

Seven new species of *Cyperus* (Cyperaceae) section *Arenarii* and one new combination and typification

Henry Väre* & Ilkka Kukkonen

Finnish Museum of Natural History, Botanical Museum, P.O. Box 7, FI-00014 University of Helsinki, Finland (*e-mail: henry.vare@helsinki.fi)

Received 8 June 2005, revised version received 27 June 2005, accepted 29 June 2005

Väre, H. & Kukkonen, I. 2005: Seven new species of *Cyperus* (Cyperaceae) section *Arenarii* and one new combination and typification. — *Ann. Bot. Fennici* 42: 473–483.

Taxonomy of species in *Cyperus* section *Arenarii* was investigated as a part of ongoing phylogenetic study. Morphological characters revealed that seven new species need to be described, three annuals, *Cyperus ephemerus*, *C. forskalianus* and *C. sahelii*, and four perennials, *C. algeriensis*, *C. gubanii*, *C. mauretaniensis* and *C. pseuderemicus*. Their relationships with closely related taxa are discussed and their distribution is presented. Annuals are not known previously in the section *Arenarii*. A new combination, *C. subtilis* (Kük.) Kukkonen & Väre is made. The name is typified.

Key words: *Cyperus*, morphology, new species, nomenclature, psammophytes, taxonomy, typification

Introduction

Cyperus belongs to Cyperaceae, subfamily Cyperoideae, tribus Cypereae. Cyperaceae are one of the largest families of vascular plants, with about 4000 to 5000 species in 70 to 105 genera (Goetghebeur 1987, Kukkonen 2001). *Cyperus* is the second largest genus after *Carex* in the family, with about 600 species included in the only monograph of the genus (Kükenthal 1936). Kükenthal had a broad species concept, and a large number of new species has been described later. Taxonomic difficulties in *Cyperus* are due to few useful morphological characters, limited number of collections (which are often inadequate, both root system and mature nuts are often required), juvenile specimens differ morphologically and grazing induces dwarf morphotypes. Proper identification requires a combination of

characters. As a result, the infrageneric treatment is unstable and controversial, not tested with phylogenetic analyses.

In *Cyperus* section *Arenarii* (syns. section *Bobartia*, section *Conglomerati*) we currently recognize 25 species and two subspecies of *C. conglomeratus*. Species of the section are usually perennial. Rhizome is short or long-creeping, roots are tomentose or nearly glabrous. Stems are 2–90 cm, terete or subtrigonus. Leaves are basal, from shorter to longer than stem, from flat to nearly unifacial, basal sheaths are soft, or stiff and hard. Inflorescence is of variable size, from a single spike to small anthelodium (*see* Kukkonen 1994) or to a globose head; spikes are mostly nearly terete in transverse section, glumes at first tightly imbricating, later rather lax, stiff and cymbiform, mucronate, many-nerved, margins more or less scarious, inner side often reddish.

Anthers and stigmas 3. Nutlets are 1–4.5 mm long, trigonous, sometimes flat or concave to winged. The section description follows Kukkonen (1995).

The total area of the section extends from the Black Sea and the Mediterranean (*C. capitatus*) all around Africa along the coastal sands (*C. crassipes* and *C. maritimus*) eastwards to India and Sri Lanka (*C. arenarius*). Towards inland the members of the section extend into areas surrounding the deserts, and some have been able to penetrate even the most arid parts of Sahara, the Arabian Peninsula and the Iranian plateau. The greatest species diversity appears to be concentrated in the the regions around the Red Sea in NE Africa and the Arabian Peninsula.

Most species are psammophytic, adapted to survive in hot dry deserts and coastal sandy shores, holding morphological characters which reduce water loss. Such common features include a thick cuticula in all parts of the plant, glaucescent colouration, canaliculate leaves minimising evaporation and reduced inflorescence structures. The long creeping rhizome, for example in *C. eremicus* and in *C. macrorrhizus* is buried deep in the sand, and the structure of the roots when thickly tomentose, are adaptations to the extreme arid conditions also (Kukkonen 1991). Tomentose roots hold moisture effectively. Species colonizing moving sand dunes are adapted to be occasionally buried by sand. Dispersal is enabled by large, flat and sometimes winged nuts, e.g. in *C. aucheri*, *C. ephemerus*, *C. eremicus* and *C. gubanii*. Some other species are less conspicuously adapted to the aridity. For example, *C. conglomeratus* s. *stricto* has a short rhizome and small nuts, and is, evidently, better suited for seed bank strategy.

Annual species have not been described earlier in section *Arenarii*. Such are known in other *Cyperus* sections (e.g. Lye 1995). Herbarium labels are generally inadequate, but on some labels it is indicated that these annual species inhabit moist sites like wadis, while most perennial species seem to thrive in drier habitats.

Analysis of the *Cyperus* section *Arenarii* for phylogenetic study has revealed seven species deserving description, four perennials and three annuals. In herbaria these are often undetermined or determined as *Cyperus conglomeratus*.

Material and methods

Plants were studied on herbarium sheets (B, BM, BR, C, E, G, H, HUJ, IRAN, K, LD, OULU, P, RIY, S, TUR, UPS, W) by stereo microscopy. Material was available from the total distribution range of the section *Arenarii*, and all type specimens have been at our disposal. Asian material includes recent collections, while African specimens are mainly old, dating from the period of British and French occupation. Terms applied are described in Kukkonen (1994, 1998, 2001).

Electron micrographs were obtained with a JEOL JSM-820 scanning electron microscope using an accelerating voltage of 3 or 4 kV.

New species and combinations

***Cyperus pseuderemicus* Kukkonen & Väre, sp. nova** (Fig. 1)

Planta perennis, glaucescens–flavescens, 30–70 cm alta. Affinis Cyperi aucheri et C. eremici, sed leniter cespitosa, rhizoma breve sed robustum, radices tomentosae, nucula non vel vix alata Cyperus conglomerati similis sed magis leniter cespitosa, vaginae molles, inflorescentia anthelodium, nucula major.

TYPE: Saudi Arabia. 5 km Northeast Dahrán, 26°21' N, 50°11' E, smooth low sand dunes, 31.III.1984 James P. Mandville 8266 (holotype H 1565009).

Glaucous to yellowish perennial, 30–70 cm (Fig. 1A). Rhizome erect, strong, usually short. Roots tomentose (sand grains are affixed between root hairs), 3–5 mm in diameter. Stem erect, 1–2 mm in diameter, cylindrical, glaucescent to yellowish. Basal sheaths to 23 cm, soft, brownish, mouth margin often concave. Ligule inconspicuous. Leaves to 60 cm, about as long as stems including inflorescence, 1–2 mm wide, channeled, slightly curved, rigid to somewhat flexuous, margins scabrous, apex long-attenuate. Inflorescence (Fig. 1B) anthelodium, to 10 × 10 cm. Bracts 2 or 3, foliaceous, to 20 cm, 1–2 mm wide. Primary branches 0–7, to 7 cm, smooth. Tubular prophyll to 9 mm, acute, mucro 3.2 mm. Cluster of spikelets spreading, with 3–6(7)

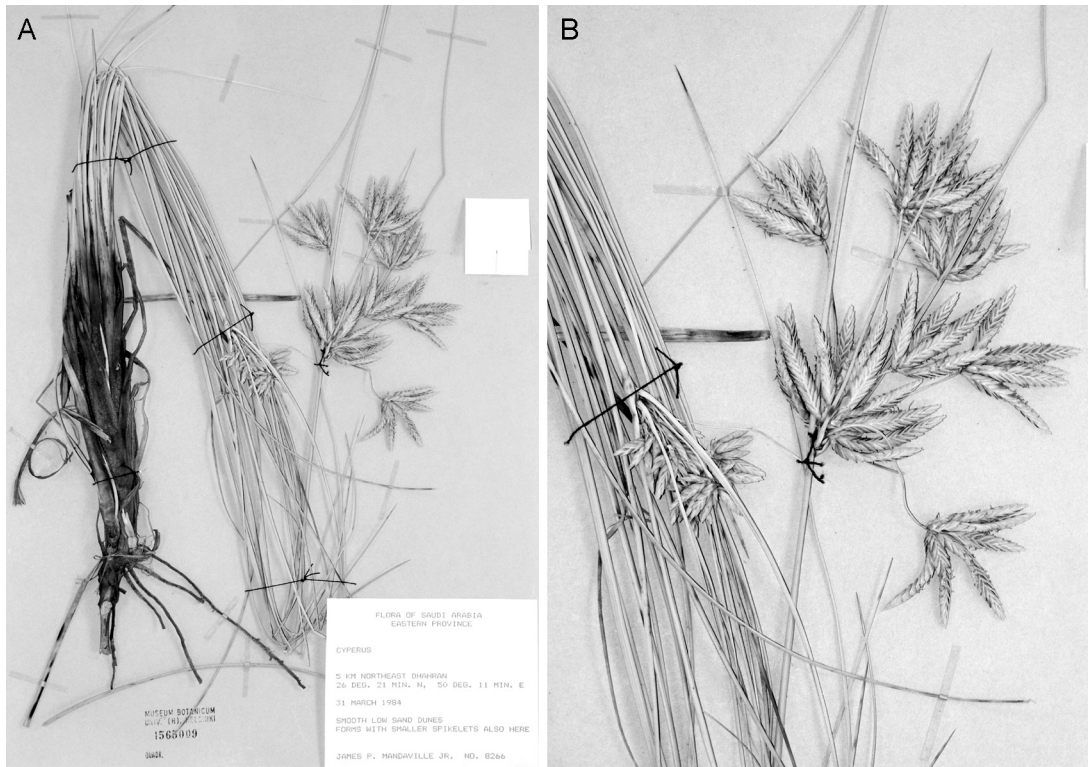


Fig. 1. Holotype of *Cyperus pseuderemicus*. — A: Whole plant. — B: Inflorescence.

spikes. Spikelets 20–25 mm × 3–5 mm, linear, slightly compressed, with 20–30 closely imbricate glumes. Glume-like bract 4 mm, acute. Glume-like prophyll 3.5 mm, acute, mucro 3.2 mm. Rachis 1.2 mm wide, yellowish brown, internodes 1.8 mm. Glumes 5.2–6.5 × 3.0 mm, cymbiform, central area turning brown, margins scarious, yellowish, sometimes brownish, adaxial side reddish brown to violet brown, mucro 0.4 mm. Stamens 3, anthers 4–4.2 mm, carpels 3, style branches to 3.0–3.2 mm. Nutlet 3.2–3.6 × 1.3–1.8 mm, ellipsoid, compressed, grey brown, finely papillose, wings very narrow (0.1 mm) or lacking.

DISTRIBUTION AND HABITAT ECOLOGY. Arabian Peninsula from southern Iraq to Yemen. On moving sands both at coastal regions and in inland. A special feature is the presence in the desert of Rub-al-Khali, one of the most hostile environments on earth. Flowering (November–)March–April.

Cyperus pseuderemicus resembles both *C. aucheri* and *C. eremicus*. The latter two have winged nuts, however, and *C. aucheri* is cespi-

tose. *Cyperus pseuderemicus* and *C. eremicus* share their distribution range in the Arabian Peninsula, but *C. eremicus* is widely spread also north of the Gulf of Persia. *Cyperus aucheri* has its main distribution in Afghanistan, Iran and Pakistan, with two collections from Oman.

***Cyperus ephemerus* Kukkonen & Väre, sp. nova** (Figs. 2 and 3A)

Planta annua, glaucescens, 15–40 cm alta, cespitosa, radices crasse tomentosae, inflorescentia anthelodium. Affinis Cyperi sahelii et C. forskaliani sed nucula late alata.

TYPE: Iran. Est du Dasht-e-lut, à l'est des grandes dunes, 59°39' E, 30°55' N, dunes mortes, sable ridé, gris, dur, végétation à Haloxylon, Calligonum et très nombreuses annuelles, annuelle commune, 14.V.1972 J. Léonard 6192 (holotype H 1258457; isotype BR).

Rosette-forming glaucescent annual, 10–40 cm (Fig. 2A). Roots tomentose (sand grains are

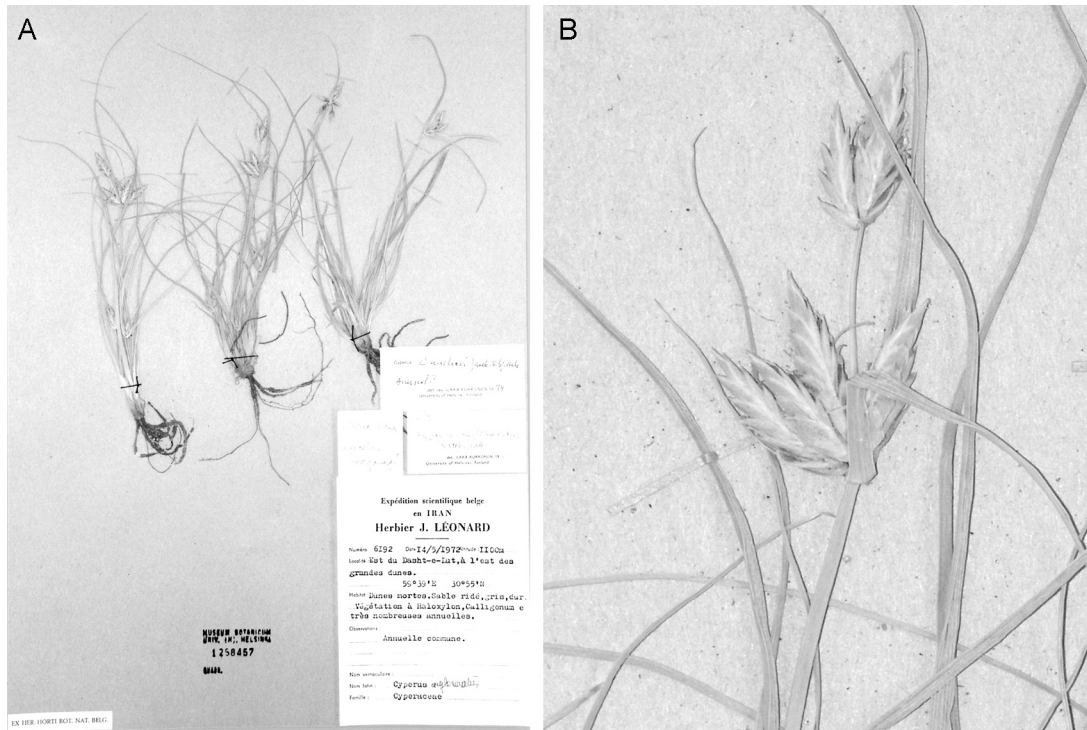


Fig. 2. Holotype of *Cyperus ephemerus*. — A: Whole plant. — B: Inflorescence.

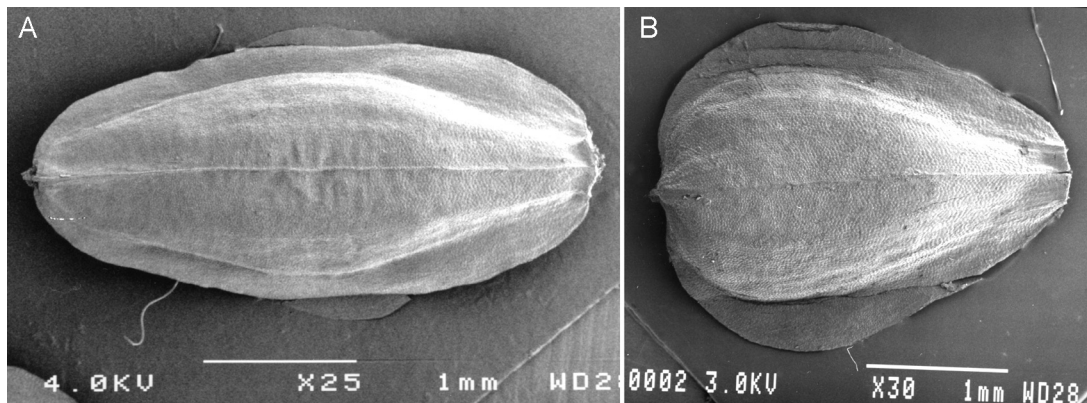


Fig. 3. Scanning electron micrographs of nutlets of (A) *Cyperus aucheri* and (B) *C. ephemerus*. Scale = 1 mm.

affixed between root hairs), 2–3 mm in diameter. Stem erect, 1–2 mm in diameter, cylindrical. Basal sheaths to 5 cm, soft, mouth margin concave. Ligule inconspicuous. Leaves to 20(25) cm, as long as or longer than stems including inflorescence, 2–3 mm wide, channeled, slightly curved, flexuous to somewhat rigid, margins scabrous, apex long-attenuate. Inflorescence

(Fig. 2B) anthelodium (rarely a head), to 5 × 5 cm (exceptionally to 20 × 15 cm). Bracts 3–5, foliaceous, to 20 cm, 1–3 mm wide. Primary branches 0–6, to 10 cm, obtusely trigonous, smooth. Tubular prophyll to 13 mm, acute, mucro 0.5 mm. Cluster of spikelets spreading, with 3–8 spreading, digitate spikes. Spikelets 10–30 × 3–5 mm, ellipsoid or ovoid, compressed, with 16–34

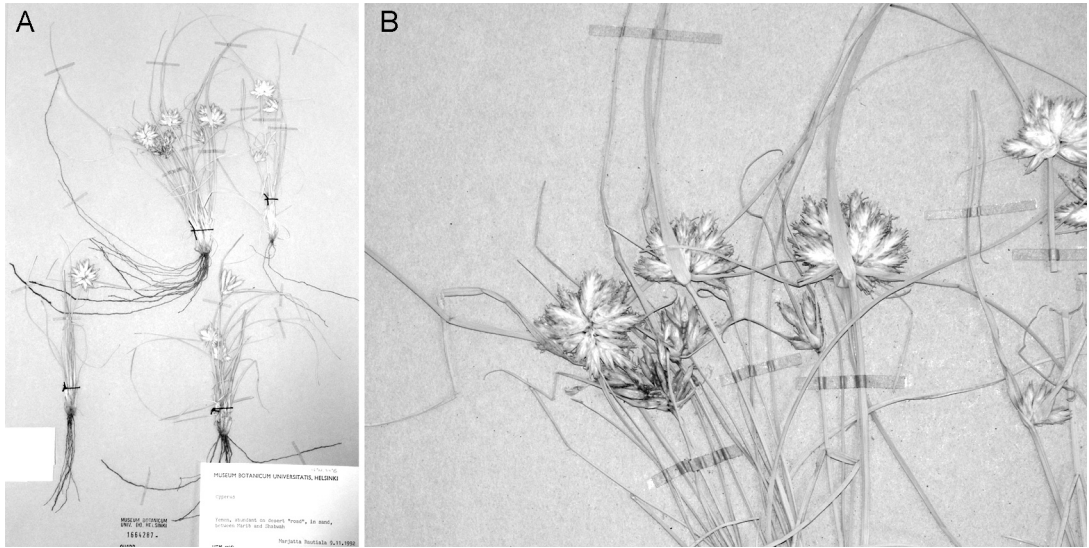


Fig. 4. Holotype of *Cyperus forskalianus*. — A: Whole plant. — B: Inflorescence.

distichous, closely imbricate glumes. Glume-like bract to 4 mm, acute. Glume-like prophyll ca. 5 mm, acute, mucro 0.4 mm. Rachis 1 mm wide, greenish or reddish brown, internodes 0.7 mm. Glumes 4.2–6.1 × 2–3 mm, cymbiform, greenish, finally yellow brown, central area wide, green, margins scarious, sides with 3–4 nerves, adaxial side reddish, mucro to 0.5 mm. Stamens 3, anthers 2.6–2.8 mm, carpels 3, style branches to 2.5–3.0 mm. Nutlet 2.3–3.4 × 1.5–1.6 mm, wide ellipsoid, compressed, grey brown, finely papillose, wings 0.5 mm wide (Fig. 3A).

DISTRIBUTION AND HABITAT ECOLOGY. On stabilized dunes along desert margins and in wadis, the latter characterized by annual vegetation community. From Afghanistan and Pakistan to Saudi Arabia and Yemen. Flowering April–May.

Cyperus ephemerus is an annual species, a feature atypical for Cyperaceae. The nutlet of *C. ephemerus* is winged like in *C. aucheri*, *C. eremicus* and *C. gubanii*, but these are tall perennial species specialized to dry sandy environments (Kukkonen 1998, 2001). Based on some sheets *C. ephemerus* seems to thrive in moist sandy habitats. *Cyperus ephemerus* was informally described in association with perennial *C. aucheri* in the Floras of Iran and Pakistan (Kukkonen 1998, 2001). It was thought to represent seedlings of *C. aucheri* able to flower in the first year. After examining more material from

Iran, we consider it justifiable to describe it as a new species along with two other new annuals *C. forskalianus* and *C. sahelii*. However, morphologically *C. aucheri* is closely related with *C. ephemerus*. In *C. aucheri* nutlets are oblongly ellipsoid and taller, 3.5–3.7 × 1.1–1.3–2.2 mm (Fig. 3B).

***Cyperus forskalianus* Väre & Kukkonen, sp. nova** (Fig. 4)

Planta annua, glaucoflavescens, 10–18 cm alta, cespitosa, radices tenue tomentosae, inflorescentia capitata. Affinis Cyperi ephemeris et C. sahelii sed inflorescentia capitata sed nucula anguste alata.

TYPE: Yemen. Between Marib and Shabwah, abundant on desert “road”, in sand, 11.XI.1992 *Marjatta Rautiala* 1413 (holotype H 1664287; isotype H 1664286).

Rosette-forming glaucescent annual, with yellowish tinge, 10–18 cm (Fig. 4A). Roots thinly tomentose (sand grains are only minutely affixed between root hairs), 0.4–0.6 mm in diameter. Stem erect, 1–2 mm in diameter, cylindrical to compressed. Basal sheaths to 2.5 cm, soft, mouth concave. Ligule inconspicuous. Leaves to 15 cm, about as long as stems including inflorescence,

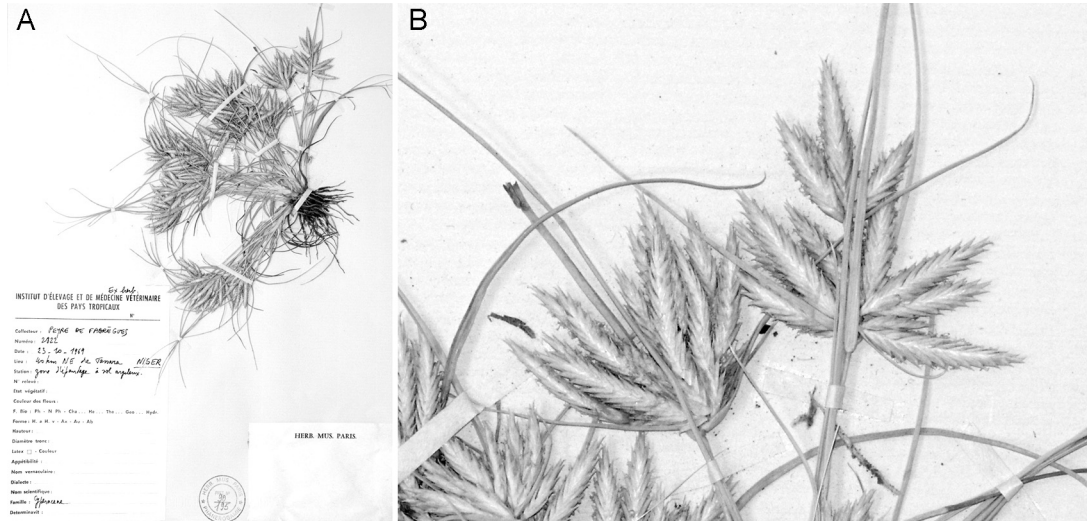


Fig. 5. Holotype of *Cyperus sahelii*. — A: Whole plant. — B: Inflorescence.

2–3 mm wide, channeled, curved, flexuous, margins not scabrous, apex long-attenuate. Inflorescence (Fig. 4B) a head, to 2 × 2 cm, with distinct yellow colour. Bracts 3 or 4, foliaceous, to 16 cm, 1–2 mm wide. Tubular prophyll to 0.6 mm, acute, mucro 0.1 mm. Spikelets 10–16, digitate, 20 × 3–5 mm, ovoid to ellipsoid, cylindrical to slightly compressed, with 14–28 distichous, closely imbricate glumes. Glume-like bract to 4 mm, acute, glume-like prophyll ca. 3 mm, acute. Rachis 1.5 mm wide, light brown, internodes 1.0 mm. Glumes 5.0–5.5 × 2.0–3.5 mm, cymbiform, central area light green, margins scarious, adaxial side light brown, mucro to 0.5 mm. Stamens 3, anthers 2.8 mm, carpels 3, style branches to 3 mm. Nuts 2 × 1.5 mm, obovoid, convex, adaxial side concave, light brown, finely papillose, wings 0.1 mm.

DISTRIBUTION AND HABITAT ECOLOGY. In sandy soil in desert. Known only from the type locality in Yemen. Flowering November.

Cyperus forskalianus is an annual species like *C. ephemerus* and *C. sahelii*. The nutlets have narrow wings (0.1 mm), while in *C. ephemerus* the wings are broader (to 0.5 mm) and *C. sahelii* is not winged. Yellowish colour characterises the type specimen. Two perennial species, *C. eremicus* and *C. pseuderemicus* grows in the inner part of the Arabian Peninsula also. In *C. eremicus* the wings of the nutlets are considerably broader, and *C. pseuderemicus* is nearly always wingless.

***Cyperus sahelii* Väre & Kukkonen, sp. nova**
(Fig. 5)

Planta annua, glaucescens, 10–18 cm alta, cespitosa, radices tenue tomentosae, inflorescentia anthelodium. Affinis Cyperi ephemeri sed nucula non alata, similis C. forskaliani sed inflorescentia anthelodium.

TYPE: Niger. 40 km NE de Tassara, zone Iléfan Sage à sol ignifère, 23.X.1969 Peyre de Fabrègues 2822 (holotype P).

Rosette-forming glaucescent annual, 5–60 cm (Fig. 5A). Rhizome short. Roots thinly tomentose (sand grains are affixed between root hairs), 0.5–0.7 mm in diameter. Stem erect, 1–2 mm in diameter, cylindrical, terete. Basal sheaths to 2.5–5 cm, soft, mouth margin shortly concave. Ligule inconspicuous. Leaves to 5–35 cm long, shorter than stems including inflorescence, 1–2 mm wide, curved, channeled, flexuous, margins scabrous, apex long-attenuate. In young specimens leaves are longer than stem, in old specimens shorter. Inflorescence anthelodium, to 6–8 × 4–5 cm. Bracts 3 or 4, foliaceous, to 10 cm, 0.6–0.8 mm wide. Tubular prophyll to 2 mm. Cluster of spikelets spreading, with 8–18 spikes (Fig. 5B). Spikelets 10–25 × 4 mm, ovoid, cylindrical to compressed, with 16–30 distichous, closely imbricate glumes. Glume-like bract to 4.2 mm, acute. Glume-like prophyll to 3.6 mm,



Fig. 6. Holotype of *Cyperus gubanii*. — A: Whole plant. — B: Inflorescence.

acute. Rachis 1–1.2 mm wide, reddish brown, internodes 1.0 mm, wider at upper part. Glumes 4.0–6.0 × 2.0–3.0 mm, cymbiform, central area light green when young, turning reddish in older specimens, margins scarious, adaxial side light to reddish brown, mucro to 0.7 mm, recurved. Stamens 3, anthers to 4–5 mm, carpels 3, style branches to 3–4 mm. Nutlet 2.2 × 1.5 mm, obovoid, convex, adaxial side concave, light brown, finely papillose, not winged.

DISTRIBUTION AND HABITAT ECOLOGY. On dunes along desert margins. Distributed in Sahel region from Mali to Niger and Chad. Flowering August–December.

Cyperus sahelii is the only annual species of section *Arenarii* in Africa. *Cyperus mauretaniensis* and *C. sahelii* are morphologically closely related, but the former is a perennial species with western Sahelian distribution and the latter is a central Sahelian annual species. There is a narrow joint distribution area in Mali. The distribution of perennial *C. falcatus* overlap with *C. sahelii* in Sahel region also, but morphologically

these two are not especially related. The main distribution area of *C. falcatus* is centered on the vicinity of the Red Sea.

***Cyperus gubanii* Väre & Kukkonen, sp. nova** (Fig. 6)

Planta perennis, glaucescens, 60 cm alta, inflorescentia anthelodium, nucula alata. Affinis Cyperi aucheri et C. eremicus, sed planta robusta, fasciculus spicarum confertim digitatus.

TYPE: Somalia. Coast 40 miles E of Berbea [= Berbera], sand dunes between hills, alt. 450 ft, 21.I.1962 *C. F. Hemming* 2380 (holotype K).

Glaucous perennial, 60 cm (Fig. 6A). Roots lacking in the herbarium specimen. Stem erect, 6 mm in diameter, cylindrical, distinctly furrowed. Leaves almost equal to stem. Basal sheaths to ca. 10 cm, soft, mouth margin deeply concave. Ligule inconspicuous. Leaves to 30

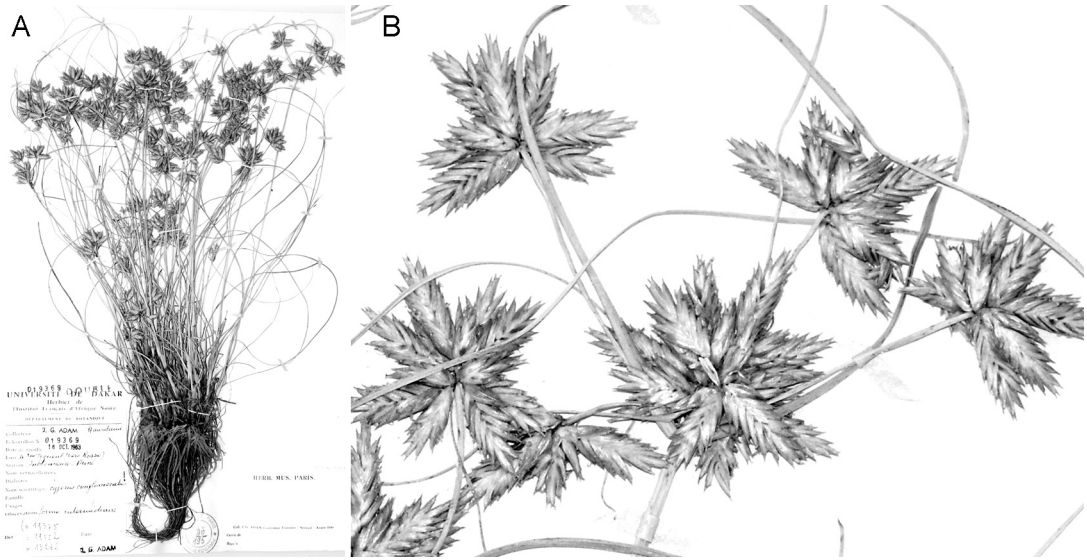


Fig. 7. Holotype of *Cyperus mauretaniensis*. — A: Whole plant. — B: Inflorescence.

cm long, 3 mm wide, straight, channeled, flexuous, margins scabrous, apex long-attenuate. Inflorescence anthelodium (Fig. 6B) 9×6.5 cm. Bracts 4 or 5, foliaceous, to 25 cm, 1.2 mm wide. Tubular prophyll 4 mm. Cluster of spikelets spreading, with 26–36 spikes. Spikelets $12\text{--}18 \times 4\text{--}5$ mm, ellipsoid with narrower tip, cylindrical, with 10–12 distichous, closely imbricate glumes. Glume-like bract to 7 mm, curved, acute. Glume-like prophyll to 6 mm, curved, acute. Rachis 1.6 mm wide, light brown, internodes 1.6 mm, with appendages. Glumes 10×4 mm, curved, cymbiform, central area light ochraceous with some reddish pigmentation, margins scarious, adaxial side ochraceous with reddish pigmentation, mucro to 1.1 mm, recurved. Stamens 3, anthers to 5 mm, carpels 3, style branches to 4 mm. Nutlet not fully developed, distinctly winged.

DISTRIBUTION AND HABITAT ECOLOGY. On dunes by coastal hills in Somalia. Known only from the type locality. Flowering January.

Although the collection lack rhizome and roots, the species is distinctly different from other species in section *Arenarii*. It is characterized by the stout and rigid habitus, and especially by very thick stem. It is perhaps related to *C. aucheri* and *C. eremicus*, which both are also tall species with winged nuts. Somalia is known for its rich *Cyperus* flora with about 80 species (Lye

1995), many of which are known only from their type locality.

***Cyperus mauretaniensis* Väre & Kukkonen, sp. nova (Fig. 7)**

Planta perennis, glaucescens, 30–60 cm alta, cespitosa, radices valde tomentosae. Affinis Cyperi conglomerati, sed vagina pallide fusca et mollis, inflorescentia anthelodium.

TYPE: Mauretania. 10 km Tiguent (vers Rosso), sablonneuse dune, 18.X.1963 J. G. Adam 19369 (holotype P).

Densely tufted glaucescent perennial, 30–60 cm (Fig. 7A). Roots tomentose, 2 mm in diameter including root hairs. Stem erect, 1.5–2 mm in diameter, cylindrical to channeled at base, finely furrowed, glaucescent, stem base is often swollen. Leaves equalling to stem including inflorescence; basal sheaths to 7 cm, soft, light brown, disintegrating into fibres, mouth margin deeply concave. Ligule inconspicuous. Leaves to 40 cm, shorter than stems, 1–2 mm wide, channeled, flexuous to rigid, margins scabrous, apex long-attenuate. Inflorescence anthelodium, to 9×7 cm. Bracts 3 or 4, foliaceous, cylindrical to channeled, to 12 cm, 0.8–1 mm wide. Primary branches 3–5, to 7 cm, smooth, cylindri-



Fig. 8. Holotype of *Cyperus algeriensis*. — A: Whole plant. — B: Inflorescence.

cal. Tubular prophyll to 1–1.5 mm, with a blunt mucro, 0.5 mm. Cluster of spikelets spreading, with 10–18 spikes (Fig. 7B). Spikelets 9–15 mm \times 3–4 mm, ovoid, slightly compressed, with 15–30 closely imbricate glumes. Glume-like bract 3 mm, acute. Glume-like prophyll 2 mm, acute. Rachis 1 mm wide, yellowish brown, internodes 1 mm, apically widened. Glumes 4 \times 2.2 mm, cymbiform, central area turning brown, margins scarios, adaxial violet brown, mucro 0.7 mm. Stamens 3, anthers 3 mm, carpels 3, style branches to 2–2.5 mm. Nutlet 1.5–2.0 \times 1.1–1.5 mm, ellipsoid, compressed, with abaxial ridge, grey brown, finely papillose, not winged.

DISTRIBUTION AND HABITAT ECOLOGY. West Africa from Mauretania and Senegal to Algeria and Mali. On dunes near coastal regions and in inland. Flowering February–November.

Cyperus mauretaniensis forms large tufts with many flowering stems. *Cyperus conglomeratus* and *C. falcatus* are also tuft forming, but their distribution range is more eastern. In *C. conglomeratus* the basal sheaths are dark reddish

brown and hard and in *C. falcatus* brown and soft, while in *C. mauretaniensis* these are very light brown and soft. The tufts both in *C. conglomeratus* and *C. falcatus* are very dense.

***Cyperus algeriensis* Väre & Kukkonen, sp. nova** (Fig. 8 and 9A)

Planta perennis, flavescens, 30–70 cm alta, rhizoma longum, erectum, radices crasse tomentosae, inflorescentia anthelodium. Affinis Cyperi macrorrhizi, sed non cespitosa, radices in parte superiore rhizomatis desunt, spicae 15–18 mm longae.

TYPE: Algeria. Ain-Sefra, in arena mobili, 22.V.1899 L. Chevallier 93 (holotype H 1218344).

Yellowish perennial, 30–70 cm (Fig. 8A). Rhizome erect, long. Roots basally on rhizome, tomentose (sand grains are affixed between root hairs), 3–4 mm in diameter including root

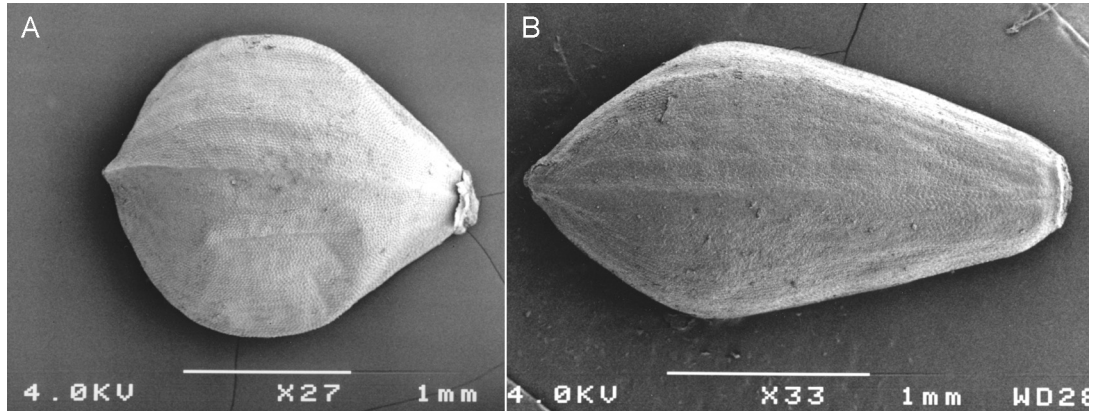


Fig. 9. Scanning electron micrographs of nutlets of (A) *Cyperus algeriensis* and (B) *C. macrorrhizus*. Scale = 1 mm.

hairs. Stem erect, 2–3 mm in diameter, grooved, obtusely trigonous or almost terete, smooth. Basal sheaths to 10 cm, soft, light brown, mouth margin concave. Ligule inconspicuous. Leaves to 70 cm, about as long as or somewhat longer than stems including inflorescence, 1–1.5 mm wide, channeled or inrolled, rigid, upright, margins mostly smooth, apex long-attenuate. Inflorescence anthelodium (Fig. 8B), rarely a head, to 7 × 5 cm. Bracts 2 or 3, foliaceous, to 19 cm, 1–2 mm wide. Primary branches 0–3, to 5 cm, channeled, smooth. Tubular prophyll to 4 mm, mouth margin concave. Cluster of spikelets spreading, with 8–10 spikes. Spikelets (10)15–18(20) mm × 4–6 mm, ovoid, slightly compressed, with 12–22 loosely imbricate glumes. Glume-like bract 3 mm, acute. Glume-like prophyll 2.8 mm, acute. Rachis 1.7 mm wide, yellowish brown to brown, internodes 2.5 mm. Glumes 5–6 × 3.0 mm, cymbiform, midnerve-area wide, triangular, grey-green or often more or less reddish-brown, margins widely scarious, inrolled towards the apex, central area of the adaxial side more or less reddish-brown, mucro 1.2 mm. Stamens 3, anthers 3–3.5 mm, carpels 3, style branches to 4.5 mm. Nutlet 2.5 × 2.0 mm (ratio 1.25) (Fig. 9A), almost triangular in outline, plano-convex, apex truncate, edges sharp, dark reddish-brown or almost black, surface finely reticulate, mostly with a papilla in each areole.

DISTRIBUTION AND HABITAT ECOLOGY. On dunes at southern border of Eastern Atlas mountains in Algeria and Tunisia from 500 to 1000 m a.s.l. Flowering April–June.

This species resembles *C. macrorrhizus*, which is a poorly circumscribed species, but will be re-described (H. Väre & I. Kukkonen unpubl. data). On average *C. algeriensis* inhabits higher altitudes, but these two species co-occur at Biskra region (Algeria). In *C. algeriensis* the upper part of the rhizome does not bear roots (or only some roots), unlike in *C. macrorrhizus*. *Cyperus algeriensis* is mainly rhizomatous, while *C. macrorrhizus* is more caespitose, although the rhizome penetrate deep in the sand. It is obvious that both species are occasionally covered by moving sand, but they are able to continue their growth. Spikelets of *C. algeriensis* are longer than in *C. macrorrhizus*, on average 15–18 mm versus 10–15 mm. Nutlets of *C. macrorrhizus* are slender, 2.5 × 1.6 mm (ratio 1.56) (Fig. 9B).

Cyperus subtilis (Kük.) Väre & Kukkonen, *comb. nova*

BASIONYM: *Cyperus maritimus* Poir. var. *subtilis* Kük., Das Pflanzenreich IV.20 (101. Heft) Cyperaceae-Scirpoideae-Cypereae: 270 (1936). — **LECTOTYPE** (designated here): Senegal. Ou fiev de la termier dune M'Bidjem, 13.X.1930 J. Trochain 646 (P!).

ADDITIONAL SPECIMENS EXAMINED. — **Mali.** Environs de Dakar, 27.III.1948 J. G. Adam (P). — **Senegal.** Cap Vert, 23.IX.1948 J. G. Adam 2018 (P); Cap Vert 1950–1951 R. P. Berhaut 5060 (P).

Kükenthal (1936) described *C. maritimus* var. *subtilis* based on material collected in Senegal by J. Trochain. However, Kükenthal did

not choose the type sheet. A label isotype has been mounted later to the sheet. Var. *subtilis* is very different from *C. maritimus* (= *crassipes*), which is a robust species with taller (2.5×1 mm) nutlets, while *C. subtilis* is a slender species with smaller (1.8×1 mm) nutlets. The distribution of *C. maritimus* is limited on the east coast of Africa, and the closely related *C. crassipes* is confined on the west coast.

Discussion

Cyperus ephemerus, *C. forskalianus* and *C. sahelii* are annuals, not known previously in section *Arenarii*. The annuals described here are geographically separate. They seem to grow in moist habitats, like annuals of other *Cyperus* sections (Lye 1995). The relationships between the annual and perennial species are unknown, but obviously certain perennial species are closely related, *C. mauretaniensis* with *C. sahelii* and *C. aucheri* with *C. ephemerus*. *Cyperus forskalianus* is morphologically distinct. As most species of *Cyperus* are perennials, it seems reasonable to think that annuals are derived from these, perhaps at least three times in section *Arenarii*, as all annual species clearly differ in their distribution. Species with winged nuts occur in Asia mainly, with a single exception of *C. gubanii*, which occurs in Somalia.

Acknowledgements

We thank Heino Vänskä for help with the Latin diagnoses, and Vanamo Salo for taking the scanning electron micrographs. Paul Goetghebeur is thanked for valuable comments on an earlier version of the manuscript.

References

- Goetghebeur, P. 1987: A holosystematic approach of the family *Cyperaceae*. — In: Greuter, W., Zimmer, B. & Behnke, H.-D. (eds.), *Abstracts of the 14th International Botanical Congress, Berlin, July 24 to August 1, 1987*: 276.
- Kükenthal, G. 1936: *Cyperaceae–Scirpoidae–Cyperae*. — In: Engler, A. (ed.), *Das Pflanzenreich IV.20*, 101: 1–671. Verlag Wilhelm Engelmann, Leipzig.
- Kukkonen, I. 1991: Problems in *Carex* section *Physodae* and *Cyperus conglomeratus* within the Flora Iranica area. — *Flora et Vegetatio Mundi* 9: 63–73.
- Kukkonen, I. 1994: Definition of descriptive terms for the *Cyperaceae*. — *Ann. Bot. Fennici* 31: 37–43.
- Kukkonen, I. 1995: New taxa, new combinations and notes on the treatment of *Cyperaceae* for Flora Iranica. — *Ann. Bot. Fennici* 32: 153–164.
- Kukkonen, I. 1998: *Cyperaceae*. — In: Rechinger, K. H. (ed.), *Flora Iranica: Flora des iranischen Hochlandes und der umrahmenden Gebirge* No. 173: 1–307 + 42 tabs. Akad. Druck- u. Verlagsanstalt, Graz.
- Kukkonen, I. 2001: *Cyperaceae*. — In: Ali, S. I. & Qaiser, M. (eds.), *Flora of Pakistan* No. 206: 1–277. Dept. Bot., Univ. Karachi, Karachi & Missouri Bot. Press, Missouri Bot. Garden, St. Louis.
- Lye, K. 1995: *Cyperaceae*. — In: Thulin, M. (ed.), *Flora of Somalia*, vol. 4: 98–147. Royal Bot. Gardens, Kew, London.