CAREX LUTEA (CYPERACEAE), A RARE NEW COASTAL PLAIN ENDEMIC FROM NORTH CAROLINA

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ABSTRACT

Carex lutea (section *Ceratocystis*) is described from the outer coastal plain of southern North Carolina. It is the only species of this section to occur south of New Jersey along the Atlantic Coast, and appears to be a localized endemic of wet savannas underlain by limestone deposits. From all other species of this section, *C. lutea* is distinguished by its pale scales, tall ((40)65–110(125) cm), slender culms, and elongate inflorescences (4.5)5.4–25(41) cm long with usually only one or two widely separated pistillate spikes below the ± long peduncled ((0.3)1–6(10.2) mm) staminate spike.

RESUMEN

Carex lutea se distinque de todas las demás especies de esta sección por sus escamas pálidas, altura ((40-)65–110(-125) cm), tallos delgados, inflorescencias alargadas de (4.5-)5.4–25(-41) cm que usualmente llevan debajo de las espigas estaminadas ± largamente pedunculadas ((0.3-)1–6(-10.2) mm) una o dos espigas pistiladas ampliamente separadas.

INTRODUCTION

Field surveys in 1991 by R.J. LeBlond of a rare, wet savanna habitat underlain by coquina limestone deposits on the outer coastal plain in Pender

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County, North Carolina disclosed an unfamiliar *Carex* with clear affinity to the well-defined boreal section *Ceratocystis*, and more specifically with the *C. flava* L. complex as defined by Crins & Ball (1988, 1989a, 1989b). Subsequent searches for the plant by LeBlond and A.S. Weakley disclosed four additional populations in Onslow and Pender counties. However, the populations were all clustered within a radius of about 4 km. Furthermore, only the original population was large; all the others consisted of fewer than 60 clumps each.

Diagnostic characters of the *Carex flava* complex include globose to ovoid, more or less approximate, short-peduncled to sessile pistillate spikes with the perigynia spreading (the lowermost often reflexed) (Crins & Ball 1989b). Three species of the complex, *C. cryptolepis* Mack., *C. flava*, and *C. viridula* Michx. subsp. *viridula*, are known from the northern coastal plain, but none has been found south of northern New Jersey (Crins & Ball 1989b). Two additional subspecies of *C. viridula*, *C. viridula* subsp. *oedocarpa* (Andersson) B. Schmid and subsp. *brachyrrhyncha* (Celak.) B. Schmid, are known from boreal habitats farther north along the Atlantic coast in the Gulf of St. Lawrence region and in Eurasia. Several other, distinct species are found elsewhere in the old world and in the temperate parts of the southern hemisphere, but the relationships of the North Carolina plants are clearly with the North American members of the *C. flava* complex.

Close examination of the North Carolina plant discloses a number of significant points of difference from the other species of the *Carex flava* complex in North America. The pistillate scales of the North Carolina plant are pale yellowish-green, immediately separating it from *C. flava* and most subspecies of *C. viridula*, the scales of which are coppery or tinged with red or brown. The larger (up to 5.2 (5.8) mm long), reflexed lower perigynia separate it from those subspecies of *C. viridula* that may have paler scales. The North Carolina plants can be separated from the pale-scaled *C. cryptolepis* by its usually sparsely serrulate perigynium beaks, as well as its taller stature and longer inflorescences.

Several features unique to the North Carolina plant separate it from all other species in the *C. flava* complex both in North America and world-wide. The North Carolina plant is taller than any other members of the section, with taller mature flowering individuals typically over 65 cm tall and reaching heights of up to 1.25 m. Even though the plants are tall, the number of pistillate spikes is normally only one or two, extremely rarely three. As well, the inflorescences of the North Carolina plants (particularly those of culms that produce two pistillate spikes) are much longer than any other species, the longest ranging from 18–41 cm. All other members of the *C. flava* complex are much shorter, rarely reaching heights of over 65 cm, and routinely producing 2–3 pistillate spikes in shorter inflorescences 1.5–12(20) cm long.

Based on its unique morphology, this rare and highly localized North Carolina plant is here described as a new species.

Carex lutea LeBlond, sp. nov. (section *Ceratocystis*). (Fig. 1)

Plantae cespitosae; culmi (40)65–110(125) cm alti; vaginae basales pallide brunneae, glabrae. Folia 3–7, plerumque basalia; laminae 5.5–28 cm longae, 1.8–3.8 mm latae; vaginae 2.5–11 cm longae; ligulae obtusae 1.4–3.6 mm longae. Inflorescentia (4.5)5.4–25(41) cm longae; spicae 2–3(4), ascendentes, spica terminalis staminata, ceterae pistillatae; bracteae infimae laminis 5–25 cm longis, 1.2–2.5 mm latis et vaginis (0)0.2–4 cm longis. Squamae pistillatae pallide flavovirentes. Perigynia (3.5)3.9–5.2(5.8) mm longa, 1.4–2.2 mm lata, patentia, extrorsus curvata, plus minusve trigona, lutea, glabra, in rostrum contracta; rostra 1.4–2.2 mm longa. Achenium 1.4–1.9 mm longum, 1.2–1.5 mm latum. Styli marcesentes; stigmata 3. Antherae 3, 2.1–3.6 mm longae.

Plants cespitose in small to large (up to ca. 45 fertile culms) clumps, with short ascending rhizomes; roots pale brown, not densely felted with root hairs; fertile culms (40)65–110(125) cm tall, 0.6–0.9 mm wide at base of lowermost spike, central, more or less trigonous, smooth except at apex where often slightly scabrous-angled, with glabrous, stramineous to pale brown bladeless basal sheaths. Leaves 3–7, mostly basal; blades 5.5–28 cm long, much shorter than culms, 1.8–3.8 mm wide, plicate, yellowish-green, glabrous, the margins antrorsely scabrous, the widest leaves 2.4–3.8 mm wide; leaf sheaths 2.5–11 mm long, more or less tightly enveloping culms, glabrous, green; inner band of sheath glabrous, whitish-hyaline, the apex thin and friable, irregularly concave, more or less truncate, or occasionally slightly prolonged; ligules obtuse, 1.4–3.6 mm long, the free portion more or less entire, whitish-hyaline, to 0.7 mm long. Vegetative shoots 40–65(90) cm tall; leaves 5–11, similar to those of fertile culms but up to 65(90) cm long and 4.6 mm wide, more or less evergreen (at least the proximal portions of the blades); pseudoculms ca. 5–13 cm tall. Inflorescences (4.5)5.4–25(41) cm long, with all spikes quite separate, the lowest 2 pistillate spikes (if present) (1.6)4.5–18(33) cm distant; spikes single at nodes, ascending; lowermost spikes with peduncles 0.4–4.5(16.5) cm long, the uppermost pistillate spike sessile; peduncles smooth and terete proximally, more or less trigonous and serrulate-angled distally; lowermost bracts usually reflexed (except when subtending long-peduncled spikes), with blades 5–25 cm long and 1.2–2.5 mm wide and sheaths (0)0.2–4 cm long, 0.5–1.3(1.9) times as long as the inflorescence, the uppermost bracts also reflexed, but much reduced. Spikes 2–3(4), the terminal staminate (very rarely with an additional small, accessory staminate spike at base), the lateral pistillate (very rarely with a small staminate apex up to 8 mm long). Terminal spikes (9)17–39 mm long, 1.4–2.5 mm wide, ca. 45–90-flowered, peduncles (0.3)1–6(10.2) cm long, (0.1)0.7–2.5(5.1) times as long as the spikes. Lateral spikes 0.7–2.7 cm long, 8–11 mm wide, globose to ellipsoid or short-cylindric,

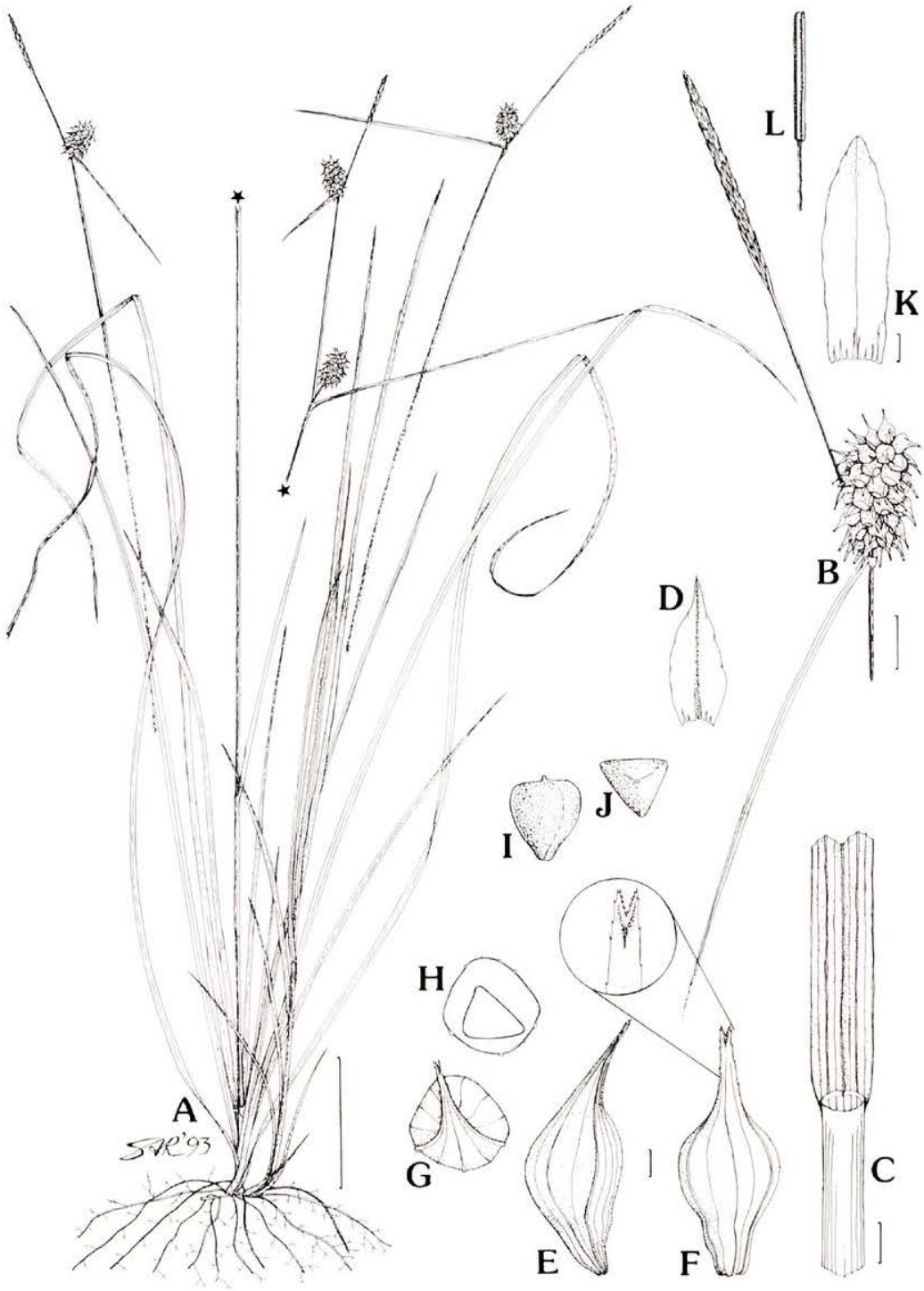

FIG. 1. *Carex lutea*, A. Habit. B. Portion of inflorescence. C. Sheath and ligule. D. Pistillate scale. E. Perigynium, side view. F. Perigynium, front view. G. Perigynium, top view. H. Perigynium and achene, transverse section. I. Achene, front view. J. Achene, top view. K. Staminate scale. L. Anther. Bar equals 5 cm in A, 5 mm in B, 2 mm in C, and 0.5 mm in D–L. Drawn by Susan A. Reznicek from the holotype.

densely 15–60-flowered. Pistillate scales 2.1–3.3 mm long, 0.9–1.3 mm wide, lanceolate to narrowly ovate, obtuse to more or less acuminate, glabrous, pale yellowish-green with a green center and wide hyaline (sometimes stramineous-tinged) margins and apex, 1-nerved, almost totally concealed by the crowded perigynia. Staminate scales 2.9–5.6 mm long, 1.2–1.9 mm wide, narrowly obovate to narrowly oblong, obtuse to acute, glabrous, stramineous to pale brown with a green center and wide hyaline margins and apex, 1(3)-nerved. Perigynia (3.5)3.9–5.2(5.8) mm long, 1.4–2.2 mm wide, spreading, strongly outcurved and squarrose in the spikes, the lowermost strongly reflexed, somewhat inflated, irregularly and asymmetrically trigonous with convex, obovate sides, glabrous, bright yellow proximally, pale yellowish-green distally, short-stipitate and tapered to the base, 7–13-nerved with two nerves much more prominent than the rest, contracted into a strongly deflexed beak; beaks 1.4–2.2 mm long, finely and sparsely serrulate or sometimes smooth, green, the apex bidentulate with teeth 0.2–0.5 mm long. Achenes 1.4–1.9 mm long, 1.2–1.5 mm wide, trigonous with flat to slightly concave, strongly obovate sides, essentially truncate apically, brown, sessile. Styles withering; stigmas 3. Anthers 3, 2.1–3.6 mm long.

TYPE: UNITED STATES. NORTH CAROLINA. Pender Co.: SW of N.C. Hwy 50, ca. 1.8 mi W of Onslow Co. line, ca. 11 mi NNW of Holly Ridge. S of secondary Rd 1532, 0.85 mi SW of N.C. Hwy 50, "Lanier Quarry Savanna," 20 May 1993, *A.A. Reznicek 8942 with S.A. Reznicek, R.J. LeBlond & B.A. Sorrie* (HOLOTYPE: MICH; ISOTYPES: BRIT/SMU, FLAS, GA, NCU, TAES, US, VDB, herb. C.T. Bryson).

Additional specimens examined: NORTH CAROLINA. **Onslow Co.**: NE side N.C. Hwy 50, ca. 10.4 mi NNW of Holly Ridge, "Powerline Savanna," 20 May 1992, *A.A. Reznicek 8954 with S.A. Reznicek, R.J. LeBlond, & B.A. Sorrie* (MICH, VPI). **Pender Co.**: Lanier Quarry Savanna, S of secondary road 1532 0.85 mi SW of Hwy NC 50, 11 Apr 1990, *R.J. LeBlond 1188* (NCU); 24 Apr 1991, *R.J. LeBlond 1985* (NCU); 22 May 1991, *R.J. LeBlond 2056* (MICH, NCU); 27 Jun 1991, *R.J. LeBlond 2267* (NCU); 20 Apr 1992, *R.J. LeBlond 2723* (NCU); Sandy Run Savanna along Hunt Club Rd 0.5 mi S of Hwy NC 50, 12 May 1992, *A.S. Weakley & R.J. LeBlond s.n.* (NCU); Watkins Savanna, 0.1 mi N of Hwy N.C. 50 ca. 0.5 mi W of the Onslow Co. line, 12 May 1992, *A.S. Weakley & R.J. LeBlond s.n.* (NCU); N side N.C. Hwy 50, ca. 1 mi W of Onslow Co. line, ca. 11.5 mi NNW of Holly Ridge, "Watkins Savanna," 20 May 1992, *A.A. Reznicek 8949 with S.A. Reznicek, R.J. LeBlond & B.A. Sorrie* (MICH, USCH).

DISCUSSION

In the key to the *Carex flava* complex in Crins & Ball (1989b), *C. lutea* keys closest to *C. cryptolepis* because of its pale, yellowish-green scales, narrow leaves, and perigynia of similar size. The overall yellowish-green color of *C. lutea* is also similar to that of *C. cryptolepis*. Insertion of the following couplet in place of the first lead of couplet 3, however, will complete the key, and

allow easy separation of *C. lutea* from *C. cryptolepis*.

1. Tallest culms 65–125 cm; lowermost pistillate spike bracts 0.5–1.3(1.9) times as long as the inflorescence; staminate spike peduncles mostly 0.7–2.5 times as long as the staminate spikes; achenes 1.2–1.5 mm wide; perigynium beaks often sparsely serrulate ..... *C. lutea*
1. Tallest culms 25–50 cm; lowermost pistillate spike bracts about 1.5–4 times as long as the inflorescence; staminate spike peduncles 0.2–0.5 times as long as the staminate spikes; achenes 1–1.2 mm wide; perigynium beaks smooth ..... *C. cryptolepis*

Although *Carex lutea* keys with *C. cryptolepis* due to its pale scales, its elongate inflorescence is most similar in aspect to that of *C. viridula* subsp. *brachyrrhyncha* var. *elatior* (Schltdl.) Crins (*C. lepidocarpa* Tausch), a boreal and subarctic taxon of highly calcareous, open wetlands in the Gulf of St. Lawrence region and Europe. *Carex lutea* differs most obviously from *C. viridula* subsp. *brachyrrhyncha* var. *elatior* in plant size, inflorescence size, and paler scales. The two taxa can be separated by the following couplet.

1. Pistillate scales pale yellowish-green, nearly the same color as the perigynia and thus inconspicuous; tallest culms 65–110(125) cm; longest inflorescences 18–41 cm ..... *C. lutea*
1. Pistillate scales with brown coloration, conspicuous among the greenish to yellowish perigynia; tallest culms (10)20–60(85) cm; longest inflorescences 2–12(18) cm long ..... *C. viridula* subsp. *brachyrrhyncha* var. *elatior*

In addition to the scale color and size differences, *Carex lutea* differs from *C. viridula* subsp. *brachyrrhyncha* var. *elatior* in inflorescence proportions. In *C. lutea*, the bracts of the lowest pistillate spikes are shorter than or equalling the inflorescence and most staminate spikes are shorter than their peduncles. In *C. viridula* subsp. *brachyrrhyncha* var. *elatior*, the bracts of the lowest pistillate spikes often equal or exceed the inflorescence and most staminate spikes are longer than their peduncles. Because of the great variability in these proportions due to differences in the number of pistillate spikes in the inflorescence and the considerable plasticity of inflorescences depending on the vigor of the plants, there is modest overlap in these proportions, rendering them unsuitable as key characters. *Carex lutea* also has proportionately narrower leaves than *C. viridula* subsp. *brachyrrhyncha* var. *elatior*. Although a significantly shorter plant than *C. lutea*, the widest leaves of *C. viridula* subsp. *brachyrrhyncha* var. *elatior* range up to 5.6 mm whereas those of *C. lutea* are at most 4.6 mm wide. Other differences include the larger staminate spikes of *C. lutea*, which are up to 39 mm long, much larger than the maximum of 25 mm in *C. viridula* subsp. *brachyrrhyncha* var. *elatior*; and larger perigynia up to 5.2(5.8) mm long in *C. lutea* whereas those of *C. viridula* subsp. *brachyrrhyncha* var. *elatior* are only up to 4.2 mm long.

It is tempting to suggest that the character of pale scales, which uniquely defines the two North American endemics, *C. cryptolepis* and *C. lutea*, indi-

cates a close relationship. However, until genetic, breeding system, and micromorphological evidence comparable to that available for the other taxa is known for *C. lutea*, statements of putative relationship are speculative. Nevertheless, when a character compatibility analysis was run with *C. lutea* added to the data matrix of Crins (1990), *C. lutea* consistently clustered with *C. cryptolepis* (unpublished data). Although genetic and micromorphological data are not yet available for *C. lutea*, it can be recognized readily and warrants description.

The ecology of *C. lutea* is quite distinctive within the section; not surprisingly, since its occurrence is so far removed from all the other species. All the sites occur in sandy soils overlying coquina limestone deposits, and the species shows a preference for the ecotone between the longleaf pine savanna and nonriverine swamp forest communities. Soil from a Lanier Quarry microsite for *C. lutea* had a pH of 5.6. This is similar to pH levels recorded at *Thalictrum cooleyi* H.E. Ahles microsites at the Lanier Quarry Savanna. *Thalictrum cooleyi* is the most frequent associate of *C. lutea*, and is similarly restricted in distribution. Soils not supporting *T. cooleyi* at the Lanier Quarry site regularly test at lower pH levels.

Most *Carex lutea* plants occur in the partially to moderately densely tree shaded savanna-swamp ecotone, with scattered shrubs and a moderate to dense herb layer. The savanna-swamp ecotone is subject to occasional to frequent fires which favor a herbaceous ground layer and suppress shrub dominance. *Carex lutea* is a subdominant to patch dominant at two of the five known sites. Occurrences are densest in areas of partial to moderate tree shading with an absence of a shrub understory. Frequent associates include *Taxodium ascendens* Brongn., *Liriodendron tulipifera* L., *Acer rubrum* L., *Myrica cerifera* L. var. *cerifera*, *Thalictrum cooleyi*, *Aletris farinosa* L., *Carex lonchocarpa* Willd., *Osmunda regalis* L. var. *spectabilis* (Willd.) A. Gray, *Physostegia purpurea* (Walter) S.F. Blake, and *Parnassia caroliniana* Michx.

Though the height of *Carex lutea* suggests that it might be easily found, the plants are slender, occur in areas with substantial graminoid cover, and, except for one site, are rare and localized. Thus, a colony may remain quite inconspicuous, even in fruit. This suggests the possibility that additional colonies may be discovered elsewhere in similar sites on the southeastern coastal plain, though the association with narrowly endemic species in an unusual habitat suggests that *C. lutea* may be a highly localized species.

The occurrence of a localized disjunct species of the boreal *Carex flava* complex on the outer coastal plain of North Carolina is quite striking. This constitutes a disjunction of about 750 km from the nearest known populations of other members of sect. *Ceratocystis*. In Eurasia, species of this complex occur as far south as Spain, Morocco, Turkey, and Iran. The most substantial range separation among close relatives in Europe is that between *C.*

viridula subsp. *brachyrrhyncha* vars. *elatior* and *nevadensis* (Boiss. & Reut.) Crins from southeastern France to southern Spain (ca. 800 km).

The type locality of *Carex lutea*, Lanier Quarry Savanna, and the other locations where it has been found are ecologically highly unusual and phytogeographically notable. The combination of fairly open conditions underlain by a calcareous substrate is very rare on the Atlantic coastal plain. Over 26 species regarded as rare in North Carolina by the state Natural Heritage Program are found at the Lanier Quarry site. Nine of these are listed as endangered, threatened or candidate species by the U.S. Fish and Wildlife service. Many of these rare plants have very restricted distributions, either being endemic to small areas or with highly scattered occurrences. The affinities of these taxa are variable, but include connections to the calcareous savannas of the Gulf Coast states, alkaline marshes of the Atlantic tidewater, calcareous glades, barrens, and prairies of the Appalachian region, and pinelands of the Carolinas and southern New Jersey. Most notable are the two endemic species closely associated with *Carex lutea*, *Thalictrum cooleyi* and an undescribed species of *Allium*. *Thalictrum cooleyi* is endemic to about a dozen sites, all savanna margins in sites underlain by calcareous deposits, in North Carolina, Georgia, and Florida. It has the highest ploidy level known in the genus (30× at 2n = 210), suggesting its derivation from a more widespread northern and inland species such as *T. revolutum* (Park 1992). The undescribed *Allium* is related to the widespread inland species *A. cernuum* Roth and *A. stellatum* Ker and is known from only 5 sites, four of them shared with *C. lutea*.

Because of their unusual edaphic conditions, these savannas underlain by calcareous deposits have evidently served as a small archipelago of phytogeographic islands for species poorly adapted to present conditions on the southeastern coastal plain. It seems likely that *Carex lutea* is a narrowly distributed, very rare endemic. It may reflect a southern extension of the *C. flava* complex during the Pleistocene glaciation, followed by isolation in a few suitable sites and speciation. Alternatively, *C. lutea* could represent the relictual occurrence of a formerly more widespread and older species in the *C. flava* complex.

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