The origins of turfgrass species

Before spiked shoes and triplex mowers,
hooves and teeth shaped the grasses we play on.

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The ancient history of our modern grass species may seem irrelevant in this age of high-performance hybrids, test-tube cultivars and genetic engineering. We're wise to remember, however, that nature has had a head start of many millions of years in which to influence the characteristics of the grasses on today's golf courses.

As much as we may wish to plant bentgrass in southern Florida or zoysiagrass in northern Michigan, those centuries of evolution and adaptation remain a hindrance. Each grass species tends to thrive best under climate and soil conditions similar to those in its region of origin. When a species is planted in climatic or soil conditions remote from its most favorable growth environment, it becomes increasingly prone to damage by environmental, biological and soil stresses. In addition, it usually requires more water, nutrients, energy or cultural inputs to maintain turf quality.

Thus, it's useful to look at the ancestral roots of our grasses to better understand where to plant these species today, especially if minimizing resource inputs is a high priority. Grasses need not be native to thrive, but they do need to be adapted to the environments in which they're placed.

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Grazing animals have shaped the evolution of grasses on multiple continents.

RESEARCH

Turfgrasses in world history

As continents have drifted apart and climates have changed, turf-type species have slowly evolved from earlier forms of plant life.

Era	Period	Epoch	Duration
Mesozoic	Triassic		45 million years
	Jurassic		70 million years
	Cretaceous	Early	40 million years
		Late	30 million years
Cenozoic	Tertiary	Paleocene	12 million years
		Eocene	16.5 million years
		Oligocene	9.5 million years
		Miocene	17.7 million years
		Pliocene	3.7 million years
	Quaternary	Pleistocene	1.6 million years
		Holocene	0.1 million years

R E S E A R C H

Major events – grass and plants	Other events
Evolution of gymnosperms (ferns, cycads, conifers) that have naked seeds (without an enclosing ovary)	Arid climate Primitive dinosaurs and mammals on land Reptiles and dinosaurs dominant
Spread and diversification of gymnosperms – firs and cypresses	Mild, moist climates Evolution of frogs First birds
Angiosperms, or vascular-seed plants, evolve – have seeds in an ovary	Land masses begin to move apart Seas flood half the land Insects spread
Evolution of nongrass flowering plants	Mild climate Extinction of large reptiles and all dinosaurs
Fossils record oldest evidence of grass pollen Flowering plants become more successful	Seas retreat South America isolated Rapid spread of mammals Early herbivorous mammals Rockies first appear
Mangrove flora **More grass pollen recorded in fossils** **Primitive C3 grasses evolve**	Warm climate North America and Europe separate Seas flood the land Mountains rise Modern mammals emerge
Abundant grass pollen fossils form **Grasses diversify** **Trees and grasses cover much of land**	Climate cools Australia separates from Antarctica Trend toward drier climates
Tropical flora develop **Large grasslands form** **C4 grasses evolve**	Sea levels fall Himalayas, Andes rise, Rockies re-emerge Golden Age of mammals – greatest diversity *Bovidae* evolves in Europe – sheep, goats and cattle
Expansion of grasslands **Grasslands replace many African forests**	Climate cools Continents move to present positions Grazing hooved animals successful *Bovidae* invade Africa Human ancestors appear in Africa
North American native grasses emerge	Ice Age covers northern lands Sea levels fall Man appears, develops hunting skills Many mammals become extinct
Present flora and fauna **Turfgrass use developed (last 1,000 years)** **Natural selection of cultivars in mowed turf**	Withdrawal of ice sheets Development of agriculture Apparent dominance of humans

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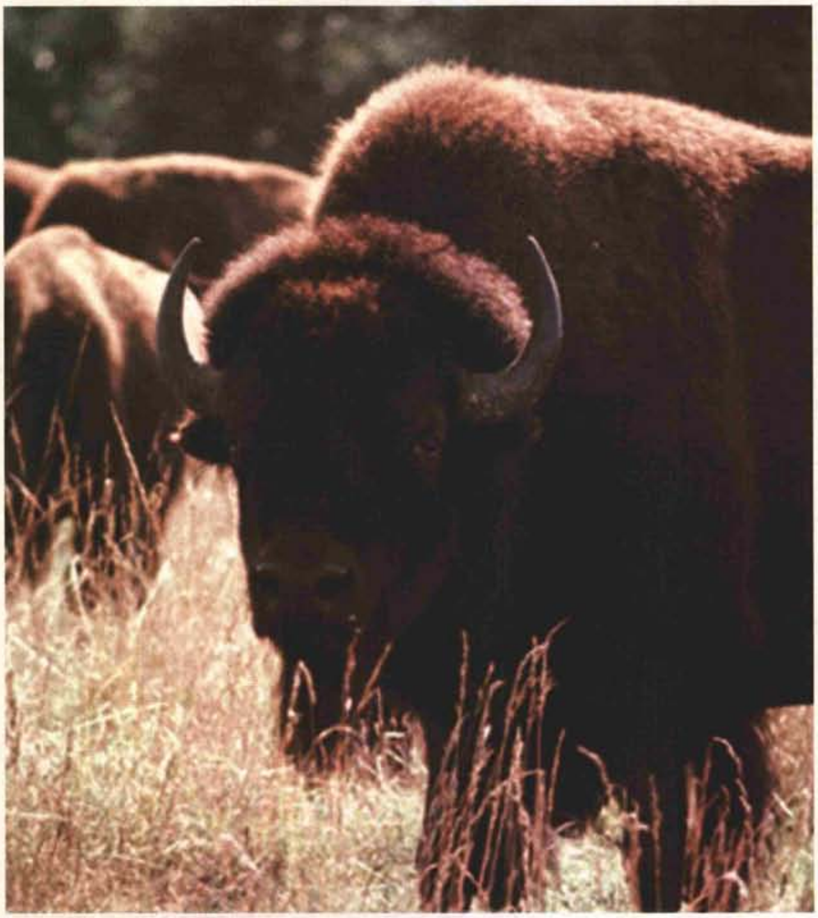
Grazed grasslands

The evolution of *Poaceae* (formerly known as *Gramineae*) as a distinct class of angiosperms (flowering plants) is recorded in very limited fossil records. It apparently occurred at least 45 million years ago during the Paleocene Epoch of the Tertiary Period, which is very late in the Earth's history. The earliest grasses were probably herbaceous perennials (unlike bamboo, for instance).

As these species evolved, grasslands developed into an important vegetative ecosystem during the Miocene Epoch. Eventually, the grasses evolved into one of the largest families of angiosperms, with more than 600 genera and 7,500 species.



Many grasses became shorter under grazing pressures.

From the grasses' standpoint, it's significant that herbivorous grazing animals also evolved during the Miocene Epoch. These mammals would be classed in today's *Bovidae* family, which encompasses sheep, goats and cattle. The grazing mammals adapted well to the evolving grasslands.

As grazing pressures increased on these grasslands with burgeoning herds of *Bovidae*, the grasses had to adapt to survive. The result was lower-growing grass species. As the herbivorous mammals in turn developed abilities for closer grazing, natural selection occurred in favor of grasses that were structurally adapted to survive the severe defoliation.

This co-evolution between low-growing grasses and herbivorous grazing animals continued over an estimated 40 million years, resulting in grasses that feature leaves with basal meristems, shoots with short basal internodes termed "crowns" and prostrate, creeping growth habits via lateral stems termed "stolons" and "rhizomes."

These morphological adaptations have eventually allowed these grasses to be used as turf under close, frequent mowing conditions.

Determining the origin of a particular grass species is not an exact science. Generally, the location with the greatest diversification of genotypes is assumed to be a genus' or species' region of origin. These locations tend to attract plant breeders and geneticists in pursuit of innovative "new" germplasm.

Cool-season turfgrasses

Grasses with the C_3 photosynthetic system are cool-season perennials. They evolved much earlier than the more-complex C_4 warm-season turfgrasses. The turf-type C_3 species evolved almost exclusively in the cool Eurasian geographical region in forest-margin areas.

This is also the area where the close-grazing sheep, cattle and goats became domesticated. The region is characterized by a cool, temperate climate, plus reasonably good precipitation and soil fertility.

To be sure, North America is host to many native cool-season species within the same genera as the common turf-type grasses. These have rarely been cultivated, perhaps in part because so many European types were already in widespread use by the time the North American species became known to European immigrants. Also, these native species are often confined to extremely specialized ecological niches, such as rocky tundra areas, and they are poorly adapted to the climates, soil types and expectations predominant in turfgrass culture.

Agrostis

Turf types in the bentgrass genus are thought to have originated under the cool continental climate of central Europe in an environment characterized by lowland fringe-forest zones of partial shade and minimal moisture stress on poorly drained clay soils.

Turf-type species include creeping bentgrass (*Agrostis stolonifera*), colonial bentgrass (*A. capillaris*) and velvet bentgrass (*A. canina*).

The species characterizations among the *Agrostis* are unresolved and need additional taxonomie studies. The modern *Agrostis* cultivars tolerate close, frequent mowing while sustaining good shoot density.

Festuca

The turf-type fescues' geographical origin is also in Europe. Tall fescue (*Festuca arundinacea*) evolved in the southern part of the continent, where summers were characterized by higher temperatures and less rainfall than in other regions. The cool forest regions of the Alps produced the turf-type fine-leaf fescues, including hard fescue (*F. longifolia*), sheep fescue (*F. ovina*), meadow fescue (*F. pratensis*), and red and Chewings fescue (*F. rubra*). Modern fescue cultivars are adapted to shaded environments and low fertility levels.

Lolium

Turf-type ryegrasses apparently originated in southern Europe and the temperate regions of western Asia around the Mediterranean Sea to northern Africa. Both perennial ryegrass (*Lolium perenne*) and annual ryegrass (*L. multiflorum*) have a bunch-type growth habit. Their limited shade adaptation suggests they originated in open to fringe areas interspersed in woodlands.

Poa

Turf-type bluegrasses evolved in European geographical areas characterized by cool continental climates and probably by open areas interspersed in forests on relatively fertile soils. Rough bluegrass (*Poa trivialis*) is thought to have evolved in the cooler, northern fringe-forest regions of Europe under relatively wet climatic and soil conditions on clay soils. Most modern Kentucky bluegrass (*P. pratensis*) cultivars have very poor shade adaptation, while rough bluegrass cultivars are adapted to wet, shaded environments.

Warm-season turfgrasses

The C_4 photosynthetic ability in warm-season grasses evolved out of cool-season species at a much later time in the Earth's history and in much greater diversity of geographical locations around the world. The complex metabolic processes greatly improved the energy efficiency and productivity of grasses under high light intensity.

The C_4 grasses generally evolved close to the equator under warm, sunny climatic conditions.

Cynodon and *Pennisetum*

The turf-type bermudagrass species include *Cynodon dactylon* (dactylon bermudagrass) and *C. transvaalensis*

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(African bermudagrass). Along with kikuyugrass, these species evolved in eastern Africa in the Kenyan and Ugandan regions under grazing pressure from large herds of unique African hooved animals that migrated from Europe.

The dry summers of this subtropical climate resulted in grasses with relatively deep, extensive root systems, low evapotranspiration rates, extensive lateral stem production and very good drought resistance. Modern *Cynodon* cultivars have retained water-conserving characteristics but lack shade adaptation. Sterile bermudagrass hybrids have been developed into cultivars that tolerate close, frequent mowing.

Paspalum

East-central South America produced the *Paspalum* genus, of which bahiagrass (*P. notatum*) and seashore paspalum (*P. vaginatum*) are the principle turf species. These species probably evolved in the area from Argentina north into Brazil somewhat later than Africa's *Cynodon* and *Pennisetum*.

Horses in this subtropical region of South American may have provided the grazing pressure on *Paspalum*.

Zoysia and Eremochloa

C_4 improvements came late to southern China and the rest of southeast Asia, as the *Zoysia* and *Eremochloa* genera evolved later than most perennial, warm-season grasses.

These two genera evolved in open habitats under a tropical climate characterized by hot, humid summers with a large amount of precipitation distributed throughout much of the year. Today's turf-type cultivars of Japanese zoysiagrass (*Zoysia japonica*), Manila zoysiagrass (*Z. matrella*) and centipedegrass (*Eremochloa ophiuroides*) still possess short root systems and limited drought resistance.

Stenotaphrum and *Axonopus*

Wet, poorly drained soils combined with high rainfall and humidity gave rise to St. Augustinegrass (*Stenotaphrum secundatum*), common carpetgrass (*Axonopus affinis*) and tropical carpetgrass (*A. compressus*). The turf types of these two genera apparently originated in the open tropical habitats of the eastern regions of the American continents, including the West Indies.

Modern St. Augustinegrass cultivars thrive in Florida and along the Gulf Coast under conditions like those that produced the genera. They tend to be strongly stoloniferous, with many cultivars exhibiting reasonably good shade adaptation but requiring relatively high mowing heights.

Buchloe and *Bouteloua*

The semi-arid and arid Great Plains have also produced warm-season C_4 grasses, although there is some evidence that their progenitors evolved in Eurasia. American buffalograss (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*) and side-oats grama (*Bouteloua curtependula*) evolved under the grazing pressure of North American bison, antelope and deer, which did not develop mouth parts capable of very close grazing.

These grass species tend to have relatively low shoot densities and are not very competitive, although breeding and selection efforts have made dramatic improvements in buffalograss. They survive drought by escaping to dormancy rather than through any inherent

Photo by Mark Kind

Kentucky bluegrass isn't from Kentucky originally, but this European species has readily naturalized in many areas of North America, including the Pacific Northwest.

Native vs. naturalized grasses

A grass species that originates and subsequently persists in a specific region is referred to as a "native" grass. Until humans began moving among the continents, oceans limited the range of grasses to their regions of origin. But as farmers, herdsmen, gardeners and other people began crossing the seas, they often brought grass seeds with them. Often, those "introduced" grasses would become "naturalized" in the new regions. They adapted if necessary and became established without need of cultivation.

In recent decades, native grasses have often been touted for landscape use on the premise that they have superior adaptation over any introduced grass. While it's appropriate and fortunate that some people are interested in propagating, sustaining and even improving native grass stands in various climates, laws and regulations that force the use of native grasses are ill-advised.

In fact, many introduced grasses are just as well adapted as native species and would likely be natives themselves if their movement hadn't been hindered by oceans for millions of years. Kentucky bluegrass (*Poa pratensis*) was introduced to North America more than 400 years ago and is well adapted to wide regions of the continent. If humans disappeared from the Earth tomorrow, Kentucky bluegrass and many other introduced grass species would continue to persist where they've naturalized.

dehydration tolerance. Compared with moist climates, arid environments rarely allow pathogen pressures, so these High Plains genera have had little natural selection for disease resistance.

Improving the species

Today, researchers are striving to expand the range and uses of our traditional turfgrass species. They've had some success in producing cool-season cultivars for the South and warm-season cultivars for the North.

Nevertheless, caution is recommended. Whenever a well-adapted species is available in a particular climate, its cultivars deserve serious consideration for planting. The probable result is vigorous growth, resistance to disease and satisfied golfers. ■

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