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77

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Cover photograph: The intriguing *Vicia sativa* subsp. *amphicarpa* - see the first article of this issue.

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Ecogeographic survey and collection of Syrian Vicieae and Cicereae (Leguminosae)

T. Ehrman[1] and N. Maxted[2]

Summary

A mission collected Vicieae and Cicereae (Leguminosae) germplasm between 19 March and 4 June 1986 in areas of Syria rich in legumes. 1 172 seed accessions representing 63 taxa were collected from 148 sites. As well as seed accessions, herbarium specimens and rhizobium samples were taken for a large proportion of the populations encountered. A new species of *Vicia* was discovered to the north of the Bekaa Valley near the Lebanese border, and the rare *Vicia faba* relative, *V. hyaeniscyamus*, was collected. Climate and soil data were related to species distribution patterns by means of two-way classification, and the results are discussed with respect to patterns of endemism and infraspecific diversity. The new species of *Vicia* may be useful to breeders attempting wide crosses between *V. faba* and its close relatives. *V. noeana* may have considerable forage potential for colder, inland areas. The underground pods of *V. sativa* subsp. *amphicarpa* may make it useful as a self-regenerating pasture plant.

Introduction

During the spring of 1986, the International Board for Plant Genetic Resources (IBPGR) sponsored a tripartite collecting mission to Syria to collect germplasm of wild Vicieae. The three collaborating groups involved were the Vicieae Project Group, Southampton, UK, the Genetic Resources Unit (GRU), International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria, and the Genetic Resources Unit, Ministry of Agriculture and Agrarian Reform (MAAR), Douma, Syria.

The legume tribe Vicieae includes relatives of faba bean, pea and lentil, while the tribe Cicereae includes relatives of the chickpea. Due to the position of Syria at the junction of the Mediterranean and Irano-Turanian floras, Syria is particularly rich in Vicieae and Cicereae taxa, with 74 wild species, many of which are rare, or endemics closely related to crop plants. For example, *Vicia hyaeniscyamus* was described by Mouterde and was known only from his collections. Specimens of this species darken on drying, obscuring some key characters. Thus in more recent years some botanists (Ladizinsky, 1975) have doubted its distinction from other members of the *V. narbonensis* group. This species is a close relative of *V. faba*, so it is important to plant breeders who are searching for the ancestor of the faba bean. Other Syrian species of particular interest as crop relatives are *Pisum fulvum*, *Lens orientalis*, *Lathyrus annuus*, *Cicer judaicum*, *Cicer pinnatifidum* and five other wild species of *Vicia* sect. *Faba*.

Syrian environment

Despite its relatively small size (18 518 000 ha), Syria is very varied both in terms of climate and, to a lesser extent, soils. Altitude varies between sea level and 2 750 m in the Anti-Lebanon, but the bulk of the country lies between 0 and 1 300 m. Climatic zones in Syria are tempered by elevation and rainfall, and so climatic type often coincides with topographic zone. The coastal strip of western Syria and the adjacent foothills of the Jebel al-Ansariyeh are Mediterranean in climate with warm, moist winters. The interior, screened by mountains from the moderating maritime influence, has a continental climate with a great range of temperatures and absolute aridity for six months of the year. This region is separated from the coastal region by the Jebel al-Ansariyeh, a mountain range of varied topography and geology, characterized by low temperatures and high rainfall during winter months. Rainfall decreases rapidly to the east of these mountains, winters are prone to frost (virtually absent in coastal areas), and summer temperature increases. In mountain areas inland — the Kurd Dagh of the northwest, the isolated massif of the Jebel Arab in the south, and the Anti-Lebanon to the west of Damascus, the growing season is highly compressed and winter temperatures are severe, with over 100 days of frost per year.

Syrian soils are dominated by terra rossa (alkaline) and black, volcanic soils (neutral) in wetter areas, with grey, calcareous and gypsic loess concentrated in the drier interior. Calcareous littorosols, chalky soils and brown woodland soils derived from gabbros and dolerites are sporadic in coastal areas.

Temperature and rainfall are the principal determining factors controlling taxon distribution and the development of plant communities, though soil type and topography play an important secondary role. The latter factors often account for the abrupt changes in vegetation in wetter areas and play a decisive role in patterns of endemism. Nevertheless the clinal and markedly seasonal variation in temperature and rainfall account for a large proportion of the diversity and taxonomic complexity of the Syrian flora. These factors undoubtedly influence the ephemeral nature of so many of the taxa encountered, which show a tendency towards autogamy and, hence, homozygosity and genotypic divergence (Stebbins, 1952).

Floristically, Syria has two distinct elements; the Mediterranean in the coastal areas and the Irano-Turanian in the drier interior, the northeast and the Jebel Arab (Zohary, 1973). The mountains, in particular, contain numerous endemic species which are either closely related to other species in the region or are relict forms of an earlier flora. Few areas of Syria remain which have not

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been altered by man. Woodland communities are now limited to coniferous enclaves north of Lattakia and isolated pockets of oak in the Jebel al-Ansariyeh.

Site selection and sampling

The mission lasted from 19 March to 4 June 1986. The areas visited were limited by the time available to those shown in Fig. 1. The collections focused on the areas of Syria rich in legume germplasm: the Anti-Lebanon, Jebel al-Ansariyeh, Aleppo region, Orontes Valley and Jebel Arab. In practice, each site was visited twice. On the first visit, sites rich in legumes were selected, the particular species present were identified and herbarium material of flowering specimens taken. Seed of each species was collected during the second visit. Vicieae species are particularly difficult to identify at the time of seed collection. At fruition many species are brittle plant remnants with pods attached but without flowers. This can lead to problems of mixed seed accessions. Our experience has shown that this hazard can be largely avoided by the practice of visiting each site on two separate occasions.

The objective was to collect 50-200 legumes from 5-20 plants of each species encountered, obtaining a representative sample from each population, these being sampled from native pastures, field margins, roadside verges, terraces and cropped fields.

Collection processing

Germplasm

The seed was threshed, fumigated and dried at the GRU, ICARDA and divided into three sets. These are held at the Genetic Resources Unit of MAAR, Douma, Syria, at ICARDA, Syria and in the Vicieae Seed Collection, University of Southampton, UK. A summary of the germplasm collected from 148 sites throughout Syria is provided in Table 1.

Table 1. Syria germplasm collected in 1986

Genus	Species identified	Accessions collected
Vicia	35	623
Lathyrus	20	384
Pisum	2	71
Lens	4	85
Cicer	2	8
TOTAL	63	1171

Herbarium specimens

The herbarium specimens were dried at ICARDA. Complete replicate sets are held at GRU, ICARDA; the Royal Botanic Gardens, Kew, UK; and at the Department of Biology, University of Southampton, UK. Partial replicate sets of the rarer species have been donated to the MAAR, Douma, Syria; the Royal Botanic Garden, Edinburgh, UK; Missouri Botanical Garden, USA; Botanical Institute of the Academy of Sciences, Armenian SSR, USSR; and the Conservatoire et Jardin Botaniques de la Ville de Genève, Chambesy, Switzerland.

Rhizobium collection

The rhizobium collections are held at the ICARDA rhizobium bank, Syria.

Survey data

The mission provided a unique opportunity to make an ecogeographic survey of the Vicieae and Cicereae of Syria. During the mission the data gathered on sites and accessions were entered in detail on to collecting forms. Subsequently these data were transferred to two databases; a Research Machines 380Z microcomputer using dBASE II software at Southampton; and a VAX mainframe using ICADET software at ICARDA. The

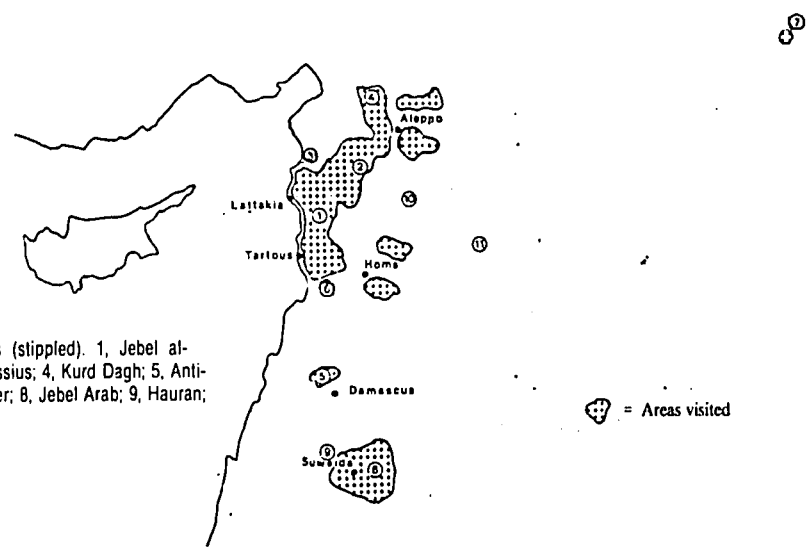

Fig. 1. Map showing collecting areas (stippled). 1, Jebel al-Ansariyeh; 2, Orontes valley; 3, Mt Cassius; 4, Kurd Dagh; 5, Anti-Lebanon; 6, Bekaa valley; 7, Tigris river; 8, Jebel Arab; 9, Hauran; 10, barley belt; 11, steppe

Table 2. Vicieae and Cicereae distribution patterns in Syria

Species	Climate								Soil						Comments
	1	2	3	4	5 ABC	6 AB	7	8	1	2	3	4	5	6	
C. judaicum	+	+									+	+	+		Coastal; alkaline soils
C. pinnatifidum					+								+		Mountains; calcareous soils
L. annuus	+	+		+	++	+			+	+	+	+	+		Widespread except dry areas
L. aphaca	+	+	+	+	+++	++			+	+	+	+	+	+	Widespread except dry areas
L. basalticus[1]		+							+						Endemic to north Bekaa; volcanic soils
L. blepharicarpus	+	+	+	+	+ +					+		+	+		Mainly coastal; alkaline soils
L. chrysanthus[1]					+				+						Endemic to Jebel-Arab; disturbed volcanic soils
L. cicera		+	+		+ +				+	+	+	+	+	+	Mainly mountains
L. ciliolatus[1]				+	+	+			+						Endemic. Mountains; volcanic soils
L. digitatus		+	+	+	+				+			+		+	Hills and mountains; terra rossa soils
L. gleosperma[1]					+				+						Endemic to Jebel-Arab; volcanic soils
L. gorgonii	+	+	+	+	+				+	+		+	+	+	Mainly coastal
L. hierosolymitanus	+	+	+	+	+++	++			+	+	+	+	+	+	Widespread except dry areas
L. inconspicuus			+		+++	++	+		+			+	+		Drier areas (< 500 mm rain)
L. laxiflorus		+								+					Oak woodland
L. marmoratus	+	+	+		+++	++			+	+	+	+	+	+	Widespread except dry areas
L. pseudo-cicera					++	++	+	+	+			+	+	+	Drier areas (< 400 mm rain)
Lens ervoides	+	+	+	+	+				+	+		+			Wetter areas (> 600 mm rain); calcifuge
Lens nigricans					+++	+			+	+					Mountains; mainly neutral soils
Lens orientalis		+	+		+ +	+	+	+	+			+	+	+	Absent from coast; mainly alkaline soils
P. fulvum	+	+	+	+	+++	++			+			+	+	+	Widespread; two distinct varieties
V. articulata					+						+				Mountains; neutral soils
V. bithynica	+	+								+					Coastal areas; brown woodland soils
V. cuspidata			+		+ +							+	+		Hills and mountains; alkaline soils
V. dionysiensis[1]					+				+						Endemic to Jebel-Arab; marshy, volcanic soils
V. ervilia		+			+++	++		+	+			+	+		Mainly mountains; often cultivated
V. hyaeniscyamus[1]		+							+						Endemic to north Bekaa; volcanic soils
V. hybrida	+	+	+	+	+ +				+	+	+	+	+	+	Coast and mountains; all soil types
V. johannis	+	+	+	+	+						+	+			Coastal hills; alkaline soils
V. kalakhensis[1]		+							+						Endemic to north Bekaa; volcanic soils
V. lathyroides			+	+	+	++			+						Mainly mountains; volcanic soils
V. michauxii						+	+					+	+		Dry areas (< 350 mm rain); weedy
V. mollis					+++				+				+	+	Mountains
V. monantha					+	+	+	+				+	+		Dry areas (< 400 mm rain); weedy
V. narbonensis	+	+	+		+++	++	+	+	+		+	+	+	+	Widespread
V. noeana					+				+		+				Mountains; neutral soils
V. palaestina	+	+	+	+	+++	+			+	+	+	+	+		Widespread except dry areas
V. peregrina	+	+	+	+	+++	+			+	+	+	+	+	+	Widespread except dry areas
V. qatmensis[1]		+								+	+	+			Endemic; mainly coastal woodlands
V. sativa	+	+	+	+	+++	++	+	+	+	+	+	+	+	+	Widespread; subsp. *amphicarpa* in dry areas
V. sericocarpa	+	+	+	+	+++	++			+	+	+	+	+		Widespread except dry areas
V. tetrasperma	+	+							+	+	+	+	+		Coastal woodlands; shade loving
V. tigridis[1]			+												Endemic to Tigris; black alluvial soils
V. villosa			+	+	+ +				+	+	+	+	+		Mainly mountains; common in ditches

[1] Endemic species. See Appendixes 1 and 2 for descriptions of climate and soil groups.

data were analyzed using the BMDP statistical package at ICARDA.

Distribution patterns

Climate and soils data were analyzed separately by means of a monothetic divisive clustering technique known as K-means clustering, using program BMDP KM (Dixon, 1983). This program partitions cases into any number of user-specified clusters. Differences between clusters can be statistically tested by means of an analysis of variance which compares between-cluster mean square to within-cluster square. The resulting climate and soil groups were related to distribution patterns of individual species as shown in Table 2. An explanation of the climate and soil classification is presented in Appendixes 1 and 2 respectively and follows the scheme devised by Ehrman and Cocks (in press) for use with other legume species in Syria. Taxa are grouped according to climate and soil type in Table 3.

Table 3. Species of Syrian Vicieae grouped according to ecological characteristics

1. GROUPS IN RELATION TO CLIMATE

   A. WIDESPREAD SPECIES. *L. annuus, L. aphaca, L. hierosolymitanus, L. marmoratus, V. narbonensis, V. peregrina, V. sativa, V. sericocarpa*

   B. COASTAL SPECIES. *C. judaicum, L. blepharicarpus, L. gorgonii, Lens ervoides, V. bithynica, V. tetrasperma, V. qatmensis*

   C. UPLAND SPECIES. *C. pinnatifidum* var. *syriacum, L. chrysanthus, L. cicera, L. digitatus, L. ciliolatus, L. gleosperma, Lens nigricans, V. cuspidata, V. ervilia, V. lathyroides, V. mollis, V. noeana, V. dionysiensis*

   D. SEMI-ARID SPECIES. *L. inconspicuus, L. pseudo-cicera, V. michauxii, V. monantha, V. narbonensis* var. *narbonensis, V. narbonensis* var. *salmonea, V. narbonensis* var. *jordanica, V. sativa* var. *amphicarpa*

2. GROUPS IN RELATION TO SOILS

   A. WIDESPREAD SPECIES. *L. annuus, L. aphaca, L. hierosolymitanus, L. marmoratus, V. hybrida, V. narbonensis, V. peregrina, V. sativa*

   B. NEUTROPHILE SPECIES. *L. basalticus, L. chrysanthus, L. ciliolatus, L. gleosperma, L. laxiflorus, Lens nigricans, P. fulvum* (one variety), *V. bithynica, V. dionysiensis, V. hyaeniscyamus, V. kalakhensis, V. lathyroides, V. noeana, V. qatmensis*

   C. CALCIFUGE SPECIES. *L. digitatus, Lens ervoides, V. palaestina, V. sericocarpa, V. tetrasperma*

   D. CALCICHOLE SPECIES. *C. pinnatifidum* var. *syriacum, V. cuspidata, V. narbonensis* var. *narbonensis, V. sativa* subsp. *amphicarpa*

   E. SPECIES TOLERANT OF WATERLOGGING. *L. aphaca, P. fulvum* (one variety), *V. dionysiensis, V. hyaeniscyamus, V. palaestina, V. sativa* subsp. *nigra, V. tigridis*

Distribution patterns and infraspecific diversity

The two legume tribes Vicieae and Cicereae are composed of six genera, of which three are relatively diverse, *Vicia, Lathyrus* and *Cicer*, while the other three genera, *Lens, Pisum* and *Vavilovia*, each contain a small number of species. As with other large legume genera of the region, *Vicia* and *Lathyrus* in particular are characterized by species with a broad spectrum of distribution patterns.

From a consideration of Table 2 it is possible to distinguish 'generalist' species, with wide ecological amplitude, from 'specialist' species which are restricted to particular habitats in specific areas. Among Syrian Vicieae the following 'generalists' may be identified; *V. sativa, V. palaestina, V. narbonensis, V. peregrina, V. hybrida, V. sericocarpa, Pisum fulvum, Lathyrus marmoratus, L. annuus, L. hierosolymitanus* and *L. aphaca*. These species generally show high levels of intraspecific diversity compared to other more restricted species. This is reflected in their taxonomy. Thus *V. sativa* has five currently recognized subspecies, *V. narbonensis* has five varieties (excluding *V. serratifolia*), *L. aphaca* has six varieties, and taxonomists are currently debating whether the specific distinction between *L. annuus* and *L. hierosolymitanus* is valid. This accords well with observations on other legume species, e.g. in *Medicago* (Heyn, 1966).

The degree to which morphological diversity and/or ecological amplitude in Syrian Vicieae and Cicereae reflects genetic diversity in other, economically significant, characteristics is at present unknown. However, observations on genetic variation in other legume genera have shown that generalist species often possess high levels of diversity in non-morphological characteristics (Ehrman and Cocks, in preparation), though this may be complicated by historical patterns of adaptive radiation (Cocks and Ehrman, 1987). Generalist species certainly merit special consideration as potential new forage and pasture domesticates. If closely related to existing domesticates their high levels of genetic diversity also give them obvious potential as gene donors.

Distribution patterns and endemism

Syria also has many 'specialist' species, exhibiting restricted ecological amplitude, and often showing highly localized patterns of distribution. The relationship between habitat specialization and endemism is particularly striking in the case of Syrian Vicieae. Of the 12 species shown in Table 2 to occupy two or fewer of the available climate and soil groups, seven are endemic to Syria. Specialization is most marked in those endemics which are morphologically highly distinct, very restricted in distribution and not apparently closely related to other species. These are probably relict species (palaeoendemics) and are usually found in small, isolated and distinctive habitats. *V. tigridis* is the most extreme example of this, being found at one locality only on riverine soils on the banks of the Tigris. It is a member of *Vicia* sect. *Hyperchusa* and as such is related to *V. noeana* and its relatives, but in this group it stands out as being morphologically isolated. Other Syrian endemics which fall into this class are as follows.

- *L. chrysanthus* and *L. gleosperma*, which are both restricted to disturbed volcanic soils in the extreme north of the Jebel Arab, an area with the most severe winter temperatures of anywhere in Syria.

- *V. dionysiensis*, restricted to a small area of marshy soils in the south of the Jebel Arab.
- *V. hyaeniscyamus*, found on seasonally inundated volcanic soils in the northern Bekaa.
- *L. basalticus*, again located on basaltic soils at the northern extreme of the Bekaa Valley.
- One final example concerns the new species, *V. kalakhensis* (Khattab *et al.*, 1988), closely related to *V. faba*, and located in the same area as *V. hyaeniscyamus* and *L. basalticus*.

It may be significant that three of the above species are restricted to soils which during the winter months are inundated for a considerable proportion of the time. Such soils are rare, limited in extent, and isolated in Syria (particularly if they are of volcanic origin). These soils provide specialized 'island-type' habitats, probably of great antiquity, which may explain their taxonomic and ecological significance.

It is likely that other endemic species, such as *L. ciliolatus*, which are less isolated taxonomically and less specialized ecologically, have evolved more recently from more widely distributed species which are in the process of expanding their range. If so, they may be classified as neoendemic species (Zohary, 1973).

One further pattern emerges in considering the biogeography of endemic Vicieae in Syria. This concerns the fact that all nine endemic species (for details see Table 2) are restricted to neutral, non-calcareous soils, which are almost entirely of volcanic origin. Such soils are characteristic of the pine woodlands north of Lattakia, the valleys and moorland of the northern Bekaa, the Jebel Arab Plateau and the extreme northeast of Syria. All these areas originated in the Tertiary and are geologically isolated, surrounded by alkaline soils derived from limestone or gypsum (Mouterde, 1966). These areas may therefore be regarded as geological 'islands,' with important consequences for genetic isolation and subsequent evolution of endemic species (e.g. Barigozzi, 1982). If volcanic soils in Syria are arranged in such a way that they exert similar evolutionary effects to real islands, then it would be expected that each endemic would be found on one and only one such geological 'island' (Simon, 1987). This is indeed the case for all endemic species with the exception of *L. ciliolatus*, which is found both on the volcanic soils of northwest Syria and on the volcanic soils of the Jebel Arab in the south. The behaviour of this species is anomalous but may possibly be explained by long-distance dispersal. An alternative explanation may relate to the systematics of the species. *L. ciliolatus* belongs to *Lathyrus* section *Lathyrus* sensu Kupicha (1983). The taxonomy of this section is, however, complex and at present unclear. It may be that with further study *L. ciliolatus* will be found to be an extreme form of one of a number of very closely related species which are common throughout Syria.

New and rare taxon locations

Localities were found for *V. articulata* and *V. noeana*, both of which were not previously thought to be found in Syria. These were found in the extreme northwest of the country in mountainous country (Kurd Dagh) near the Turkish border.

The geographical distribution of taxa within the *V. narbonensis* complex is poorly known. Three of the varieties of *V. narbonensis* recognized by Schafer (1973), var. *narbonensis*, var. *affinis* and var. *salmonea*, occur throughout the sites visited. Var. *jordanica*, however, was only found in southern Syria towards the Jordanian frontier. *V. johannis* var. *procumbens* was collected in hilly country between Tartous and Lattakia. Other taxa from *Vicia* sect. *Faba* collected were *V. bithynica* from woodland habitats north of Lattakia, and

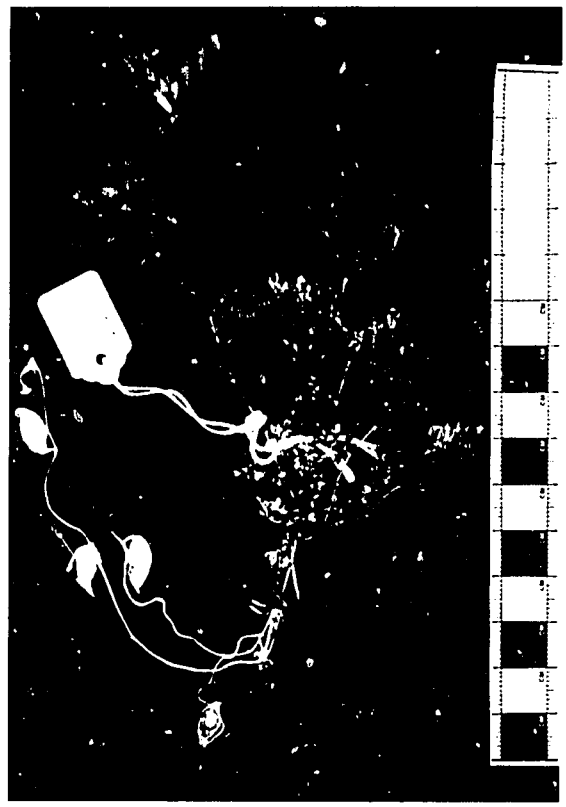

Fig. 2. *V. sativa* subsp. *amphicarpa*, showing underground pods.

Fig. 3. *P. fulvum*, also with pods shown

V. hyaeniscyamus and *V. kalakhensis* from the areas mentioned above (west of Homs). *V. galilaea*, another species from sect. *Faba* and previously recorded from the Golan Heights, was not found despite a thorough search of environmentally similar areas in southern Syria.

Other interesting collections included the three species endemic to the Jebel Arab, *V. dionysiensis*, *L. chrysanthus* and *L. gleosperma*. *V. tigridis* was collected from its type locality at Ain Diwar on the banks of the Tigris (northeast Syria). *V. qatmensis*, another endemic, was collected near Qadmous in the Jebel al-Ansariyeh and in an isolated gorge by the sea on the Turkish border near Kessab. In all, nine endemic species were collected, as shown in Table 2. No other seed collections for any of these species have previously been made.

Agricultural significance of the mission

The mission proved successful in that sizeable germplasm collections were made for the majority of the taxa located, including rare endemics and the new species of *Vicia*. This latter species may prove especially interesting to faba bean breeders attempting wide crosses between *V. faba* and its close relatives. *V. hyaeniscyamus* may prove to be of similar interest in addition to more common faba bean relatives such as *V. johannis* and *V. narbonensis*.

Numerous accessions of minor forage crops, e.g. *V. ervilia*, *V. sativa* subsp. *sativa*, *V. narbonensis*, *L. marmoratus*, *L. cicera* and *L. ochrus* were collected from fields when seen. *V. villosa* subsp. *dasycarpa* is being promoted by the Syrian Ministry of Agriculture and Agrarian Reform as a new forage crop for Syria and accessions were collected from the wild. One population of *V. noeana* found in the Kurd Dagh, Aleppo Province, was found intermixed with a clover species (*Trifolium hirtum*) in a field partially harvested for forage. The *V. noeana* was present in such large quantities that it must be concluded that it was sown as a forage mixture with the clover. It may have considerable potential for colder, inland areas.

V. sativa subsp. *amphicarpa* (Fig. 2) likewise presents some intriguing possibilities. This is found as a common weed in farmers' fields at the margins of agriculture (approx. 250 mm annual rainfall). Its major attraction lies in its underground pods, a feature it shares with populations of both *L. ciliolatus* and *P. fulvum* (Fig. 3). This implies that it might be of value as a component of self-regenerating pastures in lower rainfall areas, seed set being partially immune to the effects of heavy grazing during flowering and fruiting. It is also naturally adapted to moderate levels of disturbance which may make it an ideal candidate for ley-farming systems. In these systems a self-regenerating legume is rotated with a cereal crop in a two-year cycle. They are currently being developed by ICARDA (ICARDA, 1985). It differs in this respect from most other candidates, such as medics which are found predominantly in undisturbed habitats, and may be better adapted by virtue of its larger seeds to deep ploughing — a common feature of the region. One important characteristic as far as its suitability for ley farming is concerned lies in the fact that its seeds must be sufficiently hard. This is necessary to ensure that a high proportion of plants only regenerate once every two years (as opposed to every year), hence allowing an intervening year for cereal cultivation. This hardseededness depends on the development of a hard, impermeable seedcoat during fruit maturation thus delaying germination over a period of several years and allowing the build-up of seed reserves in the soil. These and other agronomically important traits deserve further attention.

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See p.8 for Résumé and Resumen

Appendix 1. Description of climate groups in Table 1

1. Coast
   Average annual rainfall = 920 mm
   Average number of days over 35°C = 13
   Average number of days under 5°C = 19
   Comments: mild winters. Extended rainy season (October-May)

2. Western foothills of Jebel al-Ansariyeh
   Average annual rainfall = 1160 mm
   Average number of days over 35°C = 3
   Average number of days under 5°C = 41
   Comments: Fairly mild winters. Extended rainy season (October-May)

3. Eastern foothills of Jebel al-Ansariyeh and plateaux west of Aleppo-Homs highway
   Average annual rainfall = 600 mm
   Average number of days over 35°C = 20
   Average number of days under 5°C = 60
   Comments: 'continental' Mediterranean climate. Transition zone between Mediterranean and Irano-Turanian floras

4. Peaks of Jebel al-Ansariyeh and Mt Cassius
   Average annual rainfall = 1200 mm
   Average number of days over 35°C = 3
   Average number of days under 5°C = 70
   Comments: cool winters, mild summers. Long rainy season (October-May)

5a. Kurd Dagh (northwest Syria)
5b. Jebel Arab (southern Syria)
5c. Anti-Lebanon (western Syria)
   Average annual rainfall = 500 mm
   Average number of days over 35°C = 6
   Average number of days under 5°C = 105
   Comments: severe winters, mild summers. Compressed growing season

6a. North Syrian barley belt (semi-arid)
6b. Hauran of southern Syria (semi-arid)
   Average annual rainfall = 300 mm
   Average number of days over 35°C = 35
   Average number of days under 5°C = 80
   Comments: fairly severe winters. Fairly hot summers

7. Barley belt/steppe transition zone (northern Syria)
   Average annual rainfall = 250 mm
   Average number of days over 35°C = 90
   Average number of days under 5°C = 90
   Comments: fairly severe winters. Hot summers. Dry. Erratic rainfall

8. Southern steppe (adjacent to Jebel Arab and Hauran)
   Average annual rainfall = 220 mm
   Average number of days over 35°C = 31
   Average number of days under 5°C = 86
   Comments: fairly severe winters. Mild summers. Dry. Erratic rainfall

Appendix 2. Description of soil groups in Table 1

P = available phosphorus; Ca = Calcium carbonate; OM = organic matter; EC = Electrical conductivity

1. Neutral black soils over basalt
   Average pH = 6.8 — Average clay = 40%
   Average P = 46 ppm — Average silt = 42%
   Average OM = 3.3% — Average sand = 18%
   Average Ca = 2.0%
   Average EC = 0.5 mhos
   Comments: volcanic, non-calcareous soils. Usually comparatively high levels of available phosphorus

2. Neutral soils over gabbros and pyroxites
   Average pH = 7.0 — Average clay = 37%
   Average P = 18 ppm — Average silt = 37%
   Average OM = 3.3% — Average sand = 26%
   Average Ca = 2.0%
   Average EC = 0.4 mhos
   Comments: may contain high levels of magnesium and silicates. Characteristic of *Pinus brutia* forest north of Lattakia

3. Coarse-textured neutral to mildly alkaline soils
   Average pH = 7.3 — Average clay = 21%
   Average P = 14 ppm — Average silt = 23%
   Average OM = 2.9% — Average sand = 54%
   Average Ca = 9.0%
   Average EC = 0.5 mhos
   Comments: a small, heterogeneous group. Geologically complex

4. Terra rossa
   Average pH = 7.7 — Average clay = 60%
   Average P = 20 ppm — Average silt = 30%
   Average OM = 5.5% — Average sand = 10%
   Average Ca = 9.0%
   Average EC = 0.5 mhos
   Comments: Fine-textured soils over limestone (or basalt in drier areas). Low in calcium. Often high in organic matter

5. Calcareous soils
   Average pH = 7.9 — Average clay = 39%
   Average P = 16 ppm — Average silt = 40%
   Average OM = 2.9% — Average sand = 21%
   Average Ca = 28.0%
   Average EC = 0.6 mhos
   Comments: Relatively high levels of calcium carbonate. Common particularly in drier areas

6. Highly calcareous, silty soils
   Average pH = 7.9 — Average clay = 30%
   Average P = 13 ppm — Average silt = 40%
   Average OM = 3.3% — Average sand = 30%
   Average Ca = 56.0%
   Average EC = 0.6 mhos
   Comments: medium-textured, often steppic loess soils

Résumé

Prospection éco-géographique et collecte de Vicieae et de Cicereae syriennes (Leguminosae)
Une mission a récolté du matériel génétique de Vicieae et de Cicereae (Leguminosae) entre le 19 mars et le 4 juin 1986 dans des zones de la Syrie riches en légumineuses. 1 172 spécimens de graines représentant 63 taxa ont été recueillis dans 148 sites. En plus des graines, des spécimens d'herbier et des échantillons de rhizobium ont été prélevés dans une importante proportion des populations rencontrées. Une nouvelle espèce de *Vicia* a été découverte dans le nord de la vallée de la Bekaa, près de la frontière libanaise, et la rare *Vicia faba* apparentée à *V. hyaeniscyamus* a été collectée. Les données climatologiques et pédologiques ont été mises en corrélation avec le mode de distribution des espèces au moyen d'une double classification, et les résultats sont discutés du point de vue de l'endémisme et de la diversité infraspécifique. La nouvelle espèce de *Vicia* peut être utile aux sélectionneurs qui essaient de procéder à de vastes croisements entre *V. faba* et ses proches parents. *V. novana* peut avoir une valeur potentielle considérable comme fourrage dans les zones fraîches de l'intérieur des terres. Les gousses souterraines de *V. sativa* subsp. *amphicarpa* peuvent rendre cette plante utile comme plante herbagère à autorégénération.

Resumen

Estudio ecogeográfico y recolección de Vicieae y Cicereae (leguminosas) en Siria
Entre el 19 de marzo y el 4 de junio de 1986, una misión recogió germoplasma de Vicieae y Cicereae (leguminosas) en zonas de Siria ricas en plantas leguminosas. Se recogieron en 148 lugares 1 172 muestras de semillas, correspondientes a 63 taxones. Además de las muestras de semillas, se obtuvieron ejemplares de herbario y muestras de rizobio correspondientes a una proporción elevada de las poblaciones que se encontraron. Se descubrió una nueva especie de *Vicia* al norte del Valle de la Bekaa, cerca de la frontera con el Líbano, y se recogió una especie rara emparentada con *Vicia faba*, *V. hyaeniscyamus*. Se estableció una relación entre los datos sobre el clima y el suelo y las características de distribución de las especies mediante una clasificación en dos sentidos y se analizan los resultados con respecto a las características de endemismo y diversidad infraespecífica. Las nuevas especies de *Vicia* pueden ser útiles para los fitogenetistas que intentan realizar cruces de carácter amplio entre *V. faba* y las especies estrechamente relacionadas con ésta. *V. novana* puede ofrecer posibilidades considerables como forraje en zonas más frías del interior. Las vainas subterráneas de *V. sativa* subesp. *amphicarpa* pueden convertirla en una planta útil como pasto autorregenerador.

East Asian influences in Cuban agriculture

K. Hammer[1] and M. Esquivel[2]

Summary

A study on the influence of east Asia on Cuban agriculture showed that a total of 44 crops have east Asiatic origin, which are used as vegetables (41%), medicinal plants (30%) or fruits (20%). A list is presented of these east Asiatic elements of the Cuban cultivated flora indicating botanical names and synonyms, English names, Cuban folk names and names from east Asia. Plant use, parts of plants used and other remarks concerning history, variation, sources in Cuban literature and further remarkable items are presented for each entry. The importance of east Asiatic crops in Cuba as plant genetic resources is stressed.

Introduction

An estimation of the sources of plants cultivated in Cuba (Esquivel and Hammer, 1987) found that 38% of the cultivated plants and their wild relatives had their sources of origin and/or diversity on the Asian continent. During the latest plant germplasm collecting expeditions in Cuba (Esquivel *et al.*, 1987; Esquivel *et al.*, 1988), a detailed study was made of the composition and structure of 'conucos', small fields or gardens based on traditional cropping, in which an estimated 20% of the cultivated plants are of east Asian origin (Esquivel and Hammer, 1988). In their explorations of Isla de la Juventud (Esquivel *et al.*, 1986; Esquivel *et al.*, 1989b; Pérez *et al.*, 1985; Pérez *et al.*, 1988), the authors noted a striking diversity among the plants grown by Japanese farmers and significant Japanese influence on the development of vegetable crops in the area.

For these reasons a more thorough study was made of a series of plants in Cuba with connections to Asian agriculture. These plants were treated in the same way as in the listing of plants cultivated in Cuba (Esquivel *et al.*, 1989a). The updated scientific name is given for each taxon, as well as basionyms and synonyms where these exist, together with the respective bibliographical references. The common names are also given in other languages. The Spanish name is basically the one used in Cuba. The utilization of the plant and the part used are given concisely in order of importance. References in Cuban botanical literature, where the series 'Flora de Cuba' is concerned, are listed by volume and not by author, as this is the main taxonomical source of information.

Much of the data were drawn from Mansfelds Kulturpflanzen-Verzeichnis (Schultze-Motel, 1986), although reference frequently had to be made to the original bibliographical sources. The experience of one of the authors with Asian plants, acquired during collecting expeditions in Korea (Hammer *et al.*, 1986) and during the preparation of the list of cultivated Korean Flora (Baik *et al.*, 1986), was extremely valuable. All the data have been processed using a computerized database prepared for the listing of cultivated plants in Cuba (Knüpffer *et al.*, in preparation), making for easy data handling and eventual updating.

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Background

Virtually the entire aboriginal population of Cuba was wiped out in the first years of the Conquest (Rivero de la Calle, 1966). The introduction of African slaves supplied the alternative labour needed to develop agriculture in Cuba (Lopez, 1985). Thus by 1861 nearly 60% of the Cuban population was either black or mulatto. By then, slave revolts had become increasingly common, jeopardizing the economic stability of Cuban agriculture. From its founding in 1794, the Junta Real de Fomento, Agricultura y Comercio (Royal Board of Development, Agriculture and Trade) tried to boost the numbers of non-Africans in Cuba, which led to the traffic in Asiatics in 1847 (Chuffat, 1927; Villanueva, 1877) and Yucatecan Indians in 1849 (Menendez, 1923).

After 1842, large numbers of Chinese were sent to the English colonies of Barbados, Jamaica and Trinidad. The Real Junta de Fomento, noting this, sent a representative to China in 1844 to negotiate the introduction of Chinese settlers into Cuba. A contracting agency for coolies destined for Cuba was set up, operating in Macao, Among, Swataw, Hong Kong and Wompoa. The coolies travelled through Manila in the Philippines (Jimenez, 1983). On 1 January 1847, the first lot of 1073 Chinese immigrants docked in the port of Havana. They consisted, *inter alia*, of farmers, artisans and tradespeople. By 1861 there were already over 60 000 Chinese, from Shanghai and Canton, and it is estimated that between 1853 and 1873 alone, 132 435 Chinese entered Cuba. Basically, these people worked in the agricultural sector. Many tradespeople and artisans remained in Havana, creating a little Chinatown in the Zanja Street neighbourhood, while on the outskirts of Havana, a place known as Cienaga in the Cerro district was settled by farmers who came to grow almost all of the vegetables for the capital. A major settlement of Asian vegetable farmers also developed south of Havana, in Batabanó province.

The Japanese were only a small minority among the Asiatic immigrants to Cuba, concentrated in a few places such as the Isla de la Juventud (formerly Isla de Pinos), where they have played a major role in the development of local fruit and vegetable cultivation. We have no detailed information on their arrival in Cuba, but their presence on the Isla de la Juventud goes back at least three generations, according to our information.

Direct introductions by Asian immigrants were not the only possible source for the arrival of certain species in Cuba, since

a number of institutions such as the Estación Experimental Agronómica de Santiago de Las Vegas (EEA, currently INIFAT (the Experimental Agronomical Station)), introduced a large number of plants which spread rapidly throughout the country. In the case of fruit trees specifically, a number of nurseries and gardens specialized in the introduction of exotic plants, basically through the USA.

Results

Appendix 1 lists plants of east Asian origin which were, in one way or another, introduced into Cuba. There are a total of 44 plants, corresponding to species and other infraspecific taxa, belonging to 32 genera in 22 families. Many are vegetables (41%), while some are used as medicinal plants (30%) or eaten as fruits (20%), and many have several uses. The observations concerning each taxon cite plants which have been observed or collected during our germplasm collecting expeditions. During these expeditions we collected roughly 50% and observed 66% of the plants listed in this work. There are plants which we neither collected nor observed, but this does not mean they are not found in Cuba.

Most of the taxa covered are reported in the Cuban botanical literature in one way or another. In some instances the scientific names had to be updated, and a group of species was also found which had not so far been reported for Cuba.

There has been some confusion in the classification of certain plants of Asiatic origin in Cuba. In the genus *Brassica*, León and Alain (1951) reported *B. urbaniana* O.E. Schulz and *B. integrifolia* (Willd.) Rupr., whereas Roig (1975) cites *B. lanceolata* Sauvalle. These species are presently considered synonymous with *B. juncea* (L.) Czern., a cultivated species introduced from Asia which easily reverts to the wild. It is sometimes called 'mostaza de la tierra' (native mustard), in an attempt to indicate that this species is a native of Cuba. The fact that the same common names are given to different taxa has also been a problem. This has occurred with *B. rapa* L. subsp. *pekinensis* (Lour.) Hanelt, listed for Cuba by Guenkov (1983) as *B. pekinensis* (Lour.) Rupr., with the name of 'Chinese cabbage' or 'pak choy', but this same common name is used for *B. rapa* L. subsp. *chinensis* (L.) Hanelt (Hanelt, 1986), a species also reported for Cuba by Guenkov (1983). Plants with the local name of 'berza' (cabbage) have recently been collected which appear to be *B. oleracea* L. var. *alboglabra* (Bailey) Musil., a plant of Asiatic origin which has not been reported for Cuba and which is different from the 'cabbage' commonly known in Cuba, which is *B. oleracea* L. convar. *acephala* (DC.) Alef., of European origin, which has been extensively cultivated in Cuba.

Another cultivar which has also given rise to confusion is the 'Japanese radish' or 'Chinese turnip', from Japanese living on the Isla de la Juventud. Roig (1975) reports two types of 'turnips' in Cuba. One is *B. napus* L. var. *esculenta* DC., commonly called 'turnip', and which is *B. napus* L. emend. Metzg. subsp. *napobrassica* (L.) Hanelt (Hanelt and Hammer, 1987). The other is the so-called 'Chinese turnip', which he describes as characteristic of Chinese farmers (and which might be *B. violacea* L. according to Roig). Considering this Latin name, it should be *Orychophragmus violaceus* (L.) O.E. Schulz, which has never been cultivated. The cultivar known as 'Japanese radish' or 'Chinese turnip' was collected by us in the Isla de la Juventud from Japanese farmers and corresponds to the description given by Roig (1975) of the 'giant Japanese radish' (*Raphanus sativus* L. var. *acanthiformis* Riv.), characterized by large purplish-white roots. In accordance with the classification proposed by Pistrick (1987), this cultivar falls within the group *raphanistroides*, which includes the cultivars of Japanese origin being *R. sativus* L. var. *albus* DC. emend. Pistrick. Perhaps Roig considered it to be *B. violacea* L. because of the slight bluish tinge to the roots and the fact that some plants may have purplish flowers, as we had the opportunity to observe in the Isla de la Juventud.

Some botanical names cited in the Cuban literature are presently considered synonymous, e.g. for *Vigna* species. The updated names for cultivated *Vigna* species found in Cuba have been previously discussed (Esquivel *et al.*, 1988).

'Chinese cucumber' is a typical vegetable grown by Asian vegetable growers. Roig (1975) reports three species of *Momordica* for Cuba: *M. charantia* L., *M. balsamina* L. and *M. cochinchinensis* (Lam.) Spreng., the first two cultivated by Chinese farmers and the last a recent introduction from the EEA at that time. Alain (1964) considers only *M. charantia* L. and *M. balsamina* L., without specifying that they are cultivated in Cuba. The samples we have found up to now correspond to the description of *M. charantia* L. Both the wild and cultivated forms have been collected. These are, respectively, *M. charantia* L. subsp. *abbreviata* (Ser.) Grebenšč. and subsp. *charantia*, according to Grebenščikov (1986).

The 'Chinese yam' is another cultivar reported by Roig (1975) as typically grown by Asian farmers. The species indicated, *Dioscorea batatas* Decne., is currently considered synonymous with two Asiatic species which may be found in Cuba, *D. opposita* Thunb. and *D. japonica* Thunb., though the latter is a less likely candidate as it is less widely distributed. Both species characteristically produce smooth, cylindrical tubercles, with scant hair-like roots, which perhaps occasioned the common name, the term 'Chinese' (chino) being used in Cuba to describe smooth objects lacking protuberances or hair (Ortiz, 1985). We found this to be true on earlier occasions, e.g. a cultivar of *Arachis hypogaea* L. collected in the central provinces of Cuba, called 'maní chino' (Chinese groundnut), because the fruits are smooth and unwrinkled. The same thing has been reported in other parts of the Caribbean such as Puerto Rico. In any case, a cultivar called 'ñame de agua' (water yam) was recently collected from Japanese farmers in the Isla de la Juventud, which we initially considered to be *D. opposita* Thunb., but it needs to be classified correctly, as the tubercles do not have a purplish colouring but are covered with a dense network of fine roots. There are various species of Asiatic origin in Cuba of the genus *Allium*, commonly called 'cebollinos' (chives).

Plants identified as *A. tuberosum* Rottler ex Spreng. and *A. chinense* G. Don were collected in the Isla de la Juventud. These have not been reported for Cuba. The latter plant is called 'rakkio' by the Japanese of Ciro Redondo, derived from the original Japanese 'rakkio'.

The foregoing example shows how the toponymy of a common name can sometimes be useful as a guide for species identification. Table 1 compares some common Cuban names with their counterparts in English and in various Asiatic languages. In some cases the common Cuban name is obviously a direct derivative of Asian names, as is true of *A. chinense*

G. Don (rackio (Sp) -- rakkio (J)), *Benincasa hispida* (Thunb.) Cogn. (tanqué (Sp) — tung kwa (Ch) — togwa (J) — donga (K)), *Brassica rapa* L. subsp. *pekinensis* (Lour.) Hanelt (pak tchoi (Sp) — pakchoi (Ch)) or *Lycium chinense* Mill. (cauqui (Sp) — kou chii (Ch)). In other instances the common Cuban and English names are related to the Latin name, which in turn derived from the Asiatic name, as is true of *Dimocarpus longan* Lam. (longan (Sp) — longan (E) — long yan (Ch) — long nhan (V)), and *Litchi sinensis* Sonn. (litchi (Sp) — lychee (E) — lichin (Ch)). Another possibility is that the common Cuban and English names can be derived directly from the Asian names as happens with *Fortunella japonica* (Thunb.) Swingle (kumquat (Sp) — kumquat (E) — cay quat (V)), or *Pueraria lobata* (Willd.) Ohwi. (kudzu (Sp) — kudzu bean (E) — kuzu (J)).

Table 1. Toponymy of the common Cuban, English and Asiatic names for plants

Spanish	English	Chinese	Japanese	Vietnamese
rackio		rackio k'iu t'au	rakkio	
tanqué		tung kwa	tongwa	
pak tchoi		pakchoi		
pe tsai	pe-tsai	ta pai tsai		
longan	longan	long yan		long nham
kumquat	kumquat			cay quat
litchi	lychee	li chin		
cauqui		kou-chii		
kudzu	kudzu bean		kuzu	

Conclusions

We have tried to show, in this work, how information from valuable sources such as history, ethnobotany and linguistics should be consulted in the study of plant genetic resources. Yet such sources are sometimes overlooked, leading to erroneous interpretations or appraisals. The confusion created by the inclusion of cultivated Asiatic species of the genus *Brassica* in the wild flora of Cuba is one illustrative example. On the other hand, it has once again been demonstrated that agriculture does not exist in isolation from a people's culture. An ethnic minority, such as Asians in Cuba, can often have considerable influence. The cultural heterogeneity of Cuba, and the way this shows up in agriculture, has received no attention so far. As this work and the upcoming studies of other groups of plants of various origins show, this factor needs to be taken into account.

The east Asiatic crops constitute an important part of Cuban plant genetic resources. A rich diversity of well-adapted east Asiatic cultivated plants could be collected which would be especially useful for breeding research and practical breeding purposes in Cuba.

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Résumé

Les influences de l'Asie de l'Est sur l'agriculture cubaine
Une étude concernant l'influence de l'Asie orientale sur l'agriculture cubaine a montré que 44 plantes cultivées au total, sont originaires de l'Asie orientale. Elles sont utilisées comme légumes (41 pour cent), plantes médicinales (30 pour cent) et fruits (20 pour cent). On donne une liste de ces apports asiatiques à la flore cubaine cultivée, en indiquant les noms botaniques et synonymes, les noms anglais, les noms cubains vernaculaires et les noms en Asie orientale. Pour chaque plante, on indique son utilisation, les parties des plantes consommées, des éléments historiques, la variation observée, les sources dans la littérature cubaine spécialisée et d'autres questions intéressantes. L'importance des cultures asiatiques à Cuba, comme ressources phytogénétiques est soulignée.

Resumen

Influencias de Asia oriental en la agricultura cubana
En un estudio sobre la influencia de Asia oriental en la agricultura cubana se puso de manifiesto que en esa región tiene su origen un total de 44 cultivos, de hortalizas (41 por ciento), plantas medicinales (30 por ciento) o frutas (20 por ciento). Se presenta una lista de esos elementos de la flora cultivada cubana procedentes de Asia oriental con les nombres botánicos y sus sinónimos, los nombres en inglés, los nombres populares cubanos y los nombres de la zona de procedencia. En cada planta se indican la aplicación, las partes utilizadas y otras observaciones relativas a la historia, la variación, las fuentes en la bibliografía cubana y otros datos de interés. Se pone de relieve la importancia de los cultivos procedentes de Asia oriental en Cuba como recursos fitogenéticos.

Appendix 1. List of cultivated plants of possible Asiatic origin in Cuba.

Abbreviations for plant use and part of plant used: Fi, fibres; Fo, fodder; M, medicinal; N, nuts; Ol, oil seeds; Leg, legumes; S, spices; Fr, fruit trees; V, vegetable crops; Ch, source of carbohydrates; B, bulbs; ba, bark; fl, flowers; fr, fruits; l, leaves; pl, whole plant; r, roots, rhizomes; s, seeds; st, stem.

(Sp) spanish; (Ch) chinese; (E) english; (J) japanese; (K) korean; (V) vietnamese.

Abutilon theophrasti Medik., Malvenfam. (1787) 28 — Sida abutilon L., Sp. Pl. (1753) 685; Abutilon avicennae Gaert., Fruct. sem. pl. 2 (1790). (Malvaceae)
Ch'ing-ma (Ch), China jute (E), meng-ma (Ch), odzogue (K), yute de China (Sp)
Fi (st)
Ref.: Roig (1975)

Aleurites fordii Hemsl. in Hook., Icon. pl. 29 (1906) t. 2800. (Euphorbiaceae)
Aceite chino (Sp), Chinese wood oil tree (E), tung oil tree (E), judong (K), san-nien-tung (Ch), tung-shu (Ch), yu-tung (Ch)
Ol (s)
Introduced by the EEA and various nurseries; its oil is used commercially in the preparation of paints
Ref.: Fl. Cub. 3, Roig (1975)

Allium chinense G. Don, Monogr. Allium (1827), reprined in Mem. Werner Nat. Hist. Soc. (1827) 6:83. (Liliaceae)
Cebollino (Sp), ch'iao-t'ou (Ch), Chinese chives (E), hsieh (Ch), jombutschu (K), jomdzi (K), rackio (Sp), rackio k'iu t'au (Ch), rakkyo (J)
V (l, b)
C, as yet found only among Japanese farmers on the Isla de la Juventud

Allium fistulosum L., Sp. Pl. (1753) 301. (Liliaceae)
Cebollino (Sp), Japan leek (E), spring onion (E), welsh onion (E), Japanese bunching onion (E), pa (K), ts'ung (Ch)
V (l, b)
C, as yet found only among Japanese farmers on the Isla de la Juventud.
Ref.: Guenkov (1983)

Allium sativum L., Sp. Pl. (1753) 296 var. *pekinense* (Prokh.) Maek. apud Makino, Ill. Fl. Jap. (1954) 748. (Liliaceae)
Ajo (Sp), manul (K), niniku (J), Peking garlic (E), ta suan (Ch), toi (V)
S (b), M (b)
C, characteristically has smaller bulbs
Ref.: Roig (1975), Guenkov (1983)

Allium tuberosum Rottler ex Spring., Syst. (1825) 2:38. (Liliaceae)
Cebollino (Sp), Chinese chives (E), kau ts'oi (Ch), kuit ts'ai (Ch), nira (J)
V (l, fl)
C, obtained among Japanese farmers in the Isla de la Juventud

Amaranthus lividus L., Sp. Pl. (1793) 990 convar. *oleraceus* (L.) Thell. ex Aschers. et Graeb., Syn. mitteleurop. Fl. (1914) 5:332 Amaranthus oleraceus L., Sp. Pl. ed. 2 (1763) 1403. (Amaranthaceae)., Espinaca china (Sp)
V (l)
C, with seeds collected in the Isla de la Juventud from a Chinese vegetable grower and now in the process of being correctly defined
Ref.: Roig (1975)

Averrhoa bilimbi L. Sp. Pl. (1753) 428. (Oxalidaceae).
Cucumber tree (E), grosella china (Sp), san-nien (Ch)
V (fr), M (fr)
O
Ref.: Roig (1975)

Averrhoa carambola L., Sp., Pl. (1753) 428 (Oxalidaceae)
Averrhoa (E), Caramb (E), carambold (E), carambola (Sp), ciruela china (Sp), yang-t'ao (Ch)
Fr
O
Ref.: Roig (1975)

Basella alba L., Sp. Pl. (1753) 272, emend. Roxb., Fl. ind. ed. Carey (1832) 2:104 — Basella rubra L., Sp. Pl. (1753) 272. (Basellaceae)
Ceylon spinach (E), Indian spinach (E), Malabar nightshade (E), chuan-t'sai (Ch), espinaca de Malabar (Sp), lo-k'uei (Ch), raggju (K)
V (l), M (r, l)
C, cultivated by the Chinese, who eat the leaves as spinach
Ref.: Fl. Cub. 2, Roig (1975)

Benincasa hispida (Thunb.) Cogn. in A. DC., Monogr. phan. (1881) 3:513 Cucurbita hispida Thunb., Fl. Jap. (1784) 322. (Cucurbitaceae)
Ash pumpkin (E), Chinese preserving melon (E), white gourd (E), calabaza china (Sp), tanque (Sp), donga (K), togwa (J), tung kwa (Ch)
V (fr), Fr
C, introduced by Chinese vegetable growers, the fruits are eaten in syrup
Ref.: Roig (1975)

Brasenia schreberi J.F. Gmel., Syst. nat. (1791) 853. (Nymphaeaceae)
Junsai (J), mazamorra (Sp), shun-t'sai (Ch), suntschae (K), water shield (E)
V (l)
The Chinese eat the leaves as vegetables
Ref.: Roig (1975)

Brassica juncea L. Czern. in Consp. pl. Chark. (1859) 8 — Sinapis juncea L., Sp. Pl. (1753) 668; Brassica lanceolata Sauvalle, Fl. Cub. (1873) 3, non Lange; Brassica urbaniana O. E. Schulz in Urban, Symb. antill. (1903) 3, 3:51 1. (Cruciferae)
Chien t'sai (Ch), ching t'sai (Ch, Szechuan), gas (K), Indian mustard (E), sarepta mustard (E), leaf mustard cabbage (E), mostaza china (Sp), mostaza de la tierra (Sp), tuong cai (V)
S (s), V (l), M (s)
C.
Ref.: Fl. Cub. 2

Brassica oleracea L., Sp. Pl. (1753) 667 var. *alboglabra* (Bailey) Musil., Misc. Publ. US Dept. Agric. 643 (1948) 12 — Brassica alboglabra L. H. Bailey in Gent. herb. 1, (1922) fasc. 2:79 et 2, (1930) fasc. 5:233. (Cruciferae)
Berza (Sp), chieh lan (Ch), Chinese kale (E)
V (l)
C, obtained among Japanese farmers in the Isla de la Juventud,

the leaves are used in soups and stews

Brassica rapa L., Sp. Pl. (1753) 666, emend. Metzg., Syst. Beschr. Kohlart. (1833) 48 subsp. *pekinensis* (Lour.) Hanelt in Schultze-Motel, Mansf. Verzeichnis (1986) 304 — Sinapis pekinensis Lour., Flor. cochinch. (1790) 400; Brassica pekinensis (Lour.) Rupr., Fl. ingr. (1860) 96. (Cruciferae)
Baetschu (K), celery cabbage (E), Chinese cabbage (E), Shantong cabbage (E), col china (Sp), cu cai (V), huang ya tsai (Ch, Chekiang), pak choi (Ch, Kanton), pak-tchci (Sp), pe tsai (Sp), pe-tsai (E), ta pai (Ch)
V (l)
C, introduced by Chinese vegetable growers
Ref.: Roig (1975); Guenkov (1983)

Brassica rapa L., Sp. Pl. (1753) 666, emend. Metzg., Syst. Beschr. Kohlart. (1833) 48 var. *perviridis* Bailey in Gent. herb. 2, fasc. (1930) 5:243 — Brassica perviridis (Bailey) Bailey in Gent. herb. 4, fasc. (1940) 9:328. (Cruciferae)
Mostaza espinaca (Sp), nai cay (V), po leng chieh (Ch), spinach mustard (E), tendergreen (E)
V (l)
Introduced by the EEA from the USA
Ref.: Roig (1975)

Canavalia gladiata (Jacq.) DC., Prodr. (1825) 2:404 — Dolichos gladiatus Jacq., Coll. Bot. (1788) 2:276. (Leguminosae)
Sword bean (E), canavalia (Sp), frijol de China (Sp), nata-mame (J), tau tou (Ch)
The toasted, ground seeds are used mixed with coffee, cultivated also as green manure
C, plant of dubious Asiatic origin in Cuba, there are no references on the origin of the common name.
Ref.: Fl. Cub. 2, Roig (1975)

Castanea crenata Sieb. et Zucc. in Abh. Math. Phys. Cl. Königl. Bayer. Akad. Wiss. 4, (1846) 3:224 — Fagus castanea Thunb., Fl. jap. (1784), non L. (1753). (Corylaceae)
Bamnamu (K), castaño del Japón (Sp), Japanese chestnut (E), kuri (J), yih-pen-li (Ch)
N (fr)
Introduced from Japan by the EEA
Ref.: Roig (1975)

Cinnamomum aromaticum Nees in Wall., Plant As. Rar. (1831) 74 — Cinnamomum cassia Blume, Bijdr. (1825) 370, excl. syn. Laurus cassia L. (1753). (Lauraceae)
Canela de China (Sp), Chinese cassia (E), Chinese cinnamon (E), kuei-chih (Ch), kuei-p'i (Ch), que (V)
S (ba, fr), M (ba, l, fl), shade tree
O
Ref.: Roig (1975)

Coix lachryma-jobi L., Sp. Pl. (1753) 972 var. *ma-yuen* (Romanet) Stapf in J.D. Hook., Fl. Brit. Ind. (1896) 7:100 — Coix lacryma-jobi L., Sp. Pl. (1753) 972 var. frumentacea Makino in Bot. Mag., Tokyo (1906) 20:11. (Gramineae)
Hatomugi (J), Job's tear (E), julmu (K), millo chino (Sp), Santa Juana (Sp), ta-wan-tzu (Ch)
Ch (s), occasionally cultivated by Chinese farmers
Known by the name 'millo chino' only in Santiago de las Vegas
Ref.: Fl. Cub. 1, Roig (1975)

Colocasia esculenta (L.) Schott et Endl., Melet. bot. (1832) 18 — Arum esculentum L., Sp. Pl. (1753) 965; Colocasia antiquorum Schott in Schott et Endl., l.c.; Colocasia antiquorum L., Sp. Pl. (1753) 965 var. esculenta (L.) Schott, Syn. Aroid. (1856) 41. (Araceae)
Cocoyam (E), dasheen (E), tannia (E), eddoes (E), imo (J), malanga isleña (Sp), toran (K), wu (Ch), yü (Ch), yü-tou (Ch)
Ch (r)
O., grown around Havana, gradually being replaced by Xanthosoma spp.
Ref.: Fl. Cub., Roig (1975)

Dimocarpus longan Lour., Fl. Cochinch. (1790) 233 — Euphoria longana Lam., Encycl. (1792) 3:574, nom. illeg.; Nephelium longana Cambess. in Mem. Sapind. (1829) 30. (Sapindaceae)
Cay nhan (V), long nhan (V), long yan (Ch), long-yen (Ch), longan (E), lung-yen (Ch), zapote chino (E)
Fr, M (fr)
Ref.: Roig (1975)

Dioscorea opposita Thunb., Fl. Jap. (1784) 151 — Dioscorea batatas Decne. in Rev. hortic. Paris, ser. (1854) 4, 3:243. (Dioscoreaceae)
Chinese potato (E), Chinese yam (E), ma (K), naga-imo (J), ñame chino (Sp), ñame de agua (Sp), sain-in (Ch)
Ch (r)
C, obtained from Japanese farmers in the Isla de la Juventud, the material collected is currently being correctly defined
Ref.: Roig (1975)

Diospyros kaki Thunb. in Nov. Act. Soc. Upsal. (1780) 3:208. (Ebenaceae)
Cay hong (V), Chinese persimmon (E), kakee plum (E), gamnamu (K), kaki (J), shi-tse (Ch), kaki del Japón (Sp), zapote chino (Sp)
Fr
O, very thinly distributed in Cuba
Ref.: Roig (1975)

Eriobotrya japonica (Thunb.) J. Lindl. in Trans. Linn. Soc. London (1821) 13:102 — Mespilus japonica Thunb., Fl. Jap. (1784) 206. (Rosaceae)
Biwa (J), Japan plum (E), Japanese medlar (E), kin-liu-tze (Ch), pipa (Ch), nispero del Japón (Sp), zapote del Japón (Sp)
Fr
C, thinly distributed in Cuba
Ref.: Roig (1975)

Fortunella japonica (Thunb.) Swingle in J. Wash. Acad. Sci. (1915) 5:171 — Citrus japonica Thunb. in Nova Acta Upsal. (1780) 3:199. (Rutaceae)
Cay quat (V), chin kan (Ch), kumquat (Sp), naranjita japonesa (Sp), kumquat (E), marumi (J)
Fr
O
Ref.: Roig (1975)

Glycine max (L.) Merr., Interpret. Rumph. Herb. Amboin. (1917) 274 — Phaseolus max L., Sp. Pl. (1753) 725. (Leguminosae)
Dau tuong (V), kong (K), soya (Sp), soya bean (E), soybean (E), tatou (Ch)
Leg, Ol (s), Fo (s)
Introduced in 1904 by the EEA from the USA, but possibly already found in the Isla de la Juventud, used by the Japanese to prepare a kind of cheese called 'tofu' (dau phu (V) = soya cheese)
Ref.: Roig (1975)

Hibiscus sabdariffa L., Sp. Pl. (1753) 695. (Malvaceae)
Quimbombó chino (Sp)
M (fl), a fruit drink is prepared with the calyx of the flower
O, a species of dubious Asiatic origin in Cuba, origin of common name unknown
Ref.: Roig (1975)

Lagenaria siceraria (Molina) Standl. in Publ. Field Mus. Nat. Hist. Chicago, bot. ser. (1930) 3:435 subsp. *asiatica* (Kob.) Heiser in Meggers *et al.*, Trop. Forest Ecosyst. in Afr. and Amer. (1973) 127 — Cucurbita lagenaria L., Sp. Pl. (1753) 1010; Cucurbita siceraria Molina, Sagg. Chile (1782) 133; Lagenaria vulgaris Ser. in Mém. Soc. phys. Geneve 3, (1824) 1:25, t. 2 subsp. asiatica Kob in Bull. appl. bot., Leningrad (1930) 23, 3:487. (Cucurbitaceae)
Bottle gourd (E), white flowered gourd (E), güiro amargo (Sp), lo kwa (Ch), mo kwa (Ch), bag (K), pepino chino (Sp)
M (fr, l), V (fr)
C, obtained from Japanese farmers on the Isla de la Juventud, who use the dried fruits as containers. The Chinese eat the unripe fruits as a vegetable
Ref.: Fl. Cub. 5, Roig (1975)

Litchi sinensis Sonn., Voy. Indes Or. Chine (1782) 3:230 — Euphoria litchi Desf., Tabl. (1804) 135; Nephelium litchi Cambess. in Mém. Sapind. (1829) 310. (Sapindaceae)
Cay vai (V), li-chih (Ch), likou (Ch), li-tschi (Sp), mamoncillo chino (Sp), lychee (E), ngan xanh (V), reishi (J)
Fr, M (fr)
O, formerly very common in Chinese establishments
Ref.: Roig (1975)

Lycium chinense Mill., Gard. Dict. ed. (1768) 8 no. 5. (Solanaceae)
Cauqui (Sp), Chinese wolfberry (E), gugidza (K), kou-ch'i-t'sou (Ch), kou-ch'i-tzu (Ch), kou-chii (Ch), ti-ku-p'i (Ch), kuko-cha (J)
M (fr)
V (l)
The Chinese eat the leaves in salads
Ref.: Roig (1975)

Mentha arvensis L., Sp. Pl. (1753) 577 subsp. *haplocalyx* (Briq.) Briq. in Engler et Prantl, Nat. Pflanzenfam. 4, (1895) 3a:319 — Mentha arvensis L., Sp. Pl. (1753) 577 var. piperascens Malinv. ex Holmes in Pharm. J., London, ser. 3, (1882) 13:381; Mentha haplocalyx Briq. in Bull. Soc. bot. Geneve (1889) 5:39. (Labiatae)
Bac ha (V), bagha (K), hakka (J), Japanese peppermint (E), menta japonesa (Sp), po ho (Ch)
M (pl)
Introduced by the EEA from Japan for commercial exploitation in the extraction of essential oils
Ref.: Roig (1975)

Momordica charantia L., Sp. Pl. (1753) 1009. (Cucurbitaceae)
Bitter gourd (E), cundeamor chino (Sp), fu kwa (Ch), judza (K), ki-uri (J)
V (fr), M (fr, l, s)
C, obtained from Japanese farmers on the Isla de la Juventud, the Chinese eat the seeds and fruits as a vegetable
Ref.: Roig (1975)

Nelumbo nucifera Gaertn., Fruct. sem. pl. (1788) 1:73 — Nymphaea nelumbo L., Sp. Pl. (1753) 511. (Nymphaeaceae)
Chinese water lily (E), hasu-n-né (J), hasu-no-mi (J), ho-hua (Ch), lien (Ch), lien-hua-jui (Ch), ho-yeh (Ch), cay sen (V), hoa sen (V), rjonggot (K), yuca china (Sp)
V (r), N, M (s)
Formerly grown by Chinese in Havana in waterlogged plots or in water. The cooked root is eaten
Ref.: Roig (1975)

Pogostemon cablin (Blanco) Benth. in DC., Prodr. (1848) 12:156
Mentha cablin Blanco, Fl. Filip. (1837) 473;
Pogostemon patchouly Pellet in Mém. Soc. Sco. Orléans (1845) 5:277. (Labiatae)
Hou-hsiang (Ch), pachuli (Sp), patchouly (E)
Used as an aromatic plant. Basically in the Baracoa region, the dried leaves are put into sachets for storing clothes
Ref.: Roig (1975)

Pueraria lobata (Willd.) Ohwi in Bull. Tokyo Sci. Mus. (1947) 18:16 — Dolichos lobatus Willd., Sp. Pl. 3, (1802) 2:1047; Pachyrhizus thunbergianus Sieb. et Zucc. in Abh. Akad. München 4, (1846) 3:237; Pueraria thunbergiana (Sieb. et Zucc.) Benth. in J. Linn. Soc. Bot. (1865) 9:122. (Leguminosae)
Ko (Ch), kudzu bean (E), kudzú japoñes (Sp), kuzu (J), tschilg (K)
Fo
Introduced by the EEA from Japan
Ref.: Roig (1975)

Raphanus sativus L., Sp. Pl. (1753) 669. (Cruciferae)
Daikon (J), lai-fu (Ch), lo-po (Ch), nabo chino (Sp), rábano gigante del Japón (Sp), rábano japonés (Sp), Spanish radish (E)
V (r)
C, obtained from Japanese farmers on the Isla de la Juventud, propagated in Havana by Chinese vegetable growers, although cultivars were also introduced by the EEA
Ref.: Fl. Cub. 2, Roig (1975); Guenkov (1983)

Sagittaria sagittifolia L., Sp. Pl. (1753) 993 subsp. *leucopetala* (Miq.) Hartog ex van Steenis, Fl. Malesiana ser. 1, (1955-58) 5:332 — Sagittaria sinensis Sims in Bot. Mag. (1814) 39 t. 1631. (Alismataceae)
Chinese arrow grass (E), konwai (J), malanga china (Sp), soeguenamul (K), tzu-ku (Ch)
Ch (r)
Formerly grown by Chinese on waterlogged plots in Cienaga in the Cerro district
Ref.: Roig (1975)

Vigna angularis (Willd.) Ohwi et Ohashi in Jap. J. Bot. (1969) 44:29 — Dolichos angularis Willd., Sp. Pl. (1802) 3:1051; Phaseolus angularis (Willd.) Wight in US Dept. Agric. Bur. Pl. Ind. Bull. (1909) 37:17. (Leguminosae)
Adzuki bean (E), frijol de carita (Sp), frijol maicero (Sp), pat (K)
Leg, V (fr)
C
Ref.: Roig (1975)

Vigna radiata (L.) Wilcz., Fl. Congo Belg. et Ruanda-Burundi 6 (1954) 386 var. *radiata* — Phaseolus radiatus L., Sp. Pl. (1753) 725; Phaseolus aureus Roxb., Fl. Ind. ed. Carey 3 (1832) 297. (Leguminosae)
Bundo (J), yayenari (J), frijol mungo (Sp), frijolito chino (Sp), mung bean (E), green gram (E), lantuo (Ch), lou teou (Ch), rogdu (K)
Leg
C, introduced by the EEA from India this is the mungo bean species now used in the preparation of Asian meals

Vigna umbellata (Thunb.) Ohwi et Ohashi in Jap. J. Bot. (1969) 44:31 — Dolichos umbellatus Thunb. in Trans. Linn. Soc. (1794) 2:339; Phaseolus calcaratus Roxb., Fl. Ind. ed. Carey (1832) 3:289. (Leguminosae)
Frijol arroz (Sp)
Leg
C, cultivated by Chinese vegetable growers, the seeds are used in the prr aration of Asiatic dishes such as 'chop suey'
Ref.: Roig (1975)

Vigna unguiculata (L.) Walp., Rep. (1842) 1:779 subsp. *cylindrica* (L.) Verdc. in Kew Bull. (1970) 24:544 —Phaseolus cylindricus L., Herb. Amboin. (1754) 23; Vigna cylindrica (L.) Skeels in US Dept. Agric. Bur. Pl. Ind. Bull. (1913) 282:32. (Leguminosae)
Catjang bean (E), engorda muchachos (Sp), frijol precioso (Sp)
Leg
C
Ref.: Roig (1975)

Vigna unguiculata (L.) Walp., Rep. (1842) 1:779 subsp. *sesquipedalis* (L.) Verdc. in Davis, Fl. Turkey (1970) 3:266 — Dolichos sesquipedalis L., Sp. Pl. ed. (1763) 2:1019; Vigna sesquipedalis (L.) Fruhw., Anabau Hülsenfr. (1898) 254. (Leguminosae)
Habichuela china (Sp), yard long bean (E)
Leg, V (fr)
C, propagated by Chinese vegetable growers
Ref.: Roig (1975)

Vigna unguiculata (L.) Walp., Rep. (1842) 1:779 subsp. *unguiculata* — Dolichos unguiculata L., Sp. Pl. (1753) 720; Dolichos sinensis L., Herb. Amboin. (1754) 23; Vigna sinensis (L.) Hassk., Cat. Plant. Hort. Bogor. (1844) 279. (Leguminosae)
Blackeyed pea (E), cowpea (E), frijol de carita (Sp)
Leg, Fo
C, cultivated by Chinese vegetable growers, used in the preparation of fried foods called 'bollitos de carita' (little face rolls)
Ref.: Roig (1975)

Does wild, six-rowed barley, *Hordeum agriocrithon*, really exist?

Roland von Bothmer[1], Chi Yen[2] and Junliang Yang[2]

Summary

The landraces of barley grown on the Tibetan plateau in western China exhibit a large variation amplitude. Six-rowed naked types are, however, predominating. In most fields brittle rachis types occur more or less frequently and the crop is harvested before the gene(s) is fully expressed. The brittle rachis character is thus not a symptom of a wild or even a weedy state. The gene(s) for brittle rachis merely belongs to the normal variation pattern for the landrace and has not been selected against. *Hordeum agriocrithon* Åberg, described from this area and long considered as a link in the evolution of six-rowed barley, is thus not worth taxonomic recognition.

Introduction

The priorities for IBPGR and regional genebanks have been widened during the last few years to include not only the primary genepool of the crops but also wild relatives and thus secondary and tertiary genepools (Williams, 1988). Since 1986 IBPGR has sponsored collecting missions in China mainly devoted to gathering wild species of the tribe *Triticeae*, but also the genera *Hordeum, Triticum* and *Secale*, as well as *Elymus, Agropyron, Leymus*, etc. The collecting was carried out by two teams, one working in western and one in eastern China (IBPGR, 1988). The western team in 1986 visited the plateau area of the provinces of Qinghai and Sichuan and in 1988 the province of Tibet mainly at altitudes above 3 000 m. This paper deals with the primitive barley forms occurring in the areas visited.

Barley—genepool and centres of diversity

Barley originated as a crop in southwest Asia in the famous Fertile Crescent where the original form of the crop, *spontaneum*, still exists in nature. *Spontaneum* belongs to an eastern Mediterranean flora element and is found as a native plant eastwards to Baluchistan and Tajikistan and westwards to Libya and easternmost Greece. However, two-rowed, brittle rachis types also exist in other areas, e.g. in western North Africa (Molina-Cano *et al.*, 1982) and in western China (Shao, 1981). Scientists have not agreed if these populations are originally wild in these areas, if they have spread from the area of origin, or if they represent recombination products of cultivated barley (Murphy *et al.*, 1982; Giles and Bothmer, 1985; Molina-Cano *et al.*, 1987).

Since there are no sterility barriers between the different forms, both six- and two-rowed, brittle and non-brittle barleys are considered as one species complex. All forms earlier given several species epithets are now taxonomically included in the species *Hordeum vulgare* L. Free gene exchange is thus possible, and all forms belong to the primary genepool of barley and constitute a great genetic resource.

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Phylogenetic theories—evolution of barley

The phylogeny and evolution of cultivated barley have been much debated. It is nowadays accepted that barley, together with einkorn wheat, peas and lentils, is our most ancient crop, starting to be cultivated around 10 000 years ago. There are, however, several theories on its origin. Due to the large morphological dissimilarity between two- and six-rowed barley, it was first assumed that the two forms must have had independent, parallel pathways of evolution and hence a polyphyletic origin (Åberg, 1940; Freisleben, 1940). The two-rowed form with brittle rachis, first collected in eastern Turkey (the Caucasus area) and described by Koch in 1848 as *H. spontaneum*, was considered the ancestor of two-rowed cultivated barley, whereas the progenitor to the six-rowed form was unknown and assumed to be extinct. In the beginning of the 1930s a Swedish botanist, Harry Smith, on a collecting mission in western China, gathered several samples of primitive landrace material of wheat and barley in Tibet Province (Smith, 1947). The collection was analyzed by Ewert Åberg and among the samples (as a contamination in a wheat sample) a brittle rachis, six-rowed form was detected and subsequently described as *H. agriocrithon* (Åberg, 1938). It was also considered as the missing link in the origin of cultivated, six-rowed barley. The work of botanists and geneticists later questioned this view (Harlan, 1968; Zohary, 1973). The general opinion at present is that barley has a monophyletic origin based on wild forms of *spontaneum*. The six-rowed, brittle rachis forms have puzzled many people. Tovia and Zohary (1962) claimed that these forms growing in Israel are hybrids between wild or weedy, two-rowed forms and cultivated, six-rowed barley (see, e.g., Witcombe, 1978; Murphy *et al.*, 1982). Apart from a single report (Shao *et al.*, 1975), no other author has claimed to have found a truly wild *agriocrithon*, rather that this form is occurring as a weed. Based on this, Scholz (1986) treated it as a separate taxon, *H. vulgare* subsp. *agriocrithon* (Åberg) Scholtz. In this he included all weedy forms, two- as well as six-rowed.

Cultivation of barley in western China—the role of *agriocrithon*

Barley is still a staple food for the Tibetans, who use it to prepare tsamba (roasted and milled barley) which is used in their butter tea. It is cultivated mainly in the lower valleys,

Fig. 1. Landrace of six-rowed naked barley in Tibet. Note the heavily smut-infected spike to the left

3 000–3 500 m, but cultivations up to 4 200 m were seen in Tibet (Fig. 1). No breeding efforts have been invested in the barleys of this area and the types which are still cultivated are real landraces with an extreme variation amplitude, but with naked, six-rowed forms predominating. However, two-rowed forms were also frequently found. Tough- and brittle-rachis types occurred together also in field margins, and as weeds in other crops. The impression when examining the first field was exciting: finding the famous 'wild barley' in the area of supposed origin. However, on seeing the Tibetan agricultural practice the connection became obvious. Since the fields are harvested more or less green or just turning yellow and thus unripe, the gene(s) for brittleness is not yet expressed or only to a minor extent (there is quite a variation as to the degree of brittleness). This in turn means that there has not been a need to select against the harmful, shattering effects of the fully expressed gene in quite mature crops. The conclusion must hence be that brittle-rachis barley, two- as well as six-rowed forms, should not be considered wild or even weedy—they just belong to the regular genepool of the very variable landrace itself. Shao *et al.* (1975) claimed that there is a barrier between *agriocrithon* and cultivated barley since the former would flower around two weeks earlier than the latter. In the area we studied it is definitely not so. There is an extreme variation in all characters, including time of flowering and maturity, between genotypes (plants) within a particular landrace field of both shattering and non-shattering types.

We consider that the earlier conclusions drawn by geneticists and botanists concerning brittle-rachis barleys being wild or weedy in the area of Tibet are quite logical—but wrong. There has been a tendency to consider brittle rachis as a character state typical for a wild or weedy form. It is easy to look into a field or a roadside and by finding the brittle types conclude that they must be wild. However, when examining the intricate pattern of variation and relationships in crops one has to include agricultural practice in the problem.

In any case, the relationships between the brittle and non-brittle rachis types are of great theoretical interest for evolutionists and taxonomists. However, the brittle type, together with the non-brittle landrace types from the Tibetan Plateau, constitute a very important genetic resource to be properly collected, evaluated and preserved to be used in future breeding efforts.

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Résumé

Est-ce que l'orge sauvage à six rangs, Hordeum agriocrithon, *existe vraiment?*
Les races de pays d'orge cultivées sur le plateau tibétain dans l'ouest de la Chine présentent une grande variation. Les types nus à six rangs prédominent toutefois. Dans la plupart des champs, on rencontre plus ou moins fréquemment des types à rachis cassant et la plante est récoltée avant que le ou les gènes s'expriment pleinement. Le caractère "rachis cassant" n'est donc pas le symptôme d'un état sauvage ou même adventice. Le ou les gènes responsables du rachis cassant appartiennent simplement au type normal de variation de la race de pays et n'ont pas fait l'objet d'une sélection visant à les éliminer. *Hordeum agriocrithon* Aberg, décrit dans cette zone et considéré pendant longtemps comme un maillon dans l'évolution de l'orge à six rangs ne mérite donc pas une reconnaissance taxonomique.

Resumen

¿Existe realmente la cebada silvestre de seis carreras, Hordeum agriocrithon?
Las variedades locales de cebada que se cultivan en la meseta tibetana, en China occidental, muestran una gran amplitud de variación. Sin embargo, predominan los tipos desnudos de seis carreras. En la mayoría de los campos aparecen con mayor o menor frecuencia tipos de raquis frágil que se cosechan antes de que se hayan expresado totalmente los genes. Así pues, la característica de raquis frágil no es un síntoma de estado silvestre, ni siquiera de estado de mala hierba. Los genes que determinan el raquis frágil pertenecen simplemente a la característica de variación normal de la variedad local, en contra de la cual no se ha producido selección. *Hordeum agriocrithon* Aberg, descrito en esta zona y considerado durante mucho tiempo como un vínculo en la evolución de la cebada de seis carreras, no se debe reconocer, pues, como característica taxonómica.

Mungbean genetic resources at the Asian Vegetable Research and Development Center

David C.S. Tay[1] and Yung-Kuang Huang[1]

Summary

The Asian Vegetable Research and Development Center (AVRDC) was requested by the International Board for Plant Genetic Resources (IBPGR) to keep the world mungbean collection, which contains 5 274 accessions from 50 countries. The whole collection was characterized in 1984 and 1985 for the essential agronomic and morphological characters. The variation in the collection has been assessed.

Introduction

AVRDC was requested in 1984 by IBPGR to maintain and distribute the world mungbean collection. The collection, started in 1973, presently contains 5 274 accessions from 50 countries with 2 558 (48.5%) accessions from India. Since 1973, 57 156 seed samples (both accessions and breeding lines) have been distributed to about 100 countries for testing, and 50 000 samples of the accessions tested by AVRDC scientists.

The collection

AVRDC's mungbean collection is acquired mainly through donation and exchange with different institutions and individuals (Table 1). It includes 3 425 accessions with PI No. (Plant Introduction, USA), 1 686 with M No. (Missouri, USA), 937 with LM No., 804 with PLM No. (PL-480 Mung Collection, India), 152 with IC No. (Indigenous Collection, India), 152 with NEMB No., 93 with PM No., 93 with STB No., 72 with ML (Punjab Agricultural University, India), 50 with PHLV No., 37 with UPCA No. (University of Philippines, Philippines), and 33 with CES No. Many of the accessions have more than one donor number. In addition, AVRDC's scientists also routinely make collections in various countries.

AVRDC participated in an IBPGR-sponsored mission to collect local races of *Vigna* spp. and other grain legumes in Laos (PDR) in 1983 in cooperation with the National Agricultural Research Center (NARC) and the Tropical Agricultural Research Center (TARC) of Japan (Ojima *et al.*, 1984). Fifteen mungbean samples were collected. During characterization and accessioning, samples with more than one type of seed were separated out, resulting in a total of 24 accessions.

The largest gap in the collection is the lack of representation from Indochina, i.e. Viet Nam, Kampuchea and Laos, and Burma. Presently, there are 24 accessions from Vientiane Province, Laos, 21 from Viet Nam, and 11 from Burma. Other places to be explored are Bangladesh, China, Indonesia, Pakistan and Sri Lanka (Singh, 1980).

Presently, only the following passport data are available: (a) accession number, (b) name of accession, (c) species, (d) donor numbers, and (e) country of origin. Information on the actual collecting sites is unavailable except for accessions that were collected recently.

Out of the 5 274 accessions in the collection, 34 are *Vigna mungo*, 4 *V. unguiculata*, 2 *V. angularis*, 1 *V. glabrescens*, and 165 missing accessions. 983 suspected duplicates were identified after comparing their passport information.

Table 1. AVRDC *V. radiata* var. *radiata* introductions by country of origin include 34 *V. mungo*, 4 *V. unguiculata* and 2 *V. angularis*

Country	No. of accns.	Country	No. of accns.
Afghanistan	285	Argentina	3
Australia	121	Bangladesh	6
Brazil	5	Burma	11
Canada	2	China	23
Congo (PR)	3	Cuba	1
Denmark	2	Ecuador	1
UK	42	Ethiopia	3
France	29	Ghana	2
Guam	3	Guatemala	8
Guyana	1	Hong Kong	20
India	2 558	Indonesia	66
Iran	628	Iraq	4
Côte d' Ivoire	13	Japan	3
Kenya	9	Korea	140
Laos	24	Madagascar	11
Malaysia	2	Mexico	2
Netherlands	39	Nigeria	32
Pakistan	245	Peru	4
Philippines	312	South Africa (Rep.)	2
Senegal	1	Somalia	1
Sri Lanka	16	Suriname	1
Taiwan	46	Tanzania	1
Thailand	235	Trinidad	1
Turkey	25	USA	150
USSR	4	Viet Nam	21
Unknown	107	TOTAL	5 274

2 549 accessions have a mixture of different kinds of seeds within an accession. Until recently, the collection was maintained in the form of heterogeneous populations, especially in terms of seed characteristics. From past experience, the mixture in an accession may be composed of closely related phenotypes

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(probably segregating for seed characters only) or quite distinct genotypes. In the latter case, competition between the different genotypes can be serious. It is, therefore, essential to separate the different seeded phenotypes in germplasm conservation to minimize change in genetic composition of an accession due to genotype competition, genetic drift and natural selection during regeneration.

Conservation

The base collection for permanent storage is kept at -20°C in AVRDC's long-term store in hermatically sealed aluminium-polyethylene laminated pouches. The seeds are slowly dried at 15°C and 15% RH to 6-8% moisture content before packaging. The active collection for distribution is kept in medium-term storage at 2-5°C and 40-45% relative humidity in screw-top plastic containers.

The two-step storage system of Ito (1972) is adapted to maintain and distribute the germplasm. For long-term storage, a minimum of two 2 000-seed packages and 10 smaller packages of 100 seeds each for viability monitoring are kept. Monitoring of germination is done at five-year intervals. The accessions are rejuvenated when the germination rate drops to 85% or by 10% of the initial rate.

Out of the 5 274 accessions, 4 853 are being duplicated at the IBPGR-designated regional genebank in the Philippines, and 3 425 accessions are already in the United States Department of Agriculture (USDA) collection. The remainder will be duplicated in USDA and the Philippines.

Documentation

The databases on passport, characterization, evaluation, inventory and distribution data are constructed with MINISIS developed by the International Development Research Center (IDRC) on AVRDC's HP-3000 series minicomputer.

Characterization method

Mungbean growth is affected by environmental factors, i.e. seasons, soil fertility and crop management. To avoid this, the whole collection was characterized together in single plantings so that variation due to seasons is avoided when data from the same characterization season are compared among themselves. In addition, one character was assessed by the same person or the same group of persons.

The characterization over the three seasons is summarized in Table 2. IBPGR descriptors (IBPGR, 1980) were used, and 11 other characters added. In the 1984 spring and 1984 fall seasons, observations were made for 24 characters, and in the 1985 fall, on 35 characters. The data of the 1984 fall and 1985 fall were combined for analyses.

Days to flowering and harvesting, and other qualitative characters were assessed by visual observation of the whole plot. Number of pods per plant was counted. However, caution should be taken in interpreting this character because the data are based only on a representative plant selected randomly.

Variations in the collection

Frequency of qualitative characters is summarized in Table 3. The breakdown within each country of quantitative descriptors will be reported in the AVRDC mungbean catalogue which is in preparation.

Table 2. Summary of mungbean characterization in 1984 and 1985
Planting season: 1984S - spring season (March to June), 7 640 plots from V1001 to V6112; 1984F - fall season (August to December), 3 400 entries from V1001 to V2649; 1985F - fall season (September to December), 4 714 entries from V2650 to V6111.

Character	IBPGR descriptor code	Planting season 1984	1984	1985
Growth habit	3.1	S		
Hypocotyl colour	3.3	S	F	F
Leaf:				
(1) terminal leaflet shape	3.4.1	S		
(2) pubescence - number	3.4.3	S		
(3) colour	3.4.4			F[1]
(4) petiole colour	3.4.5	S		
Raceme position	3.5.3		F	F
Flower:				
(1) calyx colour	3.5.4	S		
(2) corolla colour - standard	3.5.5	S		
Pods:				
(1) pod colour	3.6.1		F	F
(2) pod pubescence - number	3.6.7	S[1]	F	F
(3) pod length	3.6.6	S	F[2]	F[2]
Seeds:				
(1) colour	3.7.1	S[1]	F	F
(2) mottling on seed	3.7.2		F	F
(3) surface lustre	3.7.3	S[1]	F	F
Flower:				
(1) days to flowering	4.3	S	F	F
(2) plant height when flowering[2]	4.5	S	F[2]	F[2]
Flowering period	4.9		F[1]	
Numbers of clusters[2]	4.11		F[2]	F[2]
Maturity, days	4.12	S	F	F
Lodging	4.14		F	F
Pods per plant	7.1		F[2]	F[2]
Seeds per pod[2]	7.2	S	F	F
1000-seed weight	7.3		F	F
Seed protein content	11.1		F	F
Primary leaf:				
length[2]	Addition	S	F	F
width[2]	Addition	S		
shape	Addition	S		
Leaf:				
(1) pubescence length	Addition	S		
(2) vein colour	Addition	S[1]		
Flower: corolla colour - wings	Addition	S		
Pod pubescence:				
colour	Addition	S[1]	F	F
length	Addition	S[1]	F	F
Seeds: hilum colour	Addition		F	F
Plant height at maturity[2]	Addition	S	F[2]	F[2]
Seed starch content	Addition		F	F
Seed fibre content	Addition		F	F
Leaf size	Addition			F
No. characters studied per season		24 (1984S)	24 (1984F)	25 (1985F)
Total no. of recordings taken per season		313 000 (1984S)	160 000 (1984F)	231 000 (1985F)

[1] S or F - partially characterized in spring or fall.
[2] Five readings were recorded per accession.

Table 3. Frequency of qualitative characters of the AVRDC world mungbean collection

Characters/seasons	Number observed	Character states/Frequency (%)			
Hypocotyl colour		Green	Greenish purple	Red	
Spring	8200	1346 (16.42)	6807 (83.01)	47 (0.57)	
Fall	8078	1166 (14.43)	6876 (85.12)	36 (0.45)	
Primary leaf shape (length/width)		l/w< 1	l/w=1-2	l/w=2-3	l/w=3-4
Spring	8182	1 (0.01)	8 (2.1)	4246 (51.89)	3927 (48.0)
Growth habit		Erect	Semi-erect	Spreading	
Spring	8207	7295 (88.89)	715 (8.71)	197 (2.40)	
Lodging		None	Slight	Moderate	
Fall	8076	2088 (25.85)	1956 (24.22)	2624 (32.49)	
		Severe	Very severe		
		1253 (15.52)	155 (1.92)		
Leaf colour[2]		Light green (3)	(4)	Green (5)	
Fall	2747	633 (23.04)	168 (6.12)	1746 (63.56)	
		(6)	Dark green (7)		
		152 (5.53)	48 (1.75)		
Leaf size (cm)		<8	8-10	10-14	14-17
Fall	4689	8 (0.17)	272 (5.8)	751 (16.02)	1334 (28.45)
		17-20	20-25	25-30	>30
		1267 (27.02)	1041 (22.20)	14 (0.3)	2 (0.04)
Colour between petiole and leaf blade		Green	Purple		
Spring	1498	237 (15.82)	1261 (84.18)		
Colour of basal petiole		Green	Green/purple	Greenish purple	Purple
Spring	8206	265 (3.23)	7859 (95.77)	9 (0.11)	73 (0.89)
Leaf pubescence density		Few	Moderate	Many	
Spring	8197	5665 (69.11)	1860 (22.69)	672 (8.2)	
Leaf pubescence length		Short	Long		
Spring	8195	7980 (97.38)	215 (2.62)		
Raceme position		Low	Intermediate	Upper	
Fall	8052	252 (3.13)	6565 (81.53)	1235 (15.34)	
Calyx colour		Green	Greenish purple	Purple	
Spring	8180	466 (5.7)	7638 (93.37)	76 (0.093)	
Pod colour at maturity		Straw	Tan	Brown	
Fall	8073	215 (2.66)	578 (7.16)	3668 (45.44)	
		Brownish black	Black		
		2074 (25.69)	1538 (19.05)		
Pod pubescence density		Few	Moderate	Many	
Fall	8046	262 (3.26)	930 (11.56)	6854 (85.18)	
Pod pubescence colour		Gray	Light brown	Brown	
Spring	1510	16 (1.06)	520 (34.44)	974 (64.5)	
Fall	8048	191 (2.37)	5112 (63.52)	2745 (34.11)	
Pod pubescence length		Short	Medium	Long	
Spring	1504	758 (50.4)	741 (49.27)	5 (0.33)	
Fall	8048	3256 (40.46)	3357 (41.71)	1435 (17.83)	
Lustre on seed surface		Dull	Shiny		
Spring	8330	3852 (46.24)	4478 (53.76)		
Mottling on seed		Plain	Mottled		
Spring	8333	7512 (90.15)	821 (9.85)		
Seed c colour		Green	Green mottled	Yellow	
Spring	8329	6280 (75.4)	232 (2.79)	265 (3.18)	
		Yellow mottled	Brown	Brown mottled	
		4 (0.05)	846 (10.16)	5 (0.06)	
		Black	Black mottled		
		117 (1.4)	580 (6.96)		

[1] Colour graded as (4) is that between light green (3) and green (5), and (6) between green (5) and dark green (7).

Future prospects

A world mungbean collection catalogue is being produced, a database search facility will be provided, and hopefully a more systematic approach in the evaluation and utilization of the whole genepool can be executed. Future plans should, therefore, emphasize regional cooperative evaluation testing and coordinated database management.

The IBPGR Southeast Asia Food Legume Genetic Resources Workshop held at the University of the Philippines in May 1985 identified collection gaps. There is an immediate need to explore and conserve landraces of those areas.

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Résumé

Souches génétiques de haricots mungo détenus par l'"Asian Vegetable Research and Development Center"
Le Conseil international des ressources phytogénétiques a chargé l'"Asian Vegetable Research and Development Center" de conserver la collection mondiale de haricots mungo, qui contient 5 274 échantillons provenant de 50 pays. Les principales caractéristiques agronomiques et morphologiques de l'ensemble de la collection ont été déterminées en 1984 et 1985.

Resumen

Recursos genéticos del frijol mungo en el Centro Asiático de Investigación y Desarrollo de Hortalizas
El Centro Asiático de Investigación y Desarrollo de Hortalizas (AVRDC) fue designado por el Consejo Internacional de Recursos Fitogenéticos (IBPGR) para mantener la colección mundial de frijol mungo, que contiene 5 274 muestras procedentes de 50 países. En 1984 y 1985 se definieron las características agronómicas y morfológicas esenciales de toda la colección. Se ha evaluado la variación de la colección.

Wild relative germplasm at Bunso, Ghana

Forson K. Ayensu[1]

Summary

The Plant Genetic Resources Unit (PGRU) of the Crops Research Institute, Ghana has been designated as a national repository of wild germplasm with the objectives of collecting, maintaining and evaluating the genetic resources, and documenting and distributing material and information in Ghana. Wild species are acquired through transfer from genetic resources centres abroad and also by collecting expeditions. 23 species, representing the Gramineae, Papilionaceae and Solanaceae are held. Seed is multiplied and stored in deep freezers and chest freezers at a temperature of about -20°C in sealed air-tight plastic containers.

Introduction

The PGRU has the following wild relatives in storage: wild rice, wild cowpea, wild pigeonpea, wild eggplant and wild groundnut (Table 1).

Table 1. Wild relative germplasm at PGRU, Ghana

Family/Species	No. of accessions	
	As seed/plant	Herbarium only
Gramineae		
Oryza barthii	5	
O. ridleyi	1	
O. alata	1	
O. glumaepatula	1	
O. punctata	1	
O. nivara	1	
O. rufipogon	1	
O. longistaminata	10	
Solanaceae		
Solanum angui	7	7
S. torvum	2	2
S. macrocarpon (dasyphyllum)	9	9
S. scabrum	2	2
S. aerianthum	3	3
S. nigrum	2	2
S. incanum	1	1
Papilionaceae		
Arachis duranensis RR[1]	1	
A. pusilla (LLSR)	1	
A. monticola	1	
A. villosulicarpa (RR)	1	
A. rigonii	1	
A. cardenasii (RR)	1	
Vigna spp. (unidentified)	29	6
Cayanus species (unidentified)	1	

[1](RR) rust resistance; (LLSR) late leaf spot resistance.

Collection and assembly

A number of the wild germplasm accessions, namely wild eggplant, wild rice and wild cowpea, were acquired through collecting missions in 1982, 1985 and 1987. Wild germplasm at PGRU is also being assembled through correspondence and transfer from known genetic resources centres. Already six species of wild *Arachis* germplasm have been obtained for the International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India which is designated as a major repository of groundnut germplasm.

Eight wild rice accessions were also acquired from the International Rice Research Institute (IRRI), Los Baños, Philippines. PGRU personnel have participated in two collecting expeditions, which were jointly organized by the PGRU and the University of Birmingham in collaboration with the International Board of Plant Genetic Resources (IBPGR), Italy and the International Institute for Tropical Agriculture (IITA), Nigeria.

The first expedition, which was in November-December 1982, was funded by IBPGR. The second was in September-October 1985 and was funded by IRRI as part of a genetic resources conservation training programme course in 1985. The most recent collecting expedition in 1987 was funded by IITA. These expeditions provided first-hand information on the natural habitat of *Oryza*, *Vigna* and *Solanum* species, an estimate of the variability in populations of some species, and an indication of the pest and disease situation at the places of collection.

All materials introduced to the PGRU from abroad undergo quarantine inspection at the airport, port or post offices on behalf of the Government of Ghana to ensure the materials possess phytosanitary certificates from place of origin. PGRU personnel also make sure that no pests and disease are introduced.

Maintenance and storage

Seed-producing wild species are space planted in potted loamy soil after germination and transplanted from small paper cups. The plants are protected from pests when the need arises. Presently the wild species accessions are stored as unshelled pods in the case of *Arachis* and *Vigna* species. The *Oryza* species are, however, threshed and stored in laminated aluminium foil packets at a temperature of -20°C. Efforts are under way to prepare herbarium specimens for all accessions to serve as voucher specimens.

Evaluation and utilization

Wild species of crop plants are considered important sources

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of many economically important characters. A number of new accessions and species which have been collected in recent years are yet to become available at the PGRU. These materials are yet to be properly identified, described and evaluated, especially the wild *Vigna* germplasm. Descriptors for cultivated crops which were developed jointly with IBPGR and other genetic resources centres are going to be used for morphological evaluation.

Screening for various desirable attributes in the wild relatives of rice, eggplant and cowpea is yet to be carried out. Utilization of this valuable germplasm has already begun in our cowpea-improvement programme using the landraces collected in 1982.

Documentation and distribution

Most of the passport data have been filed. Morphoagronomic evaluation is in progress. All evaluation data are yet to be filed.

Worldwide distribution of germplasm to interested scientists is an important aim of the PGRU. At present the demand for wild species is not high. However, as more data on the desirable traits of wild species and the techniques for successful interspecific hybridization and transfer of desirable attributes become available, we expect to share samples with other plant genetic resources centres.

Future outlook

Acquisition of new materials by the PGRU will continue. More information on dormancy and viability of wild species will be obtained. Emphasis will be given to evaluation of wild species for various desirable traits. Descriptors for wild species have to be developed and incorporated in rice, cowpea, eggplant and groundnut descriptors. Documentation will be improved to facilitate exchange of data and germplasm to interested scientists in Ghana and abroad.

Résumé

Materiel génétique de plantes sauvages apparentées a des plantes cultivées detenu a Bunso, Ghana

La "Plant Genetic Resources Unit" (PGRU) du "Crops Research Institute" du Ghana est le dépositaire national désigné de matériel génétique de plantes sauvages. Elle est chargée de collecter, conserver et évaluer les ressources génétiques, d'en établir des descriptions et de diffuser du matériel et des informations au Ghana. Les espèces sauvages sont obtenues par des transferts à partir de centres étrangers de ressources génétiques ou proviennent d'expéditions de collecte. La PGRU détient 23 espèces, représentant les Gramineae, les Papilionaceae et les Solanaceae. Les semences sont multipliées et conservées dans des conteneurs de plastique hermétiquement fermés, placés dans des congélateurs à une température de -20°C environ.

Resumen

Estado del germoplasma de plantas afines silvestres en Bunso, Ghana

La Dependencia de Recursos Fitogenéticos (PGRU) del Instituto de Investigación sobre Cultivos de Ghana ha sido designada depositaria nacional de germoplasma silvestre, con el fin de recoger, mantener y evaluar los recursos genéticos y documentar y distribuir material e información en Ghana. Las especies silvestres se adquieren mediante transferencia de centros de recursos genéticos del extranjero y también mediante expediciones de recolección. Se conservan 23 especies, pertenecientes a las familias de las gramíneas, las papilionáceas y las solanáceas. Se multiplican semillas y se almacenan en congeladores a una temperatura aproximada de -20°C, en recipientes de plástico cerrados herméticamente.

Crop collecting in the Sultanate of Oman in the context of the Arabian Peninsula

by Luigi Guarino[1]

Summary

Wheat, barley and alfalfa were the main target species of a collecting mission in April-July 1987 to the Sultanate of Oman. Reports of genetic erosion and gaps in the world collections had been received. Altogether 58 species were collected (19 wild) and 510 accessions (32 wild). The Sultanate of Oman is an arid mostly desert country located in the southeastern corner of the Arabian Peninsula. Agriculture is confined to two main areas where water is available, the relatively dry high mountains, foothills and coastal plain of the north, and the monsoon-affected moist mountains of the south with their associated coastal strip. In the north, the main crop is the date palm. Wheat is the chief cereal; four main local varieties are recognized. Alfalfa is widely grown for fodder. All these are irrigated. In the southern mountains, cowpea and sorghum are grown under raid-fed conditions, but the people are semi-nomadic cattle pastoralists making use of the unique natural vegetation. On the coastal plain, the coconut replaces the date palm and alfalfa, and Napier and Rhodes grass are grown for fodder.

Collection of plant genetic resources in the Arabian Peninsula has not been very extensive. As this is a region where agricultural development has been particularly rapid in the last few years, it is no surprise that it is now a high priority area for the collection of a number of crops. Chapman (1985), for example, singled out the northern mountains of Oman and the Asir Mountains of the Red Sea coast of Saudi Arabia as the most important remaining sites for wheat collection in southwest Asia. Collecting of *Medicago sativa* in the Arabian Peninsula was seen as a high priority by an International Board for Plant Genetic Resources (IBPGR) Forages Working Group meeting. The southwestern corner of the peninsula is regarded as an area of primary diversity for sorghum. In addition, Zaroug (1985) has pointed out the necessity of collecting wild rangeland species in the region.

Aware of the urgency of collecting plant genetic resources, the Ministry of Agriculture and Fisheries of the Sultanate of Oman initiated a collecting programme some years ago. IBPGR supported the programme in 1987 by collaborating in a collecting mission from April to July targeted primarily on wheat, barley and alfalfa. This was the first such collaboration, and the first time IBPGR had collected cultivated species in the Arabian Peninsula outside the Yemen Arab Republic. This paper presents the results of the collecting mission and a commentary on the accessions.

Summary of the collections made

Table 1 gives the results of a survey of the representation of genetic resources from the Arabian Peninsula in some major collections of five crops of importance in the region. Only one of the five larger countries in the region, the Yemen Arab Republic, has been adequately covered, thanks to a GTZ mission in 1979 (Anon., 1979) and two IBPGR missions in 1980-81 (Ayad and Croston, 1980; Sackville Hamilton, 1981). The second IBPGR mission also collected wild forage species, as did, exclusively, the only other IBPGR mission in the Arabian Peninsula, which went to PDR Yemen in 1985.

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Also included in Table 1 are the numbers of samples of the five crops collected in Oman during the 1987 mission. A fuller list of the species collected is given in Table 2. Altogether, some 510 collections were made at 139 sites, representing about 58 species. Among these there were 32 accessions of 19 wild species.

Table 1.
Numbers of accessions originating from countries of the Arabian Peninsula found in some major world collections of five crops

Country	Wheat	Barley	Sorghum	Millet	Alfalfa	Agricultural land area (000 ha)
Bahrain	-	1[2]	-	-	-	2
Kuwait	-	-	-	-	-	1
Oman	-	-	-	-	10[3,6]	36
[This mission:	72	51	56	8	83]	
PDR Yemen	-	-	1[6]	-	5[9]	252
Qatar	-	-	-	-	-	2
Saudia Arabia	28[1]	3[3]	3[3,6]	2[3]	23[3,8]	897
UAE	-	7[4]	-	-	3[3]	20
Yemen Arab Republic	143[2] (122)[10]	142[5] (142)[10]	216[7] (356)[10]	70[7] (70)[10]	19[9,10] (11)[10]	1200
TOTAL	171	153	220	72	60	

Source: Arar, 1980.
[1]Chapman (1985) - All major collections; [2]European Barley List; [3]USDA GRIN Database; [4]ICARDA; [5]Witcombe (1983) - All barley collecting missions; [6]Mengesha, Rao and Rao (1982) - ICRISAT; [7]Acheapong, Anishetty and Williams (1984) - All major collections; [8]South Australia Department of Agriculture, Adelaide, Australia; [9]Vavilov Institute, Leningrad, USSR; [10]Reports on GTZ and IBPGR missions to the Yemen Arab Republic.

Characterization and evaluation of the entire collection of cultivated species will be carried out by the Ministry of Agriculture and Fisheries. Parts of the wheat and faba bean collections will go directly into breeding programmes abroad. The Plant Breeding Institute, Cambridge, UK, will be screening some of the wheat accessions for the ability to survive high temperatures during the

Table 2. Numbers of samples of different species collected in Oman during the 1987 mission

Species	Number of collections
Acacia nilotica (W)	1
Acacia tortilis (W)	3
Allium cepa	6
Amaranthus sp.	2
Anogeissus dhofarica (W)	1
Arundinella pumila (W)	1
Cajanus cajun	2
Carthamus tinctorius	4
Cenchrus setigerus (W)	2
Cenchrus sp. (W)	2
Chloris sp. (W)	1
Cicer arietinum	9
Citrus aurantifolia	3
Coriandrum sativum	10
Cucumis melo	6
Cucumis sativus	5
Cuminum cyminum	1
Cymbopogon sp. (W)	1
Dactyloctenium aegyptium (W)	7
Dactyloctenium scindicum (W)	1
Daucus carota	1
Delonix alata (W)	2
Dicanthium sp. (W)	1
Dodonea viscosa (W)	1
Dolichos lablab	7
Eleusine coracana	7
Eragrostis minor (W)	2
Gossypium herbaceum	4
Hordeum vulgare	51
Juglans regia	1
Lagenaria siceraria	3
Lycopersicon esculentum	2
Medicago sativa	83
Medicago sp. (W)	1
Nicotiana tabacum	1
Pennisetum americanum	7
Pennisetum sp.	1
Pisum sativum	1
Prosopis cineraria (W)	2
Prunus armeniaca	1
Prunus persica	1
Psoralea corylolia	1
Raphanus sativus	1
Ricinus communis	2
Sesamum indicum	6
Setaria italica	4
Setaria pumila (W)	1
Sorghum bicolor	56
Tamarindus indica (W)	1
Themeda quadrivalis (W)	1
Trigonella foenum-graecum	23
Triticum aestivum	63
Triticum dicoccon	9
Vicia faba	4
Vigna rediata	10
Vigna unguiculata	49
Zea mays	23
Unknown	8
TOTAL	510

NOTE: W - Wild species.

first few weeks of growth, as part of an extensive study of the genetics and physiology of high-temperature tolerance. There has been a *Vicia faba* breeding programme at the Department of Botany, University of Durham, UK, for some time, in cooperation with International Centre for Agricultural Research in the Dry Areas (ICARDA), and the Omani material will be incorporated into it.

The physical environment and land use

The Sultanate of Oman occupies the southeastern coast of the Arabian Peninsula, lying between latitudes 16°40'N and 26°20'N and longitudes 51°50'E and 59°40'E. It is bounded on the southwest by PDR Yemen, on the south and east by the Arabian Sea, on the north by the Gulf of Oman, on the northwest by the United Arab Emirates (UAE) and on the west by Saudi Arabia. A small area at the tip of the Musandam Peninsula, between the Gulf of Oman and the Persian Gulf, also belongs to the Sultanate, though it is separated from the rest of the country by the UAE. Also separated from the rest of the country, and completely surrounded by the UAE, is the small (43 km²) enclave of Mahda, just north of the UAE port of Fujayrah on the Gulf of Oman.

The total land area of the country is variously given as from 210 000 to 310 000 km², with a coastline of some 1 800 km. The latest estimates give population size as about 1.3 million. The Sultanate has a hot, arid climate; some data is presented in Table 3 (IUCN, 1987). The annual mean temperature over most of the country is about 26°C. Ninety-five percent of the country receives less than 100 mm of rainfall (Draz, 1980). There is arable agriculture on no more than about 0.15% of the total area, which is all that can be irrigated at the moment. For the Arabian Peninsula and the Near East as a whole, the figure is 4-5% (Abdalla, 1980). Rain-fed agriculture is only practised in a relatively small area of the southern mountains and opportunistically in the Musandam Mountains. This accounts for less than 10% of the total agricultural area. The equivalent figures for PDR Yemen, Saudi Arabia and the Yemen Arab Republic are 65, 80 and 90% respectively (Arar, 1980).

By far the main crop in Oman, in terms of area, is the date palm. There are some 8 million trees, accounting for approximately 50% of the agricultural land (IUCN, 1987; Directorate General of National Statistics, 1984). Over 100 distinct types are recognized. The main staple, rice, has apparently always had to be imported. Agriculture is essentially subsistence, although dates, limes, coconuts, onions and alfalfa are all important cash crops. The average size of holding is 1-2 ha (University of Durham, 1982).

Agricultural development has been rapid in the last 15 years. Food and Agriculture Organization (FAO) estimates for 1986 classify some 50% of the population as 'agricultural', compared with 70% in 1961. The number of agricultural workers per ha of arable land declined from 14.9 to 11.6 between 1961 and 1985. In 1974, some 1 400 tonnes of fertilizer were distributed to farmers; in 1983 the figure was almost 4 000 tonnes. There have been similar increases in the amounts of improved seeds and the number of spraying machines and tractors distributed by extension centres (Directorate General of National Statistics, 1984).

"Traditionally, the prime determinant of human population patterns in Oman has been water availability" (IUCN, 1987). This is still true to a great extent. The main concentrations of

Table 3. Climatic data from different sites in Oman

Station (Region)	Altitude (m)	Temperature (°C)					Mean annual rainfall (mm)
		Ann. mean	Mean max.	Mean. min.	Abs. max.	Abs. min.	
Khasab (Musandam)	0	28.6	33.8	23.3	49.0	8.4	182
Sohar (Batinah)	0	26.3	32.8	19.3	48.5	5.7	66
Buraimi (Jau)	500	27.3	35.8	18.5	48.8	2.6	82
Seeb (Batinah)	0	28.6	33.3	24.1	35.1	0.6	73
Sayq (J. Akhdar)	1 700	17.4	23.1	11.7	34.8	-3.6	286
Sur (Ja'alan and Sur)	0	26.5	33.7	23.1	49.8	7.0	95
Masirah (Island)	0	26.1	30.9	22.2	45.3	11.9	110
Ja'aluni (Ja'alan)		26.7	34.9	18.4	48.0	6.5	52
Thumrait (Southern)	500	26.1	33.7	18.5	45.4	2.4	32
Salalah (Southern)	0	26.0	29.6	22.0	43.0	10.8	124

Source: World Conservation Union (IUCN), 1987.

agriculture and, therefore, of population, are (1) in the extreme north, along the Gulf of Oman coastal plain, called the Batinah, and the Hajar chain of limestone mountains immediately behind it, and (2) in the extreme south, along the Salalah Plain on the Arabian Sea coast and the Dhofar Mountains rising above it. In between lies the bulk of the country, perhaps 200 000 km² of desert plain at 100-600 m altitude, mostly gravelly but overlain by sand dunes along the Saudi Arabian border in the west (the Rub al Khali or Empty Quarter) and in the Wahiba Sands area just south of Sur in the east. This area is inhabited by some 30 000 nomadic pastoralists. The population of the Batinah is probably about 300 000, that of the Salalah Plain and Dhofar Mountains some 100 000.

IUCN has produced a land classification of Oman based to some extent on the rangeland classification system given by GRM (1982).

Rain falling on the northern mountains, which can amount to 300 mm at the highest elevations (Jebel Akhdar reaches 3 000 m), is brought to the oases of both the gentle landward slopes and the steep seaward slopes and foothills by ancient systems of tunnels and surface conduits known as 'afalaj' to irrigate date palms, alfalfa, wheat and sorghum. Wheat and barley are grown rain-fed if precipitation is sufficient in Musandam, in particular in two places where silt has accumulated in bowl-shaped areas high in the mountains. Irrigation water for the Batinah comes from an aquifer system. Here, there are extensive date-palm plantations, though the quality of the fruits is inferior to that of the mountain oases and they are often fed to livestock. Limes, bananas, mangoes, alfalfa, sorghum, watermelons and onions are the other main traditional crops on the Batinah in terms of area. Goat, sheep and cattle husbandry are widespread throughout the northern mountains and along the Batinah, except that cattle numbers are low in Musandam and at the higher altitudes on Jebel Akhdar.

The mountains of Dhofar, though also largely limestone, are otherwise very different to the northern mountains in being

Table 4. Total area of cultivation in each region of Oman, the percentage of this area devoted to each of four major field crops, and the number of accessions of each of these crops collected on the 1987 mission

Region	Area cultivated (ha)	Wheat	Sorghum	Maize	Alfalfa
Batinah	20 750				
Area (ha)		5.1	83.8	30.1	1 079.1
% cultivated land		0.02	0.40	0.15	5.20
No. accessions		5	2	0	12
Musandam	1 030[1]				
Area (ha)		-	-	-	13.2
% cultivated land		-	-	-	1.28
No. accessions		8	0	0	3
W. Hajar	1 955				
Area (ha)		38.1	10.1	255.0	217.4
% cultivated land		1.95	0.52	13.04	11.12
No. accessions		15	6	12	16
E. Hajar	1 235				
Area (ha)		-	0.2	8.8	98.3
% cultivated land		-	0.18	0.71	7.96
No. accessions		0	2	0	5
Jau & Buraimi	885				
Area (ha)		1.3	2.4	1.5	33.2
% cultivated land		0.15	0.27	0.17	3.75
No. accessions		1	1	0	1
Dhahirah	3 303				
Area (ha)		133.1	2.2	119.2	418.4
% cultivated land		4.03	0.07	3.61	12.67
No. accessions		7	6	0	2
Interior	5 167				
Area (ha)		124.1	42.0	136.0	754.6
% cultivated land		2.40	0.81	2.63	14.60
No. accessions		30	22	8	17
Sharqiya & Ja'alan	4 285				
Area (ha)		-	4.2	85.6	796.0
% cultivated land		-	0.10	2.00	18.58
No. accessions		4	5	2	15
Southern Region	2 414				
Area (ha)		-	-	27.9	288.4
% cultivated land		-	-	1.16	11.90
No. accessions		2	12	1	12
TOTAL	41 024				
Area (ha)		301.6	145.0	664.2	3 698.6
% cultivated land		0.73	0.04	1.62	9.02
No. accessions		72	56	23	83

NOTE: Figures for crop areas are from the 1978-79 Agricultural Sample Survey.
[1]The Musandam Development Committee's most recent estimate is 772.5 ha.

swept by the southwest monsoon, or 'kharif', during July and August, the only area of the Arabian Peninsula that benefits from the phenomenon, though the island of Socotra (PDR Yemen), geologically a part of Dhofar, is also affected. The monsoon causes a bank of cloud to form that covers the seaward faces of the mountains from an altitude of 150 m to 600-1 500 m (the maximum height of the mountains is 1 900 m) for the duration

of the kharif. Areas in the mist can receive the equivalent of 1 000 mm in occult precipitation (Stanley Price, al-Harthy and Whitcombe, 1985), giving rise to various unique types of relatively lush grassland and woodland vegetation (Radcliffe-Smith, 1980).

In contrast to the farming people of the north of Oman, the various Jebali tribes of the Dhofar Mountains are, traditionally, semi-nomadic pastoralists. They are also ethnically distinct and speak a different Semitic language. They keep sheep, camels and a small local breed of cow, moving backwards and forwards between the Salalah Plain and the mountains following the grazing and trying to avoid the noxious biting flies (Sale, 1980). Lately, feed concentrates and Rhodes grass (*Chloris gayana*) hay grown on the Salalah Plain under irrigation have allowed livestock numbers to rise dramatically. Coupled with the gradual abandonment of the transhumance due to infrastructural development, this has led to severe environmental degradation in some areas. The aerial seeding of some 10 000 ha of mountain plateau with exotic forage and browse species was started in 1987 to counter this. Another approach has been the subsidized culling of cattle. The Planning Committee for Development and Environment in the Southern Region shares with the Ministry of Agriculture and Fisheries the responsibility for monitoring, and reversing, the deterioration of the range.

Rain-fed agriculture is practised to a small and decreasing extent on the Dhofar Mountains, in fenced enclosures increasingly used to grow grass for hay instead, as the more traditional means of protecting the range lapse. Sorghum, millet, cucumber and cowpea are the main crops.

On the coastal plain, the coconut replaces the date palm of the north, accounting for 10% of the total cultivated area. Many tropical fruits are also grown, as well as vegetables, alfalfa and fodder grasses, irrigated using ground water and spring water from the foot of the mountains.

Tables 4, 5 and 6 present summaries of the agricultural situation in the different administrative regions of Oman. Table 4 gives the total area under cultivation for each region and the areas under wheat, sorghum, maize and alfalfa, together with the number of accessions of each of these crops collected during the 1987 mission. It shows clearly the importance of wheat in the Interior and Dhahirah regions, and the widespread importance of alfalfa. Table 5 gives estimates of the total numbers of different domesticated animals in the various regions, together with their numbers per ha of cultivated land. What this analysis makes clear is the importance of natural forage in the Southern region relative to the rest of the country. Abdalla (1980) calculated that only 5.5% of the livestock feed supply comes from agriculture in the Gulf states, the rest coming from natural grazing and the total amounting to some 62% of requirement. Table 6 gives a summary of the distribution of the main traditional, or at least long-established, crops in the six main agro-ecological zones of Oman, together with some local names.

The main crops collected

Wheat

The main wheat-growing areas of Oman are the Dhahirah and the Interior. The introduction of the crop on the Batinah is very recent. It has apparently never been grown in the south of the country. The drastic decline in the area sown to wheat in the Dhahirah from the mid-1970s (University of Durham, 1982) is probably continuing, though at a much slower pace. This has been mainly due to increasing competition from Australian grain imported for processing at the Oman Flour Mills. Additional pressure on the local wheat varieties, mainly bread wheats, has come from the release of 'Mexipak' in the early 1970s and 'Sannine' in the early 1980s. Two ICARDA varieties (called WQS151 and WQS160 by the Ministry of Agriculture and Fisheries) were released in 1985.

According to the Directorate General of National Statistics (1984), no improved wheat varieties were made available to farmers from extension centres until 1980, when some 4 000 kg of seed were distributed; in 1983, the figure was 11 000 kg and the trend is certainly still upwards. Local varieties are preferred in terms of quality, but they are low-yielding, susceptible to lodging and lack rust and smut resistance. It is difficult to establish what proportion of the wheat area in Oman is sown to local varieties, but figures of around 50%, which are occasionally quoted, are probably underestimates. Nevertheless, local varieties are undeniably under threat of replacement, as is the case elsewhere in the Arabian Peninsula. Mu'Allem (1982) predicted that improved varieties would probably account for two-thirds of the wheat-growing area of PDR Yemen by 1984-5. El-Saadi (1974) reported that a goal of Saudi Arabian agricultural development was that 50% of the wheat area of the country should eventually be devoted to growing new, high-yielding varieties. Severe genetic erosion was reported by Ayad and Croston (1980) from the Yemen Arab Republic.

Four main local varieties are recognized: 'Kule', 'Saraya', 'Hamira' and 'Musane'. Some other names were recorded during the mission ('Ghreda', 'Mufsegha', 'Byaza', 'Ualidi' and 'Shallot'), but it is not yet clear to what extent they are synonyms. 'Kule' is by far the most commonly grown, but there are probably differences between types referred to by the same name in different areas. 'Hamira' was almost exclusively grown in the Dhahirah. In Musandam, only 'Musane' was found, though apparently at least one other variety is grown. At high altitudes on Jebel Akhdar only 'Saraya' was collected. Variation within fields is not particularly striking. The crop is sown in November-December and harvested in March-April, though 'Saraya' (and possibly 'Hamira') is said to be a four-month variety. Wheat receiving an average amount of irrigation water (3 000 mm/year) might yield 1-2 tonnes/ha (University of Durham, 1982).

Triticum dicoccon is also grown, under the name of 'alas'. In the few places where this species was collected, it was described as being rarely grown nowadays, despite its good quality, because it is too difficult to process. Ayad and Croston (1980) described a very similar situation in the Yemen Arab Republic, where the same local name is used. They recorded the presence of seven wheat varieties in that country, mostly tetraploids grown under rain-fed conditions. Mu'Allem (1982) recorded ten varieties from PDR Yemen, all haxaploid and all with the height and disease-susceptibility problems of the local Omani varieties. A variety called 'Musane' is apparently grown in the Abyan region of PDR Yemen at 1 500-2 000 m. There is little information on wheat variability in Saudi Arabia, but the traditional varieties are hard wheats, grown rain-fed in the Hejaz and Asir mountains.

Alfalfa

Alfalfa is the main fodder crop in Oman, both in the north and in the south (though it is not grown in the Dhofar Mountains),

Table 5. Estimates of livestock numbers in the regions of Oman, with numbers per ha of cultivated land

Region	Area cultivated (ha)	Goats	Cows	Sheep	Camels	Donkeys	Cow equivalents per ha[1]
Batinah	20 750	105 996	18 062	43 978	1 452	11 946	62.6
		5.10	0.87	2.12	0.07	0.58	
Musandam	1 030	43 780	40	5 610	22	440	432.2
		42.50	0.13	5.47	0.02	0.43	
W. Hajar	1 955	43 252	5 720	8 624	44	3 432	256.7
		22.12	2.93	4.41	0.02	1.76	
E. Hajar	1 235	31 724	2 772	7 942	22	2 904	288.1
		25.69	2.24	6.19	0.02	2.35	
Jau and Buraimi	885	22 352	2 662	4 070	1 694	3960	293.6
		25.26	3.01	4.60	1.91	4.47	
Dhahirah	3 303	78 012	7 986	8 668	5 786	5 324	266.4
		23.62	2.42	2.62	1.75	1.61	
Interior	5 167	49 852	11 044	12 298	660	5 016	121.3
		9.65	2.14	2.38	0.13	0.97	
Sharqiya and Ja'alan	4 285	104 962	9 438	15 466	6 732	7 370	273.9
		24.50	2.20	3.61	1.57	1.72	
Southern	2 414	105 000[2]	78 000[2]	31 592	56 000[2]	2 618	662.4
		43.50	32.31	13.09	23.20	1.08	
TOTAL	41 024	584 930	135 816	138 248	72 412	43 010	182.4
		14.26	3.31	3.37	1.77	1.05	
TOTAL (GRM)		696 199	125 886	135 654	71 488	11 127	

Source: Agricultural Sample Survey 1978-9.
[1]Calculated on the basis of 10 small ruminants being equivalent to one cow or camel.
[2]Figures taken from local sources, which give a better fit with overall livestock numbers as estimated in a separate recent survey.

despite the recent introduction and undoubted success of Rhodes grass on the Batinah and Salalah plains. This is the case throughout the Gulf and in Saudi Arabia (Farnworth and Robinson, 1972; Zaroug, 1985). Most holdings have alfalfa plots, making up about 10% of the total area under cultivation in the country. Genetic erosion does not seem to be a danger, except perhaps in Musandam, where seed from the Batinah is distributed by the Musandam Development Committee (MDC) at subsidized prices to expand the area of the crop quickly.

The crop is called 'gat' in northern Oman, 'berseem' in the south. A number of different types are recognized, mainly on the basis of longevity. The Batinah type has an expected life span on the coast of perhaps eight years. It tends to fail, or at most last only a couple of years, yielding poorly, when grown in the mountains. There are local strains in the Hajar, which are said to persist there for over ten years and which fail when grown on the coast. There are also what are said to be two distinct varieties grown at Sur and at Qurayat. The crop is grown as an annual on the Salalah Plain, succumbing to anthracnose in the Kharif. The strains grown in the south appear to be distinct from those grown in the north.

The total alfalfa area rose by 15-20% in both the Batinah and the Dhahirah between 1973 and 1975, and the upward trend continued throughout the 1970s (University of Durham, 1982). This was apparently in response to high demand and high prices in the UAE oasis of Al Ayn (just across the border from Buraimi), which can in turn be traced in part to government subsidy of camel husbandry in the UAE. The desire to increase the alfalfa area and some poor harvests caused a tenfold increase in the price of seed in the late 1970s (University of Durham, 1982) and the price is still very high, so high that the MDC, for example, subsidizes it by 50%.

Barley

Barley (six-rowed types only) is occasionally sown with alfalfa. Traditionally, it is not grown for grain on the Batinah and seed must be bought in the market. In the hinterland, it is grown on its own for grain, but not usually for human consumption, except in Musandam. This contrasts with the situation in the Yemen Arab Republic, where barley is an important food crop. Under irrigation in Saudi Arabia, it is a dual-purpose crop, used as green fodder and after one or two cuts left to grow for grain and straw (El-Saadi, 1974). New improved varieties have been introduced by the ministry, but may have found their way into the country from Saudi Arabia and the UAE. Barley is usually simply called 'shayir', the standard Arabic word for the crop: only at two sites visited in 1987 did farmers recognize and grow distinct local varieties with different names.

Other crops

Fenugreek (*Trigonella foenum-graecum*) is occasionally grown with alfalfa. Other fodder crops grown in the north, often under dates, include cowpea (*Vigna unguiculata*), *Pennisetum* sp. and sorghum, which is also grown for grain, though not to the same extent as in the Yemen Arab Republic, where it accounts for 75% of the area under cultivation (Sackville Hamilton, 1981) and PDR Yemen. Maize is not a common crop in Oman; it is said to have been introduced into the Yemen Arab Republic some 30 years ago, but it may be a much older crop in Oman, which has always been more open to trade. There seem to be two distinct types, to judge by seed colour. Cowpea and sorghum are also grown for human consumption under rain-fed conditions on the Dhofar Mountains. Cowpeas are called 'dojjir' in Dhofar, where the more usual Arabic word, 'lubia', which is used in

Table 6. Distribution of traditional crops in Oman in different agro-ecological zones

Crop	Local Name	Musandam	Jebel Akhdar		Batinah	Desert	Salalah	Jebel
			>1500 m	<1500 m	coast	plains	Plain	Dhofar
Allium cepa	Basal	X		X	X		X	
Allium sativum		X		X	X		X	
Aloe vera	Isqual?			X	X			
Amaranthus sp.	Barbir					X		
Brassica oleracea (cabbage)				X	X			
Cajanus cajan	Tovian			X	X			
Capsicum frutescens					X			
Carica papaya				X	X		X	
Carthamus tinctorius	Shawran			X	X			
Cicer arietinum	Houmus			X				
Citrullus lanatus	Battikh	X		X	X		X	
Citrus aurantifolia	Laimoon	X		X	X	X	X	X
Citrus medica						X		
Citrus paradisi				X				
Citrus x limon			X	X				
Coriandrum sativum	Gil gilan			X				
Cocus nucifera					X		X	
Coffea arabica (now absent?)				X				
Cucumis melo	Shamman	X			X		X	
Cucumis sativus	Hashwa						X	X
Cuminum cyaminum	Cumin	X						
Dactyloctenium aegyptium	Rashidia	X		X	X			
Daucus carota	Gazar	X			X			
Dolichos lablab	Mohbel	X		X			X	X
Eleusine coracana	Bambi			X		X	X	
Ficus carica				X	X	X		
Gossypium herbaceum	Gotn			X	X		X	X
Hordeum vulgare	Shayir	X	X	X	X			
Ipomoea batatas	Fundul			X	X	X	X	
Juglans regia	Naskh		X					
Lactuca sativa				X	X			
Lagenaria siceraria	Qara			X	X			
Lycopersicon esculentum	Tamatim			X	X		X	X
Malus pumila				X				
Mangifera indica	Imba			X	X	X	X	
Manihot esculenta						X		
Medicago sativa	Qat, berseem	X	X	X	X	X	X	
Mentha longifolia			X	X				
Morus ?nigra (mulberry)				X	X			
Musa spp.				X	X		X	
Myrtus communis			X	X				
Nicotiana tabacum	Tabagh	X		X				
Ocimum basilicum				X	X			
Pennisetum (fodder)	Musaybilu			X	X		X	
Pennisetum americanum	Dohan			X			X	
Phoenix dactylifera		X		X	X	X		
Pisum sativum	Bisla			X				
Prunus amygdalus			X					
Prunus armeniaca	Mish mish		X					
Prunus domestica			X					
Prunus persica	Durraq		X					
Punica granatum			X	X	X	X		
Raphanus sativus	Figil	X		X	X			
Rosa sp.			X	X	X			
Saccharum ?barberi				X	X			
Sesamum indicum	Simsim			X				
Setaria italica				X		X		
Solanum melongena			X	X	X			
Sorghum bicolor	Dhurra			X	X		X	X
Tamarindus indica				X	X			X
Trigonella foenum-graecum	Helb		X	X	X			
Triticum spp.	Gumma, burr, alas	X	X	X				
Vicia faba	Ful			X				
Vigna radiata	Mink				X		X	X
Vigna unguiculata	Lubia, dojjir			X	X		X	X
Vitis vinifera			X	X				
Ziziphus spina-christi	Sidr	X	X	X	X			X
Zea mays	Mohindo	X	X	X			X	X

Source: Adapted from R.P. Whitcombe and A.G. Miller (unpublished)

the north, refers to lablab. There is some variation in seed colour.

Other traditional field crops grown on a small scale include onions and garlic, sweet potatoes, melons, watermelons, radishes (as a leaf vegetable), sesame and safflower (apparently only as a source of dye). Tomatoes have apparently been grown for a long time both on the Batinah and the Salalah plains, but improved seed has been available on quite a large scale for at least the past ten years, as with many vegetables.

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Résumé

Collecte de spécimens végétaux dans le Sultanat d'Oman compte tenu de la situation dans la péninsule Arabique

Une mission de collecte a été effectuée en avril-juillet 1987 dans le Sultanat d'Oman, pour recueillir surtout des spécimens de blé, d'orge et de luzerne. Des rapports signalaient une érosian génétique et des lacunes dans les collections mondiales. On a collecté 58 espèces (19 sauvages) et 510 introductions (32 sauvages). Le Sultanat d'Oman est un pays aride, presque désert, situé dans le sud-est de la péninsule arabique. L'agriculture est limitée à deux régions principales, où il y a de l'eau: les hautes montagnes, les collines et la plaine côtière du nord, relativement secs, et les montagnes humides du sud touchées par la mousson, avec leurs bandes côtières. Au nord, le palmier dattier est la principale culture, et le blé, dont on reconnaît quatre variétés locales, la principale céréale. La culture de la luzerne est très étendue, en vue du fourrage. Toutes ces cultures sont irriguées. Dans les montagnes du sud, la pluie fait pousser du niébé et du sorgo, mais la population est composée de pasteurs semi-nomades qui n'utilisent que la végétation naturelle. Dans la plaine côtière, le cocotier remplace le palmier dattier et on cultive la luzerne, le napier et l'herbe de Rhodes pour le fourrage.

Resumen

Recolección de plantas cultivadas en el Sultanato de Omán, en la Península Arábiga

Las principales especies objeto de estudio en una misión de recolección en el Sultanato de Omán, en abril-julio de 1987, fueron el trigo, la cebada y la alfalfa. Se han recibido informaciones de erosión genética y de lagunas en las colecciones mundiales. En total se recogieron 58 especies (19 silvestres) y 510 muestras (32 silvestres). El Sultanato de Omán es un país árido y en su mayor parte desértico situado en el extremo sudoriental de la Península Arábiga. La agricultura se limita a dos zonas principales donde se dispone de agua: las montañas altas, sus estribaciones y la llanura costera relativamente secas en el norte, y las montañas húmedas afectadas por el monzón con su franja costera correspondiente en el sur. En el norte, la principal planta cultivada es la palma datilera. El trigo es el cereal muy importante, del cual se conocen cuatro variedades locales principales. Está bastante extendido el cultivo de la alfalfa para forraje. Todas esas plantas son de regadío. En las montañas meridionales se cultiva el caupí y el sorgo en tierras de secano, pero la población está formada por pastores seminómadas de vacunos, que utilizan la vegetación natural única existente. En la llanura costera, el coco sustituye a la palma datilera y para forraje se cultivan la alfalfa, el pasto elefante y la hierba Rhodes.

Andean crops in Ecuador: collecting, conservation and characterization

Raul O. Castillo[1]

Summary

In 1982 the National Institute of Agriculture Research (INIAP) initiated the exploration for and collecting of germplasm of important native crops which are being lost to genetic erosion. The International Board for Plant Genetic Resources supported the collecting of quinoa *(Chenopodium quinoa)*, amaranths *(Amaranthus* spp.), chocho or tarwi *(Lupinus mutabilis)*, melloco *(Ullucus tuberosus)*, oca *(Oxalis tuberosa)*, mashua *(Tropaeolum tuberosum)*, zanahoria blanca *(Arracacia xanthorrhiza)*, jicama *(Polymnia sonchifolia)* and other crops as complementary collections. To conserve these accessions INIAP built a cold room at -10°C and other facilities for vegetatively propagated species. To date, more than 50% of the accessions have been characterized.

Introduction

Most of the genetic variability of the native Andean crops is under threat from high levels of genetic erosion (INIAP, 1984; Nieto *et al*, 1984). In response to this loss of crop diversity, INIAP asked IBPGR for financial support and started to collect crops in different ecogeographic regions that were considered important within the cropping systems of the Andean farmer.

The accessions collected in the Andean region of Ecuador are being conserved in cold storage (-10 to -12°C). Several species are vegetatively propagated. These species will be conserved using *in vitro* technology in the near future at INIAP.

Results and Discussion

From 1982 to 1985, 13 Andean crops were collected (Table 1). At present 1 726 accessions are being managed. Many accessions have been sent to various scientific centres for research purposes.

Most of the quinoa accessions were collected at altitudes of 2 200 - 3 600 m.a.s.l. Wild or weedy species were found from 1 800 to 3 800 m.a.s.l. Amaranth was also collected from 1 800 to 3 200 m.a.s.l. and weedy species have been collected at lower altitudes. Chocho or tarwi accessions were collected from 2 000 to 3 300 m.a.s.l.

Generally, the Andean tubers (ulluco, oca and mashua) share the same ecosystem. Accessions of these tubers were collected from 2 800 to 3 900 m.a.s.l. The three Andean roots (arracacha, jicama and miso) also share similar ecological zones. However, arracacha grows from 1 400 to 3 200 m.a.s.l., jicama from 2 400 to 3 000 m.a.s.l. and miso from 2 500 to 3 200 m.a.s.l. Latitudes of collection sites vary from 0°55'N to 6°00'S and longitudes from 77° to 79°W.

About 60% of the accessions of different species have been evaluated using descriptors. This characterization has allowed promising accessions to be identified, which will be used in the INIAP breeding programmes.

Yield is the most important character of these species. The oca tubers for example have high quality starch. Mashua is a promising crop for stock feed, quinoa and amaranth have high protein content (14-18%) with an excellent amino acid balance.

Table 1. Number of accessions of each species conserved at Santa Catalina experimental station of INIAP, March 1988

Species	No. of accessions
Quinoa *(Chenopodium quinoa)*	430
Amaranth *(Amaranthus* spp.)	207
Chocho *(Lupinus mutabilis)*	112
Melloco *(Ullucus tuberosus)*	191
Oca *(Oxalis tuberosa)*	135
Mashua *(Tropaeolum tuberosum)*	64
Arracacha *(Arracacia xanthorrhiza)*	75
Jicama *(Polymnia sonchifolia)*	20
Sweet potato *(Ipomoea* spp.)	170
Capuli *(Prunus capuli)*	208
Chili *(Capsicum* spp.)	40
Miso *(Mirabilis expansa)*	9
Maize *(Zea mays)*	340
Others *(Lycopersicon* spp., *Phaseolus* spp., etc.)	60
TOTAL	2061

These Andean crops could be important crops in the highlands of other developing countries, for example the African highlands.

Most of the quinoa, amaranth, chocho, melloco, oca and mashua collections have been evaluated, with IBPGR support. Nearly

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50 descriptors were used to evaluate these accessions and the data are available for scientists and researchers of any organization. Future work in Ecuador will focus on evaluating Andean root crops already collected. Collecting, conservation and evaluation of other native species in danger of disappearing will be carried out. A national department of plant genetic resources is being developed that will collaborate with national and international organizations to work on plant genetic resources.

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Resumen

Cultivos andinos en el Ecuador: colección, conservación y caracterización

En 1982 el Instituto Nacional de Investigaciones Agropecuarias (INIAP) inició un importante trabajo de colección y conservación de recursos fitogenéticos de cultivos nativos de los Andes ecuatorianos. El Consejo Internacional de Recursos Fitogenéticos (IBPGR) apoyó la colección de quinua *(Chenopodium quinoa)*, amaranto *(Amaranthus* sp.), chocho *(Lupinus mutabilis)*, melloco *(Ullucus tuberosus)*, oca *(Oxalis tuberosa)*, mashua *(Tropaeolum tuberosum)*, zanahoria blanca *(Arracacia xanthorrhiza)*, jicama *(Polymnia sonchifolia)* y otros cultivos como complemento a colecciones ya existentes. Para conservar estas colecciones el INIAP construyó un cuarto refrigerado a -10°C así como otras facilidades para las especies de reproducción vegetativa. Actualmente más dell 50% de las entradas han sido caracterizadas.

Résumé

Cultures andines en Equateur: récolte, conservation et typologie

En 1982, l'Institut équatorien de recherche agronomique (INIAP) a entrepris de rechercher et de collecter le patrimoine génétique d'importantes plantes cultivées autochtones, qui menace de disparaître à cause de l'érosion génétique. Le Conseil international des ressources phytogénétiques a aidé à la collecte de quinoa (*Chenopodium quinoa*), d'amaranthe (*Amaranthus* spp.), de chocho ou tarwi (*Lupinus mutabilis*), de melloco (*Ullucus tuberosus*), d'oca (*Oxalis tuberosa*), de mashua (*Tropaeolum tuberosum*), de zanahoria blanca (*Arracacia xanthorrhiza*), de jicama (*Polymnia sonchifolia*) et autres cultures complémentaires. Pour conserver ces introductions, l'INIAP a fait construire une chambre froide (-10°C) et d'autres facilités pour les espèces à multiplication végétative. Plus de 50 pour cent des introductions ont été caractérisées jusqu'à présent.

Los recursos fitogenéticos de Castilla-La Mancha (España) I. Expediciones multicultivos a Ciudad Real y Guadalajara

F. Varela y J. Ruiz-Fernández[1]

La Comunidad Autónoma de Castilla-La Mancha, constituida por cinco provincias: Albacete, Ciudad Real, Cuenca, Guadalajara y Toledo, está situada en el centro de la Península Ibérica, ocupando la submeseta sur, con una extensión de 79 230 km². El descenso demográfico, más acentuado en el medio rural, ha propiciado el paso a una agricultura extensiva, basada fundamentalmente en los cereales y el girasol, con la consiguiente erosión genética en los cultivos de leguminosas y hortícolas.

Esta situación, unida al hecho de ser una zona poco explorada, hizo aconsejable acometer la recolección del germoplasma vegetal de la región con un sentido amplio (expediciones multicultivos), que no excluyera, en una primera fase, ninguna especie cultivada, quedando para una fase posterior las especies afines a las cultivadas y las silvestres de uso potencial.

Cuadro 1. Hortícolas: especies y número de muestras recolectadas en cada provincia

Especies	Número de muestras	
	Ciudad Real	Guadalajara
Allium cepa	19	8
Allium porrum	2	2
Allium sativum[1]	9	14
Apium graveolens	2	-
Asparagus officinalis	2	1
Beta vulgaris	11	12
Brassica oleracea	19	10
Brassica sp.	3	-
Capsicum annuum	41	15
Cichorium endivia	1	1
Citrullus lanatus	8	3
Cucumis flexuosus	2	-
Cucumis melo	11	8
Cucumis sativus	16	14
Cucurbita maxima	3	-
Cucurbita pepo	17	24
Cynara cardunculus	1	-
Cynara scolymus[1]	-	1
Daucus carota	9	3
Lactuca sativa	25	13
Lagenaria siceraria	4	-
Lycopersicon esculentum	27	10
Petroselinum crispum	14	9
Raphanus sativus	5	1
Solanum melongena	11	-
Spinacea oleracea	9	1
TOTAL:	271	150

[1] Material vegetativo

[1] Banco Nacional de Germoplasma Vegetal, Instituto Nacional de Investigaciones Agrarias, Apartado de Correos 262, 28800 Alcalá de Henares, Madrid, España

Cuadro 2. Cereales: especies y número de muestras recolectadas en cada provincia

Especies	Número de muestras	
	Ciudad Real	Guadalajara
Avena byzantina	2	-
Avena sativa	7	4
Hordeum vulgare	10	3
Pennisetum thyfoides	4	-
Phalaris canariensis	1	-
Secale cereale	2	6
Sorghum bicolor	14	2
Triticum sp.	2	8
Zea mays	13	7
TOTAL:	55	30

Cuadro 3. Leguminosas: especies y número de muestras recolectadas en cada provincia

Especies	Número de muestras	
	Ciudad Real	Guadalajara
Cicer arietinum	13	20
Coronilla scorpioides	1	-
Lathyrus cicera	2	2
Lathyrus sativus	5	3
Lens culinaris	3	17
Lupinus albus	6	-
Medicago sativa	-	4
Melilotus alba	-	1
Onobrychis viciifolia	-	4
Phaseolus vulgaris	27	104
Pisum sativum	3	3
Vicia faba	11	5
Vicia ervilia	1	4
Vicia monanthos	-	2
Vicia narbonensis	-	1
Vicia sativa	1	3
Vigna sinensis	1	-
TOTAL:	74	173

Las variedades tradicionales, base de los recursos fitogenéticos, son conservadas por agricultores de avanzada edad que practican una agricultura de autoconsumo, muchas veces influenciada por introducciones paralelas de variedades comerciales. Este fenómeno hace necesario el contacto directo con el agricultor en el momento de recoger la muestra.

Cuadro 4. Especies menores recolectadas en cada provincia

Especies	Número de muestras	
	Ciudad Real	Guadalajara
Cannabis sativa	4	-
Celosia cristata	2	-
Chamomilla recutita	3	-
Coriandrum sativum	2	-
Cuminum cyminum	1	-
Helianthus annus	11	1
Melissa officinalis	-	2
Ocimum basilicum	4	-
Physalis ixocarpa	-	2
Otras	3	6
TOTAL:	30	11

Prospección y Recolección

Durante el periodo otoño-invierno de 1986 se realizaron diversas expediciones de recolección a las provincias de Ciudad Real y Guadalajara, recolectándose un total de 794 muestras: 421 de hortícolas (Cuad. 1), 85 de cereales (Cuad. 2), 247 de leguminosas (Cuad. 3) y 41 de diversas especies menores (Cuad. 4).

Agradecimientos

Los autores agradecen al Servicio de Extensión Agraria de Castilla-La Mancha su valiosa colaboración y el apoyo prestado en las diversas misiones de recolección. Proyecto: 'La conservación de los recursos fitogenéticos de Castilla-La Mancha: Banco Regional de Germoplasma' financiado por el Instituto Nacional de Investigaciones Agrarias.

Collecting germplasm in Morocco

M. Tazi[1], A. Birouk[2], Z. Fatemi[2] and P. Heiffer[3]

Introduction

Many cultivated and wild plant species native to Morocco are subject to genetic erosion due to drought and desertification. The effect of these factors, combined with population and animal pressure, and the cropping of marginal lands, has led to a dramatic degradation of rangelands causing the loss of much potentially useful forage plant germplasm. From the rich flora of some 350 grass species and 470 species of forage legumes listed by Jahandiez and Maire (1932), only a few species are still encountered in the country. In addition, genetic erosion is affecting cultivated crops, especially cereals, as reported by Perrino *et al.* (1986).

After previous collecting missions (Perrino *et al.*, 1986; Birouk, 1987), the Institut Agronomique et Veterinaire Hassan II (IAV) at Rabat, in collaboration with the Plant Materials Centre (Centre de Production des Semences Pastorales) at El Jadida, organized during the month of July 1987 a collecting mission in the southeastern and northern parts of Morocco.

Material collected

An optimum number of samples was collected from the field. Priority was given to collecting wheat and forage species, but many samples of barley were also collected. Wild species were collected according to IBPGR standard techniques, by taking samples at 20-30-km intervals depending upon variability in environmental conditions and the occurrence of species.

Samples were taken at different altitudes from sea level to 2 200 masl and the precipitation zones varied from 50 mm to 800 mm annual rainfall.

During the mission 103 sites were sampled and 378 samples collected, including 231 samples of cultivated crops and 147 of wild species (Table 1).

The collected material, after being documented, is under conservation at the IAV Hassan II for cultivated species and at the Plant Materials Centre for wild species.

Acknowledgements

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Table 1. List of samples collected in Morocco in June 1987

Species	Samples (No.)
Cultivated species	
Hordeum vulgare	77
Medicago sativa	19
Phalaris aquatica	1
Secale cereale	4
Sorghum spp.	2
Triticum dicoccon	58
Triticum aestivum	19
Trifolium alexandrium	1
Zea mays	45
Vicia spp.	3
Hordeum/Triticum mix.	2
Subtotal	231
Wild legumes and forbs	
Astragalus spp.	7
Hedysarum flexuosum	1
Hippocrepis spp.	2
Medicago spp. (annual)	36
Medicago sativa	1
Onobrychis spp.	2
Salsola spp.	1
Sanguisorba minor	1
Scorpiurus spp.	3
Trifolium spp.	9
Trigonella spp.	1
Vicia spp.	2
Unidentified	3
Subtotal	69
Wild grasses	
Agropyron spp.	1
Andropogon spp.	3
Aristida spp.	2
Bromus spp.	1
Cenchrus spp.	2
Dactylis glomerata	12
Eragrostis spp.	1
Festuca spp.	10
Hordeum spp.	2
Hyparrhenia hirta	4
Koelaria spp.	4
Lygeum spartum	4
Oryzopsis spp.	6
Panicum spp.	1
Pennisetum spp.	2
Phalaris tuberosa	3
Phleum pratensis	2
Sorghum spp.	1
Stipa spp.	13
Unidentified	4
Subtotal	78
TOTAL	378

Wild *Beta* germplasm under threat in Italy

D. Pignone[1]

Many horticultural plants have wild relatives in the Mediterranean basin area. Italy has many undomesticated relatives of cultivated plants. Near the coast and in the south *Beta vulgaris* L., subspp. *vulgaris* and *maritima* grow wild and as weeds (Zeven and Zhukovsky, 1975). This latter subspecies is the probable progenitor of cultivated sugar beets and swiss chards (McFarlane, 1971). *Beta vulgaris* subsp. *macrocarpa* has been reported in south Italy (Pignatti, 1982). The variation in this species is noteworthy: plant habit, leaf waxes, flowering, stem colour, etc., is high. The types living near the littoral tend to be prostate, waxy and reddish while the hill types are erect, non-waxy and white. Since fodder and sugar beets are widely cultivated in Italy, occasional introgression has been observed.

Explorations have been conducted in southern Italy in which wild material was collected. The author participated in two of these missions (e.g. Hammer *et al.*, 1987). Highest variability was present in samples collected in undisturbed areas such as in samples from Le Castella and Capo Colonna, both being found in ancient ruins. Moreover, in places where wild *Beta* was supposed to occur, tourist and residential activities have reduced the incidence of these plants. In Ciró Marina and in Capo Trionto very contracted populations were found living in highly disturbed habitats. *B. vulgaris* subsp. *macrocarpa* was not found on the sites where it was identified earlier.

In the summer of 1987 and late spring of 1988, at the archaeological site of Capo Colonna, the beet populations were completely destroyed by excavations. The population of Le Castella was also completely destroyed after restoration works. In Cir Marina it was impossible to detect any beets and they were also absent from nearby areas.

Fortunately, due to the particular geography of the Capo Rizzuto area, there are several spots in which environmental conditions favour a strict isolation of wind-pollinated species. Dominant winds blow from the sea and the coastline is a steep 100-m clay cliff. In many of these spots between Capo Rizzuto and Capo Colonna (Capo Bianco, Punta Fratte, Capo Cimiti) *Beta vulgaris* subsp. *maritima* is still well established, isolated from the pollen of cultivated sugar and fodder beets.

B. vulgaris subsp. *maritima* exhibits salt tolerance, and very rarely shows *Cercospora* leaf spot. Since wild beets cross freely with cultivated *Beta* types, they could contribute these characteristics (Smith, 1980).

The most endangered area is certainly Calabria because of tourist pressure. Although several sites have been explored in that region in the past years, there are still many unexplored areas that should be visited.

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[1] CNR Germplasm Institute, Bari, Italy

The state of onion production and development in Bulgaria

Stefan Neykov[1]

The onion is a traditional vegetable crop in Bulgaria. In area cultivated, the vegetable occupies third place after tomatoes and peppers. Onions occupy 8-12 000 ha, with a total production of 100 000-120 000 tonnes. Formed bulb onions presented in the market in the form of green bunches can be obtained as early as the beginning of June through early autumn (August) and early spring sowing of early maturing cultivars like Tropicana, Barleta and Willomete Sweet. Green onions in Bulgaria are successfully produced by autumn planting of non-standardized bulb onions which can be obtained even with annual cultivation.

The cultivars representing onions with bitter taste are Liakovski 58, Yatrus 10, Trimontium, Plovdivski 10, Konkurent and Makovski. Cultivars of the semi-bitter type (annual) are Pioneer, Blunt Circle, Record 2, Ran 1, Success 6 and Jubilee 50. The sweet onion type cultivars are Assenovgradska Kaba, Samovodska Kaba and Spanish 482.

Cultivars with a high seed rate like Barleta, Regina and Balero are used for obtaining small bulb onions which are used for special canning purposes. Such cultivars are usually sown in February and March and supplied for processing in the canning industry during June, July and August.

Garlic is cultivated in winter and summer forms. Winter garlic is cultivated for the production of green garlic and bulbs. The consumption of the bulbs is from June to July. When sown in autumn green garlic is usually meant for early spring consumption. Yield of green garlic per hectare is 100 000 bunches and that of winter and summer garlic 5 000-8 000 and 4 000-6 000 kilograms respectively per hectare (in bulb form).

Leek-like garlic is cultivated in far smaller areas than onions. The long type of leek is the only cultivated one. It is represented by the cultivar Starazagorski Kamush. Cultivars of the short type are not grown.

The Institute of Introduction and Plant Genetic Resources has as one of its tasks the introduction, study and conservation of cultivars that belong to the *Allium* species. The onion cultivars are studied and assessed according to the international descriptor adopted by member states of the Council for Mutual Economic Aid.

In the past five years 200 onion and leek accessions have been studied. They include introductions from China, Czechoslovakia, Denmark, UK, FRG, GDR, Hungary, Italy, Mexico, Netherlands, Poland, Romania, Republic of South Africa, USA and USSR. During the first year of their introduction the accessions are sown in quarantine plots and in the second year in collection nurseries. Reproduction of the cultivars is carried out in 25 m^2 isolation chambers, where they are bee-pollinated. Seeds obtained from these chambers are given for long-term conservation in the genebank of the Institute to be used later as material for exchange with similar institutes in different countries and for plant breeders.

The *Allium* species is very rarely used by local gardeners, and even then by very few of them. Shallot (*A. ascalonicum*) is cultivated only by local gardeners. This is excellent material for preservation. *A. fistulosum* is found in very few places in some mountainous regions of Sofia and Kazanlak. The cultivated introductions are from the USSR. *A. schoenoprasum* is not grown in our country but it can be found in its wild form (var. *sibiricum*) along the mountain meadows of Rila, Vitosha and Stara Planina. *A. ampeloprasum* (wild leek) is not grown either but is also found in its wild form. *A. scorodoprasum* is found in the meadows and swamps throughout the whole country. It is cultivated here and there by local gardeners.

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Bambara groundnut collecting in Ghana

Forson K. Ayensu[1]

Between 1964 and 1974, 65 samples of Bambara groundnut *(Vigna subterranea* (L.) Verdc. comb. nov.) were collected, but with little detailed passport data. In November 1977 - March 1978, 59 samples of groundnut were collected, and due to the poor storage facilities available at that time, duplicates were deposited at the University of Ghana and the International Institute for Tropical Agriculture (IITA), Nigeria, respectively.

The Plant Genetic Resources Unit (PGRU) of the Crops Research Institute organized a general collecting mission in January 1982 to three regions of Ghana, upper, northern and Brong Ahafo, and Bambara groundnut germplasm was among the crops collected. 30 samples were collected then. Finally, in October 1987 the PGRU, in conjunction with IITA, collected ten samples of Bambara groundnut from the upper region of Ghana. Table 1 summarizes the collecting missions and samples collected.

Bambara groundnut is more resistant to drought than peanut *(Arachis hypogeae)* and also an important source of protein for people in the northern and upper regions.

All the Bambara groundnut germplasm collected between 1982-83 belonged to the bunch and semi-bunch types as described by Doku and Karikari (1971). The 1987 collections are yet to be evaluated. Wild forms of the species are yet to be explored. The collections differed in morphology, size and colour of seeds, number of pods per plant and colour of leaves, which ranged from light to dark green. The dark green colour of the leaves is often associated with the presence of anthocyanins.

Generally wrinkled pods on shelling gave large seeds, and smooth pods gave small seeds. Collections with large seeds have more extensive vegetative development and are more open and late maturing than small seeds. The small-seeded cultivars have thinner seed coats and as a result give quick cooking and better taste. Alleles for all red or all black colour may be at the same locus since red seeds often produce plants with seeds and red seems to be dominant to black as reported (Mergeai, 1986). Among the types collected are large black and white seeds, large red seeds, or cream seeds with large black eye, small light brown to orange coloured seeds.

Table 1. Bambara groundnut collecting expeditions in Ghana

Year	Institutions	Total samples collected	Remarks
1964/1974	PIE-PGRU[1]	65	Duplicates at the University of Ghana, Legon
1977/1978	PIE-PGRU	59	Duplicates at IITA
1982/1983	PGRU/University of Birmingham	30	In storage at PGRU
1987	PGRU/IITA	10	In storage at PGRU

[1] Plant Introduction and Exploration - PGRU

Method of sampling

Most of the samples collected were of seeds supplied by farmers from different areas around each village. This method allowed the collecting of most of the existing variability, although it was not the best sampling technique. In some villages pods were collected from the field, as well as from the farm seed store. Generally, farmers grow a mixture of seeds with different colours and samples were later sorted out into subsamples.

Genetic diversity

The importance of Bambara groundnut is gradually decreasing in Ghana but it is yet to be threatened by genetic erosion.

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Improvement on germplasm distribution at the Asian Vegetable Research and Development Center

David C.S. Tay[1]

Introduction

Annually, AVRDC's GRSU distributes about 20 000 seed samples to about a hundred countries and territories, at a cost of US$9 000 on shipment procedures alone. Including production, storage and packaging makes distribution an expensive activity. 46.7% of the shipments were acknowledged annually. A seed-distribution survey was conducted to evaluate our packaging system and to understand more about our cooperators' quarantine requirements in order to improve our services and to cut down cost.

Materials and Methods

A questionnaire consisting of 13 questions was sent out in the seed-shipment packages from 2 November 1984 to 26 June 1986. It included questions concerning shipment dates, GRSU acknowledgement card, packaging method, seed quality, recipient seed storage facilities, recipient quarantine requirements and procedures for importation of seed and vegetative materials, recipient plant introduction centre, shipment of sweet potato materials, quarantine restrictions concerning the introduction of pests and diseases for our then five principal crops and finally, suggestions to improve our seed-distribution services. The target was to obtain at least two responses from each country. A total of 329 questionnaires was sent to 111 countries.

Results

147 responses were received from 74 countries. This represented returns of 44.7%.

A seed packet may take up to 240 days to arrive at its destination (Table 1, see next page). It may take another 150 days of poor storage before the seeds are planted.

Suggestions already implemented to improve our packaging and services are as follows:

1. Introduction of two stickers with notices like "Seeds for experimental purposes (no commercial value)", "Phytosanitary certificate enclosed", "Keep in a cool place", "Please forward this parcel without delay", etc.
2. Introduction of a warning note on the acknowledgement card — "Return this card promptly in order to be able to obtain future shipments".
3. Labelling the pouches/bags clearly.
4. Sending a packing list in advance to alert the recipient about shipment (only when requested).
5. Providing seed treatments (only when requested).

The following are recommendations to improve packaging and services:

1. Use aluminium-polyethylene pouches or high-density bags hermetically sealed instead of paper bags because of delay in shipment and planting, and poor storage conditions of some recipients.
2. Have seed production fields inspected by the local quarantine office.
3. Enclose in the seed packets or publicize in the Center's publications the list of new advanced lines released for testing.

[1] Genetic Resources and Seed Unit, Asian Vegetable Research and Development Center, PO Box 42, Shanhua, Tainan 74199, Taiwan, China

Table 1. Seed-shipment arrival time from Taiwan (days)

Country	Province/city (days)	Country	Province/city (days)
Anguilla	(16)	Australia	Cleveland (13-21)
Austria	Vienna (10)	Bangladesh	Khulna (15), Noakhali (30), Chitagong (42)
Belize	Belmopan (30-40)	Bhutan	(15-42)
Botswana	(20)	Brazil	Brasilia (30)
Brunei	(14)	Burma	Rangoon (30-45)
Canada	Vancouver (10-14)	Chile	Campus Azapa (8)
Cook Islands	Rarotonga (19)	Costa Rica	(40-50)
Egypt	Dokki (16), El Sheikh (20), Cairo (16), Assiut (60)	El Salvador	San Salvador (27)
Ethiopia	Addis Ababa (13-15), Nazareth (30-35)	Fiji Islands	Sigatoka (8-60)
France	(20)	Ghana	Bekwai (37), Ashanti (37), Greater Accra (120-240)
Guyana	(21)	Haiti	(20)
Holland	Bleiswijk (15)	Honduras	(17)
Hungary	Tapioszele (14-24)	Indonesia	Kupang (20), Surabaya (30)
Iran	Karadj (30-56)	Israel	Rehovot (30)
Italy	Ghiarone (15-30)	Jamaica	St Ann's Bay (15)
Japan	Tokyo (5)	Jordan	(15)
Kenya	Endebess (9), Ndhiwa (60)	Korea	Suweon (10-15)
Liberia	Monrovia (7-32)	Malawi	Lilongwe (8), Blantyre (28), Limbe (40)
Malaysia	Sabah (30)	Mali	(26)
Martinique Islands	Fort de France Cedex (10-12)	Mexico	Nayarit (10-30), Los Mochis (20-60)
Nepal	Lalitpur (20), Nawalpur (40)	Nicaragua	Nsukka (14), Ibadan (30), Zaria (40)
Pakistan	Faisalabad (10), Karachi (15)	Papua New Guinea	(12-15)
Peru	Lima (10-120)	Philippines	Los Banos (30-90)
Reunion	Saint-Penis Cedex (13)	Saudia Arabia	Unayzah (26)
Sierra Leone	(42)	Singapore	(5)
Solomon Islands	Honiara (20-28)	Somalia	(30)
Sri Lanka	Makandura (10), Gonwila (30)	St Kitts & Nevis	Basseterre (13)
St Lucia	Vieux Fort (20-22), Castries (25)	Sudan	Khartoum (20-60)
Suriname	(18)	Tahiti	Papeete (15-20)
Tanzania	Kilosa (21-25)	Thailand	Chiang Mai (13-15)
Tonga	Nuku'alofa (18)	Trinidad	Port of Spain (14)
Turkey	(9)	USA	Saticoy (19), Washington, DC (24), Urbana (35), Florida (27)
Venezuela	Caracas (15)	Western Samoa	Apia (7)
Yemen	Taiz (40)	Zaire	(24)
Zambia	(56)	Zimbabwe	Marondera (9)

The Editor of the *Plant Genetic Resources Newsletter* will be pleased to consider reports, notes and news from anyone working with plant genetic resources. Reports should be limited to approximately 1200 words. The Editor reserves the right to edit to meet space limitations.

Please send manuscripts typed double spaced. Where possible, manuscripts should be supplied on IBM- or Macintosh-readable diskettes. Relevant photographs would also be greatly appreciated but only high quality black and white prints rather than colour prints or slides. Colour photographs will be reproduced in black and white, but this is not without a considerable loss of quality.

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All contributions should be sent to the Editor, IBPGR, c/o FAO, Via delle Sette Chiese 142, 00145 Rome, Italy.

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Cuando sea posible, los manuscritos deberán ser enviados en 'diskettes' compatibles con los sistemas IBM o Macintosh. Les rogamos envíen los trabajos mecanografiados a doble espacio. También apreciaremos el envío de fotografías relacionadas con la materia, que deberán ser de buena calidad, preferiblemente en blanco y negro. Las fotografías en color sólo serán reproducidas en blanco y negro, pero con una apreciable pérdida de calidad.

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