

YANOMAMUA ARACA (GENTIANACEAE),
A NEW GENUS AND SPECIES FROM SERRA DO ARAÇÁ, AN OUTLIER
OF THE GUAYANA REGION IN AMAZONAS STATE, BRAZIL

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Abstract. *Yanomamua araca* is described as a new genus and species from Serra do Araçá, an outlier of the Guayana Region in the state of Amazonas, Brazil. *Yanomamua* is unique in the Gentianaceae as an herb with sessile subcordate pandurate (fiddle-shaped) leaves, and inflorescences composed of oppositely paired solitary flowers situated in the axils of the upper three leaf pairs. Only limited material is available, and flower morphology is unknown. A phylogenetic approach was used to investigate possible relationships to other genera in Helieae, which yielded a likely relationship to several genera in the *Symbolanthus-Chelonanthus* clade but not a strong relationship to any particular genus. Instead it appears that this genus might represent a more internal, older branch within the tribe.

Keywords: inflorescence, morphology, new taxa, Neotropics, phylogeny, tepui.

A search through undetermined neotropical Gentianaceae at the New York Botanical Garden Herbarium (NY) revealed a specimen with an unusual suite of characters. A duplicate was found by PM at Utrecht (U), and the primary set was found during a visit by JG and LS to Manaus, Brazil (INPA). Though the specimens are in fruiting state and flowers are missing, ample characters were found to name the taxon, which is especially important since it is unlikely to be recollected anytime in the near future. Describing this taxon now also draws attention to it and its unique characteristics that might increase the likelihood of it being sought after in future expeditions.

The discovery and description of new genera

of neotropical Gentianaceae has been facilitated by numerous new collections and molecular methods for study. As a result, a number of new genera have been described recently, including *Aripuana* (Struwe et al., 1997), *Celiantha* (Maguire, 1981), *Neblinantha* (Maguire, 1985), *Rogersonanthus* (Maguire and Boom, 1989), *Saccifolium* (Maguire and Pires, 1978), *Sipapoantha* (Maguire and Boom, 1989), and *Tetrapollinia* (Maguire and Boom, 1989), while others are still in preparation (Struwe et al., in prep). The discovery of another new genus of neotropical Gentianaceae is therefore not altogether surprising, especially since the collection comes from an isolated and biologically poorly known area.

MATERIALS AND METHODS

The authors examined relevant herbarium specimens from INPA, NY, and U.

Seeds were studied using scanning electron microscopy (SEM) without pretreatment of

ultrasound. Seeds were placed on double-sided carbon stickers mounted on aluminum sample holders, sputtered with gold, and examined with a Philips XL 30 ESEM-FEG microscope.

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since these are unknown for *Yanomamua*. Only 3% of the data matrix cells contained missing data, and 1% were polymorphisms. Within MacClade, all polytomies were treated as “soft polytomies.” Possible phylogenetic relationships based on morphological data were investigated by moving *Yanomamua* to all possible place-

ments in the backbone cladogram and checking for tree lengths. A shorter tree length assumes a better morphological fit and closer relationship for a genus or clade to *Yanomamua*. Possible synapomorphies were investigated for most-parsimonious placements by using the Trace Character option in MacClade.

RESULTS

Yanomamua araca J. R. Grant, Maas & Struwe, *gen. et sp. nov.* TYPE: BRAZIL. Amazonas: Serra do Araçá, southern massif, W facing talus slope, tall montane forest, 0°48' N, 63°18' W,

herb to 1 m, fruit green, 1 March 1984, *J. Pipoly, G. Samuels, I. Dunn & C. S. Rosario* 6772 (Holotype: INPA [sheet #197.977]; Isotypes: INPA [sheet #134.040], NY, U). Fig. 2–3.

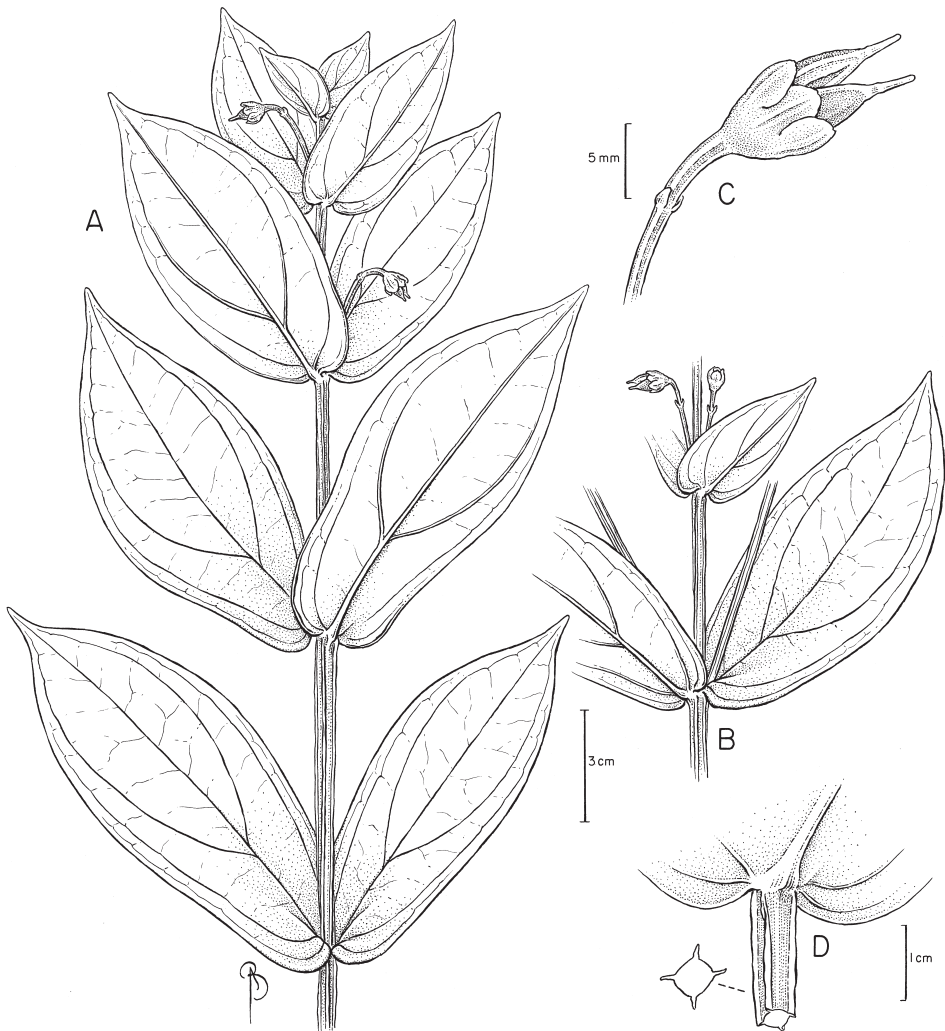


FIGURE 2. *Yanomamua araca* J. R. Grant, Maas & Struwe. A–B, habit of fruiting branches, showing pandurate, sessile leaves and axillary, opposite inflorescences of single flowers in the upper leaf axils; C, fruit after dehiscence with persistent calyx; D, quadrangular stem with decurrent wings.

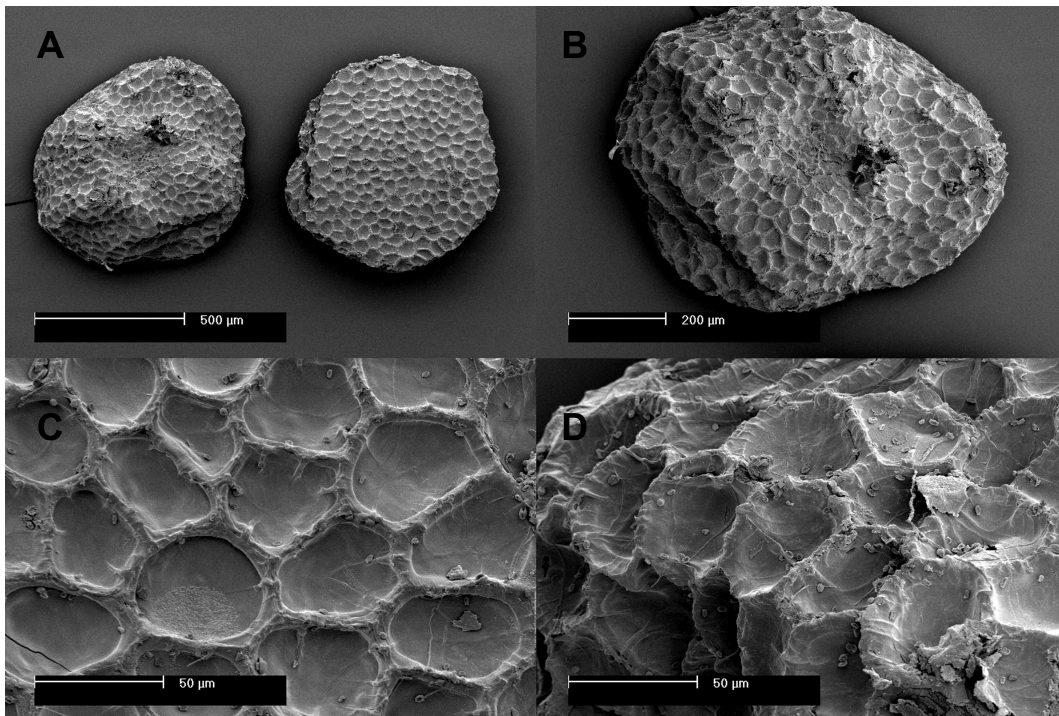


FIGURE 3. Seed anatomy of *Yanomamua araca*. A, seeds: left seed—ventral side, right seed—dorsal side; B, ventral side of seed; C, detail of testa on dorsal side; D, detail of testa on ventral side.

Genus et species novum cui Chelonantho Gilg affine, sed foliis sessilibus subcordatis panduratis, et floribus solitariis in axillis foliorum superiorum differt.

Herb to 1 m, glabrous throughout. Stems quadrangular, hollow, 3–4 mm in diam. just below inflorescence, decurrently winged, wings to 1.5 mm wide. Leaves pandurate (fiddle-shaped), varying from elliptic, obovate-pandurate, obovate, to oblong-elliptic, sessile, glabrous above and below, papery thin, 9.5–15.5 × 4.3–6.3 cm, green; leaf base oblique, inaequilateral, subcordate; leaf apex acuminate; leaf margin entire, membranaceous, not thickened or recurved; venation aside from the midvein consisting of two secondary pairs of veins, one that extends from near the base to the apex, and another more-prominent opposite-to-subopposite pair that appear about 1/4 to 1/3 of the way up the leaf extending to the apex, both pairs arcuating toward the tip, the midvein sunken above and raised below, the secondary veins less so. Inflorescence composed of solitary flowers oppositely paired in the axils of the upper three leaf pairs; sometimes the lowest pair on 13- to 15-cm-long

peduncles (defined as peduncles rather than pedicels because of the presence of both bracts and bracteoles subtending the flowers). Bracts (essentially leaves, yet defined as bracts when they directly subtend flowers), pandurate, elliptic, obovate-pandurate, obovate, to ovate, sessile, 38–78 mm × 19–41 mm; bract base oblique, inaequilateral to subcordate; bract apex acuminate. Flowers pedicellate; pedicels 2.5–7.0 cm long; bracteoles scale-like and triangular, 1.5–2.5 × 0.8–1.2 mm, to leaf-like but smaller and ovate, to 19 × 9 mm. Calyx campanulate, 5–6 × 5–6 mm, glabrous, shiny, honey to chestnut colored when dried, persistent in fruit; calyx lobes broadly ovate to orbicular, margin hyaline, 3–4 × 3–4 mm, rounded to obtuse, dorsally thickened at the middle then with a shallow depression from the lobe base to apex. Corolla, stamens, and pistil unknown. Fruit a capsule, medially dehiscent, bilocular, dry capsule with persistent style remnant, ellipsoidal, 7–9 × 2.5–4.0 mm, shiny, glabrous, rugose, brown, nodding, placentas inrolled, bilobed; style remnant 1–4 mm long, thickened toward the apex. Seeds not winged, laterally flattened disks with 5(–7) sides and measuring

100–300 × 500–900 mm, the dorsal side entirely flat (Fig. 3A, right seed), the ventral side with rounded elevations (Fig. 3A, left seed; Fig. 3B); the testa (Fig. 3C–D) reticulate to reticulate-foveate; testa cells polygonal to rounded, and irregularly oriented; anticlinal walls straight to curved, with robust band-like thickenings especially on the ventral side; cuticle smooth to interrupted by the band-like thickenings extending downward from the anticlinal walls.

Etymology: *Yanomamua* [yah-no-mah-moo-uh] derives from the name of an indigenous people of northern Brazil and southern Venezuela, the Yanomamö [yah-no-mah-moo] (aka Yanomami, Yanomama, Ianomami, Yanoama; Chagnon, 1992). The area around and northwest of Serra Araçá into southern Venezuela is indigenous Yanomamö territory, and partially protected (see map at <http://www.wausau.k12.wi.us/east/Student%20Files/anthropology/ib%20anthro/Template%202/image/good%20map.jpg>). The specific epithet is from the type locality Serra do Araçá, Brazil, and since it is based on a word used in apposition, it is to be maintained according to Article 23.1 of the ICBN (Greuter et al., 2000). Araçá is also a common name for the edible fruits of several species of Amazonian Myrtaceae and Melastomataceae.

Distribution: *Yanomamua araca* is known only from the type specimen collected on Serra do Araçá, Brazil, a low tepui-like sandstone mountain in the Guayana Region (Berry et al., 1995). Serra do Araçá has a highly distinctive Guayanian rather than Amazonian flora, typical of that of the tepuis of the Guayana Highlands (Aymard and Cuello, 2004; Berry et al., 1995; Prance and Johnson, 1992). Despite being a slight outlier, Serra do Araçá has been classified as belonging to the Central Guayana Province, and more specifically to the Vinilla-Tapirapecó Subdistrict of Unturán District (Berry et al., 1995). *Yanomamua* is therefore most likely related to the rich gentian flora of the Guayana Highlands (see Struwe et al. 1999, for a floristic treatment of this area). Serra do Araçá is included in Araçá State Park, in Amazonas state, Brazil, created in 1990, occupying an area of 1,818,700 ha.

Several genera of Gentianaceae are largely restricted to the Guayana Region and the tepuis in particular: *Adenolisanthus* (Progel) Gilg,

Celiantha Maguire, *Chorisepalum* Gleason & Wodehouse, *Neblinantha* Maguire, *Rogersonanthus* Maguire & Boom, *Saccifolium* Maguire & Pires, and *Sipapoa* Maguire & Boom (Struwe et al., 1997, 1999). Although *Macrocarpaea* and *Symbolanthus* G. Don are much more diverse in the Andean Region, they are both represented in the Guayana Region by several species (Grant and Struwe, 2001; Struwe et al., 1999).

A considerable number of new plant species have been described from the Serra do Araçá since J. Murça Pires conducted the first botanical collections in 1975, including *Stegolepis piresii* Maguire (Rapateaceae), *Caraipa aracaensis* Kubitzki (Clusiaceae), *Diacidia aracaensis* W. R. Anderson (Malpighiaceae), *Doliocarpus aracaensis* Aymard (Dilleniaceae), *Gleasonia piresii* B. M. Boom (Rubiaceae), *Gongylolepis oblanceolata* Pruski (Asteraceae), *Licania aracaensis* Prance (Chrysobalanaceae), *Meriania aracaensis* Wurdack (Melastomataceae), *Pagamea aracaensis* B. M. Boom (Rubiaceae), *Podocarpus aracaensis* de Laub. & Silba, *Raveniopsis aracaensis* J. A. Kallunki & Steyerl. (Rutaceae), *Stenopadus aracaensis* Pruski (Asteraceae), *Tepuianthus aracaensis* Steyerl. & Maguire (Tepuianthaceae), *Ternstroemia aracaensis* B. M. Boom (Theaceae), *Struthanthus prancei* Kuijt (Loranthaceae), and *Aegiphila aracaensis* Aymard & Cuello (Verbenaceae). In Gentianaceae, no fewer than five other species have been found on Serra do Araçá: *Chelonanthus cf. alatus* (Aubl.) Pulle; *C. purpurascens* (Aubl.) Struwe, S. Nilsson & V. A. Albert; *Chelonanthus* sp. 1; *Chelonanthus* sp. 2; and *Symbolanthus cf. elisabethae* Gilg. (identification to species of some these collections will probably be possible only when monographic and phylogenetic studies are completed (K. B. Lepis and L. Struwe, in prep.). The description of a new taxon of Gentianaceae from this area is therefore not entirely unexpected.

In our phylogenetic investigation of morphological similarities, it became apparent that there are several nearly equally most-parsimonious placements for *Yanomamua* in the Helieae tree (Fig. 1). Only 4 placements out of 34 possible topological placements resulted in tree lengths shorter than 118 steps: below *Adenolisanthus-Rogersonanthus* clade (115 steps), below *Zonanthus-Macrocarpaea* clade (117 steps),

below *Lagenanthus-Aripuana* (117 steps). This indicates that *Yanomamua* might be related to the ancestor of several main branches in the Helieae tribe, with some limited support for a closer relationship to a specific subclade, including *Adenolisianthus* Gilg, *Symbolanthus*, *Helia* Mart., *Chelonanthus*, *Calolisianthus*, *Tetrapollinia*, and *Rogersonanthus*. It is remarkable that the closest similarity within this group is found with

the very dissimilar *Tetrapollinia*, a small ephemeral herb common on grasslands and savannas in the Guianas and in the Amazon basin. Synapomorphies for such a sister-group relationship include bivalved, apical dehiscence of fruits and a seed character: collapsed testa cells. However, there is a stronger possible relationship to other main subclade branches within Helieae than to *Tetrapollinia*.

DISCUSSION

Yanomamua is here classified as a member of the Gentianaceae tribe Helieae by its opposite, exstipulate leaves, pedicellate, hypogynous flowers subtended by a pair of scale-like bracteoles, 5 sepals, and bilocular, syncarpous, dehiscent capsules. The seeds, however, appear similar to the neotropical genera *Coutoubea* Aubl., *Deianira* Cham. & Schltld., and *Schultesia* Mart. of tribe Chironieae subtribe Coutoubeinae, as illustrated in Bouman et al. (2002: 522). The gross morphology of the plant is, nevertheless, quite different from these three Chironieae genera, which are generally small herbs with terminal cymes of flowers with larger and much more strongly winged calyces. All three genera also have pollen in tetrads unlike the pollen tetrad types that occur in Helieae (Nilsson, 2002), but *Coutoubea* and *Schultesia* do occur in the area around Serra do Araçá. *Yanomamua* has a calyx morphology and habit typical of tribe Helieae, leading us to classify *Yanomamua* into Helieae.

The result from the phylogenetic analysis strongly supports the description of a new genus, since the character suites of *Yanomamua* do not easily fit into any existing Helieae genera using either phenetic or phylogenetic criteria. Extra caution should be given to the description of new genera since these might later be found to be nested inside existing genera, making the new genus name superfluous. The lack of floral data could be seen as a problem in placing a new taxon; however, in this case it is the vegetative, fruit, and seed data that enable us to evaluate the generic status of this new species (Fig. 1). On the basis of 30 characters, many that are traditionally used as synapomorphies for generic circumscriptions, there is a strong indication that *Yanomamua* is not easily included in an existing genus without destroying important synapomorphies. Our

phylogenetic analysis suggests that the only genus that could come into question is *Tetrapollinia*, a genus of quite different gross and seed morphology. Therefore, we argue that this taxon is best described at the generic rank.

Yanomamua also shows similarities to green- to yellow-flowered *Chelonanthus* species and *Calolisianthus* on the basis of its herbaceous habit, prominently 4-angled and winged stem, and fruit morphology (Struwe et al., 2002). The leaves of *Yanomamua* differ notably in being subcordate (which occurs rarely in *Chelonanthus*, and more commonly in *Calolisianthus* Gilg), and generally pandurate-shaped. This leaf shape is unique in the Helieae, and perhaps in the Gentianaceae.

The inflorescences of *Yanomamua* have been difficult to interpret. Either they can be interpreted as solitary flowers that are axillary in the upper leaf axils, or as few-flowered terminal cymes with leafy upper bracts sometimes without terminal flowers. This inflorescence type is unique in Gentianaceae, with the most similar probably found in the small herb *Neurotheca* (Potalieae; Struwe et al., 2002). Within Helieae, terminal and cymose inflorescences are the most common, especially in the *Adenolisianthus-Symbolanthus* subclade. Inflorescences are sometimes reduced to single solitary flowers in *Symbolanthus*. True axillary flowers occur only in *Tachia* and *Zonanthus*.

The axillary flowers of *Yanomamua* are subtended by 1–2 leaf-like bracts (which are the same as the uppermost leaves). This feature is unknown in potential close relatives of Helieae. Leaf-like bracts are common in some *Irlbachia* and *Macrocarpaea*, but then the leaf-like bracts are placed within the basal branches of a terminal cyme. Bracteoles subtend individual flowers and are scale-like in *Yanomamua*, as well as in some other Helieae genera with bracteoles.

To understand the inflorescence architecture of *Yanomamua araca*, the typical inflorescence pattern in the tribe Helieae should be explained. At the terminal point in the plant, an inflorescence begins within the axils of a “subterminal” pair of leaves with the appearance of a single flower, the “first flower.” Afterward a pair of opposite branches develops beside the first flower. The apical shoot continues to grow upward, and branches continue to form in the axils of these leaves (perhaps 1–3 pairs), until a terminal cyme develops. Each branch begins with a single first flower, in the bract axils of which a bifurcation begins. Likewise in a terminal inflorescence, development begins with a first flower, exactly above which a bifurcation occurs. In *Macrocarpaea*, first flowers may be obscured by numerous adjacent flowers, yet may be easily identified by the lack of subtending bracteoles (its bracts act as the bracteoles) (Grant, 2005).

In the case of *Yanomamua araca*, it appears that after the appearance of the first flower,

often no further development of the inflorescence occurs, leaving the inflorescence to stay single-flowered. The only known material of *Yanomamua* is in fruit, but if the material had been in anthesis with young flowers one could perhaps predict that the branches may continue growing. The material of *Yanomamua* is rather fragmented in terms of the inflorescence and flowers, and further studies are clearly needed when additional material can be collected.

The linkage to main internal branches within Helieae (Fig. 1) indicates that *Yanomamua* might be a relictual small endemic, similar to the white-sand genus *Aripuana* (Struwe et al., 1997, 2002). It is remarkable, but maybe not surprising, that many new species from the Amazon basin have been found in material collected in white-sand areas or on sandstone outcrops. These pockets probably still contain many undescribed species that will be important in understanding the evolution of Amazonian and Guayanian biodiversity.

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TABLE 1. Characters and character states.

1. Habit: woody = 0; herbaceous (sometimes woody at very base) = 1.
2. Resin at nodes: absent = 0; present = 1.
3. Leaves: evenly distributed along stem = 0; crowded at branch apices = 1.
4. Leaves in basal rosette: absent = 0; present = 1.
5. Young branches: glabrous = 0; hairy = 1; spiculate = 2; papillose = 3.
6. Very short, papill-like hairs on vegetative parts: absent = 0; present = 1.
7. Leaf underside: glabrous = 0; hairy = 1.
8. Leaf margin: chartaceous = 0; thin, colorless, membranaceous = 1.
9. Leaf margin: flat, not recurved = 0; recurved = 1.
10. Petiole: present, distinct = 0; absent or indistinct = 1.
11. Interstipular structures: line = 0; sheath = 1.
12. Secondary veins: straight (pinnate) = 0; bent toward apex (arcuate) = 1.
13. Number of pairs of secondary veins: 0 = 0; 1–2 = 1; 3 or more = 2.
14. Veins underneath leaf: not prominent = 0; prominent and raised = 1.
15. Inflorescence position: terminal = 0; axillary = 1.
16. Inflorescence type: cymose (with terminal flower) = 0; racemose (terminal flower absent) = 1; on cushion = 2.
17. Flower number: 2 or more per inflorescence = 0; solitary = 1.
18. Inflorescence branches: glabrous = 0; hairy = 1; spiculate or papillate = 2.
19. Bracteoles, appearance: triangular, scale-like (all of them) = 0; leaf-like (rarely some bract-like high up in inflorescence) = 1.
20. Flower orientation at anthesis (pedicel position): erect or sideways = 0; nodding or nutant = 1.
21. Dorsal keel on sepals: sepals not keeled = 0; with dorsal keel = 1.
22. Sepal margin: glabrous, entire or erose = 0; ciliate or papillose = 1.
23. Calyx persistence in fruit: persistent = 0; deciduous = 1.
24. Style persistence in fruit: persistent = 0; deciduous (sometimes except the very base) = 1.
25. Fruit position: erect = 0; pendulous, nodding = 1.
26. Dehiscence type: bivalved, apical = 1; 4-valved (*Chorisepalum* type) = 2; bivalved, medial (style fused at apex of fruit) = 3.
27. Fruit valves, persistence: persistent = 0; deciduous, no vascular traces = 1; deciduous, persistent vascular traces = 2.
28. Fruit, mesocarp: no separation = 0; mesocarp splits in mature fruit = 1.
29. Seed shape: angular/polyhedral = 0; globose/subglobose/elliptic = 1; flattened = 2.
30. Seeds, shape with ridges: surface even = 0; rimmed with raised ridges and sunken sides = 1.
31. Seed wing: absent = 0; present all around (single wing, sometimes on 3 sides) = 1; present on 1-many sides, partial wing, sometimes many = 2.
32. Testa, outer wall: collapsed, thin, pressed against inner wall or absent, concave = 0; not collapsed, dome-like, cells convex (rarely collapsed on sides) = 1.
33. Testa, outer wall, band-like thickenings: without = 0; with bandlike thickenings = 1.
34. Testa, anticlinal walls: straight (to slightly bent) = 0; curved, S-shaped at most = 1; waved, zig-zag shaped = 2.
35. Testa, cuticle: smooth = 0; granular with exudates = 1.

TABLE 2. Data matrix used in phylogenetic analysis.

	1	6	11	16	21	26	31	
Aden arbo	00100001010110000000000013000100120							NOTE: See Table 1 for character names and states. Polymorphisms are indicated by * (= 01) and \$ (= 02). Taxon names are indicated by the first four letters of the genus and species names; please see Fig. 1 for full names.
Arip cull	000000011000200000000010001000101100							
Calo spec	100000010101110000000000130001011?0							
Celi bell	100031001101110002011101131010011\$0							
Chel alat	10000001010110000000010*13000101110							
Chel purp	1000000100011*000000010*130001011?0							
Chor carn	01001000100??00211000011*22121111??							
Heli oblo	1001000101011000000000013000101100							
Irlb nemo	10000000000110000000010013000101120							
Irlb prat	10010000110?00000000100013000?00120							
Lage prin	00003001000110*?1001110113000101110							
Lehm sple	0000000100011000?001010013000101110							
Macr appa	0000101000112000011*011103210121100							
Macr rubr	000000000011\$0000010001103212?2?000							
Neb1 nebl	1000000?0101100?101100001?000101100							
Purd pulc	0000311000011000?20101011??00101110							
Roge arbo	00000000100??0000000010013000101100							
Sipa ostr	1001000111011000000*000103000100100							
Symb elis	00000000001\$00010000001110001011\$0							
Tach gfol	01000000101020121??0101101101000001							
Tetr caer	10000001010?000000001000*1000000020							
Zona cube	0?10000?1010201?1010001101010000001							
Yano arac	100000010101111\$100?000111000000100							