Wild lentils of central Asia

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Summary

During a collecting mission to Turkmenistan, Uzbekistan and Tajikistan in spring 1990 the distribution and ecology of *Lens culinaris* subsp. *orientalis* were studied. Genetic analyses were subsequently performed on the material collected. Chromosomally, all the populations tested were uniform, resembling the standard arrangement of *L. culinaris*. They were also found to be part of the common crossability group of this species. Allozyme polymorphism was much more restricted than in the Near Eastern populations, but a new allele of *Got-3* was found. The possibility of the central Asiatic populations of subsp. *orientalis* being involved in lentil domestication is briefly discussed.

Introduction

The wild progenitor of lentil, *Lens culinaris* subsp. *orientalis*, is distributed over a vast geographical area, from the Near East to central Asia. Barulina (1930) was the first to present a map of lentil species distribution, including subsp. *orientalis*, which was treated by her as an independent species, *L. orientalis*. That map shows subsp. *orientalis* to be particularly common in the region between the Amu Dar'ya and Syr Dar'ya rivers of central Asia.

Over the last 20 years valuable information has been accumulated on the distribution, ecology, chromosomal variation and allozyme diversity in subsp. *orientalis* of the Near East (Ladizinsky *et al.*, 1984; Pinkas *et al.*, 1985; Hoffman *et al.*, 1986). However, there was no such information on the central Asian populations of subsp. *orientalis*, and no seeds were available for examination. In a collaborative effort between the International Board for Plant Genetic Resources (IBPGR) and the Vavilov Institute, Leningrad, to collect wild legumes in central Asia, a field trip to the former USSR republics of Turkmenistan, Uzbekistan and Tajikistan was organized in late spring 1990. During this mission special attention was paid to wild lentils. This paper summarizes the distribution and ecology of subsp. *orientalis* in the visited areas, as well as the results of genetic analysis performed on material collected.

Distribution and ecology

The occurrence of *L. culinaris* subsp. *orientalis* in central Asia was already indicated by the flora of the countries visited and the relatively large number of specimens deposited in their herbaria. The field trip confirmed that subsp. *orientalis* is as common in central Asia as in the Near East, if not more so.

In Turkmenistan, the western fringe of the Kopet Dag range, near Kara-Kala, was surveyed. In Tajikistan, we explored the Dushanbe area, southwards along the road to Chorborg and back to Dushanbe via Kurgan-Tyube. The Nurex area and eastwards to Komsomolabad was surveyed, from Dushanbe northwards to Varzob and through the Anzob pass to Ayni, Rarz and westwards to Pendzhikent. Two gorges were visited in Uzbekistan: Pskem and Akhangaran, both east of Tashkent (Fig. 1).

The visited areas were arid or semi arid but subsp. *orientalis* managed to complete its life cycle there in the short period between the cold winter and the hot, dry summer. The plants occurred at altitudes of 500-1700 m, mainly on gravel of limestone, metamorphic and sandstone bedrock (Fig. 2). They grew together with a few annual plants, most commonly *Aegilops triuncialis*, and in association with tree communities of *Cercis griffithii*, *Amygdalus bucharica*, *A. spinosissima*, *Zizyphus jujuba* and *Pistacia vera* (Fig. 3). The observed populations were

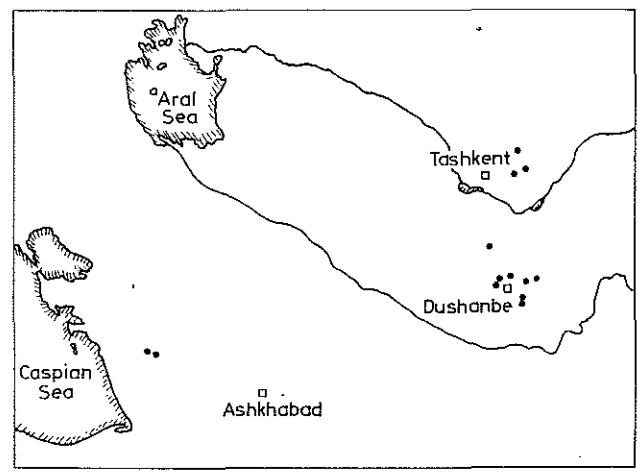

Fig. 1. Collecting sites of subsp. *orientalis* populations in central Asia

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Fig. 2. Habitat of subsp. *orientalis*, on metamorphic gravel near Konaka, Tajikistan

Fig. 3. Habitat of subsp. *orientalis*, in *Pistacia vera* plant community, near Nurex, Tajikistan

made up of a relatively small number of plants growing in open habitats, excluding the population of Yol-dere near Kara-Kala in Turkmenistan, which thrived in shady habitat at a gorge bottom where the plants were still partially green on 8 June. In open habitats lentil plants had already dispersed their seeds except at the higher altitudes near Dushanbe and Komsomolabad where, in mid-June, the plants were seen to be almost ready for seed dispersal.

Allozyme variation

Six populations were subjected to electrophoretic study. The origin of these populations is shown in Table 1. Seven to 46 plants per population and a total of 146 plants were examined. Experimental procedure was according to Pinkas *et al.* (1985) and for comparison of band migration a cultivated line, *Lc-2*, was added to each run. This line was used as the standard by Pinkas *et al.* (1985). The material was assayed for eight enzyme systems: Idh, Mdh, Sod, Me, 6Pgd, Pgm, Lap and Got, and altogether products of 14 genes were examined.

The loci *6Pgd-1*, *6Pgd-2*, *Mdh*, *Lap-1*, *Sod-1*, *Sod-2*, *Idh-1* and *Me* were monomorphic and identical to those of *Lc-2* in all the tested populations. It is pertinent to note that variation in these loci was observed by both Pinkas *et al.* (1985) and Hoffman *et al.* (1986) in material from the Near East. Polymorphism for *Pgm-1* was found in population nos 229 and 233, for *Sod-3* in nos 231 and 238, and for *Got-2* in no. 232. In these populations the *Lc-2* allele was common and the other alleles were similar to those identified in the Near Eastern populations. Much greater variation was observed in *Got-3*. Four populations were polymorphic and besides the common allele, one which has never been reported for the Near Eastern populations was observed. This allele was absent in population no. 229 but fixed in no. 238.

Chromosome arrangement of the central Asiatic populations

Chromosome rearrangements have been found in Near Eastern populations of subsp. *orientalis* (Ladizinsky *et al.*, 1984). In order to test the chromosome arrangement of the central Asiatic populations, plants from the 14 populations were crossed with the cultivated lentil *Lc-2*, representing the standard arrangement of *L. culinaris*. Hybrid seeds were easily obtained and the hybrid plants were normal. Chromosomes associated in bivalents at meiosis in the hybrids, indicating that the Asiatic populations of subsp. *orientalis* share the standard arrangement.

Crossability potential

Three crossability groups have been identified in *L. culinaris* (Ladizinsky and Abbo, 1993): the common group, which includes the cultivated lentil and most populations of subsp. *orientalis*; the unique group, which is known to occur in two populations of subsp. *orientalis* in Turkey and one in northern Syria; and the intermediate type, which occurs in

Table 1. Origin of seed samples collected in central Asia

No.[a]	Origin
229*	Yol-dere, Kara-Kala, Turkmenistan
230	Ai-dere, about 50 km E of Kara-Kala, Turkmenistan
231*	Obigarm, Dushanbe-Komsomolabad road, Tajikistan
232*	Changob, Gissar road, 20 km W of Dushanbe, Tajikistan
233*	Konaka, 20 km NW of Dushanbe, Tajikistan
234*	Varzob, 24 km N of Dushanbe, Tajikistan
235	26 km S of Dushanbe, on the road to Zargar, Tajikistan
236	20 km NE of Nurex, Tajikistan
237	5 km N of Nurex, Tajikistan
238*	5 km W of Komsomolabd, Tajikistan
239	50 km E of Pendzhikent, Tajikistan
240	Pskem, 35 km NE of Charvak, Uzbekistan
241	18 km NE of Angren, Uzbekistan
242	50 km E of Angren, Uzbekistan

[a]Populations marked with an asterisk were subjected to electrophoretic study.

one population in Turkey and three in Syria. Crosses between members of the common and unique groups fail, regardless of cross-direction, because hybrid embryos abort seven to 14 days after fertilization. Members of the intermediate group are cross-compatible with both other groups.

Successful crosses of representatives of the central Asiatic populations with *Lc-2*, a representative of the common crossability group, indicated that they were not part of the unique group. However, to test whether they belonged to the common or intermediate groups they were crossed with accession no. 133 of the unique group. Following the crosses pod development was initiated but pods ceased growing shortly thereafter, turned yellow and yielded shrunken, non-viable seeds. This indicates that the tested central Asiatic populations of subsp. *orientalis* are indeed members of the common crossability group.

Genetic attributes and their bearing on lentil domestication

Cultivated lentils possess the standard chromosome arrangement and are members of the common crossability group. Since these attributes are shared by the examined subsp. *orientalis* populations of central Asia, they could, theoretically, be part of the wild lentil stock from which the cultivated lentil developed. Obviously, additional populations from central Asia must be examined before more general conclusions can be drawn regarding their role in the evolution of the cultivated lentil. However, if the examined populations are in any way representative, central Asia could not have been the main centre of lentil domestication, because many alleles of enzymic loci of the cultivated lentil are missing in the subsp. *orientalis* from that area. This conclusion is further supported by the ecology and agricultural practices of the region. Rain-fed cereal and legume crops are common in the Near East but very rare in Turkmenistan, Uzbekistan and what is now Tajikistan. In these areas agriculture is sustained by irrigation. Lentil is not one of the area's crops and it probably never was. Even if it had been, it would most likely have been grown under irrigation, as the other crops of the area. In agricultural evolution, dry farming is thought to preceed irrigation. In central Asia, the latter method was probably used to raise introduced crops, rather than to domesticate wild plants. The oldest remains of agriculture in central Asia are of the Djeitun culture, on the narrow plateau between the steep rise of the Kopet Dag range and the Kara Kum Desert sand dunes. By means of primitive irrigation two-row barley and wheat were grown there in about 5000 BC (Masson and Sarianidi, 1972), but apparently no lentil, as can be concluded from the scanty archaeological evidence.

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Résumé

Lentilles sauvages d'Asie centrale

A l'occasion d'une récente mission de collecte au Turkménistan, en Ouzbékistan et au Tadjikistan, la répartition et l'écologie de *Lens culinaris* subsp. *orientalis* ont été étudiées. Des analyses génétiques ont ensuite été effectuées sur le matériel génétique collecté dans ces régions. Du point de vue chromosomique, toutes les populations testées sont uniformes, leur disposition ressemblant à l'arrangement type de *L. culinaris*. On a aussi constaté qu'elles font partie du groupe de croisement commun de cette espèce. Le polymorphisme allozyme est beaucoup plus restreint que dans les populations du Proche-Orient, mais un nouveau gène allélomorphe du système *Got-3* a été découvert. On étudie brièvement la possibilité d'utiliser les populations de la sous-espèce *orientalis* d'Asie centrale dans la culture des lentilles.

Resumen

Lentejas silvestres de Asia central

Durante una reciente misión de recolección en Turkmenistán, Uzbekistán y Tayikistán se estudió la distribución y la ecología de *Lens culinaris* subesp. *orientalis*. Posteriormente se realizaron análisis genéticos del material recogido. Todas las poblaciones mostraron en los análisis uniformidad cromosónica, con una distribución parecida a la normal de *L. culinaris*. También se comprobó que formaban parte del grupo común con posibilidades de crecimiento de esta especie. El polimorfismo alocimático era mucho más restringido que en las poblaciones del Cercano Oriente, pero se encontró un nuevo alelo de *Got-3*. Se examina brevemente la posibilidad de utilizar las poblaciones de Asia central de la subespecie *orientalis* en la domesticación de las lentejas.