THE *CENCHRUS SPINIFEX* GROUP (POACEAE: PANICOIDEAE) IN TEXAS AND NOTES ON REINSTATED *CENCHRUS* S.S. IN THE UNITED STATES

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ABSTRACT

An account of the *Cenchrus spinifex* group for Texas is provided based on an examination of the type specimens, field work, and the examination of herbarium accessions and digital images. From this study several species previously synonymized under *Cenchrus spinifex* are reinstated: *C. albertsonii*, *C. incertus*, *C. roseus*, *C. strictus* (coastal S. Carolina to Florida), and *C. bambusoides* (Florida, coastal southern Mexico). The Mexican species *Cenchrus roseus* is reported new for Texas. A new species of *Cenchrus* from Texas is described: **C. densiflorus** Wipff, sp. nov. from southern Texas. Keys to the documented taxa in Texas and the United States, descriptions, images of the types for each taxa, and distribution maps are provided.

RESUMEN

Se ofrece una descripción del grupo *Cenchrus spinifex* de Texas basada en el estudio de los especímenes tipo, el trabajo de campo y el examen de las accesiones del herbario y las imágenes digitales. A partir de este estudio, se restablecen varias especies anteriormente sinonimizadas bajo *Cenchrus spinifex*: *C. albertsonii, C. incertus, C. roseus, C. strictus* (costa de Carolina del Sur a Florida) y *C. bambusoides* (Florida, costa sur de Mexico). La especie mexicana *Cenchrus roseus* se registra por primera vez de Texas y se describe una nueva especie de *Cenchrus* para este territorio: **C. densiflorus** Wipff, sp. nov. del sur de Texas. Se proporcionan claves para los taxones documentados en Texas y Estados Unidos, descripciones, imágenes de los tipos de cada taxon y mapas de distribución.

INTRODUCTION

Cenchrus L. is here recognized in the strict sense (s.s.), as described in Pohl (1980), Wipff (2001), Wipff and Shaw (2018), and here. *Cenchrus* has long been regarded as closely related to *Pennisetum* Rich. and there has been considerable debate and confusion concerning the generic limits of *Cenchrus* and *Pennisetum*. Nash (1903) separated the genera as follows: *Cenchrus*—involucre of two spine bearing valves; *Pennisetum*—involucre of numerous bristles; bristles delicate, not thickened at the base, plumose; and *Cenchropsis*—involucre of numerous bristles, bristles rigid and thickened at the base. Nash (1912:146) in his generic key for the Paniceae separated *Pennisetum, Cenchrus,* and *Cenchropsis* as follows: spikelets subtended by bristles, and often plumose (= *Pennisetum*); and spikelets enclosed in an involucre of 2 valves which is deciduous with them (= *Cenchrus*); and spikelets subtended by bristles, bristles rigid, thickened at the base (*Cenchropsis*). Chase (1920: 50) separated the two genera by bristle type, in addition to fusion, "*In Pennisetum the sterile branchlets are few to many, usually very slender, not rigid, free or rarely united at the very base. In Cenchrus the sterile branchlets are rigid and united below. This specialization reaches its extreme development in our North American species, in all but one of which the united branchlets form a cuplike receptacle* [= *Cenchropsis*] *in which the spikelets are partly hidden*." Hitchcock (1931) in his treatment for North America separated the two genera as: spikelets solitary or in groups of two or three, surrounded by an involucre of bristles, these not united or only at the very base, often plumose, falling attached to the spikelets (= *Pennisetum*); and spikelets sessile, one to several together, permanently enclosed in a bristly or spiny involucre or bur, composed of more or less coalesced sterile branchlets, bristles mostly retrorsely scabrous, but some species antrorsely scabrous (= *Cenchrus*). Hitchcock (1920), in his treatment of the genera of the United States, separated them as follows: bristles not united at base, slender, often plumose (= *Pennisetum*) vs. bristles united into a bur-like involucre, the bristles retrorsely barbed (= *Cenchrus*). This 1920 treatment subsequently was followed by Hitchcock (1935, 1951) and Silveus (1933).

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Delisle (1963), though basing his treatment on the traditional criteria of bristle fusion, recognized the difficulty in the interpretation of this character, and refined his generic criteria with the addition of the following characters. *Pennisetum* has bristles that are seldom more than 0.2–0.4 mm wide, and the base of the fascicle rarely exceeds 0.5 mm in width; whereas in *Cenchrus*, "*the spines usually 0.5 mm or (more) wider and are generally united for a considerable distance above the base of the bur, with the base itself usually at least 1.5 mm in diameter. These characteristics, although admittedly arbitrary, are used in the present treatment of the genus* Cenchrus" (DeLisle 1963:269). The increase in base diameter is probably a structural response to the fusion and thickening of the bristles and is closely correlated with bristle fusion. The more fusion and thickening of the bristles that occurs then the wider the base of the fascicle. Filgueiras (1984), using criteria similar to that of Delisle (1963), separated the two genera as follows: *Cenchrus* with fused bristles, at least basally, forming a basal disc at least 1 mm in diameter, and *Pennisetum* with bristles unfused to the base, not forming a disc. Webster (1987) used only the presence of this disc or callus to separate the genera: *Cenchrus* with the callus pronounced and flared apically to form a discoid receptacle; and *Pennisetum* with the pronounced callus absent or, when present, not differentiated as in *Cenchrus*. Webster went on to say that this character allows for the separation of the species along traditional grounds. In addition, to fusion, Clayton and Renvoize (1982 & 1986) and Watson et al. (1992) also mentioned that *Cenchrus* usually had 'spiny' bristles.

Historically, a predominant character used to distinguish the two genera was fusion or lack of fusion of the inner bristles in the fascicle [involucre or bur] (e.g., Chase 1920, 1921; Hitchcock 1931, 1935, 1951; Silveus 1933; Henrard 1935; Delisle 1963; Gould 1975; Clayton & Renvoize 1982; Filgueiras 1984; Clayton & Renvoize 1986; Watson et al. 1992 onwards). But the variation of this single character across the two genera is continuous, thus making the placement of numerous species arbitrary if this is the only diagnostic character used (Webster 1987, 1988). Webster (1988) stated that even within a number of species it is open to interpretation as to whether the bristles are fused, or the callus flared. For example, in regard to bristle fusion, *Pennisetum ciliare* (L.) Link is extremely variable and has been treated in both *Cenchrus* and *Pennisetum*. Bashaw (1953) concluded that *Cenchrus setigerus* Vahl and *Pennisetum ciliare* were, "much more closely related than our present classification indicates." Read and Bashaw (1969) concluded that *P. ciliare* and *C. setigerus* are members of the same agamic complex of polyploid species with the basic number of x = 9 and most frequently occur as tetraploids, $2n = 4x = 36$. A wide range of chromosome numbers has been reported for *Pennisetum ciliare*: $2n = 32, 34, 36, 38, 40, 44, 45, 52, 54, 62, 72, 78$ (Bir & Chauhan 1990; Darlington and Wylie 1955; DeLisle 1963, 1964; Fisher et al. 1954; DeWett 1958; Gould 1958, 1965; Hignight et al. 1991; Krishnaswamy 1940; Mnif et al. 2005; Moffett & Hurcombe 1949; Nath & Swaminathan 1957). However, Visser et al. (1998) confirmed a basic chromosome number of x = 9 for *Cenchrus ciliaris* L.; observation of three different polyploid levels, tetraploid ($2n = 36$), pentaploid ($2n = 45$) and hexaploid ($2n = 54$); that almost 83% of the specimens studied were tetraploid ($2n = 36$; $n = 2x = 18$); that B-chromosomes were present in a few of the tetraploid and hexaploid specimens; and that the high frequency of aneuploidy, previously described for this species, was not observed in their study.

Unlike *Pennisetum ciliare*, the reported chromosome number of the apomictic *P. setigerum* (Vahl) Wipff [Gandhi (2018, pers. comm.)—regarding orthography of 'setigerum / setiger'] is $2n = 4x = 36$ (Bashaw 1953; Fisher et a1. 1954; Darlington & Wylie 1955; Snyder et a1. 1955; DeLisle 1963; Read and Bashaw 1969), with a basic chromosome number of x = 9. Bashaw (1953) reported that the $2n = 34$ chromosome number reported by Darlington and Janaki-Ammal (1945) was not substantiated in his study of *Cenchrus setigerus* Vahl, in which all counts were $2n = 36$. Read and Bashaw (1969) hybridized a sexual, $2n = 4x = 36$, *P. ciliare* accession (Bashaw 1969) with an apomictic accession of *Cenchrus setigerus*, with the resulting progeny showing complete intergradation in morphology between the parents. Read and Bashaw concluded that the chromosome homology and cross-compatibility of *P. ciliare* and *C. setigerus*, plus the high fertility and morphological intergradation, observed in the F1 progeny provided overwhelming evidence of a very close relationship between the species and concluded that both species belonged in the same genus.

Hignight et al. (1991) evaluated 800 accessions of *P. ciliare* collected from Africa and selected accessions

based on extreme differences in morphology, including differences in bristle fusion. Thirteen of the most diverse morphological types were studied for morphology, cytology, and fertility. Five of these diverse morphological types were used in hybridization studies with a sexual *P. ciliare* genotype (Bashaw1969). Though they found most accessions to have at least some fusion, two of the accessions studied had a complete lack of bristle fusion. These plants were verified at Royal Botanical Gardens, Kew (K) to be *P. ciliare*. Their hybridization studies with the sexual *P. ciliare* genotype (Bashaw 1969) showed a close relationship between all the accessions studied. Some of the F1 progeny from the hybridization studies segregated for union of bristles similar to the bristle fusion found in *Cenchrus setigerus* (= *Pennisetum setigerum*). Hignight et al. (1991) concluded, "that bristle union is an arbitrary character that varies with genotype and is unreliable for the taxonomic classification of buffelgrass [*P. ciliare*]." Chemisquy et al. (2010) conclusions were also congruent with reports from the earlier literature that the fusion of the bristles in the fascicle showed continuous variation. Whereas the continuous nature of bristle fusion has been well documented in the literature, it is <u>not</u> considered here as the primary diagnostic generic character. Although when used as the primary diagnostic character, this character inadequately and arbitrarily separates the two genera; however, it is of some value as a generic character when used with other primary characters.

Martel et al. (2004) and Robert et al. (2011) reported on the phylogenetic relationships in *Pennisetum* based on internal transcribed spacer (ITS) sequences. These were used to assess evolutionary trends in genome structure within the genus *Pennisetum* on the basis of observed variations in genome size, basic chromosome numbers (x = 5, 7, 8 and 9) and ploidy level (from 2x to 8x). The only "*Cenchrus*" included in their study, *Cenchrus ciliaris*, nested within *Pennisetum*. The generic position of this species has been historically contentious, but the data supports inclusion of *P. ciliare* and *P. setigerum* in *Pennisetum* s.s. This taxonomy is also supported by base chromosome number, cytology, hybridization studies and morphology.

Sohns (1949, 1955) concluded from the examination of fascicle organization in eight species of *Cenchrus* [*C. echinatus* L , C. *gracillimus* Nash, *C. incertus* M.A. Curtis; *C. myosuroides* Kunth, *C. pauciflorus* Benth. (= *C. spinifex*); *C. pilosus* Kunth; *C. setigerus* Vahl (= *P. setigerum*), and *C. viridis* Spreng. (= *C. brownii* Roem. & Schult.)]; and six of *Pennisetum* [*P. glaucum* (L.) R. Br., *P. alopecuroides* Steud., *P. peruvianum* Trin., *P. purpureum* Schumach., *P. ciliare* (L.) Link, and *P. clandestinum* Hochst. ex Chiov.] the following.

Cenchrus

1) In *Cenchrus* s.s. the spikelets themselves are terminal in the fascicles and the surrounding bristles represent sterile first-order axes and their branches all fused laterally, these at one time belonging to an elongated inflorescence branch whose axis has become shortened and whose lateral branches have become sterile. Thus, the spikelets themselves are terminal in an inflorescence branch whose axis has become shortened and whose lateral branches have become progressively sterile.

Unfortunately, the terminal axis bristle that is present in *Cenchrus setigerus* (= *Pennisetum setigerum*) was not reported by Sohns. The fascicle of *P. setigerum* only superficially resembles *Cenchrus* s.s. because it has flattened, highly fused, but grooved bristles; but all the other characteristics, cytological and morphological, are clearly *Pennisetum*. Even the fusion of the bristles is different between the two and upon closer inspection this fascicle is very different from a *Cenchrus* s.s. fascicle. The author has examined a number of sheets of *P. setigerum* and has grown accessions in the greenhouse and field, and can conclusively confirm that the fascicle indeed terminates in a bristle and not a spikelet. This terminal, and often prominent, bristle is interpreted as an axis continuation beyond the terminal spikelet as Sohns' reported in the other *Pennisetum* species that he studied. However, the terminal axis bristle in *P. setigerum* can sometimes be similar in length to the surrounding bristles and not obvious, but positionally is directly below the terminal spikelet and is often wider the other bristles. This terminal (or primary) bristle is often longer than the surrounding bristles in many accessions, if only slightly so. As we have seen earlier, *Cenchrus setigerus* belongs in *Pennisetum* as a taxon in the agamic *P. ciliare* complex not only cytologically, but also morphologically.

2) The separation of the fascicle (involucre) into two halves indicated by the appearance of the adaxial and often abaxial clefts and subsequent upward separation into individual bristles suggests a "two branch"

vascular system. Sohns' described this "two branch" vascular system as a system in which a vascular branch originates on each side of a central vascular plexus; each of these vascular branches may be traced to a group of bristles on the left and right side of the fascicle, respectively. The appearance of the adaxial and abaxial clefts give the fascicle a definite two-parted appearance. This appearance is to be attributed primarily to the pressure exerted by the expansion of the central spikelet. The proximity of the fascicle to the panicle axis, on the adaxial face, provides additional pressure which may influence the appearance of adaxial cleft, especially before the inflorescence is exserted from the sheath. The fascicle contains from one to five spikelets; one of which terminate the axis and is the largest in the fascicle.

3) One of the striking features seen in *Cenchrus* is their remarkable similarity in morphological structure, with the exception of two species in this study, (*C. myosuroides* and *C. pilosus*), the former differs from *Cenchrus* s.s. in bristle morphology. *Cenchrus myosuroides* also differs from the other species in having one spikelet per fascicle and showing clearly a two branch vascular system supplying the bristles of the fascicle. Interestingly, the suppressed lateral spikelets are represented by two lateral vascular bundles which terminate blindly in the periphery of the fascicle.

Pennisetum

The fascicle (branch) axis is prolonged as a prominent, often longer and wider, bristle that is found just below the terminal/central spikelet in the fascicle. This terminating bristle of the axis continues beyond the spikelet and is the longest, widest, largest and most prominent bristle in the fascicle, with the exception of a few species (e g , *P. clandestinum* and *P. setigerum*) where it is as long as to slightly longer than the surrounding bristles. In *P. clandestinum*, since the fascicles are enclosed in leaf sheaths, and show the influence of pressure on the fascicle, namely that there is no obviously longer bristle as seen in most other species of *Pennisetum*. In this case the terminal axis bristle in only slightly longer than the others. However, upon examination of the fascicle, though the terminal bristle is only as long as to slightly longer than the other bristles, it can be identified by its location as directly subtending the spikelet, and that it is slightly wider than the other bristles. So, positionally this terminal bristle can be identified, when not obviously longer than the surrounding bristles. This is similar to what is observed in those accessions of *P. setigerum* where the terminal bristle is sometimes not conspicuously longer than the surrounding bristles.

Sohns (1955) suggested this character as an additional differentiating character between *Cenchrus* s.s. and *Pennisetum*: whether the axis of the fascicle terminates as an often prolonged, usually prominent, bristle (*Pennisetum*) subtending the terminal/central spikelet or terminates into a spikelet (*Cenchrus* s.s , *Cenchropsis*). DeLisle (1963) stated, "*Sohns (1955), further suggested that the prolonged awn-like bristles, found in a number of species of* Pennisetum*, represent a continuation of the stem axis, that the spikelets in these forms are lateral instead of terminal, and that this character might prove useful in separating the genus* Pennisetum *from that of* Cenchrus*. However, this feature (prolonged bristle) occurs widely in both genera and is highly variable in such species as* C. caliculatus [incertae sedis] *and* C. multiflorus [= Pennisetum karwinskyi Schrader]. *It therefore does not appear to be a useful taxonomic trait except possibly on an interspecific basis*." Thus, this character's association with bristle fusion would then explain why Sohns' character has appeared to be of little taxonomic value, because when bristle fusion is used as the primary character it arbitrarily separates the two genera. But when this character is uncoupled from fusion of the bristles/spines it then becomes diagnostic in separating the genera. And as Sohns (1955) stated, "*The presence of the usually prolonged sterile axis of the fascicles of* Pennisetum *may be used to separate this genus from* Cenchrus [s.s.]*, whose fascicle axis is terminated by spikelets.*"

Cenchrus s.s. and *Pennisetum* are not only very different morphologically, but also cytologically. *Cenchrus* s.s. is of allopolyploid (allotetraploid) origin with base number of x = 17 (8 + 9) (Avdulov 1931; Pohl 1980, Wipff 2001; Veldkamp 2014). The allotetraploid hybrid origin is important in the classification of taxa in *Cenchrus*. Whereas *Pennisetum* has base chromosome numbers of x = 5, 7, 8, or 9 (Jauhar 1981; Martel et al. 2004; Robert et al. 2011).

As Weakley et al. (2017) so rightly stated, "*We use all techniques and types of evidence we can to make the*

best decisions we can now. Ecology, biogeography, phenology, cytology, and other information, as available, pertains to the task. Molecular evidence is no silver bullet and still requires just as much interpretation from all available evidence in order to make best possible taxonomic decisions." Chemisquy et al. (2010) proposed the unification of *Cenchrus* and *Pennisetum* based on their phylogenetic analysis of plastid and nuclear data. Unfortunately, the only other data examined was from a cladistic analysis of both cytological and morphological characters. Such a broad interpretation is difficult to employ to the extent that it results in confusion and the loss of substantial taxonomic information.

However, Donadio et al. (2009:400) considered that, "*If* Cenchrus ciliaris *and* C. setigerus *are treated under* Pennisetum*, based on a common basic chromosome number x = 9, and the presence of antrorsely scabrous and not spiny bristles (Wipff, 2003), the name* Cenchrus *s.str. could be restricted to a core group of species (clades A5 + A6; Fig. 2). Monophyly of* Cenchrus *s.str. is neither confirmed nor rejected by our results, but optimization of non-molecular characters such as the geographic origin (America), basic number of chromosomes (x = 17, except in* C. myosuroides *with x = 9[10]; Brown, 1950; Morrone & al., 2006), the degree of fusion of bristles (up to the middle of the bristles, except in* C. myosuroides*), the stiffness of internal bristles (stiff bristles) and the presence of retrorsely barbed bristles (except in* C. pilosus*) all could be used to support the delimitation of* Cenchrus *in a strict sense (Fig. 2). Additional molecular characters and a better sampling of the American species are required to further test the monophyly of this group.*"

The taxonomic application of all available evidence supports the delineation of *Cenchrus*, in a strict sense, from *Pennisetum*, and the recognition of *Cenchrus myosuroides* [and *Cenchrus ekmanianus* Hitchc. (Wipff & Shaw 2018)] in *Cenchropsis*. The allotetraploid hybrid origin, coupled with morphological characters discussed earlier, are important in the classification of taxa in *Cenchrus* s.s., as well as, the taxa in *Pennisetum* and *Cenchropsis*. The following diagnostic characters are considered equally important in delineating the three genera:

Cenchrus s.s.

1. Fascicle with flattened bristles that are rigid and spine-tipped, and with or without terete or very narrow flattened bristles that are flexible and not spine-tipped.
2. The bristles are usually retrorsely scabrous [when antrorsely scabrous, the inner bristles forming the cupule connate, and not grooved, and with no bristle suture lines (i.e., *C. mitis* Andersson, *C. pilosus* Kunth)].
3. Axis of fascicle terminating in a spikelet (Sohns 1949, 1955).
4. Inner bristles connate at least basally, forming a cupule (shallow in *C. biflorus* Roxb., only fused at very base forming a very thickened rim), with no suture lines visible between fused bristles. Inner whorl of modified bristles proximally flattened, usually thick, rigid and distally thorn-like or spine-tipped.
5. Allotetraploid origin with a base chromosome number of x = 17 (8 + 9).

Pennisetum

1. Fascicle with bristles basally, narrow and flattened, or terete; bristles flexible, or occasionally stiff or rigid (i.e., *P. setigerum*); thorn-like or spine-tipped bristles absent.
2. Bristles antrorsely scabrous [except *P. rigidum* (Griseb.) Hack. which has both antrorse/retrorse on the same bristle)].
3. Axis of fascicle terminating as a bristle that is often more prominent and often longer than surrounding bristles (Sohns 1955), and is subtending the central/terminal spikelet;
4. Inner bristles unfused or fused; when unfused, bristles narrow, flexible, flattened, and ciliate or eciliate. When inner bristles are highly fused, the bristles are flat, rigid, grooved, but not spine-tipped, and suture lines visible (i.e., *P. setigerum*).
5. Base chromosome numbers of 5, 7, 8, or 9.

Cenchropsis

1. Fascicles with <u>all</u> bristles terete; stiff and flexible; spine-tipped bristles absent.
2. Bristles retrorsely scabrous.

3. The axis of the fascicle terminating in a spikelet.
4. Bristles only fused at the very base.
5. Base chromosome numbers of x = [9] 10 (DeLisle 1963) or 35 (9 + 8 + 18, Avdulov 1931).

The chromosome number of *Cenchropsis myosuroides* has been reported as 2*n* = 54 (Brown 1950, 1951), = ca. 68 (Bowden & Senn 1962), = 70 (Avdulov 1928, 1931; Parodi 1946; DeLisle 1963, 1964; Gould 1965; Reeder 1968; Wipff pers. obs.), and = ca. 72 (Morrone et al. 2006). But 2*n* = 70 [n = 35] is the more commonly reported number. These counts indicate that *C. myosuroides* is a polyploid that originated either from a progenitor with a basic number of x = 9 or 10 (DeLisle 1963) or is of allopolyploid origin as in *Cenchrus* (Avdulov 1931). Avdulov (1931) considered this species an allopolyploid, but one very different from *Cenchrus* s.s. He stated (translated from Russian), "*C. myosuroides*, in addition to fairly long chromosomes, has a row of very small biscuit-shaped ones with a constriction in the middle, like *Setaria*, which are not present in *C. inflexus* [= *C. brownii* Roem. & Schult.], and at the same time a row of chromosomes that are longer than those of *Setaria*. The diversity of the set [of chromosomes] of *Cenchrus* is more reminiscent of the genus *Pennisetum*. In addition to the variation of the set, *C. myosuroides* is also remarkable for the number of chromosomes—2x = 70. This is certainly not simply a tetraploid form of *Cenchrus*, since in that case the number of chromosomes should have been 68. Meanwhile, both from the one shown in Fig. 22 and from a number of other plates, I could undoubtedly state precisely the number 70. The most likely explanation in this case, it seems to me, is the reverse hybridization of some species of *Cenchrus* with a tetraploid form of a x =9 [species] (2x = 36). The union of gametes with 17 and 18 chromosomes yields 35 chromosomes, which, if doubled, could form a form with 70 chromosomes in the soma. The path of this type of morphogenesis is quite probable and has been repeatedly established even under experimental conditions (Federley 1913; Tschermak & Bleier 1926, Karpechenko 1927; Rybin 1927; Levitsky & Benetskaya 1930). It is remarkable that, of the species I have studied, it is precisely in *C. myosuroides* that the involucre consists of the softest bristles, approaching in this respect the following genus, *Pennisetum* Pers." The unique and distinct fascicle morphology, and basic chromosome number [x = 35] place *Cenchrus myosuroides* and related taxa outside of the generic limits of *Cenchrus* sensu stricto and warrant their recognition within *Cenchropsis* Nash.

THE *CENCHRUS SPINIFEX* GROUP

The phylogenetic analysis of *Cenchrus* s.l. taxa by DeLisle (1963) resulted in 2-Groups. DeLisle defined Group 1 as follows, "These include presence of a definite bur resulting from more or less complete fusion of the spines, the presence of flattened and broad spines, and the absence of prolonged bristles." Group 1 can be further divided into two subgroups, one of which includes the *C. spinifex* group. One subgroup contained *C. echinatus* L., *C. pilosus*, *C. mitis*, and *C. brownii*; and the second subgroup contained members of the *C. spinifex* group. The following is the status of taxa in the Cenchrus spinifex group defined by DeLisle (1963) as Group 1 and here further divided as Subgroup 'Spinifex'.

1. Taxa originally treated under *C. incertus* by DeLisle (1963).
**Cenchrus spinifex* Cav. [left unresolved by DeLisle (1963:313)]—reinstated
**C. albertsonii* Runyon—reinstated
C. carolinianus Walter (1788), nomina utique rejicienda = **C. strictus** Chapm.
C. humilis Hitchc.—reinstated (South America)
**C. incertus* M.A. Curtis—reinstated
C. microcephalus Nash ex Hitchc. & Chase = **C. spinifex**
C. muricatus Phil , non *C. muricatus* L. = **C. spinifex**
C. parviceps Shinners = **C. spinifex**
C. pauciflorus Benth. = **C. spinifex**
**C. roseus* E. Fourn.—reinstated (Mexico & Texas)
***C. strictus* Chapm.—reinstated (South Carolina to Florida)

2. Other U.S. taxa recognized as species in DeLisle's Group 1: Subgroup 'Spinifex', or described after 1963.
**C. bambusoides* Caro & E.A. Sánchez (1967)—reinstated (Florida)
**C. densiflorus* Wipff, sp. nov.
C. gracillimus Nash—accepted and keyed out here, but is not discussed further.
**C. longispinus* (Hack. ex Kneuck.) Fernald—accepted
C. tribuloides L.—accepted and keyed out here, but is not discussed further.
C. palmeri—accepted [introduction into southern Arizona from SW Mexico (Malusa et al. 2013)]. This very distinct Mexican species is keyed out here, but is not discussed further.

Taxa marked with an asterisk (*) are taxa known to occur in Texas and taxa marked with two asterisks (**) are not found in Texas, but are reinstated in the eastern U.S. and will be briefly discussed.

HISTORY OF THE *CENCHRUS SPINIFEX* GROUP

Chapman (1860:578–579), in his treatment for the southern U.S., only recognized two species of *Cenchrus*; *C. echinatus* and *C. tribuloides*. Vasey (1883, 1892) in his treatments of the grasses of the United States recognized only 4 species: *C. echinatus* (South: North Carolina to Mexico); *C. myosuroides* Kunth (South and West: South Florida, Geogia to Texas and westward); *C. incertus* Curtis (including *C. strictus*) (Southern States: sandy coast Florida to North Carolina); and *C. tribuloides* (Common: extensively distributed). Vasey recognized only 2 species in the *C. spinifex* complex (*C. incertus* and *C. tribuloides*). Nash (1895) also had a broad concept of the *C. spinifex* group. In his treatment he recognized 3 species in this group: *C. tribuloides*, *C. incertus*, and *C. gracillimus*. Nash treated taxa that had fascicles without a lower (corona) of spines as *C. incertus*; this concept matches the type specimen. Fascicles with a lower (corona) of spines present and a glabrous cupule were placed into his newly described *C. gracillimus* and everything else was treated under *C. tribuloides*. Nash stated that *C. tribuloides* was "*extensively distributed in the United States ranging from Massachusetts to Ontario, Minnesota and Nebraska, south to Florida and Mexico. Extremely variable, but its robust habit, generally strongly inflated sheaths and light colored globose involucres will distinguish it from its nearest relatives*." Thus, all the *C. spinifex* Group (as defined by DeLisle 1963) was treated under *C. tribuloides* in Nash's treatment for North America. Nash (1903) maintained a similar treatment as his 1895 classification. The only addition was the recognition of *C. macrocephalus* (Döll) Scribn. (= *C. tribuloides*) as distinct from *C. tribuloides*.

In what would become the *Cenchrus spinifex* Group as defined by DeLisle (1963), Chase (1920) treated this group in a much narrower sense, though still broad. Chase's North American treatment would be followed fairly closely by subsequent authors (e.g., Hitchcock 1931, 1935, 1951) until the DeLisle (1963) treatment, and then this taxonomic concept was adopted by most subsequent authors. Chase (1920) recognized the following taxa (in part) in what would become the *C. spinifex* group as defined by DeLisle (1963): *C. incertus* (incl. *C. strictus*); *C. microcephalus*; *C. pauciflorus* [incl. *C. roseus* (type not examined by Chase, but her decision based on notes from P); and *C. echinatus* forma *longispina* Hack.]. Hitchcock (1931) in North American Flora followed Chase (1920). Hitchcock (1951) treated *C. incertus* (incl. ?*C. carolinianus*; *C. strictus*) and *C. pauciflorus* [incl. *C. albertsonii*; *C. longispinus*; *C. roseus*] for the United States.

DeLisle's (1963) very broad taxonomic circumscription of the genus *Cenchrus* encompassed taxa that have been traditionally treated in *Pennisetum*, and based on the above diagnostic characters, belong in *Pennisetum*. DeLisle also included taxa that are *incertae sedis* and probably do not belong in either genus, as well as, also including *C. myosuroides* (= *Cenchropsis*) in his circumscription. DeLisle (1963) also had a very broad interpretation of *Cenchrus incertus*. This extremely broad circumscription of *Cenchrus incertus* has been followed by most subsequent authors [e.g., Gould (1975), Stieber & Wipff (2003), and Gutiérrez (2015)]. DeLisle's interpretation of *C. incertus* had essentially made *C. incertus/spinifex* a 'dust bin' for a lot of the distinct taxa in this group. In his treatment of *C. incertus* he synonymized the following species under it: *C. strictus*, *C. roseus*, *C. humilis, C. albertsonii*; *C. microcephalus, C. muricatus, C. parviceps,* and *C. pauciflorus*. This broad treatment that encompassed taxa from several different genera, as well as, the synonymizing of a number of distinct taxa into a single taxon creates a difficult and confusing taxonomic tool.

A nomenclatural consequence of treating the *C. incertus* group sensu lato, is that the name *C. incertus* M.A. Curtis (1835) no longer has priority, but *Cenchrus spinifex* Cav. (1779) does (Stieber & Wipff 2003; Veldkamp 2014). Thus, Zuloaga and Morrone (2003:147) and Veldkamp (2014) suggested that a proposal to conserve *C. incertus* against *C. spinifex* be considered for nomenclatural stability. However, this is unnecessary: If the *C. incertus* group is treated sensu stricto, as proposed here, *C. spinifex* refers to what has historically been called *C. pauciflorus* (1844), and *C. incertus* refers to a taxon very distinct from *C. spinifex*. Chase (1920:69) treated *C. spinifex* (*incertae sedis*) under *C. pauciflorus,* because she was not able to examine the type material, and due the cryptic description and vague illustration, she was not able to determine the status of this name. However, she did know that this taxon (*C. spinifex*) was clearly distinct from *C. incertus* and best fit with *C. pauciflorus* based on the limited information she had at hand. The option of treating *C. spinifex* sensu stricto and reinstating *C. incertus* and other members of this group long lost in synonymy is preferred here. Moreover, others have also found the circumscription of DeLisle (1963) too broad, and began reinstating some of the synonymized taxa. Caro and Sánchez (1967, 1967a) reinstated *C. pauciflorus* (= *C. spinifex*) as distinct from *C. incertus,* Caro and Sánchez (1967) reinstated *C. humilus* (Peru) and described a new species in this group, *C. bambusoides*, from Florida.

As Ward (2010:445) rightly observed, "*Chase (1920), with her wider perspective, believed them* [C. pauciflorus *and* C. incertus] *to be different, but her separation was unclear since she confounded them with* C. longispinus*, a then poorly recognized species of the Midwest and Northeast. DeLisle (1963) recognized* C. longispinus *as distinct, but he did not distinguish between the perennial, mostly coastal* [*plain*] C. incertus *and the annual widespread* C. pauciflorus*. This judgement, uncritically followed, has been the origin of much of the apparently confusing variability found among the sandspurs.*" The taxonomy of the *C. spinifex* group is difficult, complex, and confusing, yet as with most difficult groups familiarity brings about clarity. My objectives were to critically analyze the *Cenchrus spinifex* group, looking for patterns in morphological variation and to search for diagnostic characters that might provide a clearer delimitation of the taxa in this group. This would involve a thorough examination of fascicle morphology and the type specimens for all taxa listed by DeLisle (1963) as synonyms of *C. incertus*, as well as the type for *C. bambusoides* (Caro & Sánchez 1967). My examination all type specimens has brought greater clarity to the understanding of this group and this, coupled with the decades of field work and intensive use of microscopy in examining 100's of herbarium specimens, and access to over 1,500 digital images from numerous herbaria has resulted in the following circumscription.

THE FASCICLE IN THE *CENCHRUS SPINIFEX* GROUP ("BUR" OR "INVOLUCRE")

"The characteristic burs of the *Cenchrus* plant cannot be interpreted easily. The stem and leaves are not special within the grasses. The spikelets (within the bur) are of typical panicoid form, each spikelet with two glumes and two florets, the lower sterile, and each floret enclosed by a lemma and palea. It is the inflorescence that challenges understanding. The entire inflorescence is believed to be a panicle, condensed and reduced to the appearance of a spike. It is further reduced by lateral branchlets that are much diminished and have coalesced to form indurated spines. These highly modified branchlets enclose one or more spikelets, and form the "bur." In some species, long bristles develop on the lower portions of these spines. In all [most] species, both spines and bristles are retrorsely barbed." Ward (2010). In this treatment fascicle is synonymous with the terms "involucre" and "bur" used in other works. The morphology and architecture of the fascicle in the *C. spinifex* group is described in detail since it is important in distinguishing taxa (Fig. 1).

The fascicle is comprised of highly modified coalescing spines/thorns representing modified sterile branches (usually called "spines" and "bristles" in the literature) on a peduncle that are variously fused or free, and flat (proximally) and terete (distally), or completely terete. These fascicles have a distinct and common architecture throughout this group. The term 'spine' is used here and defined as stiff, rigid, sharp, thorn-like, spine-tipped structure formed by the modification of a branch that contains vascular tissue and the term

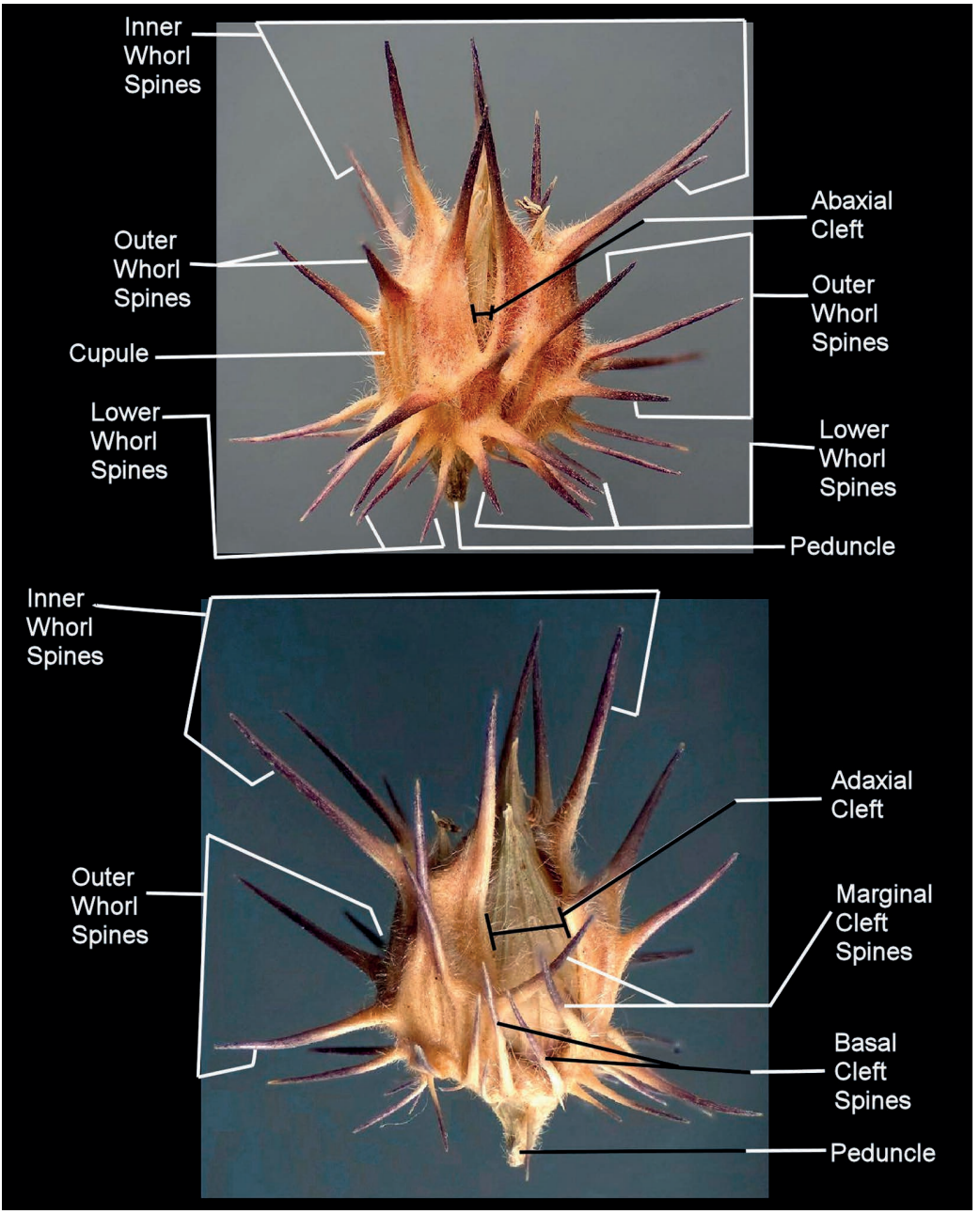

Fig. 1. Fascicle morphology. Images of *Cenchrus longispinus* by D. Walters & C. Southwick. Walters, D.S. 2011. Identification Tool to Weed Disseminules of California Central Valley Table Grape Production Areas. USDA APHIS PPQ CPHST Identification Technology Program, Fort Collins, CO. https://idtools.org/id/weed-tool/key/index.htm [9 Dec 2019]. The author is solely responsible for the labeling of the fascicle images of *C. longispinus*.

"bristle" here refers modified branchlets that are terete or very narrow flattened, slender, and stiff, but still flexible. The spines vary from basally flattened and very wide, to narrow or terete (or almost so).

The fascicle is comprised of a cupule of spines that is supported by a flared and thick peduncle that often narrows down into a stalk or stipe, which attaches to the panicle axis (rachis). The spines and bristles are retrorsely barbed. Immediately above the flared peduncle apex is often a whorl (1–3 whorls) of flattened spines (except *C. incertus* and *C. strictus* in which the lower whorl is absent). Below the lower whorl of flattened spines short terete bristles can be present. The fascicles of the *C. spinifex* group usually have basally flattened spines and terete bristles in 3 basic arrangements on the cupule: an inner whorl; outer whorl (1–4 regular or irregular rows); and a lower whorl, which can be present or absent, when present, is in a series of 1–3 whorls. Disarticulation of the fascicle at the base of the peduncle, and the entire fascicle and spikelets disarticulate as a unit.

Inner Whorl of Spines.—The inner spines of the fascicle are basally flattened, not grooved, thick, connate, basally fused and forming a distinct, rigid cupule around the spikelets. Apically the spines are terete, retrorsely scabridulous, rigid, and form spines with a very sharp-pointed tip. **CUPULE.** The basal portion of the inner spines are connate, fused at various degrees forming a cupule. Where the spines are fused, no suture line is discernable and are connate. The cupule is very thick and rigid; glabrous to pubescent, stramineous to variously colored. On the adaxially (ventral) side of the cupule there is a prominent **adaxial cleft** which forms between two inner spines and, usually runs the entire length of the cupule exposing the central (and largest) spikelet. **The cleft exposes the upper glume of the spikelet.** The **adaxially cleft** usually has a basal 1–2 pairs (2–4 spines, occasionally the lowest pair only consists of 1-spine) of basally flattened or terete spines here called **basal cleft spines** and along the margin of this cleft are usually another pair of spines present, here called **marginal cleft spines**. The basal cleft spines are erect or ascending. The marginal spines (often in pairs) are erect to ascending (occasionally spreading) and often crisscross across the cleft, appearing to protect the spikelet(s). The margins of the adaxial cleft are glabrous to long ciliate. On the abaxial (dorsal) side of the cupule, between two inner spines, there can also be an abaxial cleft. This **abaxial cleft** can be shallow, deep, or absent. When present, with or without spines at the base or along the margins of the cleft.

Outer Whorl(s) of Spines.—The cupule (formed by the inner spines) is armed with additional flattened or terete, rigid, spines that are protruding from the cupule in 1–5 distinct or irregular whorl(s), which are referred to here as the outer whorl of spines/bristles. In some taxa the outer whorl can only consist of 1 spine (e g , *C. incertus*).

Lower Whorl(s) [corona] of Spines.—The lower whorl (corona) of spines is present or absent (absent in *C. incertus* and *C. strictus*) at the base of the cupule. When present, the whorl is located at the apex of the peduncle and base of the cupule in 1–2(–3) whorls. The spines are usually flattened (terete or very narrow flattened, slender, in *C. roseus*) and are spreading to deflexed. Below the flattened lower whorl of spines, short terete bristles can be present.

Terete Bristles.—These cylindrical bristles are present, or absent, below the lowest whorl of spines. These bristles are often shorter than the above flattened spines. There can be 0–many terete bristles present.

In other species this lower whorl (corona) can consist of only terete bristles (e.g., *C. brownii*) or a combination of very narrow flattened bristles and terete bristles (e.g., *C. echinatus, C. biflorus, C. pilosus*).

KEYS AND TAXONOMIC TREATMENT

Excluded taxa from the Texas flora.—DeLisle (1963) reported that *Cenchrus tribuloides* was "restricted to the immediate coastal sand dune areas from New York south to Florida and along the Gulf coast to Texas"; however, he provided no collection records for Texas. Allen et al. (2004) reported this species as far west as Cameron Parish, LA (A Parish along border with Texas). To date, no collections from Texas have been examined by the author and so is not included in the Texas flora. The species can be identified by fascicles that are mostly densely pubescent and usually with a solitary spikelet; spikelets 6–8.8 mm long; panicles with 4–15 (–18) fascicles; primary panicles usually shortly exserted and the secondary panicles partial enclosed in the

sheaths; fascicles with 15–43 spines; plants of coastal sand dunes, found in moist sand just above high tidal zone along the Gulf coastal regions, and do not extend any great distance inland.

Cenchrus brownii Roem. & Schult. is considered here as a waif and not part of the Texas flora, since it is presently only known from one historic collection from Val Verde County, Texas.

Distribution Data.—Since these re-instated taxa have long been synonymized either under *C. incertus* or *C. spinifex* more research is needed to gain a better understanding of distribution of these taxa in the eastern United States.

Keying Notes.—Morphological measurements are taken from the primary culms and terminal inflorescence. Leaf blade measurements are taken from the primary culms. Fascicle measurements are taken from mature fascicles in the mid- to lower portion of the inflorescence. The spikelet measurements are taken from the largest spikelet (the one exposed by the adaxial cleft) in a mature fascicle in the mid- to lower fascicles on the panicle axis. Immature fascicles were not measured. Spikelet length can often be determined on the adaxial side without having to remove the spikelet from the fascicle. But sometimes a knife will be needed to cut open the fascicle, please proceed carefully.

KEY FOR EASILY CONFUSED GENERA

1. Bristles persistent; disarticulation below the spikelets.
   2. Most spikelets subtended by 1+ bristles.
      3. Spikelets subtended by 1–many bristles; paleas of the lower florets usually hyaline to membranous at maturity, absent or reduced; paleal veins not keeled _____ **Setaria**
      3. Spikelets subtended by 1 bristle; paleas of the lower florets coriaceous to indurate at maturity, the keels thickened (only known from cultivation) _____ **Ixophorus**
   2. All or most spikelets not subtended by stiff bristle, but the terminal spikelet on each branch subtended by a single bristle or the primary branch axis extends beyond terminal spikelet as a sterile point.
      4. Terminal spikelet on each branch subtended by a single bristle; other spikelets occasionally with a single stiff subtending bristle; growing mostly in dry to mesic soils _____ **Setaria**
      4. Terminal spikelet not subtended by a stiff bristle, but the primary panicle branch axis extending 2.5–4 mm beyond base of distal spikelet; growing in moist to wet, fresh to brackish, areas _____ **Paspalidium**
1. Bristles falling with the spikelets at maturity; disarticulation at the base of the fascicles.
   5. Inflorescence fascicle bristles antrorsely scabrous _____ **Pennisetum**
   5. Inflorescence fascicle bristles or spines retrorsely scabrous.
      6. Bristles all similar, terete, stiff and flexible, none rigid spines; bristles all free, only fused at very base _____ **Cenchropsis**
      6. Bristles, at least some, rigid, flattened and spine-like; with or without terete bristles in the lowest whorl; inner bristles variously fused forming a shallow disk or fused up to > 1/2 their length and forming a distinct cupule _____ **Cenchrus**

KEY TO THE *CENCHRUS* S.S. SPECIES IN TEXAS

1. Lowest whorl(s) [at base of cupule] of bristles in fascicle consisting of only slender, spreading-ascending to ascending very narrow basally flattened and long terete bristles; lower whorl of slender bristles not similar to other spines of cupule _____ **C. echinatus**
1. Lowest whorl(s) [at base of cupule] of bristles in fascicle absent or present, if present, consisting of 1–3 rows of spreading to deflexed flattened spines, with short terete bristles sometimes present below lowest whorl(s) or absent; lower whorl of flattened spines (when present) similar to other spines of cupule _____ **Cenchrus spinifex** Group

KEY TO THE *CENCHRUS SPINIFEX* GROUP IN TEXAS

1. Inflorescences with 40–54 fascicles; densely crowded on inflorescence axis; culms 60–102 cm tall; perennial; central spikelet of fascicle 3.9–4.8 mm long; lower whorl (corona) of flattened spines present _____ **C. densiflorus** sp. nov.
1. Inflorescence with 3–30 fascicles; densely crowded to loosely spaced along inflorescence axis; culms 6–90 cm tall; annual or perennial; central spikelet of fascicle 3.5–7.8 mm long; lower whorl (corona) of flattened spines present or absent.
   2. Fascicles with 40–100+ spines and bristles; the lower whorl(s) of fascicle with 20+ flattened/terete spines (at base of cupule); outer spine whorls in 2–5 series, regularly or irregularly positioned around cupule.
      3. Spikelets 6.4–7.8 mm long, cupules ovoid to globose; fascicles brown (occasionally brown-purple to dark purple); spines light brown to purple _____ **C. longispinus**
      3. Spikelets 4.5–5.8 mm long, cupules globose or narrowly to broadly ellipsoid; fascicles green, stramineous, rose, red to dark purple to almost black; spines variously colored.

4. Longest inner (apical) spines ≤ 5(–6) mm long and widest inner spines ≥ 1 mm wide; lowest whorls of flattened spines and terete bristles; cupule when immature, not dark purple; cupules maturing to stramineous, light brown to red or mottled purpled, purple to black; spines stramineous, red or purple; common throughout the State ____ **C. spinifex**
4. Longest inner (apical) spines 5–7.2+ mm long and the widest inner spines < 0.9 mm wide; lowest whorls of spines all terete or very narrow when flattened; cupule when immature dark purple, maturing to rose or light rose color; spines rose to stramineous; found only along southern coast, never inland ____ **C. roseus**

2. Fascicles with 5–40 bristles; lower whorl of fascicles with 0–15 flattened spines, with or without a few short terete spines below; outer spine whorl in 1–2 series, regularly or irregularly positioned around cupule.
5. Fascicles without a lower whorl (corona) of spines at base of cupule/peduncle apex (not including the 1–2 basal adaxial cleft spines), sometimes with ridge(s) or knobs present; fascicles of 5–16 spines; spikelets 5.5–6.1 mm long ____ **C. incertus**
5. Fascicles with a well-developed lower whorl (corona) of (1–)3–10(–15) spines at base of cupule or with a few spines and a well-developed ridge; spines flattened and with or without a few short, terete spines below; fascicles of (15–)17–40 spines; spikelets 3.5–7 mm long.
6. Spikelets 3.5–5.1(–5.8) mm long; longest outer whorl spine 1.5–5.2 mm long; longest inner whorl spine 2.3–6 mm long; primary inflorescences with 3–16(–20) fascicles, loosely (to somewhat densely) and uniformly arranged along the inflorescence axes; axis usually visible the entire length; abaxial cleft in cupule present or absent, when present the cleft rarely reaching to the bottom of the cupule; cupules greenish, stramineous, light brown to red, red-dish, purplish, mottled purpled, or purple to black; spines stramineous, red, or purple; 8–40 spines, longer cauline leaf blades 7–13 cm long; annual ____ **C. spinifex**
6. Spikelets 5–7 mm long; longest outer whorl spine 4.5–5.5 mm long; longest inner whorl spine 5–6.6 mm long; primary inflorescences with (10–)15–30 fascicles, densely crowded in the upper 2/3 length of the panicle, upper panicle axis obscured, but the lowermost fascicles often widely spaced along panicle axis; abaxial cleft of cupule distinct and reaching almost to bottom of cupule; cupules green, light tan or stramineous; spines green, tan or stramine-ous, occasionally purplish or reddish; 20–30 spines, longer cauline leaf blades (7–)10–20+ cm long; perennial ____ **C. albertsonii**

TAXONOMIC TREATMENT

Cenchrus albertsonii Runyon, Amer. J. Bot. 26(7):485–486, f. 1–2. 1939. (**Figs. 2 & 3**). TYPE: U.S.A. OKLAHOMA. Harper Co.: 4 Jul 1937, *Runyon 200* (HOLOTYPE: US–1761161-image!). U.S.A. Oklahoma. Harper Co.: 4 Jul 1937, *Runyon 201 & Runyon 202* (PARATYPES: FHKSC; USA).

Perennial. **Plants** often forming dense, sprawling clumps. **Culms** (10–)20–75 cm tall/long, geniculate, spreading, ascending, rarely suberect; freely branching at lower nodes. **Internodes** 2–12 cm long. **Nodes** glabrous. **Sheaths** 4.4–8.5 cm long; apical corners pubescent. **Ligules** 0.7–2 mm long, ciliate membrane; membrane 0.1–0.3 mm long, cilia 0.6–1.8 mm long. **Cauline Leaf blades** (7–)10–20 cm long, 2–6 mm wide; narrow, flat to folded; **adaxial surface** scabridulous, basally with scattered long hairs, hairs to 3.5 mm long; **abaxial surface** glabrous; narrow white margin. **Inflorescence. Peduncles** 6–21.5 cm long, glabrous. **Primary panicles** (3–)3.6–10 cm long, 1.2–1.6 cm wide; **central axis** 3–7.2 cm long, flattened, glabrous to scabridulous; **lowermost internode** 6–9 mm long; **middle internodes** 4–5.5 mm long; **uppermost internode** 5–7.5 mm long; sterile branch extending past terminal fascicle to 1.5 mm long; 1–fascicle per node; number of **fascicles** (10–)15–30; densely crowded in the upper 2/3–entire length of the panicle, at least upper panicle axis obscured, the lowermost fascicles often widely spaced along lower panicle axis. **Fascicle** with (16–)20–35 spines; including spines, 8.5–11 mm long, (8.5–)10–15.5 mm wide, green maturing light honey brown to bright stramineous; spines occasionally light purplish. **Fascicle peduncle** 1.1–1.7 mm long, 2–3.7 mm wide at the apex, 0.5–1 mm wide at base, cuneate, apex oval, sparsely pubescent to short pubescent, puberulent; stipe at base of peduncle 0.1–0.3 mm long, 0.2–0.6 mm wide. **Cupule** (not including spines), 2.2–4.5 mm long, 3.5–5.1 mm wide, inner bristles connate, not grooved, globose to ovoid; puberulent, sparsely pubescent to pubescent; green maturing light honey brown to bright stramineous at maturity. **Adaxial cleft** present, exposing almost the entire central spikelet, (0.9–)1–2.7 mm wide; margins glabrous to long ciliate, hairs to 1 mm long. **Basal cleft spines**, 1–2 pairs [(1)2,4 spines, sometimes lowest set with only 1 spine]; lowest pair (or only pair) 0.4–3.5 mm long, 0.08–0.4 mm wide, terete or basally flattened; upper pair (when present) (1.6–)2.5–5.1 mm long, 0.2–0.4 mm wide, basally flattened; basally pubescent, stramineous. **Marginal mid-cleft spines** 2(3), (1.8–)2.3–5.5 mm long, (0.2–)0.4–0.7 mm wide; **inner spines forming adaxial cleft** (from base of cleft): 7.1–9.2 mm long; **inner spines** (from apex of cupule) 4.2–7.3 mm long, 0.6–1.2 mm wide; basally

Fig. 2. Type of *Cenchrus albertsonii* (*Runyon 200*, US). Smithsonian Open Access. Courtesy of Smithsonian Institution, National Museum of Natural History.

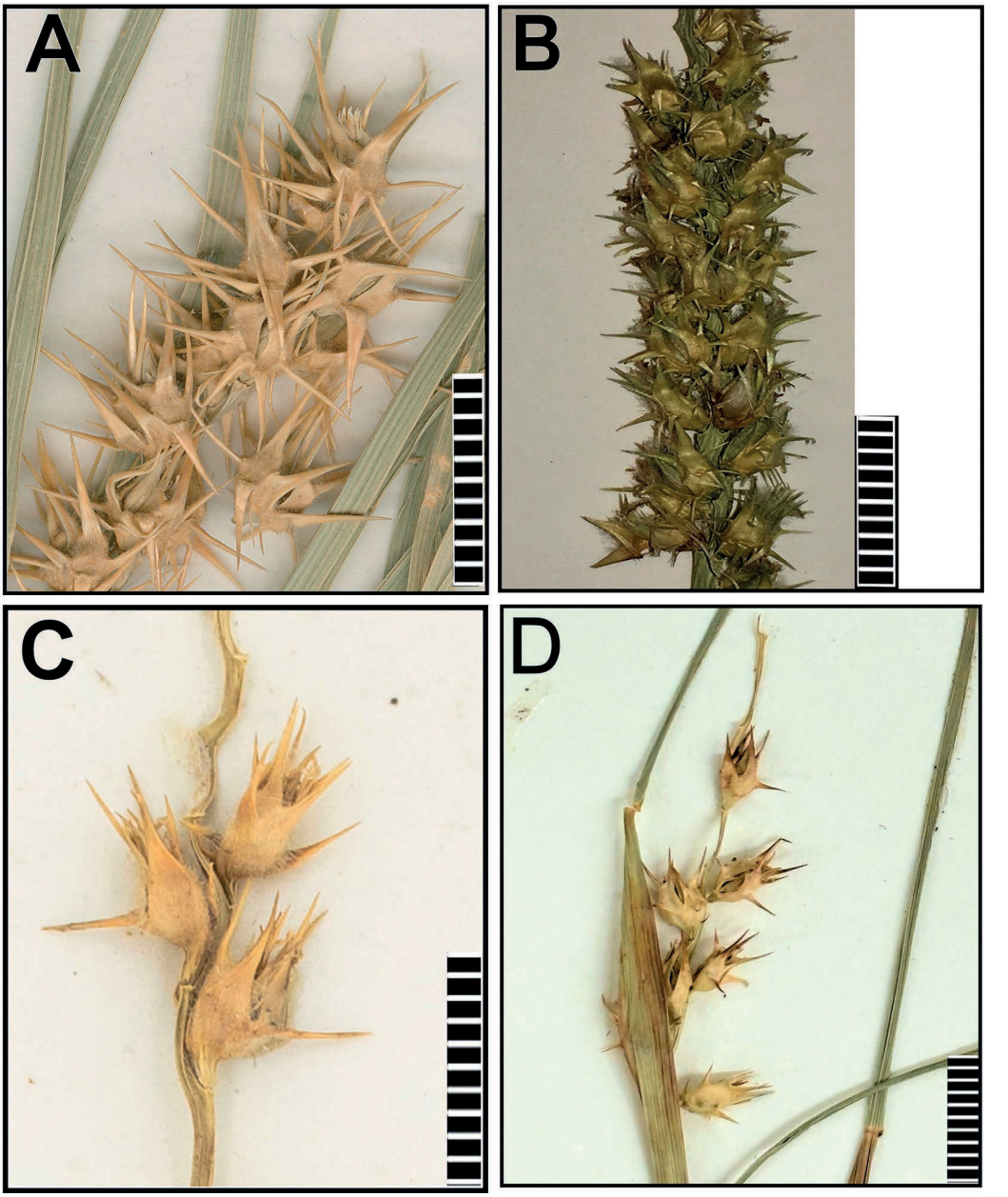

Fig. 3. Fascicles. **A.** *Cenchrus albertsonii*. Type (*Runyon 200*, US). Image courtesy of Smithsonian Open Access; Smithsonian Institution, National Museum of Natural History. **B.** *Cenchrus densiflorus*. Type (*Carr 28297*, TEX), photo by Joseph K. Wipff. **C.** *Cenchrus incertus*. Type (*Curtis s.n.*, NY). Image courtesy of the C.V. Starr Virtual Herbarium (http://sweetgum.nybg.org/science/vh/). **D.** *Cenchrus incertus*. (*Wipff 1781 & S. Jones*, TEX). Image by Joseph K. Wipff. Bar = 1 cm. Plate prepared by Annette R. Wipff.

flattened. **Abaxial cleft** deep, extending almost to the lower whorl of spines, 0.4–1.7 mm wide; clearly exposing the spikelets; margins glabrous to ciliate. Without basal or marginal spines. Abaxial cleft spines consists of only the two inner spines. **Inner spines forming abaxial cleft** (from base of cleft): 5.4–9.2 mm long; **inner spines** (from apex of cupule) 4.5–6.6 mm long, 0.7–1.3 mm wide. **SPINES. Fascicles** with (16–)20–35 spines; spines green maturing light honey brown to bright stramineous; spines occasionally light purplish. **Inner whorl of spines** (those forming the cupule) 5–8 (sometimes two of the spines are fused into one), often one is much wider than the others, 0.6–2 mm wide; **longest spine** (5–)5.3–6.6 mm long, 0.8–1.3(–2) mm wide, erect to spreading; **shortest spine** 4.2–5.5 long, 0.6–1.3 mm wide; basally flat, erect to spreading, marginal veins often green; basally usually short ciliate; hairs 0–0.7 mm long. **Outer whorl of spines (not including marginal adaxial cleft spines)** (1–)4–7, arranged in 1-whorl; **longest spine** (4.5–)4.7–5.5 mm long, 0.5–2 mm wide; **shortest spine** 3.1–5 long, 0.5–1.5 mm wide; basally flattened, spreading, basally glabrous to ciliate. Terete bristles absent. **Lower (corona) whorl(s) of basally flattened spines** 6–14; arranged in 1-whorl; **longest spine** 3–5 mm long, 0.5–1.7 mm wide; **shortest spine** 0.3–2.2 long, 0.15–0.3 mm wide; basally flattened, spreading to deflexed, basally glabrous to ciliate. **Terete bristles subtending the corona usually absent.** But when present, 1–4, **longest bristle** 0.2–1.7 mm long, 0.05–0.15 mm wide; **shortest bristle** 0.2–0.5 long, ± 0.05 mm wide. **Spikelets** (1,2)3 per fascicle. **Spikelet** 5–7 mm long, 1.7–2 mm wide, glabrous. **Lower glume** 2–3.5 mm long, 0.6–1 mm wide, 1-veined, membranous, acuminate. **Upper glume** 4.2–6.6 mm long, 1.6–2.2 mm wide, (3)4,5-veined, thin chartaceous, acute. **LOWER FLORET** staminate; anthers 3, 1.5–1.9 mm long. **Lower lemma** 4.9–6.8 mm long, 1.5–2 mm wide, (3,4)5-veined, thin chartaceous, acuminate/acute. **Lower palea** 4.4–6.7 mm long, 0.8–1.1 mm wide, membranous. **UPPER FLORET. Upper lemma** 4.9–6.9 mm long, 1.4–2 mm wide, 5-veined, coriaceous. **Upper palea** 4.5–6.5 mm long, 1.4–2 mm wide, coriaceous, acuminate. **Anthers** 3, 0.6–0.9 mm long. **Caryopsis** 2.5–3.2 mm long, 1.3–2 mm wide. **Chromosome number** 2*n* = unknown.

Flowering period.—Summer to Fall.

Habitat.—Growing in disturbed, usually sandy soil. Native.

Distribution.—Western Louisiana, Oklahoma, Texas, New Mexico, and Arizona; northern Mexico.

Texas Distribution.—Northwestern 2/3 of the State (**Fig. 4**).

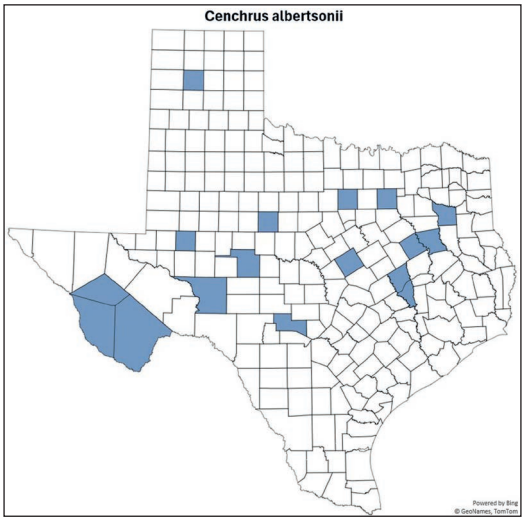

Fig. 4. Current county–level distribution of *Cenchrus albertsonii* in Texas.

Though long considered a synonym of *C. spinifex*, this species is quite distinct. *Cenchrus albertsonii* is a perennial usually forming dense clumps with much longer, narrow leaves; the longer cauline leaf blades 10–20 cm long; primary inflorescences with (10–)15–30 fascicles, densely crowded in the upper 2/3 length of the panicle, upper panicle axis obscured, but the lowermost fascicles often widely spaced along panicle axis; abaxial cleft of cupule distinct and reaching almost to bottom of cupule; cupules green, light tan or stramineous; spines green, tan or stramineous, occasionally purplish or reddish; (16–)20–35 spines; spikelets 5–7 mm long.

Cenchrus densiflorus Wipff, **sp. nov.** (**Figs. 3 & 5**). TYPE: U.S.A. TEXAS. Kenedy Co.: rare in openings in live oak-mesquite woodland on partially stabilized inland dunes of South Texas Holocene Sand Sheet, 500 ft N of Turcotte Road ca. 8 mi E of its gate on US Rt. 77, ca. 1.8–1.9 air mi W of San Antonio Windmill, ca. 1.1–1.2 air mi NE to ENE of Rodeo Windmill, at N26°56°40.1″, W097°40°59.8″; Kenedy Ranch, San Pedro Ranch Quadrangle, elev. 25–40 ft; associates: *Acalypha radian*, *Croton capitatus*, *Dichanthelium nodatum*, *Lantana urticoides*, *Malvaviscus arboreus*, *Opuntia lindheimeri*, *Prosopis glandulosa*, *Quercus fusiformis*, *Tillandsia baileyi*, *Vitis mustangensis,* 15 Jul 1990, *W.R. Carr 28297 & A. Treuer–Kuehn* (HOLOTYPE: TEX–00434892!).

Diagnosis.—Similar to *Cenchrus spinifex*, but *C. densiflorus* differs by having many more fascicles (40–54) that are densely arranged on the longer inflorescence (8–10 cm long) axes; plants perennial; and much taller in height (60–102 cm). *Cenchrus spinifex* has 3–16(–25) fascicles per inflorescence, that are loosely arranged along a shorter inflorescence [1.4–7(–8.5) cm long] axes; plants annual; and much shorter [6–50(–64) cm tall].

Description.—Perennial. **Plants** cespitose, without rhizomes. **Culms** 60–102 cm tall, erect to decumbent; branching at the lower nodes. **Culm internodes** 3–15 cm long, 1.5–2.5 mm wide, glabrous. **Nodes** 6–12, glabrous, yellowish to brown, glabrous. **Sheaths**, cauline, 5–9 cm long; lower glabrous, distally ciliate, hairs to 2.5 mm long. **Collars** pubescent at corners, hairs to 2.5 mm long. **Uppermost sheaths** 15–18 cm long. **Ligules** 0.5–1 mm long, ciliate membrane; membranous rim 0.2–0.3 mm long, cilia 0.3–0.8 mm long. **Cauline leaf blades**, 2nd and 3rd uppermost blades: 12–25 cm long, 2.5–3 mm wide, folded or flat; abaxially glabrous, adaxially with scattered long hairs to 2.1 mm long. **Upper most leaf blades** (12–)14–30 cm long, 3–5 mm wide. **Inflorescence. Peduncles** 16–27 cm long, **Inflorescences** exserted. **Panicles** 8–10 cm long, 0.9–1.2 cm wide; with 40–54 fascicles, imbricate, densely crowded along the inflorescence axes, the axis not visible the entire length; with 1(rarely 2) fascicles per node; **central axis** 7.5–9.5 cm long, compressed and angled, edges scabridulous; **lowermost internode** 6–11 mm long; inflorescence axes terminated with a sterile branch 2–5 mm long; **middle internodes** 0.5–3 mm long; **uppermost internode** 1.3–5 mm long. **Fascicles** with 22–68 spines; including spines, 5–7.5 mm long, 4–9.5 mm wide; light green to stramineous. **Peduncle** 0.2–1.2 mm long, 0.6–2.7 mm wide at the apex, apex flared; tumid, turbinate, obconic, or wedge-shaped; glabrous to puberulent, usually straight; with or without a small stipe-like structure at the base, when present, the **peduncle stipe** 0.1–0.4 mm long, 0.3–0.6 mm wide, straight or slightly angled. The abaxial side of the peduncle is usually longer than the adaxial side length. **Cupules**, not including spines, 1–3.5 mm long, 2.5–4.5 mm wide, globose to ellipsoid to wider than long; sparsely to densely short pubescent; light green to stramineous. **Adaxial cleft**, usually exposing the entire spikelet, 1–2.7 mm wide, margins glabrous to ciliate; **basal cleft spines** 2, ascending; 1–2.5 mm long; 0.15–0.3 mm wide, basally flattened to terete; **marginal mid-cleft** spines 2(3), 1–2.5 mm long, 0.2–0.4(–0.6) mm wide, basally flattened; **inner spines forming adaxial cleft** (from base of cleft): 3–5.7 mm long; **inner spines** (from top of cupule): 1.2–2.7 mm long, 0.4–0.9 mm wide. **Abaxial cleft** usually present; when present, 0.5–1.7 mm wide, shallow to deep; **basal spine** absent; **marginal spine** 0(2), rarely present, when present 1.6–2 mm long, 0.4–0.5 mm wide; margins glabrous to ciliate; **inner spines forming abaxial cleft, when present,** (from base of cleft): 2.5–5.5 mm long; **inner spines** (from apex of cupule): 1.9–3.1 mm long, 0.4–1.1 mm wide. **SPINES. Fascicles** with 22–68 spines, spines vary from basally flattened and wide to narrow, to terete (or almost so); greenish to stramineous. **Inner whorl of spines** 6–9; 1–3.2 mm long, 0.3–1.2 mm wide, erect; basally flat, flattened to narrow flattened to almost terete; marginal veins often green, stramineous, basally sparsely short to long ciliate. **Outer whorl of spines (not including marginal adaxial cleft spines)** 8–30, in a series of 1–3 distinct or irregular whorls; 1–2.6 mm long, (0.1–)0.3–1.7 mm wide; basally flat, flattened to narrow flattened to almost terete (rarely terete), spreading, basally sparsely ciliate. **Lower (corona) whorl(s) of basally flat spines and terete bristles** 4–30; 1–2 whorls (whorls sometimes irregular around cupule); terete spines, when present, intermixed with the flattened spines and/or subtending the whorl of basally flattened/terete spines; **basally flattened spines** 2–15; 0.5–2.5 mm long, (0.1–)0.2–0.8 mm wide; ascending, spreading to deflexed; **terete bristles** 0–17; 0.2–1.4 mm long, 0.05–0.1 mm wide; ascending to deflexed. **Spikelets** 1,2(3) per fascicle. **Spikelet** 3.9–4.8 mm long, 1.2–1.7 mm wide, glabrous. **Lower glume** 1.6–2.0 mm long, 0.5–0.7 mm wide, 1-veined, membranous. **Upper glume** 3.2–3.8 mm long, 1.4–1.6 mm wide, 3,5-veined, chartaceous. **Lower**

Fig. 5. Type of *Cenchrus densiflorus* (*Carr 28297*, TEX). Image by Joseph K. Wipff.

floret staminate; **anthers** 3, 1.7–2.5 mm long. **Lower lemma** 4.2–4.5 mm long, 1.5–1.7 mm wide, 5.7-veined, chartaceous. **Lower palea** 4.2–4.6 mm long, 0.8–1 mm wide, membranous. **Upper lemma** (3.5–)4–4.6 mm long, 1.2–1.7 mm wide, 5-veined, coriaceous. **Upper palea** (3.4–)3.9–4.5 mm long, coriaceous. **Anthers** 3, 1.7–1.8 mm long. **Chromosome number** $2n = 34$ [*DeLisle 923* (DeLisle 1964)].

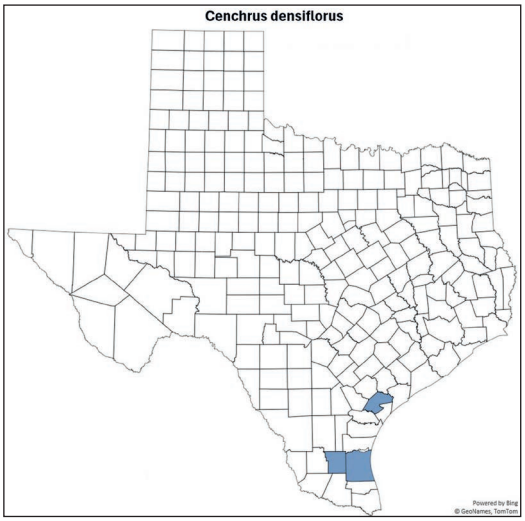

Fig. 6. Current county–level distribution of *Cenchrus densiflorus* in Texas.

Flowering period.—July–September.

Habitat.—Growing in dry, deep, coastal prairie sands; in open areas around oak mottes and in openings of oak-mesquite woodlands. Native.

Distribution.—Only known from the Texas Coastal Sand Plain (South Texas Sand Sheet) and Southern Subhumid Gulf Coastal Prairies Ecoregions (Brown et al. 1975; Brewton et al. 1976; Griffiths et al. 2007; Poole et al. 2007) (**Fig. 6**). Rare.

Etymology.—The epithet "*densiflorus*" refers to numerous small fascicles on the inflorescence.

Other Specimens Examined (Paratypes). **TEXAS. Brooks Co.:** in sandy soil in vicinity of gypsum quarry several mi SE of Falfurrias, 10 Jul 1957, *Correll 17836 & Johnston* (LL). **Kenedy Co.:** U.S. Hwy 77, 1 mi S of Sarita, 13 Jul 1963, *DeLisle 923* (TEX); loose sand in live oak motte a few miles E of Rancho Nuevo, Norias Division of King Ranch, 16 Sep 1954, *Johnston 541584* (TEX). **Refugio Co.:** occasional grass in sandy soil at W side of Hwy 77 near La Rosa Creek, ungrazed pasture, entrance to Bull Traps, 1.8 mi N of FM 2441, Woodsboro, 24 Sep 1978, *Hill 7938* (TAES).

This perennial species is currently only known from, and adjacent to, the Texas Sand Sheet in the southern Coastal Bend.

Cenchrus incertus M.A. Curtis, Boston J. Nat. Hist. 1(2):135–136. 1835 (May). (**Figs. 3, 7, 8**) Type: U.S.A. North Carolina: at Smithville in cultivated fields, near the mouth of the Cape Fear River, S of Wilmington, *M.A. Curtis s.n.* (holotype: NY 00380381–image!; isotype: US 865740–image! (fragm. & photo ex NY)).

Perennial (sometimes short-lived). **Plants** cespitose; rhizomes absent. **Culms** 30–63 cm tall, erect, decumbent; branching at the lower nodes, sometimes rooting at lower nodes. **Internodes** 0.7–4.5 cm long, 1.3–2.2 wide, glabrous. **Nodes** 5–8, glabrous. **Sheaths** 3–8 cm long; lower glabrous, upper ciliate. **Collar** conspicuous, corner usually densely ciliate, hairs to 1.5 mm long. **Ligules** 0.8–1.3 mm long, ciliate membrane; membranous rim 0.1–0.3 mm long, cilia 0.7–1 mm long. **Leaf blades** (5–)10–29 cm long, 1.9–4.5 mm wide, flat or folded; **adaxial surface** with scattered long hairs, hairs to 5 mm long; abaxial surface glabrous; narrow white margin. **Inflorescence. Peduncle** 4–27 cm long, 0.6–1.5 mm wide, glabrous to scabridulous, or pubescent distally. **Inflorescences** exserted; axillary panicles often present or absent; panicles exserted or partially enclosed in sheaths. **Panicles** 3.5–6 cm long, 0.9–1.5 cm wide; with (4)8–19 fascicles, loosely arranged along the panicle axes; axis visible the entire length, scabrous, with or with puberulent pubescence; **central axis** 2.5–5.6 cm long, 0.9–1.1 mm wide, with (4)8–19 nodes, with 1–fascicle per node; flattened, angled to narrowly winged, antrorsely scabridulous to pubescent; **lowermost internode** 4–13.5 mm long; **middle internodes** 1.5–6 mm long; **uppermost internode** (3–) 4.3–8.5 mm long; terminated with a **sterile branch** 0.3–3.8 mm long. **Fascicles** with 5–16 spines; including spines, 6.5–10.2 mm long, 4.7–9.5 mm wide, light brown to stramineous. **Fascicle peduncle** (1–)1.7–2.8 mm long; **apex** 1.5–2.6 mm wide, flared, tumid, glabrous, smooth or wrinkled, often shiny; stramineous; the **peduncle** constricted basally forming a conspicuous, large **peduncle stipe**, 1–2 mm long; distally 0.9–1.5 mm wide; proximally 0.5–0.8 mm wide, longitudinally wrinkled, glabrous, puberulent or scabridulous. **Cupules**, not including spines, 2–5 mm long, 3–4 mm wide, ovoid to ellipsoid (globose); almost glabrous or sparsely to densely pubescent, hair to 1 mm long; stramineous, tan, light

Fig. 7. Type of *Cenchrus incertus* (*Curtis s.n.*, NY) on left. Image courtesy of the C. V. Starr Virtual Herbarium (http://sweetgum.nybg.org/science/vh/). On right is a collection of *C. tribuloides*.

Fig. 8. Texas collection of *Cenchrus incertus* (*Wipff 1732 & S. Jones*, TEX). Image by Joseph K. Wipff.

brown and sometimes with small purplish spots. **Adaxial cleft**, 1–1.7(–2.5) mm wide, exposing the central spikelet; glabrous to ciliate, hair to 1.3 mm long; **basal cleft spines** 0–2; (0.1–)0.5–2.1mm long, basally (0.05–)0.1–0.3 mm wide, usually basally flattened (sometimes terete), light brown to stramineous; **marginal mid-cleft** spines (1)2–3 ascending; 1.2–2.4(–3) mm long, basally 0.2–0.6 mm wide, basally flattened, glabrous to basally ciliate, light brown to stramineous; **inner spines forming adaxial cleft** (from base of cleft): 5.4–7 mm long; **inner spines** (from apex of cupule): 2.5–4.3 mm long, 0.7–1.4 mm wide, basally glabrous, short pubescent to ciliate, stramineous or light brown. **Abaxial cleft** absent or present; when present, 0.3–1.1 mm wide; without marginal spines; **base of cleft**: outer spines below (adjacent to) the base of the cleft, on either side of base of the cleft, present or absent, if present only 1 spine, 1–3.3 mm long, 0.3–1.1 mm wide, usually glabrous; **inner spines forming abaxial cleft** (from base of cleft): (3.5–)4.2–7.4 mm long, **inner spines** (from apex of cupule): 2.3–4.5 mm long, 0.5–1.1 mm wide, basally glabrous or short pubescent, stramineous or light brown. **SPINES. Fascicles** with 5–16 spines; light brown, tan to stramineous, basally flattened. **Inner whorl of spines** 3–6; (1.5–)2–4.5 mm long, 0.5–1.2 mm wide, basally flattened, **longest spine** 3.7–4.5 mm long; **widest spine**, 1–1.2 mm wide, erect (spreading); glabrous, sparsely to densely pubescent, margins glabrous or ciliate, hair to 1.5 mm long. **Outer whorl of spines (not including marginal adaxial cleft spines)** (1)3–6, in 1–whorl; 1–4 mm long, 0.4–1(–1.5) mm wide, basally flattened, erect-ascending to spreading (some often patent), glabrous or basally ciliate; stramineous, brown to purple tipped. **Lower (corona) whorl(s) of basally flat spines and terete bristles** 0 (very rarely 1); spines reduced to a ridge(s) and small protuberances [very rarely a small flat spine (to 3 mm long) present on the abaxial side]. **Spikelets** (1)2 per fascicle. **Spikelets** 5.5–6.1 mm long, 1.7–2.1 mm wide, glabrous. **Lower glume** 3–3.5 mm long, 0.9–1.2 mm wide, 1-veined, membranous. **Upper glume** (4.6–)4.8–5.3 mm long, 1.7–2.2 mm wide, (3)5,6-veined, chartaceous. **Lower floret** neuter. **Lower lemma** 5–5.7 mm long, 1.7–2 mm wide, 5-veined, chartaceous. **Lower palea** present (rarely absent), 5.2–5.4 mm long, ±1.3 mm wide, membranous. **Upper lemma** 5.4–6 mm long, (1.7–)2–2.3 mm wide, 5-veined, coriaceous. **Upper palea** 4.5–5.5 mm long, 1.7–2 mm wide coriaceous. **Anthers** 3, ± 0.7 mm long; yellow. **Chromosome number** $2n$ = unknown.

Flowering period.—July–October.

Habitat.—Growing in, often deep, sandy soils; disturbed open to wooded uplands. Native.

Distribution.—Coastal Plain Southeastern U.S.

Texas Distribution.—eastern 1/3 of the State (**Fig 9**).

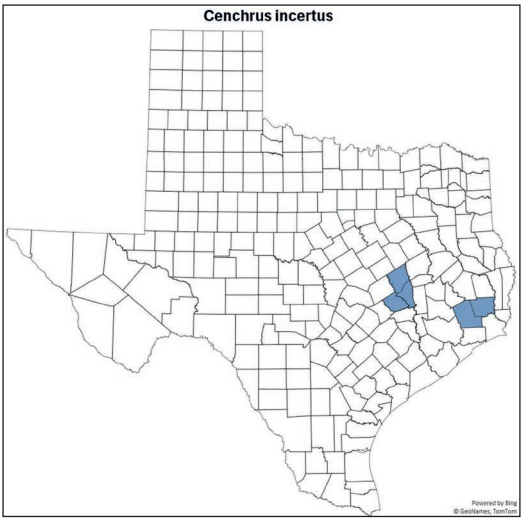

Fig. 9. Current county–level distribution of *Cenchrus incertus* in Texas.

Uncommon. A very distinctive species found in sandy woodland areas. It is distinguished by the absence of the lower whorl of spines; a low outer whorl spine number; and the fascicle peduncle with a distinct stipe 1–2 mm long. This species is related to *C. strictus* Chapm. (currently only documented from coastal South Carolina to Florida) which also has absent lower whorl (corona) of spines and the fascicle peduncle with a distinct stipe 1–2.8 mm long.

Cenchrus longispinus (Hack.) Fernald, Rhodora 45(538):388. 1943. (**Figs. 1, 10, 12**). *Cenchrus echinatus* fo. *longispina* Hack. Allg. Bot. Z. Syst. 9:169. 1903. *Cenchrus pauciflorus* var. *longispinus* (Hack.) Jansen & Wacht., Ned. Kruidk. Arch. 56:246. 1949. TYPE: U.S.A. CONNECTICUT: Oxford, 13 Aug 1902, *Harger 426* (LECTOTYPE: ISC 227735–image!, designated by DeLisle, Iowa State J. Sci. 37:298, 1963; listed as "Kneucker 426" = *Harger 426*); ISOLECTOTYPES: B 10–0278945–image!; B 10–0278946–image!; BAF 00000095–image!; BM 001042457–image!; MO 1760438–image!; MO 2885641–image!; S 14–20228–image!; US 557281–image!; W 1916–0016575–image!).

Annual. **Plants** often forming large spreading clumps with many branches. **Culms** 10–90 cm tall, cespitose, erect, decumbent or geniculate; branching at lower nodes. **Internodes** 0.3–7 cm long, lower 2–3 wide, upper 1.3–1.8 mm wide, glabrous. **Nodes** (1.9–)2–5.5 mm wide, glabrous, usually dark. **Sheaths** 3–8.5 cm long, strongly compressed-keeled, pilose on the margins and at the throat. **Ligules** 0.7–1.8 mm long, ciliate membrane; membrane 0.2–0.3 mm long, cilia 0.5–1.5 mm long. **Leaf blades** 6.3–18.7 cm long, 3–7.2 mm wide; adaxial surface scabridulous; abaxial surface glabrous. **Inflorescence. Peduncles** 5–16.4 cm long, 0.8–1.3 mm wide, ribbed, apex antrorsely scabridulous. **Inflorescences** terminal and axillary; exserted or partially enclosed in the sheath. **Panicles** 4–10.2 cm long, 1.2–2.2 cm wide, with 10–23 fascicles; **panicle axis** 3.5–8 cm long, 0.8–1.5 mm wide, angled, flexuous, and glabrous or more often scabridulous to minutely pubescent, inflorescence axes terminated with a **sterile branch** 1–2.1 mm long; panicle axis internodes: **lowermost internode** (5–)6–13 mm long; **middle internodes** 1–6 mm long; **uppermost internode** 2–4.7 mm long. **Fascicles per node**, 1; fascicles crowded along the inflorescence axes. **Fascicles** with 69–102 spines; including spines, 9–13.5 mm long, 12–15 mm wide, stramineous, light brown to golden brown, tip of spines often purple or purplish. **Fascicle peduncle** 1.2–2.8 mm long; mostly cuneate, stramineous, puberulent; **apex** 1.5–2 × 3–4.5 mm, flared; **peduncles** constricted basally forming a stipe, **stipe** 0.5–1.8 mm long; distally 0.7–2 mm wide; proximally 0.3–0.7 mm wide. **Cupules**, not including spines, 2–5.2 mm long, 5–8.3 mm wide; ovoid, ellipsoid, or globose; sparsely to densely pubescent, hair to 1 mm long; stramineous, tan, sometimes with small purplish dots. **Adaxially cleft**, 0.8–1.6 mm wide, exposing the central spikelet; margins papillose pubescent; **basal cleft spines** (3)4, ascending; 2.5–5.6 mm long, basally 0.4–0.9 mm wide, basally flattened (sometimes terete), light brown to stramineous; **marginal mid-cleft** spines 1–2(3); 4–5.3 mm long, basally 0.5–1 mm wide, basally flattened, glabrous to basally ciliate, light brown to stramineous; **inner spines forming adaxial cleft** (from base of cleft): 6–9.6 mm long; **inner spines** (from apex of cupule): 4.1–7 mm long, 0.7–1.8 mm wide, basally papillose pubescent, stramineous or light brown, tips usually purple. **Abaxially cleft** absent or present; when present, 1–1.8 mm wide; **base of cleft** with 2(1) spines on either side of cleft, 2.7–5 mm long, 0.7–1.5 mm wide; **marginal spines** 1, 4.6–5.2 mm long, 0.7–0.8 mm wide; **inner spines forming abaxial cleft** (from base of cleft): 7–8 mm long, **inner spines** (from apex of cupule): 5–5.7 mm long, 0.7–1.2 mm wide, basally papillose pubescent, stramineous or light brown, tips purplish. **SPINES. Fascicles** with 69–102 spines; light brown, tan to stramineous, basally flattened or terete, tips stramineous to purple. **Inner whorl of spines** 6–10; 4–7 mm long, 0.5–2.5 mm wide; erect, ascending to spreading; basally flattened, basally papillose-pilose, hair to 1.5 mm long; tips purple; **longest spine** 5–7 mm long; 0.7–2.5 mm wide. **Outer whorl of spines (not including marginal adaxial cleft spines)** 17–30, in a series of 2–3, distinct or irregular, whorls; spines 2.7–6.2 mm long, 0.4–1.3 mm wide, basally flattened, erect–ascending to spreading (some often patent), base usually pubescent; stramineous, brown to purple tipped. **Lower (corona) whorl(s) of basally flat spines and terete bristles** 37–59, in a series of 2, distinct or irregular whorls of basally flattened spines above and terete below; **basally flattened spines** 14–35, 4–5 mm long, 0.4–0.7 mm wide, spreading to deflexed; **terete spines/bristles** 16–37, 0.2–3 mm long, 0.05–0.2 mm wide, mostly deflexed. **Spikelets,** 2–4 per fascicle. **Spikelet** 6.4–7.8 mm long, 2.3–3 mm wide, glabrous. **Lower glume** (1.5–)2.5–3.8 mm long, 1–1.5 mm wide, 1-veined, membranous. **Upper glume** 5–6.5 mm long, 2.5–2.5 mm wide; 5(6)-veined, membranous/thin-chartaceous. **Lower florets** staminate; anthers 3, 1.8–2 mm long. **Lower lemma** 5.8–6.5 mm long, 2.3–2.5 mm wide; (4)5,7-veined, thin-chartaceous. **Lower palea** 6.2–6.9 mm long, 1–1.3 mm wide, narrow, membranous; longer than the lemma, 0.1–0.7 mm longer than the lower lemma; distally puberulent between the 2-veins. **Upper lemma** 6.2–7.7 mm long, 2.2–3 mm wide, 5-veined,

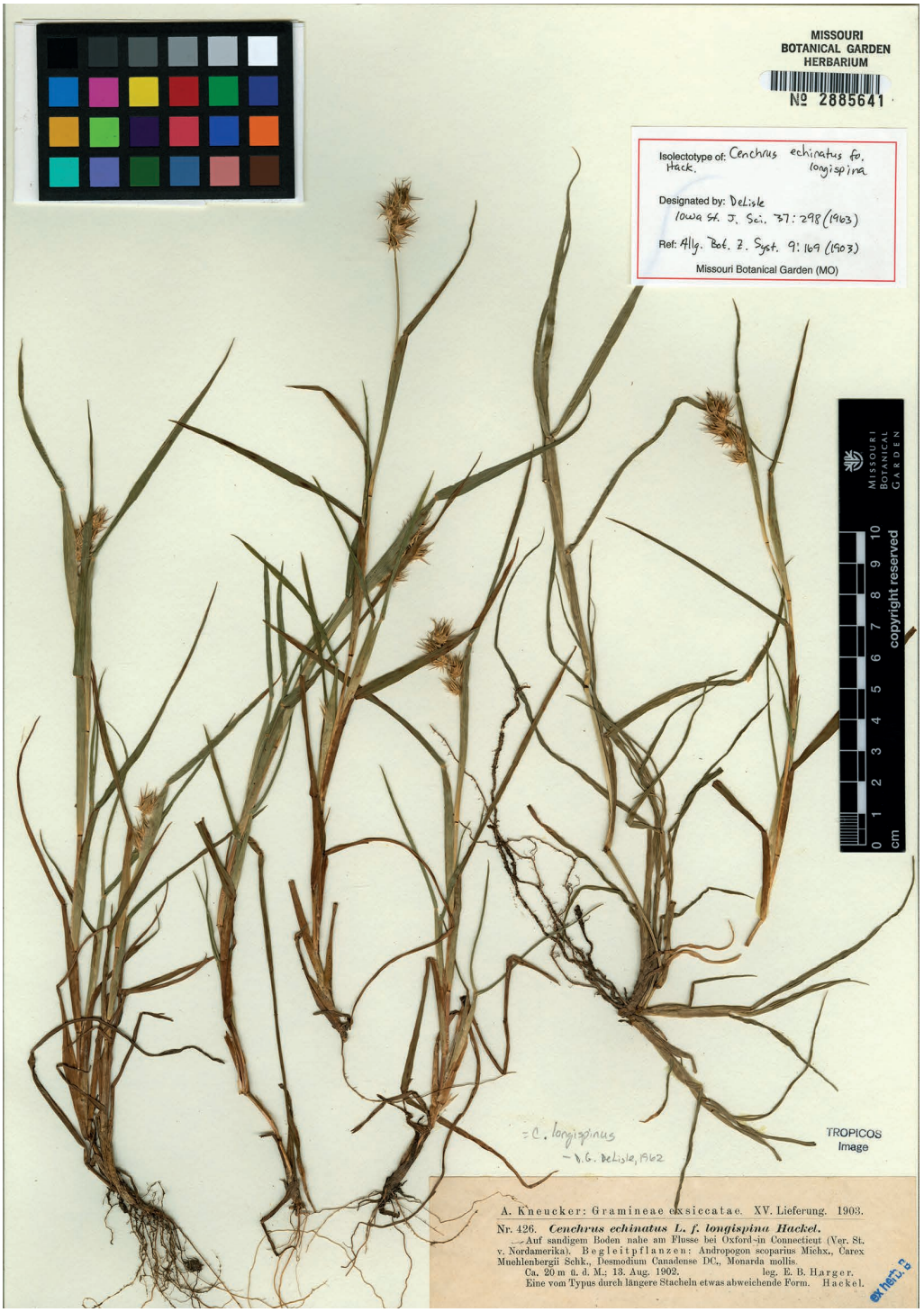

Fig. 10. Type of *Cenchrus longispinus* (*Harger 426,* MO). Image courtesy of Tropicos.org. Missouri Botanical Garden. 10 Oct 2025 https://tropicos.org/image/14372 ©2025 Missouri Botanical Garden.

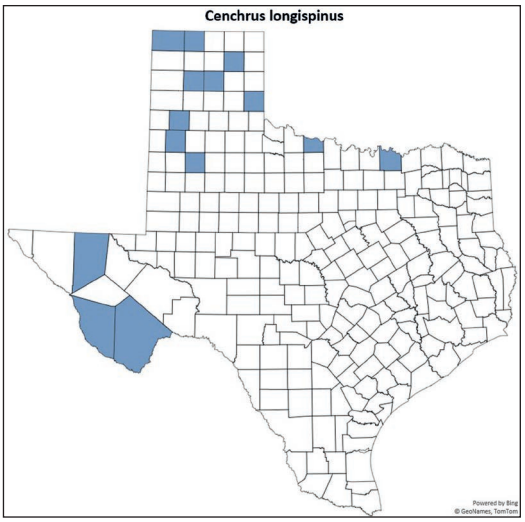

Fig. 11. Current county–level distribution of *Cenchrus longispinus* in Texas.

chartaceous, apex acuminate to long acuminate, distally scabridulous, margins flat. **Upper palea** 5.4–6.2 mm long, 2.3–2.8 mm wide, similar to upper lemma. **Anthers** 3, 0.8–1.1 mm long. **Caryopsis** 3.2–3.8 mm long, 2–2.6 mm wide. ***Chromosome number.—***2*n* = 34 (Gould 1958; DeLisle 1963, 1964).

Flowering period.—July–October.

Habitat.—Growing in mostly sandy, recently disturbed soils; fields, roadsides, and other disturbed areas. Often occurs in localized areas and can be locally abundant. Native.

Distribution.—N. America; has been introduced into other parts of the world. Often occurs in localized areas throughout its range.

Texas distribution.—western and north Texas (**Fig. 11**).

In Texas, *Cenchrus longispinus* has been confused with a form of *C. spinifex* that has up to 72 spines in a fascicle, but *C. longispinus* can be easily separated by its much longer spikelet length (6.4–7.8 mm long vs. 4.5–5.1(–5.8) mm long), its often much longer spines and higher spine number.

Cenchrus roseus E. Fourn., Mexic. Pl. 2:50. 1886. (**Figs. 12, 13, 14**). Type: MÉXICO: Veracruz: 28 Jul 1865, *Gouin 43* (lectotype: P 00642068–image!, designated by Gutiérrez & Morrone, Bol. Soc. Argent. Bot. 47(1–2):267. 2012; isolectotype: US 865724–image! Fragm. ex P). México: Veracruz: 22 Oct 1865, *Gouin 42* (syntype: P 00642069–image!; US 865723–image! Fragm. ex P).

Annual. **Plants** loosely cespitose. **Culms** 15–35 cm tall; decumbent to long decumbent, branching at lower nodes, rooting a lower nodes; aerial culms erect. **Internodes** 2.5–6.5 cm long, glabrous. **Nodes** glabrous. **Sheaths** 4–11.8 cm long. **Ligules** ca. 1 mm, ciliate membrane. **Leaf blades** 6–11 cm long, (0.5–)1.4–3.5 mm wide, folded or flat; usually abaxially glabrous. **Inflorescence. Peduncles** 8.5–11.5 cm long. **Inflorescence** exserted. **Panicles** 3–4.6 cm long, 1.2–1.5 cm wide; with 5–12 fascicles, loosely to somewhat densely arranged along the inflorescence axes; panicle axis mostly visible the entire length; glabrous, scabrous; with 1-fascicle per node; **lowermost internodes** 4–7 mm long; **middle internodes** 2.5–5 mm long.

Fascicles 64–100+ spines/bristles, including spines: 8–10.2 mm long, 12–14 mm wide. **Fascicle peduncles** 0.8–1 mm long, 2.5–3 mm wide at widest point; apex area 2 × 2.5–3 mm, oval, glabrous to sparsely pubescent; base of peduncle 0.5–0.6 mm wide; the **peduncle stipe** 0.1–0.15 mm long, 0.5–0.6 mm wide. **Cupules** 3–4.5 mm long, 3.8–4.7 mm wide, broadly ellipsoid to slightly prolate spheroid; sparsely to densely short pubescent; when immature dark purple to dark reddish-purple, but maturing to a rose or light rose color. **Adaxially cleft,** 0.8–0.9 mm wide, narrow, margins glabrous; **basal cleft spines** usually 4, in 2-pairs, spines ascending; **lowest pair spines** 2–3 mm long; 0.15–0.2 mm wide, basally flattened to terete, **second pair of basal spines** 3.6–4 mm long, 0.3–0.4 mm wide, basally flattened to terete; **marginal mid-cleft** spines 2, 3–4.2 mm long, 0.3–0.4 mm wide, basally flattened, becoming terete; **inner spines forming adaxial cleft** (from base of cleft): 6–7 mm long; **inner spines** (from top of cupule): 4.5–5 mm long, 0.6–0.9 mm wide. **Abaxially cleft** usually present; when present, 0.7–0.9 mm wide, narrow; **basal spines** absent; **marginal spines** absent; **inner spines forming abaxial cleft, when present,** (from base of cleft): 5.2–7.6 mm long; **inner spines** (from apex of cupule): 5–6 mm long, 0.7–0.9 mm wide. **SPINES. Fascicles** with 64–100+ spines, **Spines** narrow, long, stramineous and portions variously purple to rose in color. **Inner whorl of spines** 6–8, 5–7.2+ mm long, 0.3–0.9 mm wide, erect to spreading, basally short ciliate. **Outer whorl of spines (not including marginal adaxial cleft spines)** 27–40, 3.5–7.2 mm long, 0.2–0.6(–0.85) mm wide, spreading, in a series of 3–5 distinct or

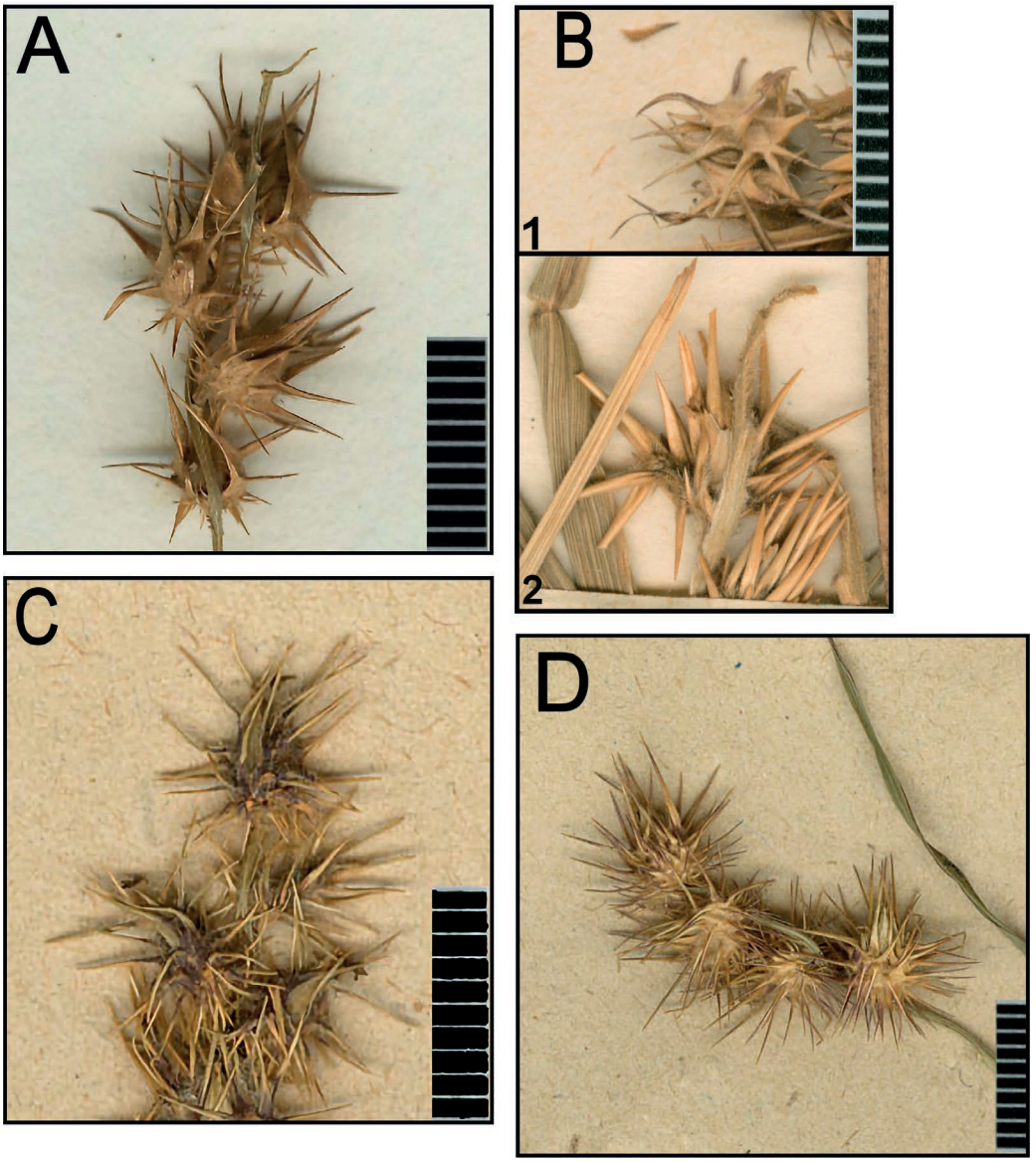

Fig. 12. Fascicles. **A.** *Cenchrus longispinus*. Type (*Harger 426,* MO). Image courtesy of Tropicos.org. Missouri Botanical Garden. 10 Oct 2025 https://tropicos.org/image/14372 ©2025 Missouri Botanical Garden . **B.** *Cenchrus spinifex*. Type [*Née s.n* (MA 475505)]. Courtesy of "Herbario del Real Jardin Botanico, CSIC, © RJB–CSIC." B1. Fascicle from fragment packet. B2. Immature fascicle on plant. **C.** *Cenchrus roseus*. Type [*Gouin 43* (P 00642068)]. Courtesy of the "Herbarium collection (P/PC/PAT), MNHN–Paris, France." Immature fascicles. **D.** *Cenchrus roseus*. Syntype [*Gouin 42* (P 00642069)]. Courtesy of the "Herbarium collection (P/PC/PAT), MNHN–Paris, France." Bar = 1 cm. Plate prepared by Annette R. Wipff.

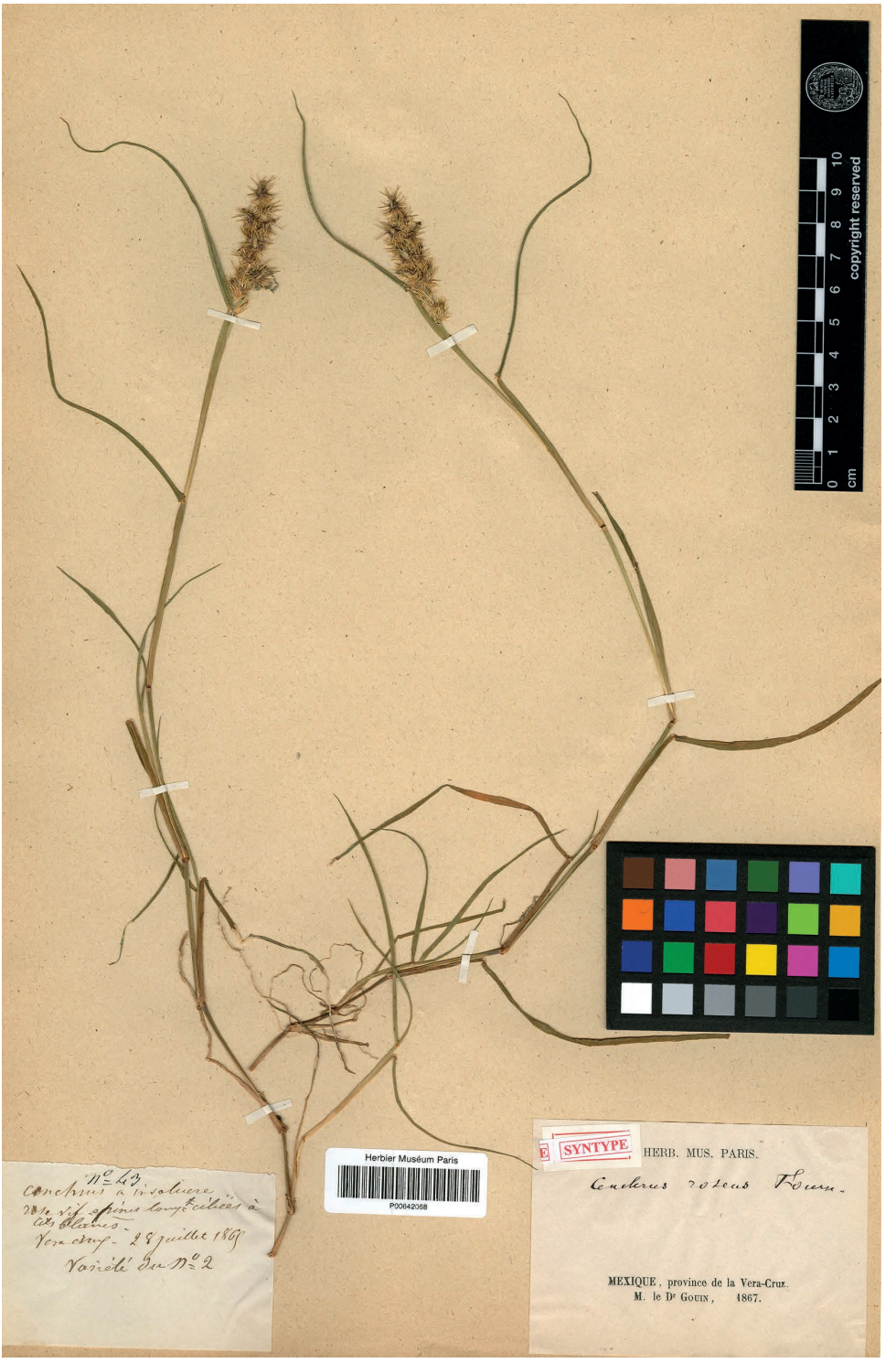

Fig. 13. Type of *Cenchrus roseus* [*Gouin 43* (P 00642068)]. Courtesy of the "Herbarium collection (P/PC/PAT), MNHN–Paris, France."

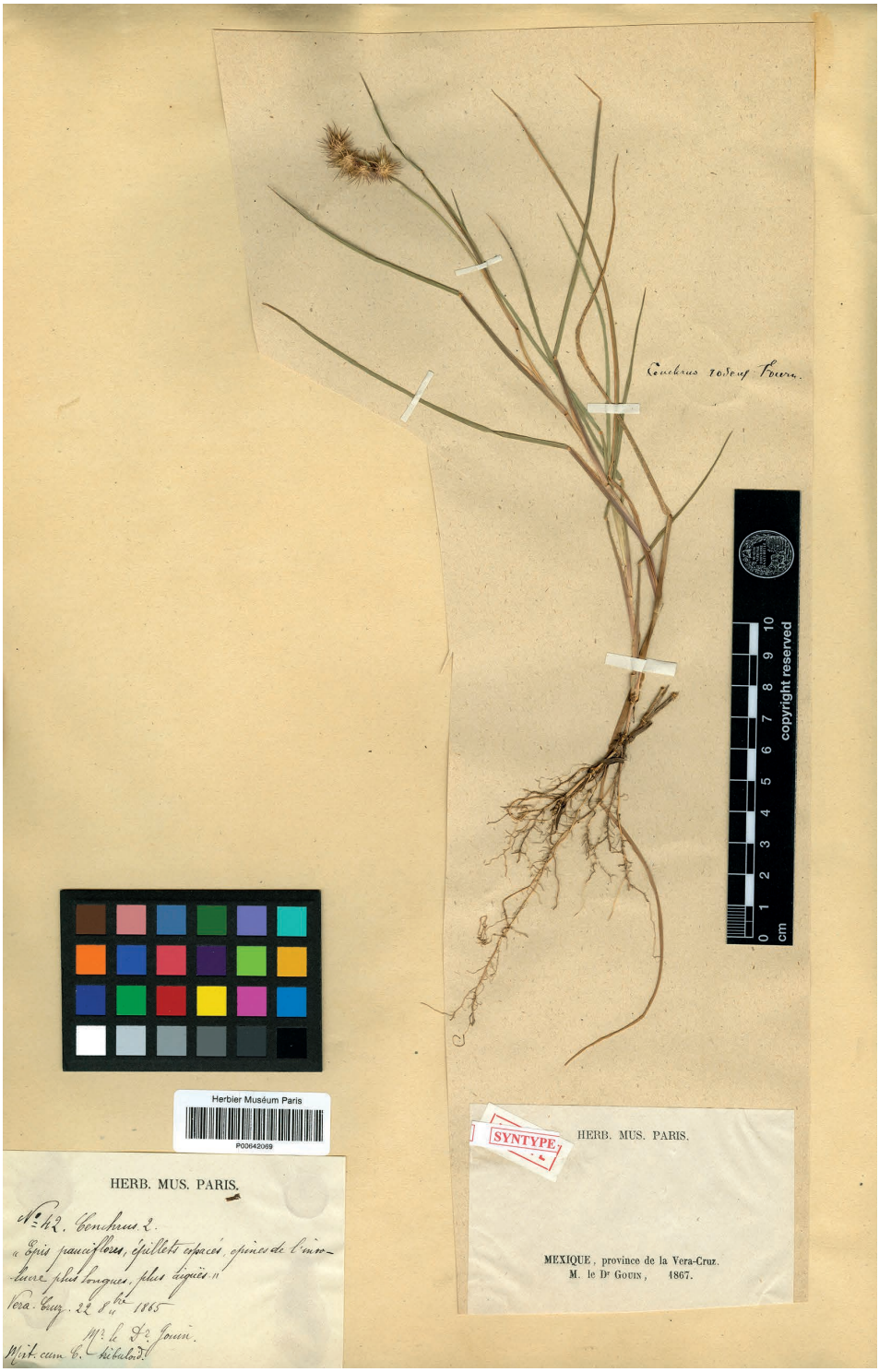

Fig. 14. Syntype *Cenchrus roseus* [*Gouin 42* (P 00642069)]. Courtesy of the "Herbarium collection (P/PC/PAT), MNHN–Paris, France."

irregular whorls; basally ciliate. **Lower (corona) whorl(s) of basally flat and terete spines** 16–42, 2–4.5 mm long, 0.1–0.45 mm wide; spreading to deflexed; **terete bristles** (below flat-terete spines) 13–20, 0.3–2 mm long, 0.1–0.15 mm wide. **Spikelets** 2 per fascicle. **Spikelets** 5–5.5 mm long, ± 1.7 mm wide, glabrous. **Lower glumes** 2.5 mm long, 0.8–0.9 mm wide, 1-veined, membranous. **Upper glumes** ± 4 mm long, ± 2 mm wide, 5-veined, chartaceous. **Lower florets** often neuter. **Lower lemmas** ± 4.6 mm long, ± 1.8 mm wide, 5-veined, chartaceous. **Lower paleas** ± 5 mm long, ± 0.8 mm wide, membranous. **Upper lemmas** ± 4.9 mm long, ± 2.2 mm wide, 5-veined, coriaceous. **Upper paleas** ± 4.7 mm long, ± 1.5 mm wide coriaceous. Anthers 3, 1–1.1 mm long. Caryopses ± 2.6 mm long, 1.5 mm wide. **Chromosome number** $2n$ = unknown.

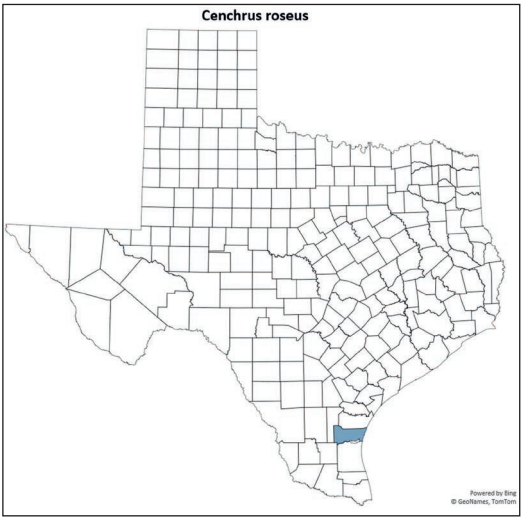

Fig. 15. Current county–level distribution of *Cenchrus roseus* in Texas.

Flowering period.—July–October.

Habitat.—Growing in loose coastal sand. Native.

Distribution.—Texas and coastal eastern Mexico.

Texas distribution.—southern coast. Rare (**Fig. 15**).

A very distinct, but poorly known species that has fascicles comprised of many long and very narrow spines. Also, the fascicle cupule color is very distinctive. The cupule of the immature fascicle is a very dark purple or dark reddish-purple which fades to rose or light rose color at maturity. Since it has long been in synonymy very little is known of this taxon or its distribution.

Voucher specimen: **U.S.A. TEXAS. Kleberg Co.:** near Mortilla Camphouse, Laureles Division of the King Ranch, loose sand, scrub live oak, 3 Jul 1953, *Johnston 5319.141* (TEX). Mixed sheet with *Cenchrus spinifex*.

Cenchrus spinifex Cav., Icon. 5:38, t. 461. 1799. (**Figs. 12, 16**). Type: SOUTH AMERICA: Chile: *Habitat in reogno Chilensi iuxta Longavi, atque etiam prope Montavideo, L. Née* s.n. (lectotype: MA 475505-image!, designated by Veldkamp, Blumea 59:71. 2014). Syntypes: MA 475503-1; 475504-1 (Garilleti 1993:50; Veldkamp 2014:71).

Cenchrus pauciflorus Benth., Bot. Voy. Sulphur 56. 1844. (**Figs. 18, 21**). Type: MÉXICO: Baja California Sur: Magdalena Bay, Nov 1840, *G.W. Barclay s.n.* (holotype: BM 00795659–image!; isotypes: BAA 00001689–image! Fragm. ex K; K 000643120-image!; K 000643121-image!; US 81749–image! fragm. ex BM & K).

Cenchrus muricatus Phil. [non *C. muricatus* L. (= *Trachys muricata* (L.) Pers. ex Trin.), 1771], Anales Univ. Chile 36:202. 1870. *hom. illeg.* Type: ARGENTINA: Mendoza: 1868–1869. *P. Ortega s.n.* (lectotype: SGO–000000148–image!, designated by Gutiérrez, Darwiniana, 3(1):143. 2015; isolectotypes: K–00643114–image!; SGO 000000149, W-0026965).

Cenchrus microcephalus Nash ex Hitchc. & Chase, Contr. U.S. Natl. Herb. 18(7):356. 1917. Type: BAHAMAS: Little Harbor: Berry Islands: meadow, 31 Jan 1905, *N.L. Britton 2249 & C.F. Millspaugh* (holotype: NY 01530424-image!; isotypes F 173363F-image!, US 3168571-image! Fragment and photo ex NY). BAHAMAS: Frozen Cay: Berry Islands: moist soil, 30 Jan 1905, *N.L. Britton 2211 & C.F. Millspaugh* (paratype: NY 00070985-image!).

Cenchrus parviceps Shinners, Field & Lab. 24(2):73. 1956. Type: U.S.A. Texas. Live Oak Co.: 7 mi W of Three River, 5 Nov 1953, *L.H. Shinners 16990* (holotype: SMU 23430–image!; isotypes: US 3168570–image! Fragm. ex-BRIT/SMU).

Cenchrus pauciflorus var. *muricatus* Caro & E.A. Sánchez, Kurtziana 4:122–123. f. 8 A–C. 1967. Type: ARGENTINA. Prov. Mendoza. Dpto. San Rafael: San Rafael, 22 Dec 1933, *Ragonese 146* (holotype: BAA–00000087–image!).

Annual (or sometimes a short-lived perennial). **Plants** can be diminutive to large and sprawling; without rhizomes. **Culms** 12–64 cm tall, cespitose, erect, decumbent to long decumbent and sprawling; branching at the lower nodes. **Internodes** 3–10 cm long, 1.4–2.3 mm wide, glabrous. **Nodes** 1.5–3.2 mm wide, glabrous. **Sheaths** 3.5–17 cm long, upper margins ciliate. **Ligules** 1–1.4 mm long, ciliate membrane, truncate; hair

Fig. 16. Type of *Cenchrus spinifex* [*Née s.n* (MA 475505)]. Courtesy of "Herbario del Real Jardin Botanico, CSIC, ©RJB–CSIC."

0.7–1.1 mm long. **Cauline leaf blades** 7–10 cm long, 2–5 mm wide (flattened), folded or flat; abaxially glabrous, adaxially with scattered long hairs to 3.5 mm long. **Inflorescence.** Usually exserted at maturity; with or without axillary panicles. **Peduncles** 10–23.5 cm long, glabrous, scabridulous, to distal 1/5 densely pubescent, hair to 1.5 mm long. **Panicles** 1.4–7(–8.5) cm long, (0.8–)1–1.8 cm wide; with 3–16(–25) fascicles; loosely (densely) arranged, equally spaced along panicle axis and the panicle axis entirely or mostly visible the entire length; 1-fascicle per node; **central axis** 0.8–6(–7) cm long, 0.6–1.2 mm wide, angled, flattened, glabrous to scabridulous; **lowermost internode** 5–7.5 mm long; **middle internodes** 3–4.5 mm long; inflorescence axes terminated with a **sterile branch** 0.8–4.2 mm long. **Fascicles** with (15–)17–72 spines; including spines, 5–13 mm long, 4.8–14 mm wide, highly variable. **Fascicle peduncle** 0.8–1.9 mm long, usually cuneate, glabrous to pubescent, stramineous; **apex** 1–2.5 x 1.5–4 mm wide, flared; with or without a **basal stipe**, but when present, 0.2–0.4(–0.6) mm long, 0.3–0.5 mm wide. **Cupules**, not including spines, 2–4.5 mm long, 2.5–5 mm wide; ellipsoid, ovoid or globose; almost glabrous, puberulent, sparsely to densely pubescent, often papillose-pubescent, hair to 1 mm long; stramineous, tan, light brown with or without mottled purple, purplish, purple, dark purple to purple-black, or reddish to red. **Adaxially cleft** 0.6–2.3 mm wide, exposing the central (largest) spikelet; margins often ciliate or papillose-ciliate; **basal cleft spines**, 1–2 pairs [(1)2,4 spines, sometimes the lowest set has only 1 spine], **basal cleft spines** 0.2–3 mm long, basally 0.1–0.7 mm wide, light brown to stramineous; **marginal mid-cleft** spines 2–4(5); 0.7–5 mm long, basally 0.4–0.9 mm wide, basally flattened, glabrous to basally ciliate, light brown to stramineous; **inner spines forming adaxial cleft** (from base of cleft): 3.2–8.2 mm long; **inner spines** (from apex of cupule): 1.5–4.2(–6) mm long, 0.5–1.2 mm wide, ciliate to papillose-ciliate, stramineous or light brown. **Abaxially cleft** present (absent); when present, 0.4–1.2 mm wide, usually to ±1/2 the length of the cupule, but sometimes extending 3/4 the way down to be base of the cupule, then marginal spines are present (or rarely absent in some of the very small fascicled populations found in S. Texas); sparsely to densely ciliate, often papillose-ciliate; **base of cleft**, 0–2 outer spines below (adjacent to) the base of the cleft, or either side of base of the cleft, if present, 2.5–4.2 mm long, 0.6–1.3 mm wide **marginal mid-cleft** spines, 0–2; when cleft shallow, then 0–spines, but deeper clefts have 1–2 spines; 1–6.2 mm long, basally 0.5–1.2 mm wide, basally flattened, glabrous to basally ciliate, light brown to stramineous; **inner spines forming abaxial cleft** (from base of cleft): 2.4–6.5 mm long, **inner spines** (from apex of cupule): 2–5(–5.7) mm long, 0.5–1.5 mm wide, basally ciliate. **SPINES. Fascicles** with (15–)17–72 spines; tan, stramineous to purple, very dark purple to purple-black to red; basally flattened to terete. **Inner whorl of spines** (4)6–8; 1.5–5(–6) mm long, 0.5–1.5(–2) mm wide, basally flattened, **longest spine** 2.3–5(–6) mm long; **widest spine**, 0.8–1.5(–2) mm wide, erect (spreading); (glabrous) sparsely to densely pubescent, margins usually basally ciliate, hair to 2 mm long. **Outer whorl of spines (not including marginal adaxial cleft spines)** 6–42 spines, in 1–4 regular or irregular whorls; spreading to deflexed (ascending); 0.5–5.2 mm long, 0.3–1.6 mm wide; **longest spine** 1.5–5.2 mm long; **widest spine** 1–1.6 mm wide; basally ciliate, hairs to 1.6 mm long. **Lower (corona) whorl(s) of basally flat and terete spines** (1–)3–35, spreading to deflexed; **flattened whorl (corona) of spines** (1–)3–26, (0.7–)1–3.6 mm long, 0.2–1(–1.5) mm wide; **longest spine** 1.4–3.6 mm long; **widest spine**, (0.3–)0.4–1(–1.5) mm wide; usually basally ciliate, hair to 0.7 mm long; **terete spines**, usually subtending the lower whorl, 0–20, 0.3–2.5 mm long, 0.1–0.25 mm wide; usually stramineous. **Note:** Diminutive plants from S. Texas can have a lower whorl of only 1-flattened spine and the rest of the whorl reduced to a distinct ridge at base of the cupule. In these populations the fascicles are also the smallest found in *C. spinifex* with the spikelets being mostly less than 3.8 mm long [this variation was included in Shinners (1956) circumscription of his *C. parviceps*]. **SPIKELETS. Spikelets** (measurements from central (largest) spikelet in the mid- to lower fascicles along central panicle axis. Immature fascicles not measured). **Spikelets** (1)2–3 per fascicle, sessile in cupule. **Spikelets** 3.5–5.1(–5.8) mm long, 1.2–2 mm wide, glabrous. **Lower glume** 0.6–2.5 mm long, 0.3–1.1 mm wide, 1-veined, scarious. **Upper glume** (2.4–)2.7–4.6 mm long, 1.2–2 mm wide, 3,4,5-veined, chartaceous. **Lower floret** usually staminate (rarely neuter); anthers 3, 1.6–1.7 mm long, yellow-brownish. **Lower lemma** 3–5.3 mm long, (1–)1.4–2 mm wide, (3)5-veined, chartaceous. **Lower palea** usually present, 3.3–5 mm long, 0.5–1.3 mm wide, 2-veined, membranous; as long as to longer than the

lower lemma. **Upper lemma** (3.4–)3.8–5(–5.7) mm long, 1.3–2.5 mm wide, (3)5-veined, coriaceous; usually minutely scabridulous. **Upper palea** 3–4.7 (–5) mm long, 2-veined, coriaceous, as long as the lemma. **Anthers** 3, 0.7–0.8 mm long, yellowish. **Caryopsis** (1.8–)2.3–2.5 mm long, (1.3–)1.5–2 mm wide. **Chromosome number** $2n = 34$ (Tateoka 1955; Gould 1958, 1960; DeLisle 1963, 1964; Pohl and Davidse 1971).

Flowering period.—January–December.

Habitat.—Growing mostly in dry sandy soils. Common. Native.

Distribution.—Southern half of the United States to South America, introduced into other parts of the world.

Texas distribution.—Throughout the State (**Fig. 17**).

This is the most common species by far and the most morphologically variable.

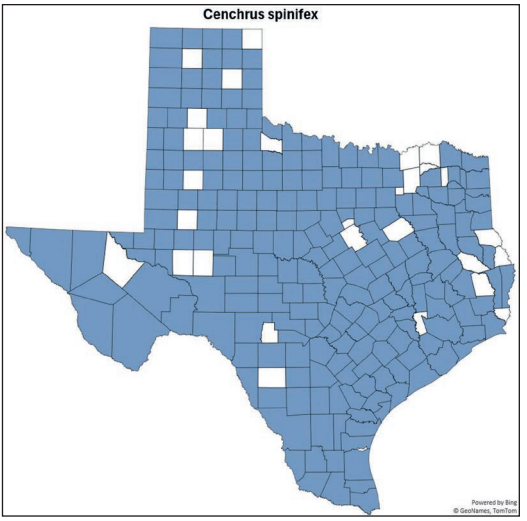

Fig. 17. Current county–level distribution of *Cenchrus spinifex* in Texas.

KEY TO THE SPECIES OF *CENCHRUS* IN THE CONTINENTAL UNITED STATES WITH NOTES ON THE TWO REINSTATED SPECIES FROM S.E. U.S.

1. Inner spines (cupule) fused at the base only, the lower surfaces with 1–3 grooves ____ **Cenchrus biflorus**
1. Inner spines (cupule) fused for >1/3 their length, the lower surfaces not grooved.
   2. Lowest whorl(s) [at base of cupule] of bristles in fascicle consisting of only slender, spreading-ascending to ascending very narrow basally flattened and long terete bristles; lower whorl of bristles not flattened spines and not similar to other spines of cupule.
      3. Fascicles, excluding bristles, 2–4.5 mm wide; fascicles numerous, crowded in a long spike; apical lobes of cupule bent inward and/or interlocking, apices acute, sharp, but not spine-like or spine-tipped; panicle axis internodes 0.8–1.7 mm long; lower whorl of bristles with some bristles equal to slightly exceeding cupule ____ **Cenchrus brownii**
      3. Fascicles, excluding bristles, (3.5–)5–7 mm. wide, not densely crowded; apical lobes of cupule erect or nearly so [or rarely 1–2 lobes loosely interlocking], the tips spinelike; panicle axis internodes 2–4 mm long; lower whorl of bristles mostly ≤ 1/2 the length of cupule ____ **Cenchrus echinatus**
   2. Lowest whorl(s) [at base of cupule] of bristles in fascicle absent or present; if present consisting of 1–3 rows of spreading to deflexed flattened spines and below the lowest whorl(s) short terete bristles may be present or absent; the lower whorl of flattened spines (when present) similar to other spines of cupule.
      4. Inflorescences with 40–54 fascicles; densely crowded on inflorescence axis; culms 60–102 cm tall; perennial; central spikelet of fascicle 3.9–4.8 mm long; lower whorl (corona) of flattened spines present ___ **Cenchrus densiflorus** sp. nov.
      4. Inflorescence with 1–30 fascicles; densely crowded to loosely spaced along inflorescence axis; culms 6–90 cm tall; annual or perennial; central spikelet of fascicle 3.5–7.8 mm long; lower whorl (corona) of flattened spines present or absent.
         5. Fascicles with 40–100+ spines and bristles; the lower whorl(s) of fascicle with 20+ flattened/terete spines (at cupule base); outer spine whorls in 2–5 series, regularly or irregularly positioned around cupule.
            6. Inflorescence of 1–3 fascicles, with 5–8 spikelets per fascicle; spines 9–14 mm long; SW Mexico and southern Arizona ____ **Cenchrus palmeri**
            6. Inflorescence of > 3 fascicles, with 1–4 spikelets per fascicle; spines ≤ 8 mm long; various habitats in the U.S.
               7. Spikelets 6–9 mm long; fascicles stramineous to brown (occasionally brown-purple to dark purple); spines stramineous, light brown to purple.
                  8. Fascicles with 2–4 spikelets; fascicles with 69–102 spines; cupules sparsely to densely short pubescent; in fields, roadsides, etc. throughout the United States ____ **Cenchrus longispinus**
                  8. Fascicles with 1(2) spikelets; fascicules with 15–43 spines; cupules usually densely long white villous, stramineous; in somewhat moist sand just above high tidal zone along Atlantic and Gulf coastal regions, but not extending any great distance inland ____ **Cenchrus tribuloides**
               7. Spikelets 4.5–6 mm long, fascicles stramineous, rose, red to dark purple to almost black; spines variously colored.

9. Longest inner (apical) spines 5–7.2+ mm long and the widest inner spines < 0.9 mm wide; lowest whorls of spines all terete or very narrow flattened spines; cupule when immature very dark purple, maturing to rose or light rose; spines rose to stramineous; fascicles with 64–100+ spines; rare along the southern Texas coast **Cenchrus roseus**

9. Longest inner (apical) spines ≤ 5(–6) mm long and the widest inner spines ≥ 1 mm wide; lowest whorls of flattened spines and terete bristles; cupule when immature, never dark purple; cupules maturing to stramineous, light brown to red or mottled purpled, purple to black; spines stramineous, red or purple; fascicles with (15–)17–72 spines; along the coast and inland.

10. Cupules maturing to stramineous, light brown to red or mottled purpled, purple to black; spines stramineous, red or purple; leaf blades flat to folded; culm often with axillary panicles in age; panicle at maturity fully exserted past collar or sometimes partially enclosed in sheath; lower leaf blades not abscising at summit of sheath; plants cespitose to decumbent and forming loose mats, axillary inflorescences often present; fascicles with (15–)17–72 spines; spikelets 3.5–5.1(–5.8) mm long; common throughout the southern ½ of the U.S.; annual **Cenchrus spinifex**

10. Cupules and spines stramineous to almost white; leaf blades flat, becoming involute in age; culms usually only with a terminal panicle; panicle usually partially enclosed by sheath and base of panicle not exserted past collar; lower leaf blades abscising at summit of sheath; plants with one or few culms from a single base, long decumbent, ascending to sub-erect; rooting at nodes, innovations in sheaths, but panicles mostly terminal; fascicles with 40–60 spines; spikelets ± 6 mm long; southern Florida, in coastal sand dunes near the shore; perennial **Cenchrus bambusoides**

5. Fascicles with 5–40 bristles; lower whorl of fascicles with 0–15 flattened spines, with or without a few short terete spines below; outer spine whorl in 1–2 series, regularly or irregularly positioned around cupule.

11. Fascicles without a lower whorl (corona) of spines at base of cupule/peduncle apex (not including the 1–2 basal adaxial cleft spines), sometimes with ridge(s) or knobs present; fascicles of 5–16 spines; spikelets 5.5–6.1 mm long.

12. Culms 30–63 cm tall, loosely cespitose, often geniculate; lower sheaths not conspicuously overlapping sheath; inner whorl of spines, widest spine 0.5–1.2 mm wide; culm often with axillary panicles in age, culm with mostly 5–8 nodes; in disturbed areas and open woodlands of the Coastal Plain **Cenchrus incertus**

12. Culms 60–90 cm tall, densely cespitose; lower sheaths conspicuously overlapping; inner whorl of spines, widest spine 1.4–2.5 mm wide; culm usually with only a terminal panicle, culm with 10–12 nodes; along coast from South Carolina to Florida **Cenchrus strictus**

11. Fascicles with a well-developed lower whorl (corona) of (1–)3–10(–15) spines at base of cupule or with a few spines and a well-developed ridge; spines flattened and with or without a few short, terete spines below; fascicles of (15–)17–40 spines; spikelets 3.5–9 mm long.

13. Fascicles all with 1(2) spikelet; cupules usually densely long white villous, stramineous to purple; spikelets 6–9 mm long; growing in somewhat moist sand just above high tidal zone along the Gulf, not extending any great distance inland **Cenchrus tribuloides**

13. Fascicles with (1)2–4 spikelets; cupules glabrous to densely pubescent, variously colored; spikelets 3.5–7 mm long; growing is various habitats.

14. Cupules glabrous; panicle with 2–7 fascicles, middle internodes 4–10 mm long; spikelets 5.5–7 mm long; inner spines 6–8 mm long; leaf blades 1–3.3 mm wide; perennial; Florida, southern Alabama and some of the Caribbean Islands **Cenchrus gracillimus**

14. Cupules sparsely to densely pubescent, to puberulent; panicle with 3–30 fascicles, middle internodes 3–5.5 mm long; spikelets 3.8–7 mm long; inner spines 1.5–6.6 mm long; leaf blades 2–6 mm wide; annual or perennial; southern U.S.

15. Spikelets 3.5–5.1(–5.8) mm long; longest outer whorl spine 1.5–5.2 mm long; longest inner whorl spine 2.3–6 mm long; primary inflorescences with 3–16(–20) fascicles, loosely (to somewhat densely) and uniformly arranged along the inflorescence axes; axis usually visible the entire length; abaxial cleft in cupule present or absent, when present the cleft rarely reaching to the bottom of the cupule; cupules greenish, stramineous, light brown to red, reddish, purplish, mottled purpled, or purple to black; spines stramineous, red, or purple; 8–40 spines, longer cauline leaf blades 7–13 cm long; annual **Cenchrus spinifex**

15. Spikelets 5–7 mm long; longest outer whorl spine 4.5–5.5 mm long; longest inner whorl spine 5–6.6 mm long; primary inflorescences with (10–)15–30 fascicles, densely crowded in the upper 2/3 length of the panicle, upper panicle axis obscured, but the lowermost fascicles often widely spaced along panicle axis; abaxial cleft of cupule distinct and reaching almost to bottom of cupule; cupules green, light tan or stramineous; spines green, tan or stramineous, occasionally purplish or reddish; 20–30 spines, longer cauline leaf blades (7–)10–20+ cm long; perennial **Cenchrus albertsonii**

NOTES ON RE-INSTATED TAXA FOR THE UNITED STATES

Cenchrus bambusoides Caro & E.A. Sánchez, Kurtziana 4:44–46, f 2. 1967. (**Figs. 18, 19, 20**). Type: U.S.A. Florida. Palm Beach Co.: 6 Jun 1896, *H.J. Webber 416* (lectotype: US-978582-image!, designated by Gutiérrez & Morrone, Bol. Soc. Argent. Bot. 47(1–2):267. 2012). U.S.A. Florida. Palm Beach Co.: 26 Dec 1895–11 Jan 1896, *A.S. Hitchcock 2287* (syntype: US-744922-image!).

Perennial. **Plants** cespitose, decumbent to long decumbent; without rhizomes. **Culms** suberect, ± 60 cm tall; with sterile basal extravaginal innovations and upper intravaginal innovations; one or a few culms from a single base, ascending to sub-erect; unbranched or simply branched; often rooting at the nodes when in contact with the soil. **Internodes** compressed, glabrous, **Sheaths** open to the base, striated, glabrous, longer than the internodes; innovations in sheaths; **sheath collar** elongated, differentiated, puberulous or glabrous; **sheath corners** with hairs on the back, hairs up to 2 mm long; without auricles. **Ligule** 0.5–1 mm long, ciliate membrane. **Leaf blades** 7–15 cm long, 5–8 mm wide; linear, flat or involute at margins; **adaxial surface** scabrous and with some long hairs at the base, **abaxial surface** glabrous, only scabrous towards the apex, striated; **margins** scabrous. The **lower leaf blades abscising** at summit of sheath. **Inflorescence. Peduncles** short. **Inflorescences** mostly terminal, often not fully exserted; panicle usually partially enclosed by sheath and the bottom of panicle not exserted past collar. **Panicles** 4.5–7 cm long; with 10–13 fascicles; **panicle axis** flexuous, angular, scabrous, and with long hairs mainly towards the base, with sub-cupuliform attachment scars. **Fascicles** with 40–60 spines, including spines, ± 8 mm long, 9–12 mm wide. **Fascicle peduncle** obconic, puberulous and pubescent (with very short and more or less long hairs). **Cupules**, not including spines, 3–4.5 mm long, 3–5 mm wide, pubescent, stramineous. **SPINES. Fascicles** with 40–60 spines, vary from basally flattened and wide to narrow, to terete (or almost so); stramineous; basally pubescent. **Inner whorl and Outer of spines** with 28–40 spines, 1–3.5 mm long, 0.8–1.7 mm wide. **Lower (corona) whorl(s) of basally flat spines and terete bristles** ± 20 spines/bristles, to 3.2 mm long and 0.62 mm wide. **SPIKELETS. Spikelets** 1–3 per fascicle. **Spikelet** ± 6 mm long, usually puberulent. **Lower glume** ± 2 mm long, 1-veined, membranous. **Upper glume** ± 5 mm long, ± 2.5 mm wide, 5,7-veined, chartaceous, usually puberulent. **Lower floret** neuter or staminate. **Lower lemma** similar to the upper glume, usually puberulent; lower palea about as long as lemma, sub-oblong, 2-veined, puberulent. **Upper lemma** ± 6 mm long, 5-veined, coriaceous. **Upper palea** slightly short than lemma, coriaceous. **Chromosome number** 2*n* = unknown. Description adapted from Caro and Sánchez (1967).

Flowering period.—June–December.

Habitat.—Growing in coastal sand dunes near the shore. Native.

Distribution.—Southern tip of Florida and east coast of southern Mexico; Caribbean.

This morphologically distinct coastal taxon that has been long overlooked and usually treated under *C. spinifex* warrants recognition at the specific rank. Ward (2010) is the first author since Caro and Sánchez (1967) to treat *C. bambusoides* at the specific level. Ward (2010) stated, "*Also unsettling is the absence of reports of this plant from elsewhere, especially the Caribbean from which have come innumerable other tropical species. The present 'best estimate' (an appropriate statistical term), subject to verification, is that* C. bambusoides *is a recognizable distinct species.*" But this species is part of the "*C. tribuloides*" distributed from the West Indies to South America as discussed by Chase (1920). Gutiérrez and Morrone (2012) lectotypified *Cenchrus bambusoides* and then synonymized *C. bambusoides* under *C. tribuloides* providing no reasoning for this taxonomic move. The vegetative and fascicle morphology are very different between these two species, and *C. bambusoides* should not be unified under *C. tribuloides*. This taxon is more closely aligned with *C. spinifex*, but is morphologically different in a number of traits, as described in the key. This very interesting taxon is in much need of further investigation.

Fig. 18. Type of *Cenchrus pauciflorus* (*Barclay s.n.*, K: http://specimens.kew.org/herbarium/K000643120). Courtesy of Royal Botanic Gardens, Kew.

Fig. 19. Type of *Cenchrus bambusoides* (*Webber 416*, US). Smithsonian Open Access. Courtesy of Smithsonian Institution, National Museum of Natural History.

Fig. 20. Syntype of *Cenchrus bambusoides* (*Hitchcock 2287*, US). Smithsonian Open Access. Courtesy of Smithsonian Institution, National Museum of Natural History.

Cenchrus strictus Chapm., Bot. Gaz. 3(3):20. 1878. (**Figs. 21, 22**). Type: U.S.A. Florida: west coast of Florida, Apalachicola and southward, *A.W. Chapman 1046* (lectotype: US-821183!, designated by DeLisle, Iowa State J. Sci. 37(3):308. 1963).

Note.—Delisle (1963) identifies this specimen in US as a neotype but provides no reference. Since, this collection is from Chapman's herbarium, Delisle (1963) could be considered as designating a lectotype under *Article 9.3* and *9.4* of The International Code of Nomenclature for algae, fungi, and plants (ICN),(Turland et al. 2018). Chase (1920) wrote, "Cenchrus strictus *Chapm, Bot Gaz. 3; 20. 1878, West Coast of Florida, Apalachicola and southward. In the National Herbarium is a specimen from Chapman's herbarium labeled in Chapman's hand*, 'Cenchrus incertus, *M.A. Curtis,* C. strictus, *Chapm, in Bot. Gaz. Florida.' This specimen agrees well with Chapman's description but, bearing no date, it is uncertain whether or not it is one of the plants from which Chapman drew up his description*." This is the only specimen currently known that has "*Cenchrus strictus*" written on the label in Chapman's hand.

Cenchrus carolinianus Walter, Flora Caroliniana, secundum 79. 1788. Type: U.S.A. South Carolina. Beaufort Co.: St. Helena Island, 12 Sep 1982, *D.E. Boufford, B. Bartholomew & S. A. Spongberg 23096* (neotype: BM–001042458!, designated by Reveal in Taxon 39:354. 1990; isotype: A–00023343!). *Nomina utique rejicienda* under International Code of Nomenclature Art. 56, see ICN Appendix V. Proposal No. 977. (http://botany.si.edu/references/codes/props/display_new.cfm)

Perennial. **Plants** densely cespitose. **Culms** 60–90 cm tall, erect; with. **Internodes**, lower, short. **Nodes** 10–12 nodes, glabrous, brown to black. Sheaths, lower, overlapping. **Leaf blade** 15–26 cm long, 2–6 mm wide, flat to folded. **Inflorescence.** Usually long exserted at maturity; usually without axillary panicles. **Peduncles** ± 12 cm long, glabrous. **Panicles** ± 7.2 cm long, ± 1.7 cm wide; with 15–23 fascicles; lower fascicles widely spaced and upper fascicles densely arranged; 1-fascicle per node. **Fascicles** with 12–19 spines, 6.2–7.6 mm long, 7.8–9.7 mm wide; spines ciliate; tan to light brown. **Cupules**, not including spines, 1–3 mm long, 2–3.5 mm wide; tan to light brown. **SPINES. Fascicles** with 12–19 spines, spines ciliate. **Inner whorl of spines** 7–9, 3.2–5mm long, 0.8–2.5, widest spine 1.4–2.5 mm wide. **Outer whorl of spines (not including marginal adaxial cleft spines)** 5–10, 2.9–4 mm long, 1–1.3 mm wide, in a series of 1(2) whorls. **Lower (corona) whorl(s) of basally flat and terete bristles** absent. **SPIKELETS. Spikelets** ± 6 mm long. Measurements taken from the type specimen and from the type of *Cenchrus carolinianus*.

Flowering period.—August–November.

Habitat.—Growing in coastal areas. Native.

Distribution.—Coastal areas from South Carolina to Florida.

This very interesting taxon also needs further investigation. Chapman (1878) described *C. strictus*, but then Chapman (1883) synonymized his *C. strictus*, without discussion, under *C. incertus*. Chase (1920) then also synonymized *C. strictus* without discussion under *C. incertus*. Which was then followed by Hitchcock (1931, 1935, 1951), DeLisle (1963) and all subsequent authors without discussion. However, with a little familiarity, *C. strictus* is very different from *C. incertus* morphologically and the two are found in very different habitats.

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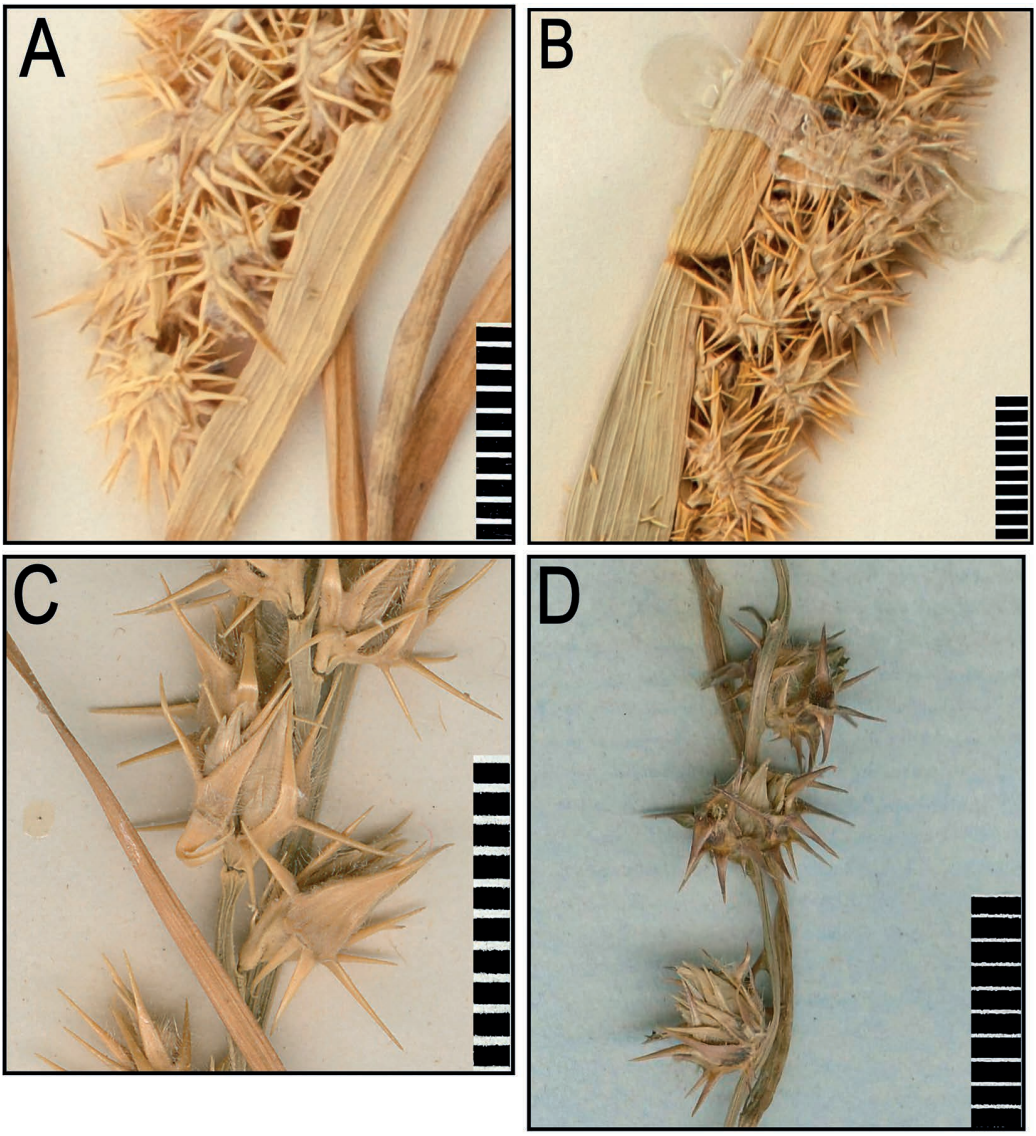

Fig. 21. Fascicles. **A.** *Cenchrus bambusoides*. Type (*Webber 416,* US). Smithsonian Open Access. Courtesy of Smithsonian Institution, National Museum of Natural History. **B.** *Cenchrus bambusoides*. Syntype of *Cenchrus bambusoides* (*Hitchcock 2287*). Smithsonian Open Access. Courtesy of Smithsonian Institution, National Museum of Natural History. **C.** *Cenchrus strictus*. Type (*Chapman 1046*, US). Smithsonian Open Access. Courtesy of Smithsonian Institution, National Museum of Natural History. **D.** *Cenchrus pauciflorus.* Type of *Cenchrus pauciflorus*. Type (*Barclay s.n.*, K: http://specimens.kew.org/herbarium/K000643120). Courtesy of Kew Royal Botanic Gardens. © Copyright of the Board of Trustees of the Royal Botanic Gardens, Kew. Bar = 1 cm. Plate prepared by Annette R. Wipff.

Fig. 22. Type of *Cenchrus strictus* (*Chapman 1046*, US). Smithsonian Open Access. Courtesy of Smithsonian Institution, National Museum of Natural History.

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