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This paper has been contributed in honor of Azaria Alon on the occasion of his 90th birthday.

Lathyrus clymenum L. in Israel: A "revival" of an ancient species

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ABSTRACT

Four populations of an annual *Lathyrus* species new to Israel have been found since 1999. Three of these are located in the Coastal Plain, the fourth in the Judean Mountains. All grow in more-or-less disturbed habitats. These populations were identified by us as *Lathyrus clymenum* and compared with related or similar species to verify the identification. *L. clymenum* is a minor crop, grown mainly in some central Mediterranean and south European countries, but it was used for food, and traded as such, already over 3,750 years ago. Archaeobotanical findings of its seeds were discovered in the northern coast of Israel (Middle Bronze Age IIA). These findings were compared with recent material. The possibilities of its re-appearance in Israel, as escaped plants or colonizers/invaders, are discussed.

Keywords: *Lathyrus clymenum*, *Lathyrus palustris*, old and new introductions, invasive plants

INTRODUCTION

A *Lathyrus* species new to Israel has been found in four sites in Israel, three of them in the Coastal Plain and the fourth in the Judean Mountains (Table 1, Fig. 1). The first population was located in spring, 1999 "on garden irrigation drip-off in the shade of pine forest" near Moza Illit, by Avinoam Danin. This population was misidentified as *L. palustris* L. and consequently was later recorded as such in the flora of Israel (Danin, 2004), until 2008 when it was reexamined by us. The first population to be identified as *L. clymenum* L. was found in April 2005 by one of the authors in Zahala, north of Tel Aviv in the Sharon Plain. Here it grows on brown-red sandy soil near an abandoned orange orchard. Two additional populations have been located in the Philistean Plain. One, in southern Gedera on a distributed brown-red soil near dumps (March 2008), and another in Kefar Azar, climbing on a fence around young olive orchards and between the olive trees (April 2008). As observed by us, the populations are well-established and seemingly persistent in their sites.

Our aims in this study have been (a) to determine and verify the systematic identification of this newly found legume, and (b) to compare the new species with related species and archaeological findings.

TAXONOMY, DISTRIBUTION, AND USAGE

Meticulous taxonomic comparisons, based on examinations of relevant literature (e.g., Ball, 1968; Davis, 1970; Kupicha, 1983; Talavera et al., 1999) and plant specimens at the Herbarium of the Hebrew University, led us to identify the plants of the four populations as belonging to *L. clymenum* (Spanish vetchling).

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Table 1
Lathyrus clymenum populations in Israel

Location	Habitat	Estimated no. of plants	Observer and date
Gedera junction, Philistean Plain 31°48′17″N 34°45′54″E	Ruderal vegetation, near dump on brown-red sandy soil. 70 m asl	>50	Y. Melamed, 7 March 2008
Kefar Azar, Philistean Plain 32°03′29″N 34°50′19″E	Fence around olive orchard. 40 m asl	±100	A. Mendelson, 9 April 2008
Moza, Judean Mountains 31°47′36″N 35°09′03″E	On garden irrigation drip-off in the shade of pine forests mixed in disturbed batha. 700 m asl	>200	A. Danin, March, 1999 U. Plitmann, 15 May 2008
Zahala, Sharon Plain 32°07′50″N 35°50′01″E	Abandoned orchard. 60 m asl	±30	O. Golan, 20 April 2005

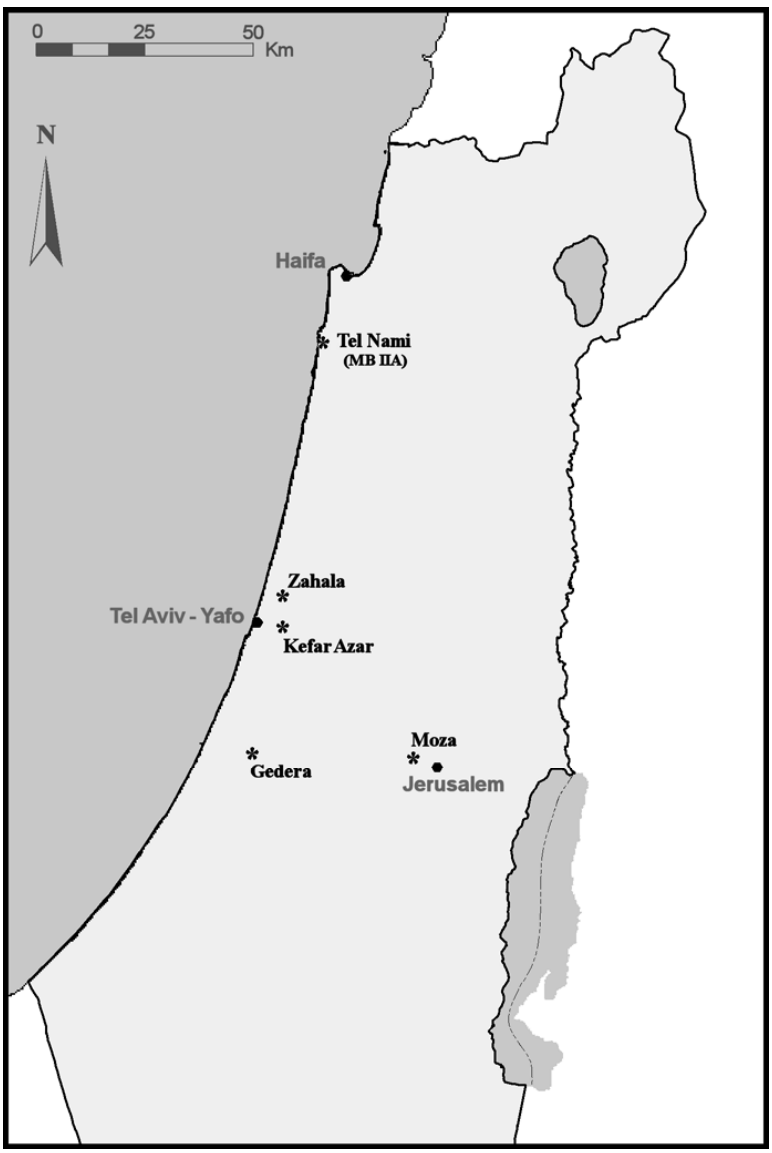

Fig. 1. The sites of *Lathyrus clymenum* in Israel.

Table 2
The differences between *L. clymenum* and *L. palustris* (according to Ball, 1968; Davis, 1970; and own measurements)

	L. clymenum	*L. palustris*
Life form	Annual	Perennial
Stem	Broadly winged stems	Narrowly winged (subsp. *palustris*) or sometimes not winged (subsp. *nudicaulis*)
Leaves	The lowest entire, oblong-lanceolate, mostly mucrunate; the median and the upper with a winged rachis, 2–4(–5) pairs of linear-oblong or linear leaflets, 15–50 × 1.5–7 mm	All (incl. the lower) with 1 or more pairs of oblong elliptic leaflets
Stipule	Semi-hastate	Semi-sagittate
Flowers	1–4 (–5) in a raceme. Corolla crimson with violet, lilac, or, rarely, pink or white wings—very rarely, pale yellow, 15–20 mm in length	(2–)3–7(–8) in a raceme. Corolla purplish-blue, purple (Davis, 1970), or bright red-purple (subsp. *nudicaulis*), 12–20 mm in length
Calyx	5–7 mm teeth sub-equal, shorter than tube	8–9 mm unequal, the lower is longer, usually about as long as the tube
Flowering	March–May (–June)	June–July
Legume	Linear-oblong, 30–70 × 5–12 mm	Linear, straight, 25–60 × (5–)7–9 mm

L. clymenum resembles in morphology two taxa in particular, namely, *L. ochrus* (L.) DC. and *L. palustris*. *L. clymenum* and *L. ochrus* are included in section Clymenum by Kupicha (1983) who, erroneously, included *L. gloeospermus* Warb. & Eig in this section. The main characters of this section are phyllodic lower leaves, pinnate upper leaves with broadly winged petiole and rachis, glabrous legume with the dorsal suture broadly or narrowly 2-winged (Davis, 1970). The genetic proximity between *L. clymenum* and *L. ochrus* (but not with *L. gleospermus*) was shown by chloroplast DNA phylogeny (Asmussen and Liston, 1998). *L. articulatus* *L.* and *L. clymenum* were once considered as two separate species (Ball, 1968), but Davis (1970) stated that plants of *L. clymenum* and *L. articulatus* could not be distinguished as different species in the Mediterranean. Thus, Greuter et al. (1989) included it, as well as the once accepted species *L. coerulescens* Boiss. & Reuter, endemic to Morocco, in *L. clymenum*.

The second similar species, *L. palustris*, is a Euro–Siberian–Irano–Turanian species that belongs to another group of the genus, section Orobus. Nevertheless, phenetically it is rather similar to *L. clymenum*, which may cause misidentification. The differences between these two taxa are summarized in Table 2. Note that the plants in the populations of Israel feature traits that characterize *L. clymenum*: Annual; the lowest leaves are oblong-lanceolate, entire, without leaflets; the stipules are semi-hastate; calyx teeth are subequal; the pod linear, straight, 52–80 × 8–9 mm.

Since the ancient records of *L. clymenum* in the Mediterranean basin were identified by seed morphology, we have paid particular attention to the seeds in our material (Fig. 2). A detailed description of the seeds of *L. clymenum* was made by Kislev et al. (1993). The seeds are variable in size and length/breadth ratio, even in the same pod. Generally, their shape is more or less laterally compressed; the dorsal side is rounded, attenuated, or carinated. Their carinated dorsal side and the biconvex (like lentil) faces in cross section distinguish them from comparable seeds of other Vicieae. The average size of the seeds (7.13 × 6.02 × 4.51 mm, N = 66) in the Israeli populations is larger than that of the archaeobotanical remains in which the seeds lost their coat and their size reduced during the charring process.

Preliminary germinability experiments, in Petri dishes, showed that germination of scarified seeds reached 100% (11 out of 11), whereas the germination of intact seeds was 4.6% (N = 11 × 2, SE = 0.9).

L. clymenum is native to the Mediterranean islands and southern Europe (from central and northwest Anatolia to the Iberian Peninsula) and northern Africa (from northeast Libya to Morocco). Its natural habitats are mostly rocky cliffs, stony slopes, taluses, crannies, amongst maquis or phrygana vegetation (Jafri, 1980; Talavera et al., 1999). In other areas, such as the Azores, Madeira, and the Canary Islands, Lebanon–Syria, as well as in western Europe, it grows either as an introduced and cultivated, or as an escaped, feral, or weedy

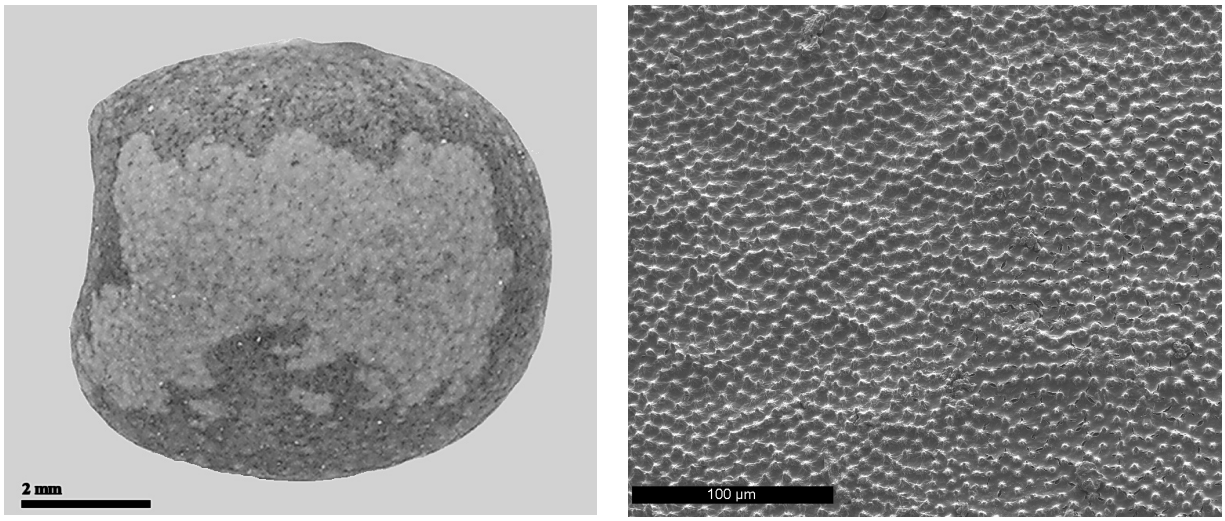

Fig. 2. *Lathyrus clymenum* seed from Gedera population. (a) Lateral view; on the upper edge, the hilum is seen on the left side and the halaza in the middle. (b) SEM of coat-surface on the lateral side of the seed, with texture typical of the group.

species (Ball, 1968; Davis, 1970; Greuter et al., 1989; Heller and Heyn, 1990). A noteworthy record is that from Japan where it is considered as a potential invasive species (Mito and Uesugi, 2004).

L. clymenum has been known as a fodder crop in southern Europe (Uphof, 1968; Halstead and Jones, 1989). It has been occasionally and locally cultivated in the western Mediterranean countries, where its seeds are consumed by humans as a pulse. Likewise, it is grown for human consumption on the Cycladic Islands of Thera (Santorini) and Anafi, as well as the southern Aegean Island of Karpathos. According to Sarpaki (1990), in Thera, the seeds are considered a staple food by the inhabitants (and see also, Halstead and Jones, 1989). Like many other legumes, the seeds are protein-rich and have considerable nutritional value. However, it is an uncommon pulse crop elsewhere since the seeds are toxic and may cause, in certain circumstances, a serious disease when eaten by man or domestic animals in large quantities, owing to the presence of a high concentration of α-amino-β-oxalylamino-propionic acid, found in several species of *Lathyrus*. This non-protein amino acid causes the classical lathyrism (Bell, 1971). For instance, during the 19th and the 20th centuries, *L. clymenum* was grown in the region of Salerno, southern Italy. Flour from its seeds was utilized in special dishes, or was mixed with wheat flour in various ratios for baking bread. During the 1870s, when its consumption was expanded due to food shortage in that region, many peasants exhibited irreversible difficulties in walking (Visco, 1924), which are typical symptoms of lathyrism.

ARCHAEOBOTANICAL FINDINGS

Generally, the archaeobotanical records of *L. clymenum* are rather rare and restricted to the Eastern Mediterranean basin. Seed remains of *L. clymenum* were found and identified in Tel Nami, on the northern coast of Israel, in excavations of a Middle Bronze IIA storage room (1,950–1,750 BCE) (Kislev et al., 1993). All other sites are located in the Aegean Sea area. The largest archaeobotanical sample of this crop was found in the archaeological site Yenibademli Höyük (Gökçeada), western Turkey, where a very large amount of seeds, radiocarbon-dated to ca. 2,900–2,700 BCE, was found on a house floor together with a few seeds of *Lathyrus sativus*/*cicera*, *Lens culinaris* Medic., and *Vicia ervilia* (L.) Willd (Oybak Dönmez, 2005). The second record in the Aegean Sea area is that of Akrotiri, Thera. A large quantity of seed remains was found in storage jars in an excavated house that had been destroyed in 1,628 BCE in the volcanic eruption of Thera (Manning, 1988; Sarpaki and Jones, 1990). Following this finding, seeds from a Late Minoan II house at Knossos, Crete (Jones, 1984) and probably from Phylakopi, Melos (Late Minoan, 1,600–1,100 BCE) were also identified as *L. clymenum* (Sarpaki and Jones, 1990). In the coastal settlement Tel Nami, 259 seeds were found in situ in four storage jars, as well as many seeds scattered on the floor of two storerooms. This finding was interpreted as evidence for regular import from the Aegean Islands (Kislev et al., 1993). These archaeological discoveries suggest that in the Bronze Age this legume was traded in the Aegean Islands and was exported to other Eastern Mediterranean

areas such as the southern coast of the Levant (Kislev et al., 1993; Oybak Dönmez, 2005). Altogether, it may explain the occurrence of *L. clymenum* in Israel in ancient times, but not its reappearance at present.

DISCUSSION

Lathyrus clymenum plants have been recorded in Israel since 1999. Their identification has been verified by us. The Moza population is known to have survived for at least 9 years, and is seemingly expanding. The three other new populations were found later, growing in weedy or disturbed habitats on the Coastal Plain. It should be noted that the flora of this area was thoroughly studied since the beginning of the 20th century (Eig et al., 1931, 1948; Post, 1932–1933; Eig, 1939) up to the intensive investigation of rare and endangered species of the coastal Plain during 1989–1994 (Shmida et al., 2002), with no record of *L. clymenum*. It is, therefore, very plausible that this species is indeed a recent introduction.

It is not clear how the first three populations have been established in their sites. However, as for the feral plants in the olive orchard at Kefar Azar, they had been sown by a gardener who considered the seeds to belong to sweet pea (*L. odoratus* L.). Although the difference between the seeds of the two species is recognizable, it is not easy for the layman to distinguish between them since, to some extent, they are roughly similar in size, shape, and color. We thus assume that, likewise, the seeds of the rest were mixed with imported leguminous ornamentals (e.g., *L. odoratus, L. latifolius* L.) or with seeds of forage/food crops (e.g., *L. sativus* L., *L. ochrus, Pisum sativum* L.) and eventually escaped from cultivation. Another possibility is that those seeds had been introduced by foreign workers who grew small gardens of exotic or useful plants near their temporary residence, a widespread phenomenon in the last decade.

The distribution pattern of this species in Israel and the man-disturbed habitats it occupies, may suggest human introduction of a colonizer. Further investigation is needed to find evidence for the actual way of introduction.

L. clymenum features certain characteristics of a colonizer: Short life cycle, large biomass, self-pollination, high fertility and seed-set, phenotypic plasticity, as well as fitness to a wide range of habitats. Its low germinability allows it to establish a large seed-bank in the soil, as well as to intermittently germinate in unpredictable conditions. All these pre-adaptations are considered advantageous for colonizers and invasive plants (Baker, 1965; Burke and Grime, 1996). As noted, *L. clymenum* is already considered as a potential invasive species in Japan (Mito and Uesugi, 2004). However, the size of the Israeli populations, their restricted distribution, and the local persistence (e.g., of the Moza population) suggest that in Israel this species either does not behave as an aggressive invader or that it may be only at the beginning phase of an invasion process. However, in the years 2008 and 2009 we realized that the Moza population has indeed spread several kilometers eastward. Besides, the fact that we have no evidence for invasion of *L. clymenum* since the Middle Bronze Age, when it had such an opportunity, should be taken into consideration.

Currently, it seems that the Zahala and Kefar Azar populations are endangered since they grow in the middle of crowded urban areas. An extinction of *L. clymenum* is recorded from Kazakhstan, where it was known as a casual alien growing in man-made habitats of a modern urban landscape (Pyšek et al., 2002). In Israel, the populations were actually found in habitats favorable for colonizers (e.g., the disturbed edges of rural areas) and thus may have a better chance to survive and to spread. If these populations would function as invasive, it may provide us with an opportunity to record and investigate the first stage of invasion. Better understanding of this initial stage is an important step to gaining the ability to control invasive plants (Kolar and Lodge, 2001).

In May 2009, unfamiliar *Lathyrus* plants were reported by Simon Cohen-Sivan and Yoav Gertman, climbing on the fence of a small garden in Neve Ativ, 980 m asl on Mt. Hermon. After visiting in Neve Ativ and collecting a specimen with speeds, we have identified it once more as *Lathyrus clymenum*.

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