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A PHENETIC INVESTIGATION OF VICIA SECTION HYPECHUSA (ALEF.) ASCHERS. & GRAEBNER (LEGUMINOSAE, PAPILIONOIDEAE, VICIEAE)

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Abstract

The taxonomic relationships between the taxa of *Vicia* L. section *Hypechusa* (Alef.) Asch. & Graebner have been studied using phenetic techniques. Morphological data were gathered from 464 herbarium specimens representing the taxa of the section. Specimens were scored for 43 vegetative, 84 inflorescence, 23 legume and 24 seed characters. The data were analysed using cluster analysis and ordination techniques. The analysis results are considered in conjunction with a literature review of the taxonomic history, cytology, phytogeography, and ecology of the taxa involved. A classification is proposed in which the eighteen taxa are divided into two series, *Hyrcanicae* B. Fedtsch. ex Radzhi and *Hypechusa*. This classification is discussed in relation to previous placements of *Hypechusa* within the Vicieae. A key to the two series, and 18 species and subspecific taxa is provided.

Introduction

The genus *Vicia* L. (Leguminosae, Vicieae) comprises approximately 170 species (ALLKIN & al., 1986), chiefly located in Europe, Asia and North America, but extend to temperate South America and tropical East Africa. The genus was revised by KUPICHA (1976), who divided the species into two subgenera, *Vicilla* (Schur) Rouy in Rouy & Fouc. and *Vicia*, and 22 sections. Within subgenus *Vicia*, she included five sections: *Atossa* (Alef.) Aschers. & Graebner, *Vicia*, *Faba* (Miller) Ledeb., *Hypechusa* (Alef.) Aschers. & Graebner, and *Peregrinae* Kupicha. The twenty first and largest section she circumscribed within subgenus *Vicia* was sect. *Hypechusa*. Kupicha's conception of sect. *Hypechusa* is derived from the genus *Hypechusa* erected by ALEFELD (1860). Alefeld noted that this group of *Vicia* have the seed lens placed on the seed circumference opposite the hilum, not adjacent to the hilum as in the other subgenus *Vicia* sections. Kupicha included twelve species in the section: *V. anatolica* Turrill, *V. assyriaca* Boiss., *V. ciliatula* Lipsky, *V. esdraelonensis* Warb., *V. galeata* Boiss., *V. hybrida* L., *V. hyrcanica* Fisch. & C.A. Mey., *V. lutea* L., *V. melanops* Sibth. & Sm., *V. noeana* Reuter ex Boiss., *V. pannonica* Crantz and *V. sericocarpa* Fenzl. KUPICHA (1976) provided the following diagnostic description for the section: "Annual; calyx irregular; inflorescence 1–many–flowered, vexillum oblong or stenonychioid [i.e. banner wider than the claw]; suture of legume not parallel; lens of seed opposite hilum"

MAXTED (1991) undertook a revision of *Vicia* subgenus *Vicia* and added two further species to sect. *Hypechusa*, *V. mollis* Boiss. & Hausskn. ex Boiss. and *V. tigridis* Mouterde. Kupicha placed *V. mollis* in sect. *Peregrinae*. Although she suggested there was a close alliance between her sects. *Hypechusa* and *Peregrinae*, the two could be clearly differentiated by the presence of 1–4 flowers per inflorescence, the seed lens being placed on the circumference opposite the hilum and the inflorescence being pedunculate in *Hypechusa* but not in *Peregrinae*. *V. mollis* does not fit within the circumscription Kupicha provides for sect. *Peregrinae*. *V. mollis* can have two flowers per inflorescence, has an obsolescent peduncle, has a relatively short pedicel (compared to the other three species of sect. *Peregrinae*) and the seed lens is always found opposite the hilum. On the basis of a morphological study combined with information taken from the literature, MAXTED (1994) transferred *V. mollis* to sect. *Hypechusa* and therefore the species is included in this study. The second species added to those circumscribed by Kupicha is *V. tigridis* Mouterde. This species is a rare endemic of Eastern Syria, it was unknown to Kupicha (pers. comm.), but on the basis of her diagnosis of sect. *Hypechusa* is a natural member of this section.

The fourteen species circumscribed here are endemic to West and Southern Europe, North Africa and South–west Asia eastward to Pakistan, although specific variation is concentrated in South–west Asia, as is indicated by the isoflor map drawn in Figure 1. Two section *Hypechusa* species are of notable agricultural use; *V. noeana* and *V. pannonica* (DUKE, 1981). *V. noeana* is grown as fodder and forage in the Eastern Mediterranean (USHER, 1974; EHRMAN & MAXTED, 1990). *V. pannonica* has recently become commercially important in the United States, on account of its seed hardiness; the species is cold tolerant to −18°C and is able to withstand heavy or clay soils better than other vetches in wet conditions. In Europe and America the green plant is used for hay, silage, green manure, pasture and the seed is incorporated in mixed ground feeds. A third species, *V. hyrcanica*, has revealed specific seed lectins that may have future applications in medical research and specifically haematology (LIEW & BIRD, 1988).

Following her revision, KUPICHA (1976) concluded that sect. *Hypechusa* requires further study and possibly subdivision. Having established that sect. *Hypechusa* does form a cohesive taxonomic unit, at least as compared with the other *Vicia* sections (MAXTED, 1993), the question at the sectional level has been answered. The seed lens placed on the seed circumference opposite the hilum is unique to this section and provides a reliable diagnostic character for distinguishing taxa of this section. KUPICHA (1975) also noted a more obscure character that was unique to this group of *Vicia*. Following an investigation of *Vicia* vascular anatomy, she found that sect. *Hypechusa* species have only partial replacement of cortical bundles at each node. MAXTED (1995) found a third character, each taxon of the section has a basal kinking of the wing petal not found in other *Vicia*. The existence of these three characteristics has obvious phylogenetic implications, reiterating that the sect. *Hypechusa* taxa do form a natural, cohesive grouping within subgenus *Vicia*. Therefore, the general aim of this research was to clarify the relationships between the taxa within sect. *Hypechusa*, determine whether the species and infra–specific taxa included are natural and establish if the section does require sub–division.

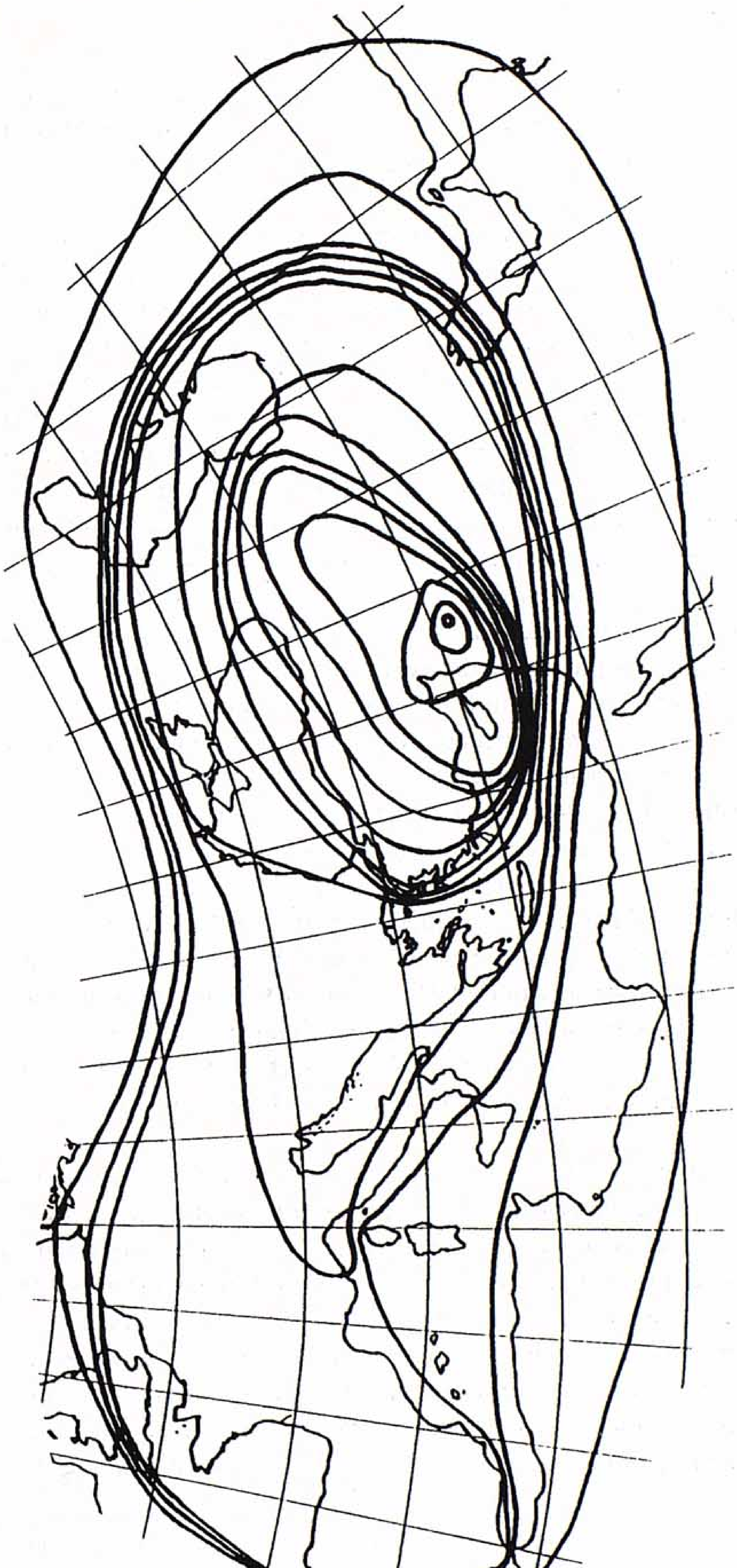

Fig. 1. Isoflor map for *Vicia* section *Hypechusa*.

Taxonomic history

The taxonomic history of *Vicia* is extensive and contentious, there being 20 major classifications of the group produced since the work of Linnaeus (MAXTED, 1993, 1995). The major classifications, including sect *Hypechusa* taxa, are summarised in Table 1.

LINNAEUS (1753) recognised two groupings within *Vicia*. His second grouping, "*floribus axillaribus, subsessilibus*", is equivalent to subgenus *Vicia* and within this grouping he recognises two sect. *Hypechusa* taxa, *V. hybrida* and *V. lutea*. The first detailed concept of intra–generic patterns in *Vicia* was produced by ALEFELD (1859, 1860, 1861a, b & c). One group he identified and raised to generic level was *Hypechusa* (ALEFELD, 1860). He combined established 'good' characters, such as, relative peduncle length and numbers of flowers per inflorescence, with relative seed hilum to lens position on the circumference of the seed to define his genus *Hypechusa*. He included six currently accepted (MAXTED, 1993) sect. *Hypechusa* species in two subgenera. He divides *V. hybrida* into a monospecific subgenus *Masarunia* Alef. (ALEFELD, 1861a) and places *V. pannonica*, *V. hyrcanica*, *V. lutea*, *V. sericocarpa* and *V. melanops* in the other subgenus. He does not elaborate on the necessity of the two subgenera.

BOISSIER (1872) also presents a detailed supra–generic classification of *Vicia*. He uses the relative seed lens to hilum position on the circumference of the seed to distinguish the sect. *Hypechusa* species from other *Vicia*. Within this group, he does not use formal taxonomic ranks but splits the species into three groups: the species with a pubescent vexillum, *V. pannonica* and *V. hybrida*; then the species without a pubescent vexillum are divided on the basis of legume pubescence, *V. lutea* and *V. sericocarpa* have pubescent legumes and *V. melanops*, *V. hyrcanica*, *V. galeata*, *V. assyriaca* and *V. noeana* have glabrous legumes. He excludes *V. mollis*, mistakenly on the basis of his own criterion, from this grouping and groups it with the sect. *Peregrinae* species *sensu* Kupicha. In a broad circumscription of *Hypechusa*, ASCHERSON & GRAEBNER (1909) include four *sensu* Kupicha sections, *Vicia*, *Faba*, *Hypechusa* and *Peregrinae*. Within this grouping of undefined taxonomic rank, the sect. *Hypechusa* taxa included are grouped into one subgroup, but are not distinguished from the other sect. *Vicia* taxa also included.

In his treatment of *Vicia* for the Flora of the U.S.S.R. FEDTSCHENKO (1948) placed the subgenus *Vicia* species into eleven series within his section *Euvicia*. He does not use the relative seed hilum to lens position character to group the species of the section, but using a combination of other characters split the sect. *Hypechusa* species into three series: *Hyrcanicae* B. Fedtsch., containing *V. hyrcanica*; *Luteae* B. Fedtsch., containing *V. lutea*; and *Hybridae* B. Fedtsch. containing *V. hybrida*, *V. anatolica* (syn. *V. hajastana* Grossh.), *V. pannonica* and *V. ciliatula*. He failed to provide a Latin diagnosis for these series and it was left to RADZHI (1971) to legitimately published the names.

PLITMANN (1967) proposed a detailed classification of the annual *Vicia* of the Middle East, using ten supra–specific taxa to group the 30 subgenus *Vicia* included. His conception is broadly similar to that of Fedtschenko, but Plitmann divides the sect. *Hypechusa* species into four series: *Hyrcanicae* containing *V. hyrcanica*, *V. assyriaca*, *V. galeata*, *V. melanops* and *V. noeana*; *Luteae* containing *V. lutea*; *Sericocarpae*

Author	Linnaeus (1753)	Alefeld (1860, 1861a)	Boissier (1872)	Ascherson & Graebner (1909)
Taxa	*Floribus axillaribus, subssessilibus*	**Genus *Hypechusa* Alef.**	**a. *Vexillum hirsutum***	**Subgen.** *Hypechusa* **Alef.**
Included		**Subgen. *Masarunia* Alef.**	*V. pannonica* Jacq.	**1. Perennes Nyman**
	V. lutea L.	*H. hybrida* Alef.	*V. hybrida* L.	*V. truncatula* Fisch. *
	V. hybrida L.	(*Vicia hybrida* L.)		*V. pyrenaica* Pourr. *
			b. *Vexillum glabrum*	**2. *Annuae* Nyman**
		Subgen. *Euhypechusa* Alef.	**X *Legumen hirsutum***	**a.**
		H. purpurascens Alef.	*V. lutea* L.	*V. lathyroides* L. *
		(*V. pannonica* Crantz)	*V. sericocarpa* Fenzl	*V. melanops* Sibth. & Sim.
		H. pannonica Alef.		*V. noeana* Reut. in Boiss.
		(*V. pannonica* Crantz)	**XX *Legumen glabrum***	*V. sativa* L. *
		H. hircania Alef.	*V. melanops* Sibth. & Sm.	*V. peregrina* L. *
		(*V. hyrcaninca* Fisch. &	*V. hyrcanica* Fisch. &	*V. lutea* L.
		C.A. Mey.)	C.A. Mey	*V. hibrida* (V. hybrida L.)
		H. lutea Alef.	*V. galeata* Boiss.	*V. pannoninca* Crantz
		(*V. lutea* L.)	*V. assyriaca* Boiss.	**b.**
		H. sericocarpa Alef.	*V. noeana* Reut. in Boiss.	*V. bithynica* L. *
		(*V. sericocarpa* Fenzl)		*V. narbonensis* L. *
		H. tricolor Alef.		*V. serratifolia* Jacq. *
		(*V. melanops* Sibth. & Sm.)		

Table 1. Major classifications of *Vicia* section *Hypechusa* sensu Kupicha. Current accepted names are indicated in brackets for synonyms, non-*Hypechusa* taxa *sensu* Kupicha are marked with an asterisk.

Author	Fedtschenko (1948)	Plitmann (1967)	Radzhi (1971)	Kupicha (1976)
Taxa Included	**Ser. *Hyrcanicae* B. Fedtsch.** *V. hyrcaninca* Fisch. & C.A. Mey **Ser. *Peregrinae* B. Fedtsch** 4 taxa* **Ser. *Luteae* B. Fedtsch.** *V. lutea* L. **Ser. *Hybridae* B. Fedtsch.** *V. hybrida* L. *V. hajastana* Grossh. (*V. anatolica* Turrill) *V. pannonica* Crantz *V. ciliatula* Lipsky	**Sect. *Vicia*** **Ser. *Hyrcanicae*** *V. hyrcanica* Fisch. & C.A. Mey *V. assyriaca* Boiss. *V. galeata* Boiss. *V. melanops* Sibth. & Sm. *V. noeana* Reut. in Boiss. **Ser. *Peregrinae*** 3 taxa* **Ser. *Luteae*** *V. lutea* L. **Ser. *Sericocarpae*** *V. sericocarpa* Fenzl *V. bombycina* Stapf ex Post (*V. montbretii* Fisch. & C.A. *Mey.**) *V. mollis* Boiss. et Haussk *V. camptopoda* Townsend (*V. mollis* Boiss. & Haussk.) **Ser. *Hybridae*** *V. hybrida* L. *V. anatolica* Turrill *V. ciliatula* Lipsky *V. hajastana* Grossh. (*V. anatolica* Turrill) *V. pannonica* Crantz	**Subgen. *Vicia*** **Sect. *Vicia*** **Subsect. *Hybridae* Radzhi** **Ser. *Luteae* Radzhi** *V. lutea* L. **Ser. *Hyrcanincae* Radzhi** *V. hyrcanica* Fisch. & C. A. Mey **Ser. *Hybridae* Radzhi** *V. hybrida* L. *V. hajastana* Grossh. (*V. anatolica* Turrill) *V. pannonica* Crantz *V. ciliatula* Lipsky	**Subgen. *Hypechusa* Alef.** *V. anatolica* Turrill *V. assyriaca* Boiss. *V. ciliatula* Lipsky *V. esdraelonensis* Warb. *V. galeata* Boiss. *V. hybrida* L. *V. hyrcaninca* Fisch. & C.A. Mey *V. lutea* L. *V. melanops* Sibth. & Sm. *V. noeana* Reuter ex Boiss. *V. pannonica* Crantz *V. sericocarpa* Fenzl

Table 1. Continued.

containing *V. sericocarpa*, *V. bombycina* Stapf ex Post (accepted name *V. montbretii* Fisch. & C.A. Mey.), *V. mollis* and *V. camptopoda* Townsend (accepted name *V. mollis*); and *Hybridae* containing *V. hybrida*, *V. anatolica*, *V. ciliatula*, *V. hajastana* Grossh. (accepted name *V. anatolica*) and *V. pannonica*. The classification includes *V. montbretii*, which is clearly not a natural member of the subgenus *Vicia* (lacking the diagnostic nectariferous stipule) and excludes *V. esdraelonensis* from sect. *Vicia*. He commented on the latter that the authors of this species allied it to either the *V. peregrina* or *V. hyrcanica*. However, he believed it was a more natural ally of *V. cretica* in sect. *Cracca*. Subsequently, both these problems were rectified in his "Flora of Turkey" account (PLITMANN, 1970); *V. esdraelonensis* is placed between *V. galeata* and *V. hyrcanica*, and *V. monbretii* is excluded from *Vicia* altogether and placed in *Lens* as *L. monbretii* (Fisch. & Mey.) Davis & Plitm.

RADZHI (1971), as well as validly publishing the names proposed by FEDTSCHENKO (1948), groups three Fedtschenko series (sect. *Hypechusa sensu* Kupicha) into one distinct taxon. The majority of the subgenus *Vicia* species are placed in her sect. *Vicia* and this is subdivided into four subsections, all *Hypechusa sensu* Kupicha are placed in subsection *Hybridae* Radzhi. This subsection then contains the three series proposed by Fedtschenko.

ALEFELD (1860), BOISSIER (1872), FEDTSCHENKO (1948), PLITMANN (1976), RADZHI (1971) and KUPICHA (1976) group the *Hypechusa* species together either by placing them in adjoining supra-specific taxa or placing them all in a single taxon. In general, however, it is more common for subgroups within *Hypechusa* to be found rather than the group to appear as a whole. For example, the species with pubescent standards *V. hybrida*, *V. pannonica* and *V. anatolica* have often been grouped in regional Floras: KOCH (1836), ASCHERSON & GRAEBNER (1909), STANKEVICH (1970), CHRTKOVA–ZERTOVA (1979) & TZVELEV (1980).

Material and methods

The species included in this study were those recognised by KUPICHA (1976), plus the two added by MAXTED (1993). Kupicha does not include infra-specific taxa in her classification, however, infra-specific taxa are often distinguished and these were taken from ALLKIN & al. (1986). The study, therefore, included 18 species and subspecific taxa and 464 specimens attributable to these taxa were seen during the study. These taxa are listed in Table 2. Specimens were borrowed from BM, CAI, E, ERE, G, HUJ, K, LE, MO, MPU, OXF, RNG, W and WIR and these were used in conjunction with the fresh material collected by Maxted & al. and held at SPN (abbreviations follow HOLMGREN & al., 1990). A specimen list is provided in Appendix 1.

Each specimen (OTU) was scored, where possible, for 174 continuous or discrete variables including 43 vegetative, 84 inflorescence, 23 legume and 24 seed features. The full character list is provided in MAXTED (1993). The characters used in the study were selected from the literature: PLITMANN (1967, 1970), BALL (1968), GUNN (1970), GUNN & KLUVE (1976), KUPICHA (1974, 1976) and from personal observations of the material. The number of character states recognised was determined in such a way that

Taxon code	Taxon name
2	*V. anatolica* Turrill
3	*V. assyriaca* Boiss.
7	*V. ciliatula* Lipsky
9	*V. esdraelonensis* Warb. & Eig
15	*V. galeata* Boiss.
21	*V. hybrida* L.
22	*V. hyrcanica* Fisch. & C.A. Mey.
29	*V. lutea* L. subsp. *lutea*
31	*V. lutea* subsp. *vestita* (Boiss.) Rouy
33	*V. melanops* Sibth. & Sm. var. *melanops*
34	*V. melanops* var. *loiseaui* Alleiz.
36	*V. mollis* Boiss. & Haussk. ex Boiss.
44	*V. noeana* Boiss. & Reut. ex Boiss. subsp. *noeana*
45	*V. noeana* subsp. *megalodonta* Rech.f.
48	*V. pannonica* Crantz subsp. *pannonica*
49	*V. pannonica* subsp. *striata* (M. Bieb.) Nyman
63	*V. sericocarpa* Fenzl
69	*V. tigridis* Mouterde

Table 2. Alphabetical listing of *Vicia* section *Hypechusa* taxa included in this study. Taxon codes used during the analysis are those used by MAXTED (1991).

permitted the greatest separation of OTUs. The code of O was taken to represent missing data.

The investigation involved a relatively large data matrix of 464 specimens by 174 characters, which proved difficult to analyse fully as a single unit. Therefore, a taxon data set was derived from the specimen data set. For the taxon data set, the mode was calculated for each continuous character and the most common character state was used for the multistate characters. The mode was calculated by dividing the range into five equal bands, scoring the number of records that fell in each band and then using the mean figure for the most common band. This method of calculating the taxon scores implies a certain characteristic for the multistate data: that only one score is common, but this assumption is valid for the majority of characters and was therefore considered a satisfactory assumption for the analysis as a whole.

The program SPSS^x (NORUSIS, 1988), via procedure DISCRIMINANT, was used to calculate F-ratio values for each character in the specimen and taxon data sets. These were used to indicate each character's discriminating power. Sixty seven characters with relatively high F-ratio values were then used to undertake the specimen analysis. The phenetic characters and character states used in the phenetic analysis are listed in Appendix 2. The specimen data set was analysed using the program CLUSTAN (version 3.1) procedure CLUSTER (WISHART, 1987), the dissimilarity coefficient selected was the squared Euclidean distance which was then analysed using Ward's method of cluster analysis.

The F-ratio values produced using DISCRIMINANT were to select the characters of the taxon data sets. Twenty seven characters were selected for use in the taxon analysis. The taxon data set was initially analysed using the program LINKAGE (WIRTH & al., 1966), which undertakes single linkage (nearest neighbour) cluster analysis. CLUSTAN procedure CLUSTER was used to further analyse the taxon data set; squared Euclidean distance was calculated which was then analysed using centroid linkage cluster analysis. CLUSTAN (version 2.1) was used for the principal components analysis of the taxon data set. Multiple methods of analysis were used because, as pointed out by DUNCAN & BAUM (1981), different algorithms bias the results in different ways. The use of different methods of analysis allows the verification of the validity of the groups suggested by these analyses. All analyses were undertaken using the IBM 3090 mainframe computers at the Universities of Birmingham and Southampton, U.K.

Results

The results of the Ward's method of cluster analysis for the specimen data set are summarised in Figure 2, the original dendrogram being difficult to interpret because of the large number of specimens included in the analysis. The first point to note from the dendrogram is the formation of largely taxon based clusters at a dissimilarity level of 0.377, clusters which containing specimens of a single taxon. It can be seen that the figure indicates two distinct clusters of specimens. The first cluster contains: *V. anatolica*, *V. ciliatula*, *V. pannonica* subsp. *striata*, *V. pannonica* subsp. *pannonica*, *V. melanops* var. *melanops*, *V. melanops* var. *loiseaui*, *V. hybrida*, another group of *V. melanops* var. *melanops* specimens, *V. sericocarpa*, *V. assyriaca*, *V. mollis*. The majority of these taxa have narrow standards in comparison with the other major cluster. This cluster can be further splits into two subgroups, one containing *V. anatolica*, *V. ciliatula*, *V. pannonica* and *V. melanops*, and the second containing *V. hybrida*, *V. sericocarpa*, *V. assyriaca*, and *V. mollis*. The second major cluster contains the species with broader standards: an isolated cluster of *V. lutea* subsp. *lutea* and *V. lutea* subsp. *vestita*, and more closely related grouping of *V. hyrcanica*, *V. tigridis*, *V. noeana* subsp. *noeana*, *V. noeana* subsp. *megalodonta*, *V. esdraelonensis* and *V. galeata* specimens, the *V. noeana* species complex (MAXTED, 1993).

The results of the single linkage cluster analysis of the taxon data set using the program LINKAGE are displayed in the form of linkage diagrams, 17 diagrams for the taxon data set analysed. The diagrams are arranged in decreasing similarity from a similarity level of 0.8301 for the first inter-OTU link to 0.5402 when all the OTU's are joined in one cluster. The diagram most useful in explaining the relationships within the section is shown in Figure 3. The linkage diagram shows two clusters, which may be referred to the group with broad standards and the group with narrow standards, indicated by a filled triangle and an open triangle in subsequent figures. The first group with a relatively broad standard contains: *V. noeana* subsp. *noeana*, *V. noeana* subsp. *megalodonta*, *V. hyrcanica*, *V. tigridis*, *V. esdraelonensis*, *V. galeata* and *V. assyriaca*, while the group with the narrow standard contains *V. anatolica*, *V. ciliatula*, *V. hybrida*,

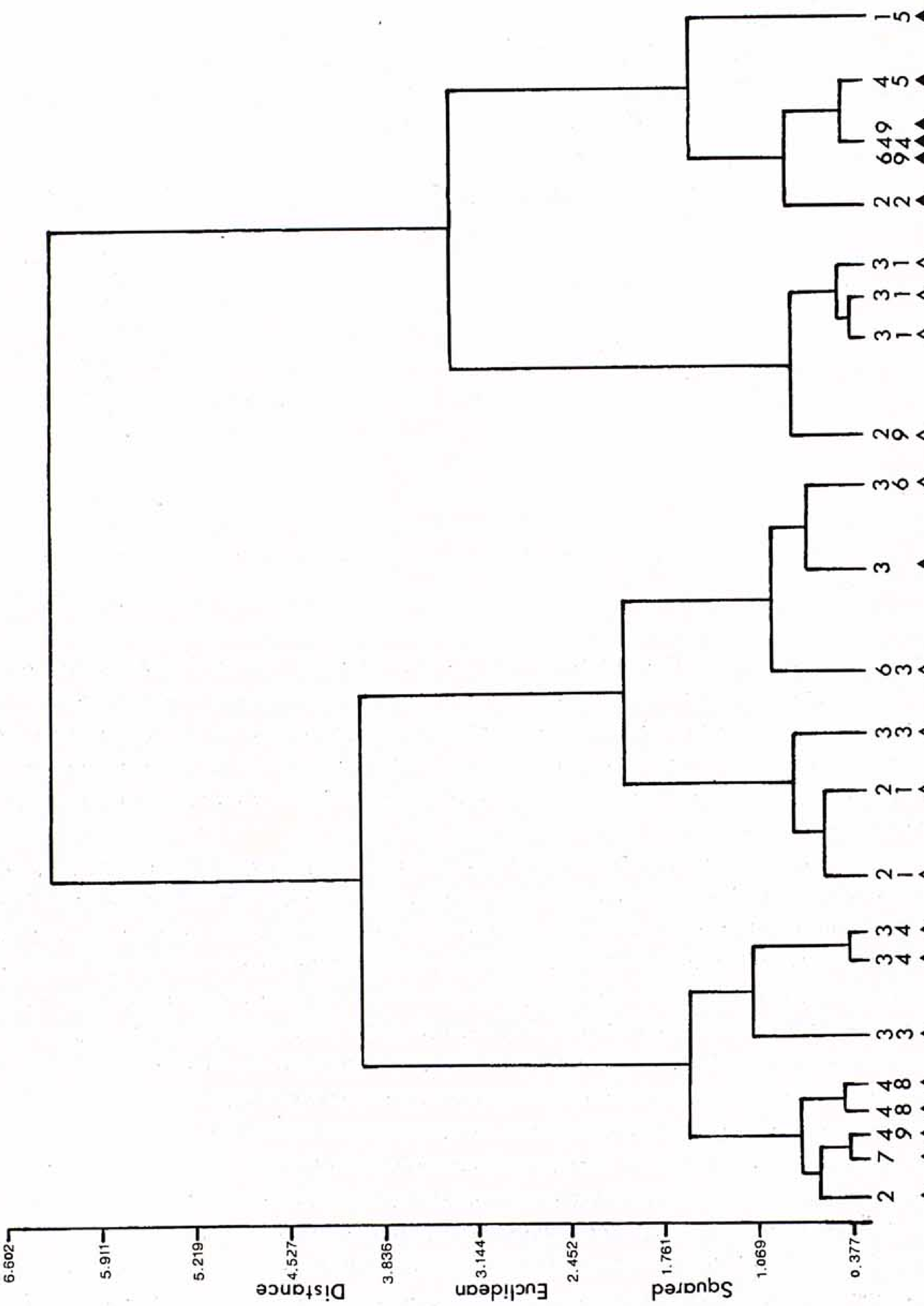

Fig. 2. Summary of Ward's Method of clustes analysis for the specimen data set.

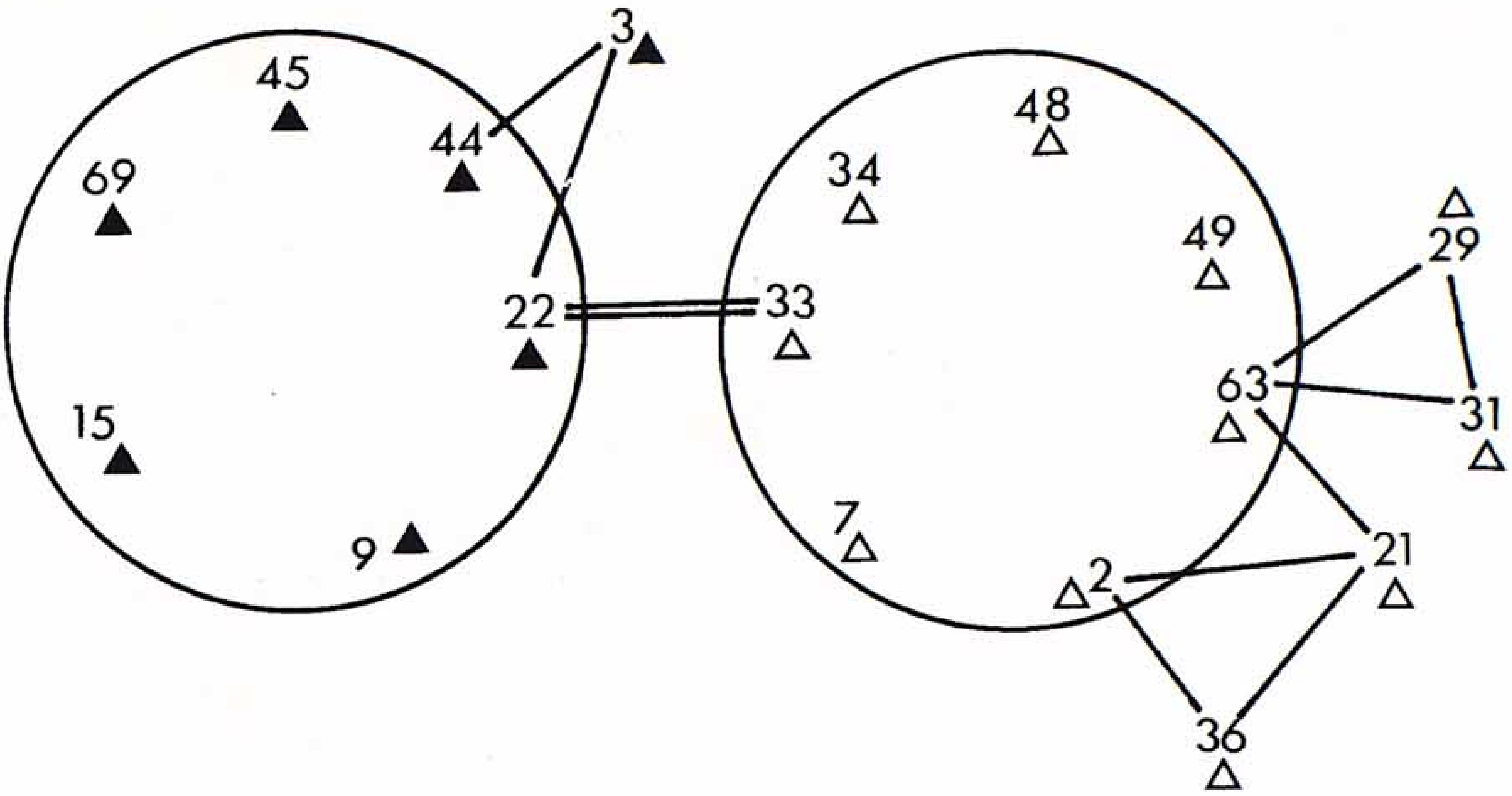

Fig. 3. Linkage diagram for *Vicia* section *Hypechusa* taxa using the taxon data set at a threshold similarity of 0.5402.

V. lutea subsp. *lutea*, *V. lutea* subsp. *vestita*, *V. melanops* var. *melanops*, *V. melanops* var. *loiseaui*, *V. mollis*, *V. pannonica* subsp. *pannonica*, *V. pannonica* subsp. *striata* and V. sericocarpa. The pattern of pair–wise clustering indicates that the taxa with a broader standard form a tighter cluster (with the exception of *V. assyriaca*), than the cluster containing the taxa with narrower standards, which indicates greater internal heterogeneity with the second group.

This pattern of relatedness is also reflected in the results of the average linkage cluster analysis shown in Figure 4. As with the single linkage analysis, the same two broad clusters of taxa are seen. *V. assyriaca* remains a peripheral member of the group with a relatively broad standard, but the group with narrower standards can be more easily subdivided into two or three subgroups. Notably one of these distinct subclusters contains all the species which have a wing apex spot, *V. anatolica* (2), *V. ciliatula* (7) and *V. melanops* (33 and 34). This analysis indicates a misleading separation of the two subspecies of *V. pannonica*, subsp. *striata* (49) and subsp. *pannonica* (48). These two subspecies are distinguished on the basis of corolla colour and size. Both these characters are included in the character set and it is likely that by using a relatively small character set of 27 characters, these characters are over weighted in comparison to the characters that would have united the two subspecies into one taxon.

The results of the principal components analysis are shown in Figure 5. The first two principal components are plotted and account for 40.84 and 12.36 percent of the variance respectively, which gives a cumulative variance of 53.21 percent. The two basic clusters can be identified and contain the same taxa as seen in the other methods of analysis. The group of taxa that have a broader standard can be seen to form a tighter cluster with the species previously peripheral, *V. assyriaca*, an integral member. The cluster containing the taxa with narrower standards is more disperse and reinforces the view that there is greater internal heterogeneity.

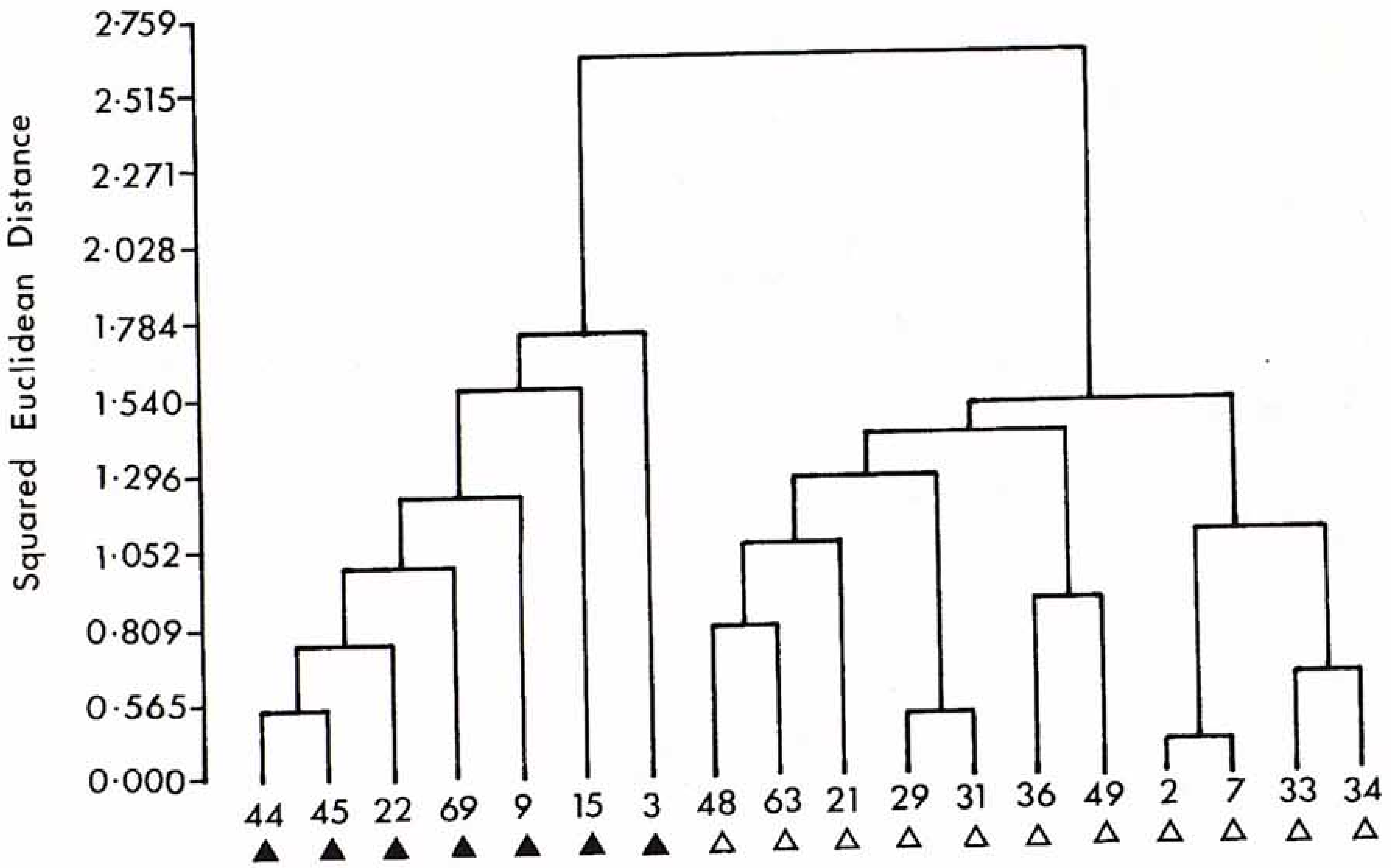

Fig. 4. Average linkage cluster analysis for *Vicia* section *Hypechusa* taxa using the taxon data set.

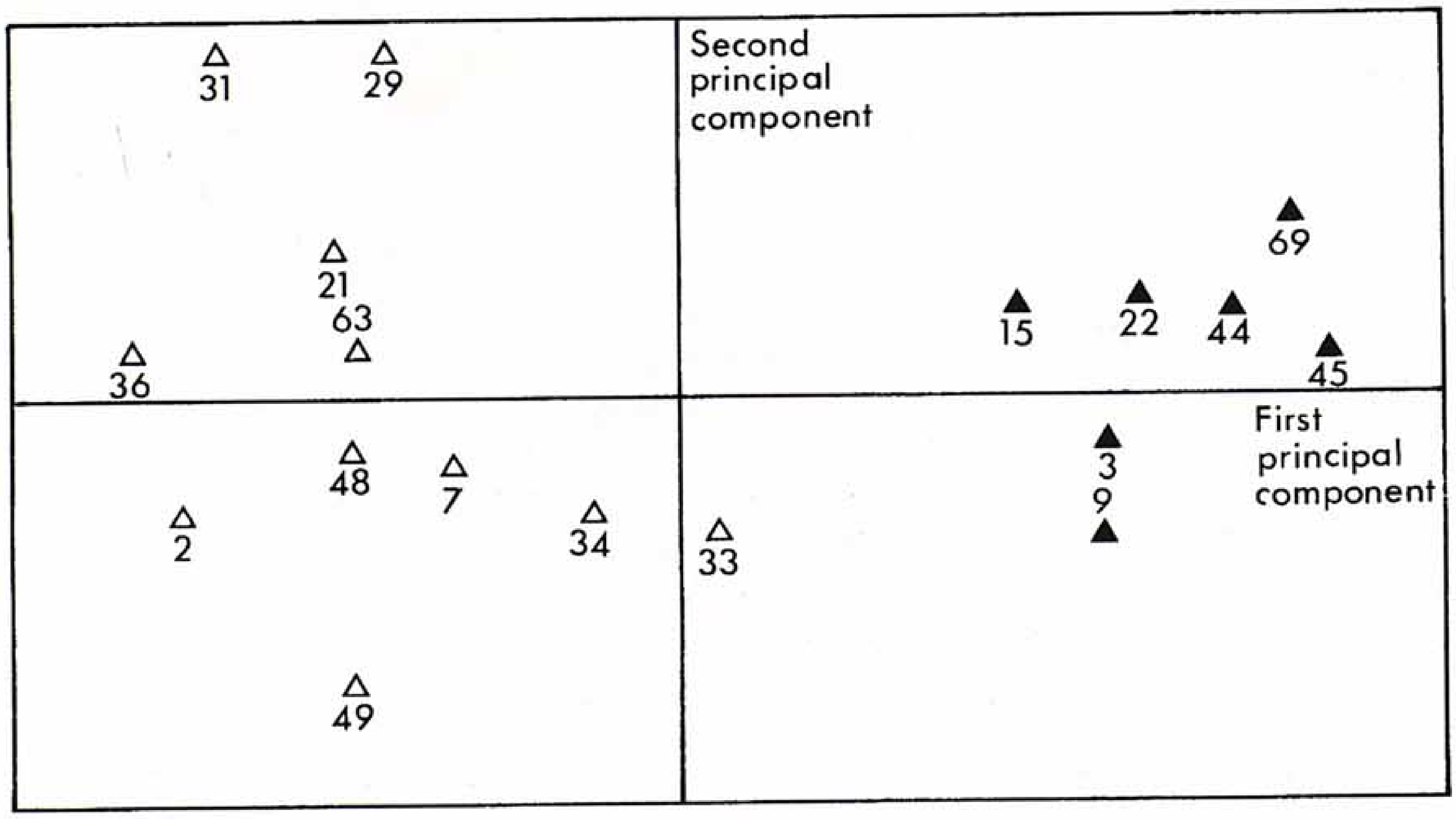

Fig. 5. Principal components scatter diagram for *Vicia* section *Hypechusa* taxa using the taxon data set.

Discussion

The proposed classification of *Vicia* sect. *Hypechusa* shown in Table 3 is based on the overall results of the phenetic analysis. A brief synopsis and key to taxa are provided in Appendix 3 and 4 respectively. The classification follows KUPICHA (1976) suggestion and divides sect. *Hypechusa* into two series. The classification attempts to reflect the natural, evolutionary relationships between the included taxa, as indicated by the data analysis, while at the same time not producing such a subdivided classification that it loses predictive value.

Series *Hyrcanicae* B. Fedtsch. ex Radzhi
- *V. assyriaca* Boiss.
- *V. esdraelonensis* Warb. & Eig
- *V. tigridis* Mouterde
- *V. galeata* Boiss.
- *V. hyrcanica* Fisch. & C.A. Mey.
- *V. noeana* (Reuter in Boiss.) Boiss.
  - i subsp. *megalodonta* Rech.f.
  - ii subsp. *noeana*

Series *Hypechusa*
- *V. melanops* Sibth. & Sm.
  - i var. *melanops*
  - ii var. *loiseaui* Alleiz.
- *V. ciliatula* Lipsky
- *V. anatolica* Turrill
- *V. mollis* Boiss. & Hausskn. ex Boiss.
- *V. pannonica* Crantz
  - i subsp. *striata* (M. Bieb.) Nyman
  - ii subsp. *pannonica*
- *V. hybrida* L.
- *V. sericocarpa* Fenzl
- *V. lutea* L.
  - i subsp. *lutea*
  - ii subsp. *vestita* (Boiss.) Rouy

Table 3. Classification of *Vicia* section *Hypechusa* (Alef.) Aschers. & Graebner

The two series proposed are *Hyrcanicae* and *Hypechusa* and they are distinguished on the basis of peduncle length, corolla shape and size, standard pubescence and degree of wing basal kinking. This division into two major subgroups is justified on the results of the analysis, however, the two series formed by this split remain somewhat heterogenous. *V. assyriaca* is peripheral to ser. *Hyrcanicae* and the series is more typically represented by taxa of the *V. noeana* complex, while *V. lutea* is peripheral to ser. *Hypechusa*. The latter species has been previously placed in a monospecific series *Luteae* B. Fedtsch. by FEDTSCHENKO (1948) and PLITMANN (1967). Although peripheral to ser. *Hypechusa*, the phenetic analysis clearly places *V. lutea* within series *Hypechusa*. Other species of this series could also be grouped into subseries taxa, by grouping the species which have a spot on the apex of the wing, *V. anatolica*, *V. ciliatula*, *V. melanops* and *V. mollis* or the species with pubescent standards, *V. anatolica*, *V. hybrida* and *V. pannonica*. Some previous authors have favoured the detailed subdivision of section *Hypechusa*, FEDTSCHENKO (1948), for example, splits the species into three series, while PLITMANN (1967) used four series. This degree of subdivision is regarded here as being excessive for a relatively small taxon and is not warranted on the basis of the analysis undertaken.

The species of ser. *Hyrcanicae*, with the exception of *V. assyriaca*, form a tight grouping and several authors TOWNSEND (1967, 1974), PONERT (1973) and MEIKLE (1977) have suggested reducing some of the included species to subspecific rank. PLITMANN (1967) notes the existence of intermediate forms between each of the ser. *Hyrcanicae* species, but ultimately retains their specific distinction. Ponert (1973) takes an extreme view and considers *V. assyriaca*, *V. noeana* subsp. *noeana* and subsp. *megalodonta* to be all subspecies of *V. hyrcanica*. Having noted these views, the specimens seen during the course of this revision were easily attributed to one of the seven taxa and specimens showing a degree of intermediacy remain rare. The ser. *Hyrcanicae* taxa do form a relatively closely related complex, but they are not considered sufficiently close to warrant reduction to subspecific taxa of *V. hyrcanica*. The retention of the specific distinction here is strengthened by comparison to the *V. narbonensis* complex species, in which the taxa are more closely related to each other and yet they retain their specific status (MAXTED & al., 1991).

The results of the phenetic analysis support the addition of *V. tigridis*, as suggested by Maxted (1993) to section *Hypechusa* and the transfer of *V. mollis* to section *Hypechusa* by MAXTED (1994). Use is deliberately made of both subspecific and varietal categories within the proposed classification in an attempt to reflect the relative taxonomic distance between the subspecific taxa.

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Appendix 1

Specimen citation

V. anatolica – Anon. s.n., SU (LE); Chernova s.n., SU (LE); Chernova s.n., SU (LE); Frantskevich 42805, SU (WIR); Gabrielian & al s.n., SU (ERE); Komarovii s.n., SU (E); Mroubern s.n., SU (LE); Mroubern s.n., SU (LE); Mulkeupeanyan & Manakyan s.n., SU (BM); Mulkeupeanyan & Manakyan s.n., SU (E); Nikitina 380, SU (WIR); Puring s.n., SU (LE); Pyankova 430, SU (WIR); Pyankova s.n., SU (WIR); Stankevich s.n., SU (WIR); Stankevich 1240, SU (WIR); Stankevich & Dorofeyev 2678, SU (WIR); Stankevich & Legotina 1184, SU (WIR); Stankevich & Legotina 1218, SU (WIR); Ulyanova s.n., SU (WIR); Ulyanova s.n., SU (WIR); Ulyanova s.n., SU (WIR); Zaktreger s.n., SU (WIR); Akman 6091, TR (E); Bozakman & Fitz 260, TR (W); Cheese & Watson 1316, TR (K); Cheese & Watson 1361, TR (K); Coode & Jones 1730, TR (E); Lindsay 51, TR (K); Maxted, Kitiki & Allkin 4498, TR (SPN); Kupicha 9600, (E).

V. assyriaca – Low 194, IQ (BM); Polunin 5149, IQ (K); Kotschy 78.98, SU (K); Balls 2147, TR (E); Davis & Hedge 28327, TR (BM, E); Haradjian 47, TR (W); Kotschy 10837, TR (BM); Kotschy 213, TR (G, K, W); Maxted, Auricht & Ehrman 4840, TR (SPN); Maxted, Auricht & Ehrman 4933, TR (SPN); Maxted, Auricht & Ehrman 4961, TR (SPN); Maxted, Auricht & Ehrman 5041, TR (SPN); Maxted, Auricht & Ehrman 5150, TR (SPN); Maxted, Auricht & Ehrman 5165, TR (SPN); Maxted, Auricht & Ehrman 5684, TR (SPN); Noe s.n., TR (W); Zohary & Plitmann 18603-61, TR (HUJ).

V. ciliatula – Gadreenyan s.n., SU (E); Grossheim & Schischkin 289, SU (K); Khinchuk 5942, SU (WIR); Lipsky 4/70.2, SU (K); Lipsky s.n., SU (LE); Sinskaya 9620, SU (WIR); Stankevich s.n., SU (WIR); Stankevich s.n., SU (WIR); Stankevich s.n., SU (WIR); Stankevich 10, SU (WIR); Stankevich 723, SU (E, MO, W); Stankevich & Dorofeyev 2498, SU (WIR); Stankevich & Dorofeyev 2828, SU (WIR); Stankevich & Dorofeyev 2901, SU (WIR); Stankevich & Legotina 954, SU (WIR); Stankevich & Vlasson s.n., SU (WIR); Stankevich & Vlassov 114, SU (WIR); Stankevich & Vlassov 496a, SU (WIR); Teplyakova & Seferova 500351, SU (WIR); Voluznyova & Semyonova 43517, SU (WIR); Bozakman & Fitz 764, TR (W); Furse & Synge 158, TR (K); Tobey 157, TR (E).

V. esdraelonensis – Smith & Maxted 9403, IL (SPN); Zohary & Plitmann 624511, IL (E); Zohary & Plitmann 62456, IL (HUJ).

V. galeata – Ball s.n., IL (K); Bornmuller 516, IL (W); Dinsmore 1370, IL (E); Eig, Zohary & Feinbrun 1145, IL (HUJ); Feinbrun & Grizi 660, IL (E, K, MO); Norris s.n., IL (BM); Pirard 1846, IL (K); Plitmann 1/15, IL (E); Zohary 1146, IL (HUJ); Zohary & Plitmann 42455, IL (HUJ); Zohary & Plitmann s.n., IL (E); Meyers & Dinsmore 3370, JO (E); Boissier 4/1846, SY (K); Boissier 51, SY (W); Kotschy s.n., SY (W); Lowne 1863, SY (E); Aucher-Eloy 971, TR (G, K); Bornmuller 1717, TR (BM); Maxted, Kitiki & Allkin 4133, TR (SPN).

V. hybrida – Podlech 10756, AF (E); Meikle 2453, CY (W); Billot 3056, FR (MPU); De Valsines s.n., FR (MPU); Khattab, Bisby & Maxted 1032, FR (SPN); Khattab & Maxted 1041, FR (SPN); Lombardelly s.n., FR (K); Magnol s.n., FR (MPU); Maxted 1002, FR (SPN); Maxted 1022, FR (SPN); St.Hilaire s.n., FR (MPU); Edmondson & McClintock 2185, GR (E); Facom 273, GR (E); Gathorne-Hardy 627, GR (E); Krendl s.n., GR (W); Krendl s.n., GR (W); Krendl & Krendl s.n., GR (W); Krendl & Krendl s.n., GR (W); Millward 5, GR (BM); Muller s.n., GR (BM); Rechinger 4554, GR (BM); Stebbing 29, GR (E); Zohary & Orshan 01501-21, GR (HUJ); Plitmann 1268, IL (HUJ); Gillett 6600, IQ (K); Eig, Zohary & Feinbrun 1249, IS (HUJ); Feinbrun, Grizi & Jacobovitch 346, IS (CAI); Bicknell & Pollini 1877, IT (K); Burri & Krendl s.n., IT (W); Boulos & Al-Eisawi 5314, JO (BM); Hepper 3165, JO (K); Trough 21.04.53, JO (E); Polunin 5298, LB (E); Grigoryan s.n., SU (LE); Grossheim s.n., SU (LE); Grossheim s.n., SU (LE); Kazn s.n., SU (LE); Popov s.n., SU (LE); Popov & Vvedensky 268, SU (E); Vasilyev s.n., SU (LE); Maxted, Ehrman & Khattab 1803, SY (SPN); Maxted, Ehrman & Khattab 1900, SY (SPN); Maxted, Ehrman & Khattab 1955, SY (SPN); Maxted, Ehrman & Khattab 2051, SY (SPN); Maxted, Ehrman & Khattab 2224, SY (SPN); Maxted, Ehrman & Khattab 2290, SY (SPN); Maxted, Ehrman & Khattab 2387, SY (SPN);

Maxted, Ehrman & Khattab 2405, SY (SPN); Maxted, Ehrman & Khattab 2637, SY (SPN); Maxted, Ehrman & Khattab 2679, SY (SPN); Maxted, Ehrman & Khattab 2691, SY (SPN); Maxted, Ehrman & Khattab 2714, SY (SPN); Davis 34593, TR (E); Davis 41206, TR (E); Davis 42071, TR (E); Davis & Hedge 27250, TR (E); Davis & Polunin 25199, TR (BM); Davis & Hedge 26226, TR (BM); Maxted, Kitiki & Allkin 4011, TR (SPN); Maxted, Kitiki & Allkin 4089, TR (SPN); Maxted, Kitiki & Allkin 4226, TR (SPN); Maxted, Kitiki & Allkin 4335, TR (SPN); Maxted, Kitiki & Allkin 4381, TR (SPN); Maxted, Kitiki & Allkin 4427, TR (SPN); Maxted, Kitiki & Allkin 4487, TR (SPN); Maxted, Ehrman & Auricht 4835, TR (SPN); Maxted, Ehrman & Auricht 5273, TR (SPN); Maxted, Ehrman & Auricht 5308, TR (SPN); Korb s.n., YU (W).

V. hyrcanica – Aitchison 604, AF (K); Alnford 1861, AF (W); Furse 6621, AF (K); Hedge & Wendelbo 3252, AF (E); Pichler 1882, AF (K); Podlech 11676 AF (E); Archibald 1982, IR (E); Bornmuller & Bornmuller 6682, IR (W); Bungeanum s.n., IR (G); Danin, Baum & Plitmann 236623, IR (HUJ); Danin, Baum & Plitmann 65-650, IR (HUJ); Pichler s.n., IR (W); Bornmuller 6682, SA (BM); Androsov 2880, SU (W); Anon. s.n., SU (MO); Graher s.n., SU (E); F. & M. 280, SU (K); Frantskevich s.n., SU (WIR); Frantskevich 42806, SU (WIR); Gudkova s.n., SU (WIR); Gudkova s.n., SU (WIR); Jakivoma 269, SU (E, MO, W); Leokene s.n., SU (WIR); Muratova 6205, SU (WIR); Novikov 280, SU (LE); Shcherbakov s.n., SU (WIR); Stankevich s.n., SU (WIR); Stankevich s.n., SU (WIR); Stankevich 807, SU (WIR); Stankevich 4589, SU (WIR); Stankevich & Legotina 1374, SU (WIR); Stankevich & Legotina 1384, SU (WIR); Ulyanova s.n., SU (WIR); Vlassov 32, SU (WIR); Zhilenko s.n., SU (WIR); Androsov 2880, TR (MO); Coode & Jones 1678, TR (E); Maunsell s.n., TR (BM); Tarman 124, TR (E); Tong 259, TR (E); Zohary 5711024, TR (HUJ).

V. lutea subsp. *lutea* – Velcev,Gancev,Bondev & Kocev 827, BG (W); Aldridge 1191, ES (BM); Allkin 83/1, ES (SPN); Anon. s.n., ES (E); Bisby & Birch 1670, ES (SPN); Cannon & Cannon 4716, ES (BM); Krendl & Krendl s.n., ES (W); Silvestra & Valdes 949.69 ES (E); De Witte 17186, FR (MO); Khattab & Maxted 1028, FR (SPN); Maxted 1006, FR (SPN); Maxted 1026, FR (SPN); Maxted 1027, FR (SPN); Maxted 1045, FR (SPN); Maxted 1051, FR (SPN); Maxted 1063, FR (SPN); Wilson 1009, FR (SPN); Cole 49/22/8, GB (SPN); Kerr s.n., GB (SPN); Lewalie 8975, MA (BM); Bisby 1804, PT (SPN); Bisby 1813, PT (SPN); Bisby 1814, PT (SPN); Bisby 1839, PT (SPN); Bisby 1869, PT (SPN); Bisby 1938, PT (SPN); Bisby 1972, PT (SPN).

V. lutea subsp. *vestita* – Davis 51561, AL (E); Krendl s.n., AL (W); Keller 246, EG (K); Allkin 82/3, ES (SPN); Bisby, Nicholls & Polhill 10, ES (SPN); Bisby, Nicholls & Grainger 1376, ES (SPN); Boissier s.n., ES (E); Davis 61741, ES (E); Gibbs & Dominguez21.06.72 ES (E); Kupicha 168 ES (E); Kupicha 182 ES (E); Brown 408, GB (K); Brown s.n., GB (K); Chelsea Physick 2599, GB (BM); Guiton s.n., GB (K); Liston 6421, IL (HUJ); Zohary 224424, IL (HUJ); Davis & Bokhari 56495, IR (E, K); Alexander & Kupicha 481, MA (BM); Font Quer 377, MA (BM); Sennen & Mauricio s.n., MA (BM); Bourgeau 1855, PT (E); Emmerikh 157, SU (WIR); Radde 3/80, SU (K); Stankevich & Vlassov 496b, SU (WIR); Stankevich & Vlassov 542, SU (WIR); Stankevich & Vlassov 770, SU (WIR); Maxted, Ehrman & Khattab 1795, SY (SPN); Maxted, Ehrman & Khattab 2740, SY (SPN); Davis & Lamond 57256, TN (BM); Coode & Jones 2599, TR (E); Fleischer s.n., TR (E); Haussknecht 291, TR (BM); Maxted, Kitiki & Allkin 4100, TR (SPN); Maxted, Kitiki & Allkin 4125, TR (SPN); Maxted, Kitiki & Allkin 4174, TR (SPN); Maxted, Kitiki & Allkin 4188, TR (SPN); Maxted, Kitiki & Allkin 4197, TR (SPN); Maxted, Kitiki & Allkin 4200, TR (SPN); Maxted, Allkin & Khattab 4260, TR (SPN); Maxted, Kitiki & Allkin 4310, TR (SPN); Maxted, Kitiki & Allkin 4329, TR (SPN); Maxted, Kitiki & Allkin 4339, TR (SPN); Maxted, Ehrman & Auricht 5318, TR (SPN); Maxted, Ehrman & Auricht 6166, TR (SPN); Zohary 8/5/1931, TR (HUJ); Balls 8733, US (BM).

V. melanops var. *melanops* – Shibing 695, BG (E); Fzelezova 464, BG (E); Charpin 13907, FR (E); Luet 1873, FR (MPU); Le Brun s.n., FR (MPU); Virot s.n., FR (MPU); Burri & Krendl 23.05.92, GR (E); Greuter & Merzmuller 17244, GR (E); Guiol 6613, GR (MPU); Krendl & Krendl s.n., GR (W); Orphanides 3316, GR (E); Rechinger 5865, GR (BM); Sibthorp s.n., GR (OXF); Anon. 1022, IT (W); Burri & Krendl s.n., IT (W); Caruel 5/1867, IT (W); Costa-Reghini s.n., IT (MPU); Fenzl 1835, IT (K); Rogers 639, IT (K); Ronniger s.n., RO (W); Fenzl 1869, TR (W); Katz 1908, TR (E); Maxted, Kitiki & Allkin 4321, TR (SPN); Maxted, Kitiki & Allkin 4413, TR (SPN); Maxted, Kitiki & Allkin 4420, TR (SPN); Maxted, Kitiki & Allkin 4440, TR (SPN); Maxted, Kitiki & Allkin 4454, TR (SPN); Bierbach s.n., YU (MPU); Hudriczka 4/1876, YU (MPU); Maly s.n., YU (K).

V. melanops var. *loiseaui* – Levier 2162, IT (MPU).

V. mollis – Eig & Zohary s.n., IQ (HUJ); Jacobs 6501, IR (E); Haussknecht s.n., SY (G, W); Maxted, Ehrman & Khattab 2277, SY (SPN); Maxted, Ehrman & Khattab 2589, SY (SPN); Maxted, Ehrman & Khattab 2648, SY (SPN); Maxted, Ehrman & Khattab 2653, SY (SPN); Maxted, Ehrman & Khattab 2670, SY (SPN); Maxted, Ehrman & Khattab 2697, SY (SPN); Maxted, Ehrman & Khattab 2706, SY (SPN); Davis 42889, TR (E); Davis & Hedge 27696, TR (K); Davis & Hedge 27917, TR (BM, E, HUJ); Davis & Hedge 28226, TR (BM, E); Maxted, Ehrman & Auricht 4807, TR (SPN); Maxted, Auricht & Ehrman 4807, TR (SPN); Maxted, Auricht & Ehrman 4936, TR (SPN); Maxted, Auricht & Ehrman 5031, TR (SPN); Maxted, Auricht & Ehrman 5092, TR (SPN); Maxted, Auricht & Ehrman 5125, TR (SPN); Maxted, Auricht & Ehrman 5131, TR (SPN); Maxted, Auricht & Ehrman 5145, TR (SPN); Maxted, Auricht & Ehrman 5168, TR (SPN); Maxted, Auricht & Ehrman 5204, TR (SPN); Maxted, Auricht & Ehrman 5236, TR (SPN); Maxted, Auricht & Ehrman 5255, TR (SPN); Sintenis 753, TR (K).

V. noeana subsp. *noeana* – Polunin 5149, IQ (E); Kotschy 98, SU (W); Kotschy s.n., SU (G); Maxted, Ehrman & Khattab 2352, SY (SPN); Maxted, Ehrman & Khattab 2422, SY (SPN); Bornmuller & Bornmuller 14046, TR (W); Bozakman & Fitz 794, TR (W); Bozakman & Fitz 859, TR (W); Coode & Jones 2205, TR (E); Davis 21754, TR (BM, E); Davis & Hedge 27436, TR (E); Davis & Hedge 27746, TR (E); Davis & Hedge 28063, TR (E); Haradjian 1149, TR (W); Haussknecht s.n., TR (BM, K, W); Helbaek 2439, TR (E); Kotte 251, TR (K); Ledingham, Ekim & Yutdakul 4362, TR (E); Maxted, Ehrman & Auricht 5035, TR (SPN); Maxted, Ehrman & Auricht 5081, TR (SPN); Maxted, Ehrman & Auricht 5207, TR (SPN); Maxted, Ehrman & Auricht 5261, TR (SPN); Maxted, Ehrman & Auricht 5276, TR (SPN); Maxted, Ehrman & Auricht 5287, TR (SPN); Maxted, Ehrman & Auricht 5293, TR (SPN); Maxted, Ehrman & Auricht 5424, TR (SPN); Sintenis 3660, TR (BM); Tarman & Elci 1956, TR (E); Watson *et al.* 2748, TR (E); Zohary 67102, TR (W); Zohary 87167, TR (HUJ).

V. noeana subsp. *megalodonta* – Davis 44942, TR (E); Davis & Hedge 28702, TR (E); Frodin 308, TR (W).

V. pannonica subsp. *pannonica* – Maxted 1179, (SPN); Polatschek s.n., AT (W); Seipka s.n., AT (W); Wittmer s.n., AT (W); Wittmer s.n., AT (W); Ronniger s.n., CS (W); Andre 4/1879, FR (MPU); De Valon s.n., FR (E); Krendl s.n., HU (W); Lamond 3049, IR (E); Bujorean 808, RO (MO); Krendl & Krendl s.n., RO (W); Anon. s.n., SU (LE); Gregoryan s.n., SU (BM); Karapetyan s.n., SU (W); Karapetyan & Aslanian s.n., SU (ERE); Popov s.n., SU (LE); Smirnova s.n., SU (LE); Davis & Coode 37084, TR (E); Parquet s.n., TR (BM); Edmondson 231, YU (E, RNG).

V. pannonica subsp. *striata* – Zeljazova 666, BG (E); Reverchon 741, ES (E); Andre s.n., FR (MPU); Breton 16/7/1903, FR (MPU); Cartier 1182, FR (MPU); Cartier 1182b, FR (MPU); Chevalier 1907, FR (MPU); Heribaud & Gasilide 2026, FR (MPU); Le Grand 3634, FR (MPU); Liendon 52, FR (E); Renaud 1150, FR (MPU); Verdcourt 4660, FR (E); Chelsea

Physick 98, GB (BM); Edmondson & McClintock 2375, GR (E); Nannfeldt 6037, SE (E); Arkhip s.n., SU (LE); Borissova s.n., SU (LE); Ganeshin s.n., SU (LE); Gelde s.n., SU (LE); Vankov s.n., SU (LE); Yarovaya s.n., SU (LE); Gardner & Gardner 794, SV (RNG); Maxted, Ehrman & Khattab 1762, SY (SPN); Coode & Jones 2756 TR (E); Davis 42087, TR (E); Davis & Coode 37081, TR (E); Krendl & Krendl s.n., YU (W); Muck 27, YU (W); Smith & Glennie s.n., YU (E).

V. sericocarpa – Meyers & Dinsmore 904b, IL (E); Zohary & Plitmann 114/55, IL (HUJ); Rawi, Nuri & Koas 28874, IQ (K); Furse 2135, IR (E); Kotschy 71, IR (K); Kotschy 99, IR (K); Davis 5947A, LB (E); Haradjian 417, SY (W); Haussknecht s.n., SY (G, W); Haussknecht 20/3/1865, SY (K); Maxted, Ehrman & Khattab 1897, SY (SPN); Maxted, Ehrman & Khattab 1996, SY (SPN); Maxted, Ehrman & Khattab 2196, SY (SPN); Maxted, Ehrman & Khattab 2262, SY (SPN); Maxted, Ehrman & Khattab 2316, SY (SPN); Maxted, Ehrman & Khattab 2470, SY (SPN); Maxted, Ehrman & Khattab 2602, SY (SPN); Maxted, Ehrman & Khattab 2683, SY (SPN); Maxted, Ehrman & Khattab 2713, SY (SPN); Maxted, Ehrman & Khattab 3165, SY (SPN); Bozakman & Fitz 567, TR (W); Coode & Jones 1000, TR (E); Davis 19421, TR (E); Davis 42869, TR (E); Davis 42933, TR (E); Davis & Dodds 19421, TR (K); Davis & Hedge 27374, TR (E); Davis & Hedge 27711, TR (E); Davis & Hedge 28848, TR (E); Davis & Polunin 25858, TR (BM, E); Davis & Polunin 25994, TR (E); Deaver 192, TR (E); Dinsmore 6904, TR (E); Kotschy 151, TR (W); Maxted, Kitiki & Allkin 4038, TR (SPN); Maxted, Kitiki & Allkin 4152, TR (SPN); Maxted, Kitiki & Allkin 4693, TR (SPN); Maxted, Kitiki & Allkin 4700, TR (SPN); Maxted, Ehrman & Auricht 4926, TR (SPN); Maxted, Ehrman & Auricht 5012, TR (SPN); Maxted, Ehrman & Auricht 5162, TR (SPN); Maxted, Ehrman & Auricht 5298, TR (SPN); Townsend 640422/14, TR (K).

V. tigridis – Maxted, Ehrman & Khattab 3287, SY (SPN); Mouterde 11387, SY (G).

Appendix 2

Phenetic character set. The character set is displayed in the order: character number: character name: character states if applicable. Character use is indicated by +, S = specimen characters set and T = taxon character set.

		S	T
1.	Stipule length mm.	+	+
2.	Stipule shape: entire, semi-hastate.	+	–
3.	Stipule colour (upper plant): green, green with purple, purple.	+	+
4.	Leaf length: mm.	+	+
5.	Petiole length: mm.	+	+
6.	Leaflet length: mm.	+	+
7.	Tendril length: mm.	+	–
8.	Tendril branching: not branched, 2 branches, 3 branches, > 3 branches.	+	–
9.	Number of leaflets / leaf.	+	–
10.	Leaflet abaxial hair density: absent, < 10 / cm^2, 10–50 / cm^2, > 50 / cm^2.	+	–
11.	Leaflet abaxial hair length: inappropriate, < 0.5mm, 0.5–1.5mm, > 1.5mm.	+	+
12.	Petiole hair density: absent, < 10 / cm^2, 10–50 / cm^2, > 50 / cm^2.	+	–
13.	Stem node colour (upper plant): green, purple.	+	–
14.	Peduncle type: obsolescent, > 2mm but shorter than flower, longer than flower.	+	–
15.	Peduncle length: mm.	+	+
16.	Rachis length: mm.	+	+
17.	Pedicel length: mm.	+	–

	S	T
18. Flower length: mm.	+	–
19. Ratio of peduncle to flower length.	+	+
20. Number of flowers / inflorescence: one, two, three or four, > four.	+	–
21. Calyx lower tooth length: mm.	+	–
22. Calyx tube length: mm.	+	–
23. Calyx tooth curvature: absent, present.	+	+
24. Calyx exterior hair density: absent, < 10 / cm^2, 10–50 / cm^2, > 50 / cm^2.	+	+
25. Calyx exterior hair length: inappropriate, < 0.5mm, 0.5–1.5mm, > 1.5mm.	+	–
26. Calyx colour: green, purple.	+	–
27. Standard length: mm.	+	–
28. Standard limb length: mm.	+	–
29. Standard limb width: mm.	+	–
30. Standard face colour: cream, yellow, yellow-pink, yellow-green, violet , purple.	+	+
31. Standard shape: platynychioid, stenonychioid.	+	–
32. Standard back pubescence: glabrous, pubescent.	+	+
33. Standard vein number: absent, 3-5 veins,> 5 veins.	+	–
34. Wing length: mm.	+	–
35. Wing limb width: mm.	+	+
36. Wing colour: cream, yellow, yellow-pink, yellow-green, lilac, violet, purple.	+	+
37. Wing markings: absent, apex coloured.	+	–
38. Wing limb base kinking: weak kinking, strong kinking.	+	+
39. Wing limb pouching: absent, present.	+	–
40. Keel length: mm.	+	–
41. Keel colour: white, purple / brown.	+	–
42. Keel hood tip colouring: absent, present.	+	–
43. Keel pouch: absent, present.	+	–
44. Staminal filament length: mm.	+	+
45. Supra-ovary extension: mm.	+	+
46. Ovary shape: linear, intermediate, oblong.	+	+
47. Stigma shape: globose, conical.	+	–
48. Supra-ovary curvature: absent, present.	+	–
49. Ovary pubescence: glabrous, sutures only, entire coverage.	+	–
50. Legume length: mm.	+	–
51. Legume width: mm.	+	+
52. Legume colour: yellow, yellow-brown, brown, black.	+	–
53. Legume coloration: uniform over legume, brown/black veins, purple patches.	+	–
54. Legume shape: oblong, rhomboid	+	–
55. Legume cross-sectional shape: rounded, intermediate, laterally flat.	+	+
56. Legume hair density: glabrous, < 10 / cm^2, 10–50 per cm^2, > 50 / cm^2.	+	+
57. Legume hair length: inappropriate, < 0.5mm, 0.5–1.5mm, > 1.5mm.	+	+
58. Legume hair position: inappropriate, sutures only, entire coverage.	+	+
59. Legume hair type: inappropriate, ciliate, ciliate with tubercular foot.	+	+
60. Hair tubercle length: absent, short, long.	+	+
61. Number of seeds / legume.	+	–
62. Seed length: mm.	+	+
63. Ratio of seed circumference to hilum length.	+	–
64. Seed shape: sperical, cubical.	+	–
65. Seed colour: yellow, red-brown, brown, black.	+	–

	S	T
66. Seed colour mottling: absent, present.	+	–
67. Hilum shape: oval, elongated.	+	–

Appendix 3

Synopsis of *Vicia* section *Hypechusa*.

Section ***Hypechusa*** (Alef.) Aschers. & Graebner, Syn. Mitteleur. Fl. 6,2: 957 (1909).

Hypechusa Alef. *Bot. Zeitung (Berlin)*, 18: 165 (1860); *Vicia* ser. *Annuae* Taubert, Die Nat. Pl. III, 10: 351 (1894), *nomen nudum*; *Vicia* sect. *Pedunculatae* Rouy, Fl. Fr., 5: 221 (1899), *pro parte excl. typ.*; *Vicia* subsect. *Brevicarpa* Stankevich, *Tr. Prikl. Bot. Genet. Sel.*, 43: 113 (1970); *Vicia* subsection *Hybridae* Radzhi, *Novosti Sist. Vyssh. Rast.*, 17: 238 (1971).

Type, *V. lutea* L. *Sp. Pl.*, 2: 736 (1753).

Annual; climbing; stem slender. Stipules entire or semi-hastate; 1.0–5.5mm long; edge entire or with 1-2 teeth. Leaf apex tendrilous, with more than 4 pairs; leaflet 5–30mm, symmetric, margins entire. One to four flowers per inflorescence; peduncle 1-28mm. Calyx mouth oblique; lower tooth longer than upper; base slightly gibbous. Flowers shorter or approximately equal to peduncle. Standard cream, yellow, blue or purple; shape platonychioid or stenonychioid; upper standard surface glabrous or pubescent, all petals approximately equal length. Wing marking absent or present; wing limb with slight kinking or strong kinking above spur. Legume length 10–50 x 4–15mm, oblong; round in cross section; sutures curved; valve hairs absent or present; hairs simple or tuberculate; septa absent; 2–7 seeds per legume. Seed diameter 3.5 to 6.0mm; round or oblong; not laterally flattened; hilum less than quarter of seed circumference; lens opposite to hilum; testa smooth.

Number of taxa. eighteen.

Chromosome number. 10, 12, 14.

Geographical distribution. West, Central and Southern Europe, Mediterranean Basin and Transcaspia.

A Series ***Hyrcanicae*** B. Fedtsch. ex Radzhi, *Novosti Sist. Vyssh. Rast.*, 7: 238 (1971).

Hypechusa subgenus *Euhypechusa* Alef. *Bonplandia* 8: 68 (1860), *pro parte*; *Vicia* Ser. *Hyrcanicae* Radzhi. *Novosti Sist. Vyssh. Rast.*, 7: 238 (1971).

Type: V. hyrcanica Fisch. & C.A. Mey. *Ind. Sem. Hort. Petr.* 2: 28 (1835).

Stipules 2.0–5.5mm long. Leaflet 5-30mm. One to four flowers per inflorescence; peduncle 8-28mm. Flowers shorter than or approximately equal to peduncle. Standard cream, yellow or blue; shape stenonychioid; upper surface glabrous. Wing marking absent; wing limb usually with strong kinking. Legume 10–50 x 8–15mm; valve hairs absent or rarely present; hairs simple. Two to seven seeds per legume.

Number of taxa. seven.

Chromosome number. 12, 14.

Geographical distribution. West Asia.

Included taxa:

V. assyraica Boiss. Diagn. Pl. Or. Nov. ser. 1(9): 123 (1849).
V. esdraelonensis Warb. & Eig. *Repert. Sp. Nov. Reg. Veg*. 25: 352 (1928).
V. tigridis Mouterde. Nouv. Fl. Liban Syrie, 2: 402 (1969).
V. galeata Boiss. *Diagn. Pl. Or. Nov.* ser. 1(2): 103 (1843).
V. hyrcanica Fisch. & C.A. Mey. *Ind. Sem. Hort. Petr.* 2: 28 (1843).
V. noeana Reuter ex Boiss. *Fl. Or.* 2: 572 (1872).
V. noeana subsp. *megalodonta* Rech.f. *Zur. Fl. Syr. Lib., Ark. Bot.* 5(1): 262 (1959).
V. noeana subsp. *noeana* (Reuter in Boiss.) Boiss. *Fl. Or.,* 2: 572-573 (1872).

B Series ***Hypechusa*** (Alef.) Aschers. & Graebner, *Syn. Mitteleur.* Fl., 6,2: 957 (1909).

Vicioides Moench, *Meth.,* 135 (1794), *pro parte*; *Vicia* sect. *Euvicia* Vis. Fl. Dalmatica 1: 317 (1852), *pro parte*; *Hypechusa* subgenus *Masarunia* Alef., *Bonplandia* 8: 68 (1860); *Hypechusa* subgenus *Euhypechusa* Alef., *Bonplandia* 8: 68 (1860), *pro parte*; *Vicia* subser. *Ochroleucae* Taubert, *Natürl. Pfaurenfam.* III, 10: 351 (1894), *nomen nudum*; *Vicia* subser. *Platycarpae* Taubert, *Natürl. Pflanzenfam.* Pl. III, 10: 351 (1894), *nomen nudum*; *Vicia* sect. *subsessiles* Rouy in Rouy & Fouc., *Fl. Fr.,* 5: 208 (1899), *pro parte excl. typ.*; *Vicia* sect. *Pedunculatae* Rouy in Rouy & Fouc., *Fl. Fr.,* 5: 221 (1899), *pro parte excl. typ.*; *Vicia* ser. *Luteae* B. Fedtsch., Fl. URSS., 13: 468 (1948); *Vicia* ser. *Hybridae* B. Fedtsch., Fl. URSS., 13: 469 (1948); *Vicia* ser. *Luteae* Radzhi, *Novosti Sist. Vyssh. Rast.*, 7: 238 (1971); *Vicia* subsect *Hybridae* Radzhi, *Novosti Sist. Vyssh. Rast.,* 7: 238 (1971); *Vicia* ser. *Hybridae* Radzhi, *Novosti Sist. Vyssh. Rast.,* 7: 239 (1971).

Type: V. lutea L. (1753) *Sp. Pl.*, 2: 736.

Stipules 1.0–5.5mm. Leaflet 10-30mm. One to four flowers per inflorescence. Flowers shorter than peduncle. Standard cream, yellow or purple; shape platonychioid or stenonychioid; upper surface glabrous or pubescent. Wing marking absent or present; wing limb with slight or rarely strong kinking. Legume 5–50 x 5–12mm; valve hairs absent or present; hairs simple or tuberculate. One to five seeds per legume.

Number of taxa. eleven.

Chromosome number. 10, 12, 14.

Geographical distribution. Europe, West Asia and North Africa.

Included taxa:

V. melanops Sibth. & Sm., *Fl. Graec. Prodr.,* 2: 72 (1813).
V. melanops var. *melanops* Sibth. & Sm., *Fl. Graec. Prodr.*, 2: 72 (1813).
V. melanops var. *loiseaui* Alleiz., *Bull. Soc. Bot. Fr.*, 105: 360 (1858).

V. ciliatula Lipsky, *Mem. Soc. Natur. Kiew* 6(2):46-47 (1891).
V. anatolica Turrill, *Kew Bull.*, 1: 8 (1927).
V. mollis Boiss. & Hausskn. ex Boiss., *Fl. Or.* 2: 576 (1872).
V. pannonica Crantz, *Stirp. Austr.* 2(5): 393 (1769).
  V. pannonica subsp. *striata* (M. Bieb.) Nyman, *Consp. Fl. Europaea*, 209 (1878).
  V. pannonica subsp. *pannonica* Crantz, *Strip. Austr.* 2 (5):393-394 (1769).
V. hybrida L., *Sp. Pl.* 2: 737 (1753).
V. sericocarpa Fenzl, Pug. *Pl. Sy. Tauri Occid.*, 4 (1842).
V. lutea L., *Sp. Pl.*, 2: 736 (1753).
  V. lutea subsp. *lutea* L., *Sp. Pl.*, 2: 736 (1753).
  V. lutea subsp. *vestita* (Boiss.) Rouy, *Fl. Fr.* 5: 219 (1899).

Appendix 4

Key to taxa of *Vicia* sect. *Hypechusa*.

Key to series of Vicia sect. Hypechusa.

1. Peduncle +/– longer than 6mm; standard stenonychioid, upper surface glabrous; wing marking absent; wing limb with strong claw kinking .... Ser. ***Hyrcanicae***
   Peduncle less than 6mm; standard platynychioid or stenonychioid; upper standard surface glabrous or pubescent; wing marking absent or present; wing limb with weak claw kinking .... Ser. ***Hypechusa***

Key to species, subspecies and varieties of Vicia sect. Hypechusa.

1 Standard upper surface subadpressed pubescent; legume pubescent 2
  Standard upper surface glabrous; legume glabrous or pubescent 5

2 Inflorescence with 2–4–flowers; flowers 15–23mm, yellow or purple .... ***V. pannonica*** 3
  Inflorescence with 1(–2)–flowers; flowers 12–35mm, yellow 4

3 Corolla dusky violet, standard face without distinct veining; flowers 15–20mm .... ***V. pannonica*** subsp. ***striata***
  Corolla yellow or cream brown; standard face with distinct veins; flowers 17–23mm .... ***V. pannonica*** subsp. ***pannonica***

4 Flowers 18–35mm, flowers sulphur yellow; standard platynychioid to stenonychioid, limb equalling claw .... ***V. hybrida***
  Flowers 15–18mm, standard yellow green, wing with dark brown apex; standard platynychioid, limb shorter than claw .... ***V. anatolica***

5 Flowers violet .... ***V. esdraelonensis***
  Flowers yellowish (or rarely purple in *V. lutea*) 6

6 Legume (and ovary) with hairy valves; peduncle much shorter than calyx tube 7
  Legume (and ovary) with glabrous valves; peduncle equalling or longer than calyx tube 10

7 Peduncle 1–2mm; standard platynychioid to stenonychioid; legume with simple or tubercular hairs .... ***V. lutea*** 8
Peduncle more than 2mm; standard platynychioid; legume with simple hairs 9

8 Subglabrous or sparsely pubescent; corolla yellow; legume glabrous or with simple hairs .... ***V. lutea*** subsp. ***lutea***
Pubescent with long tubercular hairs; corolla pale yellow or purple–violet; legume hairs tubercular .... ***V. lutea*** subsp. ***vestita***

9 Plant +/– villous; tendrils simple; flowers 12–18mm, 1–3 in axil; wing apex marking present; fruit densely villous .... ***V. mollis***
Plants adpressed–pilose; tendrils mostly branched; flowers (15)18–29mm, mostly solitary; wing apex marking absent; fruit adpressed–sericeous .... ***V. sericocarpa***

10 Sutures of legume tuberculate–ciliate; limb of standard shorter than claw 11
Sutures of legume glabrous; limb of standard to longer than claw 13

11 Wing apex with distinct brown spot; peduncle 2–9mm; flowers (1–)2–4, 17–22mm long .... ***V. melanops*** 12
Wing apex with no apex spot; peduncle 2–3mm; flowers 1–2, 12–15 mm long .... ***V. ciliatula***

12 Calyx approx. 1/5 of corolla length; standard yellow–green, wing more yellow; wings blackened at apex; keel slightly shorter than wing, prominently coloured apex; legume bredth 8–10mm; seed ovoid, slightly compressed .... ***V. melanops*** var. ***melanops***
Calyx approx. 1/4 of corolla length; standard and wings yellow–green; wings reddish brown at apex; keel distinctly shorter than wing, slightly coloured apex; legume bredth 7mm; seed round, strongly compressed .... ***V. melanops*** var. ***loiseaui***

13 Stem 10–35cm; tendrils rarely branched; lower calyx tooth 2–3.5mm; standard 15–20mm, pale yellow .... ***V. assyriaca***
Stem taller; tendrils branched; lower calyx tooth 2–9mm; standard 17–30mm, yellow–pink or yellow–brown 14

14 Peduncle 1–3mm; corolla not concolorous; legume rhomboid .... ***V. tigridis***
Peduncle longer than 3mm; corolla concolorous; legume oblong 15

15 Peduncle 1–2–flowered; legume 8–12mm broad; limb of standard slightly shorter than claw .... ***V. hyrcanica***
Peduncle (1–)2–5–flowered; legume 8–10mm broad; limbof standard as long or slightly longer than claw 16

16 Hilum 1/2 to 2/3 of seed's circumference; calyx green, teeth shorter than tube; leaflets 3–14mm broad, some obovate .... ***V. galeata***
Hilum 1/6 of seed's circumference; calyx violet, green only if lowest tooth longer than tube; leaflets 2–5(–8)mm broad, never obovate .... ***V. noeana*** 17

17 Calyx 7–10mm, usually violet, all teeth shorter than tube; leaflets obtuse or retuse to notched or tridenticulate; hilum shape elongated .... ***V. noeana*** subsp. ***noeana***
Calyx 14–16mm, pale green, at least the lowest tooth longer than tube; leaflets linear, acutish to truncate; hilum shape oval .... ***V. noeana*** subsp. ***megalodonta***

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