



Invasive Grasses and Sedges: Deep-rooted Issues

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Invasive Sedges: Impending Problems

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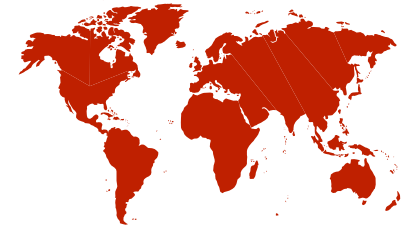
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Sedges have long been recognized among world's worst agricultural weeds.



Holm et al. (1977)

1st *Cyperus rotundus* L.

16th *Cyperus esculentus* L.

32nd *Cyperus difformis* L.

33rd *Cyperus iria* L.

40th *Fimbristylis miliacea* (L.) Vahl

Terry (2001). The Cyperaceae – still the world's worst weeds?

Characteristics of sedges promoting invasiveness



- Tolerance of a wide range of environments
- Rapid growth
- Vegetative reproduction or regeneration from fragments in perennials
- Anemophily
- Complex reproductive systems
 - Asexual + sexual modes
 - Partial autogamy
- Prolonged seed production
- Copious production of small seeds
- Adaptations for short- and long-range dispersal
- If perennial, plant brittle, so not easily drawn from ground
- Allelopathy
- C₄ photosynthesis

The world's worst weed!

Cyperus rotundus L. purple nutsedge

Aggressive perennial weed of
agricultural & urban areas

- Prolific production of rhizomes & tubers
- Seed rarely produced
- Rapid growth
- Allelopathy
- C₄ photosynthesis

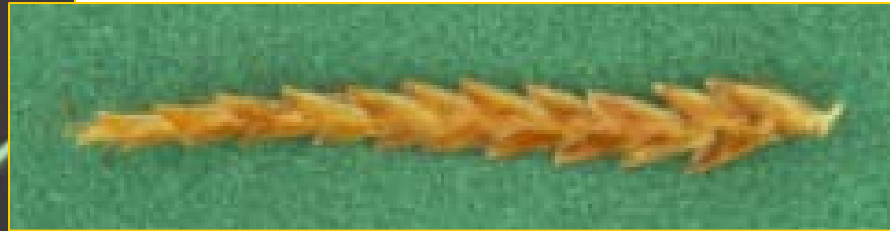


Purple nutsedge in cotton



Purple nutsedge growth in 60 days – Dr. Wills

Vegetative proliferation by rhizomes & tubers *Cyperus esculentus* L.



C. esculentus also reproduces from seeds.



Rhizomes with tubers



“Walking” vegetative proliferation of aerial stems

Eleocharis melanocarpa Torr.

Georgia, USA



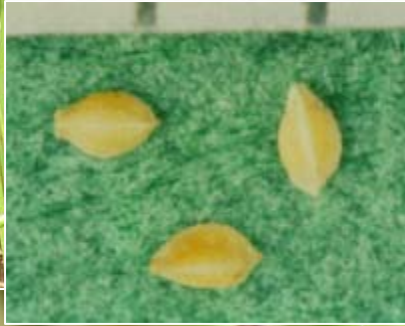
Anemophily

Fimbristylis puberula
(Michx.) Vahl

Exposed feathery,
stigmas promote
wind pollination



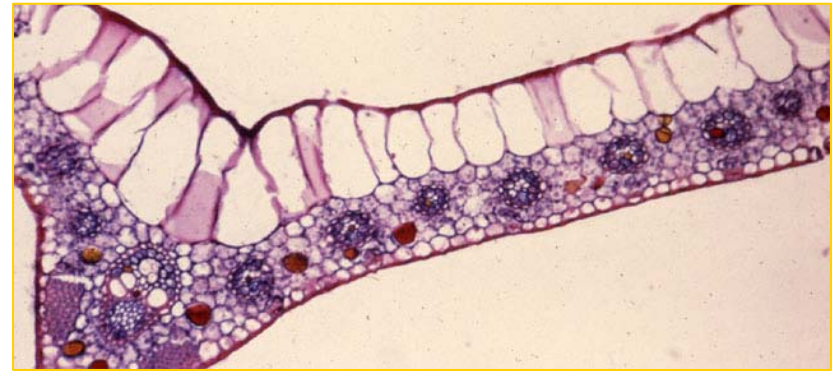
Copious production of small achenes,
short generation time
Cyperus difformis L.



C₃ & C₄ photosynthesis

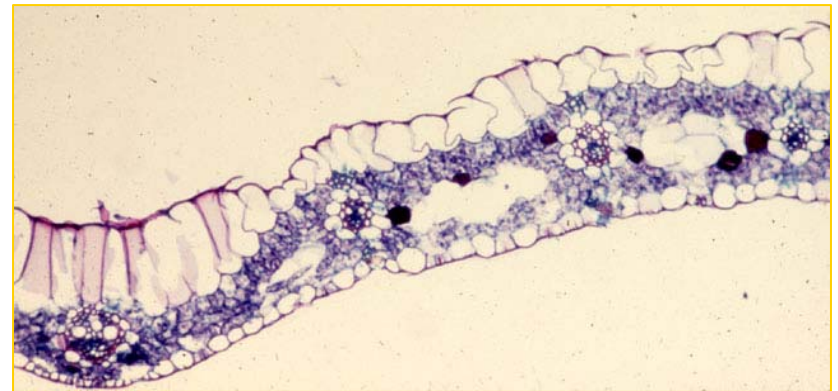
C₄ photosynthesis, kranz anatomy

- Many agricultural weeds
- Lower CO₂ compensation point
- Increased water use efficiency
- Plants more competitive
 - at higher ambient temperatures
 - during drought



C₃ photosynthesis, non-kranz anatomy

- Fewer weeds
- Plants generally adapted to hydric or mesic environments
- May be competitive in other ways in hydric or mesic environments



The process of invasion by plants



- Introduction – ***dispersal***
- Naturalization
- Facilitation
- Spread – ***dispersal***
- Interaction with other species
- Stabilization

Cronk & Fuller (1995)



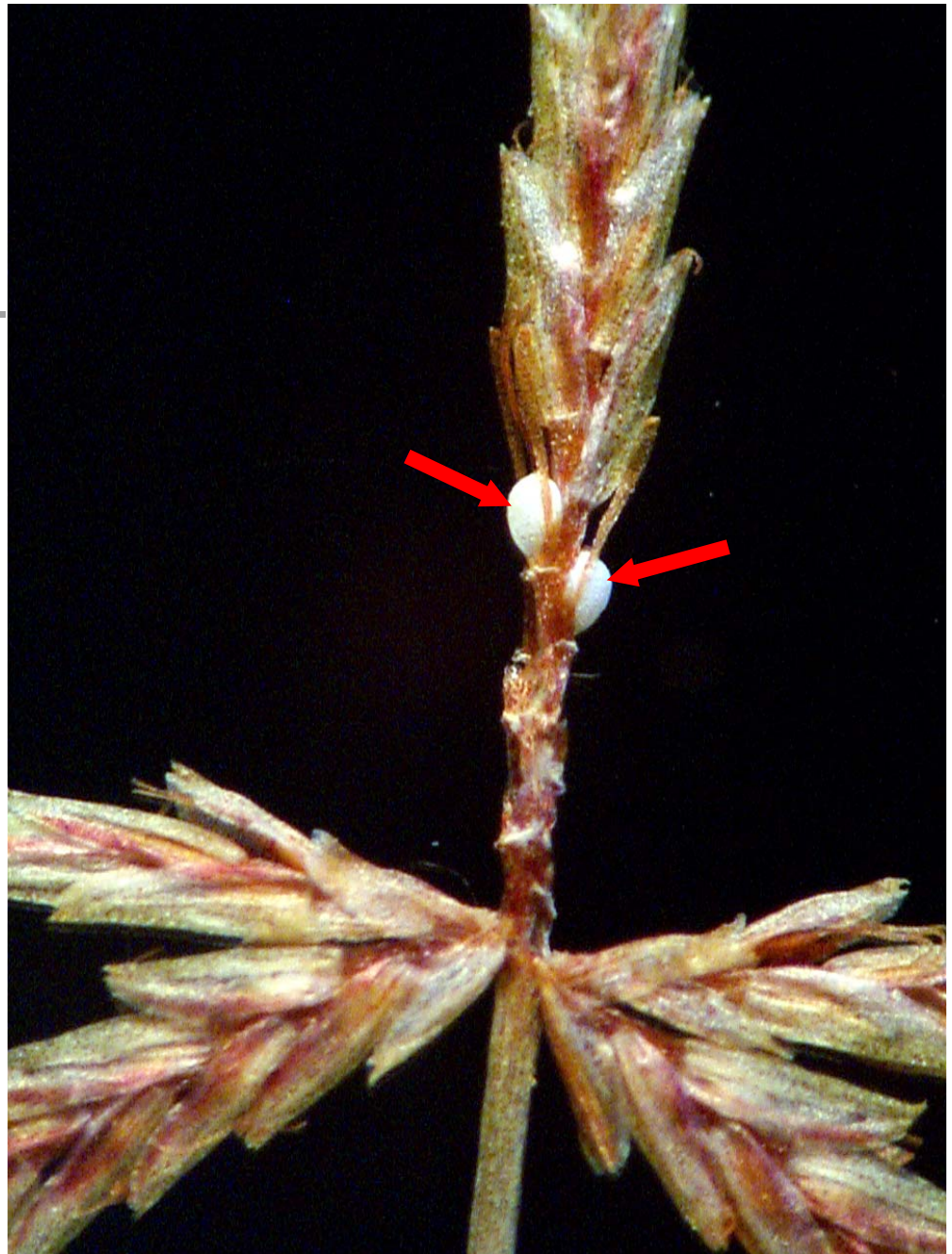
Natural dispersal of Cyperaceae

- Fragmentation
 - Rhizomes, stolons, etc.
- Hydrochory – water dispersal
 - General rain-wash
 - E.g., most species, local
 - Corky rachilla
 - Suberized pericarp
- Anemochory – wind dispersal
 - Perianth
 - Filaments
- Zoochory – dispersal by animals
 - Endozoic
 - Waterfowl
 - Aquatic/subaquatic spp.
 - Other birds
 - Cattle
 - Epizoic
 - Attachment to animal hair
 - Modified perianth
 - Modified spikelet
 - Modified rachilla
 - In mud adhering to feet of waterfowl
 - Springing spikelets – short distance
 - Production of food nodules

Dispersal of individual achenes

Cyperus haspan L.

Floral scales and achenes separate sequentially from base to apex of spikelet rachilla.



Dispersal of entire spikelet
Kyllinga odorata Vahl

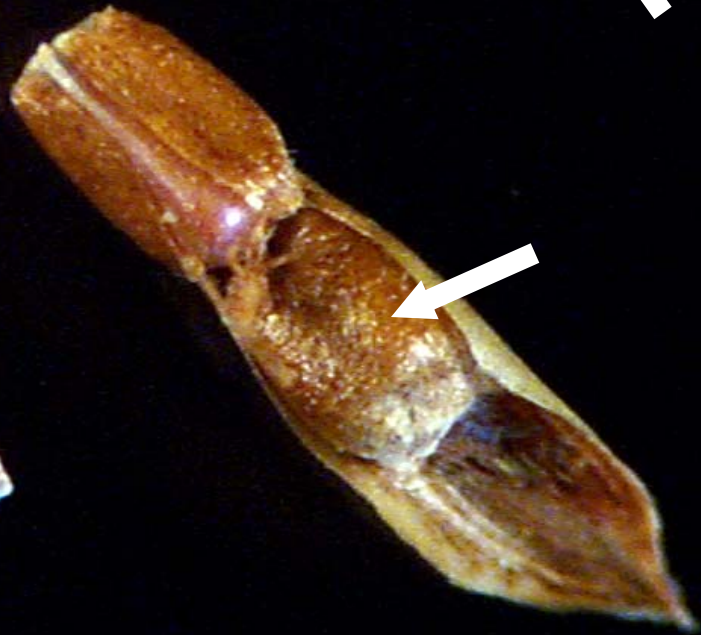


1 mm



--Spikelet breaking transversely into 1-2 fruited segments

--Water dispersal by corky rachilla

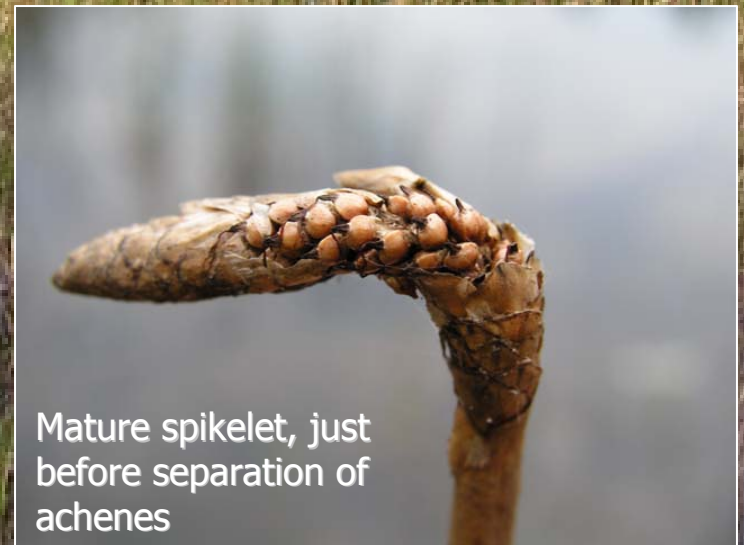


Cyperus odoratus L.

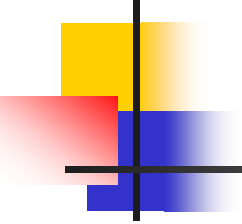
Endozoic dispersal of achenes by waterfowl

Eleocharis equisetoides (Ell.) Torr.

Flatwoods pond, Georgia, USA



Mature spikelet, just
before separation of
achenes



Epizoic achene
dispersal by toothed
perianth bristles

Eleocharis tuberculosa
(Michx.) R. & S.



Epizoid dispersal of spikelet
with pungent terminal scale
Cyperus plukenetii Fern.



Wind dispersal by persistent, silky perianth

Scirpus cyperinus (L.) Kunth





Wind dispersal of laminar spikelet
Kyllinga squamulata Thonn. ex Vahl

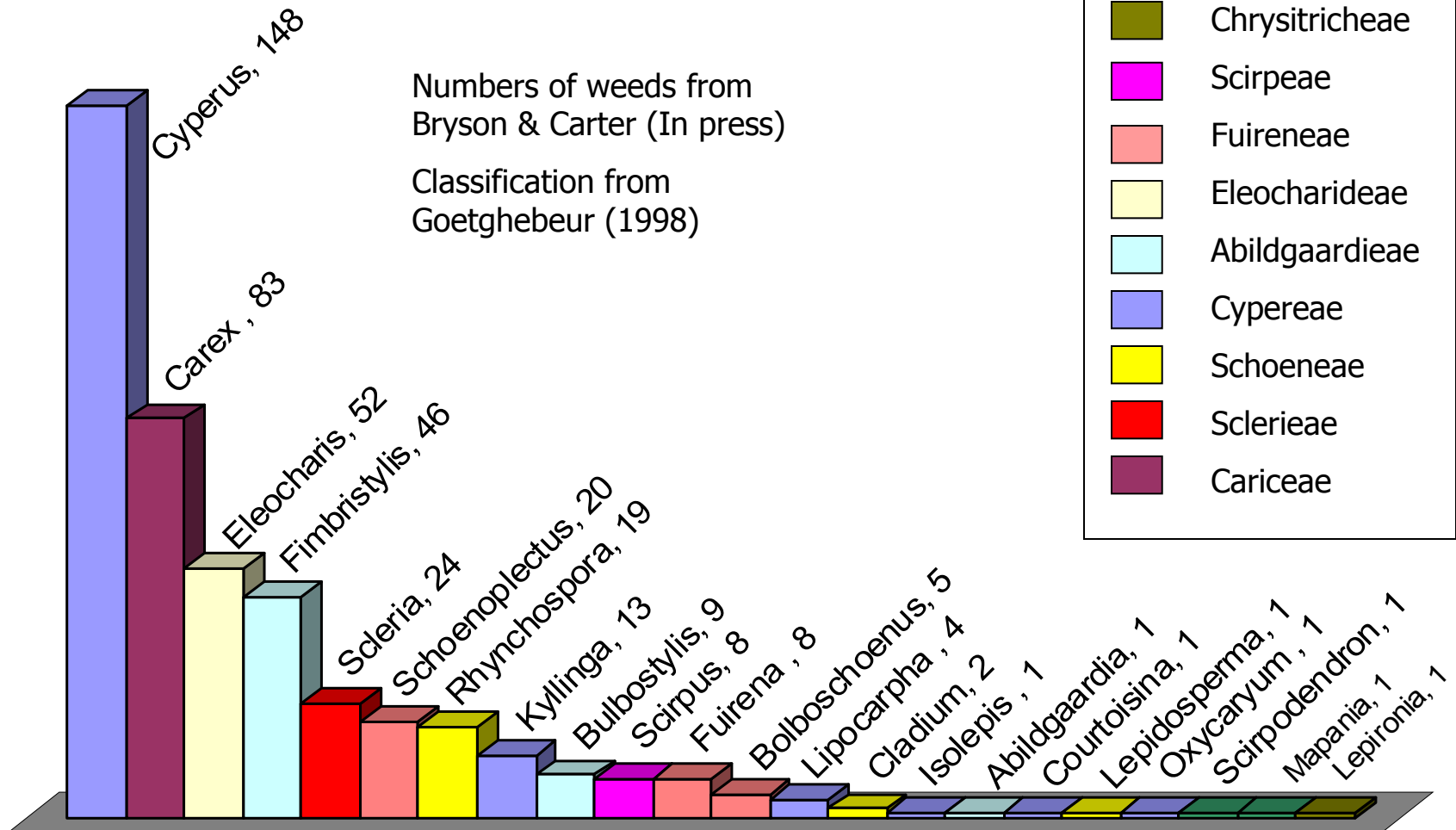
How many cyperaceous weeds are there?



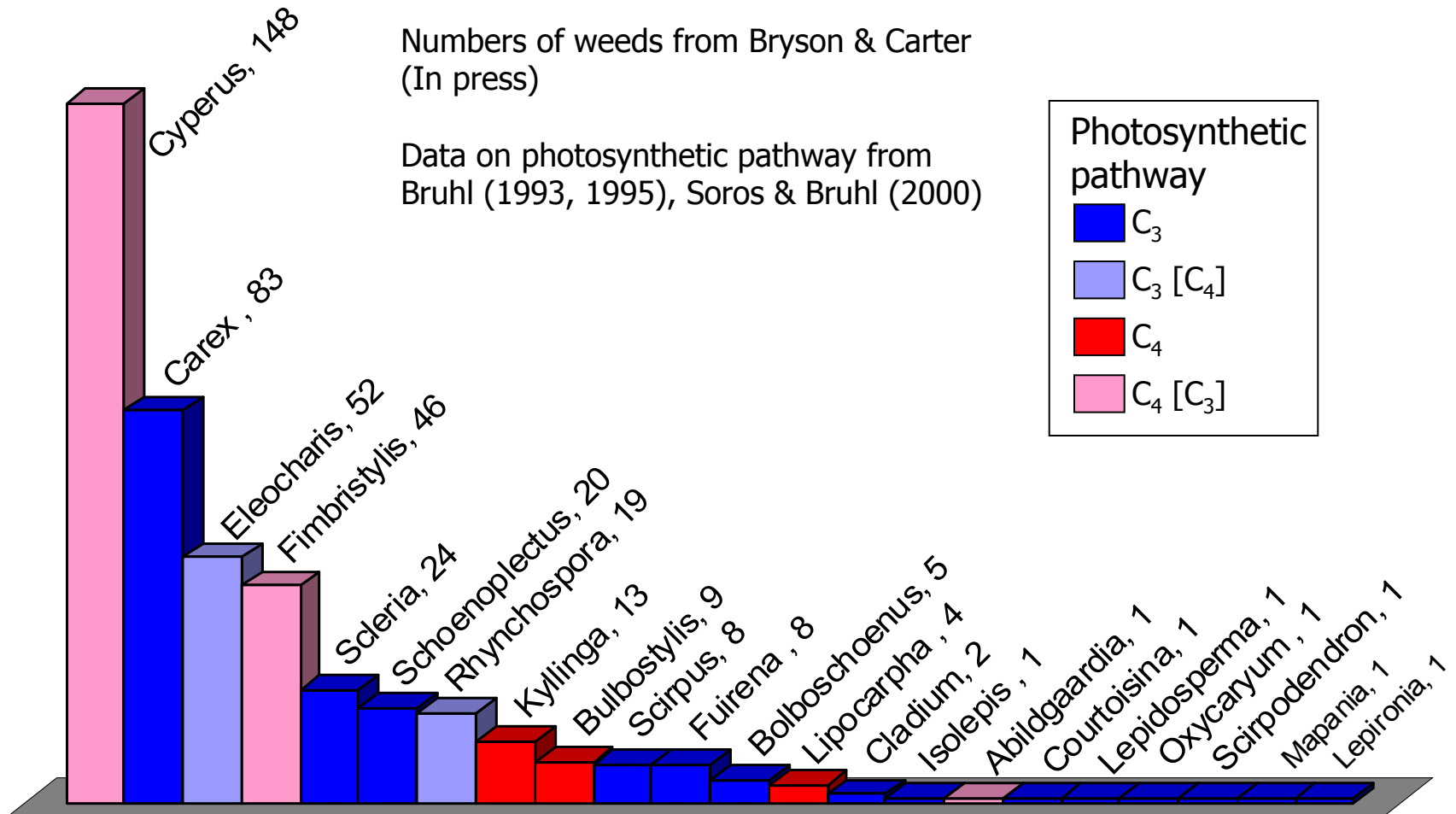
- Survey of more than 60 floras, weed lists, journal articles for references to sedge weeds
 - Explicit citations of 449 spp.

Bryson & Carter (In press)

Number of weed species by genus



C₃ & C₄ photosynthesis among weedy sedge genera





What role do human activities play in dispersal of sedges?

- Survey of literature for references to anthropogenic dispersal of sedges
 - >250 spp.

Bryson & Carter (In press)

Dispersal of sedges by humans



Unintentional dispersal

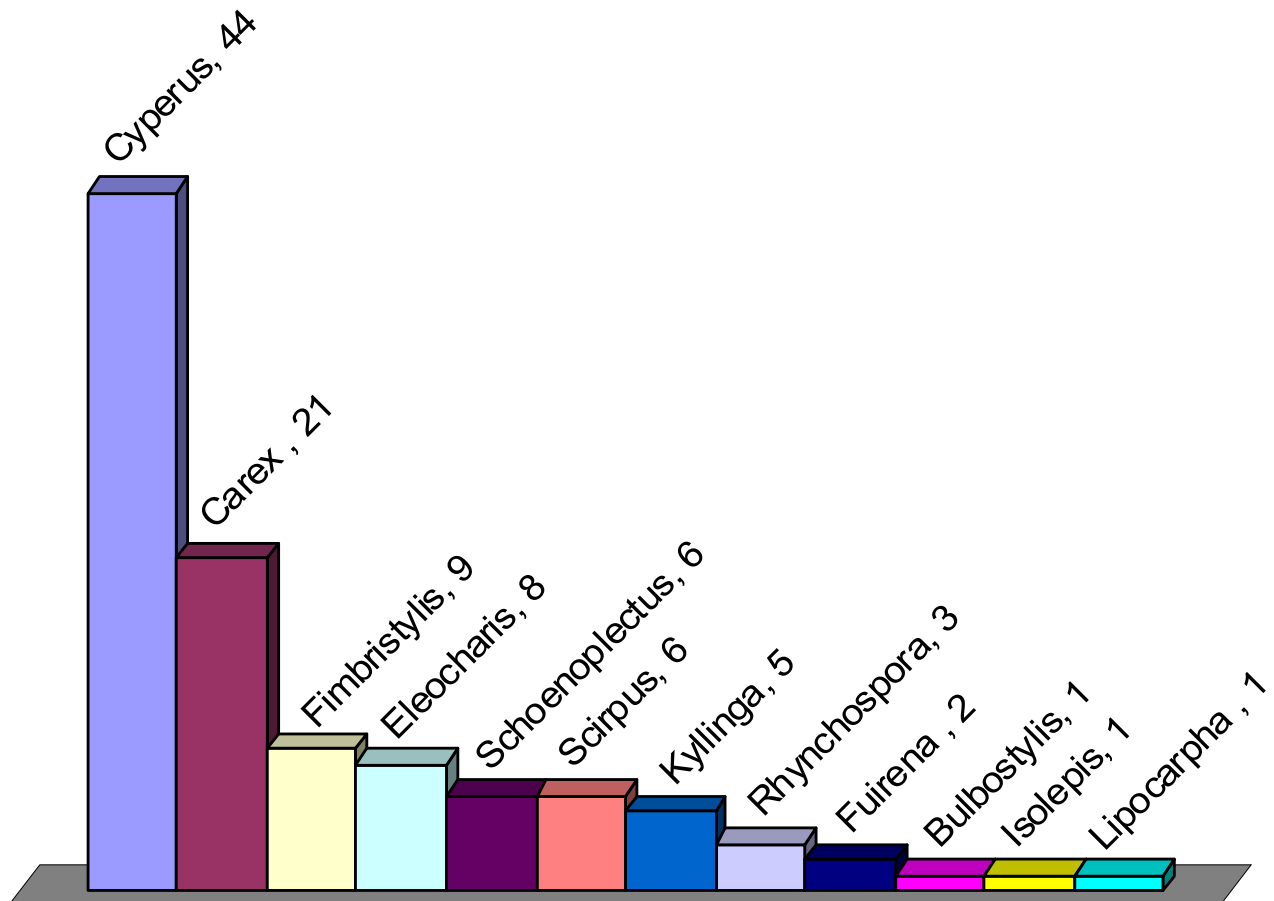
- Ballast
- Rice agriculture
- Wool aliens
- Roads
 - Construction & maintenance
 - Movement of traffic
- Railroads
- Airplanes

Intentional dispersal

- Use as ornamentals
- Use for re-vegetation
- Use for erosion control
- Use for water purification
- Misc.

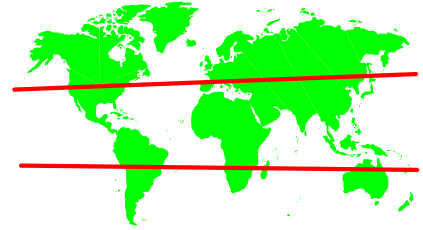
Number of weed species by genus, known or suspected to be dispersed by human activity

Data from Bryson &
Carter (In press)



Introduced with rice agriculture

Fimbristylis miliacea (L.) Vahl



- Probably indigenous to Asian rice belt (Kral 2002)
- Widely distributed in tropical & warm temperate regions of Eastern & Western Hemispheres
- Common weed of rice
- Numerous small seed



Dispersal along roads & railroads

Carex oklahomensis Mack.



Photos by CT Bryson



Dispersal along roads & railroads
Scirpus cyperinus (L.) Kunth
Georgia, USA

Dispersal in contaminated
hay & grass seed
Carex cherokeensis Schweinitz

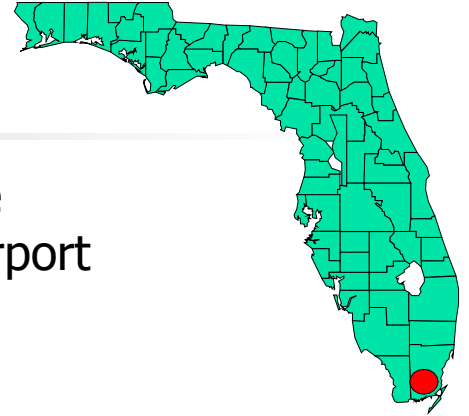


Photos by CT Bryson

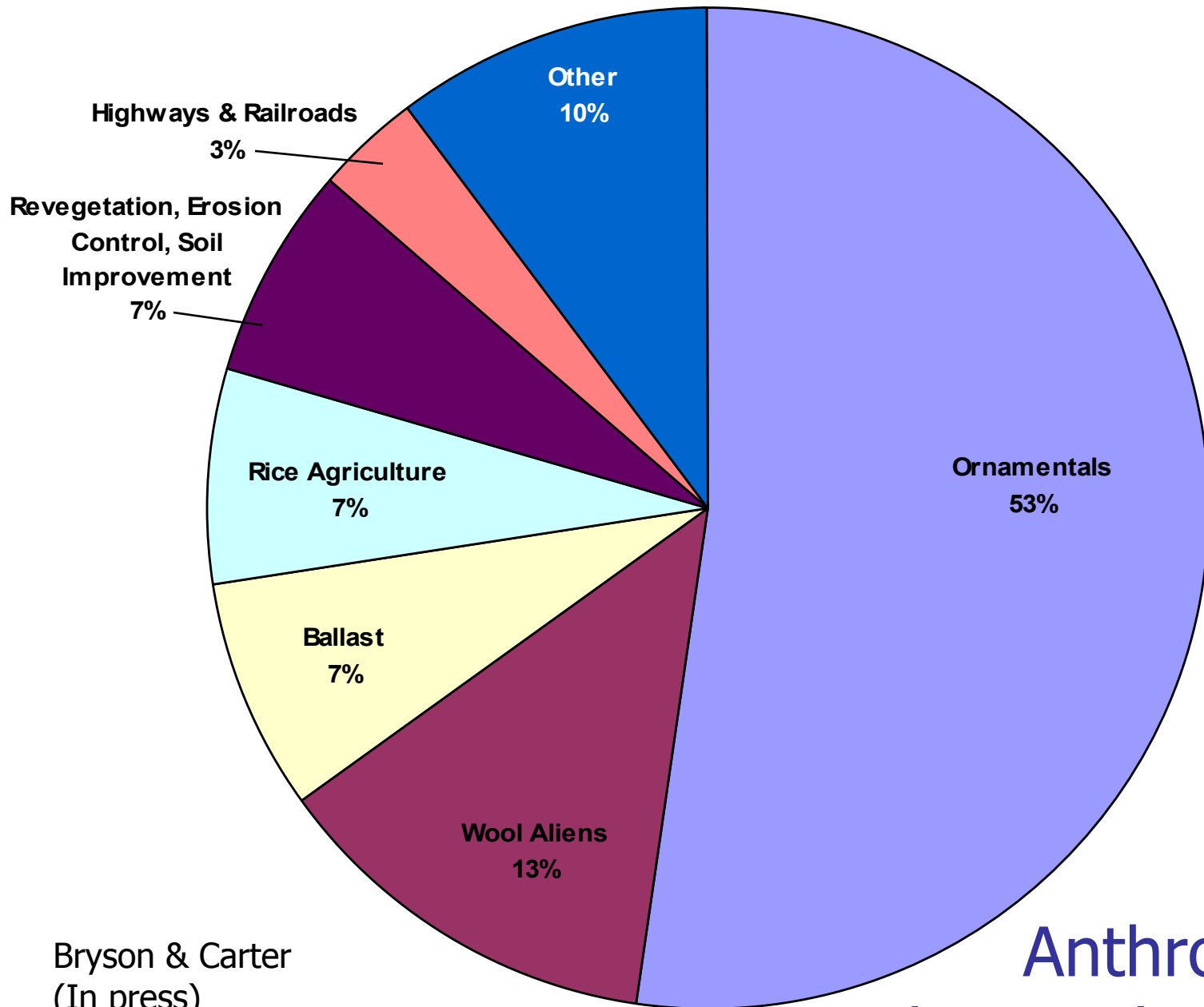
Long distance dispersal by airplane

Cyperus (subg. *Queenslandiella*) *hyalinus* Vahl

- Recently introduced into USA from E Hemisphere
- Found in 1999 adjacent to Miami International Airport (Carter & Mears 2000)



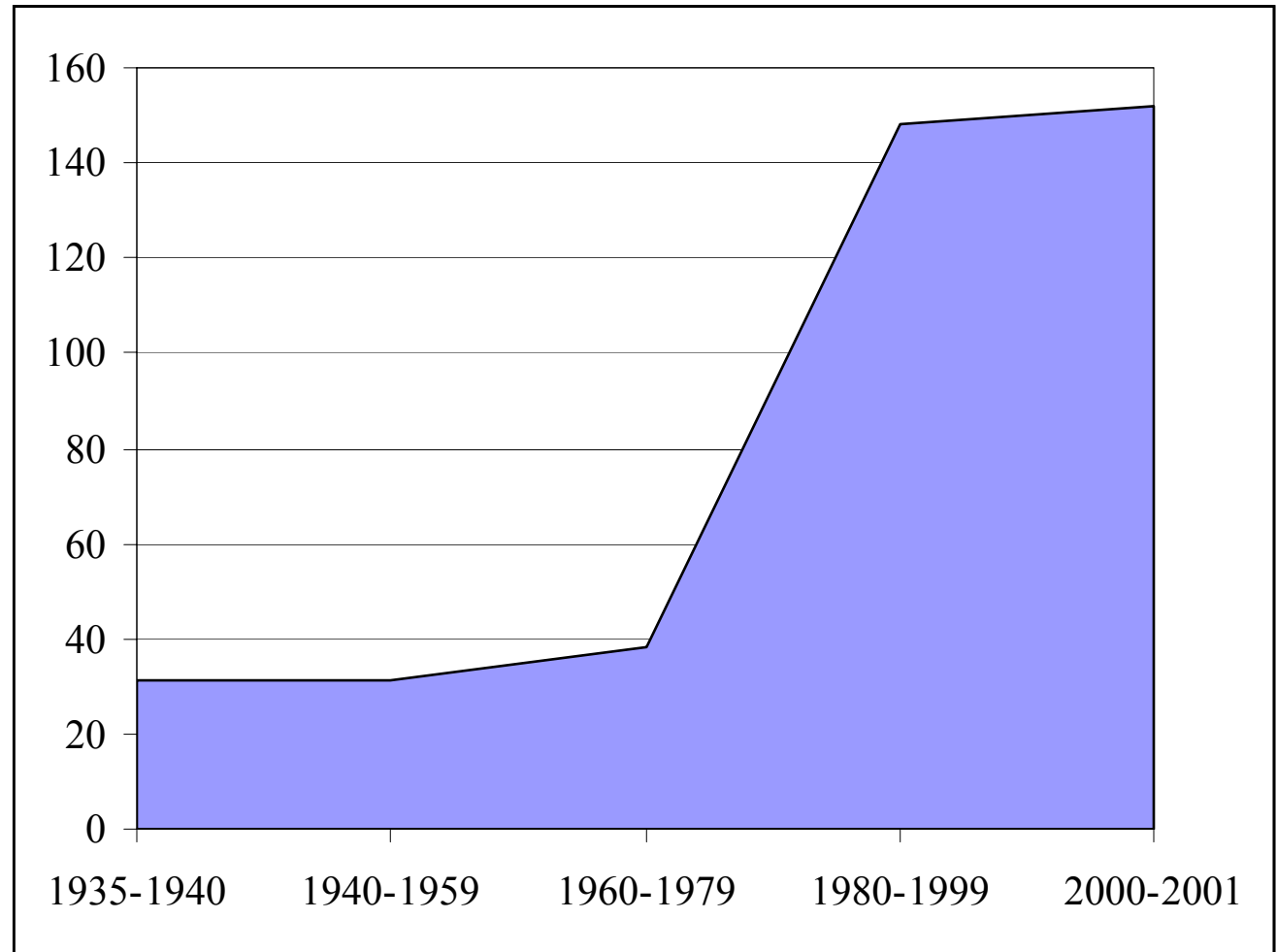
R. Mears



Bryson & Carter
(In press)

Anthropogenic dispersal of sedges

Horticultural references to sedges



Bryson & Carter
(In press)

Increased use of ornamental sedges



Cyperus cyperoides (L.) Kuntze for sale!

Valdosta, Georgia, USA

“De gustibus non est disputandum.”



Cyperus cyperoides



Cyperus papyrus L. cultivated in water garden



San Diego County,
California, USA



Cyperus involucratus Rottb.
cultivated in water garden
Lowndes County, Georgia, USA



Recent reports of sedges invading natural areas in USA

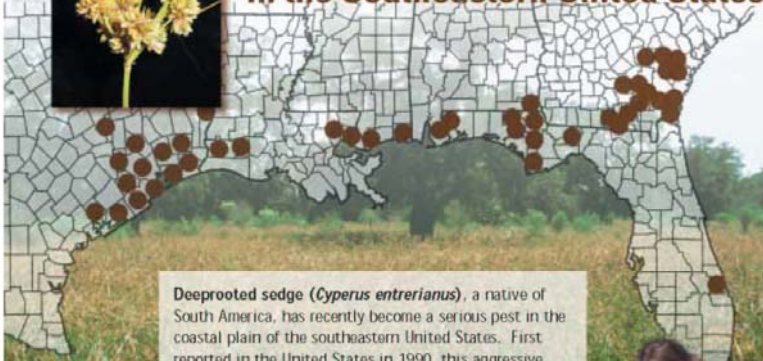
- *Cyperus alopecuroides* Rottb.
 - Florida, USA (Carter, Mears, Burks & Bryson, 1996)
- *Cyperus entrerianus* Boeck.
 - Texas, USA (Rosen, Carter & Bryson, in press)
- *Cyperus prolifer* Lam.
 - Florida, USA (Carter, Mears, Burks & Bryson, 1996)
- *Eleocharis acutangula* (Roxb.) Schult.
 - Florida, USA (Rosen, unpublished data)
- *Eleocharis mutata* (L.) R. & S.
 - Texas, USA (Rosen & Jones, 2004)
- *Oxycaryum cubense* (Poepp. & Kunth) Palla
 - Alabama, Georgia, USA (Bryson, MacDonald, Carter & Jones, 1996)
- *Scleria lacustris* C. Wright
 - Florida, USA (Jacono, 2001)

Cyperus entrerianus Boeck.

- Native of temperate S America, also known from Mexico
- Possibly introduced into SEUS with rice agriculture
- Earliest herbarium specimens from US date to 1941
- Early specimens misidentified as native species
- Not correctly identified and reported until 1990
- Now widespread in SEUS – TX to FL
- Seeds dispersed by road construction equipment, ROW maintenance equipment (mowing), and normal traffic





Deeprooted Sedge:

An Overlooked Aggressive Weed in the Southeastern United States



Deeprooted sedge (*Cyperus entrerianus*), a native of South America, has recently become a serious pest in the coastal plain of the southeastern United States. First reported in the United States in 1990, this aggressive weed is now well established in disturbed habitats in Texas, Louisiana, Mississippi, Alabama, Georgia, and Florida. Flooding, construction equipment, mowing, and soil moving activities, especially along highways, all spread its tiny seeds, resulting in infestations in new areas.

Currently deeprooted sedge is beginning to displace native vegetation even in undisturbed habitats. Without wide-spread control it will likely continue to spread rapidly, infesting agricultural, urban, forested, riparian, and other natural areas.



Prevention and control strategies

- Clean machinery, vehicles, equipment, clothing and other personal items after use in infested areas to avoid spread.
- Suppress seed production by repeated mowing at 2 to 4 weeks intervals.
- Use herbicides to control deeprooted sedge.

Check with the authors or your local Extension agent for advice on herbicide control.

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Identification and characteristics

Deeprooted sedge can be distinguished from its native relatives, Surinam sedge (*C. surinamensis*) and marsh flat-sedge (*C. pseudovegetus*) by its robust growth form, deeply set thick rhizomes, dark purplish black leaf bases, and glossy leaves.

Large plants can produce a million viable seeds per year, and this aggressive perennial can overwinter in much of the South. Preliminary studies suggest that populations will increase rapidly and potentially spread as far north as Arkansas, Tennessee, North Carolina, and even the coastal plain of Virginia



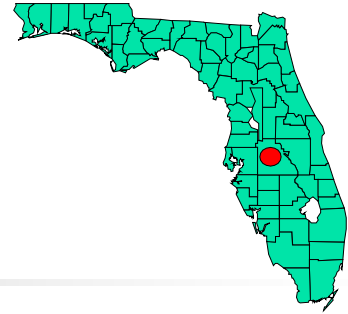
Cyperus prolifer Lam.

naturalized in Florida & Hawaii, USA

- Native E Africa
- Widely sold as ornamental for water gardens
- Naturalized & invasive in limesink ponds in Florida, forming floating mats along edges of ponds
- Naturalized in Hawaii (Strong & Wagner, 1997)



Cyperus alopecuroides Rottb. naturalized in Florida, USA



- Native – paleotropics
- Naturalized – West Indies & Florida
- Perennial
- Numerous, small achenes
- Invasive tendencies, forming floating mats in reclamation wetlands
- Potential threat to natural wetlands & limesink ponds in Florida





Wright's nut-rush
Scleria lacustris
Photo by Vic Ramey
Copyright 2001 Univ. Florida



Scleria lacustris
Photo by Vic Ramey
Copyright 2001 Univ. Florida



Scleria lacustris
Photo by Vic Ramey
Copyright 2001 Univ. Florida

Scleria lacustris C. Wright
Florida, USA (Jacono, 2001)

Eleocharis mutata (L.) R. & S.
Coastal fresh marsh, Brazoria NWR,
Texas, USA (Rosen & Jones, 2004)

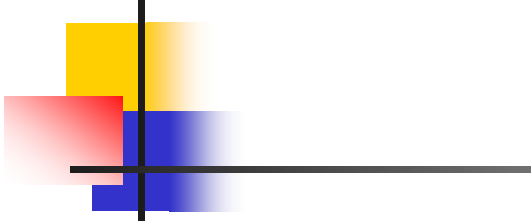


Photograph by D.J. Rosen



Eleocharis acutangula (Roxb.) Schult.
Florida, USA

Oxycaryum cubense (Poepp. & Kunth) Palla



Impounded bayswamp
Georgia, USA



- Broad, paleotropical & neotropical distribution
- Perennial, spreading locally by stolons, forming extensive floating mats in swamps & ponds
- Known from SE USA pre-1900 – TX, LA, s AL, FL
- Currently spreading in SE USA
 - 1996 – s GA
 - 2004 – Tennessee-Tombigbee River system in MS & AL



Oxycaryum cubense
fo. *paraguayense* (Maury) Pedersen

monocephalous form

Achene with corky pericarp,
dispersed by water





Communities at risk

- Aquatic systems & wetlands
- Grasslands
- Beaches & dunes
- Forests



Conclusions

- Sedges are highly competitive and well adapted for dispersal and to diverse environmental conditions and human disturbance.
- The continued disturbance of ecosystems by humans will promote invasion by additional sedge species.
- The unprecedented frequency of distant travel by humans and transportation of cargo will continue, increasing the probability of long-distance dispersal of sedges.
- Heightened interest in the use of sedges as ornamentals will increase the intentional dispersal of a greater diversity of sedge species.
- As a greater diversity of non-indigenous sedges is introduced, the potential for occupation of a much greater array of ecological niches will increase.
- If the importation and movement of sedges is not regulated and curtailed, natural communities that were previously little threatened by non-indigenous sedges will be placed at risk; e.g., aquatic systems, wetlands, forests, grasslands, beaches & dunes.



Solutions

- Education – Increased emphasis in university curricula on systematic botany, field botany & plant ecology
- Increased support for thorough floristic inventories of natural areas
 - Short-term support to obtain reliable base-line data on the current state of ecosystems
 - Long-term support to monitor ecosystems for changes
- Increased interdisciplinary collaboration among botanists, weed scientists, horticulturists, restoration ecologists, natural resource managers, and representatives of governmental agencies
- Increased international collaboration to exchange data and ideas about actually and potentially invasive species at home and abroad

*Without vigilance and action,
this could become...*



Carolina bayswamp
Grand Bay WMA, Georgia, USA

this!

Impounded bayswamp
infested with *Oxycaryum cubense*
Lowndes County, Georgia, USA



Acknowledgements

- Faculty Development Fund, Valdosta State University
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