Rangeland plants

Subodh Jain

The first European settlers found California rich in natural resources including grazing land that established the agricultural industry. The grazing of domestic animals began with the arrival of the first Spanish colonists in 1769 and the industry grew with the spread of missions in the state. Livestock ranching has continued to be the most widespread agricultural activity. However, as farming has made inroads into the valleys and foothills, more than 100 million acres in the pastoral use have shifted from these areas to the remaining grasslands and woodland communities.

Early days of ranching

Two centuries of grazing and agriculture have dramatically changed the vegetation through replacement of the native oaks, shrubs, and perennial grasses by introduced annual plants. Among these "aliens," several widespread and highly desirable species, including filarees (*Erodium* spp.), slender oats (*Avena barbata*), soft chess (*Bromus mollis*), and bur clover (*Medicago polymorpha*), represent valuable genetic resources. An historical survey by L. T. Burcham in 1957 showed that at least 100 important aliens were well established even by 1860, when crop agriculture began with the "decade of wheat."

We can only speculate now whether it would be desirable to attempt to revive large stands of native bunchgrasses like needlegrasses (*Stipa* spp.) and blue wildrye (*Elymus* spp.) or native forbs of such genera as *Lotus, Trifolium, Brodiaea* and *Allium* given current land use and management patterns. Very few genetic or ecological studies have been undertaken on these plants. In fact, unlike many of our major crops with large commercial interest, the very numerous range plants have not had any organized genetic research programs.

A few varieties such as lana woollypod vetch, Perlagrass, mission veldtgrass, and Wilton rose clover were developed by local selection and testing in California; several other varieties of clovers have been recently introduced; and only a few population or biosystematic studies on various grasses have been reported. Even preliminary efforts to collect, describe, and propagate the remaining few populations of *Stipa* and *Elymus* would be desirable.

Revegetation studies

There have, however, been scientific efforts to improve rangeland productivity. These have included (a) vegetation conversion using fire or mechanical and herbicidal treatments, followed by reseeding with various desirable annuals, (b) management to allow persistance of desirable species and elimination of weeds, (c) better water and nutrient management, (d) better seasonal availability of forage and its use by efficient grazing schemes, and (e) enhancement of multiple land use for grazing and recreation, and for soil and water conservation. The use of genetic resources would be particularly relevant to the vegetation conversion programs.

Revegetation with introduced species tested for adaptation has been a dominant approach by the plant scientists and such agencies as Soil Conservation Service and Bureau of Land Management. Following the Australians' lead in range development associated with plant breeding efforts, major interest has been shown here in using legumes such as rose clover (*Trifolium hirtum*) and subclover (*Trifolium subterraneum*) for nitrogen fixation in grass-legume mixtures, and in summer perennials like Harding grass (*Phalaris tuberosa* var. *stenoptera*). Much of this work was initiated at the University of California, Davis over the past 30 to 40 years.

Screening for diversity

In exploring the genetic resources of range plants, we are concerned with the diversity of species among native and introduced grasses, legumes, and nonlegume forbs, as well as the largely unexplored population variation within these species. To isolate germplasm resources that can contribute to successful establishment and colonization in rangelands, we must find those species and genetic types (genotypes) that either are preadapted to their new environments in California or have evolved local races (ecotypes) during recent decades.

Genetic studies began at Davis on slender oats and soft chess in 1966, and on rose clover and bur clover in 1970, with extensive collections of seed and plant materials. Characteristics scored included germination rate, seedling growth, competitive ability, seed production, and seed dispersability. Genetic variability of populations was analyzed with the help of Mendelian traits such as seed color or leaf sheath pubescence in slender oats, and leaflet markings in legumes; and of quantitative traits such as flowering time, plant height, and total seed output. The underlying rationale was to (1) survey

the role of genetic differences in adaptability of different populations, and (2) provide genetic materials for selection, testing, and development of new lines for reseeding work.

Currently, wild oats and soft chess populations are either self-sown from seed crop naturally dispersed each year, or established through various mixed seed lots with no apparent reselection or breeding work. Likewise, rose clover, subclover, and others involving imported varieties are not subjected to any breeding in California. Both soil and weather variables are highly diverse and presumably require numerous local adaptations. A study of nearly 150 populations of slender oats showed that at least three ecotypes have evolved:

- The valley ecotype, essentially monomorphic (without much genetic variation), and prevalent throughout the Central Valley, the foothills on the east side of the Valley, and in southern California.
- An ecotype common along the north coast in Mendocino County.
- A highly variable set of genotypes in the San Francisco Bay region and extending along the coast between Monterey Peninsula and Bodega Bay.

The pattern of variation in slender oats shows three different climatic regions to be broadly represented by three gene pools. (Interestingly, similar patterns were found in parallel surveys of wide collections of slender oats in Iberia and New South Wales, Australia.) Large differences in seed dormancy, plant growth, tillering, leaf number and size, flowering time, seed size, and response to grazing were found among these three ecotypes. Planned experimental plantings of their mixtures at several locations will allow their evaluation for breeding use.

In another study, 18 populations of slender oats were tested for their symbiotic role in nitrogen fixation by free-living bacteria under controlled conditions. Small but consistent differences were found among the populations: populations from sites highest in nitrogen were least able to fix nitrogen. Certain weather-related (phenological) features, such as better winter growth and indeterminate flowering, could be combined with these physiological adaptations through genetic recombination.

Similar work in soft chess showed ubiquitous genetic variation in most localities, with no distinct ecotypic variation. However, components of total plant growth and seed output as well as physiological characteristics of dormancy and drought tolerance were found to vary among collections. The relative proportion of self- and cross-pollination also varied in a wide range (less than 1 to 15 percent outcrossing) so that population structure could not be easily predicted without detailed genetic studies. Visible characteristics of one genotype can vary so much that just a few genotypes seem to adapt to many different environments through adjustments in plant form and life cycle.

Nearly 60 seed accessions of soft chess from California and nearly the same number from Iberia are maintained in our collections. The size of these holdings is perhaps unique, since most gene banks have only one or two entries for any one species of range plants.

Population studies on rose clover tell still another story. During 30 years of residence in California, it has successfully colonized many roadside areas, shows great promise as a forage plant, and exhibits extensive, genetic variability in almost all populations surveyed. A detailed agronomic evaluation of 20 populations showed promise for improvement by breeding. Large numbers of families per accession are available in which selection, testing, and some sort of synthetic strain-building program might be useful. Conservation of these genetic lines for the future is a high priority.

With the recent studies on the response to sulfur fertilization, bur clover has gained attention in some northern counties. Populations in Sonoma County differ markedly in genetic makeup from those in Yolo and Contra Costa counties. Two heritability studies have established that growth and reproductive rates can be improved by mass selection programs. From the rangeland point of view, seed dispersal, dormancy, longevity, and population persistence are to be further analyzed.

Alfalfa weevil seems to be a serious threat for bur clover in certain areas, so that resistance genes should be screened and incorporated.

These studies on a few range species represent just a pilot effort to understand their complex agronomic, genetic, and evolutionary characteristics and to conserve these extensive range plant resources. Clearly a great deal more is needed for scientific management of this valuable natural resource.

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An international graduate student works with wild *T. urartu* wheat, which was widely found throughout the Fertile Crescent by U.C. scientists.

Commercial sunflowers, which provide food and industrial oil, have been improved with germplasm drawn from wild species.

The Rio Grande desert along the Texas-Mexico border has been a source of plant materials used in tracing grape species development.

The grape species collection has drawn plant materials from jungles near Monterrey, Mexico.

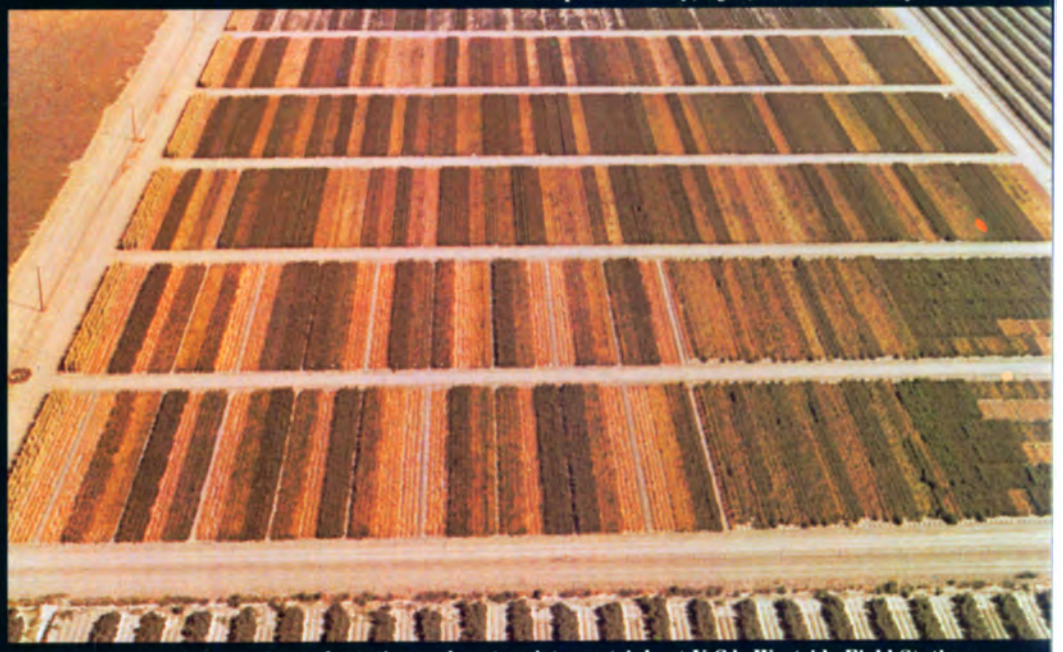
Wild strawberries from California's coastline cliffs have provided genetic material to boost state strawberry production to the highest in the world.

California's foothill rangelands are populated largely

Through induced mutation of rice germplasm, breeders are shortening stem length to produce stronger, mure nutrient-efficient plants capable of higher yields.

The availabiliy of resistant spring wheat varieties helped minimize damage caused by stripe rust: *left,* susceptible variety; *right,* resistant variety.

The wild vinifera, which has contributed many excellent qualities to cultivated grape varieties.



Aerial view of soybean variety adaptation and pest resistance trials at U.C.'s Westside Field Station near Five Points, west of Fresno, California.

by introduced grasses and forage plants.

The trend in forestry is to plant in clearcut areas the offspring of selected parents, as illustrated in this Douglas-fir plantation. However, forest tree gene conservation requires that appropriate seed collections be made before harvesting and reforestation.