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NARBON BEAN
Vicia narbonensis L. (Leguminosae)

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1 INTRODUCTION

The evolution of *Vicia narbonensis* (Narbon bean, moor's pea or narbon vetch) as a grain crop is closely associated with the cultivation and domestication of the faba bean (*V. faba*). Due to the superficial similarities between the two, as well as the frequent presence of the narbon bean in faba bean fields, it seems likely that it was domesticated and has evolved as a secondary crop in the shadow of the faba bean. *V.narbonensis* is cultivated in the Mediterranean (Mateo-Box, 1961) and the Middle-East (van der Veen, 1960). The species also grows wild in disturbed and manmade habitat throughout the same area. Its centre of origin is likely to be North-West Asia where the highest diversity of *V. narbonensis* can be found (Schäfer, 1973; Maxted *et al.,* 1991).

Exact figures for the global cultivation of *V. narbonensis* as a grain or forage crop are unavailable, but for Spain in the 1960's it was estimated at 7000ha with a global grain production of 4600 metric tons (Mateo-Box, 1961). In Turkey and Northern Iraq this species is grown on a limited scale under both, irrigation and rainfed conditions. Areas of local landrace cultivation are expanding in the Djebel Druze region of Syria (Erskine, ICARDA, pers.comm.).

2. CYTOTAXONOMIC BACKGROUND

Taxonomically, *V.narbonensis* has a close relationship with the other large-seeded, robust vetches of section *Narbonensis* (Radzhi) Maxted, with which it forms the *V.narbonensis* complex (Schäfer, 1973; Maxted *et al.,* 1991). The classification of section *Narbonensis* is provided in Table 1. Within ser. *Narbonensis* the species are distinguished on the basis of flower colour, leaf and pod shape. The flowers of *V. narbonensis* and *V. serratifolia* are purple, while those of *V. johannis* have a white, sometimes purplish veined standard and red/purple (var. *johannis*) or brown/purple (var.*procumbens*) wing spots. *V. serratifolia* , as the name implies, has serrated leaves. Specimen with leaflet serrations of more than 15 teeth can be consistently distinguished as *V. serratifolia* .

Table 1. The classification of *Vicia* L.subgenus *Vicia* section *Narbonensis* (Radzhi) Maxted

Sect. *Narbonensis* (Radzhi) Maxted
- Ser. *Rhombocarpae* Maxted
  - *V. eristalioides* Maxted
- Ser. *Narbonensis* (Radzhi) Maxted
  - *V. kalakhensis* Khattab, Maxted & Bisby
  - *V. johannis* Tamamschjan in Karyagin
    - var. *ecirrhosa* (Popov) H. Schäfer
    - var. *procumbens* H. Schäfer
    - var. *johannis*
  - *V. galilaea* Plitm. & Zoh. in Plitm.
    - var. *galilaea*

var. *faboidea* (Plitm. & Zoh. in Plitm.) H.Schäfer
V. serratifolia Jacq.
V. narbonensis L.
var. *salmonea* (Mout.) H. Schäfer
var. *jordanica* H. Schäfer
var. *affinis* Kornhuber ex Asch. & Schweinf.
var. *aegyptiaca* Kornhuber ex Asch. &Schweinf.
var. *narbonensis*
V. hyaeniscyamus Mout.

V. narbonensis has been classified into five botanical varieties (Schäfer, 1973) on the basis of seed size, hilum colour, presence of a funiculus, pod shape and leaf margin serrations. The detailed geographical distributions of the individual varieties of *V. narbonensis* have been mapped by Schäfer (1973) and Maxted (1991, ref. in Maxted *et al.* 1991). The species seems to be sparsely distributed in many parts of the Western Mediterranean and North Africa where the large-seeded vars. *aegyptiaca* and *narbonensis* tend to predominate and may reflect, as escapees, the extent of the species' former cultivation. The smaller-seeded varieties are abundant in the Eastern Mediterranean.

Seeds of *V.narbonensis* were probably, like other vetches, repeatedly introduced with traded grain to Italy, the Iberian Peninsula and North Africa, from Turkey and the Levant; or they were spread through grazing animals and seed eating birds. Chassagne (1956) reported that *V. narbonensis* had been known at Puy-de-Dôme since the 18th century, and that this species could be found established on abandoned hillsides. The cultivated variety *V. narbonensis* var. *hortensis* (syn. *V. narbonensis* var. *narbonensis*) was first noted in 1925, probably introduced with forage grain from the Black Sea region during the first world war. According to Chassagne (1956) pigeons are partial to this rarely cultivated plant and aid in its spread, and it was clearly on its way to naturalization.

More detailed knowledge about the ecogeography of section *Narbonensis* has emerged through recent collecting activity in the Eastern Mediterranean. *V. narbonensis* was found to be a widespread calcicole species in Syria and Turkey. Its semi-arid botanical varieties *narbonensis* and *salmonea* occurred throughout the area, while *jordanica* was restricted to southern Syria. Detailed information about the ecogeography of vars. *affinis* and *aegyptiaca* is presently unavailable.

Table 2. Key characters for identification of *V. narbonensis* L. varieties (Schäfer, 1973)

Var.	Characteristics
aegyptiaca Kcke	1-2-(-3) basal shoots; flowers 1-2-(-3); legume 5-7 x 1.1.-1.6 cm, rugose; seed 6-11(-13) mm, central strip of hilum white, funiculus persistent.
narbonensis L.	1-2-(-3) basal shoots; flowers 1-2-(-3); legume 5-7 x 1.1.-1.6 cm, smooth; seed 6-8 mm, central strip of hilum white, funiculus deciduous.
affinis Asch.& Schweinf.	1-2 basal shoots; flowers 1-2; legume 3.5-5.5 x 0.7-1.1 cm, smooth; seed 4.5-6.0 mm, central strip of hilum beige.
jordanica Schäf.	2-6 basal shoots, basal leaflet entire; flowers 1-2; legume 3.5-5.5 x 0.7.-1.1 cm, smooth; seed 4.5.-6.0 mm-1.1cm, central strip of hilum beige.
salmonea Mout.	1-2 basal shoots; basal leaflet crenate; flowers 1-2; legume 3.5-5.5 x).7-1.1 cm, smooth; seed 4.5-6.0 mm, central strip of hilum beige

The haploid chromosome number for sect. *Narbonensis* is n=7. They are cytologically uniform, but can be distinguished by minor variations of the short arm lengths of submedian and subterminal chromosomes and in the relative size of satellite chromosomes.

Within *V. narbonensis*, Schäfer (1973), distinguished three distinct karyotypes A, B, C. A fourth karyotype D was identified by Raina *et al.* (1989) and they conclude from meiotic pairing properties and non-viable crosses, that genome D is the most distinct and may warrant specific status. However, the single specimen cited for the D genome was obtained from ICARDA and has been identified as *V. serratifolia*.

Although the flowers of sect. *Narbonensis* are well adapted for insect pollination there is a predominance of autogamy. Based on spontaneous hybrids occurring during her study, Schäfer (1973) estimated an outcrossing rate of 5-10%.

There have been several interspecific hybridization experiments between the taxa of sect. *Narbonensis*. In general the results indicate that it is relatively easy to cross within a variety, as well as between varieties. There has been some success at crosses between species, but interspecific embryos usually abort prematurely due to lack of endosperm development and if they are successful, generally no fertile offspring are produced from the F2 (for detailed references see: Maxted *et al.*, 1991; Hanelt & Mettin, 1989).

If the gene pool concept of Harlan & De Wet is applied to *V.narbonensis* and its close relatives, it appears that: accessions of a variety are within GP1A, the five varieties of *V.narbonensis* lie in GP1B, the six species of the section lie in GP2, and the other *Vicia* species (including *V.faba*) are in GP3.

3 EARLY HISTORY

V. narbonensis is difficult to distinguish from *V. faba* in the archaeological record, unless pods are present (Zohary & Hopf, 1988). Therefore, we have no clear indication of its earliest cultivation or domestication. The earliest evidence for the cultivation of faba beans comes from Jericho dating back to 5000 B.C., and the oldest finds on the Iberian Peninsula can be traced to 3000 B.C.. Large-seededness in the faba bean developed relatively recently, for all archaeological finds from ancient sites belong to var. *minor*. A find made in Iraq and dated to A.D. 1000 is the first archaeological record of larger seeds. The seed size of the larger-seeded accessions of *V. narbonensis* approaches that of the smaller seeded faba beans. Thus, *V. narbonensis* which in its plant habit also resembles faba beans, could be considered a mimic of that crop.

The Nabathean book of Agriculture (ca. 4th century A.D., Iraq) cited by the 12th century Andalusian agriculturalist Ibn Al-Awam described a plant resembling faba beans with black odoriferous seeds. Ibn Al-Awam advised that this weed should be removed from the bean fields and used as a manure.

Pre-Linnaean botanists were familar with the otherwise rare *V. narbonensis* from their gardens and grew it for reasons of curiosity and delight in the study of herbs, but no useful properties were ascribed to it. It appears that the plant material available to most botanists at the time was black-seeded and of unpleasant, sulfurous taste. In Belgium, Dodoens (1583) noted that "if the seed is chewed it filleth the mouth full of stinking matter".

Camerarius (1586) described the taste of the seed as similar to that of broad beans. This judgement may be based on sampling the ripening seeds which, despite the garlic flavour, have a much sweeter, agreeable taste than the dried ones. From the accompanying illustration, his specimen can be clearly identified as the large-seeded var.*aegyptica* and he mentions that this plant grew, conspicuously abundant, in some parts of Southern Italy, near Naples on the promonotory of Misenum and in the fields of Apulia.

According to Gerarde (1636) the "blacke beane" or *Faba sylvestris* was regarded by some botanists to be the true "Physicke Beane of the Ancients", described in the herbal of Dioscorides.

They therefore named it *Faba Veterum* and also *Faba Graecorum*, or the "Greeke beane". A comparison of the pharmacological properties of *V. narbonensis* with those of *V. faba* might clarify whether or not early herbal remedies made use of the garlic like tasting, sulfurous constituents of the narbon bean.

The use of forage and grain legumes in European agriculture, gained new momentum from the time of the reformation in the 16th century, when protestant priests had to turn to agriculture for sustenance. As humanists they were able to read the works of roman agriculturalists such as Cato, Varro and Columella, and adopted the sowing of legumes to improve soil fertility. As a consequence, a wide variety of new legume crops were advocated in the so called "Hausvater" (Home father) literature which aimed at educating farmers to adopt more profitable farming practices. It is thus not surprising that a multitude of new crops appeared. By the end of the 18th century they had become widely disseminated.

4. RECENT HISTORY

Definitive agricultural information about *V. narbonensis* is given by Lawson (1836) who reported that it was cultivated in Germany and other parts of the continent as a substitute for common vetch (*V. sativa*). Under Scottish conditions, if sown in autumn, it yields a close-growing crop of succulent fodder due to its fast growth in the early spring months. The strong beany taste of the leaves is at first not well liked by cattle but during spring the cattle are much fonder of it due to the lack of other, better tasting feeds, such as clover.

During the 19th century cultivated and wild varieties of *V. narbonensis* are distinguished in the agricultural literature. The utilization of *V. narbonensis* var. *culta* Alefeld was similar to that of common vetch, but for favourable development it was known to demand more warmth, giving in exchange more pods and herbage. The plant was also known as an escapee from cultivation, indicating its potential to naturalize.

For Australia, the use of *V. narbonensis* from Southern Europe and South-West Asia for human consumption was advocated by the german botanist Baron von Mueller, who found it to be preferable to *V. faba* for the table because the somewhat smaller seeds were less bitter. Cultivars of *V. narbonensis* could be obtained through the seed trade and were commonly listed in catalogues of the major seed merchants. However, its use as a forage crop declined towards the end of the 19th century.

Becker-Dillingen (1926) gives data on agronomy of *V. narbonensis*, citing Fruwirth's work in Vienna and he recommends the plant as feed for cattle.

The eminent geneticist, Vavilov used *V. narbonensis* as an example of a secondary crop which had evolved from weed to cultivated plant, referring to the contrast between its weed and crop status in Spain and Italy, respectively.

With respect to it being considered as a weed in Spain, however, it is curious that Mateo Box (1961) describes the cultivation of this plant in some detail: As a forage plant, *V. narbonensis* is best utilized in hot, dry and also mild climates; it is of excellent quality and much appreciated as fodder for all types of cattle. In mixtures with other vetches or with some cereal (barley or oats) it provides a good basis for silage, but only if it is cut at flowering and chopped well. In hot and dry regions it is an excellent legume for green manure. In those places where it is cultivated, the major reason for justifying its use in place of faba beans or common vetch is its major resistance to pests & diseases. The crushed grain is fed to cattle, especially calves. When fed to cows it imparts its peculiar flavour to the milk. Feed intake of farm animals may initially be reduced but cattle, better than sheep, pigs and fowls adapt quickly to diets containing the crushed grain.

Near Beja in the Alentejo region of Southern Portugal, *V.narbonensis* (local name: Faveta de Beja) has until recently been cultivated as a special feed for pigeons. The species grows in the regions of Tras-os Montes, Estremadura, Ribatejo and Alentejo.

Birch (1983) found useful levels of partial resistance to the black bean aphid (*Aphis fabae*) in *V. narbonensis* and *V. johannis*, which is influenced by the stage of growth and is found to a greater extent in *V. johannis*. Susceptibility increased from pre-flowering/bud formation to full flowering. It then decreased rapidly during pod formation, filling and maturity. *V. narbonensis* flowered earlier than the slower growing *V. johannis*, thus it was more susceptible to aphids. In addition, *V. johannis* is more densely covered with trichomes on the leaf lamina, veins, stem internodes and pods.

Trials at ICARDA in Syria and in Northern Iraq(Van der Veen, 1960) have established that crops of *V. narbonensis* are quite resistant to bird damage and this may be due to its un-palatability factor(see below).

The species is recognized as an invaluable crop in Turkey where it has been noted to be bruchid resistant and to survive temperatures of -30 deg C (Elçi, 1975, cited by Birch, 1983). Similar observations with respect to cold resistance have been made in Northern Iraq. By contrast, in Italy, *V. narbonensis* is known to be susceptible to cold winters, and Mateo-Box (1961) noted that the plant is able to withstand cold conditions in dry soils, but is adversely affected in the presence of too much moisture. Above ground parts of the plant may die off in cold winters, but in spring regrowth from the undamaged rootsystem occurs (Mateo-Box, 1961). There may be different ecotypes with varying degrees of cold tolerance. This could also depend on other environmental factors, such as nutrient status and degree of acclimatization. In addition, some of the cold resistant *V. narbonensis* lines could have been the more cold-adapted *V. johannis* .

Allden & Geytenbeek (1980) found that Merino sheep feeding solely on whole mature stands of a small and black-seeded, shattering line of *V. narbonensis* (RL140001) grew less wool than sheep feeding on *V. sativa* or *V. faba* controls. However, recent work at the University of Melbourne indicates that there is a potential utility for the grain of *Vicia narbonensis* as a supplemental feed for sheep, with no detrimental effect on wool growth. It appears that the lower palatability of its grain compared to that of peas ensures a more even consumption over time, especially when fed twice weekly, resulting in better utilization of the grain supplement (Jacques et al., 1991). The grain is suitable as a feed for cattle (Mateo Box, 1961; van der Veen, 1960) and thus provides an opportunity of increased ruminant production for mediterranean agriculture.

5 PROSPECTS

High grain yields (1.5-5.1 t/ha) can be obtained from *V. narbonensis* under dry mediterranean-type winter rainfall conditions (250-550mm/annum) as indicated by trials in Syria, Iraq, Cyprus, Turkey, France and Australia. In Turkey, as a result of research initiated by Ömer Tarman, the species has now been identified as the most promising crop among legumes in rotation with wheat, and interest in the crop has also been expressed in Cyprus (Droushiotis, pers. comm.). It obviously has the potential to play a more prominent role in the agriculture of regions with mediterranean type environments, particularly in areas where other non- cereals cannot be grown profitably.

Sources of resistance in existing germplasm to parasitic weeds, such as *Orobranche crenata*, to the major phytoparasitc nematodes (*Pratylenchus* spp., *Meloidogyne* spp., *Ditylenchus dipsaci*), to fungal diseases caused by *Aschocyta* spp. and *Botrytis* spp., as well as to insects and viruses should be identified and incorporated, if possible, into specific cultivars, in order to facilitate their use as phytosanitary crops in areas affected by such problems.

With the help of the observation by the late Dr. R.L. Davies that narbon beans are unpalatable to pigs (Georg, 1986), the isolation of the unpalatibility principle and the elucidation of its chemical structure was achieved in the laboratory of Dr.M.E.Tate. The garlic-like flavour, already described by the early botanists, is due to a cysteine containing dipeptide (Enneking *et al*., in prep.), which negatively affects feed intake in pigs. Diets containing 10 or 20% narbon beans

also depress the feed intake of chicken (Eason *et al.*, 1990) and this effect may be related to the presence of the cysteine peptide.

As the unpalatability of the grain is the only perceived obstacle towards creating major new markets for it as a monogastric feed, the fundamental data are now in place for the future development of *Vicia narbonensis* in this direction by overcoming the anti-feedant effect of the grain either by genetic or post-harvest modification.

The "raison d'ètre" of the unpalatability factor is presently unknown, but it is reasonable to assume that it conveys protection against pests (aphids) or predators (such as birds, rats, mice), so the feasibility of developing cultivars without this factor is going to depend on an analysis of the relative costs and benefits associated with its genetic removal. The alternative approach, if economically feasible, would be to improve the palatability of the grain prior to consumption, and this would maintain any possible protective benefits derived from the unpalatibility factor.

Due to its drought- and cold-tolerance, pest resistance and high seed yields *Vicia narbonensis* is well suited for cultivation as a grain legume in dry areas. The available information suggests that this crop is particularly suited for ruminant production and shows considerable promise for arable farming in areas with mediterranean type climate.

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