Exploration for Zoysiagrass In Eastern Asia

by J. JACK MURRAY and M. C. ENGELKE*

GENETIC DIVERSITY within a plant species is the hammer and nails needed by plant breeders to develop superior varieties. Considerable effort has been taken to collect and conserve genetically diverse germplasm of major crop species, such as wheat, barley, corn, soybeans, and forage crops. By comparison, little effort has been made to collect and conserve germplasm of turfgrass species. With a few and notable exceptions, representation of primitive and wild germplasm of turfgrass species in existing collections is scant, rarely representative of the genetic diversity that exists in the geographical center of origin of the species, and was probably collected by someone not familiar with desirable turf-type characteristics. Thus, the germplasm needed by breeders attempting to develop improved turfgrass varieties for the future is not readily available.

Interest in and concern about the current and future availability of genetic resources have increased in recent years. The reasons for this are many. The emphasis by turfgrass breeders today is focused on developing improved varieties with lower maintenance requirements in terms of labor and energy savings, and adaptability to adverse environmental conditions. This shift in breeding objectives, requiring genetically different germplasm, and the realization that many of the centers of germplasm diversity that have remained undisturbed for hundreds of thousands of years are rapidly disappearing because of population increase and land development. This has led to the general realization of the inadequacy of present turfgrass germplasm as well as the urgency to broaden its genetic variability by the collection and preservation of diverse germplasm.

The Research Advisory Committee of the USGA's Green Section recognized the need to increase the germplasm available for turfgrass breeding projects. They have recently been instrumental in providing funds for two exploration trips:

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A GREEN SECTION RESEARCH PROJECT

one to collect bermudagrass (*Cynodon* spp.) in South Africa (see article in July-August, 1982, GREEN SECTION RECORD) and one to collect zoysiagrass (*Zoysia* spp.) in Southeast Asia. We believe these are the first explorations made specifically to collect germplasm of turfgrass species. Hopefully, the Research Committee's initiative can be expanded to a cooperative global network with international participation for germplasm collection and conservation of the major species.

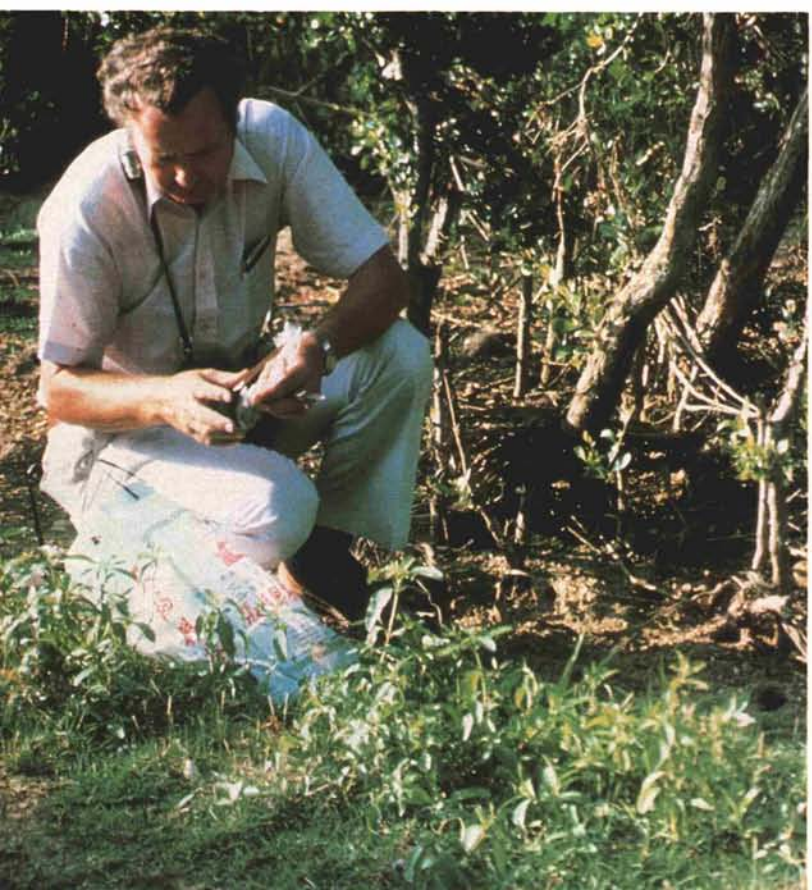
The authors submitted a proposal to the United States Golf Association and to the United States Department of Agriculture in 1981 for joint funding of an exploration of zoysiagrass germplasm to the Orient, where the species has evolved, i.e., its center of origin. Funding was approved by both organizations for travel in the spring of 1982. The trip began on May 14 and included about two weeks in each of four countries — Japan, South Korea, Taiwan, and the Philippines.

Samples were collected from as far north as 43°N latitude (equivalent to Milwaukee, Wisconsin) to as far south as 9°N latitude (equal to Panama). Samples of each of the three recognized species of zoysiagrass were collected, i.e., *Z. japonica, Z. matrella*, and *Z. tenuifolia*. Samples were also collected of two species identified in the Orient as *Z. macrostaycha* and *Z. sinica*. Samples of other grass species were collected, including bermudagrass, Kentucky bluegrass, bentgrass and fescues. The entire collection consisted of 421 samples from Japan, 261 from Korea, 53 from Taiwan, and 62 from the Philippines. All samples collected were shipped to the United States and are presently growing under greenhouse conditions.

PRIMARY EMPHASIS during the trip was to collect as much genetically diverse zoysiagrass germplasm as possible from diverse environmental niches. Many of the samples collected were existing in the wild with no fertilization or supplemental irrigation, under heavy traffic, close constant grazing, or modest to heavy shade. Samples were obtained from under seven inches of snow with good color, from salt beds, cattle and horse pastures, volcano craters, parks, cemeteries, and golf courses. Considerable differences were observed among samples in color, growth and flowering habit, leaf texture, disease resistance, and adaptability to low-maintenance environments.

Zoysiagrass grows wild throughout Japan. It was found as far north as Otura, on the northern coast of Hokkaido, the northernmost part of our trip (43°N latitude). Samples were collected from golf course fairways that had been overseeded with Kentucky bluegrass but remained about 50 percent native zoysiagrass. Along the southern coast of Hokkaido, samples were collected from unimproved range land being grazed by cattle, and along the seacoast. The soils in this area are coarse volcanic ash and droughty. The growing days are short, due to the northern latitude and frequent morning fog.

In the Hatochimatia mountains, in central Japan, we experienced subfreezing temperatures and approximately seven inches of snow at elevations of 3,000 to 4,000 feet. We randomly sampled zoysiagrass pastures at 150-foot intervals, as this area was totally under snow. Many samples appeared dormant, but a



(Above) The zoysias.

(Left) Collecting on Taiwan.

few showed definite green color. Considerable winter hardiness, drought tolerance, and fall color differences should exist among these samples.

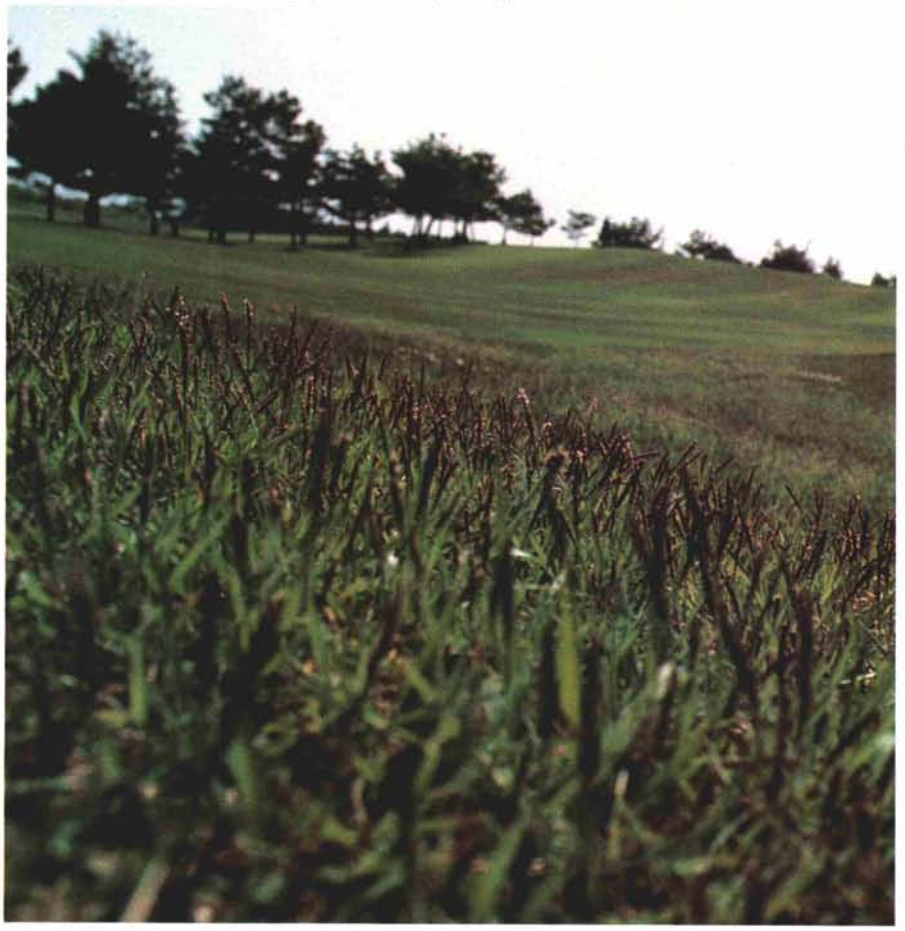
In Tokyo we visited the grounds of the Imperial Palace, which have been in zoysiagrass since the 14th century. Numerous ecotypes were found having differences in foliar color and flowering habit. On the northwestern coast of Honshu, the main island of Japan, samples of zoysiagrass, bentgrass and tall fescue were gathered from water's edge to an elevation of approximately 75 feet. These plants experience considerable salt spray from the sea. On the southern island of Kyushu, collections were made in Cape Toi and from Mt. Aso. Cape Toi is a national wild horse refuge. The horses graze on natural zoysiagrass range. When zoysiagrass seed is eaten and passes through the digestive system of the horse, the seed will germinate. Zoysiagrass is one of the first species to establish itself on volcanoes following eruption. In the crater of Mt. Aso, considerable variability was observed in time of flowering and floral characteristics.

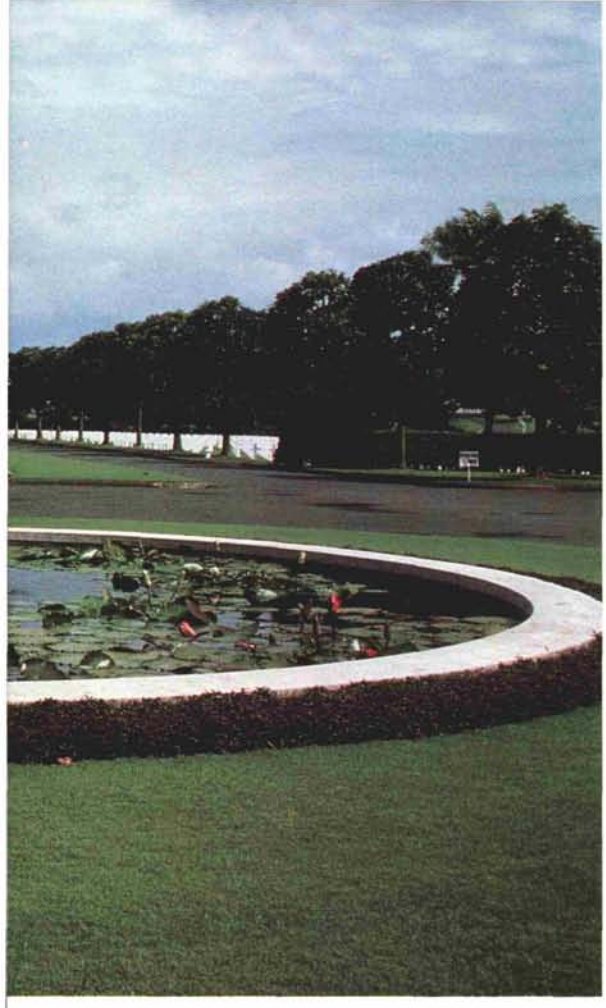
Golf is a very popular sport in Japan. Today, there are 1,400 golf courses, with 20 new ones costing $20 million each being opened each year. Courses are open year-round, except those in northern Japan, which open from April to early November because of severe cold and heavy snowfall. About 60 percent of the courses are using zoysiagrass greens and 90 percent zoysiagrass fairways and roughs. Specific zoysiagrass selections are being used on many golf courses. Selections are classified by their morphological characteristics or by names associated with area of production or origin. For example, the Tokyo selection is very popular for use on greens in the central region. There are no cultivars as we know them in the United States. This situation causes considerable confusion in classification.

WE VISITED 13 golf courses in Japan, several with members or staff of the Konsai Golf Union (KGU). The KGU is similar to the USGA Green Section in the United States. Numerous samples were taken from golf courses, greens, fairways and roughs. Some of these have been in cultivation for decades and express considerable differences in response to disease and insects, moisture stress, and management prac-

Emerald zoysiagrass on U.S. Military Cemetery, Manila, Philippines.

Zoysiagrass seedheads in a golf course rough, Japan.





Collecting zoysiagrass along a salt basin in South Korea.

Tombs in South Korea covered with zoysiagrass.

tices. In addition, we obtained cuttings from 15 accessions that the KGU has in their research program.

In South Korea, there are only 11 golf courses, eight of which have been constructed within the past eight years. Annual precipitation exceeds 67 inches and temperatures are similar to those of the transition zone in the United States. Bentgrass or zoysiagrass is used on greens, with zoysiagrass or bluegrass used on fairways and roughs. Zoysia was successfully established by seeding on several recently constructed courses. Plants appeared surprisingly uniform in newly seeded areas but quite different in leaf texture in older sod. However, this did not appear to be a problem on roughs or fairways.

Zoysiagrass is called golden grass in Korea because of its winter straw color. Selections are made for plantings based on shades of brown straw in the winter. There are many golden grass tea rooms and beer parlors. Koreans bury their dead in earthen tombs or mounds which stand approximately four feet above ground level. To hold the soil in place, these tombs are covered with zoysia sprigs. Over a period of time, the tomb is entirely covered with zoysiagrass. This procedure has become a ritual over the past several centuries. Many tombs have been planted to zoysias that were specifically selected for some agronomic trait — generally its winter straw color. A considerable amount of time was spent in surveying public and private tomb areas, and we collected many unusual samples. Few, if any, of the tombs received more than periodic attention, no fertilizer, and no supplemental irrigation. We located tombs established in 1200 A.D. of many of the early kings. Kings' tombs are 60 to 70 feet high and 800 to 900 feet in diameter. Most of the public tombs are 50 to 100 years old.

The most significant find in Korea was two additional species, *Z. macrostaycha* and *Z. sinica*, not previously worked within the United States. Samples were obtained of these species which existed primarily on the coastline and other high-salt areas, and rice paddy borders. *Z. sinica* appears to be more decumbent with a little finer and softer leaves than common *japonica*, but with larger seed and seed heads. *Z. macrostaycha* has an upright growth habit and appears stemmy. Although limited information is available, they are reported to be diploid species and not cross compatible with the three previously known species. This, of course, must be confirmed.

Kansai Golf Union Research Center near Kobe, Japan.

In Taiwan and the Philippines, zoysiagrass was more difficult to find in the wild as well as in cultivation, and diversity was less than in Japan and Korea. Cultivated turf in both countries is principally zoysia and bermuda. Northern and southern coastal areas and elevations up to 4,600 feet were surveyed in Taiwan. Zoysiagrass was not found at elevations above 2,000 feet. Several samples of *Z. matrella* and *Z. tenuifolia* with considerable diversity were obtained from coastal areas. *Z. japonica* was not observed further south than northern Taiwan. Several samples of *Z. tenuifolia* were collected from coral reefs on Orchid Island, located off the southeastern coast of Taiwan. During high tide these reefs are completely submerged. The island is inhabited by an estimated 2,000 aborigines without the conveniences of modern life. The genetic diversity observed in Taiwan is well represented among the 53 samples collected.

WE IDENTIFIED and collected a unique zoysia genotype in each major geographic area of the Philippines. On Cebu Island we found primarily *Z. matrella* on the edges of saltwater fish tanks and on the seacoast beaches. Even though few lawns or other areas of cultivated turf were evident throughout the country, those that we found are of a fine-leafed *Z. tenuifolia*. However, they were usually thought to be bermudgrass by the Filipinos. The U.S. military cemetery in Manilla has about 460 acres of emerald zoysiagrass. The original plants were obtained from the Beltsville Agricultural Research Center, in 1953. The cemetery grounds are verticut and fertilized once a year. Although the turf was relatively thatchy, it was beautiful and provided excellent turf.

We feel the genetic diversity of germplasm contained in this collection will provide the industry with the wealth of diversity needed to develop improved turfgrasses for future generations. The diversity observed among the zoysia species was much greater than we had anticipated. We look forward to having the opportunity to assess selections collected and to identify superior genotypes. This will require considerable research over an extended period of time. A few superior genotypes might be sufficiently adapted and perform well enough to be released as new cultivars. If not, they may be a source of germplasm for hybridization.