1968, J. Bisse \& H. Lippold HFC 10895 (JE); Bahía Honda, Pan de Guajaibón, 200-670 m, 14 Oct 1976, A. Álvarez \& al. HFC 32515 (HAJB, JE); Pan de Guajaibón, below top, at bottom of stairs, $22^{\circ} 47^{\prime} \mathrm{N}, 83^{\circ} 22^{\prime} \mathrm{W}, 650 \mathrm{~m}, 19 \mathrm{Mar} 2006$, Liede \& Meve 3593 (UBT).
2. Tylodontia fuscula (C. Wright) Mangelsdorff, Meve \& Liede, comb. nov. $\equiv$ Metastelma fusculum C. Wright in Anales Real Acad. Ci. Méd. Habana 7: 105. 1870 [and in Sauvalle, Fl. Cub.: 120. 1873] $\equiv$ Astephanus fusculus (C. Wright) Schltr. in Urban, Symb. Antill. 1: 242. $1899 \equiv$ Cynanchum fusculum (C. Wright) Alain in Mem. Soc. Cub. Hist. Nat. "Felipe Poey" 22: 118. 1955. - Holotype: Cuba, Prov. Holguín, "En selvas densas, Monteverde", 29 Oct 1865, C. Wright s.n. (GH $00076544!$ ). - Fig. 2D, E, 8.
$=$ Astephanus schlechterianus Urb., Symb. Antill. 9: 419. $1925 \equiv$ Cynanchum ekmanii Alain in Mem. Soc. Cub. Hist. Nat. "Felipe Poey" 22: 118. 1955 [non Cynanchum schlechterianum Warb. in Perkins, Fragm. Fl. Philipp. 1: 121. 1904]. - Holotype: Cuba, Prov. Holguín, "Prov. Oriente in Sierra de Nipe in cacumine Loma Mensura cr. 1000 m , m. Oct. flor.", E. L. Ekman 3175 (B [destroyed]; lectotype, designated here: S!).

Description - Plants ascending, twining, to 2 m high, sparsely and irregularly branched. Shoots herbaceous, ba-


Fig. 8. Tylodontia fuscula - A: flowering stem; B: flower, side view; C: longitudinal section of flower; D: longitudinal section of flower, front part of corolline corona bent away; E: gynostegium, top view; F: corolla base, adaxial view, corolline corona; G: longitudinal section of flower; H: style-head, carpels; H': style-head oblique top view; H": style-head, top view with pollinium attached; I: pollinarium; J: follicle. - Scale bars: A, J = $1 \mathrm{~cm} ; \mathrm{B}-\mathrm{H}^{\prime}=1 \mathrm{~mm} ; \mathrm{I}=0.1 \mathrm{~mm}$. - Origin: A-H": RMC 327; I: Wright s.n. (29 Oct 1865); J: Shafer 4051. - Drawn by R. D. Mangelsdorff.
sally lignified to slightly corky, bark greyish to brownish, densely covered over whole surface with multicellular, recurved, 200-1000(-1800) $\mu \mathrm{m}$-long trichomes. Internodes $3-14 \mathrm{~cm}$ long, $0.6-1 \mathrm{~mm}$ in diam. Stipules deltate, $0.14-0.2 \times$ c. 1 mm . Leaves with $1-18(-20) \mathrm{mm}-$ long petiole; blade $11-42 \times 2-14(-20) \mathrm{mm}$, herbaceous, ovatelanceolate, basally slightly cordate to obtuse or rounded, with 2 or 3 colleters at adaxial base, apically acuminate to apiculate, apiculus c. 0.6 mm long, densely pilose; lamina isolatedly to sparsely covered on veins and margins with recurved trichomes, adaxially $270-500 \mu \mathrm{~m}$, abaxially $470-1200 \mu \mathrm{~m}$ and marginally $280-800 \mu \mathrm{~m}$ long. Inflorescences pendent, sciadioidal, later thyrsoidal, 10-50-flowered, up to 15 flowers open synchronously, partial inflorescences mostly geminiflorous. Peduncles $1-3(-5) \mathrm{mm}$ long, densely covered over whole surface with recurved, $120-800 \mu \mathrm{~m}$-long trichomes. Rhachis to 15 mm long. Floral bracts linear-lanceolate, $0.8-2 \times 0.2-0.4 \mathrm{~mm}$, pilose and ciliate. Pedicels $1-4 \mathrm{~mm}$ long, densely covered with recurved, 100-400 $\mu \mathrm{m}$-long trichomes. Floral buds conical, c. $2.7 \times 1.2 \mathrm{~mm}$. Flowers spreading to pendulous, with faint jasmine-like fragrance in morning, nectariferous. Calyx basally fused; lobes narrowly triangular to ovate, c. $1.4 \times 0.7 \mathrm{~mm}$, apically acute to acuminate, glabrous. Corolla elongated urceolate, fused for c. $1 / 2$ of total length, $3.2-4.5 \mathrm{~mm}$ long, white, basally greenish; lobes lanceolate, solid, coriaceous, c. 0.6 mm wide, apically obtuse, in cross-section shallowly triangular, slightly twisted, erect to spreading, abaxially slightly warty, adaxially on central bases and on epipetalous parts of tube with multicellular, 200-360 $\mu \mathrm{m}$-long trichomes. Corolline corona white, solid, $\pm$ horizontally bulging, $0.27-0.38 \mathrm{~mm}$ long, consisting of epipetalous, inflexed, V-shaped lobes with slightly denticulate, rounded margins, notched in middle, forming a ring-like structure encircling base of gynostegium, and projecting parts of gynostegial corona. Gynostegial corona consisting of staminal and interstaminal parts; staminal parts composed of 2 or 3 small projections on back of anther bases; interstaminal parts lobulate, bluntly deltoid, apically and marginally inflexed, c. $0.1-0.18 \mathrm{~mm}$ long, free part in middle to $0.3 \times$ 0.3 mm , greenish. Gynostegium c. 1 mm long, c. 1.3 mm in diam., slightly lifted for c. 0.5 mm . Anthers almost square, abaxially convex; anther wings separated into basal part c. 0.4 mm long, centrifugal to almost perpendicular at an angle of $\mathrm{c} .20^{\circ}$ relative to flower axis, prominently bulging and secreting nectar; upper guide rail part c. 0.23 mm long, oriented at an angle of c. $40^{\circ}$ relative to flower axis, parallel and basally widened; centrifugal over whole length. Connective appendages bluntly triangular, $0.2-0.25 \times 0.37-0.45 \mathrm{~mm}$, inflexed, appressed to top of style-head, white. Pollinarium: pollinia apically attached to caudicles, $300-350 \times 150-160 \mu \mathrm{~m}$, ovoid to reniform, narrowly elliptic in cross-section, with proximal sterile hyaline region; caudicles c. $170 \mu \mathrm{~m}$ long, flattened to cylindric; corpusculum ellipsoid, c. $150 \times 60 \mu \mathrm{~m}$. Style-head $0.38-0.45 \mathrm{~mm}$ long, $0.79-0.86 \mathrm{~mm}$ in diam., green, pen-
tagonal, flat. Follicles 1 per flower, $9-12 \times 0.6-0.75 \mathrm{~cm}$, obclavate to fusiform, ovate in cross-section, apically strongly beaked, light brown, glabrous; fruit stalks curved at an angle of $90^{\circ}$. Seeds light brown, pyriform, 3.5-3.8 $\times$ $1.5-2.5 \mathrm{~mm}$, seta side faintly sculptured with longitudinal ridges, aseta side additionally with tubercles; marginally with c. 0.4 mm -wide wing; coma c. 2.5 cm long, white.

Phenology - Flowering specimens were collected in August and October. In cultivation in Germany the species flowered in December and April-August.

Distribution - Cuba: mountainous regions in the east (Fig. 11B).

Ecology - From higher regions on ultramafic soils. The first author found the species (RMC 327) growing amid dense undergrowth on the steep and shady forested banks of the Río Palenque (Fig. 2D). The plant was rooted in thick humus layers covered by mosses and next to Odontosoria aculeata (L.) J. Sm. (Lindsaeaceae), Pilea sp. (Urticaceae) and Poaceae spp.

Conservation status - This taxon has a local distribution in areas of low value for land utilization. As the political situation in Cuba might change in the future, currently unexploited or protected areas might be in danger of change of land use. The category Vulnerable VU B1ab(iiiiii) is appropriate (IUCN 2012, 2016).

Etymology - The epithet is derived from Latin fuscus (brown), presumably because of the brownish indumentum of dried specimens.

Remarks - The two specimens cited below, collected and determined by Shafer as Tylodontia fuscula, are the only known collections of fruits in this genus.

Additional specimens investigated - Cuba: Prov. Holguín: Sierra de Cristal, Pico de Cristal, 25 Aug 1959, M. Lopez Figueiras s.n. (HAC); Piedra la Vela, above banks of río Palmarito, $500 \mathrm{~m}, 29$ Mar 2003, R. D. Mangelsdorff RMC 327 (FR).

Tylodontia cf. fuscula with fruits: Cuba: Prov. Holguín: S of Sierra Moa, Camp la Gloria, N of Río Jaguaní, plain with "monte mala" over deep iron ore, exposed serpentines, 24-30 Dec 1910, J. A. Shafer 8070 (A, NY); vicinity of Camp la Benito Oriente, Troea, N of camp, 900 m, 24 Feb 1910, J. A. Shafer 4051 (NY).
3. Tylodontia stipitata Mangelsdorff, Meve \& Liede, sp. nov. - Fig. 2F, G, 9.
Holotype: Cuba, Prov. Guantánamo, Mun. Imías, Sierra del Purial, loma al noreste de Alto de la Yamagua (c. 3 km N de Los Lechugos), 800-900 m, Charrasco, suelo laterita, 18 Apr 1984, I. Arias \& al. HFC 53422 (JE!; isotypes: B [n.v.], HAJB [n.v.]).


Fig. 9. Tylodontia stipitata - A: flowering stem; B: inflorescence; C: flower, side view, front part of corolla removed, s: staminal part of corona, is: interstaminal part of corona; D: longitudinal section of flower, cc: corolline corona, s: staminal part of corona, is: interstaminal part of corona; E, E': pollinaria; F: style-head, carpels; F': style-head, oblique top view. - Scale bars: A = 1 cm; $\mathrm{B}-\mathrm{D}, \mathrm{F}, \mathrm{F}^{\prime}=1 \mathrm{~mm} ; \mathrm{E}, \mathrm{E}^{\prime}=0.1 \mathrm{~mm}$. - Origin: A, B, D, E', F': HFC 53422; C, E: HFC 44947; F: HFC 42177. - Drawn by R. D. Mangelsdorff.

Diagnosis - Differing from Tylodontia cubensis by less floriferous inflorescences, much larger flowers, a stipitate gynostegium ensheathed by a ring-like corona, and lower anther wing parts that are much more prominent than the guide rails.

Description - Plants ascending, twining, to 2 m high, sparsely to irregularly branched. Shoots basally slightly woody with brownish-greyish bark, subglabrous to strigose over whole surface with multicellular, recurved, $200-1000 \mu \mathrm{~m}$-long trichomes. Internodes $5-10 \mathrm{~cm}$ long, c. 1 mm in diam. Stipules narrowly triangular to deltate, c. $0.2 \times 0.18 \mathrm{~mm}$. Leaves with $1-18 \mathrm{~mm}$-long petiole; blade 7-40 $\times 3-19 \mathrm{~mm}$, ovate-lanceolate, basally cordate to rounded or cuneate, with 2 colleters at adaxial base, apically acuminate, apiculus c. 0.2 mm long, densely pilose; lamina glabrous, adaxially on veins and margins sparsely covered with appressed to recurved or flexuous, $100-450 \mu \mathrm{~m}$-long trichomes, abaxially with erect to recurved, 200-600 $\mu$ m-long trichomes; main vein adaxially often sunken in fold. Inflorescences thyrsoidal, to 17-flowered with up to 7 flowers open synchronously. Peduncles $4-13 \mathrm{~mm}$ long, glabrous to densely covered over whole surface with recurved, flexuous or inflexed, 100-600 $\mu \mathrm{m}$-long trichomes. Rhachis to 11 mm long. Floral bracts deltoid to lanceolate, $0.4-1 \times 0.1-0.6 \mathrm{~mm}$, pilose and ciliate. Pedicels 3-6 mm long, glabrous or sparsely to densely covered over whole surface or along a single line with flexuous to inflexed trichomes. Floral buds conical to ovoid, c. $1.8 \times$ 1.7 mm . Flowers oriented at an angle of c. $60^{\circ}$, secund. Calyx basally fused; lobes ovate, $1.2-1.6 \times 0.6-0.8 \mathrm{~mm}$, apically acute, abaxially glabrous or nearly so. Corolla urceolate, fused for c. $4 / 5$ of total length, $2.4-2.6 \mathrm{~mm}$ long, subcarnose, yellowish white, abaxially glabrous, glossy, adaxially with a few isolated, papillose trichomes; lobes triangular, c. $0.6 \times 0.5 \mathrm{~mm}$, slightly coriaceous, apically acute, left side larger than right side, twisted, spreading. Corolline corona lobes V-shaped, $0.15-0.2 \mathrm{~mm}$ long, epipetalous in middle of tube, separated from each other in petal sinuses, thereby forming a conspicuous system of ridges separating interstaminal sections, solid, surface slightly warty. Gynostegial corona with staminal and interstaminal parts, basally connate, encircling stipe of gynostegium like a collar; staminal parts shorter and more slender than interstaminal parts, erect, apically inflexed, slightly crenulate, on adaxial side connate to stipe by a ridge and here lower as in interstaminal position, abaxially basally fused with corolla tube and forming ridges that separate interstaminal cavities, interstaminal parts more prominent, free sections c. 0.3 mm long, laminar, forming a cavity below lower guide rail. Gynostegium $0.55-0.6$ long, c. 1.1 mm in diam., stipitate; free stipe $0.2-0.85 \mathrm{~mm}$ long from base of staminal corona, $0.42-0.48 \mathrm{~mm}$ from adaxial and $0.72-0.86 \mathrm{~mm}$ from abaxial base of interstaminal corona parts. Anthers broader than long, broadly rhombic, abaxially prominently convex; anther wings separated into basal part c. 0.4 mm long, centripetal, prominently bulging and spreading, up-
per guide rail part $0.25-0.3 \mathrm{~mm}$ long, centrifugal, consisting of proximal and distal ridge. Connective appendages triangular to ovate, $0.25-0.3 \times 0.15-0.32 \mathrm{~mm}$, inflexed, appressed to style-head. Pollinaria: pollinia (sub-)apically attached to caudicles, $200-240 \times 120-140 \mu \mathrm{~m}$, obliquely obovoid-rectangular, elliptic in cross-section, with an upper, prominent, deltoid protrusion; caudicles c. $80 \mu \mathrm{~m}$ long, sub-basally inserted at corpusculum, convexly recurved; corpusculum narrowly ellipsoid, c. $160 \mu \mathrm{~m}$ long. Style-head c. 0.4 mm long, c. 1.1 mm in diam., colour unknown, pentagonal, with discoid, centrally depressed upper part. Fruits and seeds unknown.

Phenology - Flowering specimens were collected in April, May and October.

Distribution - Cuba: mountainous regions in the east, rare (Fig. 11C).

Ecology - Typically found in regions with high precipitation and in Charrascos on ultramafic soils. Liede-Schumann and Meve (LM 3568, UBT) found this species in the Sierra de Moa climbing on shrubs and low tree ferns (Fig. 2F).

Conservation status - This taxon has a local distribution in areas of low value for land utilization and partly within the protected lands of the Parque Nacional Alejandro de Humboldt. As the political situation in Cuba might change in the future, currently unexploited or protected areas might be in danger of change of land use. The category Vulnerable VU B1ab(ii,iii) is appropriate (IUCN 2012, 2016).

Etymology - The epithet is derived from Latin stipes (stalk), because of the stipitate gynostegium.

Remarks - This new species has been found several times since 1980.

Additional specimens investigated (paratypes) - Cuba: Prov. Holguín: Alrededores del Aserrío La Melba, 450-500 m, Charrascos con Bonnetia cubensis [(Britton) R. A. Howard], 28 Apr 1980, A. Álvarez \& al. HFC 42177 (HAJB [2 sheets]); Moa, subida al Alto de Galinga por el camino del norte, 800-1000 m, Charrascos de altura, 4 May 1980, A. Álvarez \& al. HFC 42790 (HAJB, JE); Moa, cerca del Aserrío La Melba, 400-500 m, Charrascos, 25 Apr 1981, G. Arnold \& al. HFC 44947 (B [n.v.], HAJB, JE); Moa, Camino de la mina Delta, Jul 1949, Clemente 6827, Hno. Alain 927, Chrysogone s.n. (HAC); along road to La Melba, outside entrance of Humboldt National Park, 350 m, 3 Mar 2006, Liede \& Meve 3568 (UBT). Prov. Guantánamo: Baracoa, Alto entre la Loma al Mirador y la Loma Buena Vista en el camino desde el río Baez, hasta el río Los Naranjos, $500 \mathrm{~m}, 6$ Aug 1975, A. Álvarez \& al. HFC 26941 (HAJB).
4. Tylodontia urceolata (Griseb.) Mangelsdorff, Meve \& Liede, comb. nov. $\equiv$ Astephanus urceolatus Griseb., Cat. Pl. Cub. 173. $1866 \equiv$ Cynanchum wrightianum Alain in Mem. Soc. Cub. Hist. Nat. "Felipe Poey" 22: 118. 1955 [non Cynanchum urceolatum (E. Fourn.) K. Schum. in Engler \& Prantl, Nat. Pflanzenfam. 4(2): 253. 1895]. Holotype: Cuba, Prov. Guantánamo, "in monte Toro pr. S. Anna", C. Wright s.n. (GOET id. 9547, reg. no. 9514!) - Fig. 2H, I, 3C, 10.

Description - Plants ascending, twining to 2 m high, sparsely irregularly branched. Shoots densely covered over whole surface with multicellular, recurved and straight $80-900 \mu \mathrm{~m}$-long trichomes, basally woody, with greyish bark. Internodes $8-10 \mathrm{~cm}$ long, $0.5-1 \mathrm{~mm}$ in diam. Stipules narrowly triangular to deltate, c. $0.14 \times$ 0.1 mm . Leaves with $4-17 \mathrm{~mm}$-long petiole; blade $17-35 \times 7-18 \mathrm{~mm}$, herbaceous, ovate, basally cordate, with $0-2$ colleters at adaxial base, apically acuminate, apiculus $0.2-0.6 \mathrm{~mm}$ long, lamina on both surfaces isolatedly to sparsely covered over whole surface to mainly on veins and margins with erect to recurved, $100-800 \mu \mathrm{~m}$ long trichomes, margins sparsely to densely ciliate with appressed to recurved, $100-700 \mu \mathrm{~m}$-long trichomes. Inflorescences horizontal, thyrsoidal to sciadioidal, spreading to horizontal, 3-6(-11)-flowered, 2-4 flowers open synchronously. Peduncles $3-6 \mathrm{~mm}$ long, densely covered over whole surface with recurved or inflexed, 50-300 $\mu \mathrm{m}$ long trichomes. Rhachis straight, c. 2.4 mm long. Floral bracts lanceolate to linear, $0.5-1.8 \times 0.3-0.7 \mathrm{~mm}$, abaxially with trichomes, ciliate. Pedicels $2-4.5 \mathrm{~mm}$ long, sparsely to densely covered over whole surface with recurved or inflexed, $50-250 \mu \mathrm{~m}$-long trichomes. Floral buds conical, c. $4 \times 3.5 \mathrm{~mm}$, with 5 bulges in interstaminal and 5 smaller ones in staminal position (Fig. 10C, E). Flowers spreading to horizontal, no scent noted by collectors, nectariferous. Calyx almost free; lobes linear to ovate, c. $2.7 \times 0.7-0.8 \mathrm{~mm}$, apically obtuse to acute, glabrous or nearly so. Corolla urceolate, fused for c. $2 / 3$ of total length, $4-5 \mathrm{~mm}$ long, white, basally greenish; lobes lanceolate to triangular, c. $1.25 \times 0.9-1.3 \mathrm{~mm}$, coriaceous, adaxially rugose, apically obtuse to acute, recurved. Corolline corona forming low ridges in interstaminal position, slightly verrucose, glabrous. Gynostegial corona separated in almost free staminal and interstaminal parts, staminal parts inconspicuously lifted zones on base of anthers, c. 0.1 mm high, interstaminal parts whitishgreenish, c. 0.8 mm long, lobules triangular, apices slightly involute, enclosing a cavity below lower anther wings, basally emarginate. Dorsal anther appendage a bifurcate, solid crest on dorsal top of anther with lateral tips diverging outward. Gynostegium c. 2 mm long, c. 2.7 mm in diam., atop a stipe c. 0.8 mm long. Anthers about as long as broad, almost square, with longitudinal ridges at both sides; anther wings separated into basal part c. 0.8 mm long, to c .0 .2 mm in diam., prominently bulging over whole length, resembling spreading wings, almost paral-
lel to floral axis, secreting nectar; apical part (guide rail) c. 0.65 mm long, forming an angle of slightly more than $90^{\circ}$ to floral axis, basally centrifugal, forming a distinct "mouth" with basal parts resulting in "lips" projecting beyond plane of anthers, consisting of a distal and proximal ridge. Connective appendages narrowly ligulate, c. $1.4 \times$ 0.35 mm , erect, apically connivent, narrower than stamen, yellowish. Pollinarium: pollinia apically attached to caudicles, c. $450 \times 260 \mu \mathrm{~m}$, obliquely ovoid, elliptic in cross-section, without hyaline zone; caudicles cylindric to flattened (toward pollinium), 130-140 $\mu \mathrm{m}$ long, geniculate; corpusculum narrowly ellipsoid, c. $230 \times 120 \mu \mathrm{~m}$. Style-head c. 1.3 mm long, c. 0.75 mm in diam., whitishgreenish, pentagonal, roughly barrel-shaped, centrally depressed. Fruits and seeds unknown.

Phenology - Flowering specimens were collected in October. In cultivation in Germany the species flowered October-December.

Distribution - Cuba: mountainous regions in the east, rare (Fig. 11D).

Ecology - Regions with high precipitation, typically on ultramafic soils (R. Mangelsdorff, pers. obs.).

Conservation status - This taxon has a local distribution in areas of low value for land utilization. As the political situation in Cuba might change in the future, currently unexploited or protected areas might be in danger of change of land use. The category Vulnerable VU B2ab(ii,iii) is appropriate (IUCN 2012, 2016).

Etymology - The epithet is derived from Latin urceolus (a small urn), because of the urn-shaped (urceolate) corolla.

Remarks - The type locality given in the protologue and by Schlechter (1899: 240), Monte Toro near Santa Ana, deviates from the one given on the type specimen, Santa Ana, Monte Verde. The latter locality is about 20 km E of Monte Toro. In the distribution map (Fig. 11D), the locality given on the type sheet was used.

Within Gonolobinae, the erect, solid, and ligulate structure of the connective appendages of Tylodontia urceolata is exceptional. Grisebach (1866: 173) noticed the stipitate gynostegium; however, neither Grisebach (1866) nor Schlechter (1899) noted the prominent interstaminal corona closely attached to the base of the stipe. This character would have excluded this taxon from Astephanus. Schlechter (1899: 240), however, noted the overall similarity of the corolla with $T$. cubensis.

Additional specimen investigated - Cuba: Prov. Guantánamo: Santa Ana, Alto Iberia, c. 600 m , dwarf rainforest on plateau, 7 Mar 2002, R. D. Mangelsdorff RMC 233 (FR) and in Bot. Gard. Frankfurt am Main, 2 Dec 2005 (fl.) (FR [in alcohol]).



Fig. 11. Distribution of the species of Tylodontia - A: T. cubensis; B: T. fuscula; C: T. stipitata; D: T. urceolata.

## Acknowledgements

The first author thanks Prof. Dr Georg Zizka and the staff of the Herbarium Senckenbergianum (FR), especially the curator, Dr Stefan Dressler, for lending numerous specimens for this investigation and access to their facilities. Manfred Ruppel (Goethe-Universität Frankfurt am Main) handled the SEM-microscope. In Cuba, Dr Jorge Gutiérrez, Curator at the Jardín Botánico Nacional (HAJB), and the late Dr Armando Urquiola supported this work in every possible way, gave access to herbarium collections and taught us to understand the plant diversity in Cuba. The invitation to join one collecting excursion with the Buxus specialist Prof. Dr Egon Köhler (Humboldt-Universität zu Berlin) was very fruitful. Special thanks go to Dr Gilberto Morillo (Universidad de Los Andes, Mérida, Venezuela) for providing the key to the Antillean Gonolobinae and for his numerous comments and suggestions. All authors thank G. Zizka, S. Dressler and J. Gutiérrez for fruitful and pleasant common excursions on Cuba. The curators of the herbaria A, B, FTG, GH, GOET, HAC, HAJB, HBG, JBSD, JE, NY, P, S and US are acknowledged for long-term loans of their valuable specimens. Dr Martin Feulner (Bayreuth) helped with the map creation, and Angelika Täuber (Bayreuth) cared for the lab work. We also thank Dr David J. Goyder (Royal Botanic Gardens, Kew), Dr Hermann Manitz (Friedrich-SchillerUniversität Jena) and an anonymous reviewer for their comments on an earlier version of this paper. Finally, the careful editing of Nicholas Turland is gratefully acknowledged.

## References

Bentham G. 1876: Asclepiadeae. - Pp. 728-785 in: Bentham G. \& Hooker J. D., Genera plantarum 2. London: Williams \& Norgate.
Borhidi A. 1991: Phytogeography and vegetation ecology of Cuba. - Budapest: Akadémiai Kiadó.
Bruyns P. V., Klak C. \& Hanáček P. 2015: Recent radiation of Brachystelma and Ceropegia (Apocynaceae) across the Old World against a background of climatic change. - Molec. Phylogen. Evol. 90: 49-66.
Cunningham C. W. 1997: Can three incongruence tests predict when data should be combined? - Molec. Biol. Evol. 14: 733-740.
Endress M. E. \& Bruyns P. V. 2000: A revised classification of the Apocynaceae s.l. - Bot. Rev. (Lancaster) 66: 1-56.
Farris J. S., Källersjö M., Kluge A. G. \& Bult C. J. 1994: Testing significance of incongruence. - Cladistics 10: 315-319.
Gómez de la Maza [y Jiménez] M. 1895: Catálogo de las periantiadas cubanas, espontáneas y cultivadas. Anales Soc. Esp. Hist. Nat. 23: 267-302.

Goyder D. J. 2004: An amplified concept of Philibertia Kunth (Apocynaceae: Asclepiadoideae), with a synopsis of the genus. - Kew Bull. 59: 415-451.
Goyder D. J. 2006: Rojasia reinstated and six new names and combinations in Matelea (Apocynaceae: Asclepiadoideae). - Kew Bull. 61: 31-33.
Grisebach A. H. R. 1866: Asclepiadeae. - Pp. 173-180 in: Catalogus plantarum cubensium. - Leipzig: Engelmann.
Howard R. 1988: Charles Wright in Cuba, 1856-1867. Alexandria: Chadwyck-Healey, Inc.
Huelsenbeck J. P. \& Rannala B. 2004: Frequentist properties of Bayesian posterior probabilities of phylogenetic trees under simple and complex substitution models. - Syst. Biol. 53: 904-913.
Huelsenbeck J. P. \& Ronquist F. 2001: MRBAYES: Bayesian inference of phylogenetic trees. - Bioinformatics 17: 754-755.
IUCN2012:IUCN RedList categories and criteria. Version 3.1. Second edition. Prepared by the IUCN Species Survival Commission. - Published at http://cmsdocs. s3.amazonaws.com/keydocuments/Categories and_Criteria_en_web\%2Bcover\%2Bbckcover.pdf [accessed 18 Nov 2016].
IUCN 2016: Guidelines for using the IUCN Red List categories and criteria. Version 12 (February 2016). Prepared by the Standards and Petitions Subcommittee of the IUCN Species Survival Commission. - Published at http://cmsdocs.s3.amazonaws.com RedListGuidelines.pdf [accessed 18 Nov 2016].
Khanum R., Surveswaran S., Meve U. \& Liede-Schumann S. 2016: Cynanchum (Apocynaceae: Asclepiadoideae): a pantropical Asclepiadoid genus revisited. -Taxon 65: 467-486.
Krings A. 2008: Synopsis of Gonolobus s.l. (Apocynaceae, Asclepiadoideae) in the United States and its territories, including lectotypification of Lachnostoma arizonicum. - Harvard Pap. Bot. 13: 209-218.
Krings A. 2011: Matelea s.l. (Apocynaceae, Asclepiadoideae) in the West Indies. - Syst. Bot. 36: 730-756.
Krings A. \& Morillo G. 2015: A new species in the Matelea palustris complex (Apocynaceae, Asclepiadeae) and a synopsis of the complex in the Guianas and northern Brazil. - Syst. Bot. 40: 214-219.
Krings A., Thomas D. T. \& Xiang Q. Y. 2008: On the generic circumscription of Gonolobus (Apocynaceae, Asclepiadoideae): evidence from molecules and morphology. - Syst. Bot. 33: 403-415.
Kunth C. S. 1819: Apocyneae Juss. - Pp. 188-233 in: Humboldt A. von, Bonpland A. \& Kunth C. S., Nova genera et species plantarum, ed. quarto, 3. - Paris: Sumtibus Librariae Graeco-Latino-Germanicae.
Kunze H. 1995: Floral morphology of some Gonolobeae (Asclepiadaceae). - Bot. Jahrb. Syst. 117: 211-238.
Liede S. 1997: American Cynanchum (Asclepiadaceae) - a preliminary infrageneric classification. - Novon 7: 172-181.

Liede S. \& Kunze H. 1993: A descriptive system for corona analysis in Asclepiadaceae and Periplocaceae. -Pl. Syst. Evol. 185: 275-284.
Liede S. \& Meve U. 1997: Some clarifications, new species, and new combinations in American Cynanchinae (Asclepiadaceae). - Novon 7: 38-45.
Liede S. \& Meve U. 2003 ["2002"]: Dissolution of Cynanchum sect. Macbridea (Apocynaceae-Asclepiadoideae). - Nordic J. Bot. 22: 579-591.
Liede S. \& Weberling F. 1995: On the inflorescence structure of Asclepiadaceae. -Pl. Syst. Evol. 197: 99-109.
Liede-Schumann S., Kong H.-H., Meve U. \& Thiv M. 2012: Vincetoxicum and Tylophora (Apocynaceae: Asclepiadoideae: Asclepiadeae) - two sides of the same medal: independent shifts from tropical to temperate habitats. - Taxon 61: 803-825.
Liede-Schumann S. \& Meve U. 2015: Synonymy of three South American genera in Apocynaceae, and new combinations in Oxypetalum and Tassadia. - Phytotaxa 202: 35-44.
Liede-Schumann S., Nikolaus M., Silva U. C. S. e, Rapini A., Mangelsdorff R. D. \& Meve U. 2014: Phylogenetics and biogeography of the genus Metastelma (Apocynaceae-Asclepiadoideae-Asclepiadeae: Metastelmatinae). - Syst. Bot. 39: 594-612.
Liede-Schumann S., Rapini A., Goyder D. J. \& Chase M. W. 2005: Phylogenetics of the New World subtribes of Asclepiadeae (Apocynaceae-Asclepiadoideae): Metastelmatinae, Oxypetalinae, and Gonolobinae. Syst. Bot. 30: 184-200.
Maddison W. P. \& Maddison D. R. 2011: Mesquite: a modular system for evolutionary analysis. Version 2.75. - Published at http://mesquiteproject.org

Mangelsdorff R. 2004: Revision der Gattungen Metastelma R. Br. und Tylodontia Griseb. auf Kuba. - Frankfurt a. M.: Diploma thesis, J. W. Goethe-University.
Morillo G. N. 2012: Aportes al conocimiento de las Gonolobinae (Apocynaceae-Asclepiadoideae). - Pittieria 36: 13-57.
Morillo G. N. 2013: Aportes al conocimiento de las Gonolobinae II (Apocynaceae, Ascleiadoideae). Pittieria 37: 101-140.
Morillo G. N. 2015: Aportes al conocimiento de las Gonolobinae III (Apocynaceae, Asclepiadoideae). Pittieria 39: 191-258.
Morillo G. N. \& Krings A. 2014: A new species and a new combination in Phaeostemma (Apocynaceae, Asclepiadoideae, Gonolobinae). - PhytoKeys 33: 41-50.
Piel W. H., Donoghue M. \& Sanderson M. 2002: TreeBASE: a database of phylogenetic information. Pp. 41-47 in: Shimura J., Wilson K. L. \& Gordon D. (ed.), To the interoperable "Catalog of Life" with partners - Species 2000 Asia Oceania. - Tsukuba: Research Report from the National Institute for Environmental Studies, Japan No. 171.
Rapini A., Van den Berg C. \& Liede-Schumann S. 2007: Diversification of Asclepiadoideae (Apocynaceae)
in the New World. - Ann. Missouri Bot. Gard. 94: 407-422.
Ronquist F. \& Huelsenbeck J. P. 2003: MrBayes 3: Bayesian phylogenetic inference under mixed models. - Bioinformatics 19: 1572-1574.
Schlechter R. 1899: Asclepiadaceae. - Pp. 236-290 in: Urban I. (ed.), Symbolae antillanae seu fundamenta florae Indiae occidentalis 1. - Berolini: Fratres Borntraeger; Parisiis: Paul Klincksieck; Londini: Williams \& Norgate.
Schumann K. 1895: Asclepiadaceae. - Pp. 189-306 in: Engler A. \& Prantl K. (ed.), Die natürlichen Pflanzenfamilien 4(2). - Leipzig: Engelmann.
Stevens W. D. 1988: A synopsis of Matelea subg. Dictyanthus (Apocynaceae: Asclepiadoideae). - Ann. Missouri Bot. Gard. 75: 1533-1564.
Stevens W. D. 2001: Asclepiadaceae R. Br. - Pp. 234-270 in: Stevens W. D., Ulloa Ulloa C., Pool A. \& Montiel O. M. (ed.), Flora de Nicaragua 1. - Monogr. Syst. Bot. Missouri Bot. Gard. 85(1).
Stevens W. D. \& Morales J. F. 2009: Apocynaceae. Pp. 662-768 in: Davidse G., Sousa S. M., Knapp S., Chiang F. \& Barrie F. R. (ed.), Flora mesoamericana 4(1). Cucurbitaceae a Polemoniaceae. - México: Universidad Nacional Autónoma de México, Instituto de Biología; Saint Louis: Missouri Botanical Garden; London: The Natural History Museum.
Sukumaran J. \& Holder M. T. 2010: DendroPy: a Python library for phylogenetic computing. - Bioinformatics 26: 1569-1571.
Swarupanandan K. J. K., Mangaly T. K., Sonny K., Kishorekumar K. \& Basha S. C. 1996: The subfamilial and tribal classification of the family Asclepiadaceae. - Bot. J. Linn. Soc. 120: 327-369.
Swofford D. L. 2003: PAUP*. Phylogenetic Analysis Using Parsimony (*and other methods), ed. 4. - Sunderland: Sinauer Associates.
Taberlet P., Gielly L., Pautou G. \& Bouvet J. 1991: Universal primers for amplification of three non-coding regions of chloroplast DNA. - Pl. Molec. Biol. 17: 1105-1109.
Thiers B. [continuously updated]: Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden's virtual herbarium. - Published at http://sweetgum.nybg.org/science/ih [accessed 20 Aug 2014].
Wheeler T. J. \& Kececioglu J. D. 2007: Multiple alignments by aligning alignments. - Bioinformatics 23: i559-i568.
Woodson R. E. Jr. 1941: The North American Asclepiadaceae I. Perspective of the genera. - Ann. Missouri Bot. Gard. 28: 193-244.
Zwickl D. J. 2006: Genetic algorithm approaches for the phylogenetic analysis of large biological sequence datasets under the maximum likelihood criterion. Austin: Ph.D. dissertation, University of Texas.

Appendix. Species, vouchers, origin and GenBank accession numbers.

| Species | Voucher | Country of origin | trnT-L spacer | $\operatorname{trnL}$ intron | trnL-F spacer | rps 16 <br> intron | LEAFY |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pentacyphinae (outgroup) |  |  |  |  |  |  |  |
| Pentacyphus andinus (Ball.) Liede | Liede \& Meve 3451 <br> (UBT) | Peru | AJ492149 | AJ492150 | AJ492151 | AJ699335 | - |
| Pentacyphus lehmannii (Schltr.) Liede | Liede 3333 (cult. Bayreuth) | Ecuador | AJ290890 | AJ290889 | AJ290888 | AJ704928 | - |
| Diplolepinae |  |  |  |  |  |  |  |
| Diplolepis boerhaviifolia (Hook. \& Arn.) Liede \& Rapini | Liede \& Conrad 3062 (MSUN, ULM) | Chile | AJ428606 | AJ428607 | AJ428608 | AJ699331 | - |
| Diplolepis diemii (T. Mey.) Hechem \& C. Ezcurra | Naumann 1347 (MB) | Argentina | AJ699301 | AJ699304 | AJ699302 | AJ699303 | - |
| Diplolepis geminiflora (Decne.) Liede \& Rapini | Heyne 103 (MSUN) | Chile | AJ410181 | AJ410182 | AJ410183 | AJ699332 | - |
| Diplolepis hieronymi (Lorentz) Liede \& Rapini | Liede \& Conrad 3052 <br> (MSUN, ULM) | Argentina | AJ410211 | AJ410212 | AJ410213 | AJ699333 | - |
| Diplolepis menziesii Schult. | Liede \& Conrad 3060 (K, MSUN, ULM) | Chile | AJ699274 | AJ699273 | AJ699275 | AJ699276 | - |
| Diplolepis nummulariifolia (Hook. \& Arn.) Liede \& Rapini | Liede \& Conrad 3050 (MO, MSUN, ULM) | Argentina | AJ290853 | AJ290852 | AJ290851 | AJ699334 | - |
| Metastelmatinae |  |  |  |  |  |  |  |
| Barjonia chlorifolia Decne. | Rapini 485 (SPF) | Brazil | - | AY163667 | AY163667 | AJ704463 | - |
| Barjonia chlorifolia | Rapini 1395 (SPF) | Brazil | JN701896 | - | - | - | - |
| Blepharodon glaucescens (Decne.) Fontella | Ollerton 187 (UBT) | Guyana | AJ699290 | AJ699289 | AJ699291 | AJ699292 | - |
| Blepharodon grandiflorum Benth. | Liede \& Meve 3318 <br> (UBT) | Venezuela | AJ290836 | AJ290837 | AJ290838 | AJ699337 | - |
| Blepharodon lineare (Decne.) Decne. | Forzza 2027 (SPF) | Argentina | AJ704465 | AY163668 | AY163668 | AJ704466 | - |
| Blepharodon mucronatum Decne. | Liede 3243 (UBT) | Belize | AJ290841 | AJ290840 | AJ290839 | AJ699338 | - |
| Blepharodon pictum (Vahl) <br> W. D. Stevens | Rapini 938 (SPF) | Brazil | AJ704468 | AY163669 | AY163669 | AJ704467 | - |
| Ditassa anderssonii Morillo | Matezki SM 141 (UBT) | Ecuador | HE611702 | HE611761 | HE611800 | HE611839 | - |
| Ditassa banksii R. Br. ex Schult. | Konno 754 (SPF) | Brazil | AJ704474 | AY163674 | AY163674 | AJ704473 | - |
| Ditassa burchellii Hook. \& Arn. | Krapovickas 41170 (NY) | Argentina | AJ699294 | AJ699296 | AJ699295 | AJ699293 | - |
| Ditassa endoleuca Schltr. | Liede \& Meve 3564 (UBT) | Ecuador | HE611703 | HE611762 | HE611801 | HE611840 | - |
| Ditassa hispida (Vell.) Fontella | Konno 779 (SPF) | Brazil | AJ704479 | AJ704478 | AJ704480 | AJ704477 | - |
| Ditassa mucronata Mart. \& Zucc. | Arbo \& al. 3885 (NY) | Brazil | AJ704270 | AJ704259 | AJ704278 | AJ704279 | - |
| Ditassa obcordata Mart. | Cervi 4073 (NY) | Brazil | AJ428750 | AJ428751 | AJ428752 | AJ699340 | - |
| Ditassa retusa Mart. | Coradin \& al. 6075 (NY) | Brazil | AJ704281 | AJ704283 | AJ704282 | AJ704280 | - |
| Ditassa tomentosa (Decne.) Fontella | Konno 780 (SPF) | Brazil | AJ704485 | AJ704484 | AJ704486 | AJ704483 | - |
| Hemipogon acerosus Decne. | Wood \& Goyder 15689 (K) | Bolivia | AJ704289 | AJ704291 | AJ704290 | AJ704288 | - |
| Hemipogon andinus Rusby | Wood \& Wasshausen 16626 (K) | Bolivia | AJ704293 | AJ704292 | AJ704294 | AJ704295 | - |
| Hemipogon sprucei E. Fourn. | Wood \& Goyder 15719 (K) | Bolivia | AJ704297 | AJ704299 | AJ704298 | AJ704296 | - |
| Metastelma linearifolium A. Rich. | Urquiola \& al. 561 (FR) | Cuba | AJ428807 | AJ428808 | AJ428809 | AJ699341 | - |
| Metastelma aff. parviflorum R. Br. | Liede \& Meve 3328 <br> (UBT) | Venezuela | AJ428777 | AJ428778 | AJ428779 | AJ699342 | - |
| Metastelma schaffneri A. Gray | Liede \& Conrad 2962 <br> (UBT) | Mexico | AJ410214 | AJ410215 | AJ410216 | AJ699343 | - |
| Minaria acerosa (Mart.) <br> T. U. P. Konno \& Rapini | Ribas \& Santos 889 (NY) | Brazil | AJ699286 | AJ699288 | AJ699287 | AJ699285 | - |
| Minaria decussata (Mart.) T. U. P. Konno \& Rapini | Arbo \& al. 4039 (NY) | Brazil | AJ704218 | AJ704220 | AJ704219 | AJ704217 | - |
| Minaria grazielae (Fontella \& Marquete) T. U. P. Konno \& Rapini | Omlor 147 (MJG) | Brazil | AJ410202 | AJ410203 | AJ410204 | AJ699339 | - |


| Species | Voucher | Country of origin | $\operatorname{trnT}-L$ <br> spacer | trnL intron | trnL-F <br> spacer | rps16 <br> intron | LEAFY |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Minaria magisteriana (Rapini) T. U. P. Konno \& Rapini | Rapini 597 (SPF) | Brazil | AJ704481 | AY163681 | AY163681 | AJ704482 | - |
| Nautonia nummularia Decne. | Liede \& Conrad 3031 <br> (ULM) | Argentina | AJ410226 | AJ410227 | AJ410228 | AJ699344 | - |
| Nephradenia acerosa Decne. | Philcox 3303 (K) | Brazil | AJ704497 | AY163704 | AY163705 | AJ704496 | - |
| Nephradenia asparagoides (Decne.) E. Fourn. | Irwin 13012 (K) | Brazil | AJ704498 | AY163706 | AY163707 | AJ704499 | - |
| Peplonia asteria (Vell.) <br> Fontella \& E. A. Schwarz | Fontella sub Konno 773 <br> (SPF) | Brazil | AJ704301 | AJ704300 | AJ704302 | AJ704303 | - |
| Peplonia organensis (E. Fourn.) Fontella \& Rapini | Konno 854 (SPF) | Brazil | AJ704487 | AY163688 | AY163688 | AJ704488 | - |
| Petalostelma sarcostemma (Lillo) Liede \& Meve | Liede \& Conrad 3090 <br> (MSUN, ULM) | Argentina | AJ428786 | AJ428787 | AJ428788 | AJ699345 | - |
| Orthosiinae |  |  |  |  |  |  |  |
| Jobinia chlorantha <br> (K. Schum.) Malme | Wolff 110 (UBT) | Ecuador | HE611704 | HE611751 | HE611751 | HE611842 | - |
| Jobinia formosa (N. E. Br.) Liede \& Meve | Liede \& Conrad 3061 (MSUN) | Chile | AJ428639 | AJ428640 | AJ428641 | AJ699346 | - |
| Jobinia umbellata (Rusby) Liede \& Meve | Goyder sub Wood 15798 (K, UBT) | Bolivia | AJ704317 | AJ704316 | AJ704318 | AJ704319 | - |
| Monsanima morrenioides (Goyder) Liede \& Meve | Omlor 160 (MJG) | Brazil | AJ428684 | AJ428685 | AJ428686 | AJ699348 | - |
| Orthosia ellemannii (Morillo) Liede \& Meve | Liede \& Meve 3457 (UBT) | Ecuador | AJ428780 | AJ428781 | AJ428782 | AJ699350 | - |
| Orthosia kunthii Decne. | Valdés \& al. 1961 (NY) | Mexico | HE611720 | HE611774 | HE611813 | HE611857 | - |
| Orthosia scoparia (Nutt.) Liede \& Meve | Axelrod 8409 (NY) | Puerto Rico | HE611726 | HE611780 | HE611819 | HE611862 | - |
| Scyphostelma beckii (Morillo) Liede \& Meve | Liede \& Conrad 3141 <br> (MSUN, ULM) | Bolivia | AJ704305 | AJ704307 | AJ704306 | AJ704304 | - |
| Scyphostelma ecuadorense (Schltr.) Liede \& Meve | Harling \& Ståhl 26512 (S) | Ecuador | HE611741 | HE611791 | HE611830 | HE611874 | - |
| Scyphostelma harlingii <br> (Morillo) Liede \& Meve | Liede \& Meve 3460 (UBT) | Ecuador | AJ704309 | AJ704308 | AJ704310 | AJ704311 | - |
| Oxypetalinae |  |  |  |  |  |  |  |
| Araujia angustifolia Steud. | Liede \& Conrad 3012 <br> (UBT) | Argentina | AJ699290 | AJ699289 | AJ699291 | AJ704333 | - |
| Araujia plumosa Schltr. | Liede \& Conrad 3070 <br> (MSUN, ULM) | Argentina | AJ704335 | AJ704337 | AJ704336 | AJ704334 | - |
| Araujia sericifera Brot. | Liede \& Conrad 3007 <br> (ULM) | Argentina | AJ428792 | AJ428793 | AJ428794 | AJ699352 | - |
| Funastrum angustifolium (Pers.) Liede \& Meve | Liede \& Conrad 3401 <br> (UBT) | U.S.A. | AJ428759 | AJ428760 | AJ428761 | AJ699353 | - |
| Funastrum arenarium (Decne. ex Benth.) Liede | Liede \& Conrad 2952 <br> (GA, ULM) | Mexico | AJ290859 | AJ290858 | AJ290857 | AJ699354 | - |
| Funastrum clausum (Jacq.) Schult. | Liede \& Conrad 2599 (MO, MSUN) | Mexico | AJ290860 | AJ290861 | AJ290862 | AJ699355 | - |
| Funastrum odoratum Schltr. | Liede \& Conrad 2560 (MO, MSUN) | Mexico | AJ290871 | AJ290870 | AJ290869 | AJ699356 | - |
| Morrenia odorata (Hook. \& Arn.) Lindl. | Liede \& Conrad 3009 (MO, MSUN, ULM) | Argentina | AJ704343 | AJ704345 | AJ704344 | AJ704342 | - |
| Oxypetalum balansae Malme | Liede \& Conrad 3015 <br> (ULM) | Argentina | AJ704347 | AJ704346 | AJ704348 | AJ704349 | - |
| Oxypetalum banksii Schult. | Rapini 911 (SPF) | Brazil | AJ704503 | AY163710 | AY163710 | AJ704502 | - |
| Oxypetalum brachystemma Malme | Liede \& Conrad 3069 <br> (MSUN, ULM) | Argentina | AJ704351 | AJ704353 | AJ704352 | AJ704350 | - |
| Oxypetalum capitatum Mart | Mello-Silva 1923 (SPF) | Argentina | AJ704504 | AY163711 | AY163711 | AJ704505 | - |
| Oxypetalum coccineum Griseb. | Galetto 562 (CORD) | Argentina | AJ704328 | AJ704329 | AJ704326 | AJ704327 | - |
| Oxypetalum coeruleum <br> (D. Don ex Sweet) Decne. | Liede \& Conrad s.n. <br> (ULM) | Argentina | AJ704355 | AJ704354 | AJ704356 | AJ704357 | - |
| Oxypetalum dactylostelma Goyder. | Wood 15195 (K, UBT) | Bolivia | AJ704339 | AJ704338 | AJ704340 | AJ704341 | - |
| Oxypetalum lanatum Decne. | Rapini 929 (SPF) | Brazil | AJ704509 | AJ704507 | AJ704508 | AJ704506 | - |
| Oxypetalum minarum E. Fourn. | Rapini 908 (SPF) | Brazil | AJ704510 | AY163713 | AY163713 | AJ704511 | - |


| Species | Voucher | Country of origin | trnT-L spacer | $\operatorname{trnL}$ <br> intron | trnL-F spacer | rps16 <br> intron | LEAFY |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Oxypetalum pannosum Decne. | Rapini 935 (SPF) | Brazil | AJ704515 | AJ704513 | AJ704514 | AJ704512 | - |
| Oxypetalum pentasetum (Rusby) Goyder \& Rapini | Liede \& Conrad 3128 <br> (ULM) | Bolivia | AJ704253 | AJ704252 | AJ704254 | AJ704255 | - |
| Oxypetalum solanoides Hook. \& Arn. | Liede \& Conrad 3004 (MO, MSUN, ULM) | Argentina | AJ704359 | AJ704361 | AJ704360 | AJ704358 | - |
| Oxypetalum sublanatum Malme | Rapini 937 (SPF) | Brazil | AJ704516 | AY163715 | AY163715 | AJ704517 | - |
| Oxypetalum sylvestre (Hook. \& Arn.) Goyder \& Rapini | Liede \& Conrad 3024 (K, MO, MSUN, ULM) | Argentina | AJ410244 | AJ410245 | AJ410246 | AJ699363 | - |
| Oxypetalum warmingii (E. Fourn.) Fontella \& Marquete | Rapini 906 (SPF) | Brazil | AJ704521 | AJ704519 | AJ704520 | AJ704518 | - |
| Oxypetalum wightianum Hook. \& Arn. | Rapini 705 (SPF) | Brazil | AJ704522 | AJ704524 | AJ704523 | AJ704525 | - |
| Philibertia boliviana (Baill.) Goyder | Wood \& al. 15286 (K) | Bolivia | AJ704231 | AJ704233 | AJ704232 | AJ704230 | - |
| Philibertia candolleana (Hook. \& Arn.) Goyder | Liede \& Conrad 3055 <br> (ULM) | Argentina | AJ410175 | AJ410176 | AJ410177 | AJ699357 | - |
| Philibertia discolor (Schltr.) Goyder | Mello-Silva 1887 (SPF) | Argentina | AJ704527 | AY163700 | AY163700 | AJ704526 | - |
| Philibertia fontellae Goyder | Wood \& Goyder 15543 <br> (K, UBT) | Bolivia | AJ492152 | AJ492153 | AJ492154 | AJ699358 | - |
| Philibertia gilliesii Hook. \& Arn. | Liede \& Conrad 3054 <br> (MO, MSUN, ULM) | Argentina | AJ290896 | AJ290895 | AJ290894 | AJ699359 | - |
| Philibertia globiflora Goyder | Wood 15803 (K, UBT) | Bolivia | AJ704235 | AJ704234 | AJ704236 | AJ704238 | - |
| Philibertia latiflora (Griseb.) Goyder | Liede \& Conrad 3091 <br> (MSUN, ULM) | Argentina | AJ704240 | AJ704242 | AJ704241 | AJ704239 | - |
| Philibertia lysimachioides (Wedd.) T. Mey. | Liede \& Conrad 3139 <br> (MSUN, ULM) | Bolivia | AJ290902 | AJ290901 | AJ290900 | AJ699360 | - |
| Philibertia multiflora (T. Mey.) Goyder | Wood \& Serrano 14466 (K, UBT) | Bolivia | AJ704244 | AJ704243 | AJ704245 | AJ704246 | - |
| Philibertia parviflora (Malme) Goyder | Liede \& Conrad 3113 <br> (UBT) | Argentina | AJ410223 | AJ410224 | AJ410225 | AJ699361 | - |
| Philibertia peduncularis (Benth.) Goyder | Wood \& Goyder 15444 <br> (K, UBT) | Bolivia | AJ704249 | AJ704251 | AJ704250 | AJ704247 | - |
| Philibertia picta Schltr. | Liede \& Conrad 3104 (K, MO, MSUN, ULM) | Argentina | AJ290903 | AJ290904 | AJ290905 | AJ699362 | - |
| Tweedia brunonis Hook. \& Arn. | Liede \& Conrad 3058 <br> (UBT) | Argentina | AJ704257 | AJ704260 | AJ704258 | AJ704256 | - |
| Tassadiinae |  |  |  |  |  |  |  |
| Tassadia berteroana (Spreng.) W. D. Stevens | Nee 36277 (NY) | Bolivia | AJ428789 | AJ428790 | AJ428791 | AJ699336 | - |
| Tassadia guianensis Decne. | Wolff 528 (UBT) | Ecuador | AJ699278 | AJ699280 | AJ699279 | AJ699277 | - |
| Tassadia obovata Decne. | Matezki 332 (UBT) | Ecuador | AJ699282 | AJ699281 | AJ699283 | AJ699284 | - |
| Gonolobinae (study group) |  |  |  |  |  |  |  |
| Anemotrochus eggersii (Schltr.) Mangelsdorff \& al. | Liede \& Meve 3592 <br> (UBT) | Cuba | HF547076 | HF547131 | HF547131 | HF547185 | LN901538 |
| Anemotrochus eggersii | Neil 270 (FTG) | Caicos <br> Islands | HF547077 | HF547132 | HF547132 | HF547186 | LN901539 |
| Anemotrochus eggersii | RMC 387 (FR) | Cuba | HF547078 | HF547133 | HF547133 | HF547187 | LN901540 |
| Anemotrochus viridivenius (Alain) Mangelsdorff \& al. | Veloz \& al. 836 (JBSD) | Dominican Republic | - | - | EU031637 | EU038890 | EU038969 |
| Anemotrochus viridivenius | Clase \& al. 5609 (JBSD) | Dominican Republic | LN901501 | LN901496 | LN901496 | LN901514 | LN901527 |
| Anemotrochus yamanigueyensis Mangelsdorff \& al. | Mangelsdorff RMC 222a <br> (FR) | Cuba | LN901511 | LN901555 | LN901548 | LN901524 | LN901535 |
| Anemotrochus yamanigueyensis | Mangelsdorff RMC 222b <br> (FR) | Cuba | LN901512 | LN901556 | LN901549 | LN901525 | LN901536 |
| Anemotrochus yamanigueyensis | Mangelsdorff RMC 357 <br> (FR) | Cuba | LN901513 | LN929898 | LN929899 | LN901526 | LN901537 |
| Chloropetalum denticulatum (Vahl) Morillo | Hammel 9304 <br> (DUKE) | Costa Rica | - | - | EU031614 | EU038867 | EU038933 |
| Fischeria panamensis Spellman | Folsom 9364 (DUKE) | Costa Rica | - | - | EU031577 | EU038832 | EU038896 |
| Fischeria scandens DC. | Krings 1407 (NCSC) | Jamaica | - | - | EU031578 | EU038833 | EU038897 |


| Species | Voucher | Country of origin | trnT-L spacer | trnL <br> intron | trnL-F spacer | rps16 <br> intron | LEAFY |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Gonolobus albomarginatus (Pittier) Woodson | Taylor \& Skotak 4455 <br> (DUKE) | Costa Rica | - | - | EU031579 | EU038834 | EU038898 |
| Gonolobus arizonicus (A. Gray) Woodson | van Devender 2004-893 <br> (ARIZ) | Mexico | - | - | EU031580 | EU038835 | EU038899 |
| Gonolobus barbatus Kunth | Conrad 9325 (UBT) | Mexico | AJ704262 | AJ704261 | AJ704263 | AJ704264 | - |
| Gonolobus barbatus | Taylor 2227 (DUKE) |  | - | - | - | - | EU038900 |
| Gonolobus bibarbatus W. D. Stevens | Cowan 5620 (TEX) | Mexico | - | - | EU031581 | EU038836 | EU038901 |
| Gonolobus breedlovei <br> L. O. Williams | King 2778 (TEX) | Mexico | - | - | EU031582 | EU038837 | EU038902 |
| Gonolobus chloranthus Schltdl. | Cowan 5513 (TEX) | Mexico | - | - | EU031583 | EU038838 | EU038903 |
| Gonolobus fraternus Schltdl. | Fishbein 5164 (ARIZ) | Mexico | - | - | EU031585 | EU038840 | EU038904 |
| Gonolobus gonoloboides (Greenm.) Woodson | Reina 2003-884 (ARIZ) | Mexico | - | - | EU031587 | EU038842 | EU038905 |
| Gonolobus grandiflorus (Cav.) Schult. | Fishbein 5114 (ARIZ) | Mexico | - | - | EU031588 | EU038843 | EU038906 |
| Gonolobus iyanolensis Krings | Krings SL1 (NCSC) | Saint Lucia | - | - | EU031589 | EU038844 | EU038907 |
| Gonolobus jaliscensis B. L. Rob. \& Greenm. | Fishbein 5121 (ARIZ) | Mexico | - | - | EU031590 | EU038845 | EU038908 |
| Gonolobus jamaicensis Rendle | Krings 1393 (NCSC) | Jamaica | - | - | EU031591 | EU038846 | EU038909 |
| Gonolobus niger (Cav.) Schult. | Mayfield \& al. 860 <br> (TEX) | Mexico | - | - | EU031592 | EU038847 | EU038910 |
| Gonolobus ophioglossa Woodson | Mangelsdorff RMP 1296 <br> (FR) | Panama | LN901502 | LN901497 | LN901497 | LN901515 | - |
| Gonolobus pectinatus Brandegee | Prinzie \& Lozada 202 <br> (TEX) | Mexico | - | - | EU031593 | EU038848 | EU038911 |
| Gonolobus stapelioides Desv. ex Ham. | Krings 1395 (NCSC) | Jamaica | - | - | EU031595 | EU038850 | EU038912-15* |
| Gonolobus stenosepalus (Donn. Sm.) Woodson | Taylor 2536 (DUKE) | Mexico | - | - | EU031596 | EU038851 | EU038916 |
| Gonolobus stephanotrichus Griseb | Krings \& al. s.n. (NCSC) | Cuba | - | - | EU031597 | EU038852 | EU038917 |
| Gonolobus suberosus (L.) R. Br. | ex Wyatt s.n. (GA) | U.S.A. | AJ704275 | AJ704277 | AJ704276 | AJ704274 | - |
| Gonolobus suberosus | Krings FL9 (NCSC) | U.S.A. | - | - | - | - | EU038918 |
| Gonolobus uniflorus Kunth | van Devender 2003-1323 <br> (ARIZ) | Mexico | - | - | EU031601 | EU038855 | EU038919 |
| Gonolobus waitukubuliensis Krings | Krings 1386 (NCSC) | Dominica | - | - | EU031602 | EU038856 | EU038920 |
| Gonolobus youroumaynensis Krings | Krings 1374 (NCSC) | Saint Vincent | - | - | EU031603 | EU038857 | EU038921 |
| Ibatia rubra (H. Karst.) Morillo | Proosdij \& al. 667 (NY) | Aruba | - | - | EU031632 | EU038885 | EU038954 |
| Macroscepis diademata (Ker Gawl.) W. D. Stevens | Heyne s.n. (UBT) | Guatemala | AJ704266 | AJ704268 | AJ704267 | AJ704265 | LN901541 |
| Matelea bicolor (Britton \& P. Wilson) Woodson | Krings 1410 (NCSC) | Cuba | - | - | EU031606 | EU038860 | EU038925-27* |
| Matelea bicolor | Liede \& Meve 3583 (UBT) | Cuba | LN901503 | LN901498 | LN901498 | LN901516 | LN901528 |
| Matelea cordata (Brandegee) Woodson | Tenorio 11556 (TEX) | Mexico | - | - | EU031608 | EU038862 | EU038928 |
| Matelea cordifolia (A. Gray) Woodson | Stevens 1517 (MSC) | Mexico | - | - | EU031609 | EU038863 | EU038929 |
| Matelea correllii Spellman | Correll 48157 (DUKE) | Bahamas | - | - | EU031610 | EU038864 | EU038930 |
| Matelea cyclophylla (Standl.) Woodson | Barad s.n. (UBT) | Mexico | AJ704271 | AJ704269 | AJ704272 | AJ704273 | - |
| Matelea cyclophylla | Stevens \& al. 2299 (MSC) | Mexico | - | - | - | - | EU038931 |
| Matelea decaisnei Woodson | Tucker 2766 (DUKE) | Mexico | - | - | EU031612 | EU038866 | EU038932 |
| Matelea dictyantha Woodson | Stevens \& al. 2311 (MSC) | Mexico | - | - | EU031614 | EU038868 | EU038934 |
| Matelea ekmanii (Urb.) Woodson | Krings 1411 (NCSC) | Cuba | - | - | EU031615 | EU038869 | EU038935-39* |
| Matelea gonoloboides (B. L. Rob. \& Greenm.) Woodson | Stevens 1349 (MSC) | Mexico | - | - | EU031616 | EU038870 | EU038940 |
| Matelea hemsleyana Woodson | Stevens 1399 (MSC) | Mexico | - | - | EU031617 | EU038871 | EU038941 |


| Species | Voucher | Country of origin | trnT-L <br> spacer | $t r n L$ intron | trnL-F <br> spacer | rps 16 <br> intron | LEAFY |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Matelea inconspicua (Brandegee) Woodson | Panero 5804 (TEX) | Mexico | - | - | EU031618 | EU038872 | EU038942 |
| Matelea lanata (Zucc.) Woodson | Hinton \& al. 23755 (TEX) | Mexico | - | - | EU031619 | EU038873 | EU038943 |
| Matelea nipensis (Urb.) Woodson | Krings 1412 (NCSC) | Cuba | - | - | EU031622 | EU038876 | EU038944 |
| Matelea nipensis | Mangelsdorff RMC 318 <br> (FR) | Cuba | LN901504 | LN901550 | LN901543 | LN901517 | LN901529 |
| Matelea oblongata (Griseb.) Woodson | Krings 1413 (NCSC) | Cuba | - | - | EU031623 | EU038877 | EU038946-48* |
| Matelea phainops Krings | Liogier 16617 (NY) | Dominican Republic | - | - | EU031626 | EU038879 | EU038949 |
| Matelea prosthecidiscus Woodson | Stevens \& Fairhurst 1811 <br> (DUKE) | Mexico | - | - | EU031627 | EU038880 | EU038950 |
| Matelea pubiflora (Decne.) Woodson | Orzell \& Bridges 20226 <br> (USCH) | U.S.A. | - | - | EU031628 | EU038881 | EU038951 |
| Matelea quirosii (Stand1.) Woodson | Steinmann 1084 (NY) | Mexico | - | - | EU031630 | EU038883 | EU038952 |
| Matelea reticulata (Engelm. ex A. Gray) Woodson | Krings L3 (NCSC) | U.S.A. | - | - | EU031631 | EU038884 | EU038953 |
| Matelea sintenisii (Schltr.) Woodson | Krings 1405 (NCSC) | Puerto Rico | - | - | EU031633 | EU038886 | EU038955-58* |
| Matelea tamnifolia (Griseb.) Woodson | Krings 1414 (NCSC) | Cuba | - | - | EU031634 | EU038887 | EU038959-65* |
| Matelea tamnifolia | Mangelsdorff RMC 125 <br> (FR) | Cuba | LN901505 | LN901499 | LN901499 | LN901518 | LN901530 |
| Matelea trachyantha (Greenm.) W. D. Stevens | Stevens \& al. 2300 (DUKE) | Mexico | - | - | EU031635 | EU038888 | EU038966 |
| Matelea variifolia (Schltr.) Woodson | Krings 1397 (NCSC) | Puerto Rico | - | - | EU031636 | EU038889 | EU038968-69* |
| Schubertia grandiflora Mart. \& Zucc. | Liede \& Conrad 3033 (MSUN, UBT, ULM) | Argentina | AJ428825 | AJ428826 | AJ428827 | AJ699364 | LN901542 |
| Tylodontia cf. cubensis Griseb. | Liede \& Meve 3593 <br> (UBT) | Cuba | LN901506 | LN901500 | LN901500 | LN901519 | - |
| Tylodontia fuscula (C. Wright) Mangelsdorff \& al. | Mangelsdorff RMC 327 <br> (FR) | Cuba | LN901507 | LN901551 | LN901544 | LN901520 | LN901531 |
| Tylodontia stipitata Mangelsdorff \& al. | Mangelsdorff RMC 332 <br> (FR) | Cuba | LN901509 | LN901553 | LN901546 | LN901522 | LN901533 |
| Tylodontia stipitata | Mangelsdorff RMC 333 <br> (FR) | Cuba | LN901510 | LN901554 | LN901547 | LN901523 | LN901534 |
| Tylodontia urceolata (Griseb.) Mangelsdorff \& al. | Mangelsdorff RMC 233 <br> (FR) | Cuba | LN901508 | LN901552 | LN901545 | LN901521 | LN901532 |

## Willdenowia

Open-access online edition www.bioone.org/loi/will BiOOne Online ISSN 1868-6397 • Print ISSN 0511-9618 • Impact factor 0.500
Published by the Botanic Garden and Botanical Museum Berlin, Freie Universität Berlin © 2016 The Authors • This open-access article is distributed under the CC BY 4.0 licence


[^0]:    BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

[^1]:    1 Institut für Ökologie, Evolution und Diversität, Biologicum, Goethe-Universität, Max-von-Laue-Str. 13, 60438 Frankfurt am Main, Germany; *e-mail: mangelsdorff@bio.uni-frankfurt.de (author for correspondence).
    2 Lehrstuhl fur Pflanzensystematik, Universität Bayreuth, Universitätsstr. 30, 95440 Bayreuth, Germany.

