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Studies in Cyperaceae in southern Africa 38: The identities of *Cyperus natalensis*, *Cyperus crassipes* and *Cyperus brevis*

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Abstract

Cyperus natalensis Hochstetter ex Krauss and *Cyperus crassipes* Vahl are valuable sand stabilizers along much of the coastal fringe of eastern South Africa. The former is endemic to KwaZulu-Natal and southern Mozambique; the latter is an African endemic with a north-western and eastern coastal distribution. *Cyperus brevis* Boeck. (= *Mariscus congestus* Vahl var. *brevis* (Boeck.) C.B. Clarke) is reassessed as synonymous with *C. crassipes*. The aim of this paper is to distinguish between *C. natalensis* and *C. crassipes* and to discuss morphological and microhabitat differences. Descriptions, illustrations and a key are provided.

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Keywords: *Cyperus brevis*; *Cyperus crassipes*; *Cyperus natalensis*; Southern Africa

1. Introduction

In 1840, Krauss collected a sedge growing near the Umlaas (now uMlazi) River close to Durban, KwaZulu-Natal. Hochstetter (1845) named this species *Cyperus natalensis*. The Kew type (Krauss 207) comprises of three isotypes. One, separately mounted, consists of one culm with its uppermost basal sheath carrying a reduced (20 mm long) lamina. Another, closely resembling it but with a lamina about 150 mm long, is mounted with the third isotype. The third consists of two culms with the laminae up to 300 mm long. Clarke (1897), who had seen this type material, described *C. natalensis* as having ‘leaves usually hardly any, sometimes 2–6 ins [50–150 mm] long, in Krauss’ type specimen up to 26 in. [650 mm] long (Krauss defines the species as leafless.’). Comparison of the type with the protologue reveals that ‘up to 26 ins’ in Clarke’s description should have read ‘up to 2–6 ins’. This typographic error caused confusion, at least in Natal (now KwaZulu-Natal) where plants with long laminae (up to 500 mm) and long bracts grow in association with *C. natalensis*. This confusion was exacerbated by the establishment of *C. natalensis* var. *longibracteata* C.B. Clarke to accommodate laminate specimens

such as *Kirk s.n.* from the Zambezi Delta in Mozambique. Referring to the same specimen, Clarke (1901) commented that ‘as in many other species of Cyperaceae, the development of leaves and bracts is so variable that varieties should not be established on these characters’.

Ward (1980) working near the type locality, differentiated these two entities. One elaminate, or occasionally short-bladed and with short inflorescence bracts, growing in relatively stable situations in sand in low-lying open grass veld; the other, leafy and with long leaf-like bracts growing mainly in loose wind-blown, white beach sand. Both were included within *C. natalensis*.

Vorster (1978) traced the syntype of *Cyperus brevis* (Zeyher 16 (B)) and renamed, as this species, specimens previously included under *C. natalensis*. It is unclear whether Vorster distinguished the elaminate entity as *C. natalensis*. We are not aware of any investigation of *C. natalensis* at this time. Subsequently, *C. brevis* was recognised as a ‘good’ species (Reid, 1993; Archer, 2003). Gordon-Gray (1995) interpreted it as a variant of *C. natalensis* *sensu lato* but did not further investigate its identity. Fieldwork has revealed *C. natalensis* and *C. brevis* as two distinct species and that *C. brevis* is best treated as an expression of *Cyperus crassipes*. The latter is a tropical heliophyte of white beach sand that was thought to be limited in southern distribution to the Mozambique plain, north of Richard’s Bay (Gordon-Gray, 1995).

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In the Eastern Cape, the leafy expression of *C. natalensis* s.l. has been confused with the widespread and similar *C. congestus* Vahl [= *Mariscus congestus* (Vahl) C.B. Clarke] (Clarke, 1897; Schonland, 1922; Lubke et al., 1988).

2. Taxonomy

2.1. *Cyperus natalensis*

Hochstetter ex Krauss: 755 (1845); C.B. Clarke: 570 (1894) *pro parte*; C.B. Clarke: 181 (1897) *pro parte*; Gordon-Gray: 65 (1995) *pro parte*. Type: Krauss 207 (K!, lecto. (sheet designated 'Type of *C. natalensis*'); K!, iso.).

Perennial, mesophyte or helophyte. *Rhizome* horizontal, stoloniferous, 4–5 mm in diameter when young and fresh, shrinking with age and on drying; scale leaves overlapping, brown, usually not fragmenting into fibres; corms at bases of culms slow to develop, c. 20 × 10–15 mm. *Culms* erect, nodeless, terete, faintly trigonous below inflorescence, pliable, shrinking to irregular shapes in t/s on drying, up to 1.5 m × 3–4 mm. *Leaves* basal sheaths up to 1/2 the culm length; upper sheaths with contra-laminar zone conspicuous, brown; elaminate or uppermost 1–2 (–5) with blades glabrous, 5–60 (–460) × 3–4 (–6) mm. *Inflorescence* terminal, anthelate, primary rays up to 8, lowermost longest, 5–60 (–426) mm long; bracts 2–3, pungent when young, up

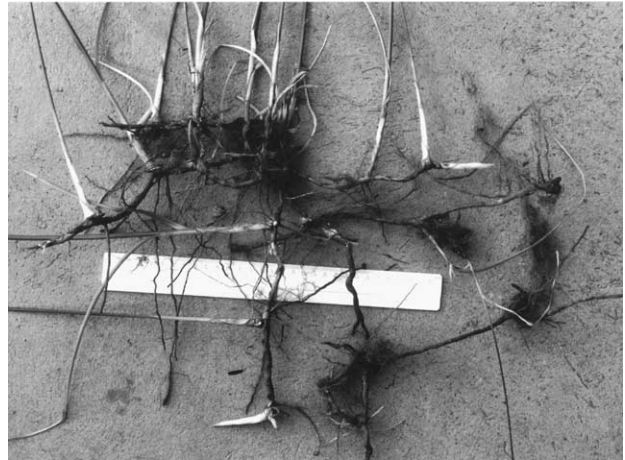


Fig. 2. *Cyperus natalensis*: rhizome and corms from plant in coastal grassland with some secondary scrub (CJ Ward 14861). Note the contrast between this figure and Fig. 6.

to 50 mm long, closely investing developing rays, sometimes lengthening to 60–70 (–247) mm, then patent or radiating (especially in colonising or mutilated plants). *Spikelets* numerous, digitate on very short axes terminating primary rays, sessile (that is secondary rays entirely absent), radiating 180°–360°, linear, 13–50 × 2.0–2.2 mm, compressed; rachilla wings narrow, delicate; glumes 2-ranked, imbricate, hard, ovate when flattened, 3–5 × 1 mm in profile, keel green-brown, flanks mid-brown, abaxial nerves numerous, conspicuous; apex acute. *Stamens* 3, filaments persistent, ribbon-like, exceeding glumes; anthers 2.3–2.5 mm long, crests short, rounded, colourless. *Ovary* often not maturing, style 1–2 mm, branches 3, longer than style, tapered, smooth. *Nutlet* oblong, 2–3 × 1 mm, narrowed basally, faintly trigonous, surface faintly cellular, cells longitudinally oblong (Figs. 1, 2, 3, and 4).

2.1.1. Habitat

C. natalensis is an effective binder of stable humic sands. Plants occur in mesic situations with grasses and occasional dicotyledons. The species also flourishes in permanent fresh water up to 1 m in depth (Fig. 3).

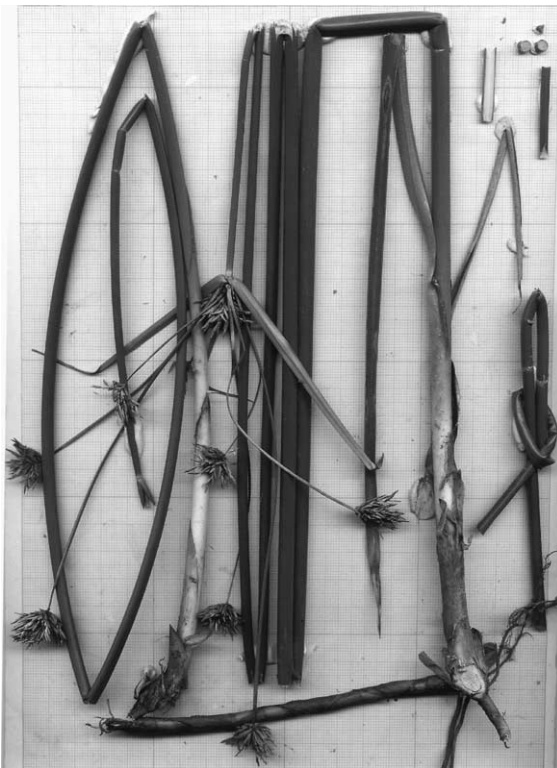


Fig. 1. *Cyperus natalensis*: portion of plant showing: (left) young elaminate culm bearing young inflorescence surrounded by short, stiff bracts; (right) two-leaved shoot bearing inflorescence with bracts not exceeding primary ray length; (extreme right) culm folded to show pliability; (extreme upper right) culm in transverse section, distal tip trigonous, otherwise terete (CJ Ward 14848).



Fig. 3. *Cyperus natalensis*, a dense stand fringing the shore of Lake Sibaya, KwaZulu-Natal.

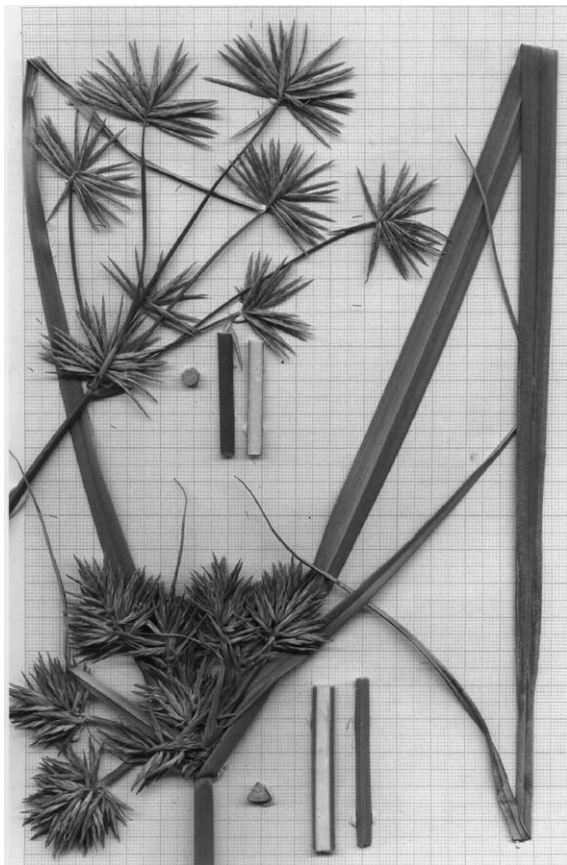


Fig. 4. Below: *Cyperus crassipes* with short stiff primary rays, long bracts, clustered spikelets and trigonous culm; above: *Cyperus natalensis* young inflorescence with long, slender primary rays, short bracts, radiating spikelets and terete culm.

2.1.2. Distribution

This prolific species occurs in coastal KwaZulu-Natal from 26° to 31° south latitude (southernmost distribution presently known is uMtamvuna River) and extends northward into southern Mozambique and Inhaca Island. The type locality was pristine in the 1840's with extremely limited habitation in adjacent Durban. Today the area is largely transformed, but in localised spots on Durban Bluff and at nearby Isipingo *C. natalensis* and *C. crassipes* are still to be found growing together.

2.1.3. Diagnostic characters

We examined 30 specimens at NU representing a distribution from Kosi Bay to Uvongo in KwaZulu-Natal. Half were elaminate and one carried elaminate and laminate shoots connected by a common rhizome. Herbarium specimens are often fragmented at mounting and in situ studies are important to understand rhizome morphology. Our field studies have shown laminate leaves to be developed most frequently in specimens from bare or sparsely vegetated land during colonization (*CJ Ward 15174*), or in response to damage (mutilation) by fire, mowing, or animal predation (*CJ Ward 14864*). Well-established reproductive stands are predominantly elaminate.

The bracts of *C. natalensis* are usually short and, together with the frequent absence of leaf blades in mature plants, have been

used in identification, but there is variation. Short bracts are hard and pungent. Longer bracts are leaf-like, very seldom exceeding the length of the longest primary inflorescence ray (*CJ Ward 15174* — bracts to 247 mm, a colonising plant). Leaf blades and bracts never attain the profusion and dimensions of *C. crassipes*.

Culm transverse sections of dried specimens should be avoided as a character in identification. Pliability is far more reliable and contrasts markedly with the stiff culms of *C. crassipes* (Fig. 1).

Because of their softness and pliability, the Zulu people utilise the culms of *C. natalensis* in basketry—'Nduli' is the name by which the plant is known.

The corms are slow to develop and smaller (c. 20 mm long) than in *C. crassipes*. The underground organs do not attain the parameters recorded for *C. crassipes* nor are they as prolific. Corms of both species are eaten by mole rats (Fig. 5).

Only primary rays develop in the inflorescences. These are extremely variable in length, the longer flexible rays usually droop, producing a shaggy untidy outline to the whole inflorescence which is exacerbated by the often irregular lengths of the spikelets aggregated on each ray.

Glumes are hard and greenish-cream to mid-brown never developing the cherry-red tint that is often a feature of the glumes of *C. crassipes*.

2.2. *Cyperus crassipes*

Vahl Enumeratio plantarum 2: 299 (1805); Haines and Lye: 236 (1983); Gordon-Gray: 55 (1995). Type: West Africa, Nigeria, Warri, P. de Beavois (P. Ju, holo.).

Cyperus maritimus Poir.: 240 (1806). Type: Madagascar, strand plant, *M. du Petit-Thours* (untraced). *C. maritimus* Poir. var. *crassipes* C.B. Clarke: 569 (1894); 326 (1901).

Cyperus brevis Boeck.: 341 (1870); Kuk.: 445 (1935). Type: South Africa, Eastern Cape, Zwartkops River, *Zeyher 16* (B!, lecto. designated here), *Ecklon and Zeyher 341* (syn., untraced).

Perennial, heliophyte or mesophyte. *Rhizome* mostly horizontal, stoloniferous, 3–4 mm in diameter, shrinking and drying with age; scale leaves overlapping, c. 20 mm long, pale when young, darkening and fragmenting into fibres, breaking



Fig. 5. *Cryptomys hottentotus*: 'common mole-rat' digging for underground plant organs that include those of *C. crassipes* and *C. natalensis*.

away to leave string-like lengths up to 300 mm long between shoots; corms initially soft, later woody, hard, oval up to $40 \times 20\text{--}25$ mm, producing lateral stolons (Fig. 6). Culms erect, nodeless, trigonous throughout, solid not pliable, up to 500×2.5 mm. Leaves basal sheaths short, overlapping, inconspicuous in life, drying pallid and closely enveloping one another; blades numerous, flat, glabrous, $400\text{--}500 \times 3\text{--}8$ (–15) mm, dark green, margins occasionally scabrid. Inflorescence terminal, variable, anthelate, globose, $400\text{--}800$ mm in diameter with primary rays mostly constant in length within anthelas, stiff, never drooping, or with few or no expanded rays; bracts conspicuous, 4–6, up to 30 mm long, flat, resembling leaf blades; secondary rays short, delicate, inconspicuous or absent. Spikelets numerous per ray, densely clustered and adpressed when young, becoming patent, linear to linear-lanceolate, $25\text{--}30 \times 2$ mm, slightly compressed, rachilla narrowly winged; glumes 2-ranked, imbricate, $5\text{--}6$ (–8) $\times 1.0\text{--}1.5$ mm in profile; keel green in life, flanks cream-brown to cherry-red fading basally; margins membranous; apex acute to minutely apiculate. Stamens 3. Style 1–2 mm long, branches 3, longer than style. Nutlets $2.0\text{--}2.2 \times 1.0\text{--}1.2$ mm, elliptic–ovate, faintly trigonous, flattened at maturity, then dark brown, surface smooth. [Figures 20 CF and front cover of Gordon-Gray (1995)].

2.2.1. Habitat

C. crassipes is a heliophyte of exposed littoral beach sands. In the tropics it extends from sea-level to 150 m altitude (Haines and Lye, 1983). In the sub-tropics it is also present in parabolic dunes ('blow-outs') where wind-blown sands have been carried into closed dense vegetation; in exposed estuarine alluvial sands and in more mesic situations in humic soils among shrubs fringing coastal dunes.

2.2.2. Distribution

Endemic to Africa, reported from West Africa (Guinea, Angola), East Africa (Kenya, Tanzania and Mozambique) and



Fig. 7. *Cyperus crassipes*, a portion of plant, medium robust expression, from slightly enriched beach sand of rehabilitated dune (CJ Ward 14833).

South Africa (KwaZulu-Natal, Eastern Cape and Western Cape).

2.2.3. Diagnostic characters

In exposed situations in sand and full sun *C. crassipes* is usually low-growing and robust with substance that may approach succulence. Mozambique and Maputaland plants conform to this phenotype; leaves up to 15 mm wide and inflorescences mostly globose. Southwards into cooler latitudes with increasing summer day lengths and more temperate climates, plants become slender and taller, with longer, narrower leaf blades and bracts. Occasionally only a metre separates the tropical expression in exposed sands and the mesic expression in littoral vegetation (Figs. 7 and 8).

Inflorescence form is extremely variable. Because different expressions occur on single clones it is of limited taxonomic merit. Variation occurs in the number and length of the stiff primary rays which may sometimes be absent. Variations of inflorescence structure recorded from the Ispingo area include:

- (a) open, 'anthelate' with rays up to 85 mm long (CJ Ward 4884, 14833)
- (b) corymb-like, with lowest 1–3 rays elongate, patent; the remainder of main axis not exceeding the length of these rays (CJ Ward 14172)
- (c) capitate with few slightly elongate rays (CJ Ward 14831)
- (d) capitate, rayless with sessile spikelets (CJ Ward 14832).

The cherry-red colouration of the glume flanks is useful in distinguishing this species from *C. natalensis* although the



Fig. 6. *Cyperus crassipes*, a population on upper beach dune undercut by marine and sub-sequent wind erosion, showing extensive development of rhizomes and corms (CJ Ward 14866).

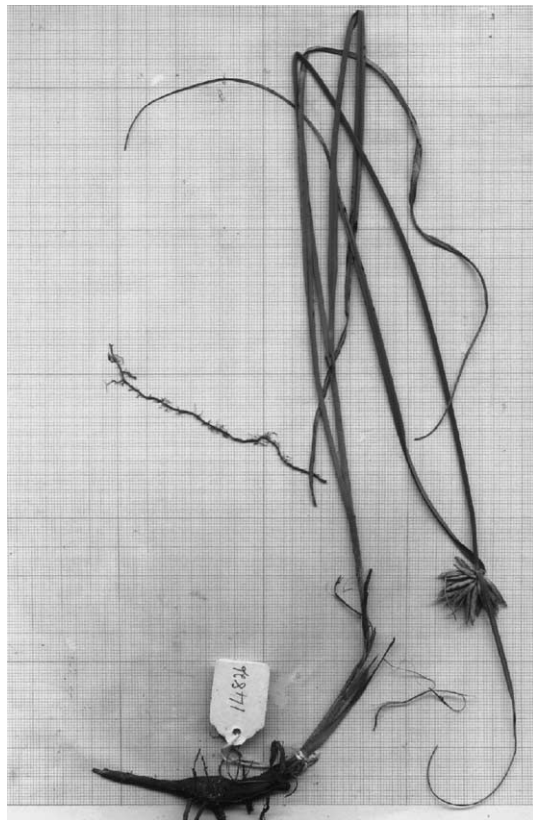


Fig. 8. *Cyperus crassipes*: portion of plant, slender expression, from beach sand with organic matter in open, degenerated dune scrub (CJ Ward 14826).

character is variable and often lost on drying. In conjunction, the membranous glume margins are a useful diagnostic feature. The glumes are also characterised by numerous, narrow, close veins.

2.3. *Cyperus congestus*:

Vahl, *Enumeratio plantarum* 2: 358 (1805); Boeck.: 347 (1869, 1870); Kükenthal: 444 (1935, 36). Type: Cap. B. spei, without precise locality or collector (C-Vahlus Herb.). *Mariscus congestus* (Vahl) C.B. Clarke: 553 (1894); 191 (1897); Schonland: 31 and Plate 23 (1922) *pro parte*; Vorster: 199 (1978); Gordon-Gray: 128 (1995).

C. congestus is included because in the Eastern Cape, where it is well represented in the sandy alluvium of streamlets and estuaries and in open damp grassland, it has been confused with the leafy form of *C. natalensis* which, as explained above, is in fact *C. crassipes*. Schonland (1922, Plate 23) shows a plant of *C. congestus* (Daly and Cherry 923) and a corm of *C. crassipes* (Potts 206). In Lubke et al. (1988), *M. congestus* is named, but *C. crassipes* is illustrated. Confusion is also evident in the short text. Sonnenberg (1997) *ined.* included specimens of *C. crassipes* among those of *M. congestus*. All specimens this author cited under *C. natalensis* should be referred to *C. crassipes*.

C. congestus has not been recorded from exposed sand dunes with *C. crassipes*. The two species have different microhabitat preferences. Morphological differences that

most clearly distinguish them are given in the key that follows.

2.4. Key

- | | | |
|----|--|--|
| 1a | Underground organ <i>never stoloniferous</i> ; stem base swollen, cormose, clothed in purplish leaf sheaths (lacking or poorly developed in young or small plants). Spikelet rachilla <i>articulated above</i> the two lowest sterile scales, abscising only tardily after some fertile scales (glumes) are shed. Perennial, widespread often in damp or wet situations; plants from 0.2 to 1.5 m tall | <i>C. congestus</i> [= <i>M. congestus</i>] |
| 1b | Underground organ <i>stoloniferous, cormose</i> in mature plants. Spikelet rachilla <i>not articulated</i> above the two lowest sterile scales, persisting after floral scales and nutlets are shed. Sand binding perennials frequent in littoral sands | 2 |
| 2a | Involucral bracts conspicuous, at least the lowest longer than the inflorescence. Leaf blades flat, numerous, well developed. Inflorescence rays, when present, stiff, never drooping. Floral scales greenish-cream, flanks flushed or margined cherry-red becoming uniformly brown in age and on drying; marked abaxially by numerous close narrow veins and marginally by a conspicuous membrane. Mature stolons bearing hard, oval corms up to 40 mm long | <i>C. crassipes</i> |
| 2b | Involucral bracts inconspicuous, very rarely exceeding the inflorescence in colonising plants or those mutilated by unnatural depredation, usually 10–50 mm long, sometimes 50–170 (–247) mm. Leaf blades often lacking, when present 1–4 (–5) per shoot the longest not exceeding 460 mm, often only 50–60 mm or less. Inflorescence rays at maturity usually flexuous, often drooping. Floral scales tough, pallid greenish to pale fawn or light brown <i>never</i> flushed or zoned cherry-red, membranous margin narrow, inconspicuous. Corms on mature stolons up to 20 mm long, relatively sparse in number | <i>C. natalensis</i> |

2.4.1. Specimens examined

C. natalensis

- 2632 Mozambique south, 6 km to Maputo Elephant Park, Ngwenya 2483 (NH). KwaZulu-Natal, Tembe Elephant Park (–CD), MC Ward 1817 (NH, NU).
- 2732 (Ubombo): Sodwana Bay (–DA), McAllister *s. n.* (NU).
- 2832 (Mtubatuba): Richards Bay West (–CC), CJ Ward 14848; 14864; 15174 (K, NH, NU, PRE, UDW); St Lucia Game Reserve, west of Lake Banghazi (–BA), CJ Ward 3638 (NU, UDW).
- 2930 (Pietermaritzburg): Isipingo Flats, west of Sasol Fibres Rd (–DD), CJ Ward 14761, (K, NH, NU, PRE,

UDW); Isipingo Flats, south east of Durban International Airport (–DD), *CJ Ward 14861* (UDW).

- **3030** (Port Shepstone): Pennington (–BC), *KD Gordon-Gray 6224* (NU); Uvongo, s. side of Ivungu R., Sarum property *I'Ons 23/81* (NU).

C. crassipes

- **1935** Mozambique, Beira distr., Beira, Savana Mouth (–CA), *CJ Ward 7989* (NU, UDW).
- **2533** Mozambique, Gaza Prov., near Joao Belo, Praia do Xai Xai (–BA), *Hennessy 253* (NU, UDW).
- **2635** Mozambique, Inhambane distr., Tafa (–CA), *Breen s.n.* (NU).
- **2632** (Bela Vista): Ingwavuma distr., Kosi Bay (–DD), *McAllister s.n.* (NU); N. of Kosi Estuary (–DD), *MC Ward 1995* (NH, NU).
- **2732** (Ubombo): Black Rock, 18 ml S. of Kosi Estuary (–BB), *Martin 141* (NU); *Tinley and Ward 20* (NU, UDW).
- **2832** (Mtubatuba): Cape Vidal (–BA), *CJ Ward 1174; 7090* (NU, UDW); Richards Bay, Harbour, west (–CC), *CJ Ward 12202* (K, NH, NU, PRE, UDW).
- **2931** (Stanger): Lower Tugela distr., Tugela Mouth (–BA), *D. Edwards 1741* (NU, PRE); Tongaat Beach (–CA), *Hillary 325* (NU); Meadowbank Beach (–CA), *CJ Ward 14866* (UDW).
- **2930** (Pietermaritzburg): Isipingo North, dunes (–DD), *CJ Ward 4882; 14172; 14822; 14831; 14832*; Isipingo North, Reunion Park (–DD), *CJ Ward 14833* (NH, NU, PRE, UDW); Isipingo Flats (–DD), *CJ Ward 4884* (NH, NU, PRE, UDW).
- **3030** (Port Shepstone): Oslo Beach, south (–CD), *CJ Ward 14826* (NH, NU, PRE, UDW).
- **3228** (Butterworth): Bashee River, mouth (–BA), *Crosby s.n.* (NU); The Haven (–BB), *JL Gordon-Gray 1335* (NU); Kei Mouth (–CB), *Sonnenberg 406* (GRA).
- **3322** (Oudtshoorn): Western Cape, Wilderness (–DC), *CJ Ward 14858* (GRA, NU, PRE, UDW).
- **3422** (Mossel Bay): Buffelsbaai area, Walker Bay south, near Rowwehoek (–BB), *CJ Ward 14857* (GRA, K, NU, PRE, UDW).

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References

- Archer, C., 2003. Cyperaceae. In: Germishuizen, G., Meyer, N.L. (Eds.), *Plants of Southern Africa: An Annotated Checklist*, Strelitzia, vol. 14. National Botanical Institute, Pretoria.
- Boeckeler, O., 1869/70. Die Cyperaceen des Koniglichen Herbariums zu Berlin. *Linnaea* 36, 271–768.
- Clarke, C.B., 1894. Cyperaceae. In: *Conspectus florae africae ou enumeration des plantes D'Afrique* 5: 526–692. Friedlaender, Berlin; Klincksieck, Paris.
- Clarke, C.B., 1897/98. Cyperaceae. *Flora Capensis*, vol. 7. Reeve, London, pp. 149–310.
- Clarke, C.B., 1901/02. Cyperaceae. *Flora of Tropical Africa*, vol. 8. Reeve, London, pp. 266–524.
- Gordon-Gray, K.D., 1995. Cyperaceae in Natal. *Strelitzia*, vol. 2. National Botanical Institute, Pretoria.
- Haines, R.W., Lye, K.A., 1983. *The Sedges and Rushes of East Africa*. East African Natural History Society, Nairobi.
- Hochstetter, C.F., 1845. Cyperaceae. *Pflanzen des cap-und Natal-Landes, gesammelt und zusammengestellt von Dr Ferdinand Krauss*, *Flora*, vol. 28, pp. 753–764.
- Kukenthal, G., 1935/36. Cyperaceae – Scirpoideae – Cyperaceae. 20 Heft 101, *Das Pflanzenreich*, vol. 4, pp. 163–671. Leipzig.
- Lubke, R.A., Gess, F.W., Bruton, M.N., 1988. *A Field Guide to the Eastern Cape Coast*, Box, vol. 73. Wildlife Society of South Africa, Grahamstown.
- Reid, C., 1993. Cyperaceae. Names. In: Arnold, T.H., de Wet, B.C. (Eds.), *Plants of Southern Africa: Names and Distribution*, *Memoirs of the Botanical Survey of South Africa*, vol. 62.
- Schonland, S., 1922. *Introduction to South African Cyperaceae*. *Memoirs of the Botanical Survey of South Africa* 3.
- Sonnenberg, B., 1997. List of localities for the Cyperaceae species in the Eastern Cape. Unpublished. Department of Botany, Rhodes University, Grahamstown.
- Vorster, P.J., 1978. Revision of the taxonomy of *Mariscus* Vahl and related genera in southern Africa. D.Sc.(Botany). Thesis, University of Pretoria.
- Ward, C.J., 1980. The plant ecology of the Isipingo Beach area, Natal, South Africa. *Memoirs of the Botanical Survey of South Africa* 45.