2008

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Philbrick, Tom PhD and Bove, Claudio P., "A new species of Castelnavia (Podostemaceae) from Tocantins, Brazil" (2008). *Department of Biology & Environmental Sciences Faculty Papers*. 2.

https://repository.wcsu.edu/biologypaper/2
A New Species of Castelnavia (Podostemaceae) from Tocantins, Brazil

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ABSTRACT. Castelnavia noveloi C. T. Philbrick & C. P. Bove is distinguished from other species of Castelnavia Tulasne & Weddell (Podostemaceae) based on the production of stems arising perpendicular from the leaf petiole (petiolar stems) and the flattened rachis of the pinnate leaves. The new species is only known from rio Taquarussu, east of the town of Taquarussu, Tocantins, Brazil.

RESUMO. Castelnavia noveloi se distingue das demais espécies de Castelnavia Tulasne & Weddell (Podostemaceae) por possuir caules que surgem perpendicularmente ao pecíolo (caules peciolares) e raque das folhas pinadas achatada. É conhecida apenas no rio Taquarussu, a leste da cidade de Taquarussu, Tocantins, Brasil.

Key words: Brazil, Castelnavia, IUCN Red List, Podostemaceae.

While conducting field studies in the state of Tocantins, Brazil, a species of Castelnavia Tulasne & Weddell was encountered that did not correspond to previously described species. It is described here as new. (In the species description below, variation is expressed as (minimum) median (maximum); N ≥ 40. The pollen grains were acetolyzed according to Erdtman [1952]; N = 25).

Castelnavia noveloi C. T. Philbrick & C. P. Bove, sp. nov. TYPE: Brazil. Tocantins: Taquarussu, 8 km E of town along Rt. TO-030, rio Taquarussu, 10°18′21.4″S, 48°10′17.7″W, 390 m, 8 June 2005, C. T. Philbrick, A. Novelo R., C. P. Bove & D. Gera 5830 (holotype, R; isotypes, MEXU, MO, WCSU). Figures 1, 2.

Hydrophyton perenne, ad rupes in currentibus aquarum adhaerens. Caules ad petiolos perpendiculares (caulis petiolaris); caulis petiolaris ramosus multifloridus ex petiolo folii oriundus, maturitate pinnatus. Folia juventate simplicia, maturite pinnata oriundis caulis prostatis raque complanata. Flores plurimi, quisque in cavitatem in caule horizontaliter interpositum, tepalis duobus. Stamina duo. Ovarium bicarpelatum, lobis inaequalibus, lobo superiore (dorsali) minore quam inferiore (ventrali), stigmatibus duobus, sub anthesi stigmatibus et staminibus supra spathella rupta vix exsertis. Capsula costata, 2-valvata, valva superiore (dorsali) 5-costata, caduca, valva inferiore (ventrali) 7-costata, persistente.

Aquatic herbs, perennial(?), attached to rocks in river rapids and waterfalls; roots not seen; stems in two locations, (1) prostrate on rocks, and (2) arising from leaf petioles (petiolar stems) or prostrate stems tightly attached to substratum throughout their length, cylindrical to flattened, (0.9)2(3) mm wide, repeatedly dichotomously or subdichotomously branched; petiolar stems unattached to substratum, repeatedly dichotomously or subdichotomously branched, usually curled, (0)2(9) per petiole. Leaves distichous, arising from stem margins, monothecous (with a single sheath) or dithecous (with 2 sheaths), simple when young to variously lobed or pinnate when mature; simple leaves linear to spatulate, (0.3)1.5(13) cm long, (0.2)0.4(0.8) mm wide at midpoint, spatulate upper regions (0.2)0.6(1.2) mm wide; pinnate leaves (1.7)13(22) × (0.4)1.3(6) cm, petiolate, petiole round to elliptical in cross section, (0.8)3.2(8) cm; rachis distinctly widened and flattened, (1.4)4.7(12) mm wide, (2)5(12)-veined, pinnae (0.2)1.5(9) cm, variously lobed, ultimate lobes (0.2)2.1(8) × (0.1)0.3(0.8) mm, linear, spatulate or triangular in outline, apex acute or obtuse; petiolar stems projecting (2.5)7.5(20) mm from petioles, (2)4(6) times dichotomously divided. Flowers numerous (few post-anthesis flowers observed), lateral on stems or axillary to branches, each in cavity in stem, oriented horizontally, hermaphrodite, zygomorphic, sessile or short pedicellate, covered by sac-like spathella; pedicel (0.4)0.5(0.7) mm long prior to anthesis, not elongating during anthesis, attached to ovary perpendicular to ovary axis; receptacle asymmetrically expanded on side opposite stamen attachment (asymmetry obscured in fruit as receptacle dries). Spathella clavate, (1.9)2.6(3) × (1)1.4(1.7) mm, papillate apically,
Figure 1. *Castelnavia noveloi* C. T. Philbrick & C. P. Bove. —A. One mature irregularly lobed pinnate leaf with branched stem (petiolar stem) arising from the petiole. Note incurved form of petiolar stem and expanded rachis of pinnate leaf. —B. One mature pinnate leaf and nine small young (simple) leaves arising from branched prostrate stem. Note the expanded rachis and irregularly lobed pinnae. —C. Section of prostrate stem showing five young leaves, one with apical lobes. Several additional leaf bases are also shown. —D, E. Details of pinnate leaves showing irregularly shaped lobes and branched veins. Drawings based on the holotype, *C. T. Philbrick* et al. 5830 (R).
Figure 2. *Castelnavia noveloi* C. T. Philbrick & C. P. Bove. —F. General habit of plant after leaves have been shed showing branched prostrate stem and lateral flowers in stem pockets. —G. Portion of prostrate stem viewed from above showing five lateral flowers, four at anthesis. Note the ruptured spatheae apices and projecting stigmas and stamens. —H. Intact spathe showing prominent papillae on the apical region. —I. Details of three flowers at anthesis partially enclosed in ruptured spatheae. Top: lateral view of one stamen and two stigmas; bottom right: dorsal view of two divergent stigmas and two stamens; bottom left: ventral view of two stamens and portion of one stigma. —J. Preanthesis flower with spathea removed. Top: ventral view showing apex of pedicel, asymmetrically expanded receptacle, two stamens, two tepals, ovary and apices of two stigmas; bottom: lateral view showing apex of pedicel, asymmetrically expanded receptacle, one stamen, one tepal, ovary.
oriented horizontally, rupturing apically or subapically into (5)7(11) linear to triangular segments, lower region remaining covered by stem tissue; tepals 2, hair-like, linear, (0.1)0.3(0.5) mm, one on either side of the fused stamen filaments, apex acute; stamens 2, filaments flattened, wider at base than apex, attached to anther in pocket-like area, prior to anthesis (0.9)1.4(1.9) × (0.6)0.8(1.2) mm, elongating and projecting from the ruptured spathella during anthesis, usually persisting in the ruptured spathella; anthers basifixed, triangular, thecae fused apically, anther apex blunt, dehiscing introrsely and longitudinally, (0.6)0.8(1) × (0.3)0.4(0.6) mm; pollen in monads, small, isopolar, oblate spheroidal, polar diam. (16.2)17.6(18.3) μm, equatorial diam. (17.5)19.1(20) μm, tricolpate, planaperturate, microechinate granulate, colpus long (9.7 × 0.2 μm), colpus membrane with conspicuous spicules, sexine ca. 0.6 μm, nexine ca. 0.8 μm; ovary 2-carpellate, unilocular, strongly anisolobous, dorsal (upper) carpel markedly smaller than ventral (lower) carpel, remaining inside spathella during and after anthesis, (1.3)1.8(2.6) × (0.9)1.1(1.6) mm; ovules (93)132(147), placenta axile, placentum thick. Stigmas 2, free, linear, papillose, offset toward one side of ovary apex, (0.1)0.4(0.6) mm long prior to anthesis, elongating to (0.7)1(1.6) mm during anthesis. Capsules oriented horizontally, partially covered by surrounding stem tissue, markedly anisolobous, (1.5)1.8(1.9) × (0.8)1.3(1.6) mm; dehiscing by 2 valves, upper (dorsal) valve deciduous, (1.1)1.6(1.9) × (0.7)0.9(1.2) mm, 5-ribbed (non-suture ribs), suture margins also appearing thickened and rib-like; lower (ventral) valve persistent, cup-like, (1.3)1.6(1.8) × (1.3)1.6(1.8) mm, 7-ribbed (non-suture ribs), suture margins also appearing thickened and rib-like; seeds orange-brown, obovate, (0.26)0.3(0.34) × (0.16)0.19(0.23) mm; (0.77)124(124) per capsule.

Distribution and IUCN Red List category. Castelnavia noveloi is known only from rio Taquaruussu, east of the town of Taquaruussu, Tocantins, Brazil. Two other species of Podostemaceae occur in the same habitat: Monostylis capillacea Tulasne and Apinagia Tulasne sp. Castelnavia noveloi is interpreted as Vulnerable (VU) according to IUCN Red List criteria (IUCN, 2001); it is only documented from a ca. 2-km region of rio Taquaruussu.

Etymology. Castelnavia noveloi is named in honor of Luis Alejandro Novelo Retana (1951–2006; MEXU) to acknowledge his important contributions to our understanding of the systematics of New World Podostemaceae. The authors’ lives were both greatly enriched by their associations with Dr. Novelo.

Additional observations. Castelnavia noveloi is most similar to species in the genus that possess prominent, cylindrical, dichotomously to subdichotomously branched, prostrate stems with numerous flowers (section Eucastelnavia Tulasne & Weddell).

Three previously described species (Castelnavia lindmaniana Warming, C. multipartita Tulasne & Weddell, and C. princeps Tulasne & Weddell [including C. cuneifolia P. Royen]) possess these features (Table 1).

Castelnavia noveloi differs from the other three species in terms of the presence or absence of petiolar stems, the number of ribs on the capsule, and the presence or absence of papillae on the upper portion of the ovary (Table 1). The presence of stems arising from the leaf petiole is characteristic for C. noveloi but is not observed elsewhere in the genus. Prostrate stems attach to the substratum and give rise to mature pinnate leaves. In addition, stems arise from the petiole (petiolar stems) on over half (62%, N = 50) of the mature pinnate leaves. Although the overall structure of petiolar and prostrate stems is the same (e.g., dichotomously divided, numerous flowers), petiolar stems are unattached to the substratum and often curled in shape. Only simple leaves have been observed on petiolar stems. Petiolar stems are not known among other New World Podostemaceae.

Leaf characteristics also distinguish Castelnavia noveloi (Table 1). Leaves of C. noveloi and C. lindmaniana are pinnate. In the former, the rachis is broad and flattened. In contrast, both rachis and petiole of C. lindmaniana are round to oval. Leaves of C. princeps are irregularly lobed. (Although the type of C. princeps lacks leaves, subsequent collections possess complete, variably lobed leaves.) Leaves of C. multipartita may be simple; however, such an
Table 1. Diagnostic characters of Castelnavia noveloi and the three other species of Castelnavia that possess cylindrical, prostrate, dichotomously branched stems with many flowers.

<table>
<thead>
<tr>
<th>Character</th>
<th>C. noveloi</th>
<th>C. lindmaniana</th>
<th>C. multipartita</th>
<th>C. princeps¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petiolar stems</td>
<td>present</td>
<td>absent</td>
<td>absent</td>
<td>absent</td>
</tr>
<tr>
<td>Mature leaf type</td>
<td>pinnate</td>
<td>pinnate</td>
<td>simple²</td>
<td>variably lobed</td>
</tr>
<tr>
<td>Rachis type on pinnate leaves</td>
<td>flattened</td>
<td>round-oval</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Capsule non-suture rib number: deciduous (dorsal) valve</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Capsule non-suture rib number: persistent (ventral) valve</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Papilae on upper region of deciduous (dorsal) capsule valve</td>
<td>absent</td>
<td>absent</td>
<td>present</td>
<td>absent</td>
</tr>
</tbody>
</table>

¹ Castelnavia cuneifolia is interpreted as a synonym of C. princeps.
² Leaf form of C. multipartita is unclear (see text).

interpretation is tentative, as the type material lacks complete leaves, and the species is known only from the type collection.

Capsules of Castelnavia noveloi, C. multipartita, and C. princeps possess prominent longitudinal ribs (Table 1). Ribs can occur along the suture margins (suture ribs) or distinct from the margin (non-suture ribs). In some species of Castelnavia, as well as other Podostemaceae, the degree to which the suture ribs develop can vary among capsules. In contrast, the non-suture ribs are prominent and their occurrence more consistent. There are five non-suture ribs on the smaller (dorsal), deciduous capsule valve of C. noveloi and C. multipartita. Three non-suture ribs occur on the smaller valve of C. princeps. The larger (ventral), persistent capsule valve is also ribbed: seven non-suture ribs in C. noveloi and C. multipartita, three in C. princeps. Although Royen (1954) reported three ribs on the deciduous valve of C. lindmaniana, our observations of the type materials indicate that capsules of this species lack ribs (smooth). Some species (e.g., C. multipartita) of Castelnavia possess prominent papilae on the upper region of the ovary and capsule. Castelnavia noveloi lacks such papilae (Table 1).

Key to Species of Castelnavia with Prostrate, Cylindrical, Branched Stems with Many Flowers

1a. Mature capsules lacking ribs; mature leaves pinnate, rachis circular to elliptical in cross section. .................. C. lindmaniana

1b. Mature capsules distinctly ribbed; mature leaves simple, pinnate or irregularly lobed, if pinnate, rachis expanded and flattened.

2a. Smaller (deciduous, dorsal) capsule valve with distinct papilae along the upper portion; leaves simple ................................ C. multipartita

2b. Smaller (deciduous, dorsal) capsule valve lacking papilae; leaves pinnate or irregularly lobed.

3a. Petioles of mature leaves lacking stems arising from them; mature leaves irregularly lobed, lacking a distinctly flattened rachis; capsules with 3 non-suture ribs on smaller (deciduous, dorsal) valve and 3 non-suture ribs on larger (persistent, ventral) valve .......................... C. princeps

3b. Petioles of mature leaves with branched stems arising from them; mature leaves pinnate with a distinctly flattened rachis (young leaves often simple); capsules with 5 non-suture ribs on smaller (deciduous, dorsal) valve and 7 non-suture ribs on larger (persistent, ventral) valve .......................... C. noveloi

Paratype. BRAZIL. Tocantins: Taquarussu, 8 km E of town along Rt. TO-030, rio Taquarussu, 10°18′21.4″S, 48°10′17.7″W, 390 m, 26 July 2006, C. T. Philbrick, C. P. Bove & S. L. Tucci 6000 (R, WCSU).

Acknowledgments. We thank Jorge Pedro Carauta for the Latin description and Albino Luna for drawing Figures 1 and 2. Special thanks are due to Vânia Gonçalves Lourenço Esteves for the pollen analysis. Material was collected with permit No. 02022.001282/2005-52 from IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Renováveis—Ministério do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal). This work was supported by: (1) National Science Foundation grants DEB-9629767 to C.T.P. and Donald H. Les, and DEB-0444399 to C.T.P.; (2) Connecticut State University–AAUP research grants to C.T.P.; (3) a National Geographic Society grant to C.T.P. & A. Novelo R.; and (4) the office of Intercambio Académico and a Direcció General de Asuntos del Personal Académico Grant (IN212596), Universidad Nacional Autónoma de México, to A. Novelo R. Thomas C. Edson and David H. Gera are thanked for their assistance in laboratory analyses and their comments on an early version of the manuscript.

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