

# Endemic non-bambusoid genera of grasses (Poaceae) in Madagascar: Review of current knowledge

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## Abstract

Non-bambusoid Poaceae genera endemic to Madagascar are reviewed and an index to generic names previously thought to be endemic is presented. There are six genera of non-bamboo grasses currently accepted as endemic to Madagascar: *Cyphochlaena*, *Decaryella*, *Lecomtella*, *Neostapfiella*, *Viguiarella*, and *Yvesia*. More collections of grasses are needed to expand current information. Descriptions, identification keys, illustrations, maps, a full list of all known specimens and IUCN conservation assessments are provided to aid future research.

**Key words:** *Cyphochlaena*, *Decaryella*, *Lecomtella*, *Neostapfiella*, Poaceae, *Viguiarella*, *Yvesia*

## Résumé détaillé

Les graminées (Poaceae) sont souvent ignorées par les scientifiques étudiant la biodiversité et sont souvent considérées comme étant des mauvaises herbes ou de fourrage pour le bétail. Les Poaceae a besoin d'être étudiée non seulement pour son importance économique car les prairies couvrent plus de la moitié de la surface de Madagascar mais aussi au vu de l'importance des lignées endémiques de la famille. La définition d'une classification pour les graminées endémiques de Madagascar ainsi que la compréhension de leur évolution vont permettre de reconstruire l'histoire des paysages et d'aider à établir des priorités pour leur conservation. Cet article a pour but de faire valoir l'importance des genres endémiques de la famille des Poaceae tout en clarifiant les classifications précédentes, souvent contradictoires, ainsi que de constituer une ressource d'information qui pourrait encourager de futures activités de collection aidant la recherche. Les

genres de Poaceae non bambusoïdes endémiques de Madagascar ont été révisés et un index des noms génériques que l'on croyait être endémique a été présenté. Six genres de graminées non-bambous sont actuellement acceptés comme endémiques de Madagascar : *Cyphochlaena*, *Decaryella*, *Lecomtella*, *Neostapfiella*, *Viguiarella* et *Yvesia*. Plusieurs collections de Poaceae sont encore nécessaires. Des descriptions, des clés d'identification, des illustrations, des cartes, une liste complète de tous les spécimens connus et des évaluations de statut de conservation de l'UICN sont présentées afin d'avancer les missions de collecte dans le futur.

**Mots clés :** *Cyphochlaena*, *Decaryella*, *Lecomtella*, *Neostapfiella*, Poaceae, *Viguiarella*, *Yvesia*

## Introduction

Representatives of the family Poaceae (grasses) in Madagascar are often considered to be weeds or cattle feed and of no interest to science. Grasslands cover more than 65% of the land surface of the island (Moat & Smith, 2007), but open grassland and savannah areas are assumed to be "degraded" land that was previously forest. Both of these perceptions are incorrect. The origin of Malagasy savannas, like their counterparts in Central Africa (Vande Weghe, 2004), is controversial (Keay, 1959; Klein, 2002): a consequence of the climate (Perrier de la Bâthie, 1921; Humbert, 1927; Burney, 1997), edaphic in origin, due to fire (Burney, 1996; Kull, 2004), or people (Gade, 1996). Many commonly seen Malagasy grasses are the same species that dominate African savannas. Of the circa 577 species and 130 genera of Poaceae in Madagascar, an estimated 248 species and six genera are unique to the island (Judziewicz & Simon, unpublished). The species level measure of endemism in grasses of circa 40% is considerably below the 80-90% average endemism for flowering plants in Madagascar (Callmander *et al.*, 2011). However, these lineages are ecologically significant both in areas where grassland and savannah are likely to form a portion of the natural ground cover (Bond *et al.*, 2008; Willis *et al.*, 2008) and in other vegetation types. The plant likely responsible for the largest total biomass production across Madagascar is the endemic *Aristida rufescens* Steud., a dominant

component of many grasslands in the Central Highlands, as well as northern and western areas (Bossler, 1969; Koechlin, 1993). The ground cover of many rainforests is dominated by endemic species of *Poecilostachys* Hack. The majority of bamboos are endemic and include *Cathariostachys* S. Dransf., *Cephalostachyum* Munro, and *Nastus* Juss., forming, for example, an important portion of the diet of the bamboo lemur *Hapalemur griseus* (Tan, 2007).

Grasses are the most economically important plant family across the world and include cultivated rice (*Oryza sativa* L.), maize (*Zea mays* L.), bread wheat (*Triticum aestivum* L.), sugar cane (*Saccharum officinarum* L.), and bamboos. This is why grasses are also the most thoroughly studied and the best taxonomically documented of the large flowering plant families, in spite of their high species number: 11,290 currently accepted species of grasses in 707 genera (Clayton *et al.*, 2013). Modern flora treatments are now available for western Africa (Hutchinson & Dalziel, 1972), eastern Africa (Clayton, 1970; Clayton & Renvoize 1982; Clayton *et al.* 1974), Zambia to Mozambique (Launert, 1971; Clayton, 1989; Cope, 1999, 2002), Central America (Davidse *et al.*, 1994), and North America (Barkworth *et al.*, 2003, 2007). Global compilations of grass species descriptions and keys are available on several websites (Clayton *et al.*, 2013; Simon *et al.*, 2013). The poor development of grass taxonomy in Madagascar is an exception and represents the largest remaining gap in the global knowledge of the grass family. Bond *et al.* (2008) overtly complain that the “current state of grass taxonomy in Madagascar” is holding back botanical diversity assessments across the island.

Most herbarium collections of Madagascar grasses are held at the Muséum national d'Histoire naturelle in Paris and the majority of species were described there by Aimée Antoinette Camus between 1924 and 1959 (Leandri, 1966). Her extensive work is difficult to synthesize due to the numerous small publications with few broader revisions or identification keys. Jean-Michel Bossler at ORSTOM in Madagascar collected grasses between 1951 and 1970 (Dorr, 1997), compiling the most comprehensive set of collections to date. His book “Graminées des pâturages et des cultures à Madagascar” (Bossler, 1969) remains the only reference publication on Madagascar grasses. It focuses on Central Highland taxa and includes 291 species of the estimated 577, the gaps representing the less common coastal and forest grasses. Little collecting of Poaceae has been done since Bossler. Herbarium work carried out

in Paris by Emmet J. Judziewicz in 1990s remains largely unpublished. This paper is part of the ongoing work by the first author to encourage collection and study of Malagasy grasses to advance taxonomic treatment of this family (Vorontsova, 2013; Vorontsova *et al.*, 2013).

The endemic grass genera of Madagascar are poorly known and under collected, partly because there is no readily available reference to their identification and distribution. The classification of grasses is continuously updated following results from both morphological and molecular phylogenetic work (Vorontsova & Simon, 2012). Clayton *et al.* (2013), Simon *et al.* (2013), and Soreng *et al.* (2013) regularly compile taxonomic updates. These sources can be difficult to use by a non-specialist.

A few authors are largely responsible for the generic classification of Malagasy grasses. Camus described 11 genera as endemic to Madagascar, not including bamboos (Camus, 1925a, 1925b, 1926a, 1926b, 1926 publ. 1927, 1927 publ. 1928, 1931, 1934, 1945, 1948 publ. 1949, 1957). Bossler (1969) recognized seven endemic genera, but only three of these are accepted here. The Madagascar Catalogue (2013) and Buerki *et al.* (2013) report 10 endemic non-bamboo grass genera, while this current treatment recognizes six of these.

We summarize the endemic grass genera accepted following the most recent data and provide information on the taxonomic placement of all Poaceae genera previously said to be endemic to Madagascar. We hope to encourage collecting and provide descriptions and illustrations to enable recognition of these plants in the field. IUCN conservation assessments and distribution maps provide information on collection localities and demonstrate how poorly collected these species are. This current treatment also includes taxa occurring on islands in the Comoros and Mascarene Archipelagos. For bamboos, the most up to date summary is Dransfield (2003).

Generic rank is by no means an accurate measure of genetic diversity: a single mutation can produce a change in morphology sufficiently distinctive to be described as a separate genus, for example, the awnless *Toliara* Judz. originally described as a different genus to the awned *Perotis* Aiton (Judziewicz 2009; Paul Peterson, pers. comm.). Speciose genera such as *Andropogon* L. and polyphyletic groupings such as *Panicum* L. each comprise multiple colonization events of Madagascar. No molecular analysis has been carried

out on the majority of endemic grasses, including those accepted as endemic genera or those placed in synonymy. Taxonomic placement and status is likely to change once these data become available. We have chosen to publish this review prior to certain research advancements to encourage further collecting efforts. We hope that this paper provides a snapshot of the most divergent and distinctive Malagasy grass lineages.

## Methods

Taxonomic literature was surveyed for references to endemic non-bambusoid Poaceae of Madagascar. BRAHMS database software (BRAHMS, 2013) and GeoCat software (Bachman *et al.*, 2011) were used. In total, 116 specimens from K, P, and TAN herbaria belonging to eight species were compiled in a BRAHMS database. IUCN red list criteria (IUCN, 2001) were used to evaluate the conservation status of each species. The Area of Occupancy (AOO) and Extent of Occurrence (EOO) were calculated using GeoCat. The default value of grid cells 2 x 2 km<sup>2</sup> recommended by IUCN was used.

## Summary of endemic non-bambusoid genera of grasses

### Family Poaceae

#### Subfamily Panicoideae

##### Tribe Lecomtelleae (Besnard *et al.*, 2013)

*Lecomtella* A. Camus (1925a) (Figures 1 & 2)

*Lecomtella madagascariensis* A. Camus (endemic monotypic genus)

**Description** – Perennial with thick bamboo-like scandent culms 1 - 2 m long. Ligule a fringe of hairs. External ligule present. Leaf-blades lanceolate, apically attenuate. Inflorescence an oblong contracted panicle 5 - 6 cm, with male spikelets on lower parts of the panicle branches and one bisexual spikelet at the tip of each branch. Bisexual spikelets 2-flowered. Glumes shorter than spikelet. Lower floret male, the lemma similar to upper glume. Upper floret female, the callus with two apical wings 0.5 mm long, the upper lemma oblong, dorsally compressed, coriaceous, pubescent, the lemma apex obtuse, tuberculate (Figure 1).

**Habitat** – Sheltered under rocks and at forest margins at higher altitudes; 1200 - 2500 m elevation.

**Distribution** – Fianarantsoa Province (Figure 2).

### Specimens – Madagascar, Fianarantsoa:

Andringitra National Park, west slopes of Massif d'Andringitra, 1600 - 2200 m, July 1911, *Perrier de la Bâthie 10816* (P); Massif d'Andringitra, 1200 m, July 1911, *Perrier de la Bâthie 11166* (K, P); Massif d'Andringitra, 1600 - 2400 m, *Perrier de la Bâthie 13598* (K, P); Andringitra National Park, 2.8 km from Camp 1 on path from Belambo camp towards summit, rocks on exposed open sunny dry hillside, 22°08'45"S, 46°53'28"E, 1737 m, 26 October 2011, *Vorontsova, Hall, Besnard, Ralimanana, Randriamboavonjy & Andriantiana 603* (K, MO, P, TAN); Southern Andringitra, Andrianony range, Manjarivolo, c. 1800 m, 2 November 1970, *Guillaumet 3477* (MO, P, TAN); Andringitra National Park, at the foot of Tsoraha, 2300 m, 10 May 1957, *Cours 5182* (P); Antambohobe near Ivohibe, Fatakomala, 12 May 1957, *Réserves Naturelles de Madagascar & Rakoto 8556* (P).

**Lookalikes** – The habit appears bamboo-like, the leaves resemble those of larger *Setaria*, while the panicle is superficially similar to other high elevation pooid genera with large spikelets such as *Helictotrichon* Besser. On closer examination the hairy fertile upper lemma subtended by winged callus appendages and tuberculate at the apex is unique in the grasses.

**Notes** – Unique divergent lineage (Besnard *et al.*, 2013). The fleshy appendage at the base of the upper floret may represent an elaiosome (Figure 1O & 1P), although no data on seed dispersal is available.

**Conservation status** – Critically Endangered (Besnard *et al.*, 2013).

### Family Poaceae

#### Subfamily Panicoideae

##### Tribe Paniceae

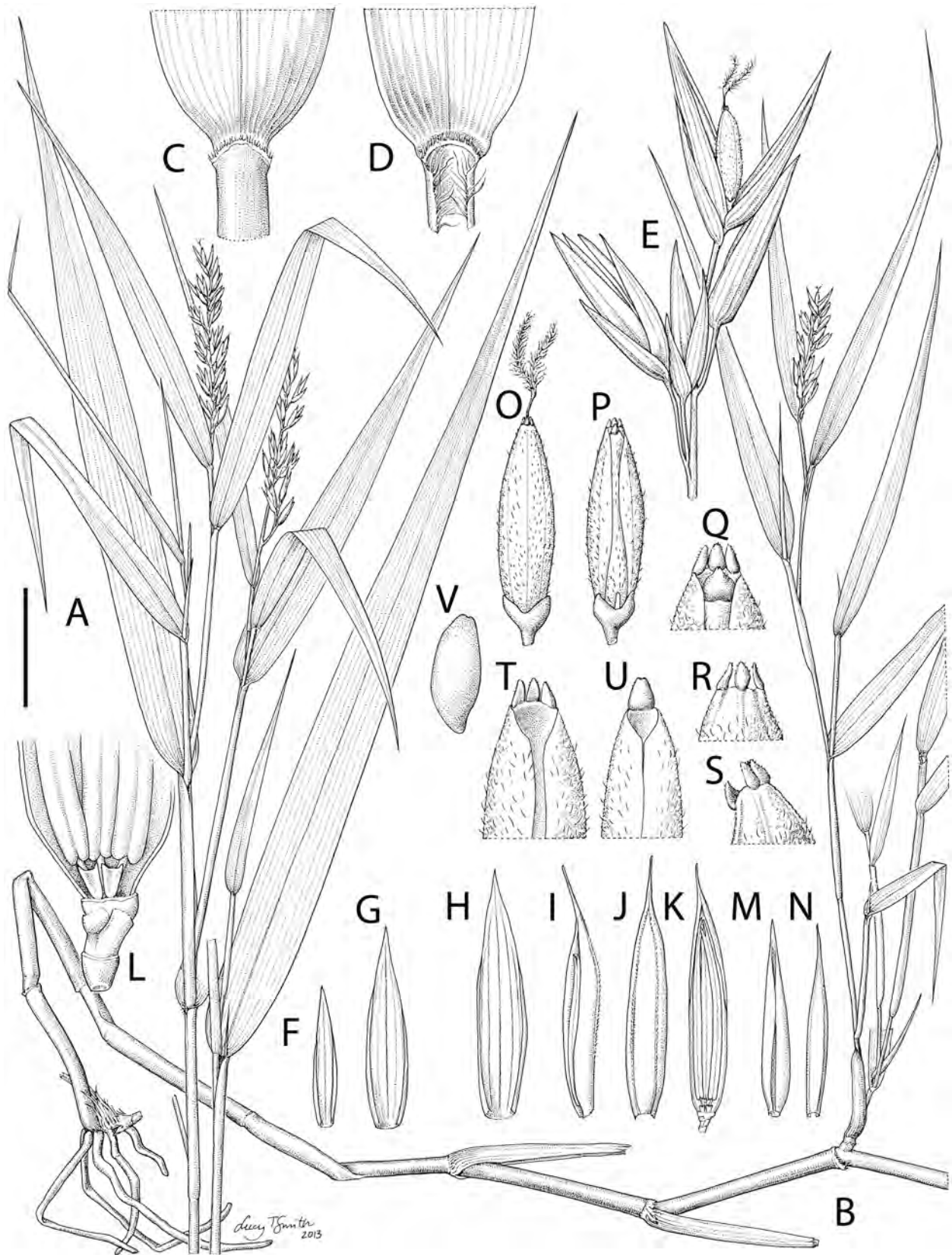
##### Subtribe Boivinellinae

*Cyphochlaena* Hack. (Hackel, 1901) (Figures 3-5)

Two species; endemic to Madagascar and the Comoros (Mayotte and Anjouan).

DNA data fide Morrone *et al.* (2011).

**Description** – Small prostrate annual. Ligule a ciliate membrane. Leaf-blades very thin, ovate to oblong, asymmetric at base. Inflorescence composed of erect unilateral racemes borne along a central axis. Spikelets in pairs of one sessile sterile spikelet and one pedicelled bisexual spikelet. Pedicelled bisexual



**Figure 1.** *Lecomtella madagascariensis*. A) Flowering habit, B) Flowering habit with creeping stolon, C) Ligule, dorsal view, D) Ligule, ventral view, E) Inflorescence branch with three proximal male spikelets and one distal bisexual spikelet, F – N) Male spikelet, F) Lower glume, G) Upper glume, H) Lower lemma, I) Lower palea, lateral view, J) Lower palea, dorsal view, K) Lower floret with the palea removed, L) Base of the lower floret with the palea removed, M) Upper lemma, N) Upper palea, O – V) Bisexual spikelet, O. Upper floret, dorsal view, P) Upper floret, ventral view, Q) Upper floret apex, ventral view, R) Upper floret apex, dorsal view, S) Upper floret apex, lateral view, T) Upper lemma apex, ventral view, U) Upper palea apex, ventral view, V) Developing caryopsis. Scale bar: A, B = 3 cm; C, D = 1 cm; E = 5 mm; F - K, M, N = 4 mm; L = 1.1 mm; O, P = 2.5 mm; Q - S = 0.8 mm; T - V = 1 mm. Drawn from Vorontsova et al. 603. (Drawn by Lucy T. Smith.)



**Figure 2.** Distribution of *Lecomtella madagascariensis*. (Drawn by Pawel Ficinski.)

spikelets obovate and appearing inflated, laterally compressed, with a basal male or sterile floret and an upper female or bisexual floret. Glumes reaching the apex of florets, firmer than fertile lemma. Lower glume linear or ovate, membranous, awned; upper glume lanceolate to oblong, indurate. Lower lemma wide and inflated, indurate, acute. Upper fertile lemma ovate, laterally compressed, inflated or not, hyaline. Sessile male spikelets represented by a single awned glume (Figures 3 & 4).

**Habitat** – Humid forest understory at 0 - 500 m elevation.

**Distribution** – Antsiranana, Mahajanga, and Toliara provinces, and the Comoros (Mayotte) (Figure 5).

**Lookalikes** – The overall appearance of the plant is strongly reminiscent of the related forest understory genus *Oplismenus* P. Beauv. with similar short awned racemes borne along an axis. The racemes on an

axis with regular rows of spikelets are also similar to small species of *Echinochloa* P. Beauv., *Urochloa* P. Beauv., and *Acroceras* Stapf. *Cyphochlaena* can be distinguished from all of these by its inflated obovate apically truncate spikelets and by its hardened upper glume (*Oplismenus*, *Echinochloa*, *Brachiaria*, *Urochloa*, and *Acroceras* spikelets are narrow, ovate or elliptic, apically rounded to acuminate; upper glume is always herbaceous). The strongly asymmetric spikelet is reminiscent of *Cyrtococcum* and some *Panicum*, but *Cyrtococcum* and *Panicum* have a panicle (not racemes) and an herbaceous upper glume (not a hardened upper glume).

**Notes** – Clayton & Renvoize (1986) suggest this genus is related to *Pseudechinolaena* Stapf, but in the molecular phylogenies of Morrone *et al.* (2011) it is sister to *Poecilostachys* and the two are sister to *Oplismenus*.

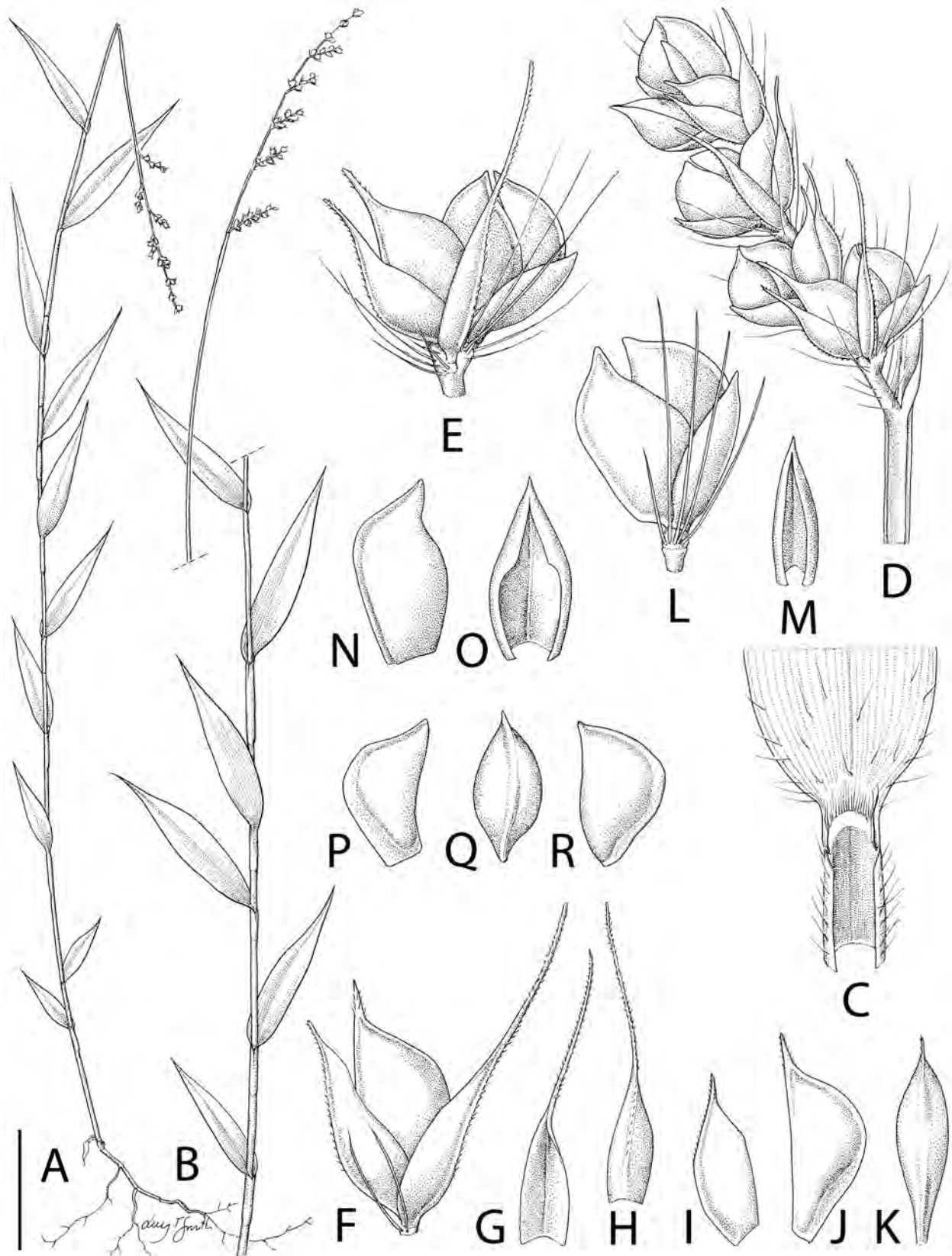
**Identification key** (adapted from Bosser, 1965):

Spikelets 1.3 - 1.7 mm long... 1a. *Cyphochlaena madagascariensis*

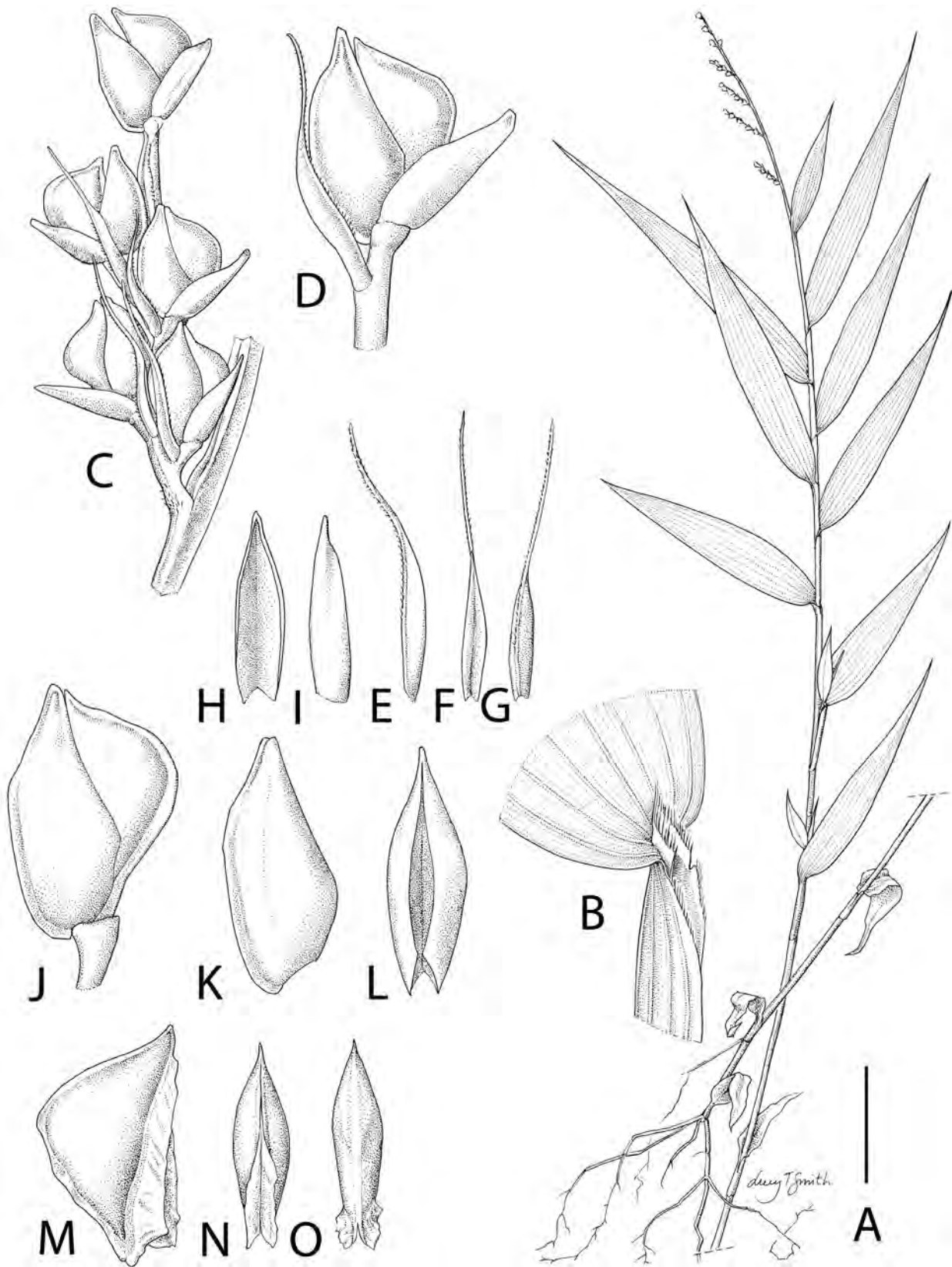
Spikelets 2 - 2.3 mm long... 1b. *Cyphochlaena scleroides*

***Cyphochlaena madagascariensis*** Hack (Figure 3).

**Specimens – Madagascar, Antsiranana:** Anivorano du Nord, PK 88, April 1970, *Bosser 20223* (P); S of Anivorano du Nord, environs of Ambalabao, 12°48'S, 49°14'E, 300 - 400 m, 11 March 1988, *Cheek & Rakotozafy B1427* (K, P, TAN); plateaux calcaires de l'Ankarana du Nord entre Ambilobe et Anivorano, 200 - 350 m, March 1951, *Humbert & Capuron 15488* (P); Ambahatra, cours moyen, plateau d'Anketraka Be, 13°56'S, 48°27'E, 180 m, 7 May 2000, *Wohlhauser 60251* (K); plateaux calcaires de l'Ankarana du Nord, entre Ambilobe et Anivorano Nord, 200 - 350 m, March 1951, *Humbert 25488a* (P); plateaux calcaires de l'Ankarana du Nord, entre Ambilobe et Anivorano Nord, 30 - 350 m, January 1960, *Humbert 32647bis* (P); plateaux calcaires de l'Ankarana du Nord, entre Ambilobe et Anivorano Nord, W de la grande route Mont Ambatopiraka, 30 - 350 m, January 1960, *Humbert 32655bis* (P); Montagne des Français, 13 April 1970, *Bosser 20164* (P); Montagne des Français, 13 April 1970, *Bosser 20168* (P); Anivorano Nord, PK 88, May 1970, *Bosser 20223bis* (P); Nosy Be, February 1880, *Hildebrandt 3354* (K, P, US). **Mahajanga:** route de Boanamary, aux environs de Majunga, February 1953, *Bosser 5422* (P, TAN);



**Figure 3.** *Cyphochlaena madagascariensis*. A) Habit, B) Habit, enlarged, C) Ligule, D) Raceme, E) Spikelet pair, F - K) Sessile spikelet, F) Sessile spikelet, G) Upper glume, ventral view, H) Upper glume, dorsal view, I) Lower floret, lateral view, J) Upper floret, lateral view, K) Upper floret, dorsal view, L - R) Pedicelled spikelet, L) Pedicelled spikelet, M) Upper glume, ventral view, N) Lower floret, lateral view, O) Lower lemma, ventral view, P) Upper floret, lateral view, Q) Upper floret, dorsal view, R) Upper floret, lateral view. Scale bar: A = 3 cm; B = 2 cm; C = 2 mm; D = 1.6 mm; E = 1.1 mm; F - R = 1 mm. A - C from Cheek *et al.* B1427; D - R from Hildebrandt 3354. (Drawn by Lucy T. Smith.)



**Figure 4.** *Cyphochlaena scleroides*. A) Habit, B) Ligule, C) Raceme, D) Spikelet pair, E – G) Lower spikelet remnant, E) Lower spikelet remnant, lateral view, F) Lower spikelet remnant, ventral view, G) Lower spikelet remnant, dorsal view, H – O) Pedicelled spikelet, H) Upper glume, ventral view, I) Upper glume, lateral view, J) Pedicelled spikelet with the upper glume removed, K) Lower floret, lateral view, L) Lower lemma, ventral view, M) Upper floret, lateral view, N) Upper floret, ventral view, O) Upper floret, dorsal view. Scale bar: A = 3 cm; B, C = 1.6 mm; D = 1.1 mm; E - O = 1 mm. A from *Humbert 32666bis*; B - O from *Humbert & Capuron 25488*. (Drawn by Lucy T. Smith.)



**Figure 5.** Distribution of *Cyphochlaena*. Black circles = *Cyphochlaena scleroides*. Grey circles = *Cyphochlaena madagascariensis*. (Drawn by Pawel Ficinski.)

11 km E Antsalova, near the edge of the Tsingy of Bemaraha, 12 March 1993, *Klackenberg 06* (P); RN8, Allomavo, Soalala, 20 January 1954, *Réserves Naturelles de Madagascar & Rakotovo 6411* (P); on the track from Majunga-Ankarafantsika road towards Anjohibe cave and Androhibe, 15°42'29"S, 46°31'39"E, 16 February 2013, *Vorontsova, Besnard, Ralimanana & Razanatsoa 954* (K, MO, P, TAN); ca 2 km NE of Tsaramandroso, 16°21'46" S, 47°03'48" E, 81 m, 19 February 2013, *Vorontsova, Besnard, Ralimanana & Razanatsoa 982* (K, MO, P, TAN); Bemarivo, Boina region, February 1907, *Perrier de la Bâthie 11906* (K, P); Tsingy du Bemaraha, 17 February 1933, *Leandri 924* (P). **Toliara:** 50 km de Tulear, route de Sakaraha, March 1960, *Bosser 14066* (P); Beomby, ouest d'Ejeda, Plateau Mahafaly, March 1960, *Bosser 14171* (P); Ankazoabo, February 1963, *Bosser 17257* (P, TAN); forêt de Zombitsy,

Sakaraha, February 1963, *Bosser 17705* (P, TAN); Vohibasias Forest, SW of Ankazoabo, 20 February 1970, *Bosser 19940* (P); Vohibasias (Ankazoabo), March 1970, *Morat 3567* (TAN); 20 km de Sakaraha route d'Ankazoabo, 21 February 1970, *Bosser 19967* (P); 20 km au Nord de Sakaraha 451 m, March 1970, *Morat 3588* (TAN); rive gauche de Fiherenana aux environs de Manera, May 1933, *Perrier de la Bâthie 19219bis* (P). **[Province Unknown]:** Ouest, *Perrier de la Bâthie 11306* (P). **Mayotte.** Grande Terre, Kani Kely, Mbouini, 15 March 2002, *Barthelat, M'changama & Ali Sifari 762* (P); sous les buissons de la côte Ouest de Pamanzi, April 1950, *Boivin s.n.* (P); Ilot Choazil, 29 April 1999, *Mas 105* (P); Sazilé Bé, Pied de Falaise, 12°58.65'S, 45°12.02'E, 100 - 150 m, 11 April 1999, *Pignal, Pibot & Soumille 1122* (K, P); Bandrele, 12°54.93'S, 45°11.92'E, 0 - 1 m, 14 April 1999, *Pignal 1146* (K, P).

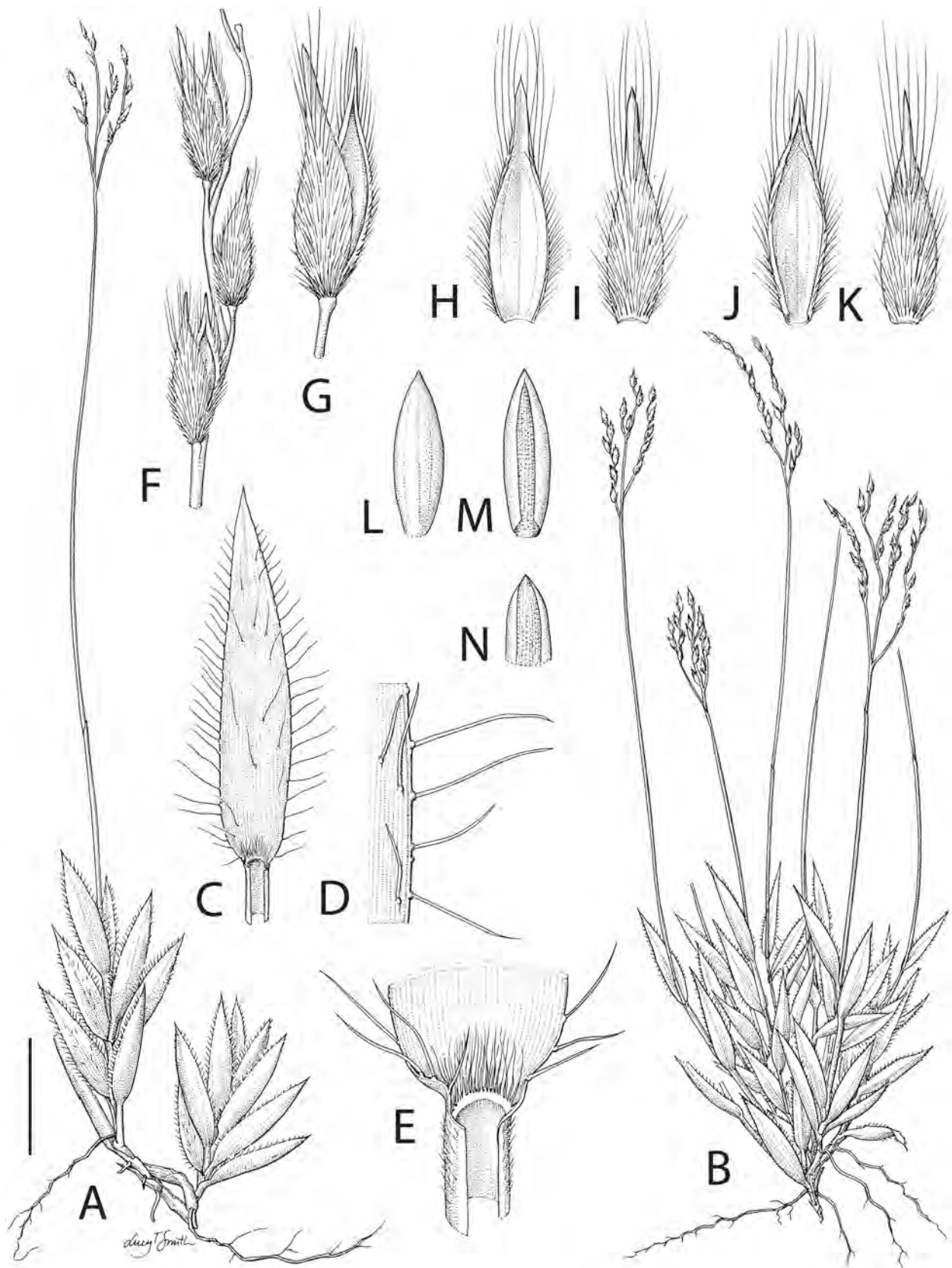
**Conservation status** – Least concern: even though the AOO is considerably below 2 000 km<sup>2</sup>, the EOO is above 300 000 km<sup>2</sup> and the species is known from more than 10 locations.

***Cyphochlaena scleroides*** (A. Camus)  
Bosser (Figure 4).

**Specimens** – **Comores.** Nzwani, Anjouan, 691 m, 1847, *Boivin s.n.* (P); Mohéli, Nioumachoua, 28 m, May 1963, *Bosser 18028* (P). **Madagascar, Antsiranana:** plateaux calcaires de l'Ankarana du Nord, entre Ambilobe et Anivorano Nord, 200 - 350 m, March 1951, *Humbert 25488b* (P); plateaux calcaires de l'Ankarana du Nord, entre Ambilobe et Anivorano Nord, lisière de la calcaire au S d'Anivorano, 30 - 350 m, January 1960, *Humbert 32439* (P); collines et plateaux calcaires de l'Ankarana du Nord, 30 - 350 m, February 1960, *Humbert 32576* (P); collines et plateaux calcaires de l'Ankarana du Nord, Ambatompiraka, W de la route nationale, 30 - 350 m, February 1960, *Humbert 32666bis* (P). **Mahajanga:** Ankirihitra près du Mont Tsitondroina, April 1902, *Perrier de la Bâthie 11234* (P).

**Conservation status** – Near Threatened: despite a broad EOO of over 100 km<sup>2</sup> this species has only been reported from six locations with an estimated AOO of 16 km<sup>2</sup>.





**Figure 6.** *Yvesia madagascariensis*. A) Habit with a single culm, B) Habit with multiple culms, C) Leaf, D) Detail of leaf trichomes, E) Ligule, F) Raceme fragment, G) Spikelet, H) Upper glume, ventral surface, I) Upper glume, dorsal surface, J) Lower lemma, ventral surface, K) Lower lemma, dorsal surface, L) Upper floret, dorsal surface, M) Upper floret, ventral surface, N) Apex of a different upper floret, ventral surface. Scale bar: A, B = 2 cm; C = 5 mm; D = 1.6 mm; E, F = 2 mm; G – N = 1.3 mm. A drawn from *Bosser 5319*; B - N from *Perrier de la Bâthie 13010*. (Drawn by Lucy T. Smith.)

**Family Poaceae****Subfamily Panicoideae****Tribe Paniceae****Subtribe Melinidinae**

*Yvesia* A. Camus (1926 publ. 1927) (Figures 6 & 7)

*Yvesia madagascariensis* A. Camus (monotypic endemic genus).

**Description** – Erect or geniculately ascending annual 15 - 20 cm long. Ligule a fringe of hairs. Leaf-blades lanceolate, stiff, with tubercle based hairs. Inflorescence composed of several small racemes on a central axis. Spikelets solitary, held erect, on short pedicels, white. Spikelets with 1 basal sterile floret and one apical fertile floret, lanceolate, dorsally compressed, 2 - 3 mm long. Lower glume absent or vestigial. Upper glume longer than the fertile lemma, pilose with white-pink hairs in the lower part. Lower lemma acute, also pilose with white-pink hairs in the lower part. Fertile lemma thick, acute. No awns (Figure 6).

**Habitat** – Savannas and stream sides; 0 - 1000 m elevation.

**Distribution** – Antsiranana, Mahajanga, and Fianarantsoa provinces (Figure 7).

**Specimens** – **Madagascar, Antsiranana:** entre Ambanja et Ambilobe, April 1970, *Bosser 20242* (P).

**Mahajanga:** Ambalakida, environs de Majunga, July 1953, *Bosser 5319* (K, P, TAN); Androhibe, January 1967, *Granier 166* (P); Manasamody entre Port Berge et Antsohihy, April 1974, *Morat 4456* (P, TAN); Manasamody entre Port Berge et Antsohihy, April 1974, *Morat 4563* (P); aux environs de Majunga, February 1914, *Perrier de la Bâthie 10884* (P); environs de la baie de Bombetoke, January 1908, *Perrier de la Bâthie 11055* (P); Majunga, February 1920, *Perrier de la Bâthie 13010* (K, P); plateau de Morohogo, March 1926, *Perrier de la Bâthie 17619* (K, P); aux environs de Majunga, February 1927, *Perrier de la Bâthie 17927* (P); ca 5 km on the track from Majunga-Ankarafantsika road, between Station Forestière Marohogo and Andradia, 15°42'47.4"S, 46°29'33.2"E, 38 m, 16 February 2013, *Vorontsova, Besnard, Ralimanana & Razanatsoa 957* (K, MO, P, TAN); ca 3 km on the track from Majunga-Ankarafantsika road, between Station Forestière Marohogo and Andradia, 15°43'31.1"S, 46°28'39"E, 39 m, 19 February 2013, *Vorontsova, Besnard, Ralimanana & Razanatsoa 971* (K, MO, P, TAN); Grottes d'Anjohibe, May 1969, *Morat 3305* (TAN);

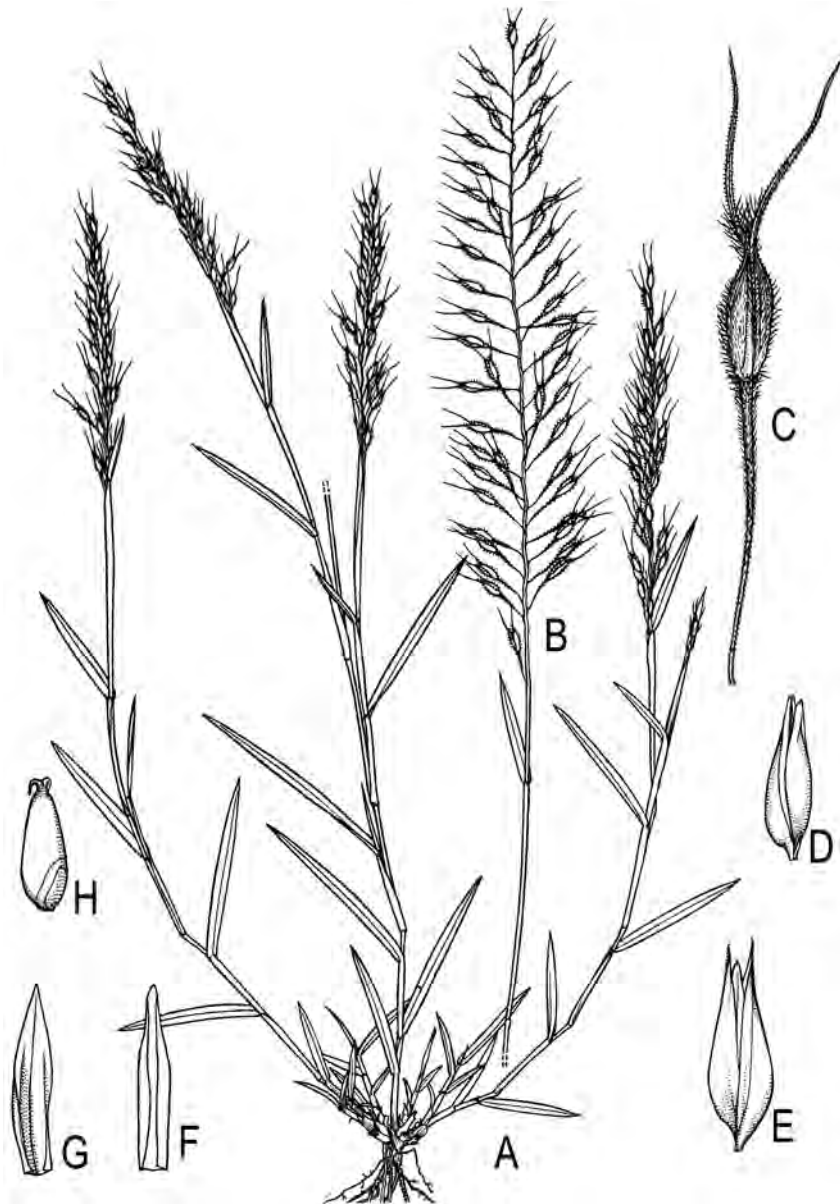
Ouest, Nosi-lada (Iles Barren), Antsalova, 7 June 1921, *Perrier de la Bâthie 13821* (P). **Fianarantsoa:** Horombe, February 1967, *Morat 2596* (P).

**Lookalikes** – The habit and inflorescence of *Yvesia* resembles the abundant weedy *Brachiaria umbellata* (Trin.) Clayton; no *Panicum* or *Urochloa* species have the long white-pink hairs on the lower parts of the upper glume and lower lemmas (although some *Brachiaria* endemic to Madagascar have a line of hairs on the upper part of the upper glume and lower lemma, but never on the lower part).

**Notes** – Placed in Melinidinae by Salaria *et al.* (2010) based on morphology only; partial sequence of the *ndhF* gene was analyzed by Morrone *et al.* (2011) and confirmed the placement in Melinidinae. *Yvesia* is sister to *Thuarea involuta* R.Br. with low support; *Thuarea* Pers. is the only other genus in the Melinidinae to have an absent lower glume.



**Figure 7.** Distribution of *Yvesia madagascariensis*. (Drawn by Pawel Ficinski.)



**Figure 8.** *Decaryella madagascariensis*. A) Habit, 10 - 30 cm tall, B) Inflorescence, 4 - 12 cm long, C) Spikelet, 6 - 8.5 mm long including the callus, D) Floret of one-flowered spikelet, 2.2 - 3 mm long, E) Florets of a two-flowered spikelet, F) Palea, ventral view, G) Lemma, ventral view, H) Young caryopsis. (Reproduced from Bosser, 1969.)

**Conservation status** – Least Concern: with a fairly broad distribution and an estimated EOO of 250 km<sup>2</sup> and AOO of 48 km<sup>2</sup>.

#### Family Poaceae

**Subfamily Chloridoideae: Incertae sedis** fide Soreng *et al.* (2013)

*Decaryella* A. Camus (1931) (Figures 8 & 9)

*Decaryella madagascariensis* A. Camus, endemic monotypic genus.

**Description** – Decumbent ascending annual 10 - 30 cm. Ligule a ciliate membrane. Leaf blades linear

and stiff. Inflorescence a single racemes single with solitary spikelets on long pedicels. Pedicels widening towards the top and spikelets falling together with pedicels. Spikelets with 1 - 2 fertile florets, ovate, laterally compressed, 6–8.5 mm long. Glumes equal, exceeding apex of florets, firmer than fertile lemma, coriaceous, 5-veined, dark grey, hairy, awned at the apex. Lemma ovate; membranous; 1- 3 veined (Figure 8).

**Habitat** – Dry forest and degraded open areas.

**Distribution** – Toliara Province (Figure 9).

**Specimens** – Madagascar, Toliara: environs d'Ihosal, March 1934, 800 - 900 m, *Humbert 14456* (P); piste de Tsihombe à Faux-Cap, April 1972, *Morat 3941* (P, TAN); vallée de Mandrare, Anarafaly, March 1960, *Bosser 14570* (K, MO, P, TAN); Ambovombe, May 1924, *Decary 2704* (P, US); Beloha, November 1956, *Bosser 10096* (P); Beloha, March 1960, *Bosser 14150* (K, MO, P, TAN); à quelques kms à Beloha, piste Beloha à Ampotaka, 29 March 1960, *Keraudren 935* (P).

**Lookalikes** – Quite unique in the Poaceae.

**Notes** – Does not look like a typical grass. Rare. The two dark grey glumes covering the spikelet each have a noticeable apical awn so every spikelet has two “tails” at the tip. DNA has not been analyzed and placement is uncertain.



**Figure 9.** Distribution of *Decaryella madagascariensis*. (Drawn by Pawel Ficinski.)

**Conservation status** – Vulnerable: an estimated EOO of ca 18,000 km<sup>2</sup>, with the species known from fewer than 10 locations.

### Family Poaceae

**Subfamily Chloridoideae: Incertae sedis** fide Soreng *et al.* (2013)

***Neostapfiella*** A. Camus (1926a, 1944)  
(Figures 10 - 13)

Two species: endemic to Madagascar.

**Description** – Ascendant annual to 30 cm long, usually stoloniferous. Leaf sheaths flat at base. Ligule a ciliolate membrane. Leaf-blades linear or lanceolate, fairly broad and apically obtuse or rounded, pale white-green. Inflorescence composed of 1 - 2(3) erect flat terminal racemes. Spikelets sessile, in 2 rows, wedge-shaped. Spikelets comprising 2 fertile florets, broadly triangular; laterally compressed, 3 - 5.5 mm long, disarticulating below each fertile floret. Glumes shorter than spikelet, gaping. Fertile lemma elliptic or obovate, laterally compressed, coriaceous, keeled, awned. Awn straight, 2 - 15 mm long. Apical sterile florets sometimes present and awned (Figures 10 - 12).

**Habitat** – Sand, dry forest and savanna; 0 - 500 m elevation.

**Distribution** – Antsiranana, Mahajanga, and Toliara provinces (Figure 13).

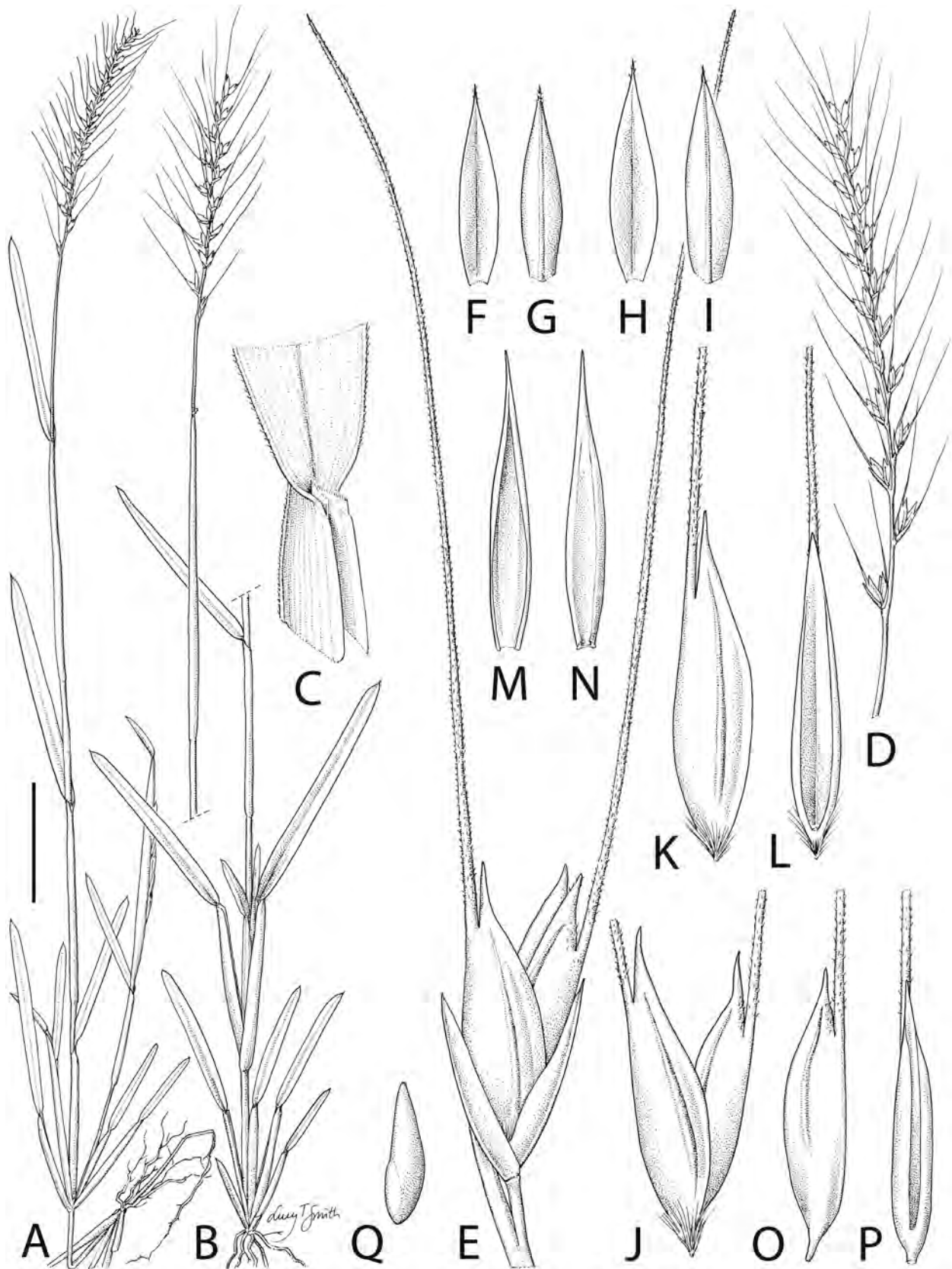
**Lookalikes** – The flat branching points, rounded leaf apices and triangular spikelets are similar to those of the related common weedy genus *Chloris* Sw. *Chloris* usually has more numerous and more densely packed racemes, and it always produces only one seed per spikelet. The small habit in dry areas and erect awned racemes can resemble *Dimeria* R.Br., *Dichanthium* Willem., and *Bothriochloa* Kuntze, and can be distinguished from these by a close examination of spikelet packing: *Dichanthium* and *Bothriochloa* have more than three racemes while *Neostapfiella* has 1 - 2(3); in *Dimeria* the awn is geniculate on drying rather than straight and the leaf apices are acuminate rather than obtuse or rounded.

**Notes** – DNA has not been analyzed and placement is uncertain.

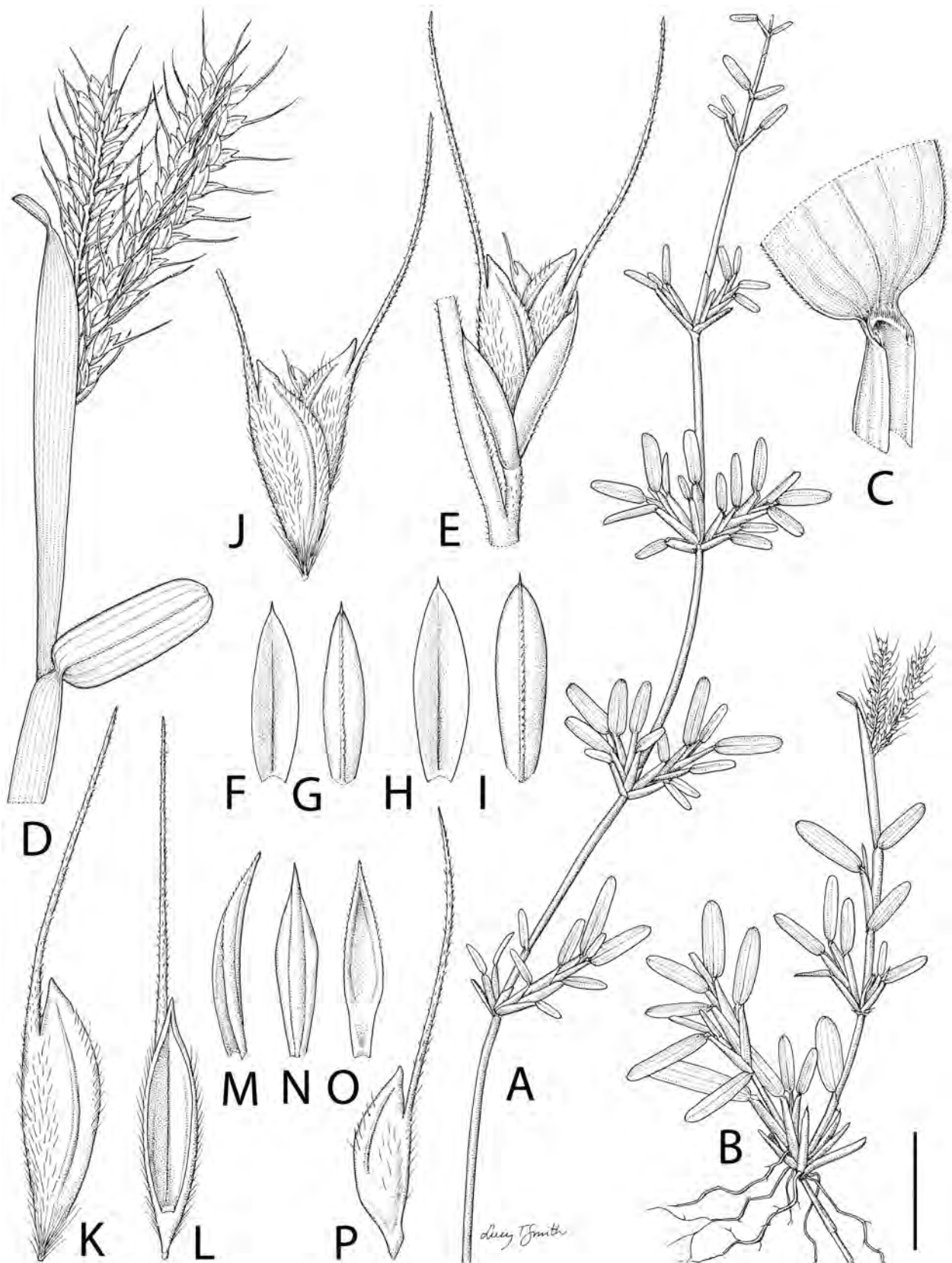
**Identification key** adapted from Camus (1944):

1a Apical rudimentary floret present above the fertile florets.. 4b. *Neostapfiella humbertiana*

1b No apical rudimentary floret.. 2



**Figure 10.** *Neostapiella chloridiantha*. A) Habit, B) Habit, enlarged, C) Ligule, D) Raceme, E) Spikelet, F) Lower glume, ventral view, G) Lower glume, dorsal view, H) Upper glume, ventral view, I) Upper glume, dorsal view, J) Spikelet with glumes removed, K) Lower floret, lateral view, L) Lower floret, ventral view, M) Lower palea, ventral view, N) Lower palea, dorsal view, O) Upper floret, lateral view, P) Upper floret, ventral view, Q) Developing caryopsis. Scale bar: A = 3 cm; B = 2 cm; C, E - Q = 1.6 mm; D = 1.5 cm. A, B from *Perrier de la Bâthie 11046*; C - Q from *Villiers et al. 4992*. (Drawn by Lucy T. Smith.)



**Figure 11.** *Neostapfiella humbertiana*. A) Stolon, B) Habit, C) Ligule, D) Flowering culm, E) Raceme fragment with spikelet, F) Lower glume, ventral view, G) Lower glume, dorsal view, H) Upper glume, ventral view, I) Upper glume, dorsal view, J) Spikelet with glumes removed, K) Lower floret, L) Lower lemma, ventral view, M) Lower palea, lateral view, N) Lower palea, ventral view, O) Lower palea, dorsal view, P) Second floret, lateral view. Scale bar: A = 3 cm; B = 2 cm; C, F - I, K - P = 1.4 mm; D = 7 mm; E, J = 1.6 mm. Drawn from *Humbert 12581*. (Drawn by Lucy T. Smith.)

2a Racemes single, glumes glabrous.. 4a. *Neostapfiella chloridiantha*

2b Racemes paired, glumes hirsute.. 4c. *Neostapfiella perrieri*

***Neostapfiella chloridiantha*** A. Camus (Figure 10).

**Specimens – Madagascar, Mahajanga:** au bord de la baie de Bombetoke, March 1908, *Perrier de la Bâthie 11046* (K, P); Mt Ambohibenga, Milanja, April 1904, *Perrier de la Bâthie 11111 bis* (P); 12 km ESE Ankiliromotsy, 26 km SE Antsalova, 30 March 1993, *Villiers, Klackenberg & Badré 4992* (MO, P).

**Conservation status** – Vulnerable: only known from a total of three locations, with an estimated AOO of 12 km<sup>2</sup>.

***Neostapfiella humbertiana*** A. Camus (Figure 11).

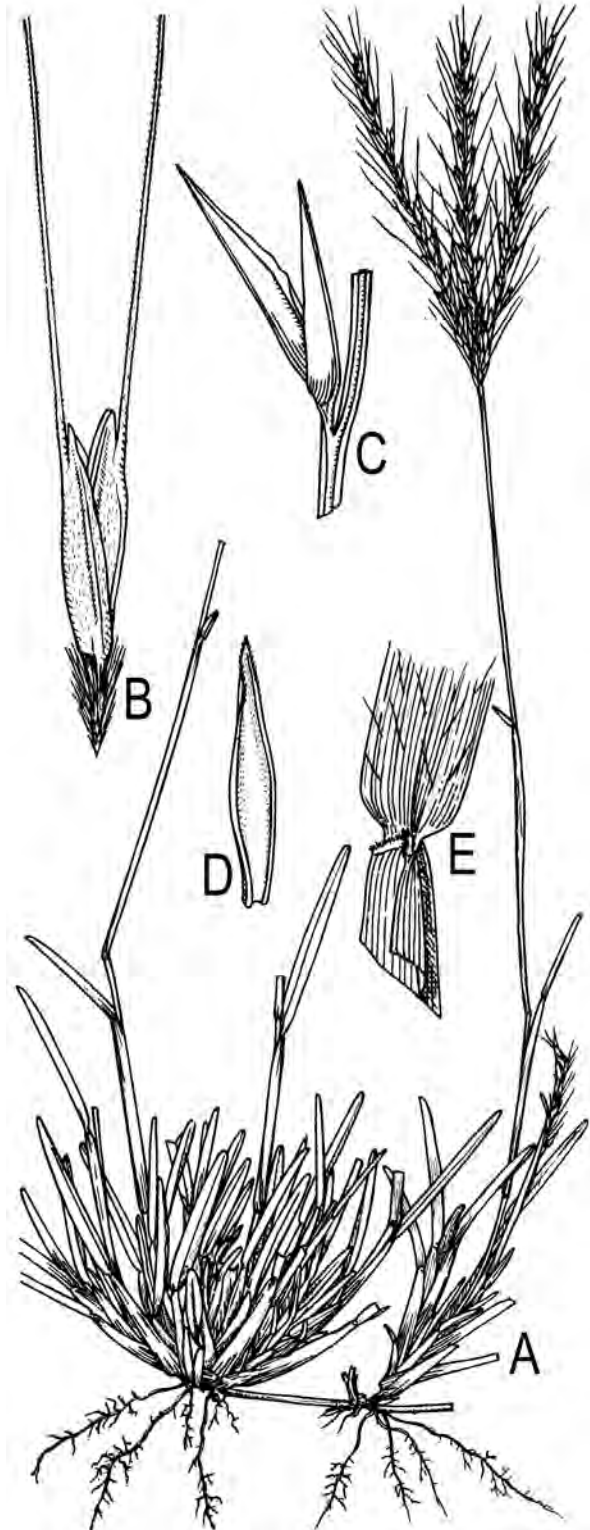
**Specimens – Madagascar, Toliara:** Vallée moyenne du Mandrare près d'Anadabolava, December 1933, *Humbert 12371* (P); Vallée moyenne du Mandrare près d'Anadabolava, December 1933, *Humbert 12581* (K, P, TAN); basse vallée de la Mananara, affluent de Mandrare, 50 - 150 m, March 1955, *Humbert & Capuron 29186* (P); Baie d'Italy, Fort Dauphin, June 1965, *Morat 1337* (P).

**Conservation status** – Endangered: with an estimated EOO of 70 km<sup>2</sup>, AOO of 12 km<sup>2</sup>, and all three known locations are outside protected areas.

***Neostapfiella perrieri*** A. Camus (Figure 12).

**Specimens – Madagascar, Antsiranana:** Baie de Rigny, July 1953, *Bosser 5382* (K, MO, P); Baie de Rigny, July 1953, *Bosser 5384* (P); route de la Baie de Rigny; P-ce de Diego Suarez, May 1970, *Bosser 20206* (P); Vohémar, Nosy Be, Anjiabe, 13°04.72' S, 49°54.07' E, 13 May 2004, *Razakamalala, Rabehevitra & Mathieu 1281* (K, MO, P, TEF), Sosumav; Ambilobe, 13°05.63' S, 48°51.00' E, December 1964, *Morat 1273* (P, TAN). **Mahajanga:** Bongolava, Nord de Majunga, April 1967, *Morat 2684* (P, TAN); Grottes d'Anjohibe, May 1969, *Morat 3304* (P, TAN); Bongolava de Port Berge, April 1974, *Morat 4451* (P, TAN); Ankarafantsika, *Perrier de la Bâthie 102 s.n.* (G, K); Ankarafantsika, près de "Marovoay" (Boeny), May 1910, *Perrier de la Bâthie 11218*

(P); environs de Majunga, April 1929, *Perrier de la Bâthie 14668* (P); Anjiajia, September 1952, *Bosser 3204* (MO, TAN); Antanandava II, entre Antsohihy et Ambanja, June 1953, 17 m, *Bosser 5456* (TAN).



**Figure 12.** *Neostapfiella perrieri*. A) Habit with a flowering culm, B) Spikelet with glumes removed, 4.5 - 5.5 mm long, C) Raceme fragment with a pedicel and two glumes, the glume 3 - 4 mm long, D) Palea, E) Ligule. (Reproduced from Bosser, 1969.)



**Figure 13.** Distribution of *Neostapfiella*. Black circles = *Neostapfiella chloridiantha*. Grey circles = *Neostapfiella perrieri*. White circles = *Neostapfiella humbertiana*. (Drawn by Pawel Ficinski.)

**Conservation status** – Near Threatened: with 13 known locations, an estimated EOO of 50 km<sup>2</sup> and AOO of 36 km<sup>2</sup>, this species occupies vulnerable sites largely outside protected areas.

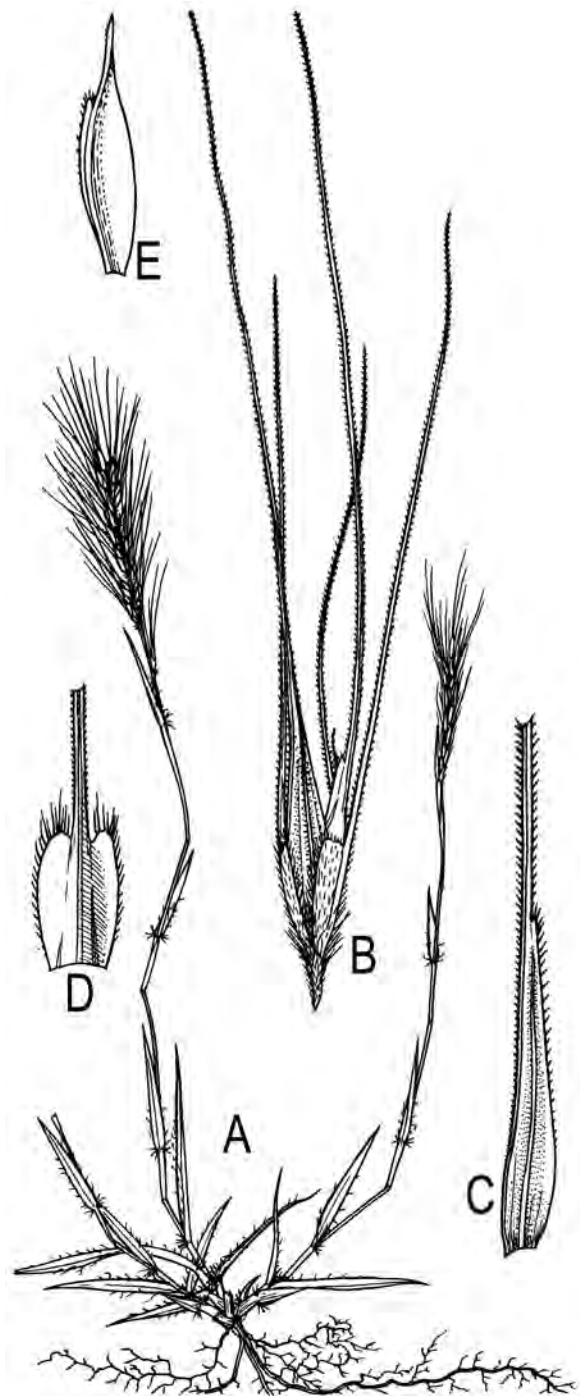
#### Family Poaceae

**Subfamily Chloridoideae: Incertae sedis** fide Soreng *et al.* (2013)

*Viguerella* A. Camus (1926b) (Figures 14 & 15)

*Viguerella madagascariensis* A. Camus (monotypic endemic genus)

**Description** – Geniculately ascending loosely tufted annual with culms 10 - 40 cm long. Ligule a fringe of hairs. Leaf blades flat, narrow, apically acuminate. Inflorescence a single terminal multilateral raceme 2 - 7 cm long, purple when young. Spikelets single,



**Figure 14.** *Viguerella madagascariensis*. A) Habit, B) Spikelet, 5 - 8 mm long without the awns, C) Lower lemma, 4 - 6 mm long, lateral view, D) Upper glume, dorsal view, E) Lower palea. (Reproduced from Bosser, 1969.)

sessile, 4 - 6 mm long, held erect, each spikelet subtended by a small bract. Spikelets with one basal fertile floret and 1 - 3 smaller apical male or sterile florets. Callus pubescent, pungent. Glumes shorter than spikelet, pubescent, every glume with an awn 6 - 15 mm long. Lemma elliptic, coriaceous, 3 - 5 veined, awned. Apical sterile lemmas awned (Figure 14).



**Habitat** – Dunes, arid open grassland and roadsides; 0 - 500 m elevation.

**Distribution** – Antsiranana, Toliara, and Mahajanga provinces (Figure 15).

**Specimens** – **Madagascar, Antsiranana:** presqu'île d'Ampasindava, April 1970, *Bosser 20145* (P); 57-58 km N of Ambanja, 22 May 1974, *Gentry 11882* (MO); Ambilobe, sur le terrain d'aviation, 5 m, March 1951, *Humbert & Capuron 25468* (P); Vallée de l'Ifasy en aval d'Anaborano, Anaborano near Ifasy, 50 - 200 m, March 1951, *Humbert & Capuron 25916* (P). **Mahajanga:** Miadana, 8 May 1962, *Boudet 1267* (P); environs de Majunga, 2 - 15 m, 27 July 1924, *Humbert & Perrier de la Bâthie 2040* (P); Manasamody, entre Port Berge et Antsohihy, April 1974, *Morat 4564* (P, TAN); près de Majunga, February 1925, *Perrier de la Bâthie 10883* (P); Mahavana près Majunga, March 1908, *Perrier de*

*la Bâthie 11044* (P); environs d'Amparimentera (Boina), April 1907, *Perrier de la Bâthie 11246* (P); Majunga, February 1920, *Perrier de la Bâthie 13018* (K, P, TAN); ca 3 km on the track from Majunga-Ankarafantsika road, between Station Forestière Marohogo and Andradia, 15°43'13.1"S, 46°28'39"E, 39 m, 19 February 2013, *Vorontsova, Besnard, Ralimanana & Razanatsoa 966* (K, MO, P, TAN); ca 3 km on the track from Majunga-Ankarafantsika road, between Station Forestière Marohogo and Andradia, 15°43'13.1"S, 46°28'39"E, 39 m, 19 February 2013, *Vorontsova, Besnard, Ralimanana & Razanatsoa 967* (K, MO, P, TAN); Analalava, terrain d'aviation, May 1952, *Bosser 2755* (TAN); PK 395, Ambalabonga, aux environs de Maevatanana, May 1958, *Descouings 3437* (TAN); environs de Mevatanana, Sakoa-Be, February 1899, *Perrier de la Bâthie 889* (P); Anjiajia, Ambato-Boeny, August 1952, *Bosser 3236* (TAN). **Toliara:** Andranobevora, Betioky, May 1963, *Bosser 19673* (P); sud-ouest, May 1953, *Portères s.n.* (P); Morombe, Mangoky, September 1956, *Bunière 116* (TAN). **[Province Unknown]:** PK 407, April 1967, *Morat 2697* (P).

**Lookalikes** – *Viguerella* is not immediately distinctive and can be difficult to recognize. *Aristida* L. is also a densely awned grass of arid environments but it is usually perennial while *Viguerella* is an annual and it usually has panicle, unlike single racemes of *Viguerella*. When a spikelet and floret is pulled out it is possible to see that every *Aristida* floret has a 3-branched awn; *Viguerella* awns are simple with no branches and they arise from glumes as well as lemmas. *Perotis* has a superficially similar terminal fluffy spike, but almost always wider ovate or lanceolate leaves; *Perotis* also has softer awns with only 2 awns per every spikelet, unlike the stiff awns of *Viguerella* with more than 4 awns per spikelet.

**Notes** – DNA has not been analyzed and placement is uncertain. Clayton & Renvoize (1986) connect this species with *Scleropogon* Phil. on the basis of the subtending bract.

**Conservation status** – Least Concern with a fairly broad distribution and an estimated EOO of 270 km<sup>2</sup> and AOO of 64 km<sup>2</sup>.

### Index to Poaceae genera previously thought to be endemic to Madagascar

**Boivinella** A. Camus (1925b, 1925c) was thought to consist of two species, *Boivinella comorensis* A. Camus and *B. scleroides* A. Camus. Bosser (1965) determined that *B. comorensis* is



**Figure 15.** Distribution of *Viguerella madagascariensis*. (Drawn by Pawel Ficinski.)

in fact the same species as *Cyphochlaena madagascariensis* Hack. In spite of numerous differences between *Boivinella* and *Cyphochlaena* suggested by Camus (1925d) the correct name for *Boivinella* is *Cyphochlaena*.

**Camusia** Lorch (1961) was described when *Camusia perrieri* (A. Camus) Lorch was moved from the Old World genus *Dactyloctenium* Willd. to a monotypic genus (Lorch, 1961). It was recognized by Bosser (1969). Numerical re-evaluation of Eragrostideae by Phillips (1982) placed it within the small Old World genus *Acrachne* Chiov.

**Camusiella** Bosser was a genus of two species segregated from *Setaria* P. Beauv. by Bosser (1966, 1969) and placed back within *Setaria* by Clayton & Renvoize (1986) who called it a "minor segregate from *Setaria*... largely a matter of subjective opinion... marginally better retained in *Setaria*".

**Cathariostachys** is a bamboo, not treated in this publication.

**Chasechloa** A. Camus (Camus 1948 publ. 1949, 1954) was recognized by Bosser (1969) and contained three Malagasy species. It was placed within the Neotropical genus *Echinolaena* Desv. by Clayton & Renvoize (1986) and this placement is accepted by Soreng *et al.* (2013) even though no DNA analysis has yet been carried out.

**Cyphochlaena** is accepted and described in this publication.

**Decaryella** is accepted and described in this publication.

**Decaryochloa** is a bamboo, not treated in this publication.

**Hitchcockella** is a bamboo, not treated in this publication.

**Humbertochloa** A. Camus & Stapf was considered to be a Madagascar endemic with a single species *H. bambusiuscula* A. Camus & Stapf (Camus, 1934) until a second species was discovered in Tanzania (Hubbard, 1939).

**Isalus** Phipps (1966) recognized by Bosser (1969) contained three Malagasy species previously placed in *Tristachya* Nees and *Danthoniopsis* Stapf. These were moved back into the widespread genus *Tristachya* by Clayton & Renvoize (1986).

**Lasiorrhachis** (alternative spelling *Lasiorrhachis*) was described by Stapf (1927) and reassembled by Bosser (1968) from species that Camus placed

in *Erianthus* Michx. and *Miscanthidium* Stapf. Clayton & Renvoize (1986) placed all three species within *Saccharum* L. No DNA analysis has yet been carried out and its placement remains uncertain.

**Lecomtella** is accepted and described in this publication.

**Neostapfiella** is accepted and described in this publication.

**Perrierbambus** is a bamboo, not treated in this publication.

**Perulifera** A. Camus (1927 publ. 1928) has been placed within *Pseudechinolaena* by Bosser (1975).

**Poecilostachys** Hack. includes numerous Madagascar endemics and one tropical African species, *P. oplismenoides* (Hack.) Clayton.

**Pseudechinolaena** Stapf is a genus of five Madagascar endemics and one broadly distributed species *Pseudechinolaena polystachya* (Kunth) Stapf; for a revision see Bosser (1975).

**Pseudolasiacis** (A. Camus) A. Camus (Camus, 1945) with three species was placed within the Neotropical genus *Lasiacis* (Griseb.) Hitchc. by Clayton & Renvoize (1986) but accepted as an endemic genus of three species by Bosser & Florens (1999). No DNA data exists and this group may have been overlooked by global compilations; it could be accepted as an endemic genus in the future.

**Pterochloris** A. Camus (Camus, 1957) is placed within *Chloris* by all modern treatments.

**Schizostachyum** is a bamboo, not treated in this publication.

**Sirochloa** is a bamboo, not treated in this publication.

**Toliara** Judz. described by Judziewicz (2009) is nested in the genus *Perotis* and will be included in *Perotis* (Paul Peterson, pers. comm.)

**Valiha** is a bamboo, not treated in this publication.

**Viguiarella** is accepted and described in this publication.

**Yvesia** is accepted and described in this publication.

## Conclusion

In spite of the abundance of grasses (family Poaceae) across Madagascar and their common utilization, the island is also home to many unique and rare lineages of Poaceae, which form an integral part of the island's native biota. The endemic Poaceae of Madagascar

are in need of collection and study in order to understand the history of the island's landscape, as well as the history of its inhabitants.

## Acknowledgements

This research would not have been possible without the extensive collections and taxonomic work carried out by Jean Bosser. We are grateful to Emmet Judziewicz for identifications of specimens in the Paris herbarium and for providing unpublished manuscripts. We would also like to thank Lucy T. Smith for the beautiful drawings and Pawel Ficinski for the maps. Field work in Madagascar was supported by the Kew Madagascar Conservation Centre, National Geographic Global Exploration Fund grant GEFNE10-11, and the Bentham-Moxon Trust; we would like to thank Stuart Cable, H el ene Ralimanana, and Roger Rajaonarison for field work support. Herbarium work at the Mus eum national d'Histoire naturelle was supported by SYNTHESYS grants and by a Mus eum national d'Histoire naturelle visiting professorship and we would like to thank Thomas Haevermans, Caroline Loup, and Pete Phillipson. Assistance at Parc de Tsimbazaza herbarium was provided by Franck Rakotonasolo and Jacqueline Razanatosoa. Many thanks also to Emmet Judziewicz and to Bryan Simon for their review comments.

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