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Questa è la Versione finale referata (Post print/Accepted manuscript) della seguente pubblicazione:

*Original Citation:*

Cryptochloa stapfii (Poaceae: Bambusoideae: Olyreae), a new neotropical herbaceous bamboo from Panama / Riccardo M. Baldini; Orlando O. Ortiz. - In: PHYTOTAXA. - ISSN 1179-3155. - STAMPA. - 203(3):(2015), pp. 271-278. [10.11646/phytotaxa.203.3.6]

*Availability:*

This version is available at: 2158/990806 since:

*Published version:*

DOI: 10.11646/phytotaxa.203.3.6

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## *Cryptochloa stapfii* (Poaceae: Bambusoideae: Olyreae), a new neotropical herbaceous bamboo from Panama

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### Abstract

*Cryptochloa stapfii*, a new herbaceous bamboo species from Panama is described. This new bambusoid grass inhabits semi-shaded lowland forests in Bocas del Toro (Panama) and is related to *C. dressleri* Soderstr., an endemic species from Panama. This new taxon increases the number of species in *Cryptochloa* to eight, most of them present in Panama.

**Key words:** Taxonomy, Bocas del Toro, Central America, Flora of Panama, Poales

### Introduction

Among the tribe Olyreae (Poaceae: Bambusoideae), *Cryptochloa* Swallen in Woodson & Schery (1942: 317) is one of the most well represented genera in the Republic of Panama with seven species (Judziewicz *et al.* 2000, TROPICOS 2014), including three endemics, i.e., *C. decumbens* Soderstrom & Zuloaga (1985: 29), *C. dressleri* Soderstrom in Soderstrom & Zuloaga (1982a: 25), and *C. soderstromii* Davidse in Davidse & Pohl (1992: 96).

The general distribution of the genus (Baldini & Ortiz 2014) shows a range from southern Mexico to northern South America (Colombia, Ecuador, Peru, Brazilian Amazonia) (Judziewicz *et al.* 1999). However, *C. capillata* (Trinius 1834: 114) Soderstrom (1982b: 202) from South America, extends its range up to Brazilian Atlantic Forest, but more investigations are required in order to establish its taxonomic status in *Cryptochloa* (Baldini & Ortiz 2013, 2014). Panama is a crucial centre of differentiation for *Cryptochloa* and other herbaceous bamboos, as there are several endemic taxa in the country (Calderón & Soderstrom 1973, Soderstrom & Calderón 1979, Soderstrom 1982a, 1982b, Soderstrom & Zuloaga 1985, Davidse & Pohl 1992, Judziewicz *et al.* 1999, Baldini & Ortiz 2014).

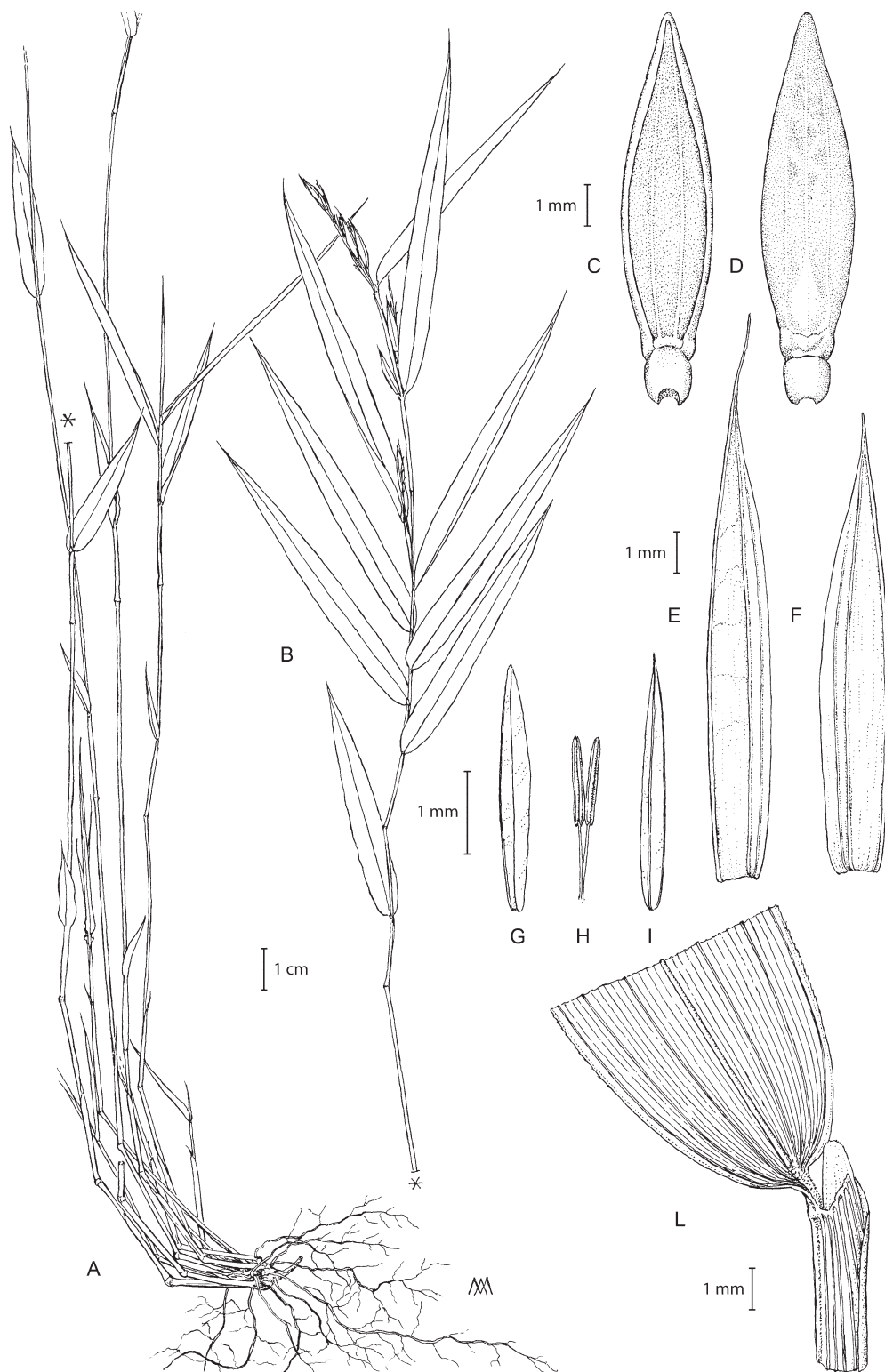
The grass flora of Panama, even though a relatively small region, is well represented by many forest endemics, a consequence of its paleogeographic history. It is therefore an important centre of conservation (Lewis 1971, Davidse 1985, Graham 2011, Bacon *et al.* 2012, Leigh *et al.* 2014, Bagley & Johnson 2014). According to the most recent floristic inventory, the grass family in Panama includes 417 taxa (Correa *et al.* 2004), and more taxa are expected to be described or reevaluated from taxonomical and nomenclatural points of views, according to our studies that are in progress.

In the present paper we describe a new species of *Cryptochloa* discovered in the Province of Bocas del Toro (Republic of Panama) during our field trips carried out from 2012–2014 with the aim to study the herbaceous bamboos of the Panamanian Flora and other Mesoamerican grasses.

### Materials and methods

This study is based on the investigations of five living populations and herbarium collections of *Cryptochloa* taxa collected in Panama and housed at FT, MO, NY, PMA, SCZ and US. Field trips were carried out in the Republic of

Panama in different periods of the year, either in dry or wet seasons. All of our new collections are deposited at FT, MO, PMA and SCZ herbaria. For SEM investigation, dried leaf fragments (5–10 mm), female florets and elaiosomes were taken from herbarium specimens (see figure captions for voucher details), mounted on standard stubs with double-sided adhesive tape, and examined with a Quanta 200 Esem (Fei) scanning microscope, at 1–30 kv. Original drawings were prepared by Mrs. Anne Maury (Florence, Italy).



**FIGURE 1.** *Cryptochloa stapfii* Baldini & Ortiz: Panama, Bocas del Toro, M.S. Stapf 865, R.M. Baldini R. & O.O. Ortiz (from holotype, PMA). A. Habit, basal part. B. Habit, upper part with slender inflorescences. C. Female floret (ventral view). D. Female floret (dorsal view). E. Lower glume of female floret. F. Upper glume of female floret. G. Lemma of male floret. H. Stamens. I. Palea of male floret. L. Basal leaf blade with ligule. Illustration by Anne Maury.



## Taxonomy

### *Cryptochloa stapfii* Baldini & O. Ortiz, *sp. nov.* (Figs. 1–2)

*A C. dressleri* foliis intense viridis, raro purpureis, linearis angustatis, et maturitatem dispositione lemmatum florum femineorum ad basim nunquam mutue suprainposita, filamentibus antherarum longioribus.

Type:—PANAMA. Bocas de Toro, Camino Rambala-Platanarito, E de Rambala, área semi-sombreada, 8°55'28"N 82°09'53"W, 85 m, 21 January 2012, *M.S. Stapf, R.M. Baldini R. & O.O. Ortiz 865* (holotype PMA!, isotypes FT!, MO!, SCZ!).



FIGURE 2. *Cryptochloa stapfii* Baldini & O. Ortiz, in its habitat at the type locality (Panama: Bocas del Toro, Camino Rambala-Platanarito, E de Rambala) Photo: Riccardo M. Baldini.

Perennial, short-rhizomatous, delicate, 5–15(–20) culms, 20–40 cm tall. Leaves narrowly lanceolate, green, rarely purplish, 3–7 cm long, 0.3–0.6 cm wide, ligule truncate, glabrous, prominent, 5.5–6 mm long. Monoecious. Inflorescences paniculiform, 2–3 at the upper nodes of each terminal leaf, simply exerted, generally sticking along the axis, with 1 terminal female spikelet and few lateral spikelets with 1 branch of 3–5 male spikelets, borne in the lower part of the rachis, or at the end of the inflorescence. Female spikelet: glumes green, glabrous, scabrous at the margin, lower glume glabrous, 9–11(–11.5) mm long, aristate, awns up to 2.5 mm long, upper glume acuminate, 8–10 mm long. Lemma 8–9 mm long; palea narrowly ovate, 2-nerved, acute at the apex, margins not folding toward at the base at maturity; lodicules 3, sometimes reduced to 2, glabrous, slightly coriaceous. Male spikelets: deciduous after anthesis, glumes lacking, lemma glabrous, elliptic, linear not curved at the apex, palea glabrous; lodicules 3, fleshy; stamens 2, anthers basifixed, 2 mm long, filaments 0.8–2 mm long. Fruit: caryopsis, elliptic.

**Etymology:**—This species is dedicated to Maria Stapf, expert botanist of the Flora of Panama.

**Distribution:**—*Cryptochloa stapfii* is known only from the type locality on Bocas del Toro (Panama), around Chiriquí Grande and its surroundings (Fig. 3).

**Habitat and Ecology:**—This species is present in moist forest remnants on steep slopes, in semi-shaded areas (Fig.

4). *Cryptochloa stapfii* grows in an area of very wet tropical forest according to the classification of zones proposed by Holdridge *et al.* (1971), in association with *Miconia ampla* Triana (1871: 10, Melastomataceae), *Neonicholsonia watsonii* Dammer (1901: 179, Arecaceae), *Calypstrogyne pubescens* de Nevers (1995: 336, Arecaceae), *Ichnanthus pallens* (Swartz 1788: 23) Munro ex Bentham (1861: 414, Poaceae) and *Arberella lancifolia* Soderstrom & Zuloaga (1985: 25, Poaceae) and others species of the Arecaceae family.



**FIGURE 3.** Distribution of *Cryptochloa stapfii* Baldini & Ortiz in Panama. Star: type locality (holotype). Square: Paratype, B. Hammel, G. McPherson & L. Sanders 14746 (MO, PMA).



**FIGURE 4.** Rachillas of the internode of the antherium (elaiosomes). A. *Cryptochloa dressleri* B. *C. stapfii*.



**Phenology:**—Flowering and fruiting throughout the year, with a peak in the dry season (January–March).

**Conservation status:**—This species is notable for its reduced geographical range and small population size. It is endangered, being not yet protected and subjected to habitat degradation as a result of the forest cutting and agricultural activities in its area of distribution. We suggest it be considered in the CR B2ab(iii) category according to the IUCN Red List Criteria (IUCN 2001).

**Additional specimens examined (paratypes):**—PANAMA. Bocas del Toro, hill just S of Chiriquí Grande, at end of pipeline access road 2 mi N of 2nd large bridge N (10 mi) of continental divide, in forest along ridge & draws, 350–500 m asl, 8°54'N 82°10'W, 10 March 1986, *Hammel, McPherson & Sanders 14746* (MO, PMA) [this specimen bears a comment by G. Davidse (MO) about its unusual leaf morphology]; Carretera hacia Chiriquí Grande, Rambala, Platanarito, 8°55'28"N, 82°90'53"W, 2 February 2014, *Ortiz, Baldini & Galdames 1995* (BM, FT, K, PMA).

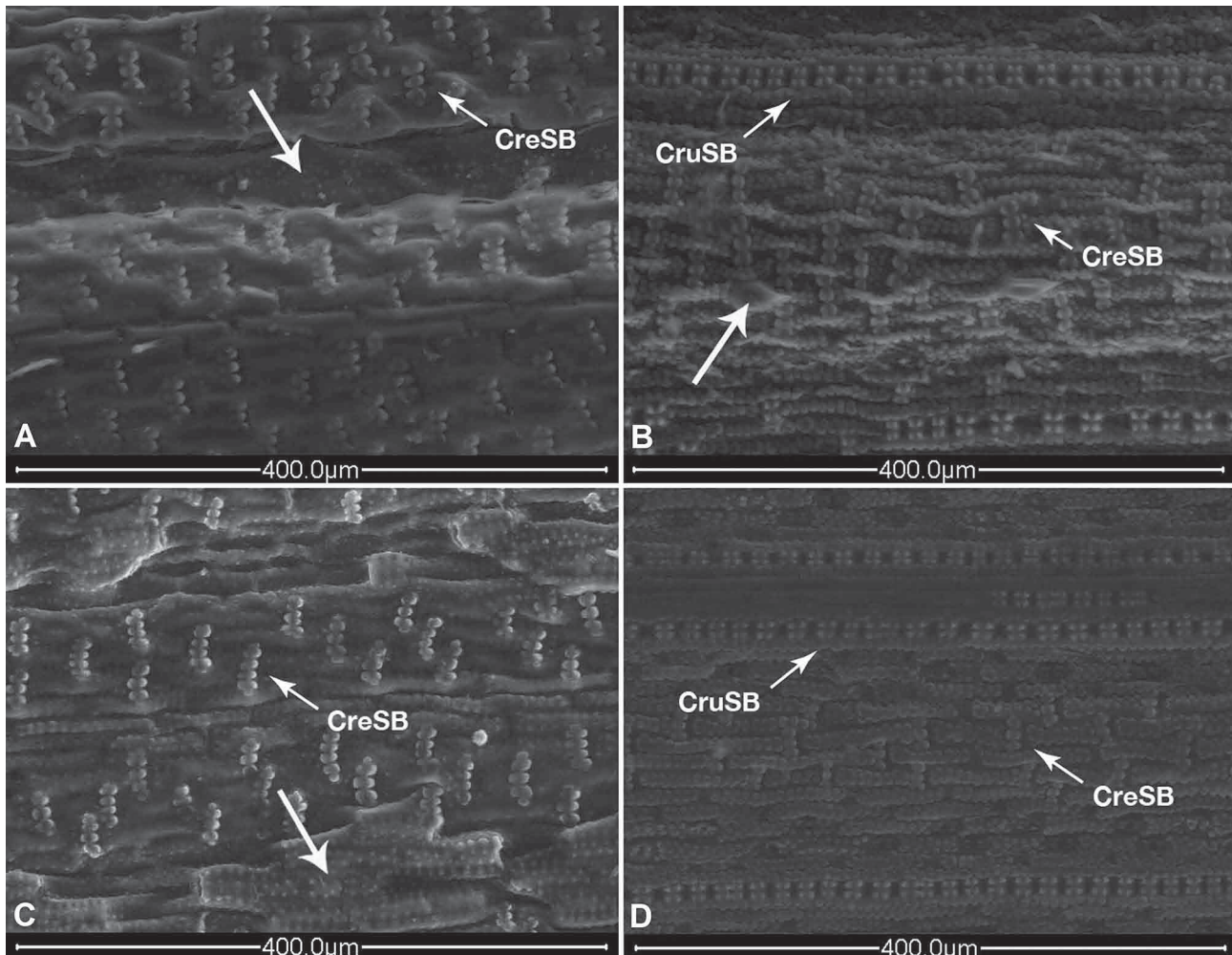
**Discussion:**—*Cryptochloa stapfii* is an endemic species closely related to *C. dressleri*, with which it shares the presence of two rather than three stamens as in the rest of the species in the genus (Soderstrom 1982a). *Cryptochloa stapfii* differs from *C. dressleri* in its narrow green leaves, not deeply purplish as in *C. dressleri*. Soderstrom (1982a) discussed the role of the purplish color of leaves in tropical plants, especially in herbaceous bamboos, in enhancing the capture of light in shaded habitats (Lee *et al.* 1979). While *Cryptochloa dressleri* has this feature, in accordance with its typical shaded habitat, *C. stapfii*, with green leaves, seems to have evolved a different adaptation to the semi-shaded habitats to which it is restricted along the edge of the mist forest, where it receives more intense sunlight. During three years of field observations in Bocas del Toro area of five different populations at different times of the year, *C. stapfii* always showed the same green coloration. The main morphological distinguishing features in *C. stapfii* and *C. dressleri* are given in the Table 1.

During our field trips in Panama, we have observed that small dipteran insects visit some herbaceous bamboos (i.e., *Arberella lancifolia*, *Pariana argentea* Hollowell & Davidse in Davidse & Pohl 1992: 98) and presumably also species of *Cryptochloa*, confirming the role of insect pollination in the herbaceous bamboos (Soderstrom & Calderón 1979). However, the role of insect pollination in *Cryptochloa* needs more evidence to be accepted. The presence of elaiosomes confirms and enforces the role of ants in fruit dispersal in the new species (Davidse 1987, Bronstein *et al.* 2006, Lengyel *et al.* 2010). Dispersal of diaspores via elaiosomes has also been suggested for some panicoid genera (Davidse 1987), including genera occupying the same habitat as *Cryptochloa*, including *C. stapfii*, such as *Ichnanthus* Palisot de Beauvois (1812: 56). Species in the bamboo tribe Olyreae are monoecious with very reduced male spikelets, while the female spikelets are frequently and clearly modified, with an elongated and solid internode present between the glumes and the floret. This internode is made of a tissue that produces oils at fruit maturity, and has a function similar to an elaiosome (Davidse 1987, Judziewicz 1990). The elaiosomes of *C. stapfii* and *C. dressleri* (Fig. 4, cf. Table 1) differ (papillate vs. not papillate), and this feature may be worth investigating more carefully throughout the genus as a source of taxonomic characters.

**TABLE 1.** Characters distinguishing *Cryptochloa dressleri* from *C. stapfii*.

|   | <i>Cryptochloa dressleri</i> | <i>Cryptochloa stapfii</i>                 |
|---|------------------------------|--|
| <b>Leaves</b>   |                              |  |
| Color   | Purplish to burgundy         | Green, rarely purplish                     |
| Blade size  | 8–14 × 0.8–2.0 cm            | 3–7 × 0.3–0.6 cm                           |
| Ligule length   | 3–5 mm                       | 5.5–6 mm                                   |
| Prickles on abaxial surface                                     | Present                      | Absent                                     |
| Papillae on abaxial surface                                     | Reticulate                   | Linear                                     |
| Siliceous bodies on adaxial surface                             | Thin and continuous          | Thick and alternate                        |
| <b>Female spikelet</b>  |                              |  |
| Lower glume awn length  | Up to 1–2 mm                 | Up to 2.5 mm                               |
| Lower glume length  | 8–9(–10) mm                  | 9–11(–11.5) mm                             |
| Upper glume length  | 6–9 mm                       | 8–10 mm                                    |
| Lemma length  | 6–8 mm                       | 8–9 mm                                     |
| Palea shape   | Ovate                        | Narrowly ovate                             |
| <b>Male spikelet</b>  |                              |  |
| Lemma shape   | Elliptic, curved at the apex | Elliptic to linear, not curved at the apex |
| <b>Stamens</b>  |                              |  |
| Anther length   | 1.3 mm                       | 2 mm                                       |
| Filament length   | 0.4–0.5 mm                   | 0.8–2 mm                                   |
| <b>Rachilla internode</b> ( <i>elaiosome</i> ) of the antherium | Not papillate                | Papillate                                  |

Comparative leaf morphology between *C. dressleri* and *C. stapfii* clearly shows some differences (Fig. 5), such as the absence of prickles on the abaxial leaf surface in *C. stapfii*, and their presence in *C. dressleri* (Jaén *et al.* 2013, Jaén 2014). The siliceous bodies in the adaxial leaf surface are reticulately arranged in *C. dressleri* and linear in *C. stapfii*. Discovery of *C. stapfii* brings the number of species of *Cryptochloa* in the Flora of Panama to eight (Table 2), considering the present unresolved taxonomical status of *C. granulifera* Swallen in Woodson & Schery (1942: 321). The exact number of the species in the entire genus will only be known upon completion of an on-going taxonomical revision of the genus by us.



**FIGURE 5.** Comparison of leaf morphology between *Cryptochloa dressleri* and *C. stapfii*. A. *C. dressleri*, adaxial leaf surface, with linear rows of bulliform cells (large arrow), and crenate (olyroid) silica bodies (CreSB). B. *C. dressleri*, abaxial leaf surface, with prickles (large arrow), crenate (olyroid) silica bodies (CreSB), and cruciform silica bodies (CruSB). C. *C. stapfii*, adaxial leaf surface with irregular rows of bulliform cells (large arrow) and crenate (olyroid) silica bodies (CreSB). D. *C. stapfii*, abaxial leaf surface without prickles, crenate (olyroid) silica bodies (CreSB), and cruciform silica bodies (CruSB). Specimens: *C. dressleri* (Stapf *et al.* 785, FT, PMA, SCZ), *C. stapfii* (Stapf *et al.* 865, FT, PMA, SCZ).

## Acknowledgements

We are very grateful to everyone who has helped us during our research, either in the field or herbaria, especially Prof. Mireya D. Correa (Director of PMA herbarium) and her staff for their support in Panama, and the guides who patiently supported us during the field trips. Special thanks to Dr. Gerrit Davidse (MO) for giving us important suggestions with special emphasis on the interpretation of the floral morphology; directors and curators of MO, NY and US for permitting the loans of material; and Anne Maury (Florence, Italy) for her mastery in the execution of the plates. We also thank the reviewers for critically reading the manuscript. The financial support of STRI (Smithsonian Tropical Research Institute) to R.M. Baldini & O. O. Ortiz, in Panama, and of CSET (FT herbarium), of the University of Florence (Italy) to R.M. Baldini, are very gratefully acknowledged. This is the publication n. 144 of the Tropical Herbarium FT.

**TABLE 2.** Synopsis of the geographic distribution of species of *Cryptochloa*. Data according to Judziewicz *et al.* (2000), Correa *et al.* (2004), TROPICOS (2014), herbarium data (MO, US) and unpubl. data. (\*) means a taxon of uncertain taxonomic status, but according to Davidse (1994) this species must be considered a synonym of *Cryptochloa strictiflora* (Fournier 1876: 465) Swallen in Woodson & Schery (1942: 321).

| <b>Taxon</b>   | <b>Distribution</b>   |
|--|---|
| <i>Cryptochloa capillata</i><br>= <i>Olyra capillata</i>   | Brazil, French Guiana   |
| <i>Cryptochloa concinna</i> (Hooker f. 1896: t. 7469) Swallen in Woodson & Schery (1942: 320)<br>= <i>Olyra concinna</i><br>= <i>Raddia concinna</i> (Hooker f.) Chase (1908: 185) | Belize, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, <b>Panama</b> and Peru |
| <i>Cryptochloa decumbens</i>   | <b>Panama</b> (endemic)   |
| <i>Cryptochloa dressleri</i>   | <b>Panama</b> (endemic)   |
| * <i>Cryptochloa granulifera</i>   | Costa Rica, Ecuador, Guatemala, Honduras, Mexico, <b>Panama</b>                                       |
| <i>Cryptochloa soderstromi</i>   | <b>Panama</b> (endemic)   |
| <i>Cryptochloa strictiflora</i><br>= <i>Strephium strictiflorum</i>  | Belize, Honduras, Mexico, Nicaragua Honduras, Costa Rica, <b>Panama</b> , Ecuador                     |
| <i>Cryptochloa stapfii</i>   | <b>Panama</b> (endemic)   |
| <i>Cryptochloa unispiculata</i> Soderstrom (1982b: 200)  | Brazil, Colombia, Bolivia, Ecuador, <b>Panama</b> (unpubl. data), Peru                                |
| <i>Cryptochloa variana</i> Swallen in Woodson & Schery (1942: 318)   | Caribbean, Colombia, Honduras, <b>Panama</b>  |

## References

- Bacon, C.D., Mora A., Wagner, W.L. & Jaramillo C.A. (2012) Testing geological models of evolution of the Isthmus of Panama in a phylogenetic framework. *Botanical Journal of the Linnean Society* 171 (1): 287–300.  
<http://dx.doi.org/10.1111/j.1095-8339.2012.01281.x>
- Bagley, J.C. & Johnson, J.B. (2014) Phylogeography and biogeography of the lower Central America Neotropics: diversification between two continents and between two seas. *Biological Reviews* 89: 767–790.  
<http://dx.doi.org/10.1111/brv.12076>
- Baldini, R.M. & Ortiz, O.O. (2013) *The herbaceous bamboos in Panama: the case study of Cryptochloa Swallen*. XXVI Congreso Científico Nacional, Republica de Panamá, 123 pp.
- Baldini, R.M. & Ortiz, O.O. (2014) Panama as a crucial centre of differentiation for the herbaceous bamboos (Poaceae: Bambusoideae: Olyreae); a study in progress. *Plant Biosystems* 148 (3): 558–564.  
<http://dx.doi.org/10.1080/11263504.2014.900128>
- Bentham, G. (1861) *Flora hongkongensis: a description of the flowering plants and ferns of the island of Hongkong*. London, L. Reeve, 482 pp.  
<http://dx.doi.org/10.5962/bhl.title.23084>
- Bronstein, J.L., Alarcon, R. & Geber M. (2006) The evolution of plant-insect mutualisms. *New Phytologist* 172: 412–428.  
<http://dx.doi.org/10.1111/j.1469-8137.2006.01864.x>
- Calderón, C.E. & Soderstrom, T.R. (1973) Morphological and anatomical considerations of the grass subfamily Bambusoideae based on the new genus *Maclurolyra*. *Smithsonian Contributions to Botany* 44: 1–27.  
<http://dx.doi.org/10.5479/si.0081024X.11>
- Chase, A. (1908) Notes on genera of Paniceae. *Proceedings of the Biological Society of Washington* 21: 175–188.
- Correa, A.M.D., Galdames, C. & De Stapf, M.S. (2004) *Catálogo de las Plantas Vasculares de Panamá*. Quebecor World Bogotá, Colombia, 600 pp.
- Dammer, U. (1901) *Neonicholsonia* Dammer: a new genus of Palms from Central America. *The Gardeners' Chronicle: a weekly illustrated journal of horticulture and allied subjects ser. 3* 30: 178–179.
- Davidse, G. (1985) The phylogeographic relationships of the Panamanian grasses. In: D'Arcy, W.G. & Correa, A.M.D. (Eds.) *The botany and natural history of Panama: La Botanica y Historia Natural de Panamá*. Missouri Botanical Garden, Saint Louis, USA, pp. 13–24.
- Davidse, G. (1987) Fruit dispersal in the Poaceae. In: Soderstrom, T.R., Hilu, K.W., Campbell, C.S. & Barkworth, M.E. (Eds.) *Grass systematics and evolution*. Smithsonian Institution Press, Washington, DC and London, pp. 143–155.
- Davidse, G. & Pohl, R.W. (1992) New taxa and nomenclatural combinations of Mesoamerican grasses (Poaceae). *Novon* 2 (2): 81–110.  
<http://dx.doi.org/10.2307/3391667>
- Davidse, G. (1994) *Cryptochloa* Swallen. In: Davidse, G., Sousa, M.S. & Chater, A.O. (Eds.) *Flora Mesoamericana 6. Alismataceae a*



- Cyperaceae*. Universidad Nacional Autónoma de México, D.F., pp. 213–214.
- de Nevers, G. (1995) Notes on Panama palms. *Proceedings of the California Academy of Sciences* 48 (16): 329–342.
- Fournier, E.P.N. (1876) Sur les Graminées mexicaines à sexes séparés. *Bulletin de la Société Botanique de Belgique* 15 (3): 459–476.
- Graham, A. (2011) *A Natural History of the New World. The Ecology and Evolution of Plants in the Americas*. The University of Chicago Press, Chicago, 387 pp.
- Holdridge, L.R., Grenke, W.C., Hatheway, W.H., Liang, T. & Tosi, J.A. (1971) *Forest Environments in Tropical Life Zones: a pilot study*. Pergamon Press, New York, 747 pp.
- Hooker, J.D. (1896) *Olyra concinna*, Native of Costa Rica. *Botanical Magazine* 122: t. 7469.
- IUCN (2001) *The IUCN Red List categories and criteria*, version 3.1. IUCN Species Survival Commission. Gland, Switzerland and Cambridge, U.K. Available from: <http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria> (accessed 9 October 2014).
- Jaén, N. (2014) *Anatomía foliar de 4 especies del género Cryptochloa Swallen (Poaceae: bambusoideae)*. Tesis de Licenciatura. Departamento de Botánica. Facultad de Ciencias Naturales, Exactas y Tecnología. Universidad de Panamá, 55 pp.
- Jaén, N., Garibaldi, C., De Stapf, M.S. & Baldini, R.M. (2013) *Contribución a la anatomía foliar de 4 especies del género Cryptochloa Swallen*. XXVI Congreso Científico de la Universidad de Panamá, República de Panamá, 123 pp.
- Judziewicz, E.J. (1990) Gramineae. In: Görts-van Rijn A.R.A. (Ed.) *Flora of the Guianas*. Koeltz Scientific Books, Koenigstein, Germany, pp. 151–154.
- Judziewicz, E.J., Clark, L.G., Londoño, X. & Stern, M.J. (1999) *American Bamboos*. Smithsonian Institution Press, Washington DC and London, 392 pp.
- Judziewicz, E.J., Soreng, R.J., Davidse, G., Peterson, P.M., Filgueiras, T.S. & Zuloaga, F.O. (2000) Catalogue of New World Grasses (Poaceae): I. Subfamilies Anomochlooideae, Bambusoideae, Ehrhartoideae, and Pharoideae. *Contributions of the United State National Herbarium*. 39: 1–128.
- Lee, D.W., Lowry, J.B. & Stone, B.C. (1979) Abaxial anthocyanin layer in leaves of tropical rain forest plants: enhancer of light capture in deep shade. *Biotropica* 11 (1): 70–77.  
<http://dx.doi.org/10.2307/2388175>
- Leigh, E.G., O’Dea, A. & Vermeij, G.J. (2014) Historical biogeography of the Isthmus of Panama. *Biological Reviews* 89:148–172.  
<http://dx.doi.org/10.1111/brv.12048>
- Lengyel, S., Gove, A.D., Latimer, A.M., Majer, J.D. & Dunn, R.R. (2010) Convergent evolution of seed dispersal by ants, and phylogeny and biogeography in flowering plants: A global survey. *Perspectives in Plant Ecology* 12: 43–55.  
<http://dx.doi.org/10.1016/j.ppees.2009.08.001>
- Lewis, W.H. (1971) High Floristic Endemism in Low Cloud Forests of Panama. *Biotropica* 3 (1): 78–80.  
<http://dx.doi.org/10.2307/2989708>
- Palisot de Beauvois, A.M.F.J. (1812) Essai d’une Nouvelle Agrostographie ou Nouveaux Genres des Graminées. In: Palisot de Beauvois, A.M.F.J. (Ed.) *Essai d’une Nouvelle Agrostographie*. Imprimerie de Fain, Paris, pp. 1–182.  
<http://dx.doi.org/10.5962/bhl.title.474>
- Soderstrom, T.R. (1982a) *Cryptochloa dressleri* (Poaceae), a new bambusoid grass from Panama. *Brittonia* 34 (1): 25–29.  
<http://dx.doi.org/10.2307/2806396>
- Soderstrom, T.R. (1982b) New species of *Cryptochloa* and *Piresia* (Poaceae: Bambusoideae). *Brittonia* 34 (2): 199–209.  
<http://dx.doi.org/10.2307/2806376>
- Soderstrom, T.R. & Calderón, C.E. (1979) *Arberella* (Poaceae: Bambusoideae): a new genus from Tropical America. *Brittonia* 31 (4): 433–445.  
<http://dx.doi.org/10.2307/2805992>
- Soderstrom, T.R. & Zuloaga, F.O. (1985) New species of grasses in *Arberella*, *Cryptochloa*, and *Raddia* (Poaceae: Bambusoideae: Olyreae). *Brittonia* 37 (1): 22–35.  
<http://dx.doi.org/10.2307/2806239>
- Swartz, O. (1788) *Nova Genera et Species Plantarum, seu Prodromus descriptionum vegetabilium maximum partem incognitorum quae sub itinere in Indiam occidentalem annis 1783–1787*. Uppsala, 152 pp.
- Triana, J.J. (1871) Les Mélastomatacées. *Transactions of the Linnean Society of London* 28: 10.
- Trinius, C.B. (1834) Panicearum genera retractavit speciebusque compluribus illustravit. *Mémoires de l’Académie Impériale des Sciences de Saint-Petersbourg. Sixième Série. Sciences Mathématiques, Physiques et Naturelles. Seconde Partie: Sciences Naturelles* 3 (2): 90–355
- TROPICOS (2014) Tropicos online database. Missouri Botanical Garden, St. Louis, MO, USA. Available from: <http://www.tropicos.org> (accessed:15 July 2014).
- Woodson, R.E. & Schery, R.W. (Eds.) (1942) Contributions toward a Flora of Panama. VI. Collections chiefly by H. von Wedel in Bocas del Toro. *Annals of the Missouri Botanical Garden* 29: 317–322.  
<http://dx.doi.org/10.2307/2394325>