

OBSERVATIONS ON THE DISTRIBUTION AND ECOLOGY OF *VICIA* AND *LATHYRUS* SPECIES IN NORTHERN MOROCCO

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SUMMARY

An ecogeographical survey of the distribution of *Vicia* and *Lathyrus* in Morocco was conducted in 1993 with seed samples collected from 174 sites in four geographical areas. A total of 450 accessions were used in a preliminary study of the distribution of these genera.

Vicia sativa was the dominant species found in more than 80% of collection sites. Among the *Lathyrus*, *L. articulatus* was the most common species, recorded in 34% of sites.

Vicia sativa spp. *nigra* showed better adaptation to high altitudes than the other subspecies of *sativa*. *Vicia villosa* was also well adapted to high altitudes, while *Lathyrus* species were generally confined to altitudes of less than 500 metres.

Both *Vicia* and *Lathyrus* favoured high pH soil, *Lathyrus* more strongly. *Vicia villosa* spp. *dasycarpa* was an exception and was more frequent on mildly acid soils.

V. villosa spp. *dasycarpa* and *L. articulatus* were the most competitive species as crop weeds.

There appeared to be a small, but potentially important, residual population of reduced shattering genotypes in *V. sativa* spp. *sativa* and *nigra* and possibly *L. articulatus*.

KEY WORDS: Distribution, ecology, *Vicia*, *Lathyrus*, shattering.

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RESUME

Des prospections pour la collecte des genres *Vicia* et *Lathyrus* au Maroc ont été effectuées par l'échantillonnage de 174 sites situés dans quatre régions géographiques. Un total de 450 populations ont été utilisées dans une étude préliminaire de distribution de ces deux genres.

Vicia sativa a été l'espèce la plus fréquente, rencontrée sur plus de 80% des sites de collecte. Parmi les *Lathyrus*, l'espèce *L. articulatus* était la plus répandue, trouvée dans 34% des sites.

V. sativa spp. *nigra* a montré une meilleure adaptation aux hautes altitudes que les autres sous-espèces de *sativa*. *V. villosa* était aussi adaptée aux altitudes élevées, alors que les espèces du genre *Lathyrus* ont été généralement restreintes à des altitudes de moins de 500 mètres.

Aussi bien *Vicia* que *Lathyrus* ont préféré les sols à ph élevé, *Lathyrus* plus particulièrement. *Vicia villosa* spp. *dasycarpa* était une exception et était plus fréquente sur les sols faiblement acides.

V. villosa spp. *dasycarpa* et *L. articulatus* ont été les espèces les plus compétitives vis à vis des cultures céréalières.

Il semble qu'une petite, mais potentiellement importante population résiduelle de géotypes à déhiscence réduite existe chez *V. sativa* spp. *sativa* et *nigra*, et peut être aussi chez *L. articulatus*.

MOTS CLES: Distribution, écologie, *Vicia*, *Lathyrus*, déhiscence.

INTRODUCTION

Vicia and *Lathyrus* have long been known as genera with considerable potential for both forage and grain and their cultivation for human food pre-dates modern agriculture by thousands of years (Marinval 1985). Altogether some 36 species have been recorded as cultivated species (Reid, Bettencourt and Konopka 1993). Of these, only *Vicia faba*, *V. Sativa*, *V. ervilia* and to a lesser extent *Lathyrus sativus* and *Lathyrus cicera* are, or have been, cultivated in Morocco (Foury 1954).

Morocco offers a great diversity of soil type, winter temperatures and rainfall, and is a centre of *Vicia* and *Lathyrus*. The reported genetic diversity of *Vicieae* in Morocco (Allkin, Bisby and White 1983), together with the wide environmental range, makes Morocco an ideal country, not only to increase the genetic resource base, but also to study the range of adaptation of the species.

While cultivated *Vicia* and *Lathyrus* species are generally adapted to alkaline and heavy soils, there appears much to learn about the ecology of many, if not most, of the species of the two genera. Many articles have been written on the systematics of the *Vicieae* (Hanelt and Mettin 1989), but few provide information on the climatic and edaphic requirements of the species. Such information is essential in the development of new species for agriculture, and in particular, for the choice of species most likely to succeed in a given environment.

To this end, a survey of the genetic diversity of natural populations of *Vicia* and *Lathyrus* species was made from both the high-altitude cold regions and the coastal low-altitude area of northern Morocco. We have used this survey to relate the natural distribution of *Vicia* and *Lathyrus* species to some ecologically important soil and climatic factors.

MATERIALS AND METHODS

An ecogeographical survey of the distribution of *Vicia* and *Lathyrus* in Morocco was conducted in 1993. The collections covered a total travel distance of 5000 km. The altitude varied from sea level to 2400 m and the rainfall from 250 to 1200 mm (25 years average). A total of 174 sites were sampled in four geographical areas (Figure 1):

1. Middle Atlas (Provinces of Khémisset, Khénifra, Ifrane, Fès, Béni-Mellal, Azilal and Marrakech): 61 sites.
2. High Atlas (Province of Marrakech): 9 sites.
3. Low-altitude and coastal area (Provinces of Kénitra, Larache, Tanger and Tétouan): 46 sites.
4. Rif mountains (Provinces of Chefchaouen, Al Hoceïma, Taza and Sidi Kacem): 58 sites.

As far as possible, records were made of country rock, soil type and pH, slope, drainage, crop practices and relative abundance of the species. Altitude was estimated by a hand altimeter and rainfall from locally available data.

A preliminary survey was conducted in March to locate some key collection sites and seed collection was undertaken in June-July, 1993. Classical procedures (Marshall and Brown 1971) suggest a transect type of approach with frequent short stops. However, so few were the reasonable collection sites that this method was not appropriate. To maximise the number of ecotypes under these conditions, we sampled thoroughly the scattered populations of diversity remaining.

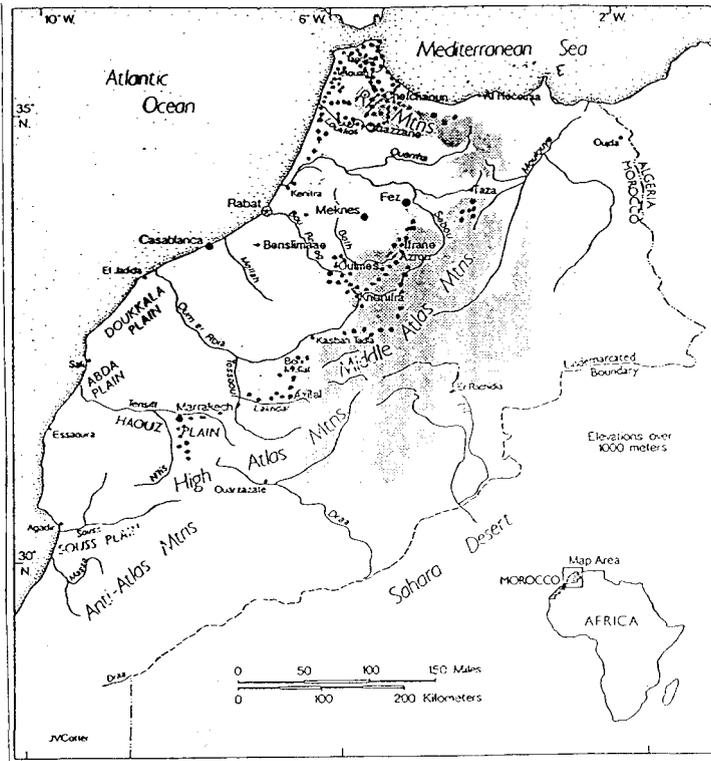


Fig. 1. Map of the study area.

• COLLECTION SITES

RESULTS AND DISCUSSION

Frequency distribution of species

More than 450 accessions were used in a preliminary study of the distribution of *Vicia* and *Lathyrus* species in Morocco. This represents the most comprehensive collection of *Viciaeae* from the North African region.

Twenty species of *Vicia* have previously been described from Morocco (Allkin, Bisby and White 1983). In our study, only 11 were positively identified. Drought conditions may have reduced the diversity available, while a more detailed study of the vegetative parts may well increase the number. It is apparent, nevertheless, that species such as *Vicia narbonensis*, *V. serratifolia*, *V. cedrorum*, *V. vicioides*, *V. durandii* and *V. glauca* are at least rare in Morocco. With the increasingly intense grazing and cropping pressure in Morocco, some of these species may well be victims of genetic erosion.

A summary of the species collected is presented in Table 1 and the most common *Vicia* and *Lathyrus* species are shown in Figure 2 in terms of their frequency distribution.

Table 1. Summary of species collected.

<i>Vicia villosa</i> spp. <i>dasycarpa</i>	21	<i>Vicia tetrasperma</i>	2
<i>ervilia</i>	28	<i>tenuifolia</i>	1
<i>hybrida</i>	5	<i>fabia</i>	2
<i>lutea</i>	31	sp.	6
<i>monantha</i>			
spp. <i>monantha</i>	20		
spp. <i>cinerea</i>	7	<i>Lathyrus aphaca</i>	7
<i>onobrychiodes</i>	5	<i>articulatus</i>	63
<i>pannonica</i>	2	<i>cicera</i>	17
<i>peregrina</i>	2	<i>ochrus</i>	5
<i>sativa</i>		<i>sativus</i>	9
spp. <i>amphicarpa</i>	1	<i>tingitanus</i>	9
spp. <i>angustifolia</i>	2	sp.	5
spp. <i>cordata</i>	5		
spp. <i>hyemalis</i>	1		
spp. <i>macrocarpa</i>	4		
spp. <i>nigra</i>	88		
spp. <i>sativa</i>	149		

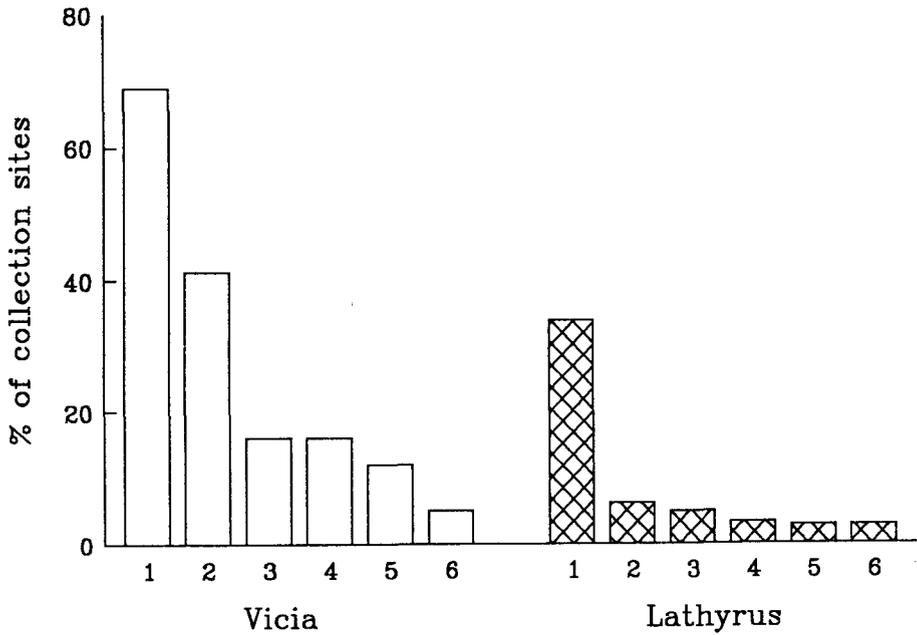


Fig. 2. Frequency of occurrence of Viciae in 174 sites in Morocco.

(Vicia: 1 = *sativa*, 2 = *sativa ssp nigra*, 3 = *lutea*, 4 = *villosa ssp dasy-carpa*, 5 = *ervilia*, 6 = *monantha*. Lathyrus: 1 = *articulatus*, 2 = *sativus*, 3 = *cicera*, 4 = *aphaca*, 5 = *ochrus*, 6 = *tingitanus*).

Population Ecology and variability

The large collection enabled some important ecogeographical observations to be made.

Size and complexity of the *Vicia sativa* gene pool

While other *Vicia* and *Lathyrus* species were dominant in localised environments, the *Vicia sativa* complex was widely adapted and found in more than 80% of the sites visited. It was apparent from examination of the seeds and pods that the gene pool was considerable and active and that there has been much introgression, especially between *Vicia sativa* spp. *sativa* and *Vicia sativa* spp. *nigra*. Seed and pod colour and calyx length, for example, represent a continuum between these two. Intercrossing rates exceeding 10% have been recorded by Hanelt and Mettin (1989) and no doubt contributes to obscuring the inter-subspecies boundaries in Morocco where large populations of both are contiguous.

Although *V. sativa* as a species is not generally adapted to cold environments or to acid soils, a significant number of ecotypes (12 to 14%) were found in such locations. It appears the situation may be analogous to that found in *Medicago truncatula* (Bounejmame 1992). In the latter situation, the massive gene pool of the medic appears to have facilitated the selection of a small, but significant, number of ecotypes with adaptation well outside the normal range of the species.

Competiveness of *Vicia villosa* spp. *dasycarpa* and *Lathyrus articulatus* as weeds in cereal crops

A striking feature was the 'success' of some of the *Vicieae* in competition with cereals. In crops in the Rif mountains and valleys, *Lathyrus articulatus* was a dominant 'weed' and on occasions had overgrown the cereal crop. In the colder (and higher) Middle and High Atlas, *Vicia villosa* spp. *dasycarpa* was a dominant crop contaminant.

The reasons for their relative success as crop weeds deserve further study as the two species are quite different. *L. articulatus* has long sprawling vines and can grow taller than the cereal crop canopy. It has entirely different growth form than the much shorter and more determinant *V. villosa* spp. *dasycarpa*. The latter species appears to rely on early maturity relative to the

cereal, strongly shattering pods and a high content of hard seed. Both species clearly have ability to produce large quantities of seed in the competitive situation with cereals. It will be of considerable interest to evaluate the competitive ability of these species against others apparently less successful as crop competitors, e.g. *V. lutea*.

A high content of hard (impermeable) seed may contribute to the success of a species as a crop weed. Foury (1954) has quoted early work noting *V. villosa* to have a high hard seed content relative to *V. sativa* and that pale-seeded genotypes were more permeable than dark-seeded types. Certainly our observations support these conclusions. Dark grey to black seeds of *V. villosa* were invariably found on the ground and in many cases were hard seed from the previous season's crop.

Specific soil and climatic adaptation

The *Vicia* species generally were far more widespread than the *Lathyrus*. They occupied both a wider soil range and much colder winter environments (Figure 3).

Some of the species demonstrated specific adaptative characteristics, notably:

- (1) *Vicia sativa* spp. *nigra* predominated in the highest (and coldest) regions where it was sympatric with perennial species *V. onobrychioides* and *V. tenuifolia*.

V. villosa spp. *dasycarpa* was also common in cold high altitude environments. It may be that *V. villosa* spp. *dasycarpa* has an obligate cold requirement as it was rare or absent from the milder winter climate of northern regions of the Rif and surrounding coastal plains.

Lathyrus species showed a strong affinity for lower altitudes. ICARDA's breeding aim of greater cold tolerance in *Lathyrus ochrus* is unlikely to be realized as a result of this mission. All accessions were from mild winter, near coastal, environments. Only *L. cicera* occurred in the cold winter environments of the Middle Atlas where it was occasionally sympatric with *V. villosa* spp. *dasycarpa*.

- (2) Acid soils were associated with both granite and basalt parent rock. The coarse-textured granitic soils were dominated by *Trifolium* species and contained far fewer *Viciae* than the more fertile basaltic soils.

V. villosa spp. *dasycarpa* was the most widespread species on the mildly acid (pH 5 to 6.5) soils of the Middle and High Atlas with 52% of its ecotypes found on such soils. In these situations, it was a common crop contaminant. Other *Vicia* species, viz. *lutea* and *sativa* had a much smaller proportion of ecotypes (12 to 14%) associated with the acid soils (Figure 3).

Lathyrus species showed a strong affinity for loamy soils of higher pH. More than 80% of the ecotypes were from soils of pH 7.6 or greater. On the mildly acid infertile granitic soils, e.g. west of Chefchaouen, *Lathyrus* was rare.

- (3) *V. ervilia* was commonly cultivated as a crop in the Rif, reflecting no doubt the past tradition of culture under French and Spanish influence. It has not spread naturally outside this cultivated area. This may be due to features of its domestication (upright growth habit, non-shattering pods and soft seed) making it uncompetitive in the wild.

Adaptation of *V. ervilia* to shallow (dry) stony soils and more importantly to drought was expressed by successful seed set relative to other *Vicieae* in what was a serious drought year. As an already domesticated species, there is much to recommend further selection within the species. One immediate problem is its susceptibility to attack by *Orobanche crenata* for which variation between varieties of five *Vicia* species has been reported recently by Linke, Abd El Moneim and Saxena (1993).

Non-shattering genes

Non-shattering pods are an important feature for the domestication of grain and forage legumes. While shattering pods have clear ecological advantage in the wild to ensure spread and survival, there appeared to be a small, but potentially important, residual population of reduced shattering genotypes in *Vicia sativa* spp. *sativa* and *nigra* and possibly *Lathyrus articulatus*.

The apparently reduced shattering genotypes were best expressed in the dry seasonal finish of the Middle Atlas where all except isolated plants had shattered. The putative non-shattering genotypes were characterised by oblique splitting of the pod wall. It may be that several genes are involved. Assessment of the efficacy and inheritance of these 'genes' in relation to those already defined by Abd El Moneim (1993) will be one of the more immediate studies required as a follow up of the mission.

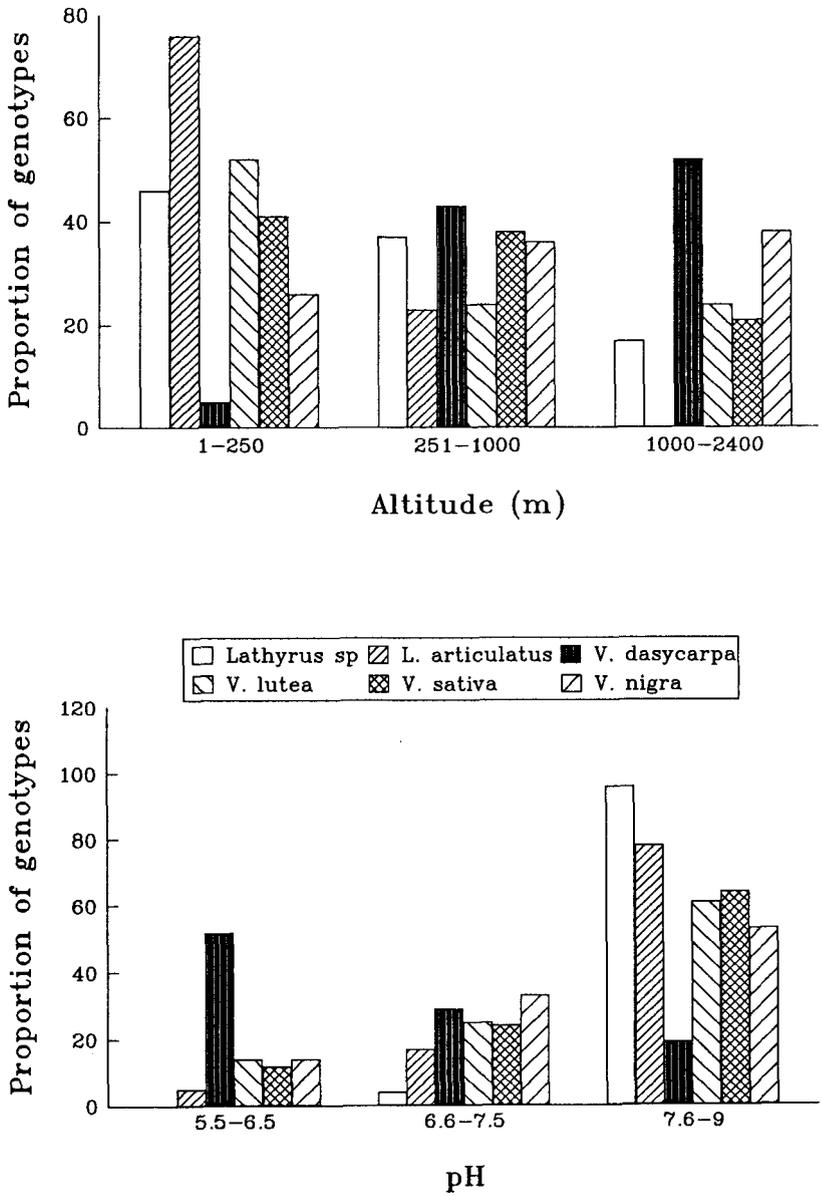


Fig. 3. Frequency of occurrence of *Viciae* in various classes of altitude and pH.

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