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Conservation Field Guide to Medics

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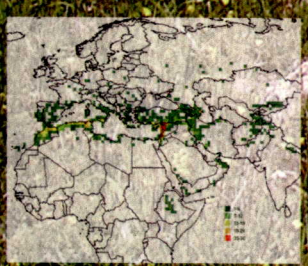
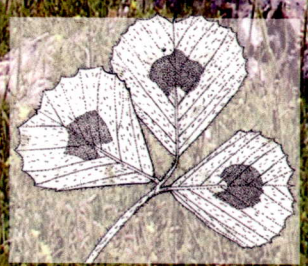


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PREFACE

Agrobiodiversity in West Asia and North Africa region and particularly in the Mediterranean and the Fertile Crescent Centres of diversity has a global significance. *Medicago* species, with their centre of diversity in the region, are a good example of shared benefits from expansion and exchange of genetic resources throughout the World. Alfalfa (*M. sativa* L.) is the most widely grown forage species in temperate countries and with other *Medicago* species constitute the basis for ley farming systems around the world. The genetic resources collected from the Middle East region and the genetic variability still existing *in situ* are an invaluable germplasm resource for regional and global breeding programs. The potential uses of *Medicago* in soil improvement, bioremediation, cover crops, food and medicines and production of enzymes also offer additional benefits which underlines the necessity to conserve *in situ* and *ex situ* and sustainably use the *Medicago* species richness and its intra-species diversity.

However, conservation of any group of species is often limited by the conservationists own ability to identify the target species in the field, as such this Conservation Field Guide aims to provide a comprehensive means for non-experts to identify *Medicago* in the West Asia region and provide the necessary baseline to facilitate their conservation by national programmes in the CWANA region and other regions.

This Conservation Field Guide is an important output of the GEF funded-ICARDA coordinated West Asia dryland Agrobiodiversity Project and is aimed to help field conservationists, agriculturalists, extension agents, students and teachers identify *Medicago* species in a novel, and contemporary manner.

Dr Mahmoud Solh
Director General
ICARDA

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1. INTRODUCTION

1.1 Necessity for a Conservation Field Guide to Medics (*Medicago* L.)

The genus *Medicago* is arguably the most important of the temperate pasture legume genera containing as it does the widely cultivated perennial plant *Medicago sativa*, (Lucerne or Alfalfa) along with a range of annual species important in specific regions (Prosperi *et al.*, 2001), which are used for animal feed and contain unparalleled level of Total Digestible Nutrients (Gateway, 2006), but also because many of the other *Medicago* species, such as *M. truncatula* (Barrel medic), *M. littoralis* (Strand medic), *M. polymorpha* (Burr medic), are cultivated and there is potential for further exploitation of the *Medicago* gene pool. Therefore, the collection, conservation, characterization, study of genetic diversity and utilization of the genus *Medicago* deserves immediate attention as a priority research area. There is an urgent need to conserve the genetic diversity of the genus using both *ex situ* (gene banks) and *in situ* (natural habitats) conservation methods. This will permit a critical assessment of the genetic diversity and the genetic erosion of the genus, along with enhancing its exploitation.

Taxonomy forms the cornerstone of all the biological sciences whether ecology, biotechnology, botany and conservation. It is used in the identification of taxa, the characterisation of those taxa and the determination of relationships with other taxa. Perhaps the first of these, the identification process, is arguably the most important because without correct identification any research will be seriously hampered. The inability of many conservationists and field biologists to use traditional identification aids has led to confusion of specimen identity and has undoubtedly resulted in the application of poor conservation and as a result poor utilisation of much valuable material. Plant species that are not accurately identified, either remains uncollected, because their value is not recognised when encountered, or is collected, but remains unidentified and is incorporated into gene banks as "unknown legume species" or "*Medicago* sp.", or is collected, but misidentified, leading to spurious results when utilised. The growing out and re-identification of several large germplasm collections (Maxted 1989, 1992; Maxted and Bisby 1986, 1987) has established that a significant proportion, between 10 and 35%, of *ex situ* conserved material currently held in national and international gene banks is either wrongly identified or is not identified at all. In this state, the material is of limited conservation value and is unlikely to ever be utilized. If the justification for active conservation is potential use, then the onus must be on the conservationists to promote effective conservation and link that conservation to use by supplying the conserved diversity to the user community in the most appropriate manner.

Species recognition based on experience is also of limited value for field biologists, particularly in the centres of diversity, because as Morse (1971) concludes initially recognition depends on either being self-taught or learned from an expert, which

implies the requirement for taxonomic expertise which in West Asian region is in short supply. In contrast, comparison covers a broad array of approaches, including searching through museum specimens for matching specimen, reading descriptions, reviewing illustrations and flicking through named photographs. This approach works but is impractically time-consuming and requires access to an extensive range of named comparative materials. By far the most practical and efficient means of identification is the use of user friendly keys or related identification aids. Keys offer a step-by-step approach to identify a species commonly employing a dichotomous hierarchical tree in which the user follows a sequential path to the end of the branch, at which time the species of interest is identified. Despite their widespread use by the taxonomic community (Fortuner, 1989; Thompson, 1999), traditional dichotomous keys have serious limitations due to the amount of technical botanical terminology used to describe plant parts and their stylized format. Also writing keys is highly skilled and badly written keys abound. The use of these traditional keys remains a seriously limiting problem for those who lack formal biological training and is an unnecessary limitation to plant conservation and exploitation in many regions of the world.

Specifically there are many difficulties with the available keys to *Medicago* in the literature and the genus lacked of comprehensive set of comparative illustrations (Small and Jomphe, 1989). *Medicago* is considered by many as one of the most difficult plant groups to identify. Possibly the most comprehensive key is provided by Heyn (1963) but only the annual species are included. All of which makes recognising and identifying it by the field workers difficult. To surmount these 'problems' of plant identification and aid conservation and use of genetic diversity, it is necessary for a paradigm shift in biodiversity identification. The conservation and other non-taxonomic communities needs to benefits from recent but well-established developments in computer science to apply innovative methods of plant identification and computer-aided-learning programs, which can be used by professional and amateur communities alike. This Conservation Field Guide is the first of a proposed series that will employ these contemporary techniques to aid non-experts field botanists identify the plant diversity that requires conservation.

1.2 Projected Audience for the Guide

The necessity for such a field guide was underlined by experience gained during the field survey activities of the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP) funded project on "Conservation and Sustainable Use of Dryland Agrobiodiversity in Jordan, Lebanon, the Palestinian Authority and Syria". The field botanists employed to undertake the survey work had little prior experience of using traditional identification aids and this proved a serious project limitation. So the Conservation Field Guides are primarily aimed at field botanists in West Asia, but the projected audience for the guide is much wider. The Guide is aimed at both professional and amateur botanists who need to identify plant species, whether for conservation, the various forms of utilisation or

simply for pleasure. As this particular Conservation Field Guide is for *Medicago* taxa and the genus has its centre of diversity in the Mediterranean Basin and West Asia, it will be most useful to those working in the region or on plants from the Middle East.

1.3 The Process of Identification

Identification is the naming of an organism by reference to an already existent classification (Stace, 1989). Identification can be achieved through recognition of many parts of the plant simultaneously or by analysis of its individual characteristics, or 'characters'. The former requires many years of practice and is the way well-experienced experts, such as botanists, herbalists or farmers identify plants (Lawrence and Hawthorn, 2006). Often when questioned about a particular identification experts are unable to clearly say why the specimen belongs to that species, they just know. In the absence of the years of experience required to establish such knowledge the person attempting the identification resorts to some form of identification aid. Either by comparison of the unknown plant with named specimens from a herbarium, photographs, diagrams or descriptions, or most commonly by the application of dichotomous, diagnostic keys. These are the traditional means of identification which more recently have been complemented by use of multi-access keys and interactive identification programs.

Identification or "determination" of a plant specimen involves two steps; firstly, the decision as to which taxon (e.g. genus, species or subspecies) the specimen represents, and secondly, the decision as to what is the "accepted" name to use for it, if more than one name has been used for that taxon (Maxted and Crust, 1995). The second step is largely related to establishing the accepted name for a taxon; distinguishing between this Latin name and numerous synonyms or misapplied names that have been used for the taxon historically. Establishing which names are accepted is achieved by discussion with an appropriate taxon expert or taxonomic checklist (such as Species 2000 - http://www.sp2000.org/), or simply by using the most recent or most commonly applied name for the taxon in the literature.

Specimens are commonly identified to species, but if lower taxonomic entities have been described they could be named to subspecies, variety, etc. The correct identification of the specimen is achieved by comparing its characteristics to the sets of "key" characteristics possessed by each species. If the specimen's characteristics fall within the range of a species' "key" characteristics, then the specimen is identified as a representative of that species, the range of the "key" characteristics for each species having been previously determined by a detailed study of a broad range of specimens representing that species.

There are basically two forms of identification, matching and elimination. Matching involves the comparison of the specimen to taxon descriptive data or some form of exemplar, such as a named herbarium sheet. Clearly, trying to

match a specimen to one of a large number of possible taxa could be impossibly time-consuming. Some method is needed to narrow down the possibilities. Identification by elimination involves the user in comparing a specimen to a set of mutually exclusive short descriptions and making a decision as to which fits the specimen better, repeating the process for another set of descriptions until only one taxon remains, giving the identification. Often, identification will begin by elimination, and proceed by matching when the range of possible taxa has been narrowed down to manageable proportions.

The identification process using a Conservation Field Guide relies on a combination of simple traditional keys, descriptions, illustrations and more contemporary computer based identification. Using descriptions, photographs or illustrations for identification involves the matching of a particular specimen with the characteristics of known species drawn, photographed or described in text in the guide. While keys help the user focus their search in a section of the guide in which the number of choices is relatively small. Then by scanning the species illustrations a tentative identification can be made, this is often the process used in bird and butterfly guides where few formal keys are included, whereas for plant guides the user will often need to use two or three different characteristics to help narrow their scanning efforts (Stevenson *et al.*, 2003). The best guides are the ones that give references to similar species in each species account. Users can make direct comparisons with these to increase the confidence of a positive identification. Sometimes, one single taxon-specific character among all of those given is enough to identify the species (e.g. a leaf, a flower, a twig, a fruit, or a piece of bark for trees or even a specific habitat type).

Given that identification is often an unconscious process, software tools should try to mimic the way we identify objects naturally and help reduce the user's frustration when the process becomes more explicit. Stevenson *et al.* (2003) suggested that software should: (a) provide training tools and games to let people become familiar with the "cast of characters" slowly, instead of being overwhelmed and confused by having to learn a lot of new things at once; (b) work to reduce the time necessary to identify a species by choosing likely possibilities from a line-up approach; and (c) suggest further queries that will aid in making the final positive identification. Conservation Field guides are a way for people to connect with their environment by putting a specific face on the term "biodiversity". The eco-informatics revolution is helping professional and amateur biologists alike take advantage of the rapid advances in digital technologies to share their knowledge about biodiversity with non-specialists. Non-specialists, in turn, through citizen science projects, are showing that their knowledge of species can be used to help monitor ecological changes as they relate to evolutionary dynamics and more pressing issues such as biodiversity loss, invasive species, and global climate change (Lubchencho *et al.*, 1991).

Currently, the most widely used computer-based programme for the creation and utilisation of identification keys is LUCID (Lawrence and Hawthorn, 2006). LUCID and the majority of interactive computer-based keys function by using a matrix of characters and character states in a database that allows the sorting and querying of data in any formation, for example, the keys allow the characters that are easiest to observe or are the most reliable, to be scored first (Lawrence and Hawthorn, 2006). Computer-based keys usually identify specimens by the process of elimination; character states that are present on the specimen are chosen, and the taxa that possess these attributes are kept and the rest discarded. This process continues until there is only one species remaining, thus confirming the identification of the specimen. The identification can then be validated by matching it with a description (including distribution and ecological preferences), photographs, diagrams and or drawings to obtain the final identification.

What is a Conservation Field Guide necessary? Previous field guides have a focus on identification alone but the authors of this field guide, being professional plant genetic resources conservationists themselves, wish to enhance the conservation value of the guide by including information on current conservation status and threat assessment in the centre of diversity of the genus. Also they further believe it is essential to link conservation to use if the conservation is to be sustainable, there for each species there is additional information of the actual and potential use value.

1.4 Content of the Conservation Field Guide

There is no universal format for what constitutes a field guide, they might focus on a particular habitat, region or taxon, and they commonly presents taxonomic background, morphological descriptions, habitats, behaviour, ecology, distribution maps, uses, conservation notes and simple dichotomous keys suitable for field use, possibly annotated with line drawings, photographs or paintings. The key point is that field guides are likely to contain multiple identification tools rather than just the traditional keys of more formal taxonomic works. The level of technicality and detail can vary in field guides, ranging from a 'pragmatic flora' designed for use in both the herbarium and field and containing extensive taxonomic information, to laminated card guides, which are more portable and often consist primarily of photographs, highlighting the most obvious characteristics of the species (Lawrence and Hawthorn, 2006).

This Conservation Field Guide to Medics includes all of these components, plus notes on the current conservation status, threat assessment and usage which will be include within each taxon statement. As well as the printed guide, this guide, in an attempt to specifically address the problem of non-expert identification, also this guide is accompanied by a CD with an interactive identification system, Lucid, and the *Medicago* data set, specifically designed to help the non-expert identify *Medicago* taxa.

Lucid was developed specifically by the Centre for Biological Information Technology, at the University of Queensland in Australia as a means of helping taxonomists communicate their data sets to non-specialists who wish to identify animals, plants and other organisms. Once constructed the keys are easily shared and distributed via CD-ROM or the internet, particularly using the Lucid website (www.lucidcentral.com). Lucid based keys are accessed via the Lucid Player which provides the interface for users to load and interact with the Lucid keys, using text, images, videos and sounds to help select those taxonomic, diagnostic or other features that best describe the particular case being investigated. The key works by elimination so that as the user selects character states, the program eliminates the taxa that do not possess that state, and this is repeated until a single taxon remains and the identification is achieved. Once a specimen has been identified to a particular taxon the user is provided with a full range of multimedia fact sheets, sub-keys for infra-specific taxa or links to websites for further information or recommendations. Lucid keys can be built in various languages and use terminology familiar to the user, allowing the package to be used internationally and across a wide range of capabilities. Potential users range from biologists, geologists, agriculturists, veterinary and medical scientists to university and high-school students and the public at large. Details on operation of the Lucid key are provided in Appendix 1.

1.5 Conservation Field Guide Construction

Although the production of this field guide is directly associated with the problems encountered during the field survey activities of the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP) funded project on "Conservation and Sustainable Use of Dryland Agrobiodiversity in Jordan, Lebanon, the Palestinian Authority and Syria", the realisation of the need for Conservation Field Guides, and therefore the gestation of the project, has been much longer. In fact at least since the explosion in crop and wild species conservation in the 1960s, the problem of identification of wild species has been appreciated by professional conservationists. As such the data sets used to construct this volume have been accruing for the same time period.

The methodology employed for Conservation Field Guide construction is an adaptation of Maxted (1996) and involves the following stages:

- The taxon group is selected and delimited.
- Diagnostic characters were selected which distinguish each taxon from related taxa.
- All taxa are scored for the character set producing a data matrix.
- Data matrix entered into DELTA (Dallwitz *et al.*, 2000) format and descriptions and dichotomous keys generated using the DELTA associated programs TONAT and KEY.
- DELTA format descriptive data were then imported to LUCID via Lucid Translator, manipulated in Lucid Builder which generated the interactive key

that may be viewed with Lucid Player.
- To aid visual identification various illustrations (line drawings and photographs) were prepared.
- An ecogeographic survey was undertaken to collate the necessary geographic, ecological, taxonomic and genetic data to complete the conservation element of the field guide.

The process that was followed for the 'Conservation Field Guide to Medics' is described in the following sections.

1.5.1 Selection and delimitation of the study group

The study group are all *Medicago* species worldwide as defined by Small and Jomphe (1989), plus those few species more recently described. *Medicago* are economically important forage legumes, they are globally used as a quality fodder for the livestock and as ornamental species. *Medicago* is extremely useful in agricultural systems as green manure and as an environmental plant for the sustainable conservation and land improvement especially in the dry areas, because the drought tolerance and the fast growing as a green weed. *Medicago* is composed of about 84 species and 9 subspecies (ILDIS, 2006), most of which are present in the Mediterranean basin countries and the Mediterranean Basin and West Asia region and these are covered by the guide.

1.5.2 Selection of characters

Selection of characters is an important step for producing a good key. Characters need to have a high content of information and be easy to distinguish in the field or the laboratory. Many literatures used to select the characters for this study include Floras, monographs, published papers, and previous identification keys. For *Medicago* these included: Heyn (1963), Davis (1970), Townsend (1974), Lesins and Lesins (1979), Zohary (1984), and Small and Jomphe (1989), as well as personal observation by the field guide authors. The characters are of morphological nature most of which are easily determined in the field though some require a hand lens. One hundred and five characters were chosen with maximum number of state of ten. Most of the characters were given few states to avoid the loss of information. Few states per character are preferable, because making an objective choice between states is difficult when there are too many options (Askevold and O'Brien, 1994). The character set is included in Appendix 2.

1.5.3 Scoring of taxa for characters

Eighty-three species and nine subspecies were scored for the selected characters depend on the species description in the Floras, Monographs, and other literatures. Some species have a comprehensive description in the literatures, and some have a brief one depend on the literature resource. For those, which have a brief one, gaps of information in the description were filled from herbarium specimens from herbaria (Royal Botanical Gardens, Edinburgh, UK; and ICARDA, Aleppo, Syria). It was difficult to score the characters, which related to flowers from the old dried

specimens. Most of the characters were given few states to avoid the loss of information. Any character states which were unknown or couldn't be scored from the herbarium specimens were ignored. Characters were only scored if they were actually mentioned in the description, or seen in the herbarium specimens. Thus no assumption were made

1.5.4 Computer aided description and key generation

The DELTA system has three main files, which are constructed from the character list (file - CHARS), the character scores for individual taxa (file - ITMS) and the directive information (file - SPECS). Creating these files is explained in details in the "User's Guide to the DELTA System" Edition 4.12 by (Dallwitz *et al.*, 2000). All data was checked for errors using the standard DELTA error checking directive file (file – CHECK) and any errors encountered corrected. Once the three data files were completed, the description generating directive file (file – TONAT) was used to generate the natural language description and the key generating directive file (file – TOKEY) were used to create natural language descriptions and keys via the DELTA associated programs CONFOR and KEY respectively.

1.5.5 Production of Lucid key for interactive identification

Lucid Professional is a complete system for developing and distributing multimedia tools (keys) for identification, diagnosis and other purposes. As the identification data was initially held in DELTA format the data was imported to Lucid using the Lucid Translator and then manipulated using Lucid Builder. At this stage the descriptions, ecogeographic summary, distribution maps, illustrations and photographs were attached to the taxa using Lucid Builder. The Lucid Builder allows to design and build identification or diagnostic keys for any group of organisms, objects or problems, and to illustrate keys with notes, HTML pages, audio files, images and video clips. Character scores can be imported from DELTA or entered direct into Lucid Builder using a simple point-and-click procedure. Once complete the interactive key was generated by Lucid Builder and then was run using Lucid Player.

The Lucid Player provides the interface by which users can load and interact with Lucid keys, using text, images, videos and sounds to help select those taxonomic, diagnostic or other features that best describe the particular case being investigated. As the user selects character states, Lucid narrows down the particular options, such as specific taxa or causes of particular symptoms. When the user of a Lucid key is deciding which character states or symptoms best describe the particular specimen or problem of concern, multimedia material, such as line drawings, photographs, videos or sounds, can be used to help make the right decision. Once a specimen has been identified to a particular taxon or a diagnosis made. Lucid keys can provide the user with a full range of multimedia fact sheets, sub keys or links to websites for further information or recommendations. Lucid keys can be built in various languages and use terminology familiar to the user, allowing the

package to be used internationally and across a wide range of capabilities. Notes on the use of the CD are included in Appendix 1.

The keys had to be manipulated by increasing or decreasing characters reliability to produce the preferable key. They key had to be edited with the text editor in order to make it more user friendly. The multi-access key need less modification compared to the single-access keys. The tabular keys suffered from being in a slightly different format to the character list, the keys use letters for the character states while the character listed use numbers. If the character list were to written initially using letters, this would aid easily understanding the tabular key; however, this would be unsatisfactory for the bracketed key and interactive key.

1.5.6 Illustrations

One of the unfortunate problems associated with non-specialists learning to use traditional keys is the amount of technical botanical terminology involved. However, the problem can be circumvented somewhat by providing illustrations (line drawings, photographs, paintings etc) of taxa or the key features necessary for identification, hence avoiding recourse to complex terminology. The use of illustrations, when combined with technical terminology, can not only aid identification, but can also help the user learn and understand the meaning of the botanical terminology used. The relative efficacy of using line drawings, paintings or photographs to aid identification is a matter of subjective assessment and individual preference. However, one problem associated with using photographs for identification is that they can only show what is observed at that time in a two dimensional image, whereas with a drawing or painting the illustrator can enhance the observed two dimensional image to include features that may be less obvious on an individual specimen or in that particular plane of view. For this reason line drawing illustrations are provided for fifty taxa and are included in the ecogeographic conspectus, as well as complex character states along with the photographs.

1.5.7 Ecogeographic survey

An ecogeographic survey is defined by Maxted *et al.* (1995) as: "an ecogeographic survey is an ecological, geographical and taxonomic information gathering and synthesis process. The results are predictive and can be used to assist in the formulation of collection and conservation priorities". Ecogeographic studies involve the collation and analysis of large and complex data sets obtained from the literature and from the passport data associated with herbarium specimens and germplasm accessions. The data compiled are of four basic kinds: ecological, geographic, taxonomic and genetic. These data are synthesised to produce three basic products: the database - which contains the raw data for each taxon; the conspectus - which summarises the data for each taxon; and the report - which discusses the contents of the database and conspectus, as well as proposing future conservation priorities and a coherent strategy. As such undertaking an ecogeographic survey is essential for efficient and effective conservation, for example it helps identify

centres of plant diversity taxonomic and genetic diversity, areas that require *ex situ* collection and where *in situ* genetic reserves may best be sited. The methodology used for the ecogeographic survey is that proposed by Maxted *et al.* (1995).

1.6 General Information on Taxa Covered

Alfalfa, Lucerne or Purple Medic (*Medicago sativa*) is the most important forage crop in the world. The name alfalfa is derived from the Arabic for "best fodder" (). Lesins and Lesins (1979) believe that the word alfalfa can also be traceable to the Iranian word "aspoasti" meaning horse fodder. In fact the importance and spread of this species as a crop probably itself lies in the importance of the horse in early societies. The cultivation of alfalfa is thought to have originated in South-western Asia.

It is known that the value of alfalfa (Lucerne) as animal feed is unparalleled, as it has highest Total Digestible Nutrients (TDN) of all fodder crops (Gateway, 2006). The economic importance of any forage crops is related to the numbers of the livestock in that area, the size and the spread of livestock industries like dairy farming and processing are related to the available sources of alfalfa and the availability of producing this important fodder. Animals can eat alfalfa as a food in different ways; it can be used as fresh green fodder, it made into silage (a moist feed which is preserved by fermentation in anaerobic conditions), it can be used as fields pasture and rangelands but it does not tolerate close grazing well, most commonly it cut, dried, baled and fed as hay. Alfalfa is generally grown alone but can also be mixed with grasses or other legumes. It is extensively sown under irrigation. The leaves are highly nutritive and are often dried for 2.5-5% inclusion in animal feeds as a source of vitamin A and other nutrients. Unfortunately, the leaves are easily lost in haymaking. Good hay can be machine threshed so that the stems can serve as roughage, and the leaves can be used in concentrate mixtures. Sun-dried leaves contain less vitamin A than artificially dried leaves but provide vitamin D instead. Where alfalfa can easily be grown, it is regarded as key forage for high-producing ruminants because of its richness in protein, palatability and high calcium and vitamin content. In many cases animals feeding on alfalfa do not require supplements. It should be harvested before full flowering; the nutritive value and digestibility are lower after blooming.

Keuren and Marten (1972) defined the agriculture value of alfalfa as a: "superior pasture legume for many classes of livestock because of its high yield, forage quality, wide climate and soil adaptation. It is a dependable and economical protein source for the grazing animals due to its independence of soil nitrogen. The protein is of good quality, especially important for non-ruminants on pasture. Alfalfa is an excellent source of calcium, magnesium, phosphorous, and vitamins A and D. Intake of alfalfa is usually greater than of the grasses of equal digestibility. Alfalfa provides greater flexibility for livestock producer than many other pasture legumes. Because of upright growth habit and rapid recovery it lends itself to harvest as hay

and silage, as well as pasture. This flexibility is desirable in livestock areas where harvested feed utilised for portions of the year. It is drought resistance and also provides more uniform seasonal growth pattern than that the most legumes and grasses"

The annual species of *Medicago* has been used as a source of germplasm for the alfalfa breeding programs, to improve the productivity and as a source of supplying nitrogen to other crops. Annual species have been extensively used as winter forage and green manure crops in Mediterranean region. They have the potential for producing a high yield of quality forage, and could be used as short-season annual crops for harvest in autumn and summer when forage supplies may be inadequate (Zhu *et al.*, 1996). In general legumes provide an important genetic resource throughout the world, only ranking second to the Gramineae in economic importance to man (Heywood *et al.*, 2006). *Medicago* is one of the most important legume genera, which has an important agricultural value outside of its direct feed value due to its ability to fix nitrogen and improving the soil characteristics.

2. TAXONOMIC AND ECOGEOGRAPHIC BACKGROUND

2.1 Taxonomy of *Medicago* L.

2.1.1 The family Leguminosae (Fabaceae)

The genus *Medicago* L. is one of approximately 727 genera contained within the family Leguminosae (Lewis *et al.*, 2005) and the medics are members of subfamily Papilionoideae (Fabaceae, Faboideae, Papilionaceae). The Leguminosae are a morphologically diverse family, ranging from trees to aquatics to xerophytes, and ranks second only to the Gramineae in economic importance (Heywood et al., 2006). The family contains approximately 19,327 species, and is the largest family of plants after the Compositae and Orchidaceae (Lewis *et al.*, 2005). The family is normally divided by taxonomists into three sub-families, Mimosoideae, Caesalpinioideae and Papilionoideae, of which the latter is the largest and contains largely herbs and shrubs with a few trees. The Papilionoid legume species are distributed through temperate, sub-tropical and tropical regions of the world (Polhill *et al.*, 1981). The leaves are usually pinnate; the flowers are irregular with lateral petals enclosed by the standard in the bud; there are usually 10 stamens, commonly diadelphous but sometimes monadelphous or free. The Papilionoideae have been traditionally divided into 10 or 11 tribes on the basis of habit, vegetative and floral characters. More recently legume taxonomists have tended to increase the number of tribes; Gillett *et al.* (1971) used 17 tribes and Polhill (in Lackey 1977) suggests a complete break with prior tribal delimitations to form 31 tribes, while Polhill *et al.* (1981) divide the sub-family into 32 tribes. This sub-family is probably second only in economic importance to the Gramineae yielding foodstuffs, timber, vegetable extracts and ornamental plants (Townsend, 1974). Recent phylogenetic analysis of the Leguminosae using the 319 *rbc*L sequence has highlighted the monophyly of the Papilionoideae. Although a few major clades were well supported, the overall topology for the sub-family was unresolved (Kajita *et al.*, 2001); however one of the strongest clades contained the taxa from the Trifolieae. The tribe Trifolieae is considered relatively advanced and is placed twenty-first in Polhill classification (Polhill et al, 1981).

Compared with other families, the *Leguminosae* are notably 'generalists' ranging from forest giants to tiny ephemerals, with great diversity in their methods of acquiring the essentials for growth, reproduction and defence. The family is to be found in all terrestrial habitats from the equator to the polar fringes, it has much of its diversity centred in areas of varied topography with seasonal climates, as is the case for *Medicago* in the Mediterranean basin. The versatility of legumes enhances their great economic importance, which is likely with increased human pressure on marginal lands (Polhill *et al.*, 1981).

2.1.2 The tribe Trifolieae (Bronn) Benth.

The tribe Trifolieae was considered by Heyn (1981) in her review in the sense of Bentham (1865) to include *Ononis* L. (1753), *Parochetus* Buch.-Ham. Ex D. Don (1825), *Melilotus* Mill. (1754), *Trigonella* L. (1753), *Factorovskya* Eig. (1927), *Medicago* L. (1753) and *Trifolium* L. (1753). Though more recently the monospecific *Factorovskya* was sunk by Small and Brooks (1984) into *Medicago* L. an in the contemporary sense the Trifolieae contains 6 genera and about 485 species (Lock, 2005). Heyn (1981) does note that *Ononis* was included in the Genisteae by Bronn (1822) and separated from the Trifolieae by Taubert (1891), placed in the monotribal Ononideae by Hutchinson (1964), and kept separately by Davis (1970), Zohary (1972), Townsend (1974) and Meikle (1977). Also Small and Jomphe, (1989) mentioned that *Ononis,* and *Parochetus* are not closely related to the tribe and there relationships are in need of study. On the basis of ovule morphology and position of seeds in the pod Schulz in (1901) divides the tribe into two sub-tribes; sub-tribe Trifolieae contains *Trifolium, Ononis,* and *Parochetus* while sub-tribe Trigonelleae contains *Medicago, Trigonella* and *Melilotus*. In *Trifolium, Trigonella, Medicago* and *Melilotus* the basic chromosome number is x=8 and the great majority of species are diploids (2n=16), a few are tetraploids (2n=32); higher polyploid levels are very rare; reduction of the basic number below x=7 has been found only in *Trifolium.* Although Heyn (1981) notes that this division of the genera into two sub-tribes has not been accepted widely in the botanical literature.

There is a close relationship between *Medicago, Trigonella* and *Melilotus,* this is the main reason of the confusing between them and has resulted in numerous species transfers between these genera leading to abundant synonymy (Small *et al.*, 1987; Lock, 2005). Small and Brookes (1984) sank *Factorovskya aschersoniana* Urb. in *Medicago* as *Medicago hypogaea* E. Small, because the single species possessing all the diagnostic features of *Medicago*. Delimitation of *Melilotus* is not so controversial and the main area of contention has concentrated on the relationships between *Medicago* and *Trigonella* (Small *et al.*, 1987). Recent morphological and molecular phylogenetic studies (Chappill, 1995; Doyle, 1995; Liston, 1995; Endo and Ohashi, 1997; and Wojciechowski *et al.*, 2000) do not support a monophyletic origin for the Trifolieae and further study is required to resolve these issues (Lock, 2005), possibly resulting in the grouping of *Medicago, Trigonella* and *Melilotus* in the tribe Trigonelleae as suggested by Schultz (1901).

Heyn (1981) goes on to note that there are problems in the delimitation of some of the genera within the Trifolieae (see Sirjaev, 1935; Heyn, 1959; Baum, 1968), often trying to apply new criteria to the generic delimitation of *Trifolium, Trigonella* and *Medicago*. The existence of species intermediate between these genera bears witness to the close relationship between them. Note that in the past 10 years *Medicago* has grown significantly from 65 to 85 species with the transfer of 23 species from *Trigonella*. The Trifolieae are a group of genera with advanced characters, but it does not seem possible to point out any ancestors common to it and

any other tribe. The geographic distribution of the genera are distinct (Meusel and Jaeger, 1962), however, the Mediterranean basin may be considered as the main centre of diversity of the tribe in general, whereas the species with the most primitive characters in *Trigonella* and *Medicago* occur mainly in Central Asia. *Trifolium* is the only genus which occurs outside the Eastern Hemisphere and has a centre in the Americas. All genera include many synanthropic species. Heyn (1981) provides the following key to the genera included:

1. Stamens monadelphous (very rarely vexillary stamen partly free); anthers dimorphic; plants often viscid; keel acute to rostrate ..... *Ononis*
1. Stamens diadelphous; anthers monomorphic; plants not viscid 2
2. Keel of flowers somewhat acute; stipules not adnate to petiole; a creeping herb of tropical Asia and Africa rooting from the nodes ..... *Parochetus*
2. Keel of flowers obtuse, rarely subacute; stipules at least partly adnate to petiole; not creeping herbs, except for rare cases in *Trifolium* 3
3. Petals often persisting in fruit; filaments dilated below anthers; fruit 1-few-seeded, often indehiscent and included in calyx; leaves usually digitately, sometimes pinnately 3(-7)-foliolate ..... *Trifolium*
3. Petals not persisting in fruit; filaments not dilated; fruit usually more than 1-seeded, not included in the calyx; leaves pinnately 3-foliate 5
4. Fruits usually coiled, very rarely falcate, scarcely dehiscent, often spiny; flowers with explosive tripping mechanism ..... *Medicago*
4. Fruits not coiled, dehiscent or indehiscent, never spiny; flowers without explosive tripping mechanism 5
5 All fruits buried in the soil as the result of gynophore growth after fertilisation ..... *Factorovskya*
5 No fruits buried in soil 6
6 Fruit nutlet-like, 1-few-seeded, mainly indehiscent, often withsculptured surface; flowers in racemes ..... *Melilotus*
6 Fruit a straight or rarely falcate legume, usually many-seeded and dehiscent; flowers single, in heads or racemes ..... *Trigonella*

Heyn (1981) also provides the following description of the Trifolieae:

"Annual or perennial herbs, rarely shrubs; leaves pinnately or digitately 3-foliolate (rarely 1- or 5-7-foliolate); veins of leaflets usually extended to the teeth or the margin; stipules ± adnate to the petiole (in *Parochetus* nearly free); inflorescence auxiliary, exceptionally terminal; flowers in few-many-flowered capitate or spicate racemes or flowers solitary; bracts usually present, bracteoles absent; calyx campanulate, usually with 5 subequal lobes; stamens diadelphous (9 filaments united into staminal tube, vexillary stamen free) or monadelphous (all united); free part of filaments filiform or dilated at apex; anthers monomorphic or dimorphic; ovary sessile or stipitate; ovules 1-many; style glabrous, straight to bent; fruits various: straight, falcate, spirally coiled or ovate, included in or exserted from the calyx, dehiscing

by one or both sutures, or indehiscent; seeds exarillate; seed coat smooth, tuberculate or verrucose. Seedlings epigeal, eophylls alternate or crowded, first 1(-3) l-foliolate. 2n usually = 16, (30, 32, 64). Canavanine often present. 7 genera, Eurasian, extending thinly to Africa, the Americas, and exceptionally to Australia."

The genus *Medicago* is economically the most important in terms of forage diversity in the temperate world and the adaptability of the Leguminosae enhances their great economic importance, which is likely to increase with increased human pressure on marginal lands (Polhill *et al.*, 1981).

2.1.3 The genus *Medicago* L.

Linnaeus (1753) recognised 22 *Medicago* species, but Urban (1873) was the first to produce a comprehensive monograph of *Medicago*, recognising 46 species. This was followed one hundred years later by the first contemporary monograph of the genus by Lesins and Lesins (1979), in which they formally accepted 56 species. Subsequently, extensive taxonomic study has been undertaken Ernest Small in Canada (Small *et al.*, 1987; Small, 1987a; 1987b; 1989). His studies provided further clarification of generic limits and resulted in a broader generic concept, transferring several former *Trigonella* into the genus, which now contains 85 accepted species (Small and Jomphe, 1989). These changes included the transfer of the monotypic *Factorovskya* to *Medicago* as *M. hypogaea* (Small and Brookes, 1984) and the inclusion of 23 species from *Trigonella* to *Medicago* by Small (1987a). This transfer is supported by recent molecular phylogenetic studies (Bena *et al.*, 1998a and b). Small and Jomphe (1989) then distinguish *Medicago* from *Trigonella* species on the basis of floral characters, *Medicago* species possessing typical Papilionaceous corolla with nine stamens fused to form a staminal column, the tenth stamen being free, and together the corolla and the staminal column form the tripping mechanism characterising the entire genus. The genus contains both selfing and outbreeding species (Small *et al.* 1987). The most comprehensive taxonomist study of *Medicago* is by Small and Jomphe (1989) in which the species are distributed between 12 section and 8 subsections (see Table 2.1). Most of the sections used by Small and Jomphe (1989) represent taxonomic reduction from existing taxa erected by Lesins and Lesins (1979); subgenera have been reduced to sections of the same name, e.g. subgenus *Medicago* in Lesins and Lesins (1979) becomes section *Medicago* in Small and Jomphe (1989) and incorporates all the sections and subsections of the former subgenus (except section *Arboreae*). Section *Arborea* has become section *Dendrotelis* in Small and Jomphe (1989).

2.2 Ecogeographic Background

The foundation of the ecogeographic survey was primarily literature based with additional data collated from the passport data of herbarium specimens (Royal Botanic Gardens, Kew and Edinburgh and the Natural History Museum, London)together with all accessions held in the ICARDA genebank.
About 400 specimens of *Medicago* have been observed during the survey for

more than 84 species of *Medicago*. The main purpose of the herbarium specimen survey was to collecting taxonomic information and filling the gaps in species description and in the selected characters. The survey covered *Medicago* species worldwide. Each specimen has been characterized to obtain the morphological and botanical characters, as well the ecological and geographical information.

2.2.1 Delimitation of the target area

Ideally when undertaking an ecogeographic study the target taxon should be studied throughout its range to obtain an accurate and unbiased overall picture of the genepool (Maxted *et al.*, 1995). However, in the case of *Medicago*, which is mainly spread in the west and central Asia, the taxonomic, botanical and ecological information were collected for all species in the world using data published by Small and Jomphe (1989), ILDIS (2006) and personal observation in the centre of diversity of *Medicago*, so the field guide covers the global distribution of medics however the line drawing illustration focus on the 50 species which are most commonly found in west central Asia and north Africa. The native distribution for these species is summarised in Table 2.2.

Table 2.1. Classification of *Medicago* L. (Small and Jomphe, 1989).

Section	Subsection	Species
Dendrotelis (Vassilcz.) Lassen.		2 species
Medicago L. (= section *Falcago* (Reichenb.) Gren. & Godr.).		12 species
Carstiensea Kozukharov.		1 species
Spirocarpos Ser.		
	Pachyspireae (Urb.) Heyn.	13 species
	Rotatae (Urb.) Heyn.	7 species
	Intertextae (Urb.) Heyn.	4 species
	Leptospireae (Urb.) Heyn.	11 species
Geocarpa Small.		1 species
Section *Lupularia* Ser. in DC.		2 species
Heynianae Greuter.		1 species
Orbiculares Urb.		1 species
Hymenocarpos Ser. (= Section Medicago)		1 species
Platycarpae E. Small		8 species
Lunatae (Boiss.) E. Small		4 species
Buceras (Ser.) E. Small		
	Erectae (Sirj.) E. Small	15 species
	Deflexae (Sirj.) E. Small	1 species
	Reflexae (Sirj.) E. Small	1 species
	Isthmorcarpae (Boiss.) E. Small.	species

Table 2.2. Native distribution range of *Medicago* species in centre of diversity.

Medicago	Portugal	Morocco	France	Libya	Russia	Jordan	Syria	Caucasus	Iran
Species	Spain	Algeria	Italy	Egypt	Turkey	Palestine	Lebanon		Afghanistan
		Tunisia	Balkans		Ukraine		Iraq		
arborea	√		√		√				
strasseri			√						
sativa	√	√	√	√	√	√	√	√	√
sativa subsp. *caerulea*					√			√	√
sativa subsp. *sativa*	√	√	√	√	√	√	√	√	√
sativa subsp. *glomerata*	√	√	√	√	√	√	√	√	√
sativa subsp. *falcata*	√	√	√	√	√	√	√	√	√
sativa subsp. *xvaria*	√	√	√	√	√	√	√	√	√
papillosa					√			√	
papillosa subsp. *papillosa*					√			√	
papillosa subsp. *macrocarpa*					√			√	
prostrate			√						
rupestris					√				
cancellata					√				
rhodopea			√						
saxatilis					√				
daghestanica						√			√
pironae			√						
hybrida			√						
suffruticosa	√	√	√						
suffruticosa subsp. *suffruticosa*	√	√	√						
suffruticosa subsp. *leiocarpa*	√	√	√						
marina	√	√	√	√	√	√	√	√	
carstiensis			√						
soleirolii	√	√	√		√				
italica	√	√	√	√		√	√		
littoralis	√	√	√	√	√	√	√	√	

Table 2.2. (continued).

Medicago	Portugal	Morocco	France	Libya	Russia	Jordan	Syria	Caucasus	Iran
Species	**Spain**	**Algeria**	**Italy**	**Egypt**	**Turkey**	**Palestine**	**Lebanon**		**Afghanistan**
		Tunisia	**Balkans**		**Ukraine**		**Iraq**		
truncatula	√	√	√	√	√	√	√	√	√
doliata	√	√	√		√	√	√		
turbinata	√	√	√	√	√	√	√		√
rigidula	√	√	√	√	√	√	√	√	√
constricta			√		√	√	√	√	
lesinsii		√	√			√			
murex	√	√	√	√		√	√		
rugosa	√	√	√			√	√		
scutellata	√	√	√		√	√	√		
blancheana	√		√		√	√	√		
rotata		√			√	√	√		
noeana					√		√		
shepardii					√				
intertexta	√	√	√	√	√	√	√		√
ciliaris	√	√	√		√	√	√		√
muricoleptis			√						
granadensis			√	√		√	√		
sauvagei		√							
laciniata		√		√		√	√		√
minima	√	√	√	√	√	√	√	√	√
praecox	√		√		√		√		
coronata	√		√	√	√	√	√		√
polymorpha	√	√	√	√	√	√	√	√	√
laxispira							√		
arabica	√	√	√	√	√	√	√	√	√
tenoreana	√		√						
disciformis			√	√					
lanigera									√
hypogaea				√		√	√		
lupulina	√	√	√	√	√	√	√	√	√
secundiflora	√	√	√						
heyniana			√		√				
orbicularis	√	√	√	√	√	√	√	√	√
radiata			√			√	√	√	√
plicata					√				
platycarpa					√				
ruthenica					√				
popovii									
archiducis-nicolai									

Table 2.2. (continued).

Medicago	Portugal	Morocco	France	Libya	Russia	Jordan	Syria	Caucasus	Iran
Species	Spain	Algeria	Italy	Egypt	Turkey	Palestine	Lebanon		Afghanistan
		Tunisia	Balkans		Ukraine		Iraq		
edgeworthii									√
cretacea					√				
ovalis	√	√							
rostrata					√				
biflora					√		√		√
brachycarpa					√		√	√	√
huberi					√				
astroites					√	√	√		√
halophila					√				
arenicola					√				
heldreichii					√				
phrygia					√		√		√
fischeriana					√			√	√
persica							√		√
medicaginoides						√			√
rigida					√				
crassipes					√		√		√
pamphylica					√				
carica					√				
monantha					√	√	√	√	√
orthoceras					√		√	√	√
polyceratia	√	√							√
retrorsa									√
monspeliaca	√	√	√	√	√	√	√	√	√
rhytidiocarpa					√				
isthmocarpa					√				
rigiduloides							√		√
syriaca					√		√		

Having established the general target area, taxonomic and ecogeographic information on local geographical distribution and ecological preferences for *Medicago* species and further detailed information was obtained from local Floras and monographs identified using Frodin (2001). These included:

Boulos, L., (1999). *Medicago* L. in Flora of Egypt, Volume 1: 267-276. Al-Hadara Publishing. Cairo.

Davis, P.H., (1970). *Medicago* L. in Flora of Turkey and the East Aegean Islands, Volume 3: 483-511. Edinburgh University Press, Edinburgh.

Dominguez, E., (1987). Flora Vascular de Andalusia Occidental. Ketres, Barcelona.

Grossheim, A.A., (1945). *Medicago* L. in Flora of the U.S.S.R., Volume XI: 129-189. Nauka, Moscow and Leningrad.

Heyn, C.C., (1984) *Medicago* L. in Flora Iranica, Volume 157: 253-274. Akademische Druck- u. Verlagsanstalt, Graz.
Mouterde, P., (1966). *Medicago* L. in Nouvelle Flore du Liban et de la Syrie, Volume 2: 252-265. Librairie Orientale, Beirut, Lebanon.
Negre, R. (1961). Petite flore des régions arides du Maroc occidentale Volume 1. Centre National de la Recherche Scientifique, Paris.
Parsa, A., (1948). Flore de l'Iran, Volume 2. Imprimerie Mazaheri, Teheran.
Quezel, P. and Santa, S., (1962). Nouvelle flore de l'Algérie et des régions désertiques méridionales, Volume 1. Centre National de la Recherche Scientifique, Paris.
Tackholm, V., (1956). Students' flora of Egypt. Cairo University Press, Cairo.
Townsend, C.C. (1974) *Medicago* L. in Flora of Iraq, Volume 3: 112-142. Ministry of Agriculture and Agrarian Reform, Baghdad.
Turland, N.J., Chilton, L. and Press, J.R., (1993). Flora of the Cretan area. Her Majesties Stationary Office, London.
Tutin, T.G., (1968). *Medicago* L. in Flora Europaea, Volume 2: 153-157. Cambridge University Press, Cambridge and London.
Zohary, M., (1978). *Medicago* L. in Flora Palaestina, Volume 2: 137-153. Israel Academy of Sciences and Humanities. Jerusalem.

2.2.2 Ecogeographic conspectus

The genus *Medicago* as circumscribed by Small and Jomphe (1989), contain 85 species with a native distribution centred on the Mediterranean basin and spreading into Northwest Asia. The ecogeographic conspectus comprises a summary of the ecogeographic information available for these taxa. Where available the following information is provided for each taxon included in the genus:

- Accepted taxon name, author(s), date of publication, where published
- Synonyms for each taxon with author(s), date of publication, where published
- Description
- Chromosome number
- Closely related species
- Habitat
- Distribution map
- Geographical distribution (countries from which the taxon recorded) and if it is N: native, I: introduced or U: uncertain (derived from personal study and ILDIS, 2008).
- Conservation and threat assessment (derived from personal study, IUCN, 2008 and ILDIS, 2008)
- Actual and potential usage
- Line drawing illustration
- Photographs

3. CONSERVATION FIELD GUIDE CONSPECTUS

3.1. *Medicago arborea* L., Sp. Pl.: 778 (1753).

Synonyms: *M. arborescens* C. Presl, Fl. Sic. 1: 20 (1826); Ic: Sibth. & Sm, Fl. Gr. 8: t. 768 (1835); *Medicago arborea* L. subsp. *citrina* (Font Quer) O. Bolos & Vigo, Bull. Inst. Catalana Hist. Nat. 38: 69 (1974); *Medicago citrina* (Font Quer) Greuter, Willdenowia 16: 112 (1986).

Perennial shrub, 100-400 cm, vegetative parts densely pubescent, with appressed, white silky simple hairs. Stipules triangular, margin entire. Leaflet 10-20 x 8-18 mm, ovate to obovate, apex truncate, dorsally some times glabrous or densely pubescent, ventrally densely pubescent, with appressed hairs, margins with scarcely noticeable tooth or entire. Peduncle with 7-14 flowers, longer than the corresponding petiole, with terminal cusp. Flower 11-13 mm. Pedicle longer than the calyx tube, bract much shorter than the pedicel, calyx equalling half of the corolla, teeth shorter than tube. Corolla green to yellow, standard elliptical. Pods coiled, densely pubescent, with glandular hair, green-brown to yellow, flat, discoid, spineless, not sessile, face reticulate, centre with a large opening. Coil number 0.5-1.5, diameter 10-15 mm, flat, veins numerous and slender, anastomosing near the ventral suture, venation is a net of veins. Seeds 3-4.5 x 2-3 mm, brown, 2-8 per pod, separated with thin spongy partition between them, radicle equalling or more than half seed length.

Chromosome number: 32.

Closely related species: It is a relatively easily distinguished species, but has similar but larger fruits than *M. strasseri*.

Habitat: Preferring rocky hillsides, generally in dry soils.

Geographical distribution: Africa: Canary Is (U), Ethiopia (I), Tunisia (N), South Africa (I) Asia: China (I) Australasia: Australia (I), Tasmania (I). Australia: Queensland Europe: Albania (N), Balearic Is (N), Crete (N), France (I), Greece (N), Italy (N), Malta (I), Monaco (N), Portugal (I), Sardinia (U), Sicily (I), Spain (N) Middle East: East Aegean Is (Greek) (N), Israel-Jordan (U), Palestine (U), Turkey in Asia (N) Pacific Ocean: New Zealand (I) South America: Chile (U).

Conservation and threat assessment: Not threatened, but as *Medicago citrina assessed as* Critically Endangered (CR B1ab [iii, v] + 2ab [iii, v]).

Actual and potential usage: Environmental and ornamental.

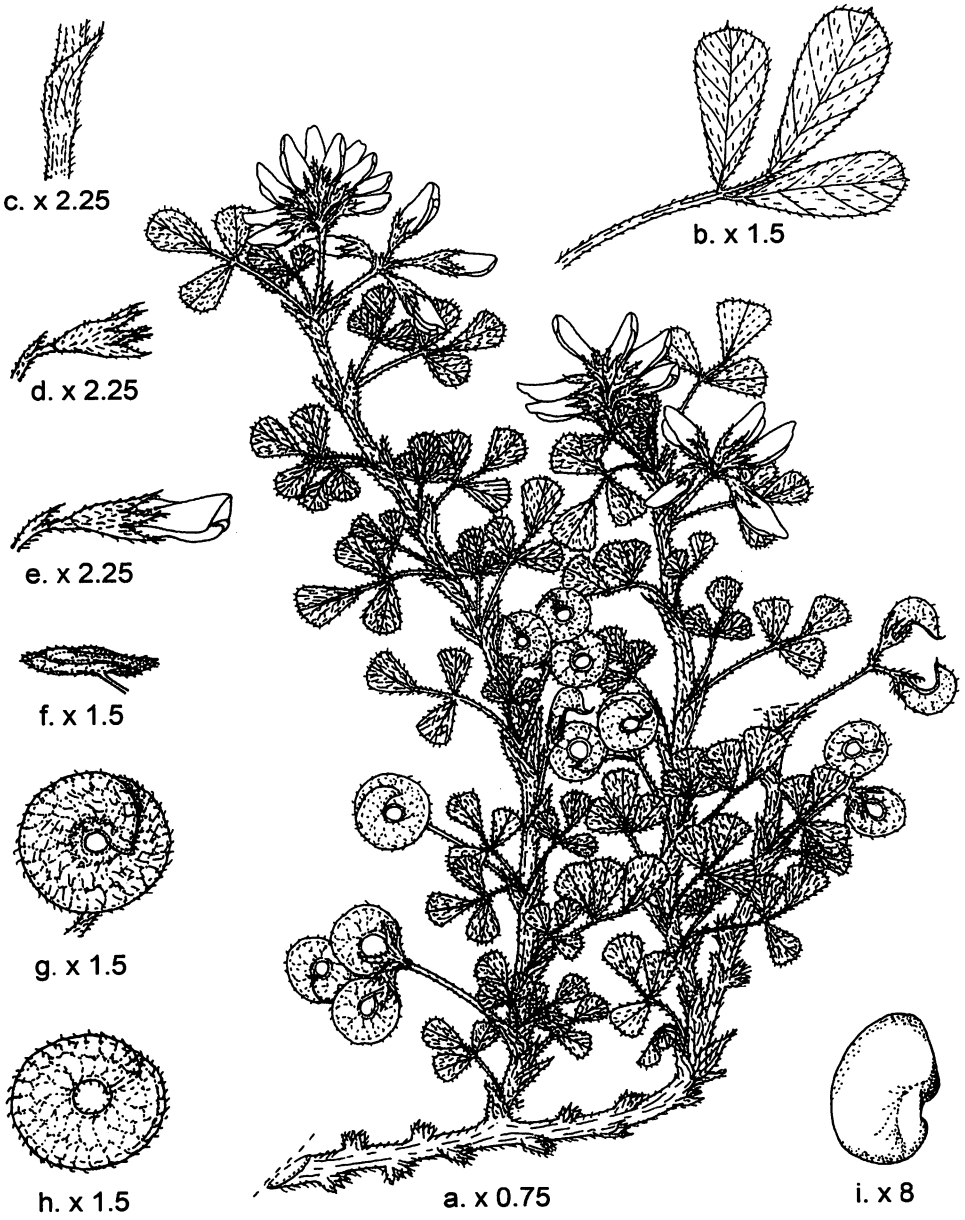

Figure 3.2. *Medicago arborea*: a, habit (x 0.75); b, leaflet (x 1.25); c, stipule (x 2.25); d, calyx (x 2.25); e, flower (x 2.25); f, pod side view (1.5); g, pod tip view (x 1.5); h, pod venation(x 1.5); i, seed (x 8).

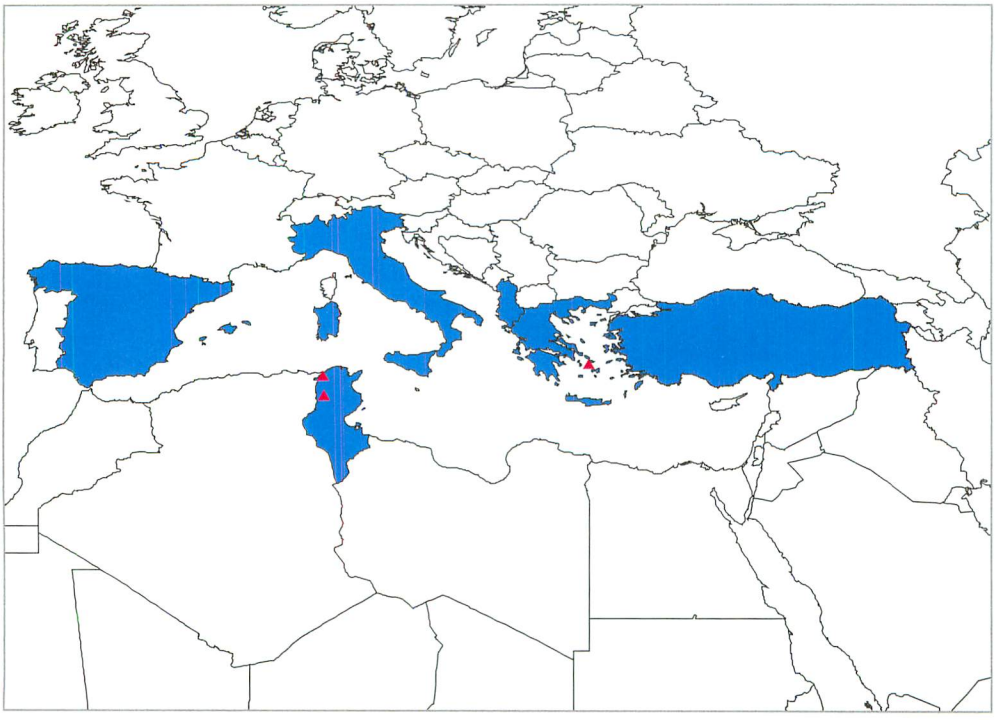

Figure 3.1. Geographical distribution *of Medicago arborea* L. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.2 *Medicago strasseri* Greuter, Matthas & Risse, Willdenowia 12(2): 201-206 (1982).

Perennial shrub, 100-400 cm, vegetative parts densely pubescent, with appressed, simple or glandular hairs. Stipules triangular, margin dentate. Leaflet obovate, apex apiculate or retuse, base cuneate, ventrally densely pubescent, margins at apex dentate. Peduncle with 6-12 flowers, shorter than the corresponding petiole. Calyx 4-5 mm, teeth triangular to subulate, teeth shorter than tube. Corolla yellow, keel is equal or slightly longer than standard. Pods coiled, green-brown, cylindrical, spiny or spineless, face reticulate, centre with a small opening (0.5mm in diameter). Coil number 1.5-2.5(-3), diameter 5-7 mm, flat, veins curved, anatomising before entering lateral vein. Spines bifurcated at the base, grooved, 1-2 mm. Seeds 2-2.5 x 1.2-1.5 mm, brown, reniforme, 2-3 per pod, radicle equalling or more than half seed length.

Figure 3.3. Distribution of *Medicago strasseri*. (shading represents native distribution).

Closely related species: This rare endemic is easily distinguished from the only similar species, *M. arborea* by smaller pods and seeds.
Habitat: Vertical limestone cliff-faces in Crete.
Geographical distribution: Europe: Crete (N).
Conservation and threat assessment: Rare (IUCN)
Actual and potential usage: Potential as ornamental shrub.

3.3 *Medicago sativa* L., Sp. Pl.: 778 (1753).

Synonyms: *Medicago grandiflora* (Grossh.) Vassilcz. Vol. Sci. Works Leningrad 1941-43, ed. Schischk., 101 (1946); *Medicago sogdiana* (Brand) Vassilcz. Journ. Bot. URSS, xxxi. No. 3, 24 (1946); *Medicago ladak* Vassilcz. Journ. Bot. URSS, xxxi. No. 3, 27 (1946); *Medicago mesopotamica* Vassilcz. Journ. Bot. URSS, xxxi. No. 3, 27 (1946); *Medicago polia* (Brand) Vassilcz, Journ. Bot. URSS, xxxi. No. 3, 27 (1946); *Medicago orientalis* Vassilcz. Journ. Bot. URSS, xxxi. No. 3, 28 (1946); *Medicago praesativa* Sinskaya. Fl. Cult. Pl. USSR, xiii. 1. 51 (1950).

Perennial herb, 10-70(-120) cm, stem arising from the crown, procumbent or ascending to erect. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules margin entire or dentate, teeth at base. Leaflet 4-22 x 2-5 mm, ovate and obolanceolate, base cuneate, dorsally glabrous, and ventrally densely pubescent, with appressed hairs, margins at apex serrate. Peduncle with 7-35 flowers in a slender lax raceme, longer than the corresponding petiole, with terminal cusp. Flower 6-12 mm. Pedicle equal or longer than the calyx tube, bract ± equalling the pedicel, calyx teeth ± equalling tube. Corolla violet or rarely creamy white, wings longer than the keel. Pods coiled, glabrous or densely pubescent, with simple or glandular hair, black to brown, cylindrical, spineless, face reticulate. Coils 1-5, turning clockwise, loose, 3-9 mm in diameter, veins not changing direction before joining the dorsal suture, anatomising in the outer part of the pod face, venation obscure. Seeds 1.2-1.5 x 1-1.5 mm, brown or yellow or green-yellow, radicle more than half seed lengths.

Chromosome number: 16, 32.
Closely related species: This species is very polymorphic whose identification is complicated by hybridisation, polyploidy and domestication. It is treated variously as constituting several species or infra-specific taxa. The subspecies are often confused (ILDIS recognises the subspecies *falcate* and *glomerata* as distinct species), also it can be confused with *M. rupestris* and *M. prostrate* which have much more evident venation on the fruits or with *M. papillosa* which always has distinctive pads of tissue separating the seeds.
Habitat: Generally found in open habitats with moderately fertile, calcareous soil, dry semi-desert to agricultural land, occasionally scrub and woodland.
Geographical distribution: Africa: Algeria (I), Canary Is (I), Chad (I), Djibouti (I), Egypt (I), Ethiopia (I), Kenya (I), Libya (I), Morocco (I), Niger (I), South Africa (I), Tunisia (I). Asia: Afghanistan (I), Armenia (I), Azerbaijan (I), China (I), Georgia (I), India (I), Indonesia-ISO (I), Iran (N), Iraq (I), Japan (I), Java (I), Kazakhstan (I), Kyrgyzstan (I), Korea (I), Mongolia (I), Nepal (I), Pakistan (I), Russia in Asia (I), Sri Lanka (I), Tadzhikistan (I), Taiwan (I), Turkmenistan (I), Uzbekistan (I). Australasia: Australia (I), Papua New Guinea (I), Tasmania (I). Australia: New South Wales, Queensland, South Australia, Victoria, Western Australia Azerbaijan: Azerbaijan, Nakhichevan. Belarus: Brest, Gomel, Grodno, Minsk, Mogilev, Vitebsk. Caribbean: Caribbean-TRP (U), Dominican Republic (I), Haiti (I). Central America: Costa Rica (U), Guatemala (U), Mexico (North and Central) (U). Europe: Albania (I), Austria (I), Balearic Is (I), Belarus (I), Belgium (I), Bulgaria (I), Corsica (I), Crete (I), Czech Republic and Slovakia (I), Denmark (I), Estonia (I), Finland (I), former Yugoslavia (I), France (I), Germany (I), Great Britain (I), Greece (I), Hungary (I), Ireland (I), Italy (I), Latvia (I), Liechtenstein (I), Lithuania (I), Luxembourg (I), Moldova (I), Netherlands (I), Norway (I), Poland (I), Portugal (I), Romania (I), Russia in Europe (I), Sardinia (I), Sicily (I), Spain (I), Sweden (I), Switzerland (I), Turkey in Europe (I), Ukraine (I). Georgia: Abkhazia, Adzharia, Georgia. India: Bihar, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu-Kashmir, Karnataka, Madhaya Pradesh, Maharashtra,

Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal. Indian Ocean: Mauritius (I) Kazakhstan: Aktyubinsk, Alma-Ata, Chimkent, Dzhambul, Guryev, Karaganda, Kokchetav, Kzyl-Orda, Mangyshlak, Pavlodar, Semipalatinsk, Severo-Kazakhstanskaya, Taldy-Kurgan, Tselinograd, Vostochno-Kazakhstanskaya. Kyrgyzstan: Frunze, Issyk-Kul, Osh. Middle East: Cyprus (U), East Aegean Is (Greek) (U), Israel (I), Jordan (I), Lebanon (I), Palestine (I), Oman (I), Qatar (I), Saudi Arabia (I), Sinai (I), Syria (I), Turkey in Asia (N), Yemen (I). Mongolia: Arkangai, Dornod, Dornogovi, Govi-Altai, Khovd, Selenge. North America: Alaska-Aleutian Is (I), Canada (I), United States (I). Pacific Ocean: Chatham Is (I), Fiji (I), Hawaii (I), Kermadec Is (I), New Zealand (North) (I), New Zealand (South) (I), Northern Marianas (I). Russia in Asia: Altay, Buryatiya, Checheno-Ingushetia, Chita, Chukot, Dagestan, Gorno-Altaisk, Irkutsk, Kabardino-Balkaria, Karacheyevo-Cherkessia, Kemerovo, Khabarovsk, Khakassia, Krasnodar, Krasnoyarsk, Kurgan, Magadan, Novosibirsk, Omsk, Primorye, Stavropol, Tomsk, Tuva, Tyumen, Yakutiya. Russia in Europe: Astrakhan, Bashkiria, Belgorod, Bryansk, Chuvashia, Gorki, Ivanovo, Kalinin, Kaliningrad, Kalmykia, Kaluga, Kirov, Komi, Komi-Permyak, Kostroma, Kuibyshev, Kursk, Leningrad, Lipetsk, Mari, Mordovia, Moscow, Murmansk, Novgorod, Orel, Orenburg, Penza, Perm, Pskov, Rostov-Don, Ryazan, Saratov, Smolensk, Tambov, Tataria, Tula, Udmurtia, Ulyanovsk, Vladimir, Volgograd, Vologda, Voronezh, Yaroslavl. South America: Argentina (I), Bolivia (I), Chile (I), Colombia (I), Peru (I). Tadzhikistan: Dushanbe, Gorno-Badakshan, Kulyab, Kurgan-Tyube, Leninabad. Turkmenistan: Ashkhabad, Chardzhou, Krasnovodsk. Ukraine: Cherkassy, Chernigov, Chernovtsy, Dnepropetrovsk, Donetsk, Ivano-Frankovsk, Kharkov, Kherson, Khmelnitski, Kiev, Kirovograd, Krym, Lvov, Nikolaev, Odessa, Poltava, Rovno, Sumy, Ternopol, Vinnitsa, Volynia, Voroshilovgrad, Zakarpatskaya, Zaporozhye, Zhitomir. United States: Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming. Uzbekistan: Andizhan, Bukhara, Dzhizak, Fergana, Karakalpakia, Kashkadarinskaya, Khorezm, Namangan, Samarkand, Surhandarinskaya, Syr-Darya, Tashkent.

Conservation and threat assessment: Not threatened
Actual and potential usage: Forage, environmental, food, drink and medicine.

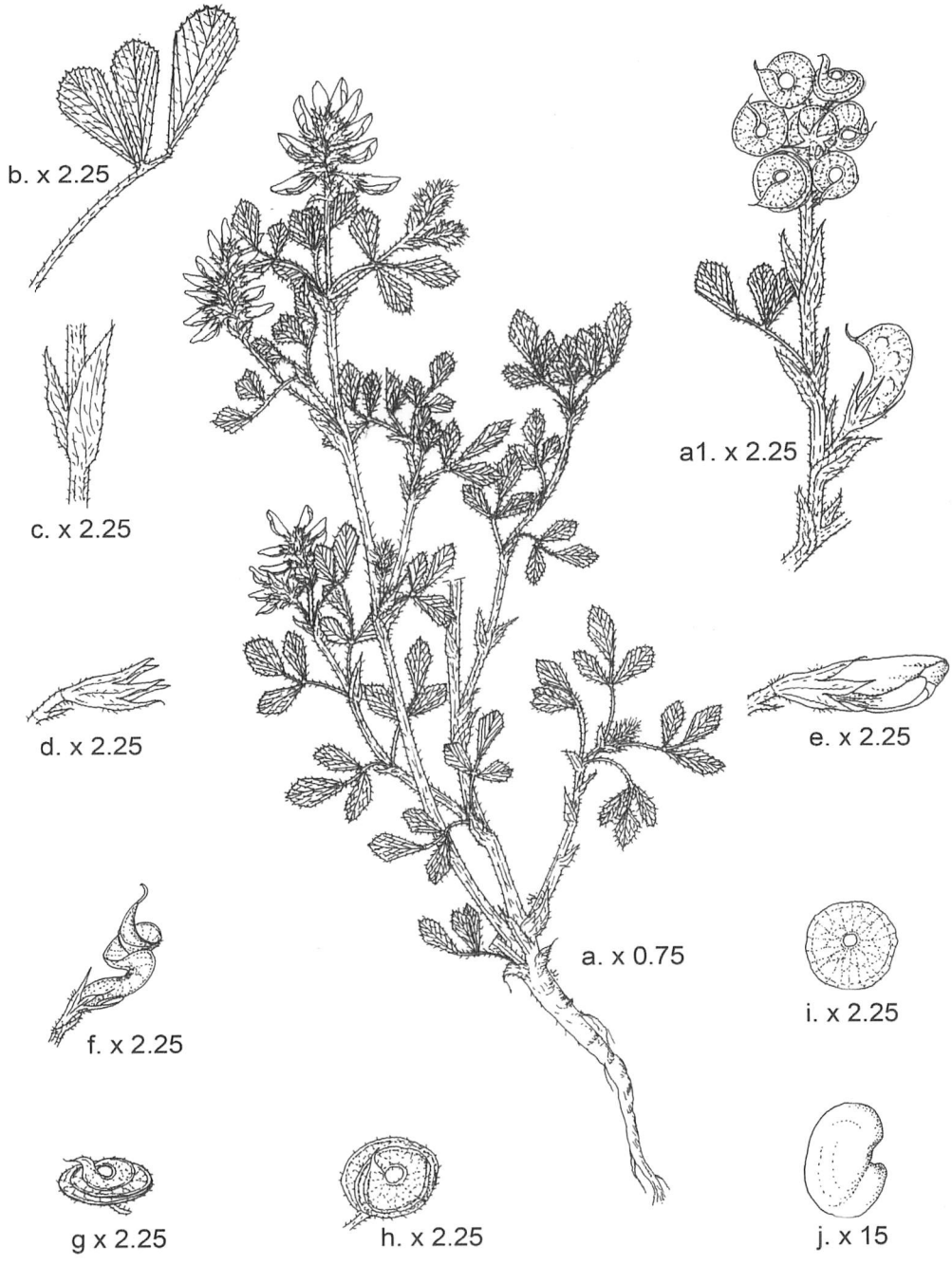

Figure 3.5. *Medicago sativa*: a, habit (x 0.75); b, leaflet (x 2.25) c, stipule (x 2.25); d, calyx (x 2.25); e, flower (x 2.25); f, immature pod (x 2.25); g, pod three dimension view (x 2.25) h, pod tip shape, (2.25); i, pod venation(x 2.25); j, seed (x 15).

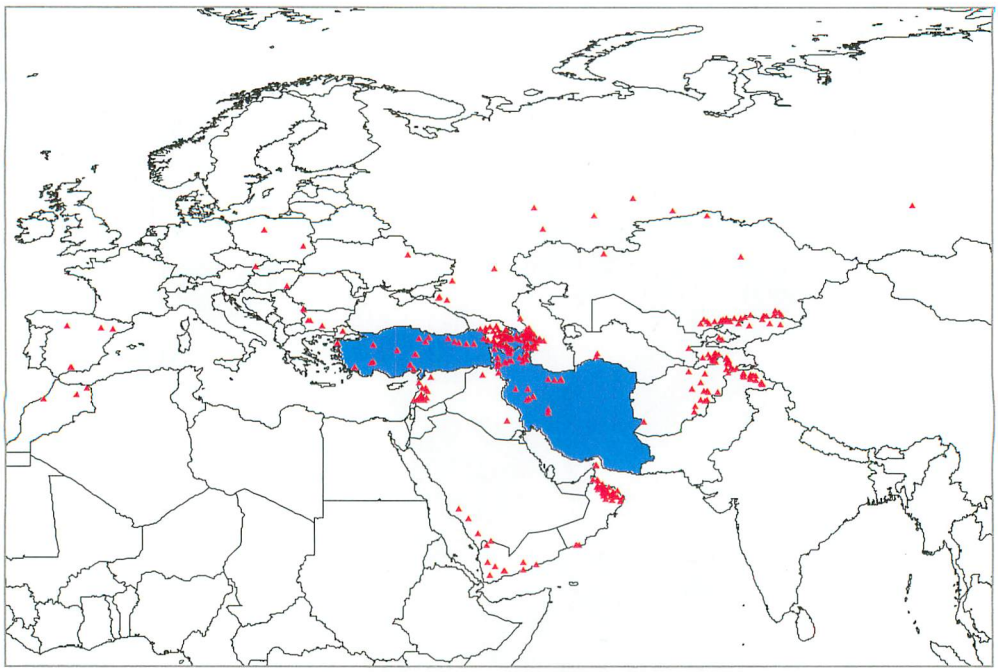

Figure 3.4. Distribution of *Medicago sativa*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.4 *Medicago sativa* subsp. *caerulea* (Less. ex Ledeb.) Schmalh., Fl. Sred. Juz. Ross. 1: 226 (1895).

Synonyms: *Medicago caerulea* Ledeb., Fl. Ross.1: 526 (1843).
Perennial herb, 10-70(-120) cm, stem arising from the crown, procumbent or ascending to erect. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules margin entire or dentate, teeth at base. Leaflet 4-22 x 2-15 mm, ovate and obolanceolate, base cuneate, dorsally glabrous, and ventrally densely pubescent, with appressed hairs, apex margin serrate. Peduncle with 7-35 flowers, in a slender lax raceme, longer than the corresponding petiole, with terminal cusp. Flower 5-6 mm. Pedicle equal to or longer than the calyx tube, bract ± equalling the pedicel, calyx less than 4-4.5 mm, teeth ± equalling tube. Corolla violet or creamy white, wings longer than the keel. Pods coiled, glabrous or densely pubescent, with simple or glandular hair, black to brown, cylindrical, spineless, face reticulate. Coils 1-5, turning clockwise, loose, 2.5-3.5(-5) mm, veins not changing direction before joining the dorsal suture, anatomising in the outer part of the pod face, venation obscure. Seeds 1.6-2.1 x 1.2-1.5 mm, brown or yellow or green-yellow, radicle more than half seed length.

Chromosome number: 16.
Closely related species: This diploid taxon is similar to subsp. *sativa* in having decidedly coiled fruits and violet flowers, but distinguishable from the latter by a stronger blue tint to the flowers, smaller flowers, fruits and seeds, and usually narrower leaflets and an overall more delicate appearance.
Habitat: Warm and dry condition such as, semi-desert, (Lesins and Lesins, 1979) dry meadows, steppe, plains, foothills and low montane belt, often associated with calcareous soils.
Geographical distribution: Africa: Egypt (I). Asia: Armenia (N), Azerbaijan (N), Georgia (N), Iran (N), Kazakhstan (N), Russia in Asia (N). Azerbaijan: Azerbaijan, Nakhichevan. Europe: Russia in Europe (N). Georgia: Abkhazia, Adzharia, Georgia. Kazakhstan: Aktyubinsk, Alma-Ata, Dzhezkazgan, Guryev, Mangyshlak, Turgaiskaya . Middle East: Turkey in Asia (N). Russia in Asia: Checheno-Ingushetia, Chelyabinsk, Dagestan, Kabardino-Balkaria, Karacheyevo-Cherkessia, Severo-Osetia, Stavropol. Russia in Europe: Astrakhan, Kalmykia, Kirov, Kuibyshev, Moscow, Saratov, Volgograd.
Actual and potential usage: Forage.

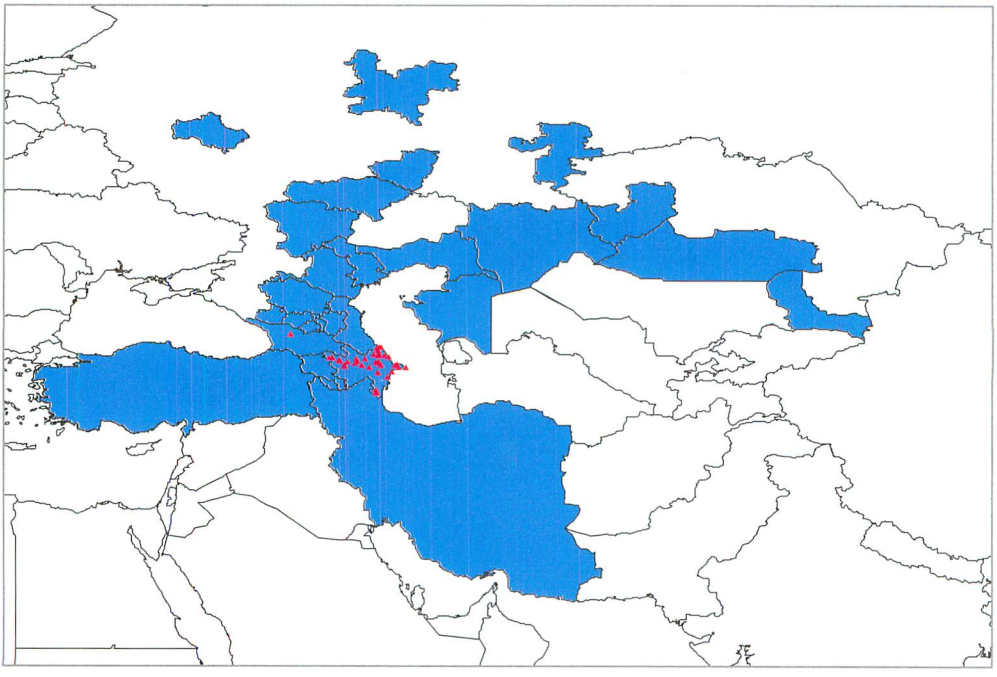

Figure 3.6. Distribution of *Medicago sativa* subsp. *caerulea*. (shading represents native distribution, triangle indicates population sample held ex *situ*).

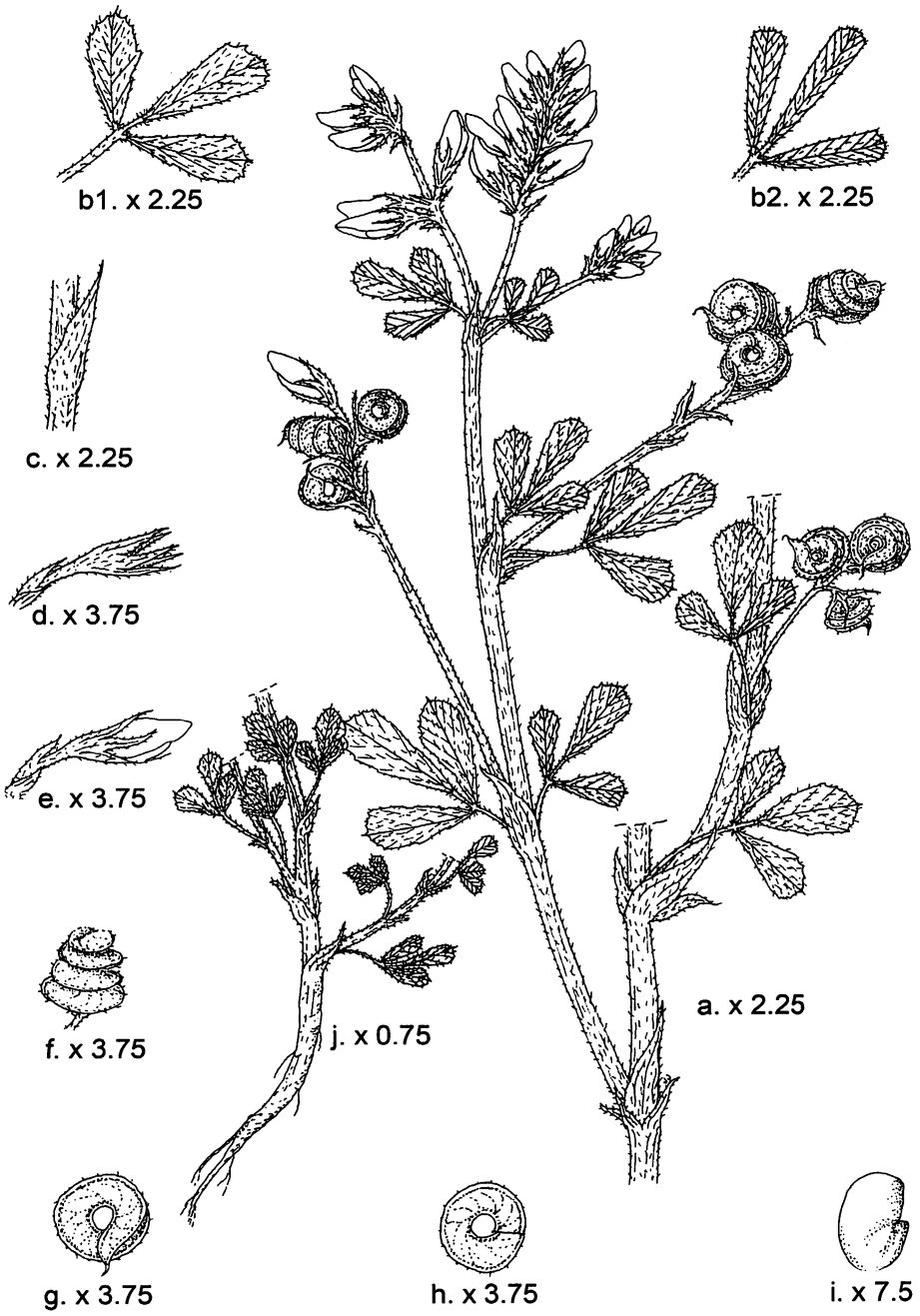

Figure 3.7. *Medicago sativa* subsp. *caerulea*: a, habit (x 2.25); b1, leaflet (x 2.25); b2, un mature leaflet (x 2.25) c, stipule (x 2.25); d, calyx (x 3.75); e, flower (x 3.75); f, pod three dimension view (x 3.75); g, pod tip view (x 3.75) h, pod venation(x 3.75) i, seed (x 7.5); j, roots and stem (x 0.75).

3.5 *Medicago sativa* L. subsp. *sativa*

Perennial herb, 10-70(-120) cm, stem arising from the crown, procumbent or ascending to erect. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules margin entire or dentate, teeth at base. Leaflet 4-22 x 2-5 mm, ovate and obolanceolate, base cuneate, dorsally glabrous, ventrally densely pubescent, with appressed hairs, apex margin serrate. Peduncle with 7-35 flowers, flowers in a slender lax raceme, longer than the corresponding petiole, with terminal cusp. Flower 6-12 mm. Pedicle equal to or longer than the calyx tube, bract ± equalling the pedicel, calyx teeth ± equalling tube. Corolla violet or (rarely) creamy white, wings longer than the keel. Pods coiled, glabrous or densely pubescent, with simple or glandular hair, black to brown, cylindrical, spineless, without gland-tipped trichomes, face reticulate. Coils 1-5, turning clockwise, loose, 5-9 mm diameter, veins not changing direction before joining the dorsal suture, anastomosing in the outer part of the pod face, venation obscure. Seeds 2.2-2.5 x 1-1.5 mm, brown or yellow or green-yellow, radicle more than half seed length.

Chromosome number: 16, 32.
Closely related species: Possibly originating in historical times in the western distribution range of subsp. *caerulea*. Hybrids between this taxon and subsp. *glomerata* are common within the distribution of subsp. *glomerata*, and are characterised by segregating flowers colours (violet yellow and variegated) (Small and Jomphe, 1989).
Habitat: Probably evolved under warm, dry, semi-desert conditions (Lesins and Lesins, 1979), calcareous soils ranging in texture from silt and heavy clays to rocky (Rihan, 1988).
Geographical distribution: Africa: Algeria (I), Canary Is (I), Chad (I), Djibouti (I), Egypt (I), Ethiopia (I), Kenya (I), Libya (I), Morocco (I), Niger (I), South Africa (I), Tunisia (I). Asia: Afghanistan (I), Armenia (I), Azerbaijan (N), China (I), Georgia (I), India (I), Indonesia-ISO (I), Iran (N), Iraq (I), Japan (I), Java (I), Kazakhstan (I), Kirgizstan (I), Korea (I), Mongolia (I), Nepal (I), Pakistan (I), Russia in Asia (I), Sri Lanka (I), Tadzhikistan (I), Taiwan (I), Turkmenistan (I), Uzbekistan (I). Australasia: Australia (I), Papua New Guinea (I), Tasmania (I). Australia: New South Wales, Queensland, South Australia, Victoria, Western Australia Azerbaijan: Azerbaijan, Nakhichevan. Belarus: Brest, Gomel, Grodno, Minsk, Mogilev, Vitebsk. Caribbean: Caribbean-TRP (U), Dominican Republic (I), Haiti (I). Central America: Costa Rica (U), Guatemala (U), Mexico (North and Central) (U). Europe: Albania (I), Austria (I), Balearic Is (I), Belarus (I), Belgium (I), Bulgaria (I), Corsica (I), Crete (I), Czech Republic and Slovakia (I), Denmark (I), Estonia (I), Finland (I), former Yugoslavia (I), France (I), Germany (I), Great Britain (I), Greece (I), Hungary (I), Ireland (I), Italy (I), Latvia (I), Liechtenstein (I), Lithuania (I), Luxembourg (I), Moldova (I), Netherlands (I), Norway (I), Poland (I), Portugal (I), Romania (I), Russia in Europe (I), Sardinia (I), Sicily (I), Spain (I), Sweden (I), Switzerland (I), Turkey in Europe (I), Ukraine (I). Georgia: Abkhazia, Adzharia, Georgia. India: Bihar, Delhi, Goa, Gujarat, Haryana, Himachal

Pradesh, Jammu-Kashmir, Karnataka, Madhaya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal. Indian Ocean: Mauritius (I) Kazakhstan: Aktyubinsk, Alma-Ata, Chimkent, Dzhambul, Guryev, Karaganda, Kokchetav, Kzyl-Orda, Mangyshlak, Pavlodar, Semipalatinsk, Severo-Kazakhstanskaya, Taldy-Kurgan, Tselinograd, Vostochno-Kazakhstanskaya. Kirgizstan: Frunze, Issyk-Kul, Osh. Middle East: Cyprus (U), East Aegean Is (Greek) (U), Israel (I), Jordan (I), Lebanon (I), Palestine (I), Oman (I), Qatar (I), Saudi Arabia (I), Sinai (I), Syria (I), Turkey in Asia (N), Yemen (I). Mongolia: Arkangai, Dornod, Dornogovi, Govi-Altai, Khovd, Selenge. North America: Alaska-Aleutian Is (I), Canada (I), United States (I). Pacific Ocean: Chatham Is (I), Fiji (I), Hawaii (I), Kermadec Is (I), New Zealand (North) (I), New Zealand (South) (I), Northern Marianas (I). Russia in Asia: Altay, Buryatiya, Checheno-Ingushetia, Chita, Chukot, Dagestan, Gorno-Altaisk, Irkutsk, Kabardino-Balkaria, Karacheyevo-Cherkessia, Kemerovo, Khabarovsk, Khakassia, Krasnodar, Krasnoyarsk, Kurgan, Magadan, Novosibirsk, Omsk, Primorye, Stavropol, Tomsk, Tuva, Tyumen, Yakutiya. Russia in Europe: Astrakhan, Bashkiria, Belgorod, Bryansk, Chuvashia, Gorki, Ivanovo, Kalinin, Kaliningrad, Kalmykia, Kaluga, Kirov, Komi, Komi-Permyak, Kostroma, Kuibyshev, Kursk, Leningrad, Lipetsk, Mari, Mordovia, Moscow, Murmansk, Novgorod, Orel, Orenburg, Penza, Perm, Pskov, Rostov-Don, Ryazan, Saratov, Smolensk, Tambov, Tataria, Tula, Udmurtia, Ulyanovsk, Vladimir, Volgograd, Vologda, Voronezh, Yaroslavl. South America: Argentina (I), Bolivia (I), Chile (I), Colombia (I), Peru (I). Tadzhikistan: Dushanbe, Gorno-Badakshan, Kulyab, Kurgan-Tyube, Leninabad. Turkmenistan: Ashkhabad, Chardzhou, Krasnovodsk. Ukraine: Cherkassy, Chernigov, Chernovtsy, Dnepropetrovsk, Donetsk, Ivano-Frankovsk, Kharkov, Kherson, Khmelnitski, Kiev, Kirovograd, Krym, Lvov, Nikolaev, Odessa, Poltava, Rovno, Sumy, Ternopol, Vinnitsa, Volynia, Voroshilovgrad, Zakarpatskaya, Zaporozhye, Zhitomir. United States: Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming. Uzbekistan: Andizhan, Bukhara, Dzhizak, Fergana, Karakalpakia, Kashkadarinskaya, Khorezm, Namangan, Samarkand, Surhandarinskaya, Syr-Darya, Tashkent.

Conservation and threat assessment: Not threatened

Actual and potential usage: Forage, environmental, food, drink and medicine.

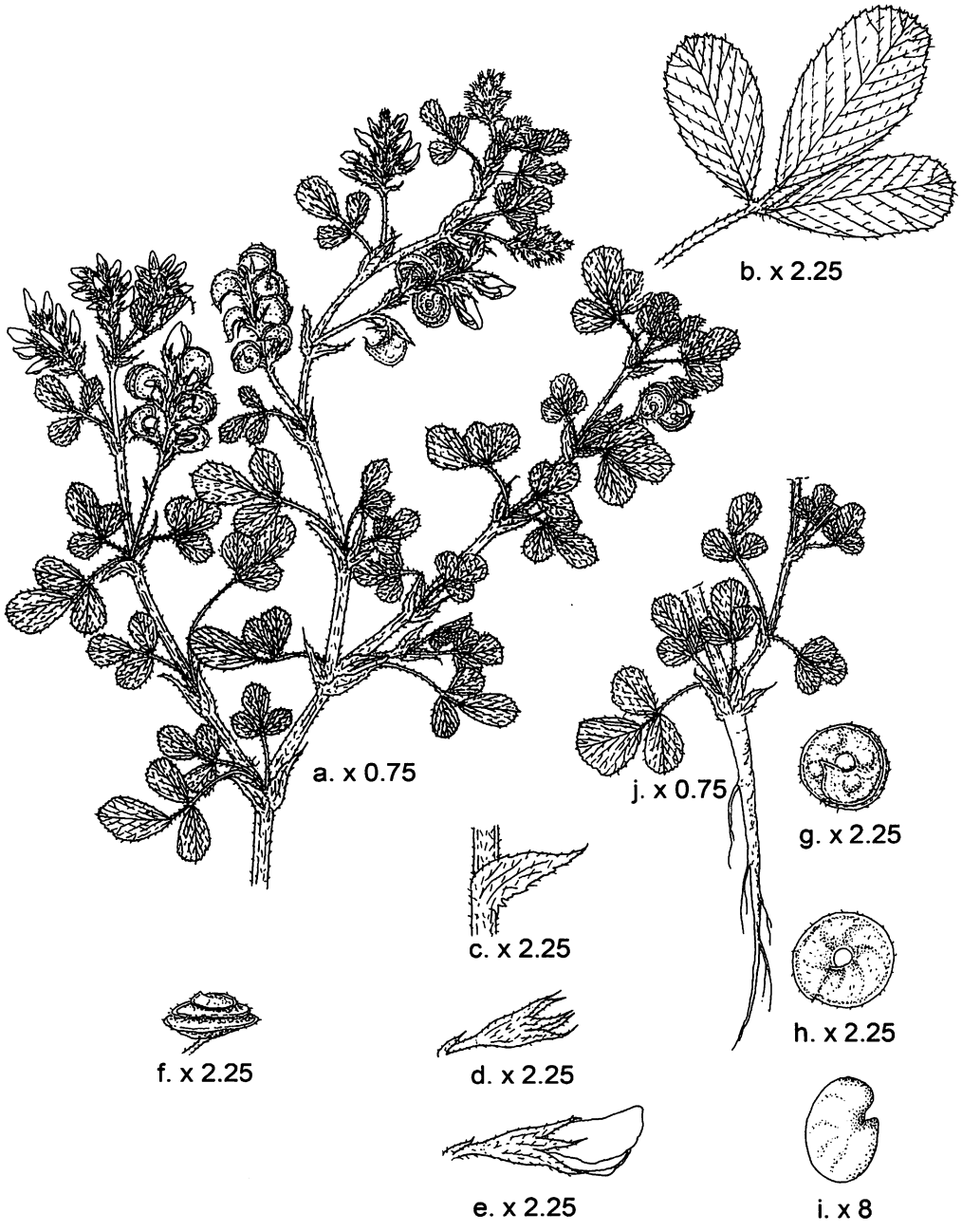

Figure 3.9. *Medicago sativa* subsp. *sativa*: a, habit (x 0.75); b, leaflet (x 2.25); c, stipule (x 2.25); d, calyx (x 2.25); e, flower (x 2.25); f, pod three dimension view (x 2.25); g, pod tip view (x 2.25) h, pod venation(x 2.25) i, seed (x 8); j, root and stem, (x 0.75).

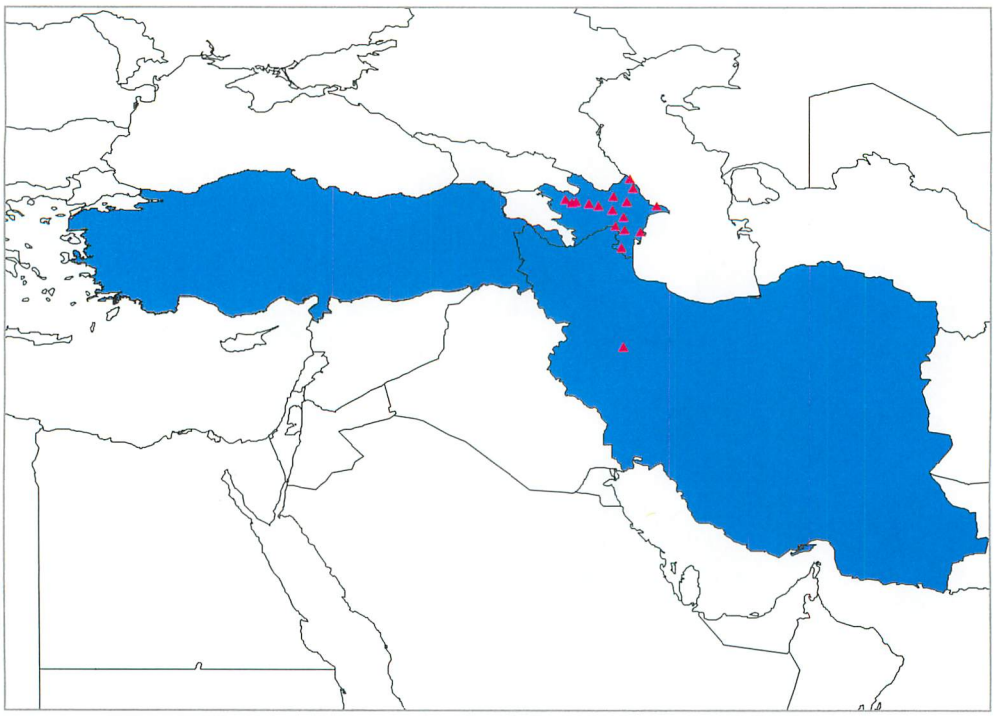

Figure 3.8. Distribution of *Medicago sativa* L. subsp. *sativa*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.6 *Medicago sativa* subsp. *glomerata* (Balbis) Rouy, Feddes Repert 79(1-2): 53 (1986).

Synonyms: *Medicago glomerata* Balbis, Elenco.: 93 (1801); *Medicago glutinosa* M. Bieb. Fl. Taur. – Cauc. 2: 224 (1808); *Medicago glutinosa* M. Bieb. subsp. *glomerata* (Balbis) Nyman Consp. Fl. Eur.: 166 (1878).

Perennial herb, 30-50 cm, stems ascending to erect. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules margin entire or serrate, teeth at base. Leaflet 7-14 x 2-5 mm, obovate, apex often truncate, dorsally glabrous, ventrally sparsely pubescent, margins serrate. Peduncle with 4-17 flowers, longer than the corresponding petiole, with terminal cusp. Flower 9-10 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx 3-5 mm, densely pubescent, with simple appressed hairs. Corolla yellow, standard oval shaped, wings equal or slightly longer than the keel. Pods coiled, spineless, densely pubescent, with glandular hair, face reticulate, centre with a small opening. Coils 1.5-3.5 in number, 4-6

mm diameter, veins anastomosing near the ventral suture. Seeds 2-2.5 x 1.5 mm, green-yellow, ovoid, radicle equalling half seed length.

Chromosome number: 16, 32.
Closely related species: This subspecies could be confused with *M. suffruticosa* subsp. *suffruticosa*, but the latter usually has broader leaves, fewer flowers (3-10 as opposed to 4-18), and somewhat longer radicles (about 2/3 of seed length, as opposed to ca. 1/2) (Small and Jomphe, 1989).
Habitat: Montane areas e.g. sub-alpine meadows, among scrub, forest glades, and river valleys, in calcareous, rocky soils with a precipitation of 500 mm or more, mainly during spring and summer (Lesins and Lesins, 1979).
Geographical distribution: Africa: Morocco (N), South Africa (I). Asia: Afghanistan (N), Armenia (N), Azerbaijan (N), China (N), Georgia (N), India (N), Iran (N), Kazakhstan (N), Kirgizstan (N), Mongolia (N), Nepal (N), Pakistan (N), Russia in Asia (N), Tadzhikistan (N). Australasia: Australia (I), Tasmania (I). Australia: Queensland. Azerbaijan: Azerbaijan. Belarus: Brest, Gomel, Grodno, Minsk, Mogilev, Vitebsk. China: Xinjiang Uygur, Xizang Zizhiqu. Europe: Albania (N), Austria (N), Balearic Is (U), Belarus (N), Belgium (N), Bulgaria (N), Corsica (U), Crete (I), Czech Republic and Slovakia (N), Denmark (N), Estonia (N), former Yugoslavia (N), France (N), Germany (N), Great Britain (N), Greece (N), Hungary (N), Ireland (N), Italy (N), Latvia (N), Liechtenstein (N), Lithuania (N), Luxembourg (N), Moldova (N), Netherlands (N) Norway (N, Poland (N), Portugal (N), Romania (N), Russia in Europe (N), Spain (N), Sweden (N), Switzerland (N), Turkey in Europe (N), Ukraine (N). Georgia: Abkhazia, Adzharia, Georgia. India: Assam, Haryana, Himachal Pradesh, Jammu-Kashmir, Punjab, Sikkim, Uttar Pradesh. Kazakhstan: Aktyubinsk, Alma-Ata, Chimkent, Dzhambul, Dzhezkazgan, Guryev, Karaganda, Kokchetav, Kustanai, Pavlodar, Semipalatinsk, Severo-Kazakhstanskaya, Taldy-Kurgan, Tselinograd, Turgaiskaya, Uralsk, Vostochno-Kazakhstanskaya. Kirgizstan: Frunze, Issyk-Kul, Osh. Middle East: East Aegean Is (Greek) (N), Lebanon (N), Syria (N), Turkey in Asia (N) Mongolia: Arkangai, Bayan-Ulgi, Bayankhongor, Bulgan, Dornod, Govi-Altai, Khenti, Khovd, Selenge, Sukh Baatar, Tuv, Umnu-Govi, Uvs, Uvurkhangai, Zavkhan. North America: Alaska-Aleutian Is (I), Canada (I), United States (I). Russia in Asia: Altay, Amur, Buryatiya, Checheno-Ingushetia, Chelyabinsk, Chita, Dagestan, Gorno-Altaisk, Irkutsk, Kabardino-Balkaria, Karacheyevo-Cherkessia, Kemerovo, Khabarovsk, Khakassia, Krasnodar, Krasnoyarsk, Kurgan, Novosibirsk, Omsk, Primorye, Severo-Osetia, Stavropol, Sverdlovsk, Tomsk, Tuva, Tyumen, Yakutiya. Russia in Europe: Arkhangelsk, Astrakhan, Bashkiria, Belgorod, Bryansk, Chuvashia, Gorki, Ivanovo, Kalinin, Kaliningrad, Kalmykia, Kaluga, Karelia, Kirov, Komi, Komi-Permyak, Kostroma, Kuibyshev, Kursk, Leningrad, Lipetsk, Mari, Mordovia, Moscow, Murmansk, Novgorod, Orel, Orenburg, Penza, Perm, Pskov, Rostov-Don, Ryazan, Saratov, Smolensk, Tambov, Tataria, Tula, Udmurtia, Ulyanovsk, Vladimir, Volgograd, Vologda, Voronezh, Yaroslavl. Tadzhikistan: Dushanbe, Gorno-Badakshan, Leninabad. Ukraine: Cherkassy, Chernigov, Chernovtsy, Dnepropetrovsk, Donetsk, Ivano-Frankovsk, Kharkov, Kherson, Khmelnitski, Kiev, Kirovograd, Krym, Lvov,

Nikolaev, Odessa, Poltava, Rovno, Sumy, Ternopol, Vinnitsa, Volynia, Voroshilovgrad, Zakarpatskaya, Zaporozhye, Zhitomir. United States: Arizona, California, New York

Conservation and threat assessment: Not threatened

Actual and potential usage: Tolerant to comparatively moist growing conditions, but moderate to low tolerance of cold temperate winters (Lesins and Lesins, 1979).

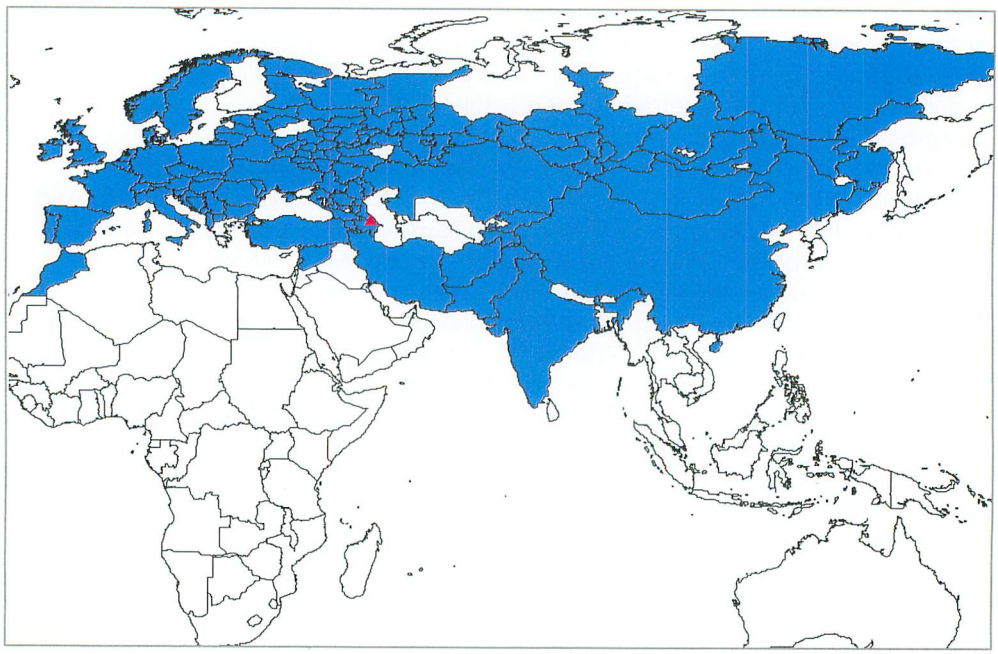

Figure 3.10. Distribution of *Medicago sativa* subsp. *glomerata*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.7 *Medicago sativa* subsp. *falcata* (L.) Arcang, Comp. FL. Ital. 160 (1882).

Synonyms: *Medicago falcata* L., Sp. Pl.: 779 (1753); *Medicago procumbens* Besser, Prim. Fl. Galiciae Austriac. 2: 127 (1809); *Medicago aurantiaca* Godron, Mém. Sect. Méd. Acad. Sci. Montpellier 1: 425 (1853); *Medicago sativa* L. subsp. *glandulosa* (Koch) Arcang., Comp. Fl. Ital. 160 (1882); *Medicago glandulosa* Davidoff. □esterr. Bot. Z. 52: 493 (1902); *Medicago falcata* L. subsp. *urumovii* Degen, Magyar. Bot. Lapok 12: 214 (1913); *Medicago romanica* Prodan., Fl. Român. 1: 617 (1923); *Medicago falcata* L. subsp. *romanica* (Prodan) O. Schwarz & Klinkowski, Verh. Bot. Vereins Prov. Brandenburg 74: 182 (1933); *Medicago romanica* (Prodan.) O.

Schwarz & Klink, Verh. Bot. Vereins Prov. Brandenburg 74: 182 (1933); *Medicago tenderiensis* Klokov. Bot. □urn. (Kiev) 5(2): 44 (1948); *Medicago falcata* L. subsp. *tenderiensis* (Klokov) Vassilcz., Trudy Bot. Inst. Akad. Nauk SSSR, Ser 1, Fl. Sist. Vys□. Rast. 8: 43 (1949); *Medicago quasifalcata* Sinsk, Proc. Lenin Acad. Agric. Sci. USSR, xviii. No. 4, 300 (1945); cf. Sinsk. in Fl. Cult. Pl. USSR, xiii. 1. 126 (1950); *Medicago falcata* L. subsp. *glandulosa* (Koch) Greuter & Burdet, Willdenowia 19: 32 (1989).
Perennial herb, 15-80(-120) cm, stem arising from the crown, procumbent to ascending. Vegetative parts glabrous or densely pubescent, with appressed, simple hairs. Stipules margin serrate or dentate, teeth at base. Leaflet 2-20 x 2-10 mm, obovate to obolanceolate, apex often retuse, base cuneate, margins at upper part serrate. Peduncle with 3-20(-25) flowers in a slender lax or head-shape raceme, longer than the corresponding petiole, with terminal cusp. Flower 7-11 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx 3.5-6 mm, teeth shorter or longer than tube. Corolla orange yellow, standard curved or obovate, wings slightly longer than keel. Pods uncoiled, glabrous, 7-15 mm, occasionally corkscrew twisted, straight to sickle-shaped, spineless, without gland-tipped trichomes. Seeds 1.7-2.5 x 1-1.5 mm, brown or yellow or violet brown (rarely), 2-9 per pod, radicle more than half seed length.

Chromosome number: 16.
Closely related species: Two varieties are recognised by Small and Jomphe (1989), var. *falcata* (widespread in N. Eurasia and introduced elsewhere) and var. *viscosa* (Reichenb.) Posp. The former has been extensively and unjustifiably given specific rank according to Small and Jomphe (1989).
Habitat: Var. *falcata* is adapted to and generally prefers dry, boreal and steppe condition, particularly found in the northwest Caucasus in moister conditions and mainly associated with calcareous rocks.
Geographical distribution: Africa: Morocco (N), South Africa (I). Asia: Afghanistan (N), Armenia (N), Azerbaijan (N), China (N), Georgia (N), India (N), Iran (N), Kazakhstan (N), Kirgizstan (N), Mongolia (N), Nepal (N), Pakistan (N), Russia in Asia (N), Tadzhikistan (N). Australasia: Australia (I), Tasmania (I). Australia: Queensland. Azerbaijan: Azerbaijan. Belarus: Brest, Gomel, Grodno, Minsk, Mogilev, Vitebsk. China: Xinjiang Uygur, Xizang Zizhiqu. Europe: Albania (N), Austria (N), Balearic Is (U), Belarus (N), Belgium (N), Bulgaria (N), Corsica (U), Crete (I), Czech Republic and Slovakia (N), Denmark (N), Estonia (N), former Yugoslavia (N), France (N), Germany (N), Great Britain (N), Greece (N), Hungary (N), Ireland (N), Italy (N), Latvia (N), Liechtenstein (N), Lithuania (N), Luxembourg (N), Moldova (N), Netherlands (N) Norway (N, Poland (N), Portugal (N), Romania (N), Russia in Europe (N), Spain (N), Sweden (N), Switzerland (N), Turkey in Europe (N), Ukraine (N). Georgia: Abkhazia, Adzharia, Georgia. India: Assam, Haryana, Himachal Pradesh, Jammu-Kashmir, Punjab, Sikkim, Uttar Pradesh. Kazakhstan: Aktyubinsk, Alma-Ata, Chimkent, Dzhambul, Dzhezkazgan, Guryev, Karaganda, Kokchetav, Kustanai, Pavlodar, Semipalatinsk, Severo-Kazakhstanskaya, Taldy-Kurgan, Tselinograd, Turgaiskaya, Uralsk, Vostochno-Kazakhstanskaya. Kirgizstan: Frunze, Issyk-Kul, Osh.

Middle East: East Aegean Is (Greek) (N), Lebanon (N), Syria (N), Turkey in Asia (N) Mongolia: Arkangai, Bayan-Ulgi, Bayankhongor, Bulgan, Dornod, Govi-Altai, Khenti, Khovd, Selenge, Sukh Baatar, Tuv, Umnu-Govi, Uvs, Uvurkhangai, Zavkhan. North America: Alaska-Aleutian Is (I), Canada (I), United States (I). Russia in Asia: Altay, Amur, Buryatiya, Checheno-Ingushetia, Chelyabinsk, Chita, Dagestan, Gorno-Altaisk, Irkutsk, Kabardino-Balkaria, Karacheyevo-Cherkessia, Kemerovo, Khabarovsk, Khakassia, Krasnodar, Krasnoyarsk, Kurgan, Novosibirsk, Omsk, Primorye, Severo-Osetia, Stavropol, Sverdlovsk, Tomsk, Tuva, Tyumen, Yakutiya. Russia in Europe: Arkhangelsk, Astrakhan, Bashkiria, Belgorod, Bryansk, Chuvashia, Gorki, Ivanovo, Kalinin, Kaliningrad, Kalmykia, Kaluga, Karelia, Kirov, Komi, Komi-Permyak, Kostroma, Kuibyshev, Kursk, Leningrad, Lipetsk, Mari, Mordovia, Moscow, Murmansk, Novgorod, Orel, Orenburg, Penza, Perm, Pskov, Rostov-Don, Ryazan, Saratov, Smolensk, Tambov, Tataria, Tula, Udmurtia, Ulyanovsk, Vladimir, Volgograd, Vologda, Voronezh, Yaroslavl. Tadzhikistan: Dushanbe, Gorno-Badakshan, Leninabad. Ukraine: Cherkassy, Chernigov, Chernovtsy, Dnepropetrovsk, Donetsk, Ivano-Frankovsk, Kharkov, Kherson, Khmelnitski, Kiev, Kirovograd, Krym, Lvov, Nikolaev, Odessa, Poltava, Rovno, Sumy, Ternopol, Vinnitsa, Volynia, Voroshilovgrad, Zakarpatskaya, Zaporozhye, Zhitomir. United States: Arizona, California, New York

Conservation and threat assessment: Not threatened

Actual and potential usage: Forage.

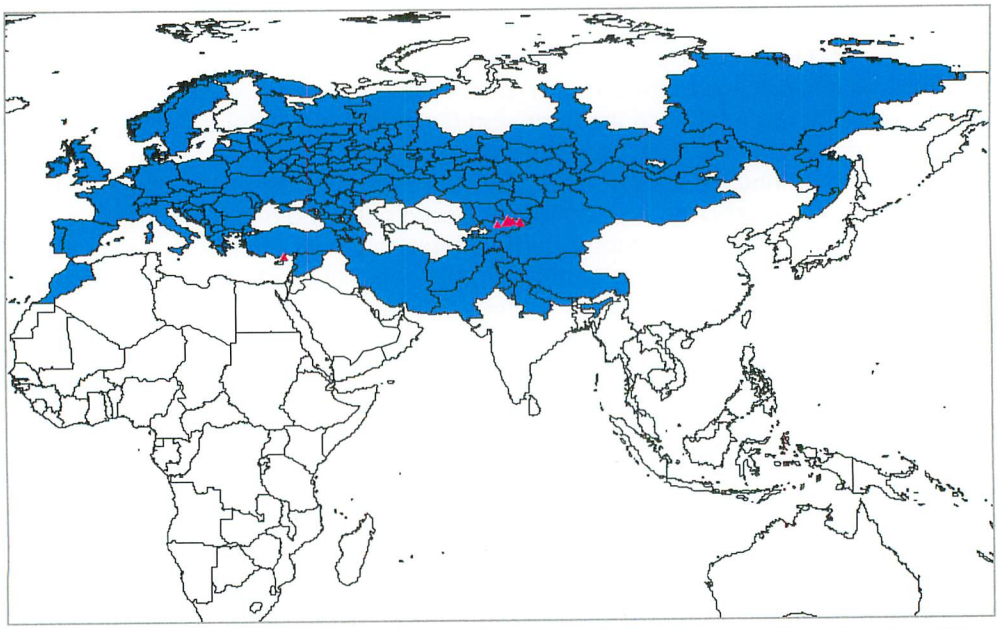

Figure 3.11. Distribution of *Medicago sativa* subsp. *falcata* (L.) Arcang var. *falcata*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

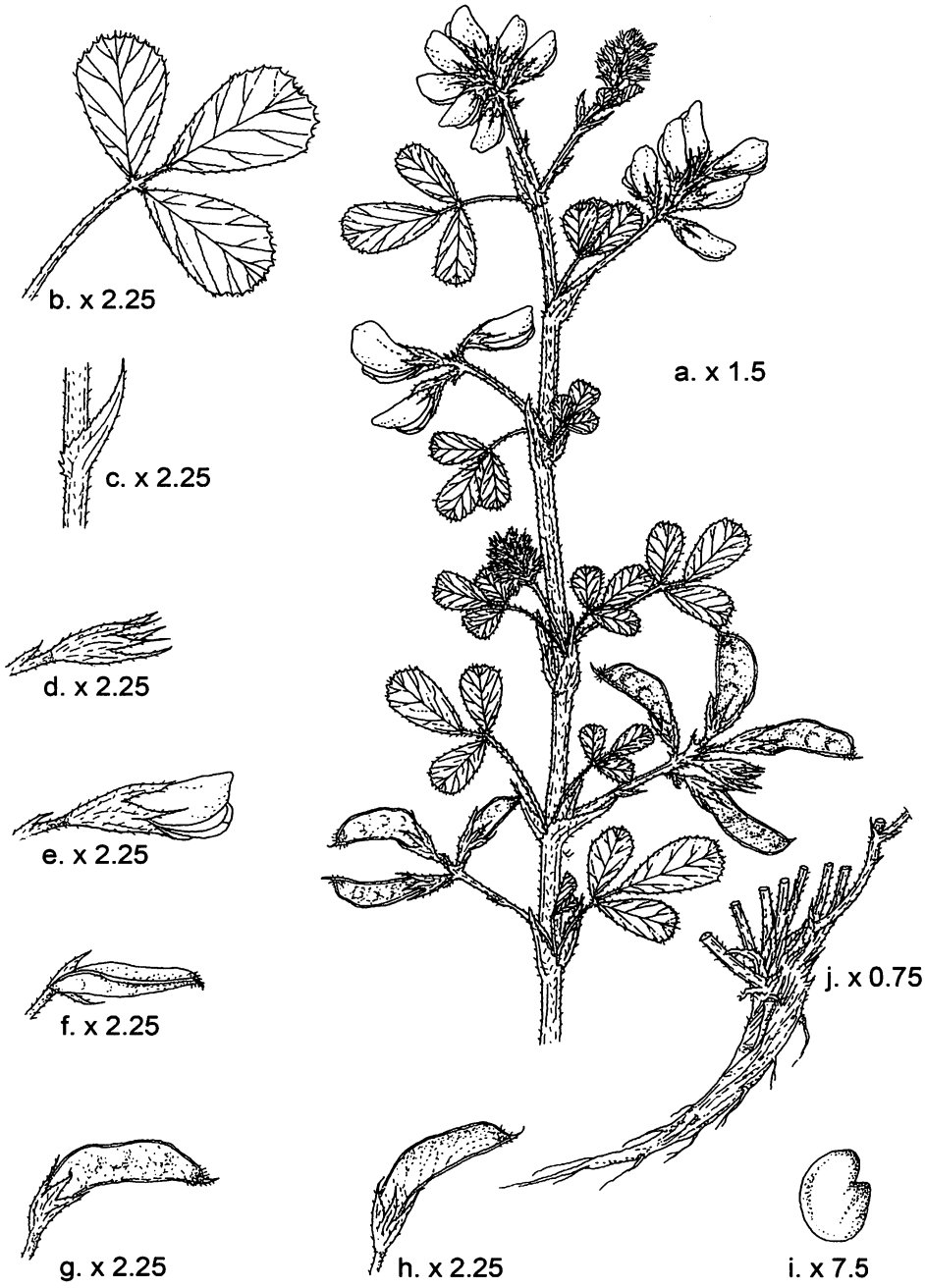

Figure 3.12. *Medicago sativa* subsp. *falcata* (L.) Arcang var. *falcata*: a, habit (x 1.5); b, leaflet (x 2.25) c, stipule (x 2.25); d, calyx (x 2.25); e, flower (x 2.25); g, pod three dimension view (x 2.25); h, pod venation (x 2.25) i, seed (x 7.5); j, root and stem habit (x 0.75).

3.8 *Medicago sativa* subsp. x *varia* (T. Martyn) Arcang, But. Inst. Catalana Hist. Nat, 38 Bot, 1: 70 (1974).

Synonyms: *Medicago media* Pers. Syn. Pl. (Pers.) 2(2): 356 (1807); *Medicago hemicycla* Grossh. in Zap. Nauchno-prikl. Otd. Tiflis. Bot. Sada 4: 147 (1925), *Medicago sylvestris* Fries. Mant. iii. 92; *Medicago tianschanica* Vassilcz. Journ. Bot. URSS, xxv. 244 (1940).

Perennial herb, 10-70(-120) cm, stem arising from the crown, procumbent or ascending to erect. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules margin entire or dentate, teeth at base. Leaflet 4-22 x 2-15 mm, ovate and obolanceolate, base cuneate, dorsally glabrous, ventrally densely pubescent, with appressed hairs, apex margin serrate. Peduncle with 8-15 flowers, flowers in a slender lax raceme, longer than the corresponding petiole, with terminal cusp. Flower 7-10 mm. Pedicle equal to or longer than the calyx tube, bract ± equalling the pedicel, calyx 4-6 mm, teeth subulate, teeth ± equalling tube to longer than tube. Corolla violet or pale mauve, green, yellow, creamy white, wings longer than the keel. Pods coiled, densely pubescent, with simple or glandular hair, black to brown, cylindrical, spineless, without gland-tipped trichomes, face reticulate. Coils 0.5-1.5(-2), turning clockwise, loose, 4-7 mm. diameter, veins not changing direction before joining the dorsal suture, anastomosing in the outer part of the pod face, venation obscure. Seeds 2 mm, brown, radicle more than half seed length.

Chromosome number: 32.
Closely related species: This is the hybrid between subsp. *falcate* and either subsp. *sativa* or subsp. *caerulea* but treated as a subspecies due to its independent existence in many localities (Stace, 1991). Stabilised introgressive populations are common and widespread, and have been unjustifiably recognised as taxa. Since several of the diagnostic characters segregate and combine more or less independently, precise delimitation from parental species is difficult (Small and Jomphe, 1989). A multiple access pictorial key based on discriminatory characters is given in Small and Brooks (1984b).
Habitat: Found in agricultural areas due the nature of its origin.
Geographical distribution: Asia: Armenia (N), Azerbaijan (N), China (I), Georgia (N), Iran (N), Kazakhstan (N), Kirgizstan (N), Pakistan (N), Russia in Asia (N), Tadzhikistan (N), Uzbekistan (N). Azerbaijan: Azerbaijan. Belarus: Brest, Minsk. Europe: Belarus (I), Belgium (N), Bulgaria (U), Estonia (I), France (U), Great Britain (N), Italy (N), Liechtenstein (N), Luxembourg (N), Portugal (U), Russia in Europe (I), Spain (N), Switzerland (N), Ukraine (I). Georgia: Abkhazia, Adzharia, Georgia. Kazakhstan: Aktyubinsk, Alma-Ata, Chimkent, Dzhambul, Karaganda, Kokchetav, Kustanai, Pavlodar, Semipalatinsk, Severo-Kazakhstanskaya, Taldy-Kurgan, Uralsk, Vostochno-Kazakhstanskaya. Kirgizstan: Frunze, Issyk-Kul, Osh. Middle East: Cyprus (N), Syria (N), Turkey in Asia (N). Russia in Asia: Dagestan. Russia in Europe: Bashkiria, Kaluga, Kirov, Leningrad, Mordovia, Moscow, Novgorod, Pskov, Smolensk, Tambov, Tataria, Tula,

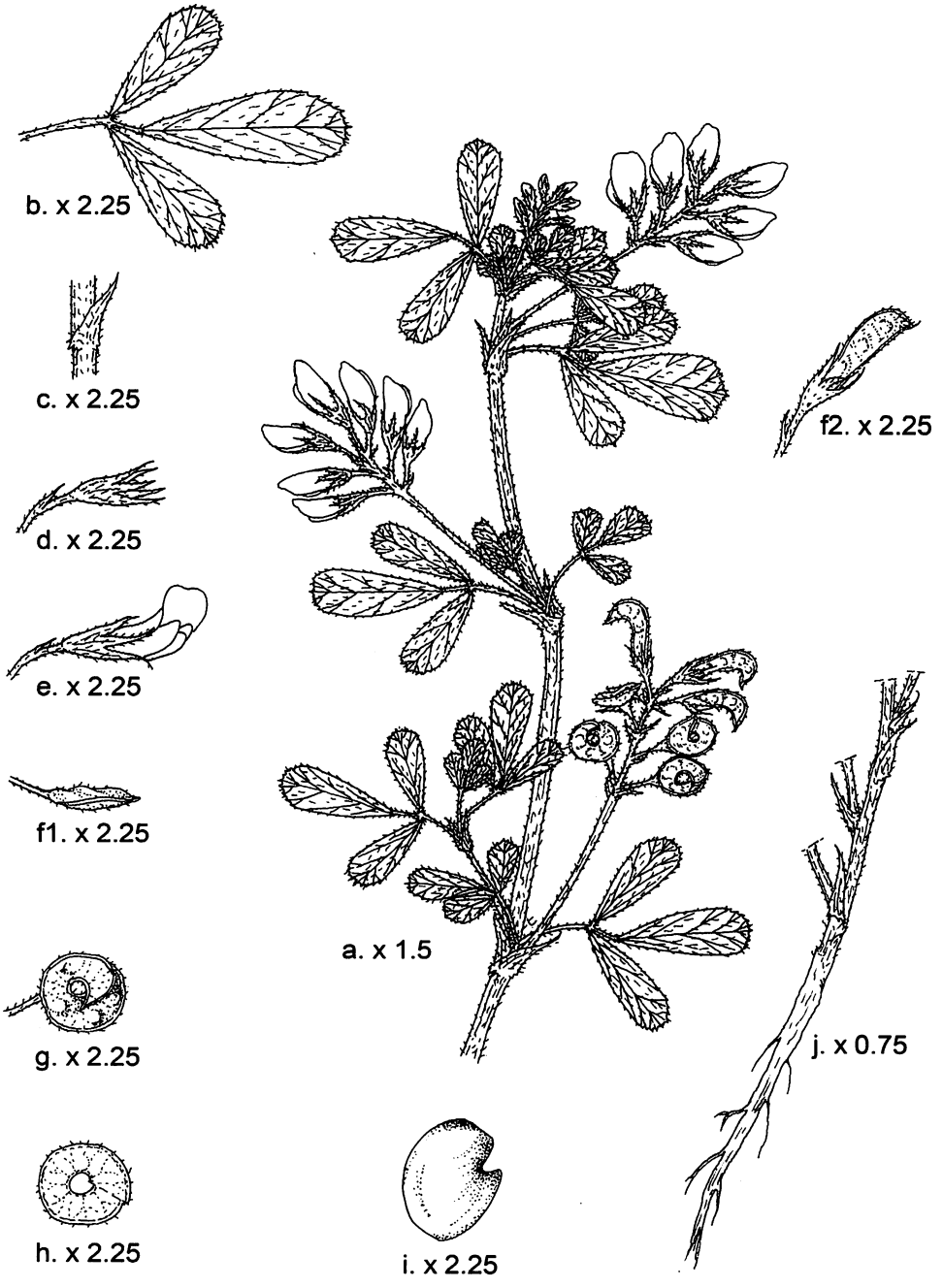

Figure 3.14. *Medicago sativa* subsp. *x varia*: a, habit (x 1.5); b, leaflet (x 2.25) c, stipule (x 2.25); d, calyx (x 2.25); e, flower (x 2.25); f1, pod three dimension view (x 2.25); f2, immature pod (x 2.25); g, pod tip view (x 2.25); h, pod venation (x 2.25); i, seed (x 2.25); j, root and stem (x 0.75).

Volgograd, Voronezh. Tadzhikistan: Kurgan-Tyube. Ukraine: Kiev, Krym, Lvov, Nikolaev, Odessa, Zakarpatskaya, Zhitomir. Uzbekistan: Tashkent.
Conservation and threat assessment: Not threatened
Actual and potential usage: Forage

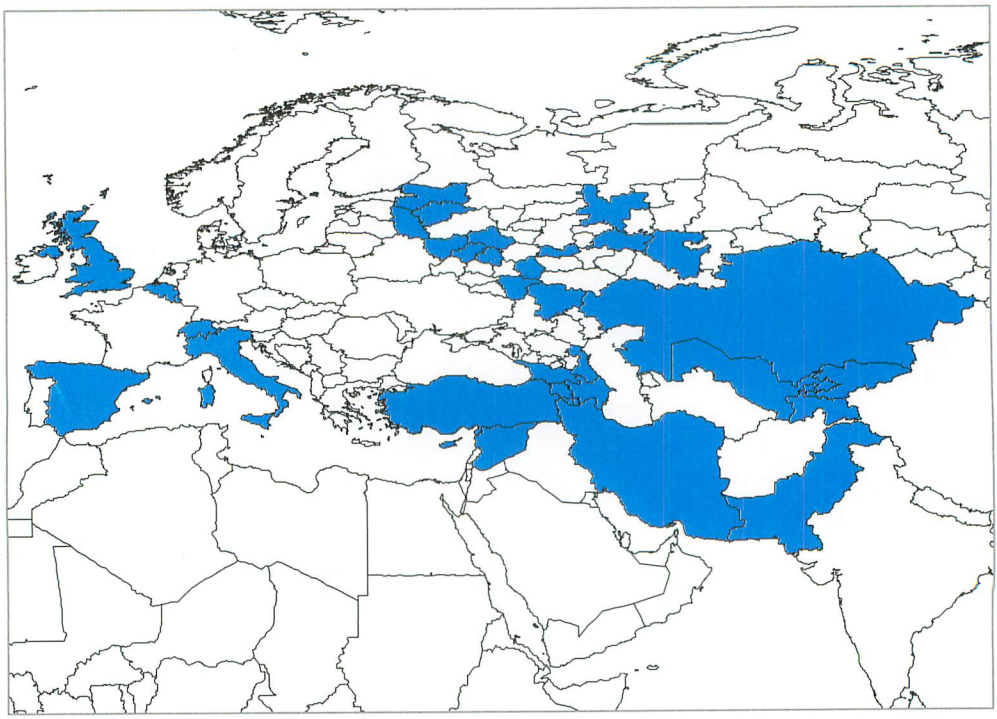

Figure 3.13. Distribution of *Medicago sativa* subsp. *x varia*. (shading represents native distribution).

3.9 *Medicago papillosa* Boiss., Diagn. Pl. Orient, 1 (2): 23 (1843).

Synonyms: *Medicago dzhawakhetica* Bordz, Port. Zased. Kievsk. Obschch. Estestv. 24 (1909).

Perennial, (5-)20-60 cm, stem procumbent to erect. Vegetative parts glabrous or densely pubescent, with appressed, simple hairs. Stipules adnate triangular or lanceolate, margin dentate, teeth at base or around margin. Leaflet 3-12(-20) x 5-12 mm, obovate or elliptical, margins almost entire or serrate (at apex). Peduncle with 4-15(-18) flowers, flowers in a head-shape raceme, longer than the corresponding petiole, with terminal cusp. Flower 6-10 mm. Pedicle longer than the calyx

tube, bract shorter than the pedicel, calyx glabrous or densely pubescent, with simple appressed hairs, teeth lanceolate, and teeth shorter than tube. Corolla bright yellow, standard tongue-shaped, wings longer than the keel. Pods coiled, densely pubescent, with glandular hair, covered with rough articulated hairs, black to yellow, spineless, face reticulate. Coils 1.5-4(-5), turning clockwise, not tightly appressed, 4-8 mm diameter, veins 8-12, curved, anastomosing near the ventral suture, venation often obscured by hairs. Seeds 2.3-2.5 x 1.3-1.5 mm, brown to green-yellow, 1-3 per coil, separated, with thick partition between them, radicle more than half seed length.

Chromosome number: 16, 32.
Closely related species: This can be confused with other yellow-flowered, montane perennial species with coiled, non-spiny fruits, especially *M. sativa*, however the prominent inter-seed fruits partitions make it quite distinctive (Small and Jomphe, 1989).
Habitat: Mid-mountain zone in, pastures, dry meadows, on rocky igneous and calcareous slopes and rock debris.

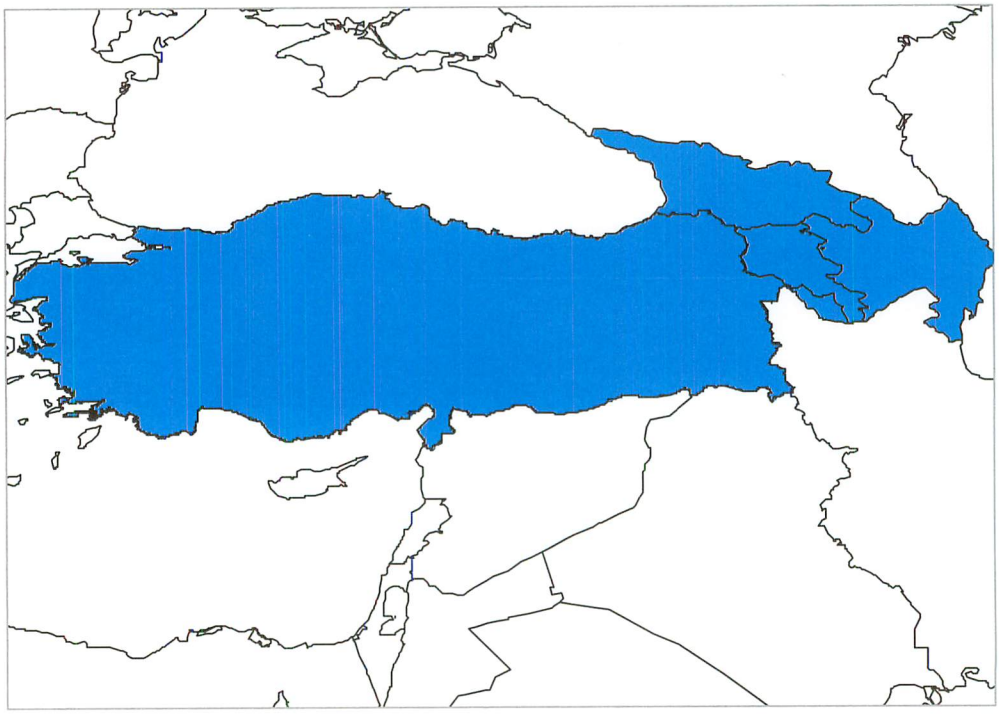

Figure 3.15. Distribution of *Medicago papillosa*. (shading represents native distribution).

Geographical distribution: Asia: Armenia (N), Azerbaijan (N), Georgia (N). Azerbaijan: Azerbaijan. Georgia: Adzharia, Georgia. Middle East: Turkey in Asia (N).
Conservation and threat assessment: Insufficiently known
Actual and potential usage: Forage. Germplasm may be useful in alfalfa breeding for disease resistance and improving the adaptation to mountain pastures.

3.10 *Medicago papillosa* Boiss. subsp. *papillosa*

Perennial, (5-)20-60 cm, stem procumbent to erect. Vegetative parts glabrous to densely pubescent, with appressed, simple hairs. Stipules adnate, triangular or lanceolate, margin entire or serrate, teeth over all margin. Leaflet 3-12(-20) x 5-12 mm, obovate or elliptical, margins almost entire or serrate (at apex). Peduncle with 4-15(-18) flowers, in a head-shape raceme, longer than the corresponding petiole, with terminal cusp. Flower 6-8 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx glabrous or densely pubescent, with simple appressed hairs, teeth lanceolate, teeth shorter than tube. Corolla bright yellow, standard tongue-shaped, wings longer than the keel. Pods coiled, densely pubescent, with

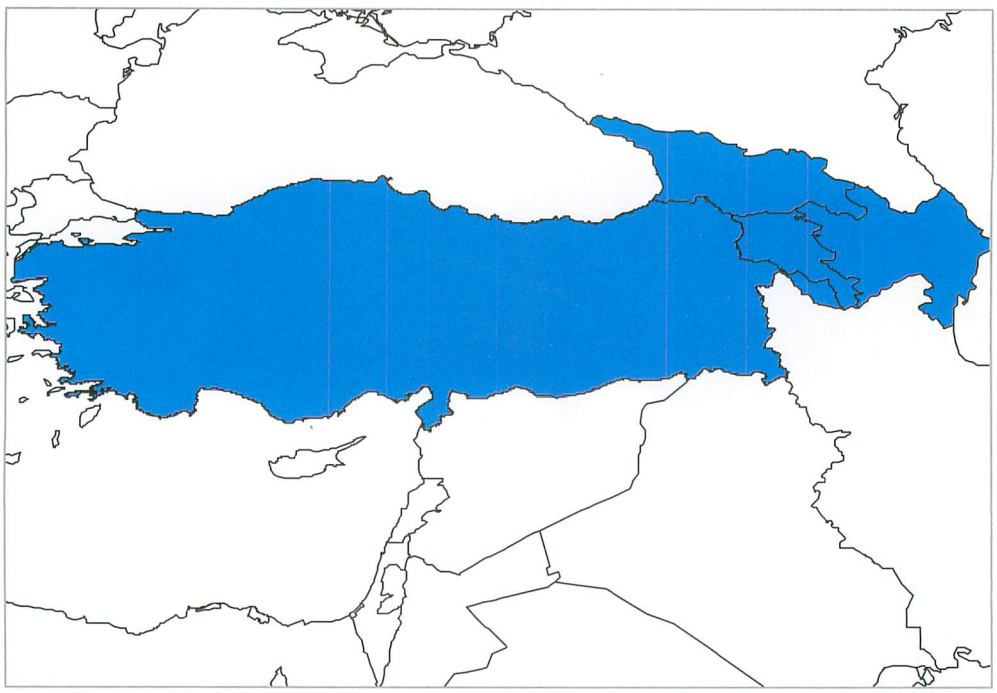

Figure 3.16. Distribution of *Medicago papillosa* subsp. *papillosa*. (shading represents native distribution).

glandular hair, covered with rough articulate hairs, black to yellow, spineless, face reticulate. Coils 1.5-4(-5), turning clockwise, not tightly appressed, 4-6.3 mm diameter, veins 8-12, curved, anastomosing near the ventral suture, venation obscure (observed after cleared of hairs). Seeds 2.3-2.5 x 1.3-1.5 mm, brown to green-yellow, 1-3 per coil, separated, with thick partition between them, radicle more than half seed length.

Chromosome number: 16, 32.
Closely related species: This subspecies is distinguished from the *M. papillosa* subsp. *macrocarpa* by having a fruit diameter no more than 6.3 mm, flowers less than 8 mm, and stipules of mature leaves entire or with few basal serrations (as opposed to having a few serration distally as well as proximally) (Small and Jomphe, 1989).
Habitat: Valleys in the mid-mountain zone, dry rocky slopes, cliffs and mountain pastures. Volcanic soils on calcareous slops.
Geographical distribution: Asia: Armenia (N), Azerbaijan (N), Georgia (N). Azerbaijan: Azerbaijan. Georgia: Adzharia, Georgia. Middle East: Turkey in Asia (N).
Conservation and threat assessment: Not threatened
Actual and potential usage: Forage.

3.11 *Medicago papillosa* subsp. *macrocarpa* (Boiss.) Urban, Verh. Bot. Vereins Prov. Brandenburg 15: 56 (1873).

Perennial, (5-)20-60 cm, stem procumbent to erect. Vegetative parts glabrous or densely pubescent, with appressed, simple hairs. Stipules adnate triangular or lanceolate, margin laciniate, teeth at base or around margin. Leaflet 3-12(-20) x 5-12 mm, obovate or elliptical, margins almost entire or serrate (at apex). Peduncle with 4-15(-18) flowers, flowers in a head-shape raceme, longer than the corresponding petiole, with terminal cusp. Flower 8-10 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx glabrous or densely pubescent, with simple appressed hairs, teeth lanceolate, shorter than tube. Corolla bright yellow, standard tongue-shaped, wings longer than the keel. Pods coiled, densely pubescent, with glandular hair, covered with rough articulate hairs, black to yellow, spineless, face reticulate. Coils 1.5-4(-5), turning clockwise, not tightly appressed, 6.3-8 mm diameter, veins 8-12, curved, anastomosing near the ventral suture, venation obscure (observed after cleared of hairs). Seeds 2.3-2.5 x 1.3-1.5 mm, brown to green-yellow, 1-3 per coil, separated, with thick partition between them, radicle more than half seed length.

Chromosome number: 16, 32.
Closely related species: This is distinguished from *M. papillosa* subsp. *papillosa* by larger fruits and flowers and more deeply dissected stipules.
Habitat: Volcanic soils on calcareous slopes on mid-mountain zone, less frequently on dry slopes, cliffs and in pastures. It seems to occupy more mesic habitats than

subsp. *papillosa* (Vassilczenko, 1949).
Geographical distribution: Asia: Armenia (N), Azerbaijan (N), Georgia (N). Azerbaijan: Azerbaijan. Georgia: Adzharia, Georgia. Middle East: Turkey in Asia (N)
Conservation and threat assessment: Insufficiently known.
Actual and potential usage: Forage

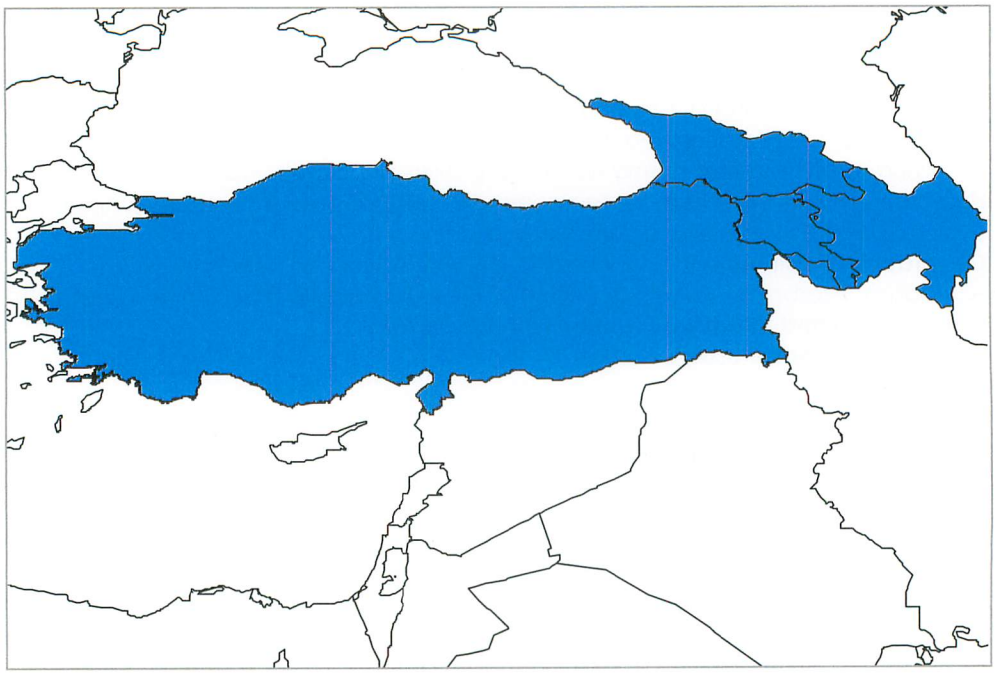

Figure 3.17. Distribution of *Medicago papillosa* subsp. *macrocarpa*. (shading represents native distribution).

3.12 *Medicago prostrata* Jacq., Hort. Vindob. 1: 39 (1770).

Synonyms: *Medicago declinata* Kit. Linnaea 32: 613 (1863).
Perennial, shrub, 25-60 cm, stem ascending. Vegetative parts densely pubescent, with simple or glandular hairs. Stipules acuminate, margin entire or dentate, teeth at base. Leaflet 4-15 x 1-5 mm, obovate, dorsally glabrous, ventrally densely pubescent, margins slightly serrate (with tri-dentate apex). Peduncle with 1-8 flowers, longer than the corresponding petiole, with terminal cusp. Flower 7-8 mm. Pedicle thin recurved equal to the calyx tube. Calyx shorter than or equalling half of the corolla, teeth ± equalling tube. Corolla yellow, standard oval, wings longer than the keel. Pods coiled, glabrous or densely pubescent, with simple or glandular hair,

brown, cylindrical, spineless, not sessile, with coiled tip, centre almost with no opening. Coils 2-4.5, turning clockwise, loose, 2.5-4(-5) mm diameter, veins 5-8, slender shaped, anastomosing in the outer part of the pod face, venation indistinct at the coil edge, obscure. Seeds 2-2.3 x 1-1.3 mm, brown or green-yellow, 1-2 per coil, not separated or separated, with thin membrane between them (if present), radicle more than half seed length.

Chromosome number: 16, 32.

Closely related species: This can be confused with other yellow-flowered, montane perennials with coiled, non-spiny fruits and gland-tipped trichomes, however, *M. sativa* subsp. *glomerata* does not have the long reflexed pedicels of *M. prostrate* and *M. suffruticosa* has much wider leaflets, *M. rupestris* and (the non-montane) *M. cancellata* are well to the east and the venation of their fruits is much more prominent, and *M. papillosa* has distinctive inter-seed fruits partition (Small and Jomphe, 1989).

Habitat: Limestone rocks and scree, rocky hillsides, waste ground, and riverside.

Geographical distribution: Europe: Albania (N), Austria (N), Czech Republic and

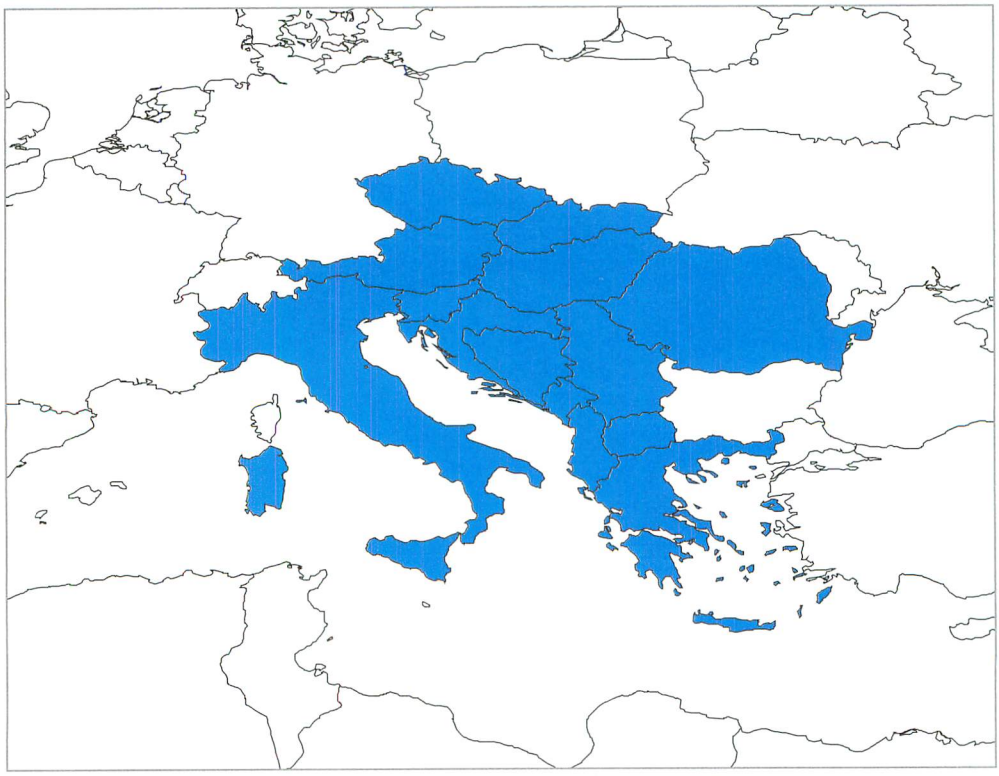

Figure 3.18. Distribution of *Medicago prostrate*. (shading represents native distribution).

Slovakia (N), former Yugoslavia (N), Greece (N), Hungary (N), Italy (N), Romania (N)
Indian Ocean: Mauritius (I).
Conservation and threat assessment: Not sufficiently known

3.13 *Medicago rupestris* M. Bieb. Fl. Taur. Cauc. 2: 225 (1808).

Perennial herb, 10-20 cm, stem numerous, short, thin arising from the crown. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules lanceolate, margin entire or dentate, teeth at base. Leaflet 5-10 x 1.5-3 mm, wedge-shape, linear, apex obtuse (with few apical teeth), dorsally densely pubescent, with appressed hairs, margins entire. Peduncle with 2-4 flowers, equal to or longer than the corresponding petiole, without terminal cusp. Flower 4-6 mm. Pedicle longer than the calyx tube. Calyx densely pubescent, with simple appressed hairs, equalling half of the corolla, teeth subulate, teeth ± equalling tube. Corolla yellow, standard oval, wings slightly longer than the keel. Pods coiled, sparsely pubescent, with simple hair, yellow, reniforme, spineless, not sessile, without gland-tipped trichomes, face reticulate, spineless pod on the plant only, centre with no opening. Coils 1-1.5, turning clockwise, 3-4 mm diameter, veins 8-11, anastomosing in the half distance from the dorsal suture, venation is a net of veins. Seeds 1.7-2 x 1-1.5 mm, green-yellow, ovoid, 1-2 per coil, not separated, radicle equalling half seed length.

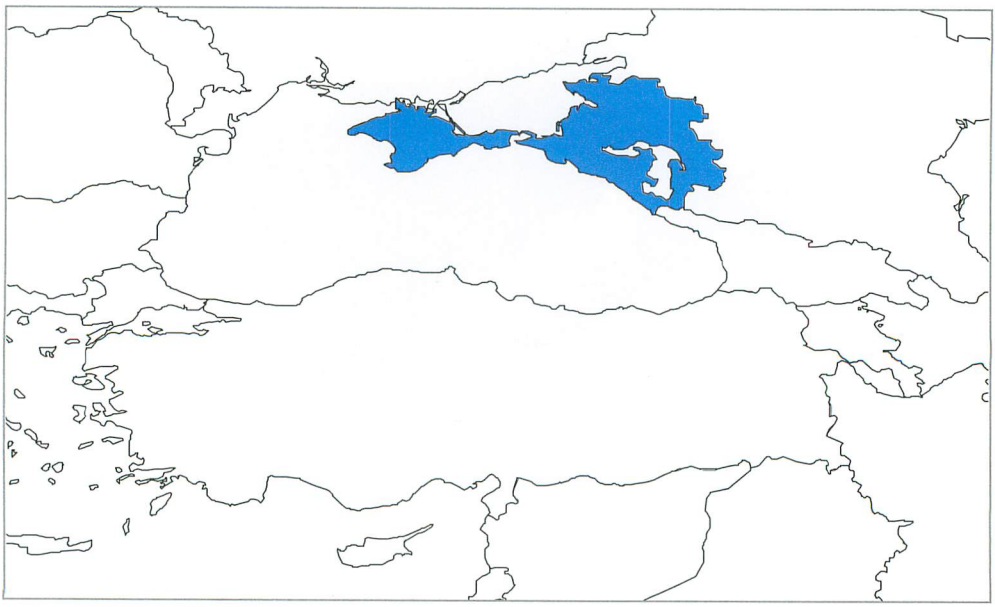

Figure 3.19. Distribution of *Medicago rupestris*. (shading represents native distribution).

Chromosome number: 16.
Closely related species: This species can be confused with *M. prostrata* and *M. cancellata*.
Habitat: Calcareous, rocky areas in lower mountain zone.
Geographical distribution: Asia: Russia in Asia (N). Europe: Ukraine (N), Russia in Asia: Krasnodar, Ukraine: Krym

3.14 *Medicago cancellata* M. Bieb. Fl. Taur. Cauc. 2: 226 (1808).

Synonyms: *Medicago ciscaucasica* B. Fedtsch. Not. Syst. Herb. Inst. Bot. Acad. Sci. URSS, viii. 176 (1940).

Perennial herb, 50-80 cm, stems arising from the crown, ascending to erect. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules lanceolate, margin entire or dentate, teeth at base. Leaflet 8-10 x 4-5 mm, obovate, base obcordate, dorsally glabrous, margins serrate (at apical third). Peduncle with 5-12 flowers, longer than the corresponding petiole, with terminal cusp. Flower 10 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx 4 mm, teeth longer than tube. Corolla yellow, standard obovate, wings longer than the

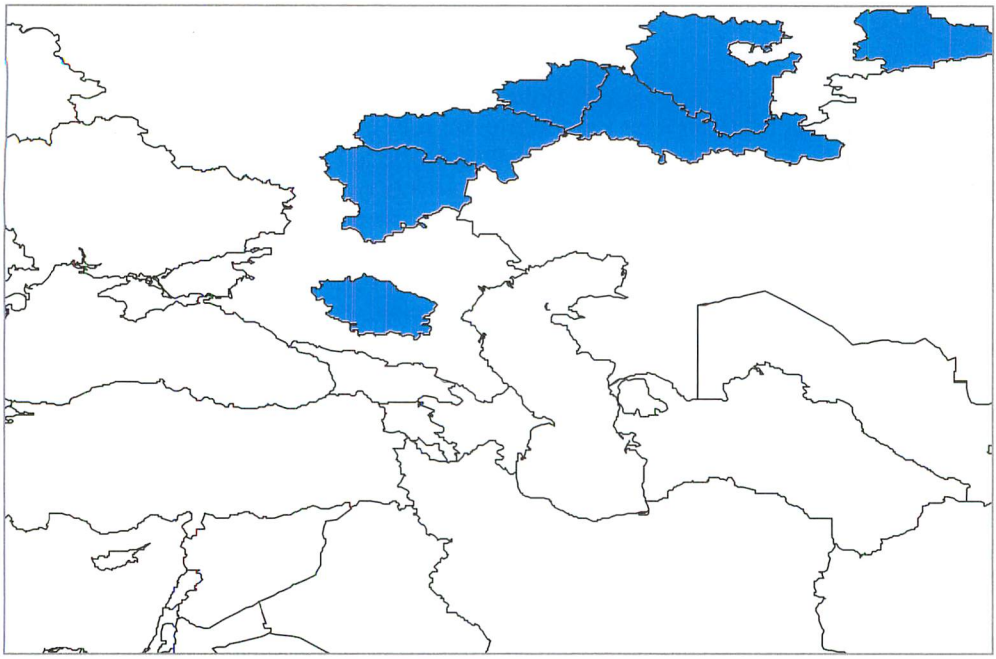

Figure 3.20. Distribution of *Medicago cancellata*. (shading represents native distribution).

keel. Pods coiled, glabrous, brown, not subterranean, discoid, spineless, face reticulate, centre with no opening. Coils 1.5-3, turning clockwise, 4-6 mm diameter, veins 9-10, not changing direction before joining the dorsal suture, venation as shoulders siding at 90 degrees. Seeds 3 x 1.2 mm, brown, reniforme, 1-2 per coil, 2-6 per pod, not separated, radicle more than half seed length.

Chromosome number: 48.
Closely related species: This is very similar in appearance to one of its putative ancestors, *M. rupestris*, in having narrow leaflets and prominent fruit venation, but it is distinguishable by its larger fruits.
Habitat: Infertile soils of steppe and semi-desert areas.
Geographical distribution: Asia: Russia in Asia (N). Europe: Russia in Europe (N) Russia in Asia: Kurgan, Stavropol, Russia in Europe: Bashkiria, Kuibyshev, Orenburg, Saratov and Volgograd.
Conservation and threat assessment: Not threatened
Actual and potential usage: Forage. It may provide a source of resistance to *Stemphylium* leaf spot (Borges *et al.* 1976).

3.15 *Medicago rhodopea* Velen. in Sitzun., B□hm. Ges. Wiss. Prag. Math.-Naturwiss Cl. 37: 21 (1894).

Perennial herb, 10-30 cm, stem arising from the crown, procumbent to ascending, branching over the ground level. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules lanceolate, margin entire. Leaflet 8-9 x 2.5 mm, obovate, base obcordate, margins crenate (at apex). Peduncle with 4-10 flowers, longer than the corresponding petiole, with terminal cusp. Flower 5-7 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx shorter than half of the corolla, teeth ± equalling tube. Corolla yellow, standard obovate, with retuse apex, wings more or less equalling the keel. Pods coiled, ash-grey, not subterranean, discoid or cylindrical, spiny or with tubercles, not sessile, with coiled tip, face reticulate, centre with no opening. Coils 1-2.5, turning clockwise, 2.5-4 mm diameter, flat, veins 6-12, slender shaped, not changing direction before joining the dorsal suture, venation darker than the middle of the coil, grooves quadrangular between lateral vein and dorsal suture. Spines triangular flattened, slender, fine, with thin tip. Seeds 2.3 x 1-1.3 mm, brown, reniforme, 1-2 per coil, separated, with thin spongy partition between them, radicle equalling half seed length.

Chromosome number: 16.
Closely related species: This species is distinguishable from its close allies *M. prostrata* and *M. rupestris* by prominent pod veins with short spins or tubercles. Rare spineless forms can make identification problematical, but *M. prostrata* and *M. rupestris* occur well to the west of *M. rhodopea* (Small and Jomphe, 1989).
Habitat: Calcareous rocky sites in lower mountain zones.
Geographical distribution: Europe: Bulgaria (N).

Conservation and threat assessment: Rare (IUCN)
Actual and potential usage: Although of little agricultural value due to its low productivity, it may harbour characters of value to the breeding of *M. sativa* and relatively easy hybridisation is possible between the two taxa (Lesins and Lesins, 1979).

Figure 3.21. Distribution of *Medicago rhodopea*. (shading represents native distribution).

3.16 *Medicago saxatilis* M. Bieb. Fl. Taur. Cauc. 2: 225 (1808).

Perennial herb, 10-50 cm, stem arising from the crown, decumbent. Vegetative parts sparsely pubescent, with appressed, simple hairs. Stipules lanceolate, margin entire. Leaflet 9-13 x 4-7 mm, obovate, apex retuse, dorsally glabrous, ventrally sparsely pubescent, with appressed hairs, margins entire or serrate (at apex). Peduncle with 4-8 flowers, longer than the corresponding petiole, with terminal cusp. Flower 12 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx densely pubescent, with simple appressed hairs, equalling half of the corolla, teeth subulate, teeth ± equalling tube. Corolla yellow, standard oval, wings

slightly longer than or equal to the keel. Pods coiled, glabrous or sparsely pubescent, ash-grey, not subterranean, cylindrical, spiny or with tubercles, not sessile, with coiled tip, face reticulate, centre with no opening. Coils 2-5, turning clockwise, loose, 6-8 mm diameter, veins 8-10, curved, anastomosing in the outer part of the pod face, venation darker than the middle of the coil, more three grooves between lateral vein and dorsal suture, grooves wide shallow between lateral vein and dorsal suture. Spines triangular flattened, 1-2 mm, at two rows on a coil edge, 12-14 per row. Seeds 3.5-3.7 x 2 mm, green-yellow, 1-2 per coil, separated, with thin spongy partition between them, radicle more than half seed length.

Chromosome number: 48.
Closely related species: It is similar to another spiny-fruited species, *M. rhodopea*, which is distributed well to the west of its range. It has much smaller fruits; the other closely related spiny-fruited perennial species are also distinctive: *M. daghestanica* usually has violet flowers, and *M. pironae* has fruit covered with glandular hairs (Small and Jomphe, 1989).
Habitat: Calcareous rocky sites in mid-mountain zone, dry meadows.
Geographical distribution: Europe: Ukraine (N). Ukraine: Krym.
Actual and potential usage: Is crossable *M. sativa* so may be able to donate useful characters to this species, if any exist (Lesins and Lesins, 1979).

Figure 3.22. Distribution of *Medicago saxatilis*. (shading represents native distribution).

3.17 *Medicago daghestanica* Rupr. ex Boiss, Fl. Orient. 2: 95 (1872).

Perennial herb, 20-45 cm, stem arising from the crown, decumbent, branching over the ground level. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules lanceolate, margin entire or serrate, teeth at base. Leaflet 4-6 x 3-6 mm, obovate, base obcordate, dorsally glabrous, ventrally densely pubescent, with appressed hairs, margins entire, blue-green. Peduncle with 4-11 flowers, longer than the corresponding petiole, with terminal cusp. Flower 6-7 mm. Pedicle shorter than the calyx tube, bract shorter than the pedicel, calyx 4 mm, densely pubescent, with simple hairs, teeth lanceolate, teeth ± equalling tube. Corolla violet, standard oval, wings equal or slightly longer than the keel. Pods coiled, sparsely pubescent, with simple hair, green-brown, cylindrical, spiny or with tubercles (rarely), face reticulate, centre with no opening. Coils 3-6, turning clockwise, 3.5-4.5 mm diameter, veins 5-6, curved, branching near lateral outer vein, grooves quadrangular between lateral vein and dorsal suture. Spines triangular flattened, grooved, with thin tip, 1-2 mm, at two rows on a coil edge, 6-10 per row, arching upwards of the coil. Seeds 2.5 x 1.2 mm, green-yellow, 1-2 per coil, separated, radicle equalling half seed length.

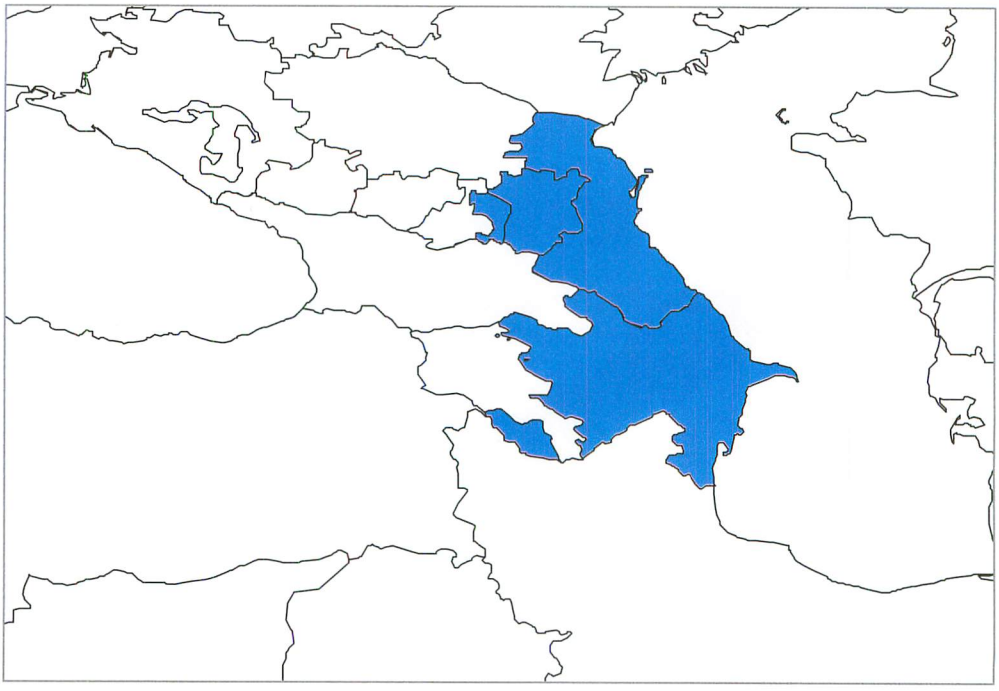

Figure 3.23. Distribution of *Medicago daghestanica*. (shading represents native distribution).

Chromosome number: 16.
Closely related species: This is not the only species with the combination of spiny, coiled fruits and (white or light blue to) violet flowers (Small and Jomphe, 1989).
Habitat: Calcareous rocks in mid-mountain zone.
Geographical distribution: Asia: Azerbaijan (N), Russia in Asia (N). Azerbaijan: Azerbaijan. Russia in Asia: Checheno-Ingushetia, Dagestan.
Conservation and threat assessment: Not known (insufficient data).
Actual and potential usage: Possible donor of genetic material to *M. sativa*.

3.18 *Medicago pironae* Vis., Index Sem. Hort. Bot. Patavia: 365 (1885).

Perennial herb, up to 40 cm, stem arising from the crown, ascending to erect. Vegetative parts glabrous. Stipules acuminate margin entire or serrate, teeth at base. Leaflet 4-11 x 4-10 mm, ovate, dorsally glabrous, ventrally glabrous, apex margin serrate. Peduncle with 4-10 flowers, more or less equal to the corresponding petiole, with terminal cusp. Flower 6-8.5 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx densely pubescent, with simple appressed hairs, shorter than half of the corolla, teeth longer than tube. Corolla yellow, standard oblong, wings longer than the keel. Pods coiled, densely pubescent, with glandular hair, black to brown, cylindrical, spiny, not sessile, face reticulate. Coils

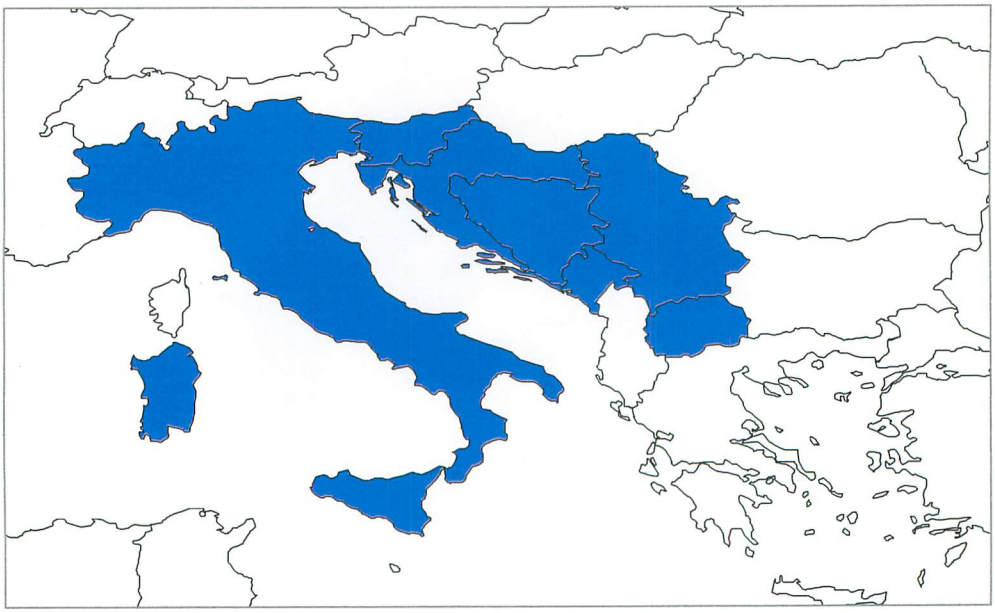

Figure 3.24. Distribution of *Medicago pironae*. (shading represents native distribution).

1.5-4, turning clockwise, loose, 5.5-6.5 mm diameters, veins 9-10, slender shaped, branching near lateral outer vein, grooves wide shallow between lateral vein and dorsal suture. Spines stocky, thick, with grooved base, grooved to ± half their length, 1 mm, at two rows on a coil edge, 8-10 per row, inserted at almost 90 degree to the coil face. Seeds 2.5 x 1.2 mm, yellow, 1-2 per coil, not separated radicle more than half seed length.

Chromosome number: 16.
Closely related species: This is the only perennial *Medicago* with spiny, coiled fruits covered with gland-tipped hairs. However, the fruits are remarkably similar to those of the annual species *M. rigidula*.
Habitat: Sub-mountain, rocky hillsides, between low bushes.
Geographical distribution: Europe: former Yugoslavia (N), Italy (N).
Conservation and threat assessment: Rare.

3.19 *Medicago hybrida* (Pourret) Trautvetter, Bull. Sci. Acad. St. Petersburg 8: 271 (1841).

Synonyms: *Trigonella hybrida* Pourr. Mem. Acad. Toul. 3: 331 (1788); *Medicago pourretii* Noulet, Fl. Bass. Sous-Pyr. 151 (1837).
Perennial herb, 20-40 cm, stems arising from the crown, procumbent to decumbent. Vegetative parts glabrous or densely pubescent, with simple hairs. Stipules margin entire or serrate, teeth around margin. Leaflet 14-22 x 9-19 mm, at upper nodes ovate to obovate, dorsally glabrous, margins entire or serrate. Peduncle with 3-5 flowers, longer than the corresponding petiole, with terminal cusp. Flower 8-8.5 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx 3-4 mm, densely pubescent, with simple appressed hairs, teeth ± equalling tube. Corolla yellow, standard obovate (to rounded), wing longer than the keel. Pods uncoiled, glabrous, brown, 7.5-10 mm, straight to sickle-shaped, spineless, not sessile, face reticulate, veins 14-17, anastomosing in the outer part of the pod face. Seeds 3 x 1.5 mm, green-yellow, 2-4 per pod, not separated, radicle more than half seed length.

Chromosome number: 16.
Closely related species: It is easily distinguished species, except for perhaps *M. strasseri*, which has similar but larger fruits.
Habitat: Grassy glades on limestone slopes, dry rocky hillsides, open scrub, pine forest. Lesins and Lesins (1979) collected this taxon in a gorge with higher air humidity. They suggested that the taxon is the most self–fertile member of the *Suffruticosae*, and this could perhaps be attributed to the humidity resulting in a scarcity of pollinating insects.
Geographical distribution: Africa: Morocco (N). Europe: France (N).
Conservation and threat assessment: Not threatened
Actual and potential usage: It may have merits under certain mountain pasture

condition, specifically after hybridisation with more vigorous *M. suffruticosa* (Lesins and Lesins, 1979).

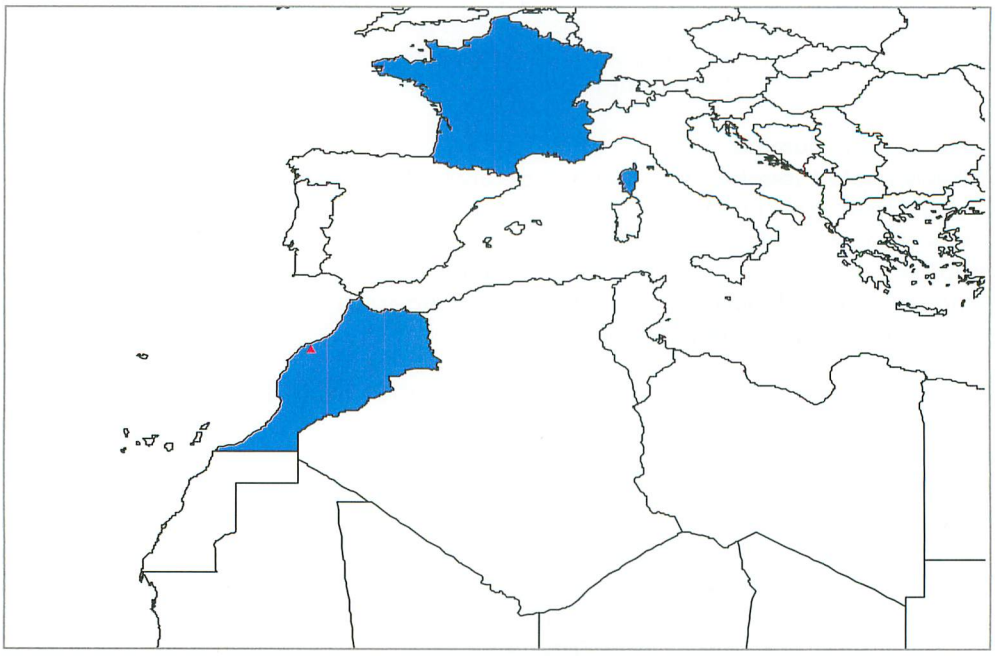

Figure 3.25. Distribution of *Medicago hybrida*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.20 *Medicago suffruticosa* DC. in Lam. & DC., Fl. Franç. 4: 541 (1805).

Perennial herb, 4-35(-70) cm, stem arising from the crown, procumbent or decumbent. Vegetative parts sparsely pubescent, with simple hairs. Stipules ovate to lanceolate, margin dentate, teeth around margin. Leaflet 12-21 x 10-16 mm, obovate to elliptical, apex retuse, base cuneate, dorsally glabrous, ventrally densely pubescent, margins entire or dentate (at apex). Peduncle with 3-10 flowers, longer than the corresponding petiole, with terminal cusp. Flower 7.5-8.5 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx 3-3.5 mm, densely pubescent, with defuse hairs, teeth ± equalling tube. Corolla yellow, standard obovate, with obcordate apex, with a violet hue on the outer side, wings longer than the keel. Pods coiled, glabrous or densely pubescent, with simple hair or simple and glandular hairs, black or green-brown, discoid to cylindrical, spineless, not sessile,

face reticulate, centre with a small opening. Coils 1.5-3.5, turning clockwise, not tightly appressed, 4-7.5 mm diameter, flat, with thin wall, veins 6-8, passing obliquely to the dorsal suture, slender shaped. Seeds 2.5 x 1.5 mm, brown to green-yellow, 3-6 per coil, not separated radicle more than half seed length.

Chromosome number: 16.
Closely related species: This species is polymorphic and differences with other species are best addressed by contrasting the constituent subspecies with other species.
Habitat: Calcareous rocks in mid-mountain zone.
Geographical distribution: Africa: Morocco (N) Europe: France (N), Spain (N).
Conservation and threat assessment: Not threatened.

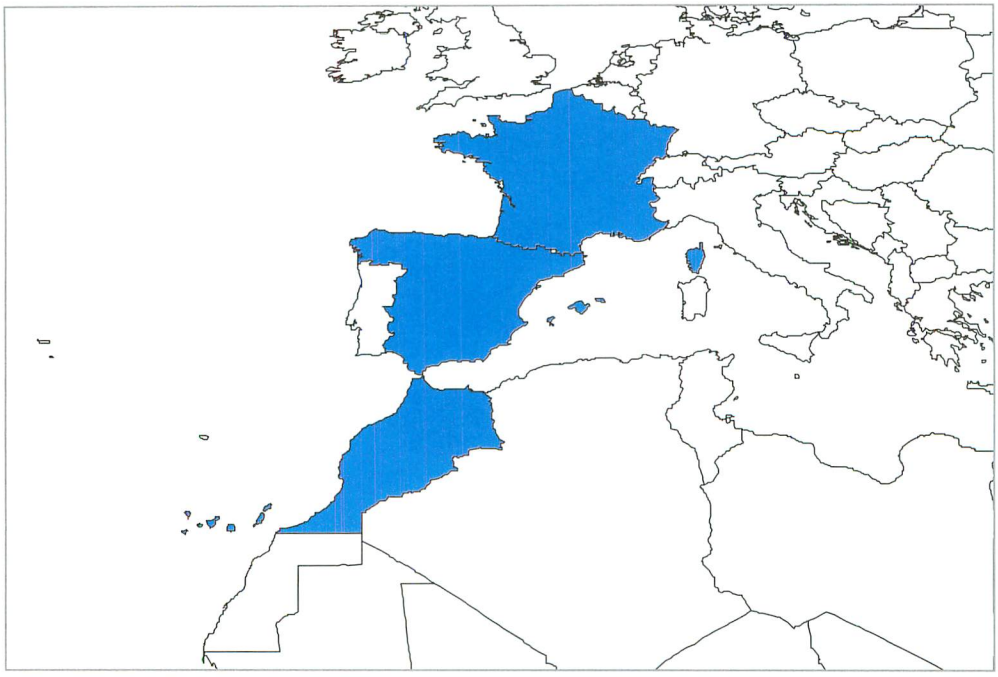

Figure 3.26. Distribution of *Medicago suffruticosa*. (shading represents native distribution).

3.21 *Medicago suffruticosa* DC. subsp. *suffruticosa*

Perennial herb, 4-35(-70) cm, stem arising from the crown, procumbent or decumbent. Vegetative parts densely pubescent, with simple hairs. Stipules acuminate, margin dentate, teeth around margin. Leaflet 12-21 x 10-16 mm, obovate to ellipti-

cal, apex retuse, base cuneate, dorsally glabrous, ventrally densely pubescent, margins entire or dentate (at apex). Peduncle with 3-10 flowers, longer than the corresponding petiole, with terminal cusp. Flower 7 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx 3-3.5 mm, densely pubescent with defuse hairs, teeth ± equalling tube. Corolla yellow, standard obovate, with obcordate apex, with a violet hue on the outer side, wings longer than the keel. Pods coiled, glabrous or densely pubescent, with simple hair or simple and glandular hairs, black or green-brown, discoid to cylindrical, spineless, not sessile, with gland-tipped trichomes, face reticulate, centre with a small opening. Coils 1.5-3.5, turning clockwise, not tightly appressed, 4-7.5 mm diameter, flat, with thin wall, veins 6-8, passing obliquely to the dorsal suture, slender shaped, venation is a net of veins. Seeds 2.5 x 1.5 mm, brown to green-yellow, 3-6 per coil, not separated radicle more than half seed length.

Chromosome number: 16.
Closely related species: This subspecies could be confused with the possibly sympatric *M. sativa* subsp. *glomerata*. The *M. suffruticosa* subsp. *suffruticosa* usually has broader leaves, fewer flowers (3-10 as opposed to 4-18), and somewhat longer radicles (about 2/3 of seed length, as opposed to ca. 1/2). (Small and Jomphe, 1989

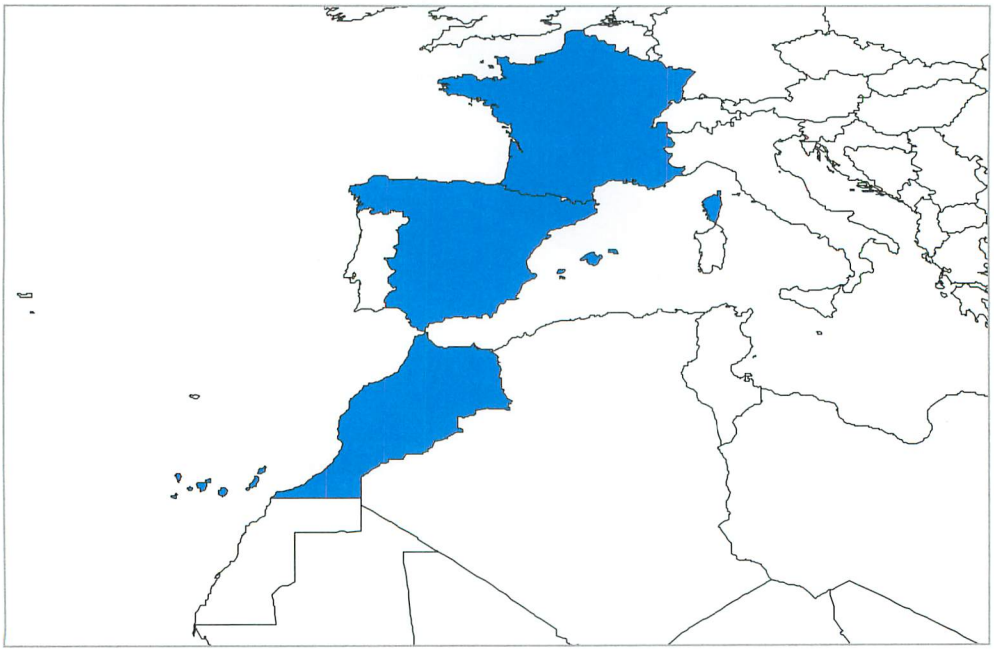

Figure 3.27. Distribution of *Medicago suffruticosa* subsp. *suffruticosa*. (shading represents native distribution).

Habitat: Bare ground, rocky slopes, ravines, banks, *Pinus sylvestris* forest, pastures.
Geographical distribution: Africa: Morocco (N) Europe: France (N), Spain (N).
Conservation and threat assessment: Not threatened

3.22 *Medicago suffruticosa* DC. subsp. *leiocarpa* (Benth.) Urban, Verh. Bot. Ver. Brandenburg 15: 58 (1873).

Synonyms: *Medicago leiocarpa* Benth, Cat. Pl. Pyren. 100 (1826).
Perennial herb, 4-35(-70) cm, stem arising from the crown, procumbent or decumbent. Vegetative parts densely pubescent, with simple hairs. Stipules ovate, margin dentate, teeth around margin. Leaflet 12-21 x 10-16 mm, obovate to elliptical, apex retuse, base cuneate, dorsally glabrous, ventrally densely pubescent, margins entire or dentate (at apex). Peduncle with 3-10 flowers, longer than the corresponding petiole, with terminal cusp. Flower 3 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx 3-3.5 mm, densely pubescent, with defuse hairs, teeth ± equalling tube. Corolla yellow, standard obovate, with obcordate apex, with a violet hue on the outer side, wings longer than the keel. Pods coiled, glabrous, black or green-brown, short cylindrical, spineless, not sessile, face reticulate, centre with a small opening. Coils 2-4, turning clockwise, not tightly appressed,

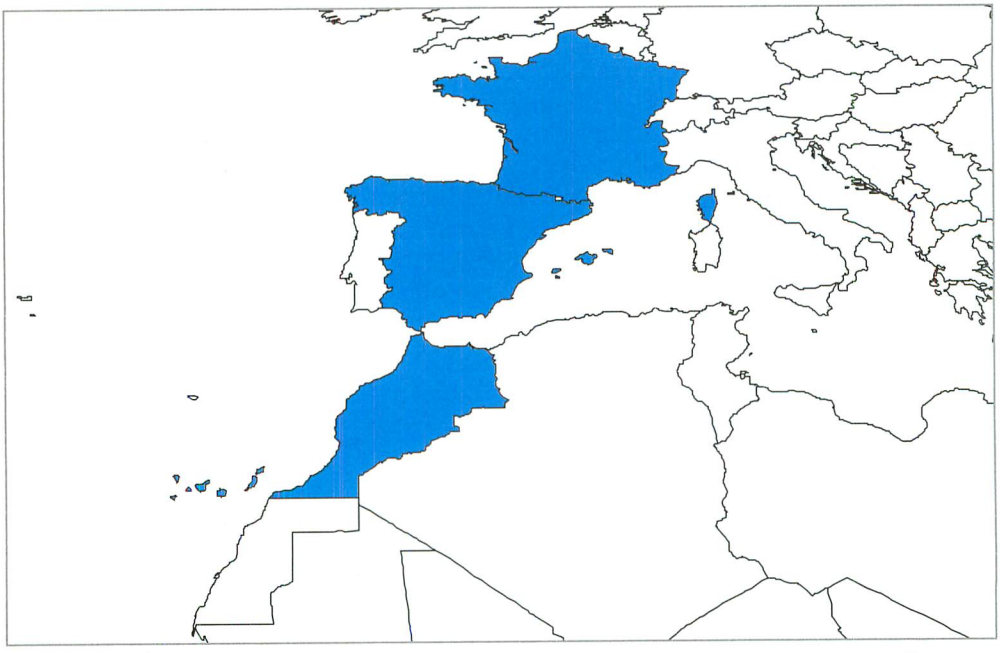

Figure 3.28. Distribution of *Medicago suffruticosa* DC. subsp. *leiocarpa*. (shading represents native distribution).

4-7.5 mm diameter, flat, with hard wall, veins 6-8, slender shaped (passing obliquely to the dorsal suture), venation prominent darker than the middle of the coil, dorsal suture below the lateral veins. Seeds 3.2-3.5 x 1.5-1.8 mm, brown to green-yellow, 3-6 per coil, not separated radicle more than half seed length.

Chromosome number: 16.
Closely related species: This subspecies is quite distinct and is unlikely to be confused with other species.
Habitat: Limestone and igneous sub-strata. Herb rich sites, open maquis, moist cultivated sites and rocky slopes. Found at lower altitudes and can tolerate dryer soils than the other subspecies.
Geographical distribution: Africa: Morocco (N) Europe: France (N), Spain (N).
Conservation and threat assessment: Not threatened

3.23 *Medicago marina* L., Sp. Pl.: 779 (1753).

Perennial herb, 10-40(-60) cm, stem arising from the crown, round in cross section, procumbent to decumbent. Vegetative parts densely pubescent, with simple hairs. Stipules ovate, margin entire or dentate, teeth at base. Leaflet 8-16 x 7-11 mm, obovate, apex often truncate to emarginate, base obtuse, dorsally densely pubescent, ventrally densely pubescent, apex margin dentate. Peduncle with 5-12(-14) flowers, flowers in a head-shape raceme, longer than the corresponding petiole, with terminal cusp. Flower 6-10 mm. Pedicle shorter than the calyx tube, bract shorter than the pedicel, calyx 2-4 mm, teeth shorter than tube. Corolla yellow, standard obovate, wings equal or longer than the keel. Pods coiled, densely pubescent, with simple hair, ash-grey to yellow, 5-6 mm, truncate on both end, discoid or cylindrical, spiny or spineless or with tubercles, face reticulate. Coils 2-4, turning clockwise, not tightly appressed, 4-6 mm diameter, veins 6-7, slender shaped, anastomosing in the outer part of the pod face, grooves wide shallow between lateral vein and dorsal suture. Spines conical, with thin tip and grooved base, 8-11 per row. Seeds 3-3.8 x 1.5-2 mm, brown, reniforme, 1-2 per coil, separated, with thin membrane between them, radicle less than half seed length.

Chromosome number: 16.
Closely related species: It is easily recognised by the dense white tomentum over most parts of the plants.
Habitat: Exclusively on seashores, usually in loose sand, cliffs and sandy meadows.
Geographical distribution: Africa: Algeria (N), Canary Is (N), Egypt (N), Libya (N), Morocco (N), Tunisia (N). Asia: Georgia (N), Russia in Asia (N). Europe: Albania (N), Balearic Is (N), Bulgaria (N), Corsica (N), Crete (N), former Yugoslavia (N), France (N), , Greece (N), Italy (N), Malta (N), Portugal (N), Romania (N), Sardinia (N), Sicily (N), Spain (N), Turkey in Europe (N), Ukraine (N). Georgia: Abkhazia, Adzharia, Georgia. Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel-Jordan (N), Palestine (N), Lebanon (N), Sinai (N), Syria (N), Turkey in Asia (N). Russia in Asia:

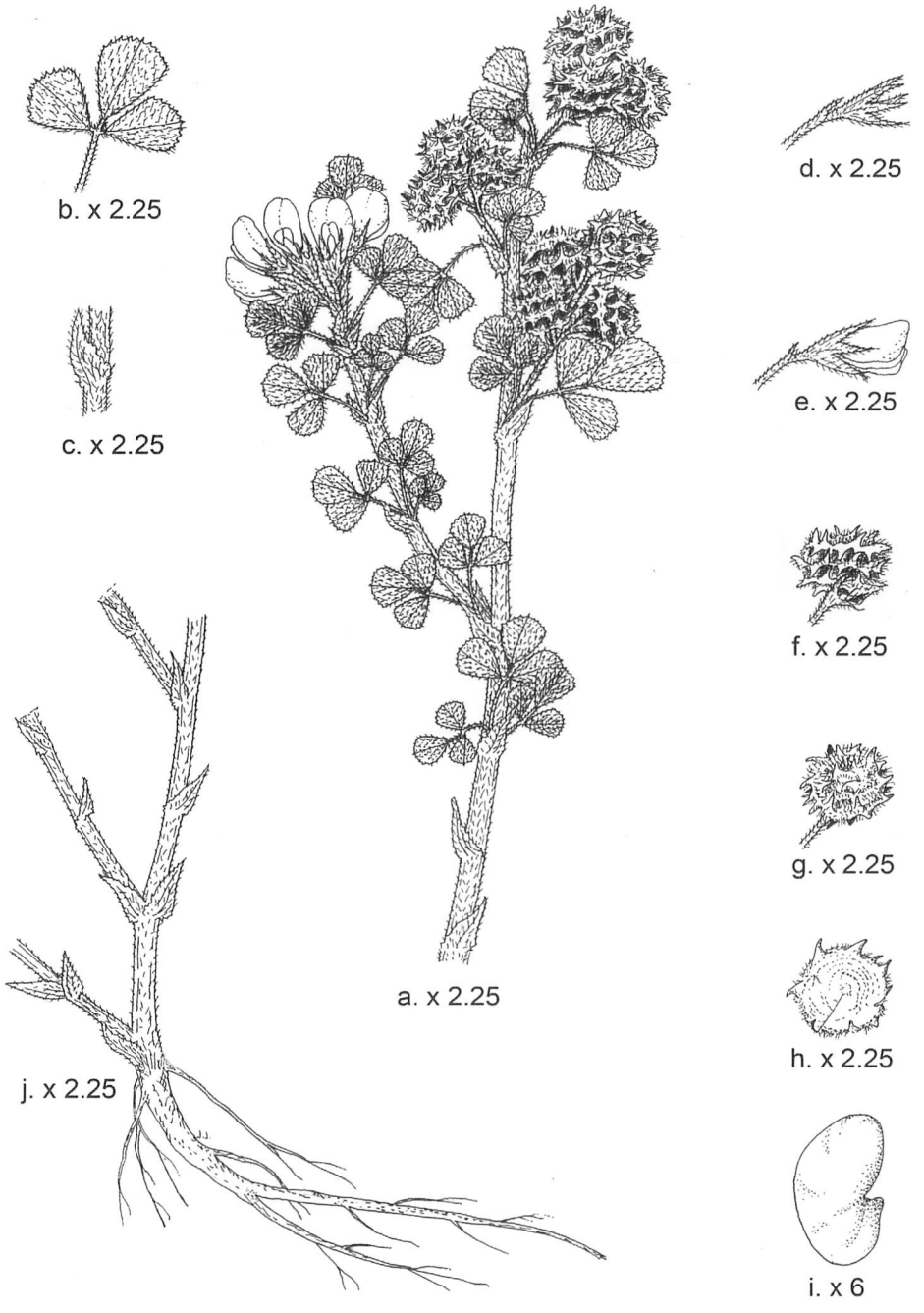

Figure 3.30. *Medicago marina*: a, habit (x 2.25), b, leaflet (x 2.25) c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 3), f, pod three dimension view (x 2.25), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 6), j, root and stem habit (x 2.25).

Krasnodar. Ukraine: Krym.

Conservation and threat assessment: Not threatened

Actual and potential usage: This is a perennial species that can survive in the harsh, saline, arid, nutrient poor and highly alkaline conditions of the seashore. It therefore seems that it could be a potential donor for many useful traits for forage *Medicago* species.

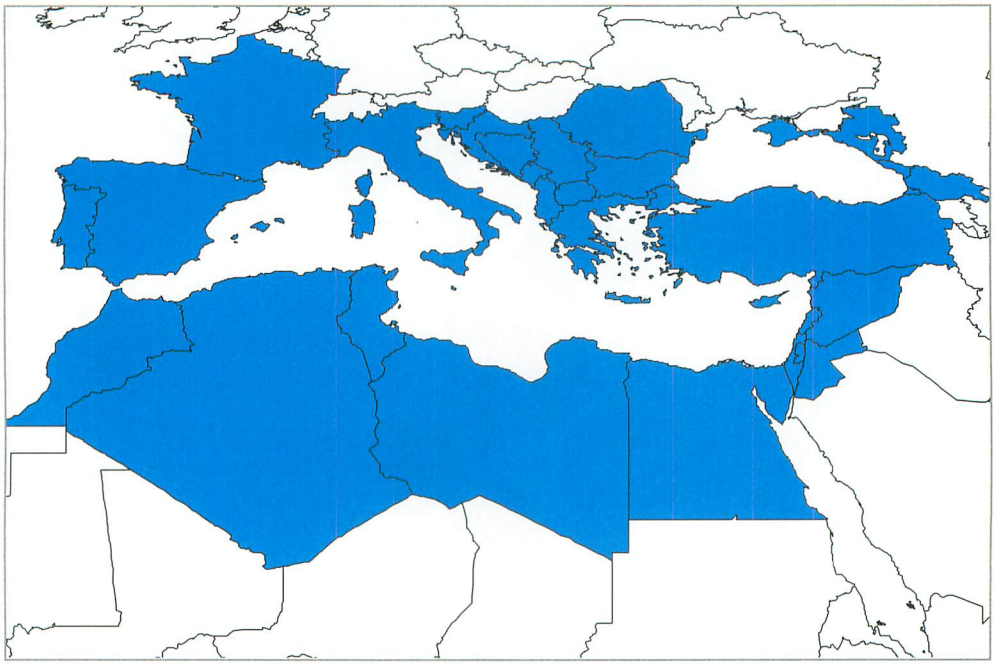

Figure 3.29. Distribution of *Medicago marina*. (shading represents native distribution).

3.24 *Medicago carstiensis* Wulfen in Jacquin, Collectanea Bot. 1: 86 (1786).

Perennial herb, 40-60 cm, stem arising from the creeping rootstock, angular in cross section, ascending to erect. Vegetative parts glabrous or sparsely pubescent, with simple hairs. Stipules triangular, margin entire or serrate. Leaflet 11-22 x 7-14 mm, ovate to elliptical, dorsally glabrous, ventrally sparsely pubescent or densely pubescent, margins except the basal part serrate. Peduncle with 5-12 flowers, longer than the corresponding petiole, with terminal cusp. Flower 8-10 mm. Pedicle equal to the calyx tube or longer than the calyx tube, bract shorter than the pedicel, calyx 3.5-4 mm, teeth lanceolate, teeth shorter than tube. Corolla yellow, standard

obovate, with red-brown veins, wings same length or longer than the keel. Pods coiled, glabrous, black, flat at apical and base, cylindrical, spiny. Coils 5-8, turning clockwise, loose to 5-8 mm diameter, veins 6-8, venation appear harder horny substance, dorsal suture lower the edge margins, is a shallow depression in the middle of the edge. Spines flexible, slender, fine, with thin or with hooked tip, if grooved so grooved to ± half their length, 3-9 mm, at two rows on a coil edge, 14-18 per row. Seeds 1.7-2 x 1.2-1.7 mm, yellow to brown, 1-3 per coil, radicle more than half seed length.

Closely related species: It is the only *Medicago* that always has rhizomes. This trait occurs sporadically in a few other species, including alfalfa, where it is known as the "creeping rooted" habit.
Habitat: It is endemic to the coastal regions of the eastern part of the Adriatic Sea, though not abundant in any location. Unlike most other species *M. carstiensis* thrives in shade such as found in rocky wooded areas.
Geographical distribution: Europe: Albania (N), Austria (N), Bulgaria (N), former Yugoslavia (N), Italy (N).
Conservation and threat assessment: Not threatened
Actual and potential usage: The species is moderately resistant to *Pseudopeziza medicaginis* subsp. *sativa* (Schmiedeknecht and Lesins, 1968).

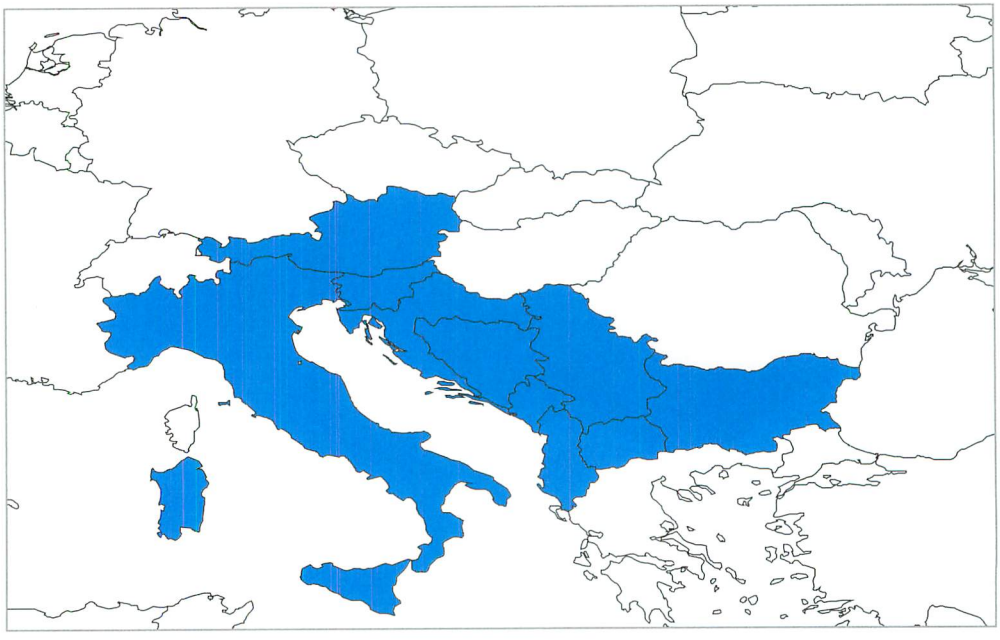

Figure 3.31. Distribution of *Medicago carstiensis*. (shading represents native distribution).

3.25 *Medicago soleirolii* Duby, Bot. Gall.: 124 (1828).

Synonyms: *Medicago plagiospira* Duchartre, Rev. Bot. 1: 366 (1845).
Annual, herb, 20-25 cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with erect, simple and glandular hairs. Stipules margin dentate to laciniate or incised. Leaflet 12-22 x 8-21 mm, ovate to obovate, apex more or less obtuse, dorsally sparsely pubescent (often), margins serrate. Peduncle with (2-)3-9 flowers, longer than the corresponding petiole, with terminal cusp. Flower 7-10 mm. Pedicle shorter than the calyx tube, bract longer than the pedicel, calyx densely pubescent, with glandular hairs, longer than half of the corolla, teeth awl-shape, lanceolate, teeth longer than tube. Corolla yellow, standard obovate, wings shorter than the keel. Pods coiled, glabrous, black to green-brown, 2-3 mm, discoid or cylindrical, spineless. Coils 2-5, turning clockwise, appressed, 5-8.5 mm diameter, with hard wall, veins 5-7, slender shaped, anastomosing before entering lateral vein, venation fine is a net of veins, vein-less zone absent. Seeds 4 x 2.5 mm, brown to yellow, curved, 1-2 per coil, coat smooth, separated, with thin membrane between them, radicle less than half seed length.

Chromosome number: 16.
Closely related species: It is easily confused with *M. italica* but is distinguishable by

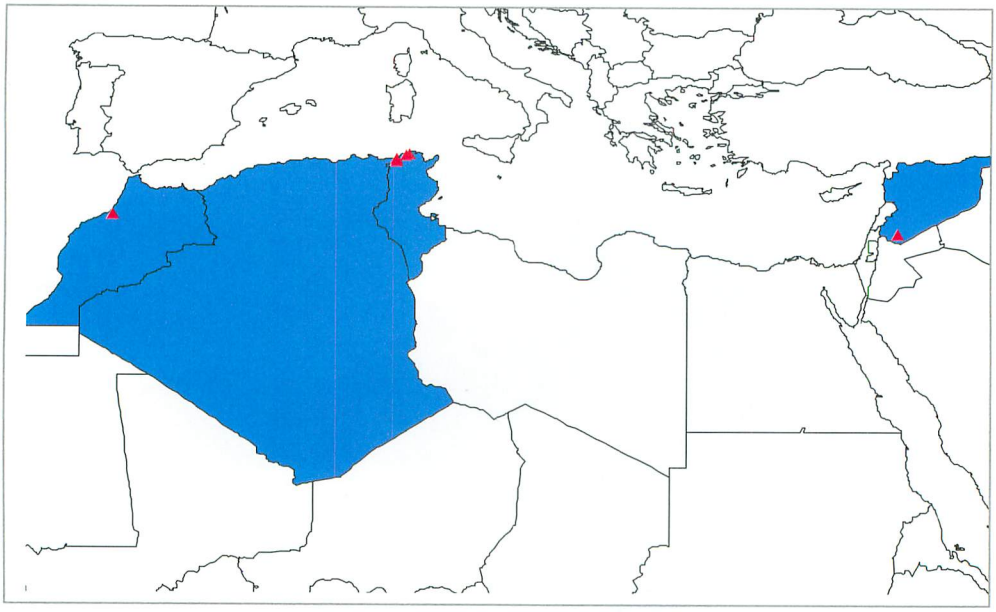

Figure 3.32. Distribution of *Medicago soleirolii*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

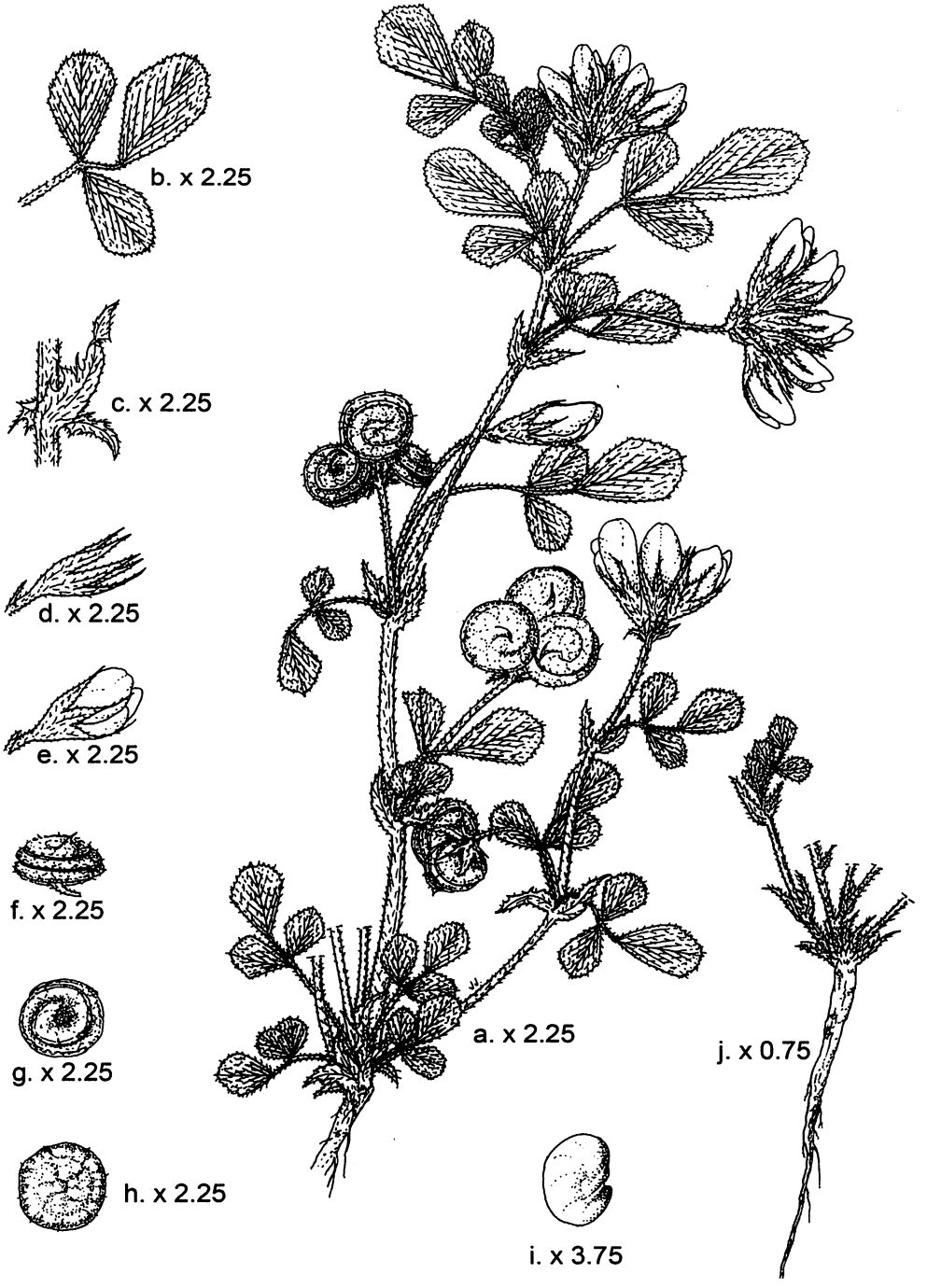

Figure 3.33. *Medicago soleirolii*: a, habit (x 2.25), b, leaflet (x 2.25) c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 2.25), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 3.75), j, root and stem habit (x 0.75).

the presence of gland-tipped hairs on the leaves.
Habitat: Found on grassy slopes, in fields, and scrub with calcareous soils. Lesins and Lesins (1979) collected it in sandy soils and fertile hill slopes on the plains of Annaba, Algeria.
Geographical distribution: Africa: Algeria (N), Morocco (N), Tunisia (N). Europe: Balearic Is (U), Corsica (U), France (I), Italy (U), Ukraine (U). Ukraine: Krym. Middle East: Syria (N).

3.26 *Medicago italica* (Mill.) Fiori in Fiori & Paol., Iconogr. Fl. Ital. 2: 237 (1921).

Synonyms: *Medicago tornata* (L.) Miller, Gard. Dict. Ed. 8(3): (1768).
Annual, herb, 15-40(-70) cm, stem procumbent to ascending, branching at the ground level. Vegetative parts glabrous (almost) or densely pubescent, with defuse, simple hairs. Stipules broadly triangular, margin entire to laciniate. Leaflet 6-18 x 4-14 mm, obovate or rhombic, apex retuse (rarely), base obtuse, dorsally glabrous, ventrally densely pubescent, apex margin serrate or dentate. Peduncle with (1-)2-15(-25) flowers, longer than the corresponding petiole, with terminal cusp. Flower 4-10 mm. Pedicle shorter than the calyx tube, bract ± equalling the pedicel, calyx densely pubescent, with simple hairs, equalling half of the corolla, teeth ± equalling tube. Corolla yellow, standard obovate, wings shorter than the keel. Pods coiled, glabrous, black to ash-grey, discoid to cylindrical, spiny or spineless, centre with no opening. Coils 1.2-8, turning clockwise or anticlockwise, loose to appressed, 3-10 mm diameter, size the same for all, veins 10-14, curved, branching near lateral outer vein, no grooves between lateral vein and dorsal suture, dorsal suture more prominent than the lateral veins, some times in the same level of the edge margin. Spines conical, with thin tip or hooked tip, with conical base or inflated base (some times), 1-2 mm, at two rows on a coil edge, 8-15(-22) per row, inserted at 135-180 degree to the coil face. Seeds 2-4 x 1-2 mm, brown to yellow, 1-2 per coil, coat smooth, separated, with thin membrane between them, radicle less than half seed length.

Chromosome number: 16.
Closely related species: It is similar to the preceding species *M. soleirolii* but is distinguishable by the lack of gland-tipped hairs on the leaves.
Habitat: Sandy soils, often on the seashore.
Geographical distribution: Africa: Algeria (N), Egypt (N), Libya (N), Morocco (N), Tunisia (N) Asia: Pakistan (N), Turkey in Asia (N). Europe: Corsica (N), France (N), Italy (N), Malta (N), Portugal (N), Sardinia (N), Sicily (N), Spain (N) Middle East: Cyprus (N), Israel-Jordan (N), Palestine(N), Syria (N).
Conservation and threat assessment: Not threatened

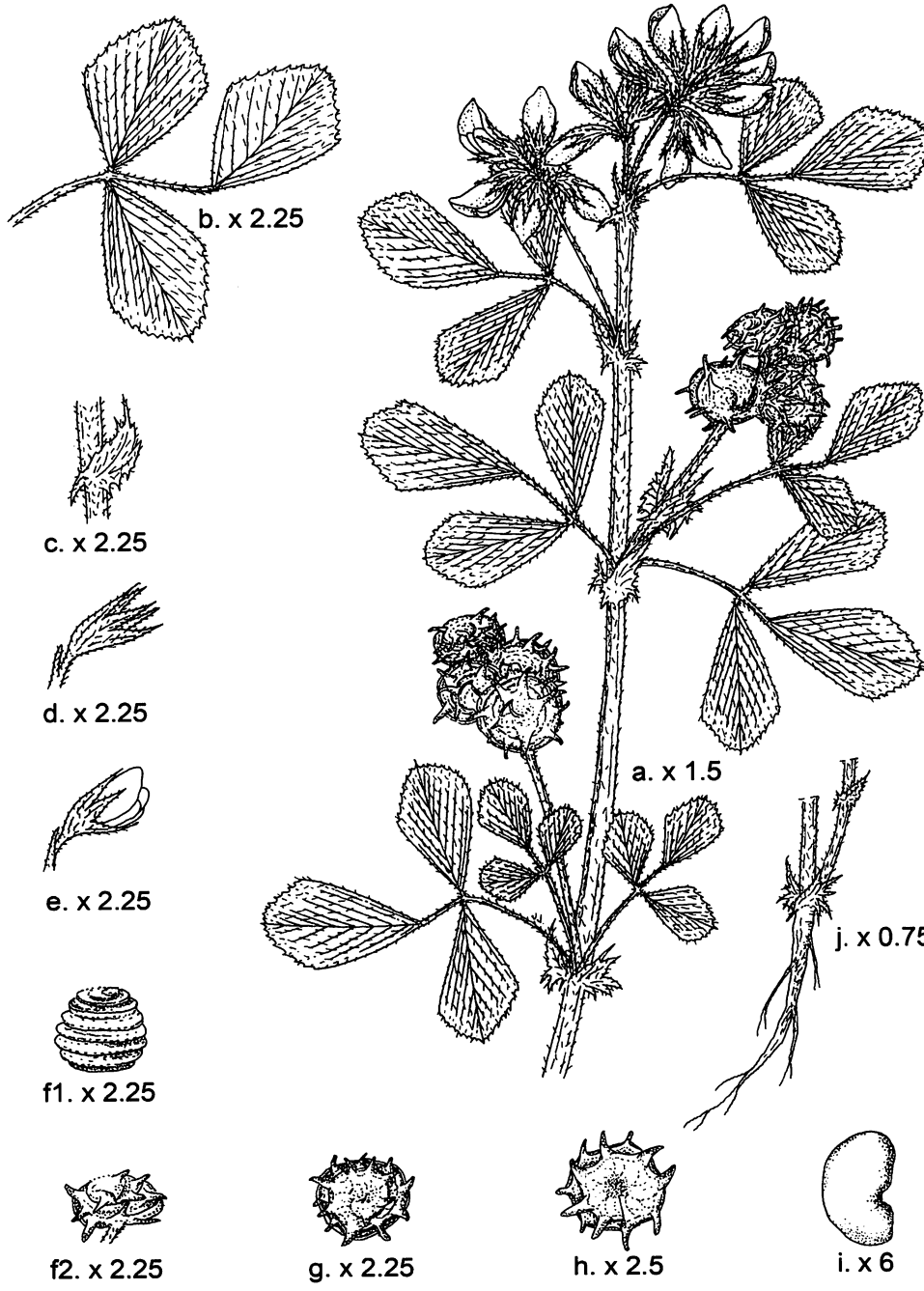

Figure 3.35. *Medicago italica*: a, habit (x 1.5), b, leaflet (x 2.25) c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f1, spineless pod three dimension view (x 2.25), f2, spiny pod three dimension view (x 2.25), g, pod tip view (x 2.25) h, pod venation (x 2.25), i, seed (x 6), j, root and stem habit (x 0.75).

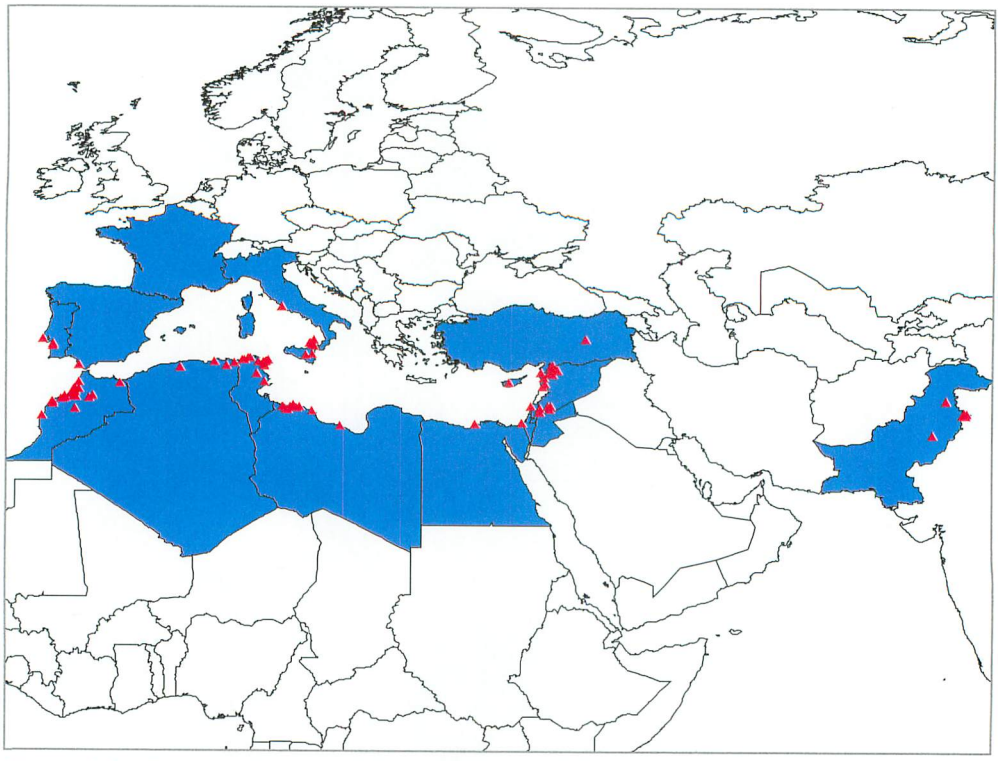

Figure 3.34. Distribution of *Medicago italica*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.27 *Medicago littoralis* Loisel., Not. Fl. France: 118 (1810).

Synonyms: *Medicago cylindracea* DC., Cat. Pl. Hort. Monsp. 123 (1813); *Medicago tricycla* DC., Cat. Pl. Hort. Monsp., 125 (1813); *Medicago arenaria* Ten. Cat. Pl. Hort. App. 1: 66 (1815); *Medicago subinermis* Bertol., Fl. Ital. 8: 290 (1852); *Medicago littoralis Lois.* subsp. *cylindracea* (DC.) Nyman, Consp. Fl. Eur.: 167 (1878); *Medicago littoralis* Lois. subsp. *tricycla* (DC.) J.M. Lainz., Anales Inst. Forest. Invest., 12: 26 (1968); *Medicago truncatula* Gaertner subsp. *littoralis* (Lois.) Ponert., Feddes Repert. 83: 639 (1973).

Annual, herb, 7-45(-120) cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with simple hairs. Stipules lanceolate, margin dentate or laciniate. Leaflet 3-8(-22) x 2-7(-20) mm, obovate, obcordate, apex truncate, dorsally densely pubescent, ventrally densely pubescent, margins around the apex serrate. Peduncle with 1-5 flowers, equal to the corre-

sponding petiole, with terminal cusp. Flower 3-7 mm. Pedicle shorter than the calyx tube, bract longer than the pedicel, calyx 2.5-4 mm, densely pubescent, with simple, appressed or erect hairs, teeth ± equalling tube. Corolla yellow, standard obovate, wings usually slightly shorter than the keel. Pods coiled, glabrous, ash-grey to brown, 3-10 mm, discoid or cylindrical, spiny or spineless or with tubercles, occasionally spiny and spineless pod on the same plant. Coils 2-8, turning clockwise or anticlockwise, very strongly appressed, 3-7 mm diameter, with hard wall, veins 8-10, running into a lateral vein, curved, branching near lateral outer vein, venation obscure (by the spongy tissue), dorsal suture below the lateral veins. Spines if present conical, 1-4 mm, 6-8 per row, inserted at 90-130(-180) degree to the coil face. Seeds 2.5 x 1.5-2 mm, brown to yellow, reniforme, 1-2 per pod, coat smooth, separated, with thin membrane between them, radicle less than half seed length.

Chromosome number: 16.
Closely related species: This species may be confused with *M. truncatula*; however the mature fruit of *M. littoralis* is glabrous whereas that of *M. truncatula* usually has at least a few trichomes.
Habitat: Mainly found on beach sands and in dunes, but can also be found further inland on sandy soils.
Geographical distribution: Africa: Algeria (N), Egypt (N), Libya (N), Morocco (N),

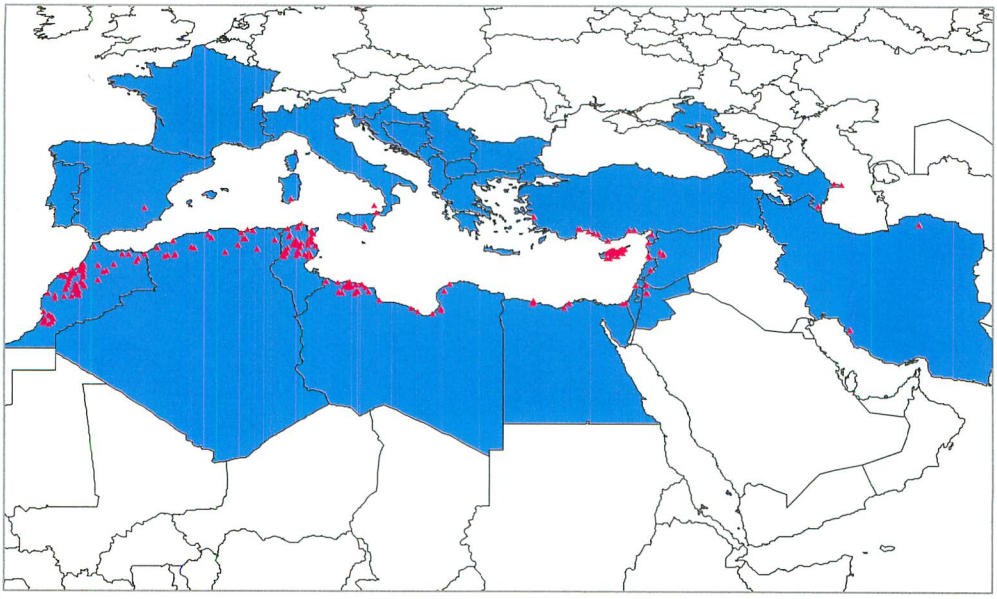

Figure 3.36. Distribution of *Medicago littoralis*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

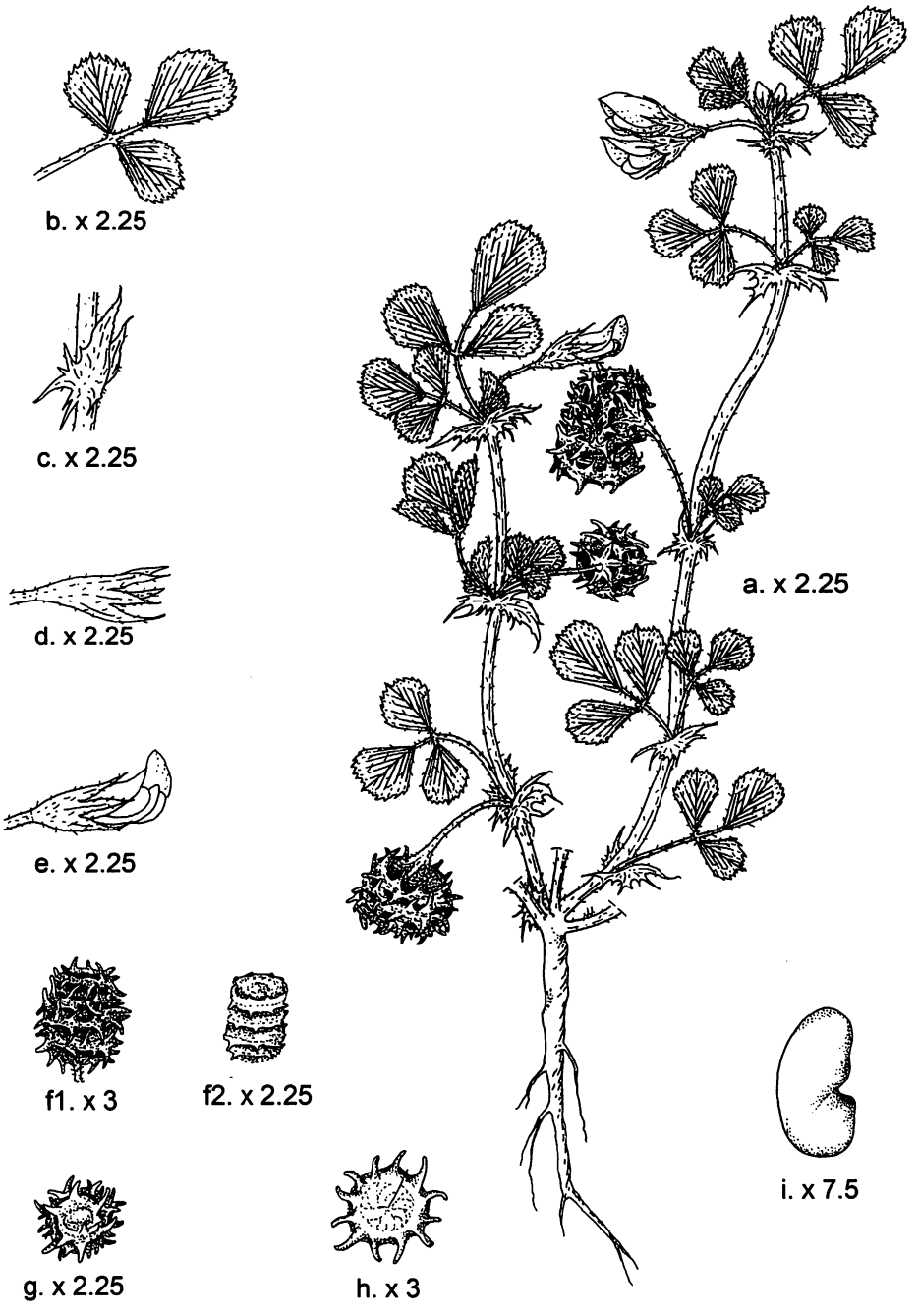

Figure 3.37. *Medicago littoralis*: a, habit (x 2.25), b, leaflet (x 2.25) c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f1, pod three dimension view (x 2.25), f2, tuberculed pod three dimension view (x 2.25), g, pod tip view (x 2.25), h, pod venation (x 3), i, seed (x 7.5).

Tunisia (N). Asia: Azerbaijan (N), Georgia (N), Iran (N), Russia in Asia (N). Australasia: Australia (I). Australia: South Australia, Western Australia. Azerbaijan: Azerbaijan. Europe: Albania (N), Balearic Is (N), Bulgaria (N), Corsica (N), Crete (N), former Yugoslavia (N), France (N), Gibraltar (N), Greece (N), Italy (N), Malta (N), Portugal (N), Sardinia (N), Sicily (N), Spain (N), Turkey in Europe (N). Georgia: Georgia. Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel (N), Palestine (N), Lebanon (N), Sinai (N), Syria (N), Turkey in Asia (N). North America: United States (U), Russia in Asia: Krasnodar.
Conservation and threat assessment: Not threatened
Actual and potential usage: Forage.

3.28 *Medicago truncatula* Gaertner, Fruct. Sem. Pl. 2: 350 (1971).

Synonyms: *Medicago tentaculata* Willd., Sp. Pl. 3: 1413 (1802); *Medicago uncinata* Willd., Sp. Pl. 3: 1417 (1802); *Medicago tribuloides* Desr. in Lam., Encycl. Method. 3: 635 (1792); *Medicago truncatula* Gaertner subsp. *longiaculeata* (Urban) Ponert. Feddes Repert. 83: 639 (1973).

Annual, herb, 15-30(-80) cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with simple hairs. Stipules lanceolate or acuminate, margin dentate to laciniate. Leaflet 8-27 x 7-21 mm, obovate, apex truncate or retuse (often), base obcordate, dorsally glabrous or densely pubescent, ventrally densely pubescent, margins serrate or laciniate (some times). Peduncle with 1-3(-5) flowers, shorter than or rarely equal to the corresponding petiole or longer than it, with terminal cusp. Flower 5-8 mm. Pedicle shorter than the calyx tube, bract longer than the pedicel, calyx 2.5-4 mm, densely pubescent, with simple hairs, longer than half of the corolla, teeth slender, teeth longer than tube. Corolla yellow, standard obovate, wings shorter than the keel. Pods coiled, rarely glabrous or densely pubescent, with simple and glandular hair (occasionally), yellow, 5-12 mm, discoid or cylindrical, spiny or with tubercles (rarely). Coils (2-)2.5-8, turning clockwise or anticlockwise, appressed, 4.5-12 mm diameter, with hard wall, veins 6-12, slender shaped, branching near lateral outer vein, grooves wide shallow between lateral vein and dorsal suture, dorsal suture more prominent than or in the same level as the lateral veins. Spines irregular shape, with conical base or grooved base, 1-4 mm, 6-11 per row, inserted at 90-180 degree to the coil face. Seeds 2.5-4.5 x 1.3-2.5 mm, brown to yellow, reniforme, 1-2 per coil, coat smooth, separated, with thin membrane between them, radicle less than half seed length.

Chromosome number: 16.
Closely related species: This species resembles the preceding species.
Habitat: Seashore, arid slopes, meadows, garrigue, fields, light scrub, alluvial plains. Calcareous, alluvial and terra rosa soils.
Geographical distribution: Africa: Algeria (N), Canary Is (N), Egypt (N), Libya (N), Madeira (N), Morocco (N), Tunisia (N). Asia: Armenia (N), Azerbaijan (N), Georgia

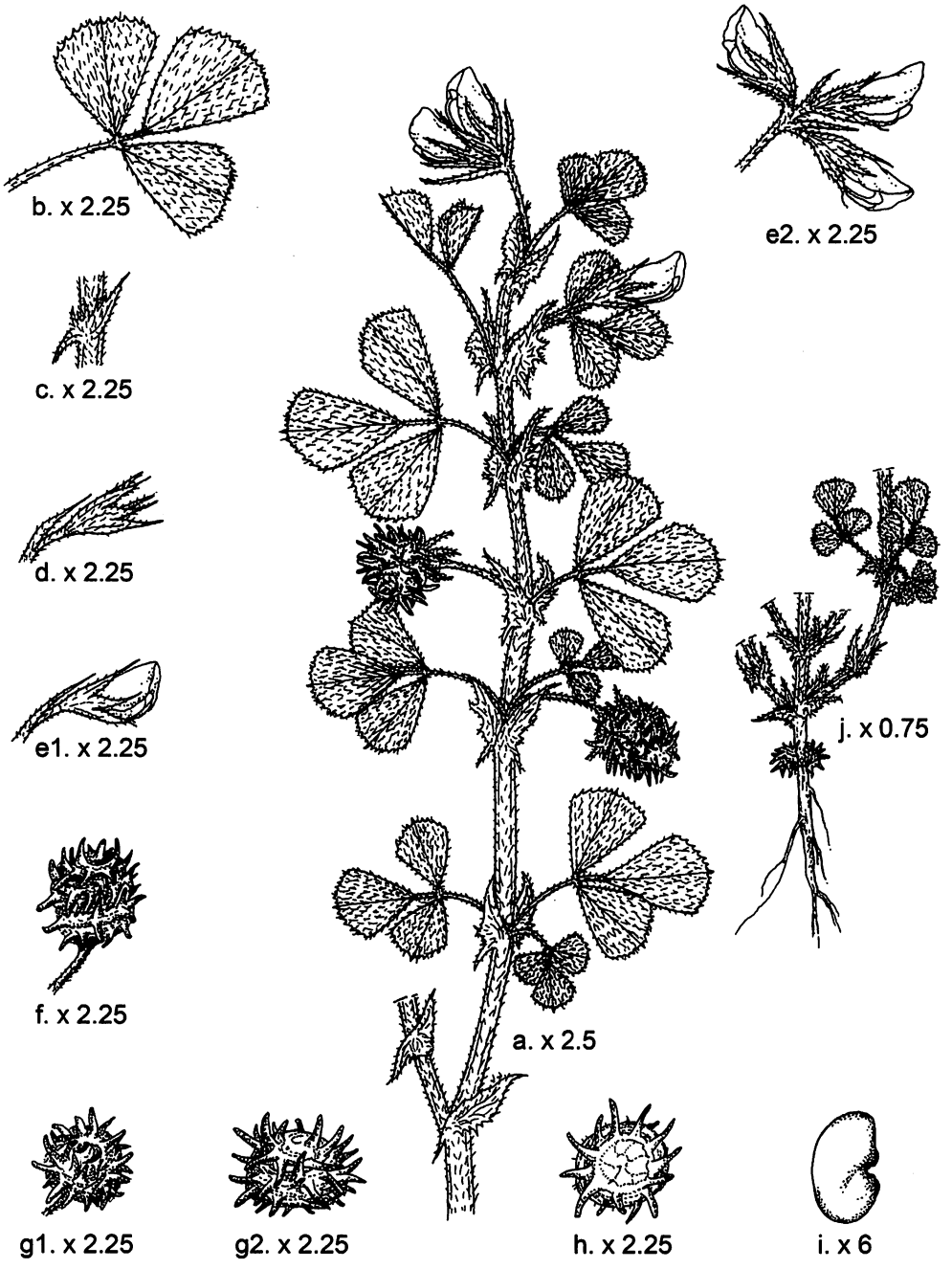

Figure 3.39. *Medicago truncatula*: a, habit (x 2.5), b, leaflet (x 2.25), c, stipule (x 2.25), d, calyx (x 2.25), e1, single flower (x 2.25), e2, peduncle with three flower (x 2.25), f, pod three dimension view (x 2.25), g1, pod tip view (x 2.25), g2, spines distribution (x 2.25), h, pod venation (x 2.25), i, seed (x 6), j, root and stem habit (x 0.75).

(N), Iran (U), Iraq (N), Turkmenistan (N). Australasia: Australia (I). Australia: New South Wales, Northern Territory, Queensland, South Australia, Victoria, Western Australia. Azerbaijan: Azerbaijan, Nakhichevan. Europe: Balearic Is (N), Corsica (N), Crete (N), former Yugoslavia (N), France (N), Gibraltar (N), Greece (N), Italy (N), Malta (N), Portugal (N), Sardinia (N), Sicily (N), Spain (N), Turkey in Europe (N), Ukraine (N). Georgia: Georgia. Middle East: Cyprus (N), East Aegean Is (Greek) (N), Palestine (N), Israel (N), Jordan (N), Lebanon (N), Syria (N), Turkey in Asia (N). Turkmenistan: Ashkhabad, Krasnovodsk. Ukraine: Krym.
Conservation and threat assessment: Not threatened.
Actual and potential usage: None recorded.

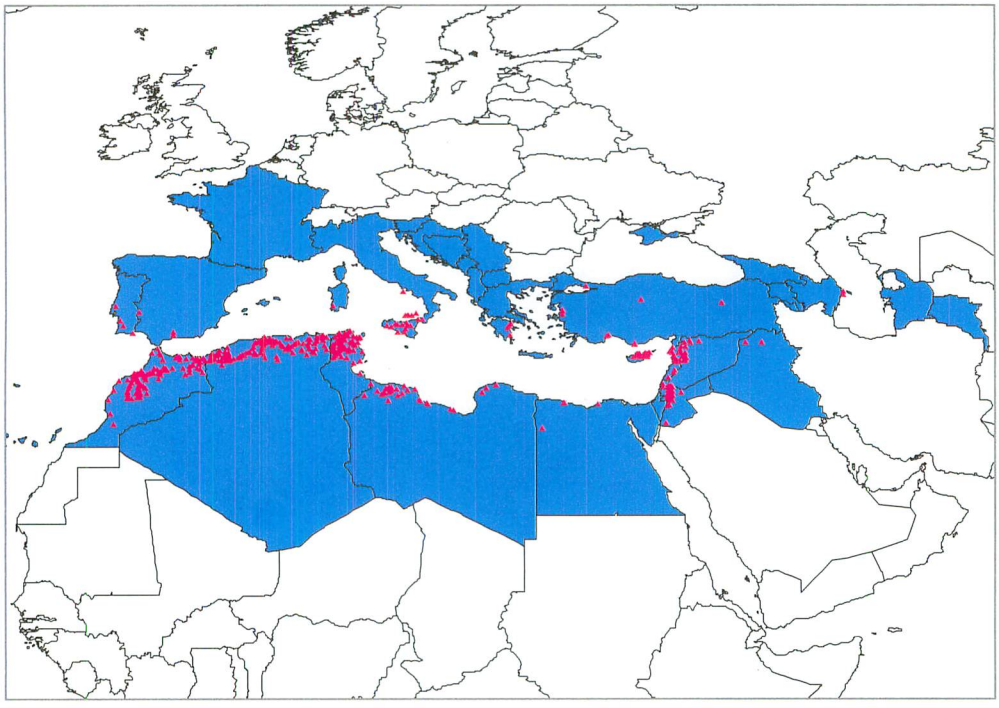

Figure 3.38. Distribution of *Medicago truncatula*. (shading represents native distribution, triangle indicates population sample held ex *situ*).

3.29 *Medicago doliata* Carmignani, Giorn. Pisano 12: 48 (1810).

Synonyms: *Medicago aculeata* Gaertn, Fruct et Sem. 2: 349 (1791); *Medicago turbinate* Willd, Sp. Pl. 3: 1409 (1802).

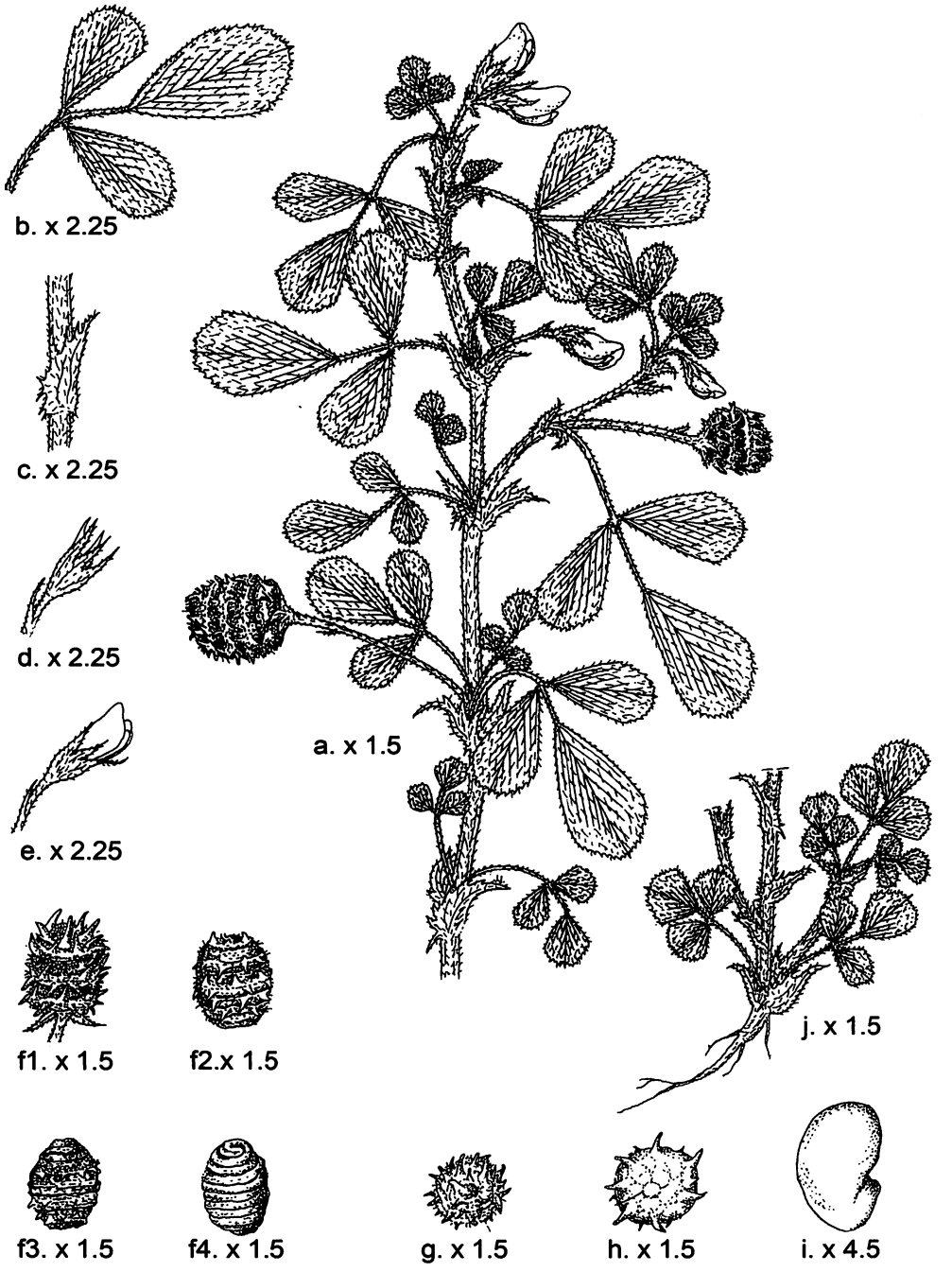

Figure 3.41. *Medicago doliata*: a, habit (x 1.5), b, leaflet (x 2.25) c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f1, spiny pod three dimension view (x 1.5), f2, pubescent spiny pod three dimension view (x 1.5), f3, pubescent spineless pod three dimension view (x 1.5), f4, spineless pod three dimension view (x 1.5), g, pod tip view (x 1.5), h, pod venation (x 1.5), i, seed (x 4.5), j, root and stem habit (x 1.5).

Annual, herb, 20-50 cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with defuse, simple hairs or simple and glandular hairs (occasionally). Stipules margin dentate. Leaflet 11-16(-25) x 5-14(-20) mm, obovate or obovate to obolanceolate, apex apiculate, apex margin serrate. Peduncle with 1-2(-5) flowers, shorter than or equal to the corresponding petiole or longer than it, with or without terminal cusp. Flower 4-7 mm. Pedicle shorter than the calyx tube, bract ± equalling the pedicel, calyx 2.5-4 mm, densely pubescent, with simple hairs or simple and glandular hairs, teeth narrowly triangular, teeth shorter than or ± equalling or longer than tube. Corolla yellow, standard obovate, wings shorter than the keel. Pods coiled, before maturity densely pubescent, with simple or glandular hair or simple and glandular hairs, black to ash-grey, 7-15(-20) mm, ovoid to spherical, spiny or spineless or with tubercles. Coils 5-9, turning clockwise or anticlockwise, appressed, 6-10 mm diameter (less in first and last), with hard wall, veins 8-10, curved, venation often obscure, dorsal suture below or at the same level as the lateral veins. Spines if present conical, with thin and hooked tip, conical base, 1-4 mm, at two rows on a coil edge, 10-14 per row, inserted at 150-180

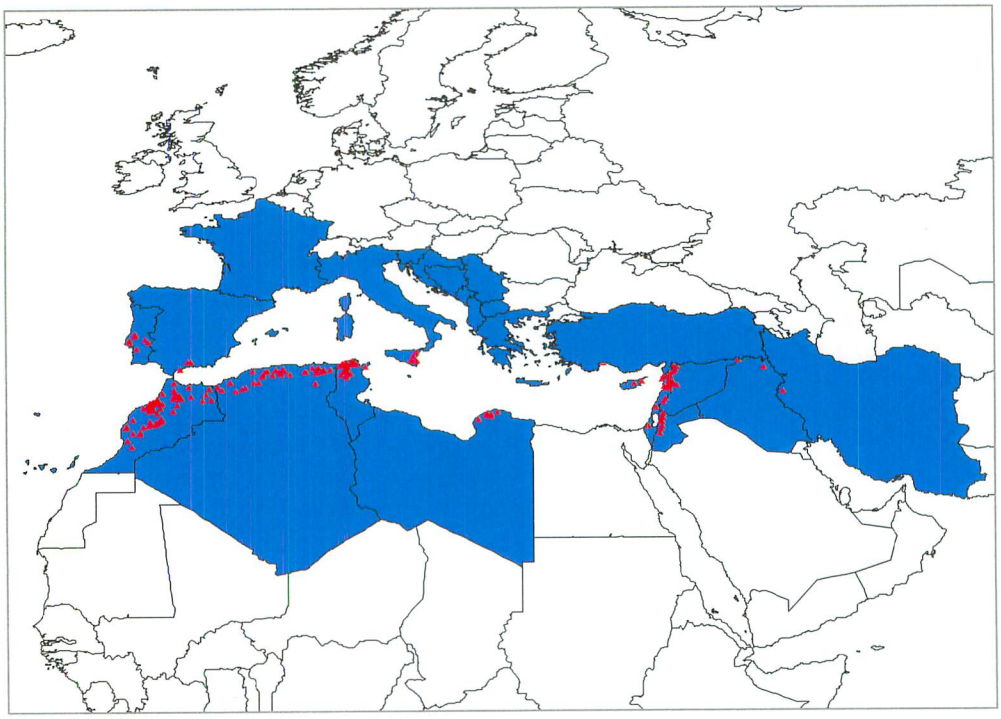

Figure 3.40. Distribution of *Medicago doliata*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

degree to the coil face. Seeds 3-4.5 x 2-3 mm, brown to yellow, curved, 1-3 per coil, size varying considerably in the same pod, separated, radicle less than half seed length.

Chromosome number: 16.
Closely related species: This species can possibly be confused with *M. rigidula* (both species frequently have fruits covered with gland-tipped trichomes, however, the venation of the coil face of *M. rigidula* is more anastomosed peripherally than is the case in *M. doliata* (Lesins and Lesins, 1979). *M. doliata* also resembles *M. constricta*, which has less evident, if any, gaps between the fruits coils at maturity.
Habitat: Chalky and sandy soils, in fields or field margins.
Geographical distribution: Africa: Algeria (N), Libya (N), Morocco (N), Tunisia (N) Asia: Iran (N), Iraq (N). Europe: Albania (N), Corsica (N), Crete (N), former Yugoslavia (N), France (N), Gibraltar (N), Greece (N), Italy (N), Malta (N), Portugal (N), Sardinia (N), Sicily (N), Spain (N) Middle East: Israel-Jordan (N), Lebanon (N), Palestine (N), Syria (N), Turkey in Asia (N).

3.30 *Medicago turbinata* (L.) All., Fl. Pedem. 1: 315 (1785).

Synonyms: *Medicago polymorpha* L., Sp. Pl.: 780 (1753); *Medicago polymorpha* L. var. *tuberculata* Retz., Observ. Bot. 2: 23 (1781); *Medicago spinulosa* DC. In Lam. & DC., Fl. Franç. Ed. 3(5): 569 (1815); *Medicago turbinata* (L.) All. subsp. *spinulosa* (DC.) Ponert. Feddes Repert. 83: 640 (1973).

Annual, herb, 15-40(-50) cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with erect, simple hairs. Stipules ovate to lanceolate, margin dentate. Leaflet 11-22(-35) x 6-16(-30) mm, ovate or obovate or elliptical (at upper nodes), apex apiculate, base obtuse, margins serrate. Peduncle with (1-)3-8(-10) flowers, longer than the corresponding petiole, with terminal cusp. Flower 5-8 mm. Pedicle shorter than the calyx tube, bract shorter or longer than the pedicel, calyx 3.5-4 mm, glabrous or sparsely pubescent, with simple hairs or simple and glandular hairs, longer than half of the corolla, teeth longer than tube. Corolla yellow, standard obovate, wings shorter than the keel, rarely equal or longer. Pods coiled, glabrous, black to ash-grey, 6-12(-15) mm, cylindrical to barrel-shape, spiny or spineless or with tubercles. Coils 4-7(-9), turning clockwise or anticlockwise, appressed, 5-8 mm diameter, veins 5-10, curved, venation often obscure, vein-less zone about 20%-35% of the radius, grooves wide shallow between lateral vein and dorsal suture, dorsal suture steeply elevated in the middle of the coil edges. Spines with hooked tip or with straight tip, conical base, 1-5 mm, 12-16 per row, inserted at 180-225 degree to the coil face, arching upwards of the coil or arching to opposite direction of the pod coiling (in some forms). Seeds 4.5-4.7 x 2.2-2.5 mm, brown to yellow, 1-2 per coil, coat smooth, separated, with hard tissue between them, radicle less than half seed length.

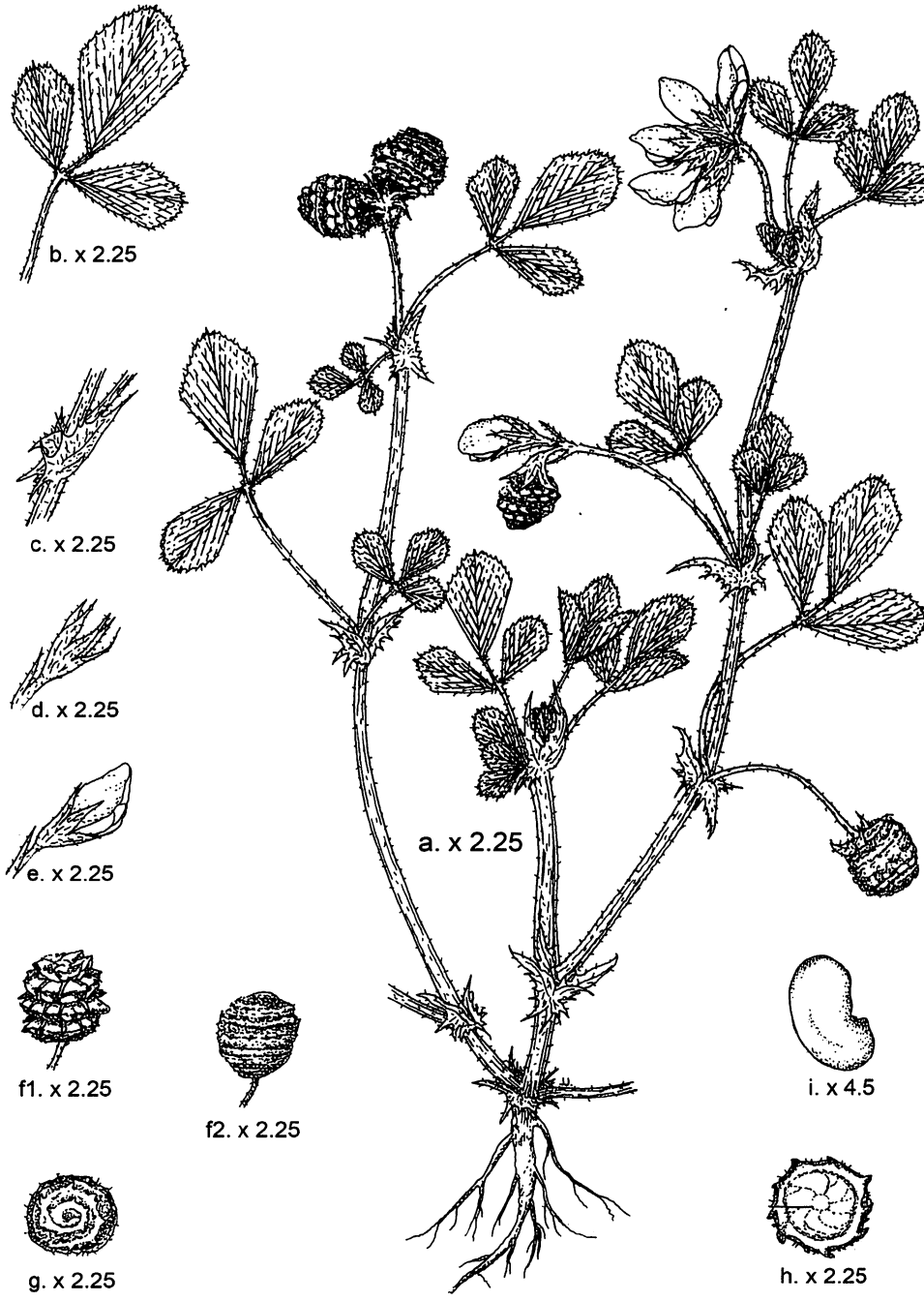

Figure 3.43. *Medicago turbinata*: a, habit (x 2.25), b, leaflet (x 2.25), c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f1, tuberculed pod three dimension view (x 2.25), f2, spineless pod three dimension view (x 2.25), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 4.5).

Chromosome number: 16.
Closely related species: This species is most likely to be confused with the preceding species *M. doliata*.
Habitat: Sandy and limestone soils, in field margins and rocky places in mountains.
Geographical distribution: Africa: Algeria (N), Egypt (N), Libya (N), Morocco (N), Tunisia (N) Asia: Iran (N), Iraq (N) Europe: Balearic Is (N), Corsica (N), Crete (N), former Yugoslavia (N), France (N), Greece (N), Italy (N), Malta (N), Portugal (N), Sardinia (N), Sicily (N), Spain (N), Turkey in Europe (N) Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel (N), Jordan (N), Lebanon (N), Palestine (N), Syria (N), Turkey in Asia (N).
Conservation and threat assessment: Not threatened

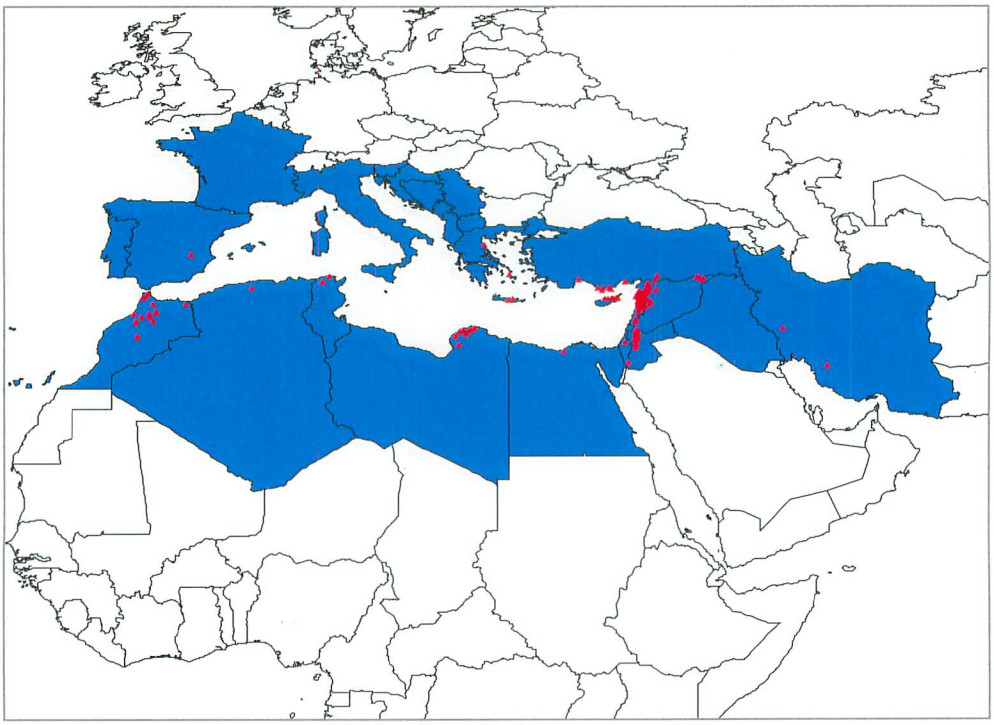

Figure 3.42. Distribution of *Medicago turbinata*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.31 *Medicago rigidula* (L.) All., Fl. Pedem. 1: 316 (1785).

Synonyms: *Medicago polymorpha* var. *rigidula* L. Sp. Pl. : 780 (1753); *Medicago gerardii* Willd, Sp. Pl. 3: 1415 (1802); *Medicago agrestis* Ten., Fl. Napol. 1: lxxi (1811-

1815); *Medicago depressa* Jordan., Cat. Graines Jard. Dijon 1848: 28 (1848); *Medicago timeroyi* Jordan, Cat. Graines Jard. Dijon 1848: 29 (1848); *Medicago morisiana* Jordan, Mém. Acad. Roy. Sci. Lyon, Sect. Sci. ser. 2(1): 264 (1851); *Medicago cinerascens* Jordan in F.W. Schultz, Arch. Fl. France Allemagne: 316 (1854); *Medicago germana* Jordan. in F.W. Schultz, Arch. Fl. France Allemagne: 316 (1854); *Medicago rigidula* (L.) All. subsp. *cinerascens* (Jordan) Ponert. Feddes Repert. 83: 639 (1973); *Medicago rigidula* (L.) All. subsp. *agrestis* (Ten.) Ponert., Feddes Repert. 83: 640 (1973).

Annual, herb, (10-)25-70 cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with erect, simple hairs or glandular hairs. Stipules lanceolate, margin dentate. Leaflet 4-8(-20) x 3-6(-19) mm, obovate, apex truncate, base obtuse, apex margin serrate. Peduncle with 1-6(-7) flowers, usually longer than the corresponding petiole, with terminal cusp. Flower 5.5-7 mm. Pedicle shorter than the calyx tube, bract ± equalling the pedicel, calyx 3-5 mm, sparsely pubescent, with simple or simple and glandular hairs, longer than half of the corolla, teeth ± equalling tube. Corolla yellow, standard rounded to oval, wings shorter than or very rarely as long as the keel. Pods coiled, usually sparsely pubescent, with simple and glandular hairs, brown, discoid to cylindrical or ovoid (rarely), spiny. Coils 3.5-7, turning clockwise, appressed, 4.5-10(-15) mm diameter, with hard wall, veins 7-17, curved or S shaped (occasionally), branching near lateral outer vein, dorsal suture steeply elevated in the middle of the coil edges. Spines with conical base or grooved base, grooved to ± half their length, 6-18 per row, inserted at 90-120(-180) degree to the coil face. Seeds 2.5-4.5 x 1.3-2.5 mm, yellow, 1-3 per coil, coat smooth, separated, with thin membrane between them, radicle less than half seed length.

Chromosome number: 14.
Closely related species: The species most likely to be confused with *M. doliata*, but the coil face venation of *M. rigidula* is more anastomosed peripherally than is the case in *M. doliata*.
Habitat: Sandy, clay, volcanic and calcareous soils in low mid-mountain zones, cultivated and uncultivated fields, rocky places, woodlands, scrub, pasture, grassland, and steppe.
Geographical distribution: Africa: Algeria (N), Egypt (N), Libya (N), Morocco (N), Tunisia (N). Asia: Afghanistan (N), Armenia (N), Azerbaijan (N), Georgia (N), Iran (N), Iraq (N), Kazakhstan (N), Kirgizstan (N), Russia in Asia (N), Tadzhikistan (N), Turkmenistan (N), Uzbekistan (N). Azerbaijan: Azerbaijan, Nakhichevan. Europe: Albania (N), Balearic Is (N), Bulgaria (N), Corsica (N), Crete (N), Czech Republic and Slovakia (I), former Yugoslavia (N), France (N), Greece (N), Hungary (I), Italy (N), Malta (N), Moldova (N), Portugal (N), Romania (N), Russia in Europe (N), Sardinia (N), Sicily (N), Spain (N), Turkey in Europe (N), Ukraine (N). Georgia: Georgia. Kazakhstan: Chimkent, Dzhambul. Kirgizstan: Frunze, Osh. Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel (N), Jordan (N), Palestine (N),

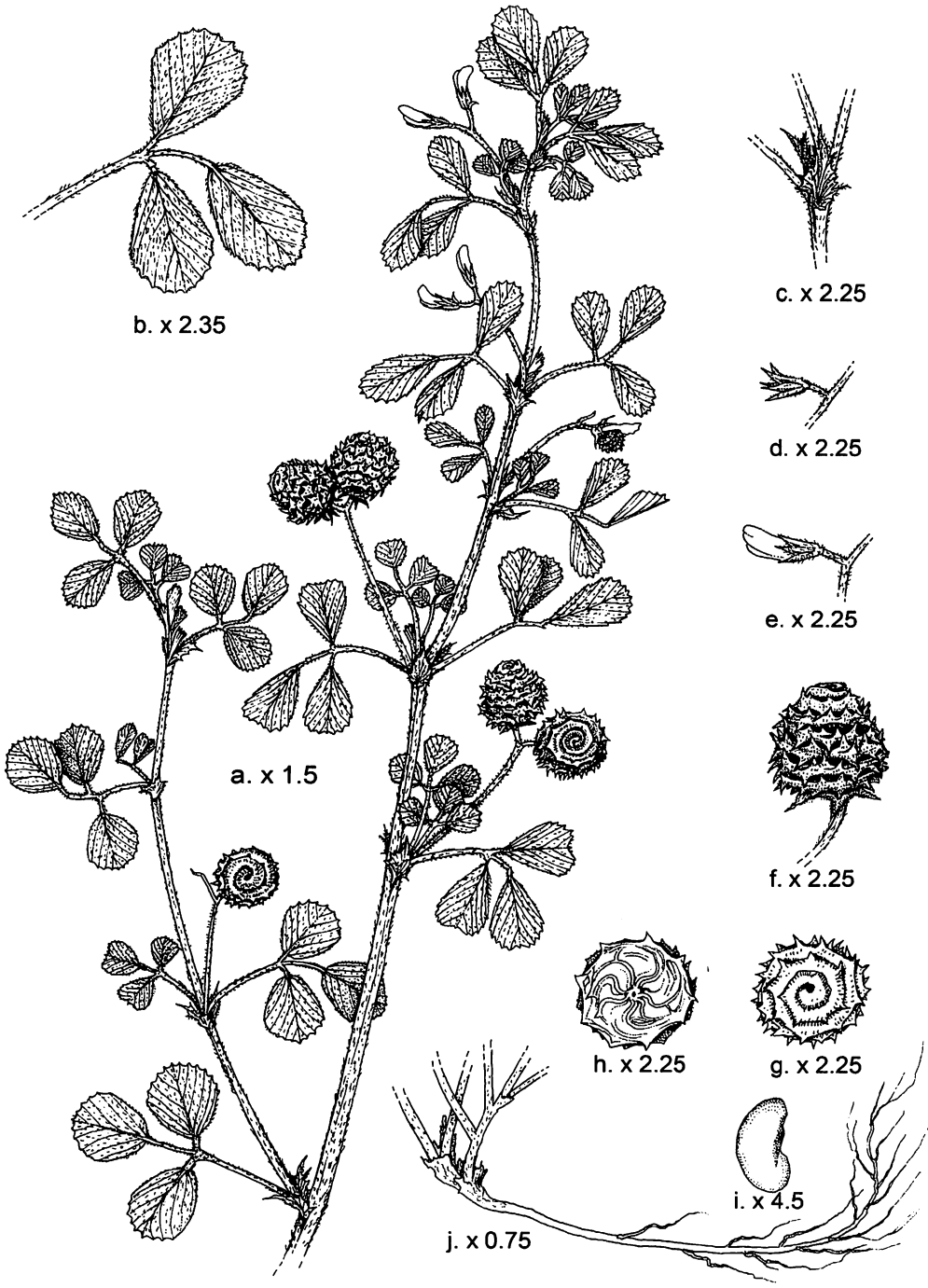

Figure 3.45. *Medicago rigidula*: a, habit (x 1.5), b, leaflet (x 2.35) c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 2.25), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 4.5), j, root and stem habit (x 0.75).

Lebanon (N), Syria (N), Turkey in Asia (N). Russia in Asia: Checheno-Ingushetia, Dagestan, Krasnodar, Severo-Osetia. Tadzhikistan: Dushanbe, Gorno-Badakshan, Kulyab, Kurgan-Tyube, Leninabad. Turkmenistan: Ashkhabad, Chardzhou, Krasnovodsk, Mary. Ukraine: Kherson, Krym, Nikolaev, Odessa. Uzbekistan: Fergana, Kashkadarinskaya, Samarkand, Surhandarinskaya, Tashkent.
Conservation and threat assessment: Not threatened
Actual and potential usage: Forage.

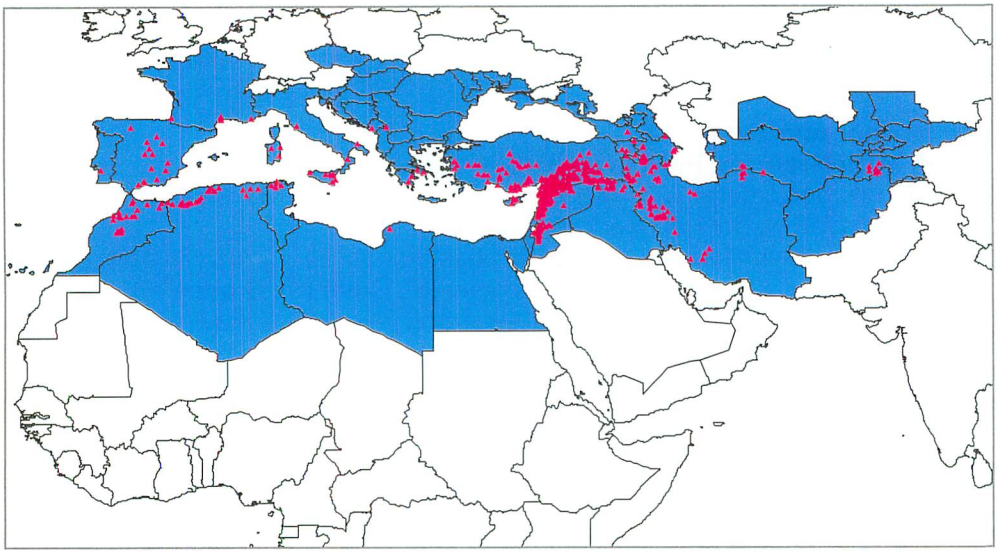

Figure 3.44. Distribution of *Medicago rigidula*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.32 *Medicago constricta* Durieu, Actes Soc. Linn. Bordeaux 29(2): 15 (1873).

Synonyms: *M. globosa* Presl, Del. Prag: 45 (1822); *M. globosa* Urb, Verh. Bot. Ver. Brand. 15: 71 (1873).

Annual, herb, 10-30(-50) cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with erect, simple hairs. Stipules lanceolate (to oblong), margin dentate. Leaflet 3-7(-18) x 2-7(-12) mm, obovate, apex retuse or obtuse, base cuneate, dorsally densely pubescent, apex margin serrate. Peduncle with 1-5 flowers, longer than the corresponding petiole, with or without terminal cusp. Flower 4.5-6 mm. Pedicle shorter than or equal to the calyx tube, bract shorter than the pedicel, calyx 2.5-4 mm, sparsely pubescent, with simple

and glandular hairs, equalling half of the corolla (nearly), and teeth ± equalling or longer than tube. Corolla yellow, standard obovate (to round), with rounded apex, wings shorter than the keel. Pods coiled, at maturity glabrous or sparsely pubescent (before maturity), dark brown, 6-12 mm, discoid to ovoid or cylindrical, spiny. Coils 4.5-8.5, turning clockwise, appressed, 4.5-8 mm diameter, may be concave, with hard wall, edge margin may beer the facial plane, veins 6-10, strongly curved, venation obscure (by loose cellular tissue), dorsal suture in the same level as the lateral veins. Spines with often with hooked tip, grooved base, 2-3 mm, at two rows on a coil edge, 8-10 per row, inserted at 180-210 degree to the coil face. Seeds 3.5-4.5 x 1.3-2.5 mm, yellow, reniforme, 1-2 per pod, coat smooth, separated, with thin membrane between them, radicle less than half seed length.

Chromosome number: 14.
Closely related species: This species is like *M. rigidula* and *M. doliata*.
Habitat: Disturbed limestone, and dry sandy, soils. Dry, stony hillsides and banks, arable fields, fallow, pasture, meadows, and pine forest.
Geographical distribution: Africa: Algeria (N), Morocco (N), Tunisia (N). Asia: Georgia (I)., Iran (N), Iraq (N). Europe: Bulgaria (N), Crete (N), Greece (N). Georgia: Abkhazia. Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel-Jordan (N), Lebanon (N), Palestine (N), Syria (N), Turkey in Asia (N).
Conservation and threat assessment: Not threatened
Actual and potential usage: Environmental.

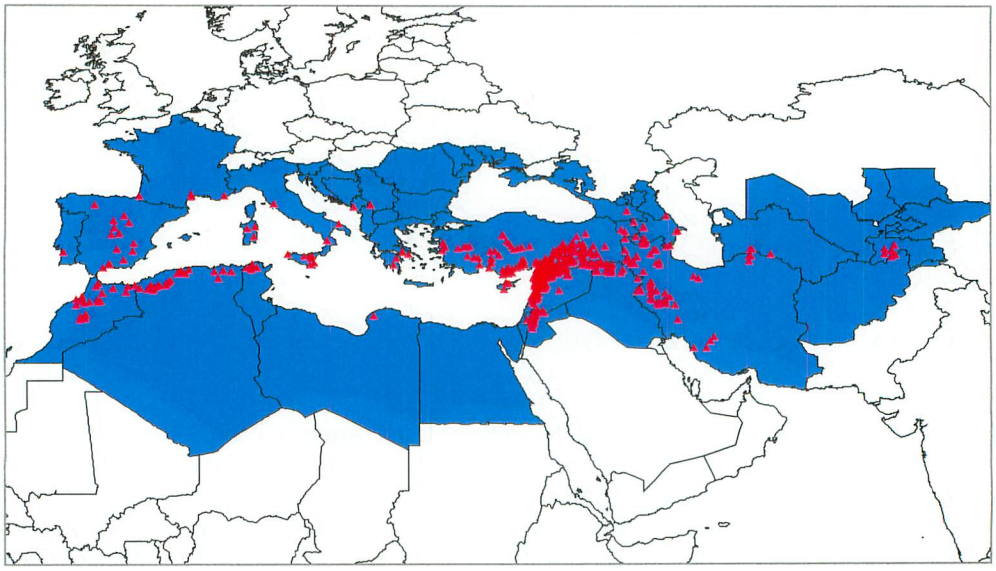

Figure 3.46. Distribution of *Medicago constricta*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

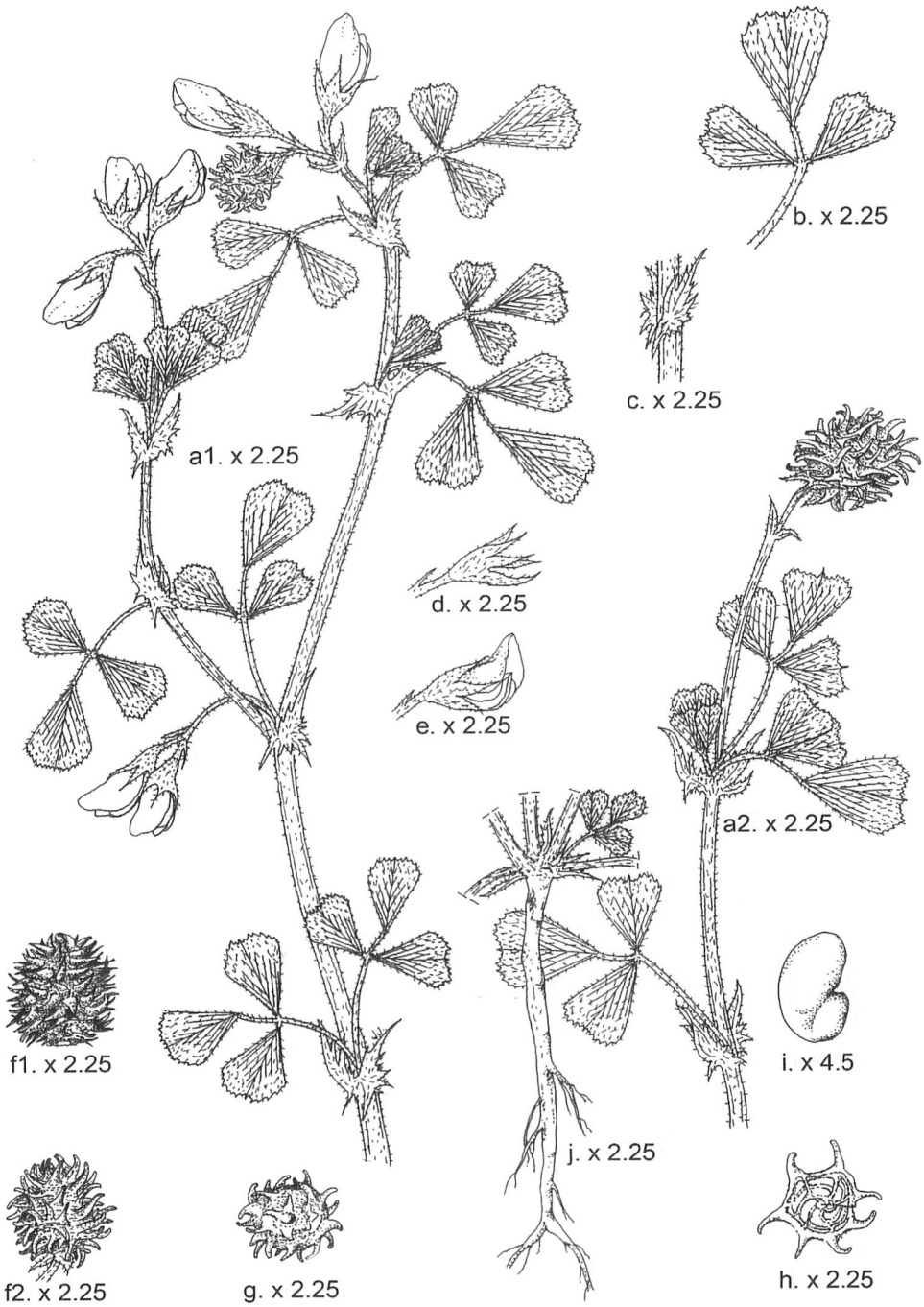

Figure 3.47. *Medicago constricta*: a1, habit (x 2.25), a2, branch habit (x 2.25), b, leaflet (x 2.25) c, stipule (x 2.25), d, calyx (x 2.5), e, flower (x 2.25), f1, pod three dimension view (x 2.25), f2, spines appearance (x 2.25), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 4.5), j, root and stem habit (x 2.25).

3.33 *Medicago lesinsii* E. Small. Can.J.Bot.63: 728-734.

Annual, herb, (10-)20-50(-90) cm, stem procumbent to ascending. Vegetative parts mostly glabrous. Stipules lanceolate, margin laciniate. Leaflet 7-21 mm ovate to obovate, apex truncate to emarginate, dorsally glabrous, margins serrate. Peduncle with 1-2 flowers, longer than the corresponding petiole. Flower 3-5 mm. Calyx sparsely pubescent, with simple hairs, shorter than half of the corolla, teeth lanceolate. Corolla yellow. Pods coiled, glabrous, 6-10 mm, not subterranean, spherical, spiny or spineless, not sessile, without gland-tipped trichomes, face reticulate, and centre with no opening. Coils 5-9, turning clockwise, appressed, with hard wall, edge margin same level of facial plane, veins 4-8, curved, vein-less zone about 20%-35% of the radius, no grooves between lateral vein and dorsal suture. Spines conical, stocky, thick, not grooved, with some times with hooked tip, base close to the margin of the coil edge, 0.5-3 mm, at two rows on a coil edge, 9-14 per row. Seeds 3-5 mm, brown to yellow, 1-2 per coil, coat smooth.

Chromosome number: 16.
Closely related species: This species is confused with *M. murex* from which it can be

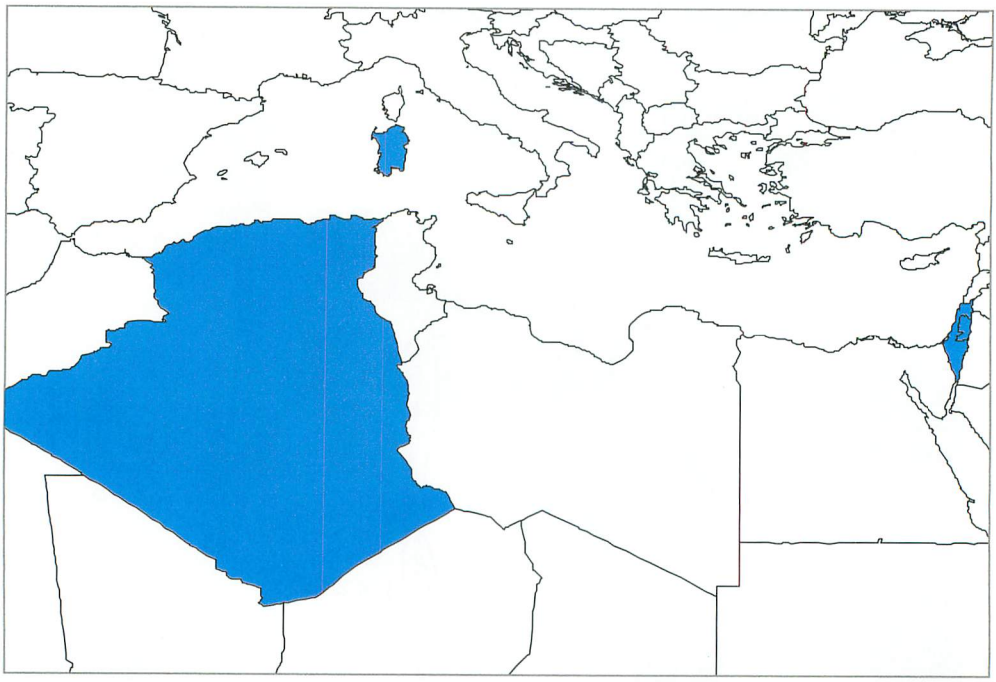

Figure 3.48. Distribution of *Medicago lesinsii*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

distinguished by lack of noticeable ridges on the coil edge beside the dorsal suture (ridges are almost always evident in *M. Murex*), also the racemes of *M. lesinsii* usually have one flower, whereas many of *M. murex* have two flowers.
Habitat: Mediterranean countries; infrequently collected but widely distributed.
Geographical distribution: Mediterranean area: Algeria, Sardinia, Israel, And Palestine.

3.34 *Medicago murex* Willd., Sp. Pl. 3: 1410 (1802).

Synonyms: *M. sphaerocarpos* Bertol, Rar. Ital. Pl. 3: 60 (1810), *M. muricula* St. Lag., Ann. Soc. Bot. Lyon 6: 130 (1880); *M. murex* Willd. subsp. *sphaerocarpos* (Bertol.) K.A. Lesins and I. Lesins, Gen. Medicago: 175 (1979).

Annual, herb, 10-50(-90) cm, stem procumbent or ascending. Vegetative parts densely pubescent, with defuse, simple hairs. Stipules ovate to lanceolate, margin dentate or laciniate. Leaflet 7-21 x 5-12 mm, obovate, apex apiculate or truncate to retuse, base cuneate, dorsally glabrous, ventrally densely pubescent, apex margin serrate to crenate. Peduncle with 1-6 flowers, 2-5 times longer than the corresponding petiole, with terminal cusp. Flower 4-7 mm. Pedicle shorter than the calyx tube, bract ± equalling the pedicel, calyx 3-4 mm, sparsely pubescent, with simple hairs, longer than half of the corolla, teeth ± equalling tube. Corolla yellow, standard obovate, wings distinctly longer than the keel. Pods coiled, green-brown to black, 6-12(-14) mm, ovoid to spherical, spiny or spineless. Coils 5-9, turning clockwise, appressed, 4-10 mm diameter, with hard wall, veins 5-9, running into a vein-less outer zone curved, venation appear harder horny substance and darker than the middle of the coil, vein-less zone about 20%-35% of the radius, dorsal suture in the same level of the edge margin. Spines if present often with hooked tip, conical base, 0.5-3 mm, at two rows on a coil edge, 9-14 per row, inserted at 180-240 degree to the coil face. Seeds 3.5-4 x 1.5-2.5 mm, brown to red-yellow, bow-shaped, 1-2 per coil, coat smooth, separated, with thin membrane between them, radicle equalling half seed length.

Chromosome number: 16.
Closely related species: Very close related to *M. lesinsii*, but *M. murex* is much more vigorous and common.
Habitat: Sandy, calcareous soils, fields, light woodlands and marginal lands.
Geographical distribution: Africa: Algeria (N), Libya (N), Morocco (N), Tunisia (N). Asia: Iran (N), Iraq (N). Europe: Balearic Is (N), Corsica (N), Crete (N), former Yugoslavia (N), France (N), Greece (N), Italy (N), Malta (N), Portugal (N), Sardinia (N), Sicily (N), Spain (N), Turkey in Europe (N) Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel-Jordan (N), Lebanon (N), Palestine (N), Syria (N), Turkey in Asia (N).
Conservation and threat assessment: Not threatened

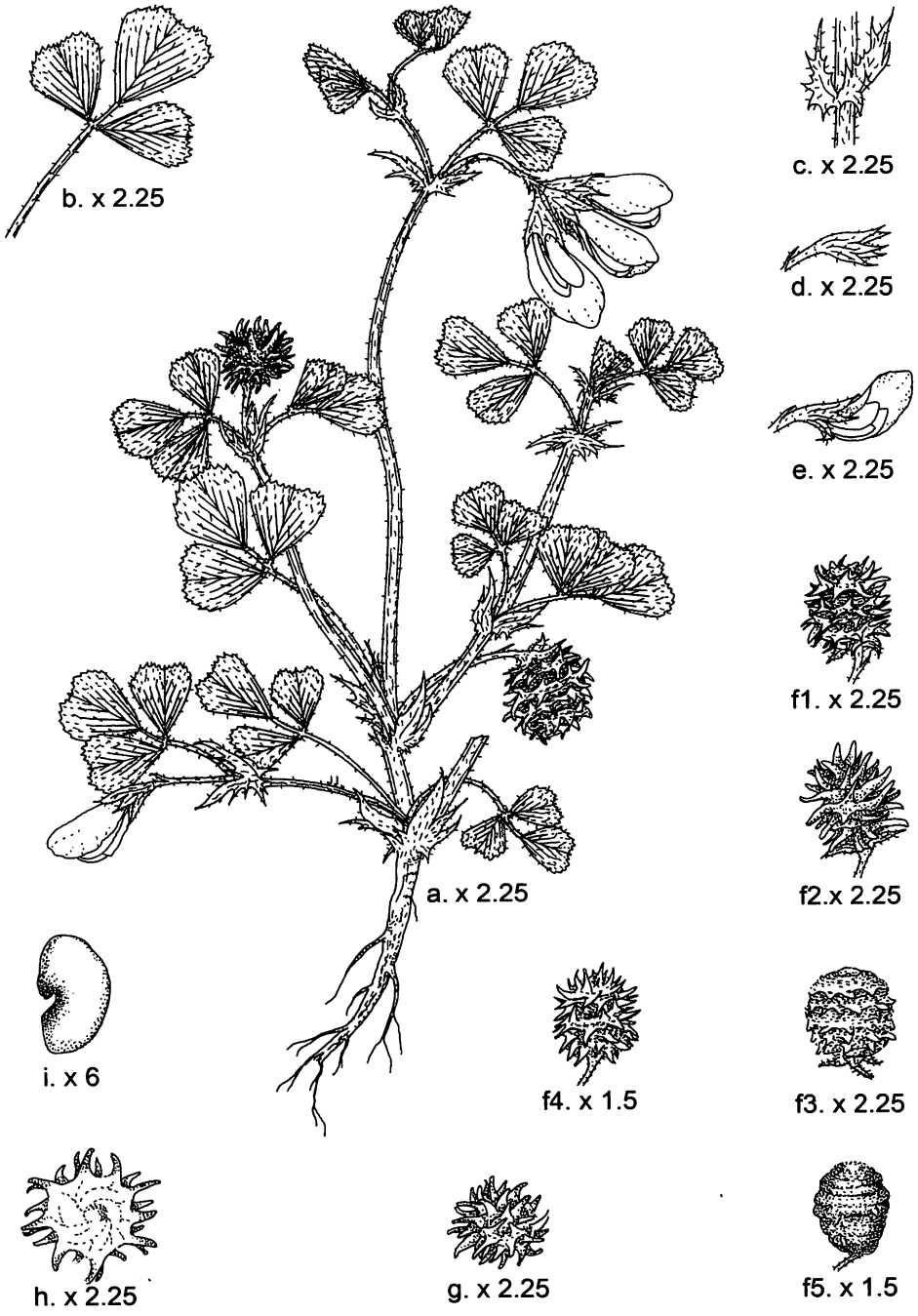

Figure 3.50. *Medicago murex*: a, habit (x 2.25), b, leaflet (x 2.25) c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f1, pod three dimension view (x 2.25), f2, pod spines appearance (x 2.25), f3, pod three dimension view (x 2.25), f4, pod three dimension view (x 1.5), f5, spineless pod three dimension view (x 1.5), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 6), g, pod spines with hook tip (x 2, 25).

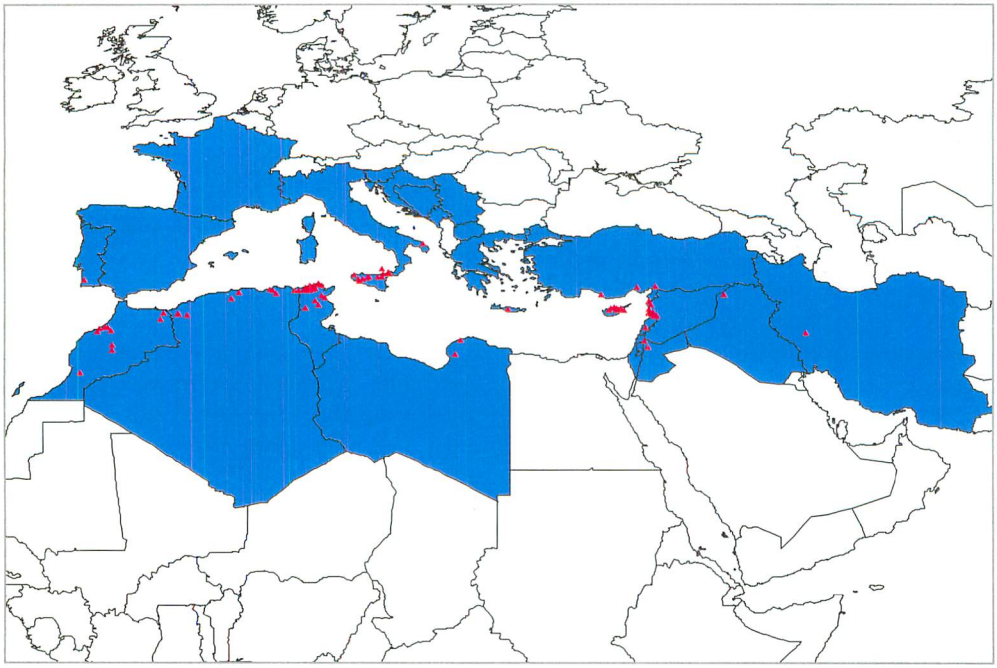

Figure 3.49. Distribution of *Medicago murex*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.35 *Medicago rugosa* Desr. in Lam., Encycl. Meth. Bot. 3: 632 (1792).

Synonyms: *Medicago elegans* Jacq. ex Willd, Sp. Pl. 3: 1408 (1802); *Medicago orbicularioides* Candargy, Bull. Soc. Bot. France 44: 161 (1897).

Annual, herb, 15-30(-40) cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with simple hairs and glandular hairs. Stipules ovate, margin dentate, teeth around margin. Leaflet 10-23 x 7-19 mm, obovate to obolanceolate, base cuneate, dorsally glabrous, ventrally densely pubescent, margins at apical third serrate. Peduncle with 1-5(-7) flowers, shorter than or equal to the corresponding petiole, with terminal cusp. Flower 2.5-5 mm. Pedicle shorter than the calyx tube, bract about ± equalling the pedicel, calyx 2.5-3 mm, densely pubescent, with simple and glandular hairs, longer than half of the corolla, teeth triangular, teeth shorter than or ± equals tube. Corolla yellow, standard obovate, wings slightly shorter than the keel. Pods coiled, densely pubescent, with simple and glandular hairs, brown to yellow, 3-5 mm, discoid to cylindrical,

spineless, and face reticulate. Coils 2.5-5, turning clockwise, not tightly appressed, (4-)5-10(-12) mm diameter, veins (12-)18-25(-30), curved to S shaped, anastomosing near the ventral suture, venation is a net of veins. Seeds 2.5-4.5 x 1-3 mm, brown to yellow, curved, 1 per coil, 1-3 per pod, not separated, radicle less than half seed length, radicle shaped as a round hook.

Chromosome number: 30, 32.
Closely related species: It may be confused with *M. noeana*, but unlike *M. rugosa*, its leaves do not have gland-tipped trichomes.
Habitat: Heavy clay soils in ruderal habitats and fallow fields, associated with limestone in rocky fields and maquis.
Geographical distribution: Africa: Algeria (N), Libya (N), Tunisia (N). Asia: Iran (N). Europe: Corsica (N), Crete (N), France (I), Greece (N), Italy (N), Malta (N), Portugal (I), Sardinia (N), Sicily (N), Spain (I) Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel-Jordan (N), Lebanon (N), Palestine (N), Syria (N), Turkey in Asia (N) Pacific Ocean: Hawaii (I).
Conservation and threat assessment: Not threatened
Actual and potential usage: Insect resistance.

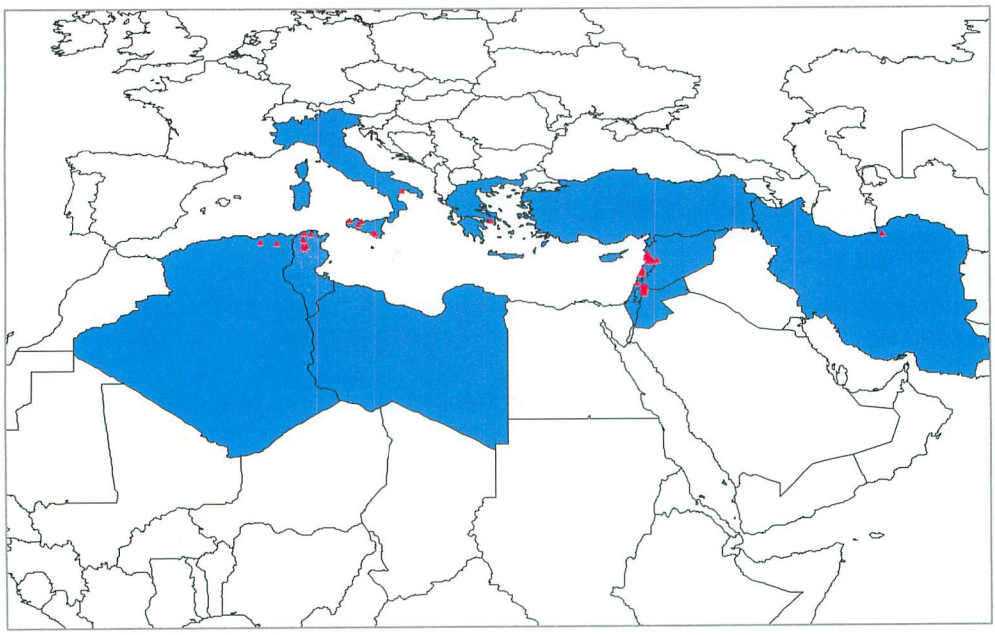

Figure 3.51. Distribution of *Medicago rugosa*. (shading represents native distribution, *t*riangle indicates population sample held *ex situ*).

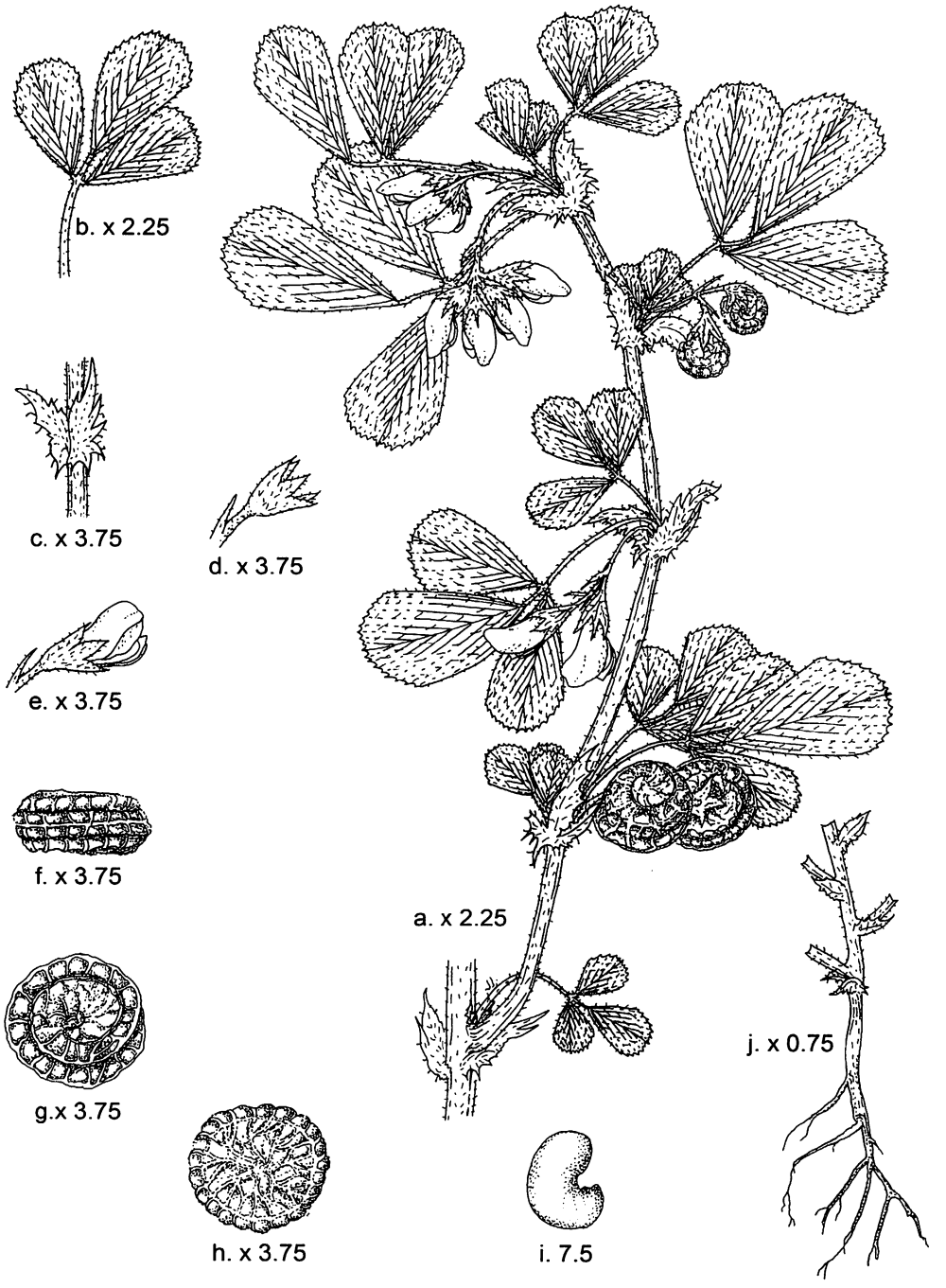

Figure 3.52. *Medicago rugosa*: a, habit (x 2.25), b, leaflet (x 3.75) c, stipule (x 3.75), d, calyx (x 3.75), e, flower (x 3.75), f, pod three dimension view (x 3.75), g, pod tip view (x 3.75), h, pod venation (x 3.75), i, seed (x 7.5), j, root and stem habit (x 0.75).

3.36 *Medicago scutellata* (L.) Miller, Gard. Dict. ed. 8, Medicago no. 2 (1768).

Synonyms: *Medicago polymorpha* L. var. *scutellata* L., Sp. Pl.: 779 (1753).
Annual, herb, 25-60 cm, stem decumbent to ascending, branching over the ground level. Vegetative parts densely pubescent, with simple and glandular hairs. Stipules ovate to lanceolate, margin dentate to laciniate, teeth around margin. Leaflet 10-30 x 5-20 mm, ovate or obovate or obolanceolate, apex apiculate, dorsally glabrous, ventrally densely pubescent, margins serrate. Peduncle with 1-3(-4) flowers, shorter than the corresponding petiole or equal to the corresponding petiole, with terminal cusp. Flower 6-9 mm. Pedicle much shorter than the calyx tube, bract longer than the pedicel, calyx densely pubescent, with simple and glandular hairs, equalling or longer than half of the corolla, teeth occasionally ± equalling or longer than tube. Corolla yellow, standard obovate, wings about the length of the keel. Pods coiled, at maturity densely pubescent, with glandular hair, black to ash-grey, 7-15(-18) mm, cup shaped, spineless, sessile. Coils 5-7(-8), turning clockwise, 10-16 mm diameter, convex to imbricate like stacked bowls, convex towards the pod base only, with thin wall, 2-3 apical coils seedless, veins anastomosing near the

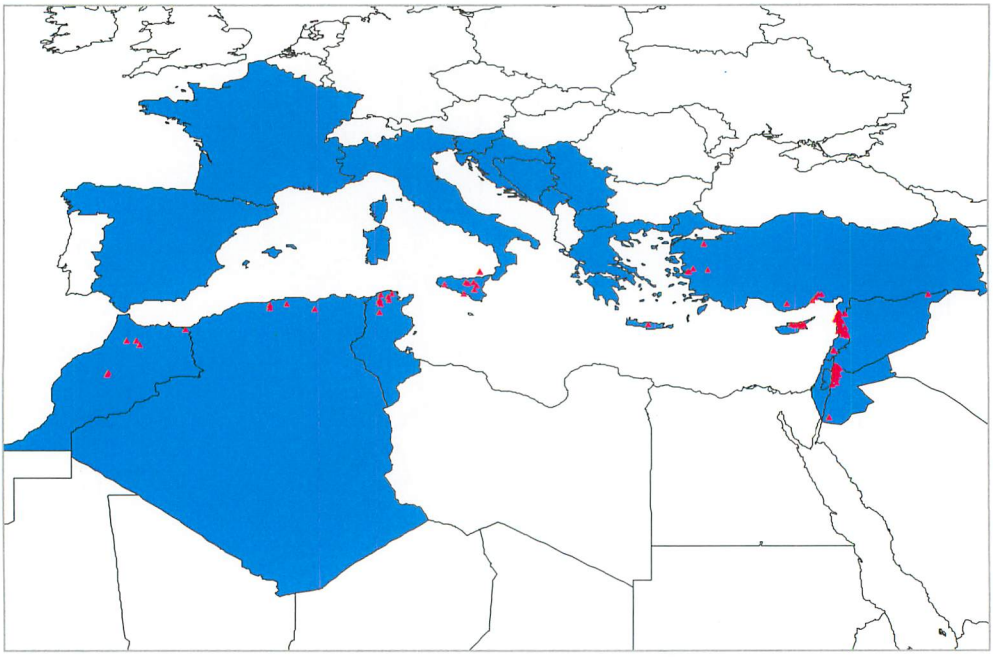

Figure 3.53. Distribution of *Medicago scutellata*. (shading represents native distribution, triangle indicates population sample held ex *situ*).

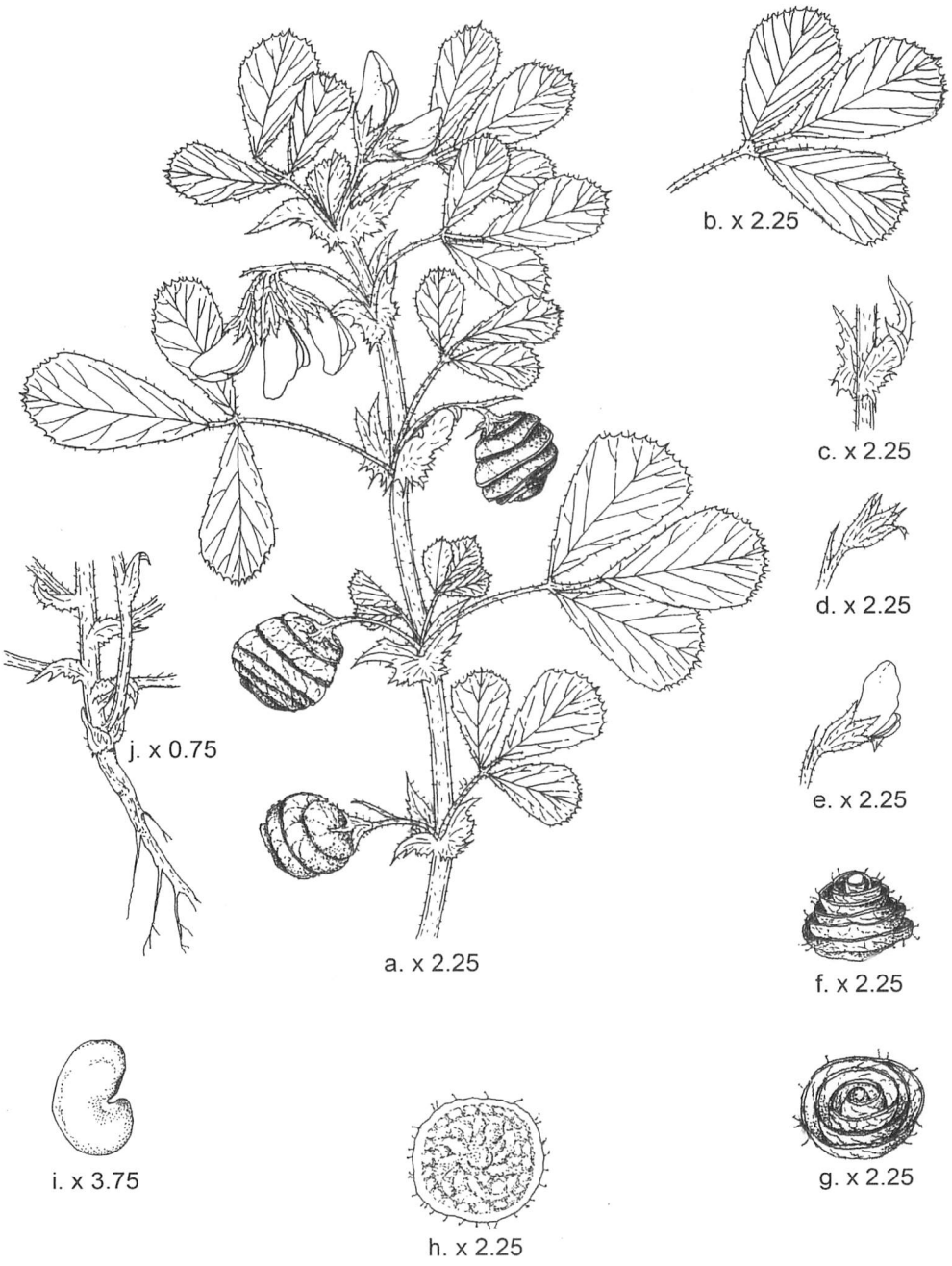

Figure 3.54. *Medicago scutellata*: a, habit (x 2.25), b, leaflet (x 2.25) c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 2.25), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 3.75), j, root and stem habit (x 0.75).

ventral suture (entering dorsal suture at angle opposite to the coil direction), venation darker than the middle of the coil. Seeds 4-7 x 2.5-4 mm, yellow, curved, 1-2 per coil, coat smooth, separated, with thin membrane between them, radicle less than half seed length, radicle as exclamation mark.

Chromosome number: 30, 32.
Closely related species: It is easily distinguished species as it unique in having imbricate fruit coils, giving appearance of a stack of bowls.
Habitat: Mainly in heavy soils, often in fallow fields, less frequently in cultivated fields, plains, forest meadows, roadsides, and dry hillsides, occasionally costal.
Geographical distribution: Africa: Algeria (N), Morocco (N), South Africa (I), Tunisia (N). Australasia: Australia (I), Tasmania (I). Australia: New South Wales, South Australia, Victoria, Western Australia. Europe: Austria (I), Balearic Is (N), Corsica (N), Crete (N), former Yugoslavia (N), France (N), Greece (N), Italy (N), Malta (N), Portugal (U), Sardinia (N), Sicily (N), Spain (N), Turkey in Europe (N), Ukraine (U). Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel-Jordan (N), Lebanon-Syria (N), Palestine (N), Turkey in Asia (N) Pacific Ocean: New Zealand (South) (I) Ukraine: Dnepropetrovsk, Krym, Odessa.
Conservation and threat assessment: Not threatened
Actual and potential usage: Forage, environmental and insect resistance.

3.37 *Medicago blancheana* Boiss, Diagn. Pl. Orient. Nov. 3(5): 75 (1856).

Synonyms: *Medicago bonarotiana* Arcang., Nouv. Giorn. Bot. Ital. 8: 6 (1876); *Medicago blancheana* Boiss. var. *bonarotiana* (Arc.) Fl. Ital.: 61 (1882).
Annual, herb, 15-30 cm, stem ascending, branching at the ground level. Vegetative parts densely pubescent, with simple and glandular hairs. Stipules margin dentate. Leaflet 10-15 x 5-8 mm, ovate (rarely) or obovate or obolanceolate (rarely), apex about truncate, dorsally densely pubescent, ventrally densely pubescent, margins serrate or laciniate (very rare). Peduncle with 1-3 flowers, 2 times longer than the corresponding petiole, with terminal cusp. Flower 6-8 mm. Pedicle longer than the calyx tube. Calyx densely pubescent, with simple and glandular hairs, shorter than half of the corolla, teeth ± equalling tube. Corolla pale mauve to yellow, standard twice as long as keel and wings. Pods coiled, rarely glabrous or densely pubescent, with glandular hair, 9-12 mm, cylindrical, spiny or spineless, not sessile, face reticulate. Coils 4-5(-6), turning anticlockwise, 8-12 mm diameter, size decreasing gradually towards first and last coil, convex and flat (at the pod middle), with thin wall, veins 20-30 (running to the dorsal suture), venation dense in a net of veins. Spines triangular flattened and conical, 1 mm, at two rows on a coil edge, 27-37 per row, inserted at 30-70 degree to the coil face. Seeds brown to yellow, 1-2 per coil, coat smooth, some times separated, with thin membrane between them, radicle equalling half seed length.
Chromosome number: 16.

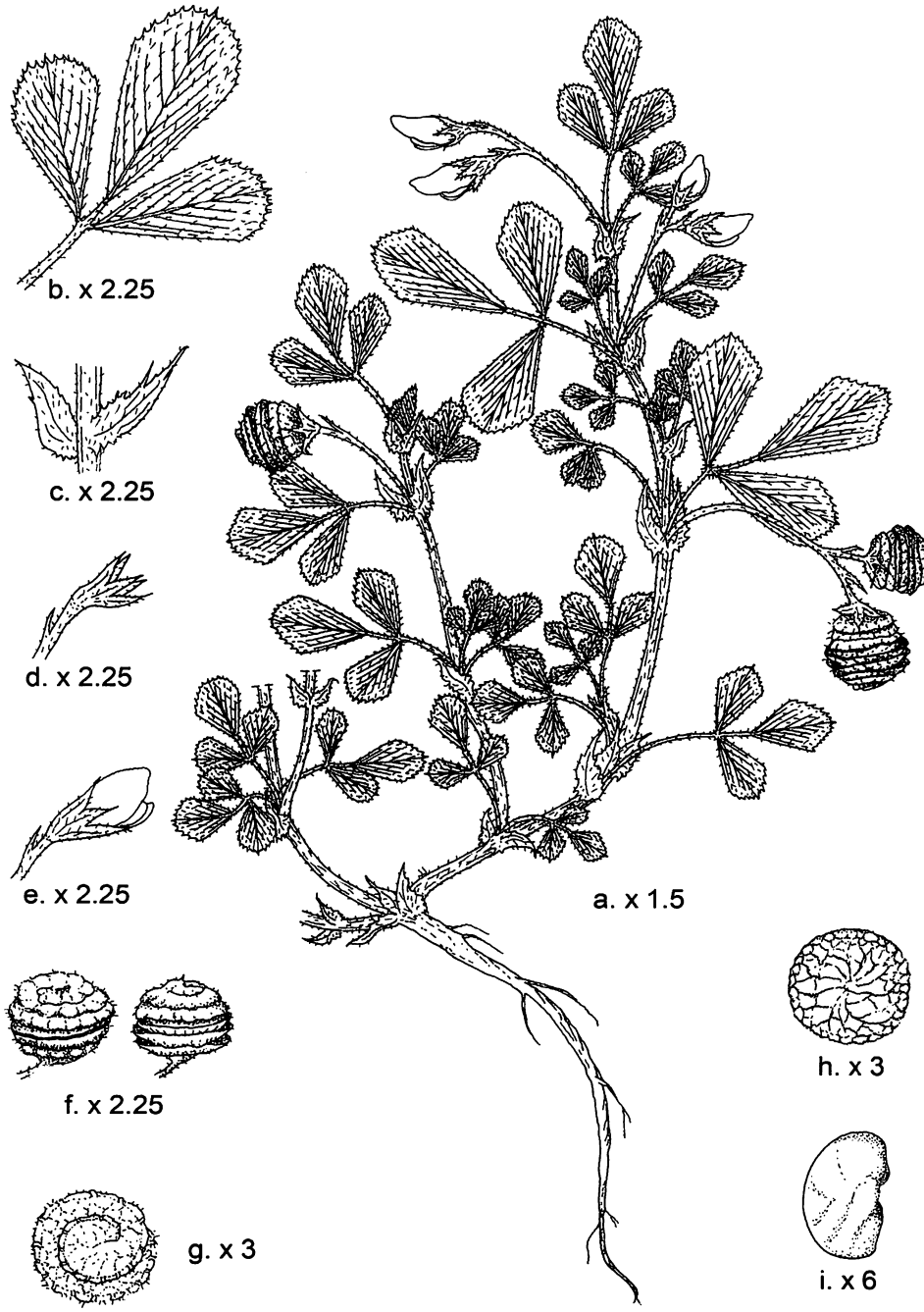

Figure 3.56. *Medicago blancheana*: a, habit (x 1.5), b, leaflet (x 2.25) c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 2.25), g, pod tip view (x 3) h, pod venation (x 3) i, seed (x 6).

Closely related species: It is easily distinguished species as the coils decrease gradually towards first and last coil.
Habitat: Limestone rocks, steppe, pinewoods, cultivated and fallow fields, dry meadows. Heavy red clay soils, as a weed in cultivated crops and in fallow fields.
Geographical distribution: Africa: Tunisia (N). Europe: Italy (U), Portugal (N), Spain (I), Turkey in Europe (N) Middle East: Cyprus (N), Israel-Jordan (N), Lebanon (N), Palestine (N), Syria (N), Turkey in Asia (N).
Conservation and threat assessment: Not threatened
Actual and potential usage: None known.

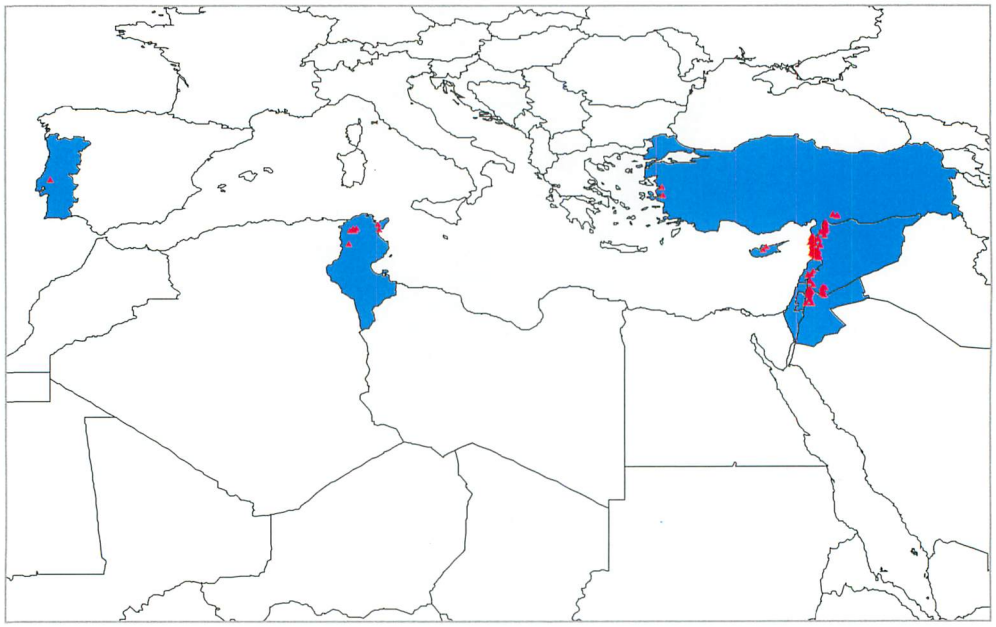

Figure 3.55. Distribution of *Medicago blancheana*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.38 *Medicago rotata* Boissier, Diagn. Pl. Orient. Nov. 2: 24 (1843).

Synonyms: *Medicago rotata* subsp. *eliezeri* (Eig) Ponert, Feddes Repert. 83: 639 (1973).
Annual, herb, 15-30(-50) cm, stem ascending, branching over the ground level. Vegetative parts glabrous or densely pubescent, with appressed or erect, simple hairs. Stipules ovate, margin dentate, teeth at base. Leaflet 8-15(-24) x 4-8(-15) mm, usually ovate or elliptical or obolanceolate, apex truncate, ventrally densely pubescent, margins entire or dentate (irregularly), some times with anthocyanin-

coloured patch in the middle. Peduncle with 1-5(-6) flowers, longer than the corresponding petiole, with terminal cusp. Flower 6-9 mm. Pedicle shorter than the calyx tube, bract ± equalling the pedicel, calyx 3-5 mm, densely pubescent, with simple hairs, teeth shorter than or ± equalling tube. Corolla yellow, standard obovate, wings slightly shorter than the keel. Pods coiled, glabrous, black to brown, 4-10(-12) mm, cylindrical, spiny, face reticulate. Coils 3-5(-7), turning clockwise, not tightly appressed, 4-10 mm diameter, the apical one concave, at maturity with hard wall, veins several slender shaped, venation distinct is a net of veins. Spines irregular shape, 0.5-3 mm, at two rows on a coil edge, 25-35(-45) per row, inserted at 90 degree to the coil face. Seeds 3.5-4.5 x 2-2.5 mm, brown to yellow, 1-2 per coil, coat smooth, separated, radicle less than or equalling half seed length.

Chromosome number: 16.
Closely related species: It is easily distinguished species an easily identified by the short, irregular spines at right angles to the coil face.
Habitat: Most commonly found as a field weed, usually on terra rosa soils, occasionally on rocky ground.
Geographical distribution: Africa: Morocco (N), Tunisia (N). Asia: Iraq (N). Middle East: Cyprus (N), Israel (N), Jordan (N), Lebanon (N), Palestine (N), Syria (N), Turkey in Asia (N).
Conservation and threat assessment: Not threatened
Actual and potential usage: None known.

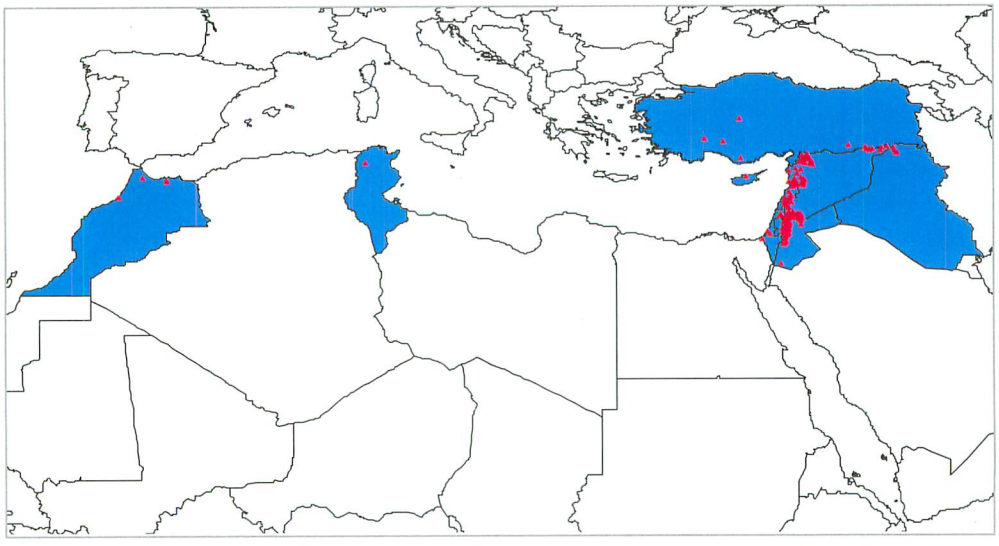

Figure 3.57. Distribution of *Medicago rotata*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

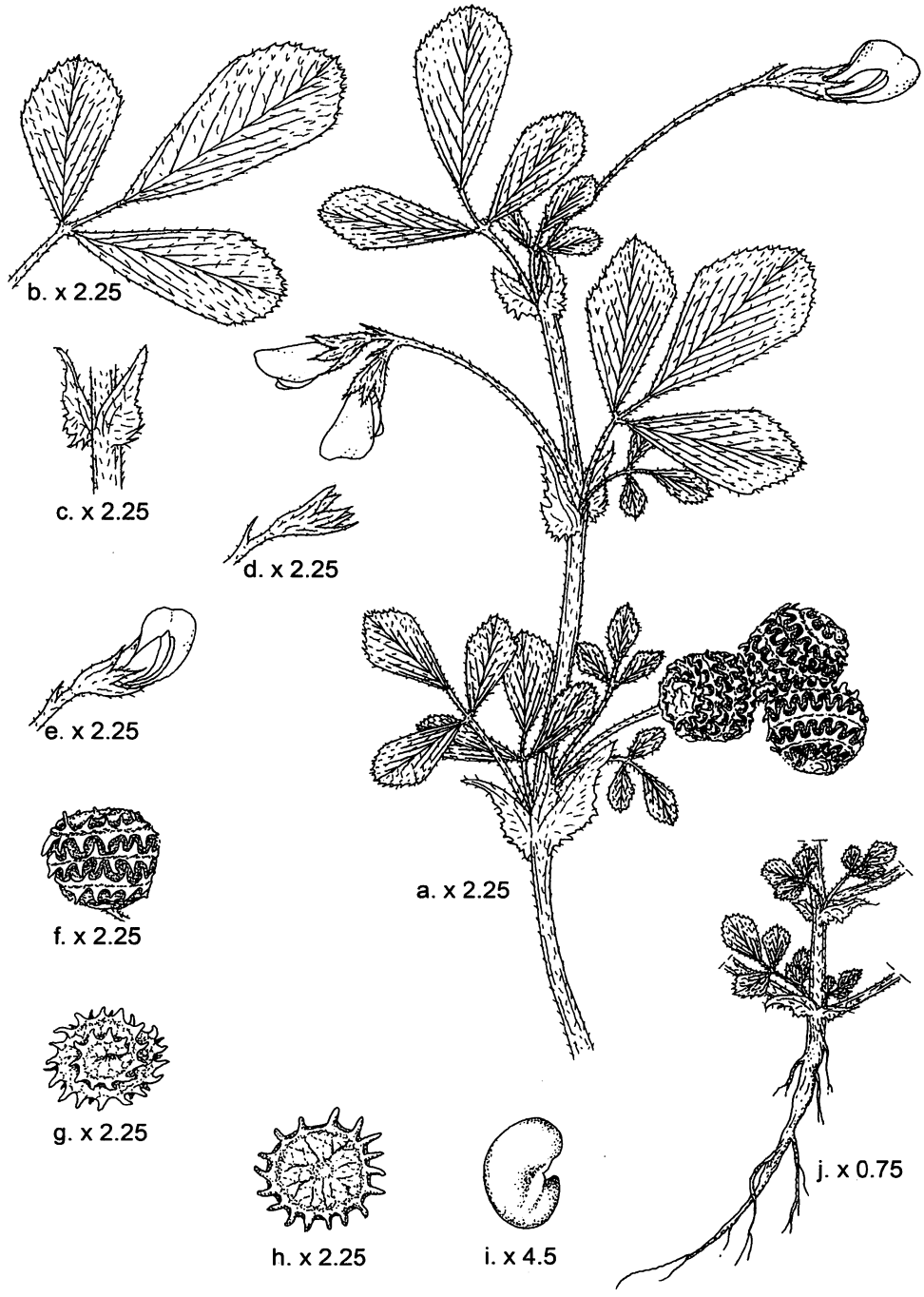

Figure 3.58. *Medicago rotata*: a, habit (x 2.25), b, leaflet (x 2.25) c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 2.25), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 4.5), j, root and stem habit (x 0.75).

3.39 *Medicago noeana* Boiss., Diagn. Pl. Orient. Ser. 2, 2: 10 (1856).

Annual, herb, 10-30(-60) cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with erect, simple hairs. Stipules margin entire or serrate. Leaflet 10-15(-20) x 5-8(-16) mm, ovate or elliptical or rhombic, apex truncate to obtuse, dorsally densely pubescent, margins at apical half serrate. Peduncle with 1-7 flowers, longer than the corresponding petiole, with terminal cusp. Flower 6-7 mm. Pedicle shorter than the calyx tube, bract ± equalling the pedicel, calyx densely pubescent, with simple hairs, longer than half of the corolla, teeth ± equalling tube. Corolla yellow, standard oval, wings shorter than the keel. Pods coiled, glabrous, ash-grey to brown, 5-6 mm, cylindrical, spineless, base with calyx remains appressed as a regular five-rayed star. Coils 2.5-5, turning not in one direction, loose, 4-7.5 mm diameter, at maturity with hard wall, veins 14-17, slender shaped, branching near lateral outer vein, venation obscure (becoming thick near the lateral vein), dorsal suture located in a groove. Seeds 3.5-4.7 x 2-2.5 mm, brown to yellow, 1-2 per coil, coat smooth, separated, with thin membrane between them, radicle less than or equalling half seed length.

Chromosome number: 16.
Closely related species: An easily distinguished species as the calyx remains appressed to the base of the pod as a regular five-rayed star.
Habitat: Mid-mountain zone habitats on calcareous, rocky slopes, in grass and woodland.

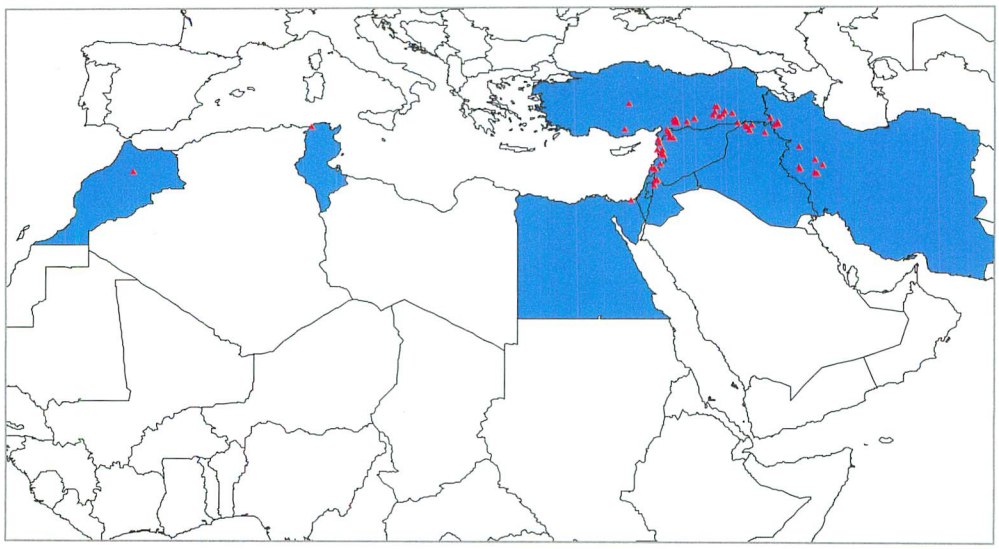

Figure 3.59. Distribution of *Medicago noeana*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

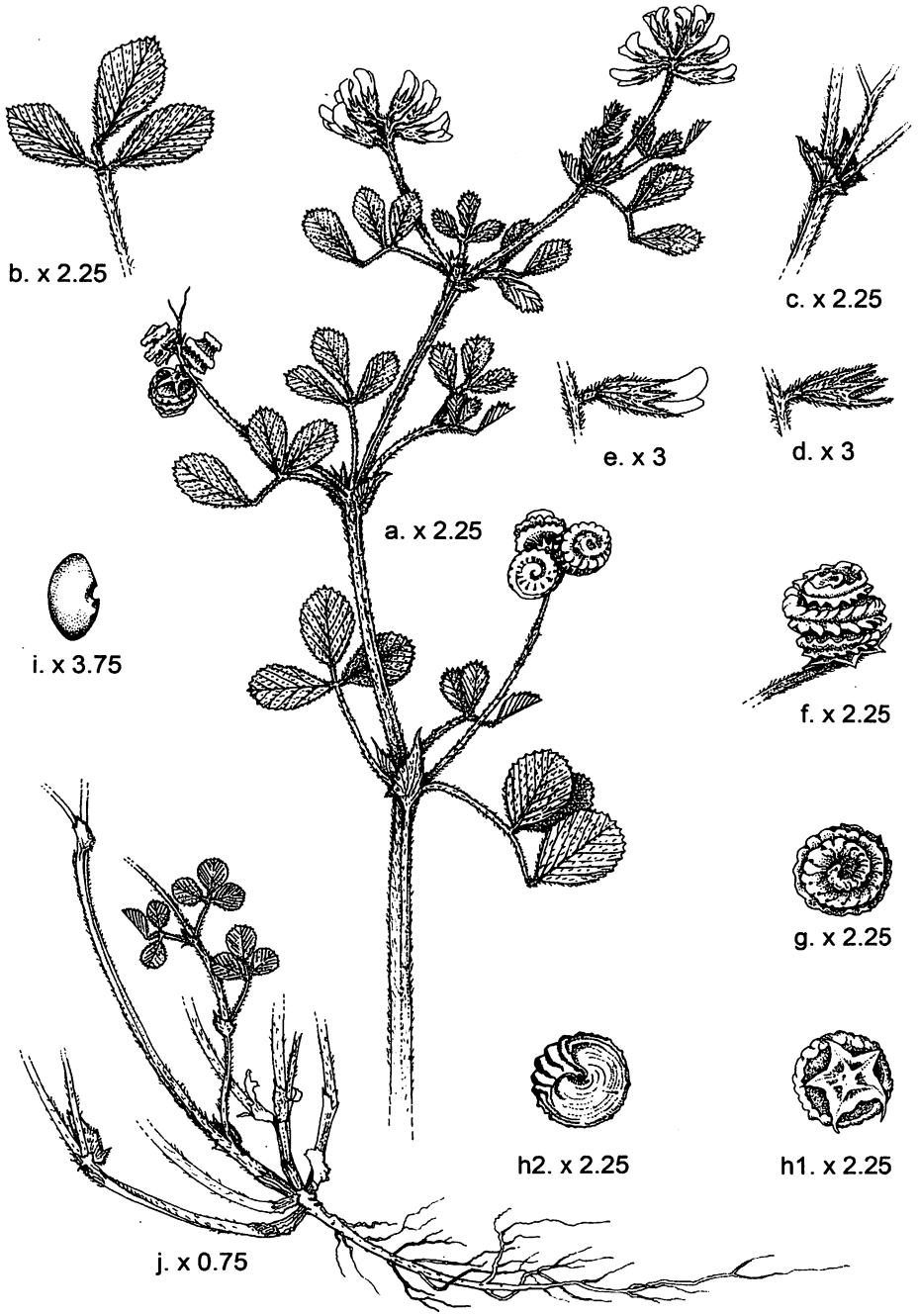

Figure 3.60. *Medicago noeana*: a, habit (x 2.25), b, leaflet (x 2.25) c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 3), f, pod three-dimension view (x 2.25), g, pod tip view (x 2.25), h1, pod based view (2.25), h2 pod venation (x 2.25), i, seed (x 3.75), j, root and stem habit (x 0.75).

Geographical distribution: Africa: Egypt (N), Morocco (N), Tunisia (N).Asia: Iran (N), Iraq (N) Middle East: Jordan (N), Lebanon (N), Palestine (N), Syria (N) Turkey in Asia (N).
Actual and potential usage: May be of value as a forage crop at high altitude.

3.40 *Medicago shepardii* Post ex Boiss., Fl. Orient. Suppl. 163. (1888).

Synonyms: *Medicago shepardii* Post, J. Linn. Soc. Bot. 24: 425 (1888).
Annual, herb, 15-30(-50) cm, stem decumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with defuse, simple hairs. Stipules lanceolate, margin at lower nodes dentate. Leaflet 5-10(-16) x 6-7(-10) mm, obovate, base cuneate, dorsally densely pubescent, ventrally densely pubescent, with defuse hairs, margins at apical part serrate. Peduncle with 2-5(-6) flowers, longer than the corresponding petiole, with terminal cusp. Flower 3.5-4 mm. Pedicle equal to the calyx tube, bract shorter than the pedicel, calyx densely pubescent, with simple hairs, longer than half of the corolla, teeth shorter or ± equalling tube. Corolla yellow, standard oval, wings shorter than the keel. Pods coiled, densely

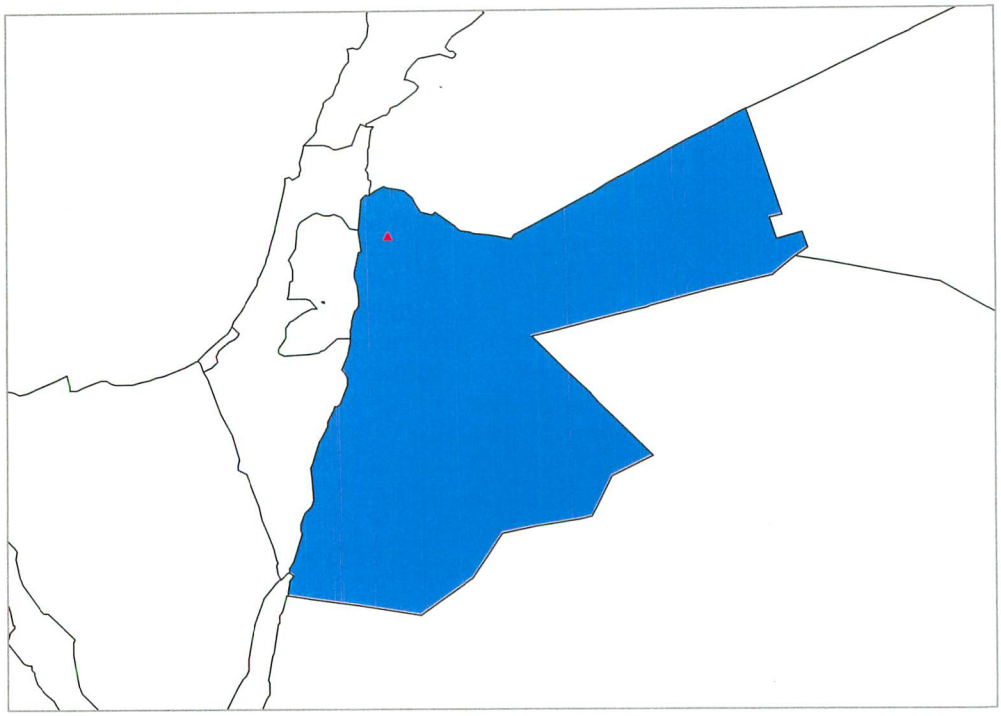

Figure 3.61. Distribution of *Medicago shepardii*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

pubescent, with simple hair, green-brown, discoid, spineless, face reticulate. Coils 1.5, turning clockwise, 3-5 mm diameter, veins several distinct slender shaped, anastomosing before entering lateral vein, venation is a net of veins, dorsal suture steeply elevated in the middle of the coil edges. Seeds 3.3 x 2 mm, brown to yellow, 1-3 per pod, separated, and radicle equalling half seed length.

Chromosome number: 16.
Closely related species: This species may be confused with *M. rugosa*. The fruits have wing-like protrusions on the coil margins, reminiscent of *M. rugosa*, but are hairy, and the leaves lack the gland-tipped trichomes of the latter species (Small and Jomphe, 1989).
Habitat: Volcanic soils and heavy brown soils on basalt, fields and pasture and roadsides.
Geographical distribution: Middle East: Jordan (N). Asia: Turkey (U).
Conservation and threat assessment: Rare (IUCN)

3.41 *Medicago intertexta* (L.) Miller, Gard. Dict. ed. 8: Medicago no. 4 (1768).

Annual, herb, 30-50(-100) cm, stem decumbent to ascending, branching at the ground level. Vegetative parts glabrous or densely pubescent, with simple hairs or simple and glandular hairs. Stipules ovate, margin dentate to laciniate. Leaflet 6-20(-29) x 5-20 mm, obovate or obolanceolate, apex apiculate or retuse (rarely), dorsally glabrous, margins above serrate to dentate, some times with a red blotch in their basal part. Peduncle with (1-)3-11 flowers, equal to the corresponding petiole, with or without terminal cusp. Flower 5-10 mm. Pedicle equal to the calyx tube, bract shorter or ± equalling the pedicel, calyx 3-5 mm, densely pubescent, with simple hairs, teeth ± equalling tube. Corolla yellow, standard oval, wings longer than the keel. Pods coiled, glabrous or densely pubescent, with celled hairs, green-brown, 10-20 mm, ovoid to spherical, spiny, without gland-tipped trichomes. Coils 3-10(-12), turning clockwise, loose, the broadest 9-15 mm diameter, veins 6-9, anastomosing in the half distance from the dorsal suture, venation a coarse is a net of veins. Spines grooved to ± half their length, 1-5(-8) mm, at two rows on a coil edge, 16-19 per row, inserted at 90-100(-130) degree to the coil face, arching and interlocking with spines of adjacent coil. Seeds 4.5-6 x 3-3.5 mm, red-yellow to black, 1-2 per coil, coat smooth, not separated or separated, radicle less than half seed length.

Chromosome number: 16.
Closely related species: It is closely related to *M. ciliaris* and the wisdom of separating these species has been widely debated (Small and Jomphe, 1989).
Habitat: Arable land and field margins, rocky outcrops, soils heavy and moist, but more rarely on sand.
Geographical distribution: Africa: Algeria (N), Canary Is (N), Egypt (N), Madeira (N),

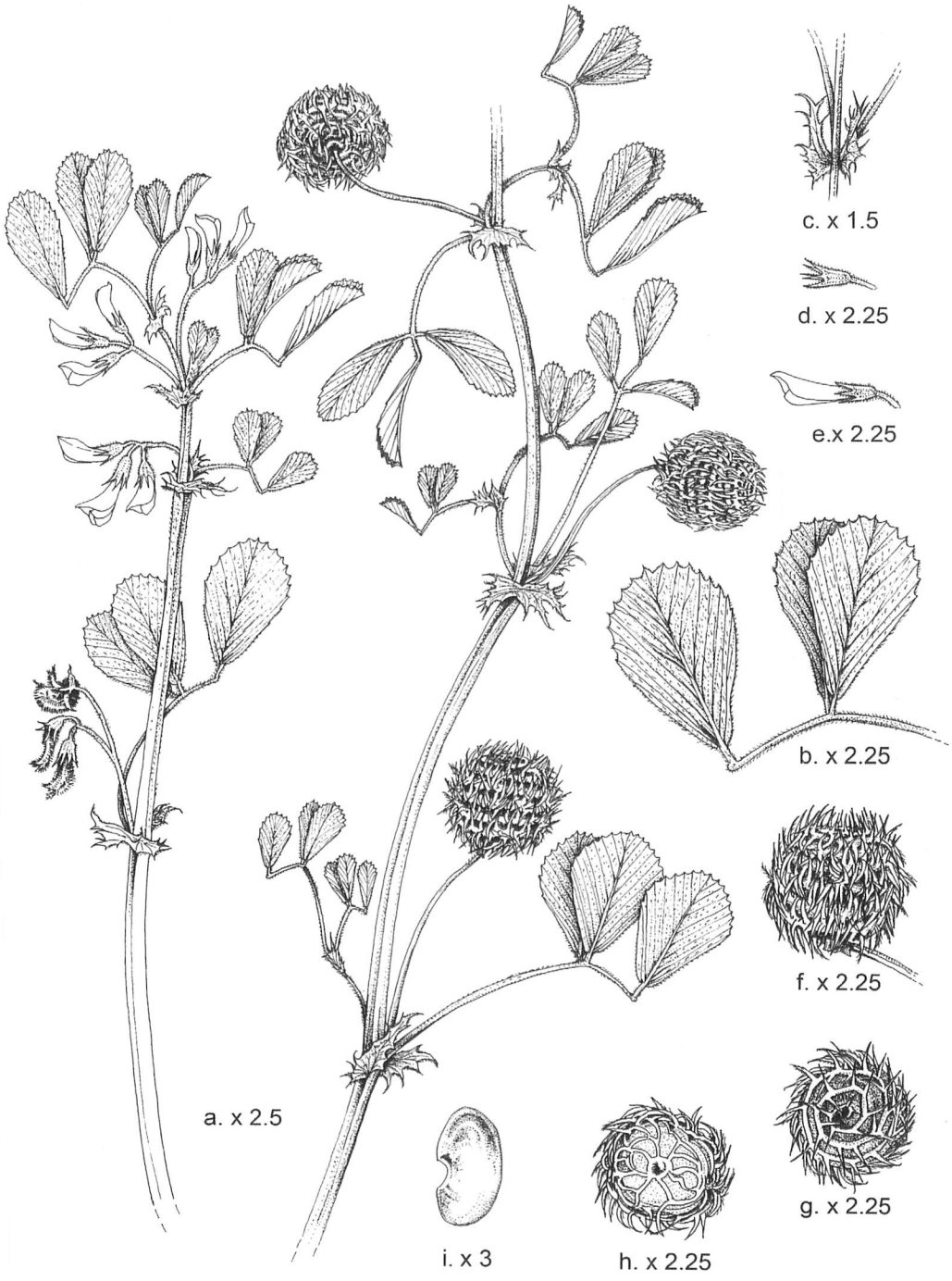

Figure 3.63. *Medicago intertexta*: a, habit (x 2.5), b, leaflet (x 2.25) c, stipule (x 1.5), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 2.25), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 3).

Morocco (N), South Africa (I), Tunisia (N) Asia: Iran (N), Iraq (N) Australasia: Australia (I) Europe: Balearic Is (N), Corsica (N), Crete (N), France (N), Greece (N), Italy (N), Malta (N), Portugal (N), Sardinia (N), Sicily (N), Spain (N), Turkey in Europe (N) Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel-Jordan (N), Lebanon (N), Palestine (N), Syria (N), Sinai (N), Turkey in Asia (N).
Conservation and threat assessment: Not threatened

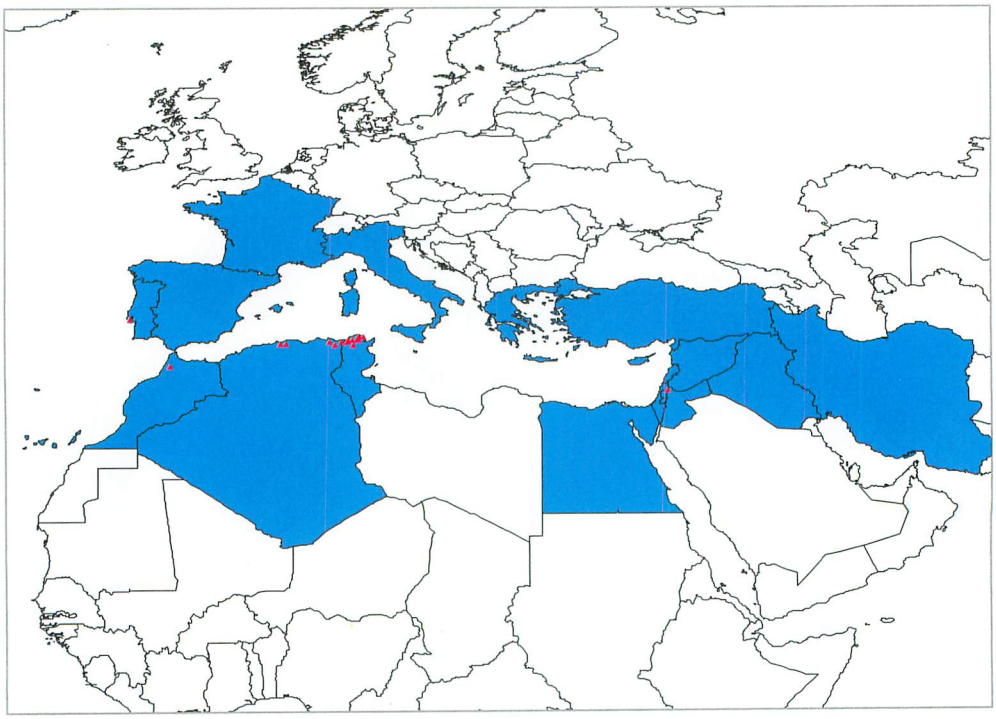

Figure 3.62. Distribution of *Medicago intertexta*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.42 *Medicago ciliaris* (L.) Krocker, Fl. 2(2): 244 (1790).

Synonyms: *Medicago polymorpha* L. var. *ciliaris* L, Sp. Pl.: 780 (1753); *Medicago intertexta* (L.) Miller var. *ciliaris* (L.) Heyn., Scripta Hierosolymitana12: 129 (1963).
Annual, herb, 35-55 cm, stem decumbent to ascending, branching at the ground level. Vegetative parts sparsely pubescent, with simple hairs. Stipules ovate, margin incised, teeth around margin. Leaflet 14-25 x 9-22 mm, obovate to elliptical, margins above serrate. Peduncle with 1-4 flowers, equal to or longer than the corresponding petiole, with terminal cusp. Flower 7.5-8 mm. Pedicle equal to or longer

than the calyx tube, bract shorter than the pedicel, calyx 3.5-4 mm, sparsely pubescent, with simple hairs, teeth shorter or ± equalling tube. Corolla bright yellow, standard broadly oval, wings longer than the keel. Pods coiled, densely pubescent, with glandular hair, brown to green-brown, not subterranean, ovoid to spherical, spiny, with gland-tipped trichomes, centre with no opening. Coils 9-10, turning clockwise, not firmly appressed, 9-11 mm diameter, veins 6-8, anastomosing in the outer part of the pod face, venation is a net of veins. Spines triangular flattened, grooved, with straight tip, covered with many-celled hairs grooved to ± half their length, 2-3 mm, at two rows on a coil edge, 15-18 per row, inserted at about 90-135 degree to the coil face, arching and interlocking with spines of adjacent coil. Seeds 4.8 x 3 mm, red-yellow to black, 1-2 per coil, coat smooth, not separated radicle less than half seed length.

Chromosome number: 16.
Closely related species: It is much like the preceding species, but the fruits are covered with gland-tipped trichomes, and the purple leaf blotches are uncommon (Small and Jomphe, 1989).

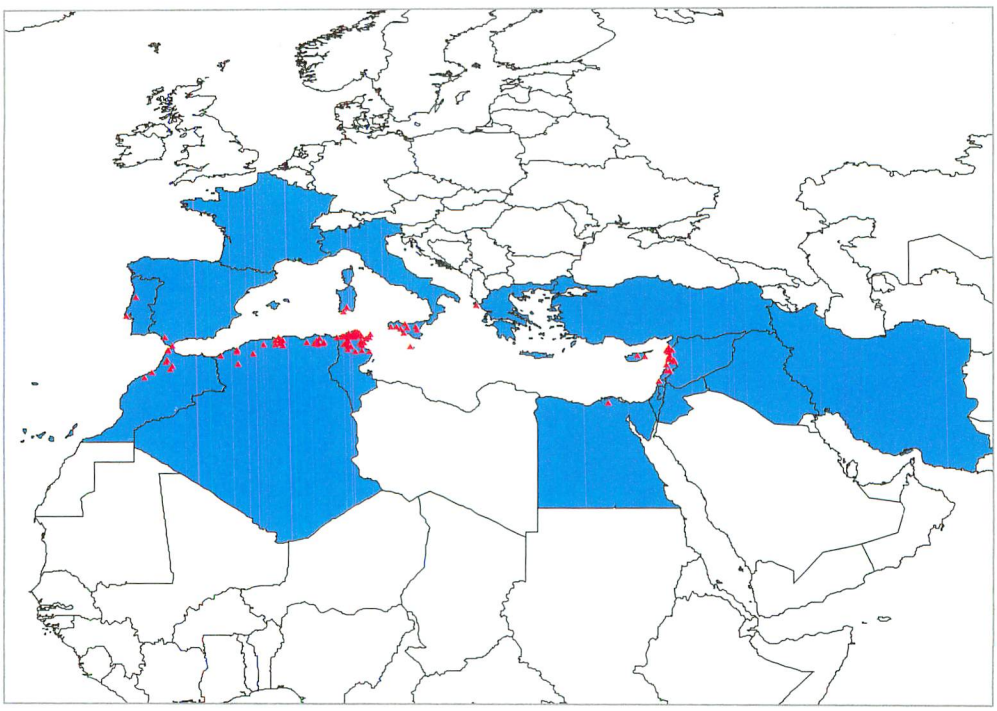

Figure 3.64. Distribution of *Medicago ciliaris*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

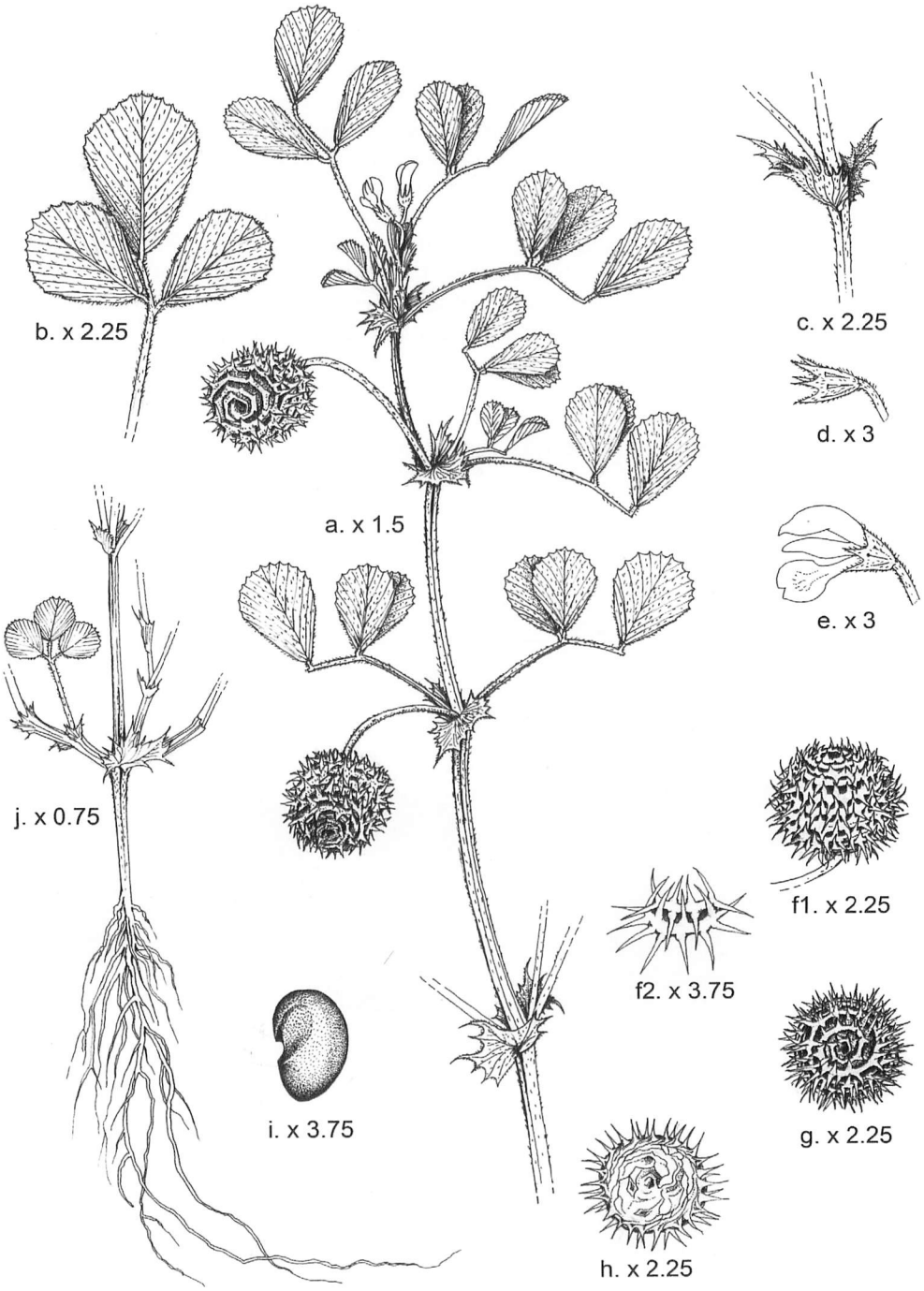

Figure 3.65. *Medicago ciliaris*: a, habit (x 1.5), b, leaflet (x 2.25), c, stipule (x 2.25), d, calyx (x 3), e, flower (x 3), f1, pod three dimension view (x 2.25), f2, coil edges with spines (x 3.75), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 3.75), j, roots and stem habit (x 0.75).

Habitat: Heavy moist soils, marshes near the sea, uncultivated olive groves, arable fields, banks of ditches and water bodies.
Geographical distribution: Africa: Algeria (N), Canary Is (N), Egypt (N), Madeira (N), Morocco (N), Tunisia (N) Asia: Iran (N), Iraq (N) Europe: Balearic Is (N), Corsica (N), Crete (N), France (N), Greece (N), Italy (N), Malta (N), Portugal (N), Sardinia (N), Sicily (N), Spain (N), Turkey in Europe (N) Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel-Jordan (N), Lebanon (N), Palestine (N), Syria (N), Sinai (N), Turkey in Asia (N).
Conservation and threat assessment: Not threatened.

3.43 *Medicago muricoleptis* Tineo, Pl. Sic. Rar. Pugill. 1: 18 (1817).

Synonyms: *Medicago decandolii* Guss, Fl. Sic. Syn. 2: 369 (1844).
Annual, herb, 15-70 cm, stem procumbent to ascending, branching at the ground level. Vegetative parts glabrous or densely pubescent, with simple hairs. Stipules margin incised with 8-11 slender teeth. Leaflet (3-)8-17 x 2-7(-15) mm, obovate or obolanceolate, apex obtuse, margins at upper part serrate or crenate. Peduncle with (1-)2-7 flowers, equal to or longer than the corresponding petiole, with or without terminal cusp. Flower 5-7.5 mm. Pedicle shorter or equal to the calyx tube, bract ± equalling the pedicel, calyx 3-4 mm, glabrous or densely pubescent, with simple appressed hairs, teeth ± equalling tube. Corolla yellow, standard oval, wings about the length of the keel. Pods coiled, glabrous, green-brown, discoid or cylindrical, spiny. Coils 3-6.5, turning clockwise, loose, 8-12 mm diameter, size of the last one smaller than the first, veins 7-10, curved, branching near the ventral suture and branching near the dorsal suture, venation is a net of veins (one vein entering one root of each spine). Spines slender, fine, grooved, 1-2 mm, at two rows on a coil edge, 16-24 per row, inserted at 90-180 degree to the coil face, arching and interlocking with spines of adjacent coil or pointing in different direction (also). Seeds 4-5 x 2-2.5 mm, brown or black, 1-3 per coil, coat smooth, not separated or separated, with thin membrane between them, radicle less than or equalling half seed length.

Chromosome number: 16.
Closely related species: This species is easily mistaken for *M. granadensis*.
Habitat: Heavy moist soils.
Geographical distribution: Middle East: Lebanon (N), Syria (N). Europe: France (I), Greece (N), Italy (N), Sicily (N).
Conservation and threat assessment: Rare

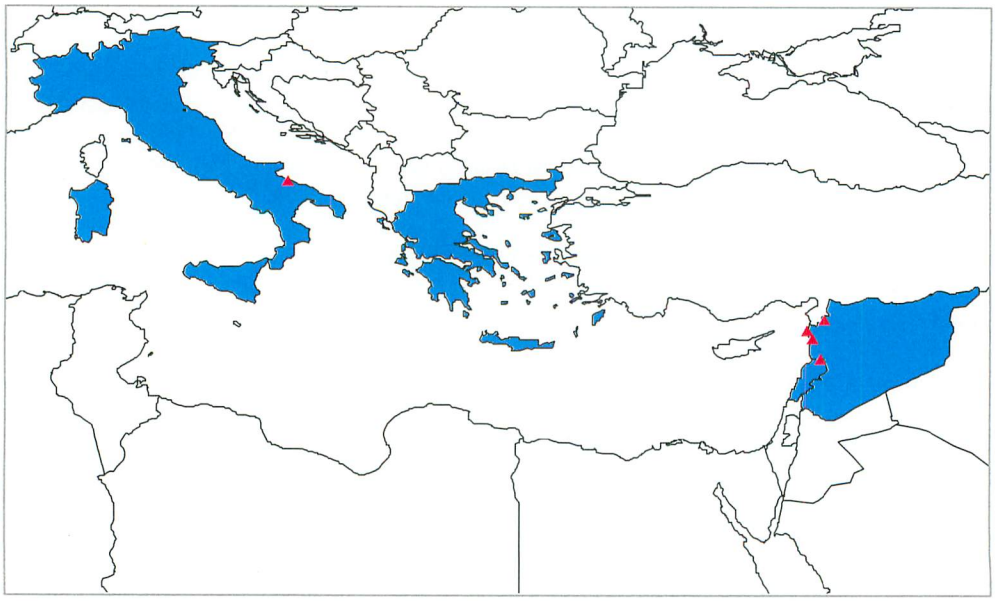

Figure 3.66. Distribution of *Medicago muricoleptis*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.44 *Medicago granadensis* Willd., Enum. Hort. Reg. Bot. Berol.: 803 (1809).

Synonyms: *Medicago granatensis* Willd. ex Ser. in DC. Prodr. 2: 180 (1825); *Medicago galilaea* Boiss., Diagn. Pl. Nov. 9: 10 (1849).
Annual, herb, 15-40(-70) cm, stem decumbent to ascending, branching at the ground level and over the ground level. Vegetative parts glabrous or densely pubescent, with glandular hairs. Stipules ovate, margin dentate to laciniate. Leaflet 10-23 x 5-14 mm, obovate to elliptical or obolanceolate, apex apiculate, dorsally glabrous, margins at apical part serrate. Peduncle with (1-)2-6 flowers, longer than the corresponding petiole, with terminal cusp. Flower 4-6.5 mm. Pedicle equal to the calyx tube, bract ± equalling the pedicel, calyx 2.5-3.5 mm, densely pubescent, with simple hairs, teeth ± equalling tube. Corolla yellow, standard obovate, at bud stage with a violet hue on the outer side, wings equal or slightly shorter than the keel. Pods coiled, glabrous, green-brown, 5-8 mm, barrel-shape, spiny. Coils 5-7, turning clockwise, loose, 7-12 mm diameter, size decreasing gradually towards first and last coil, with thin wall, veins 8-14, anastomosing in the outer part of the pod face, venation is a net of veins. Spines grooved to ± half their length, 1-2 mm, at two rows on a coil edge, 18-22 per row, inserted at 90 degree to the coil face, arching and interlocking with spines of adjacent coil. Seeds 3.3-4 x 2-2.5 mm, brown

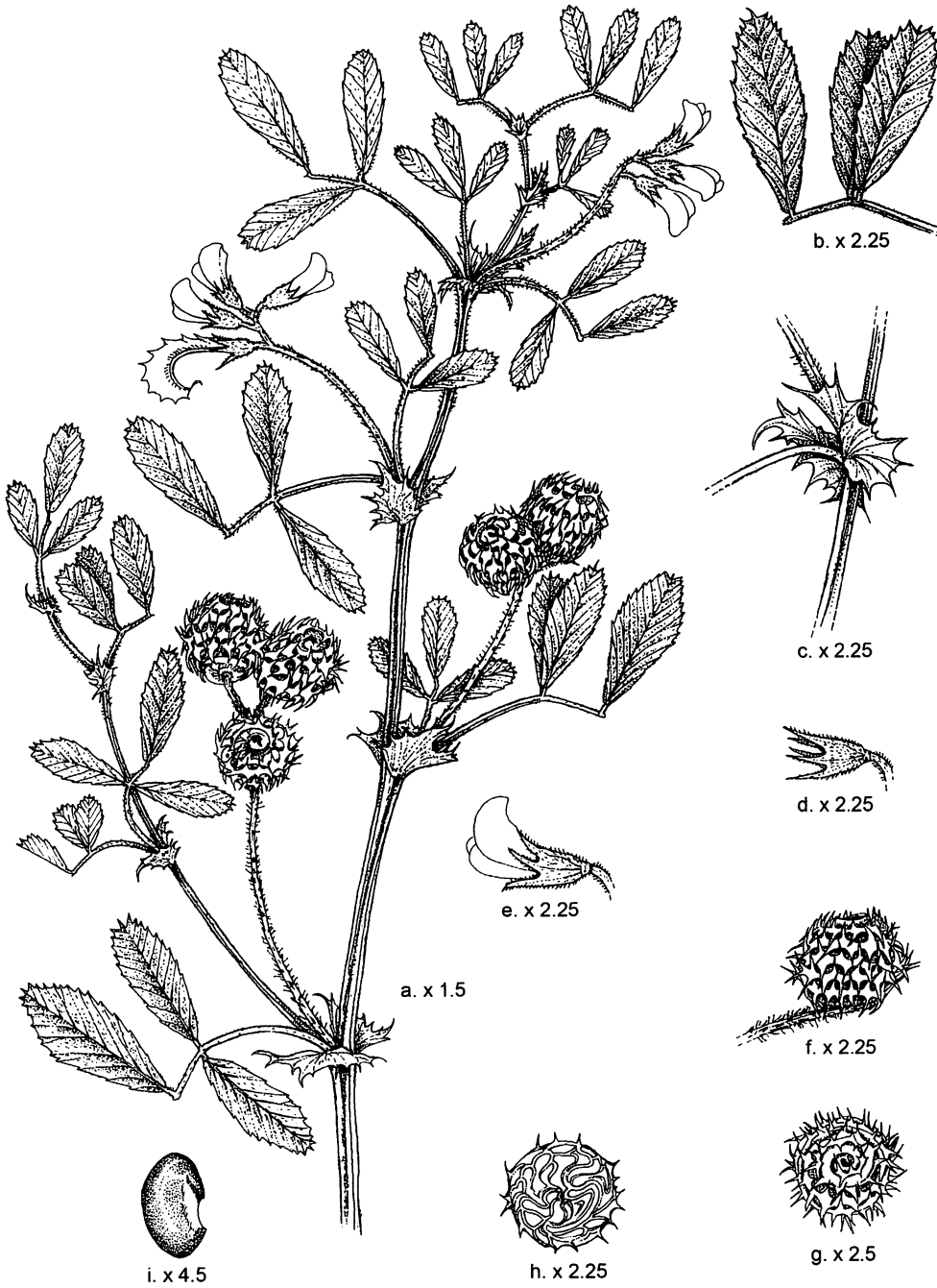

Figure 3.68. *Medicago granadensis*: a, habit (x 1.5), b, leaflet (x 2.25), c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 2.25), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 4.5).

or black, 3 per coil, separated, with thin spongy partition between them, radicle less than half seed length.

Chromosome number: 16.
Closely related species: This species is similar to *M. muricoleptis*, see it for distinction.
Habitat: In heavy soils, fallow fields and ditch sides.
Geographical distribution: Africa: Egypt (N), Tunisia (N). Europe: France (I), Spain (I), Turkey in Europe (N) Middle East: Israel-Jordan (N), Lebanon (N), Palestine (N), Syria (N), Turkey in Asia (N).
Conservation and threat assessment: Not threatened

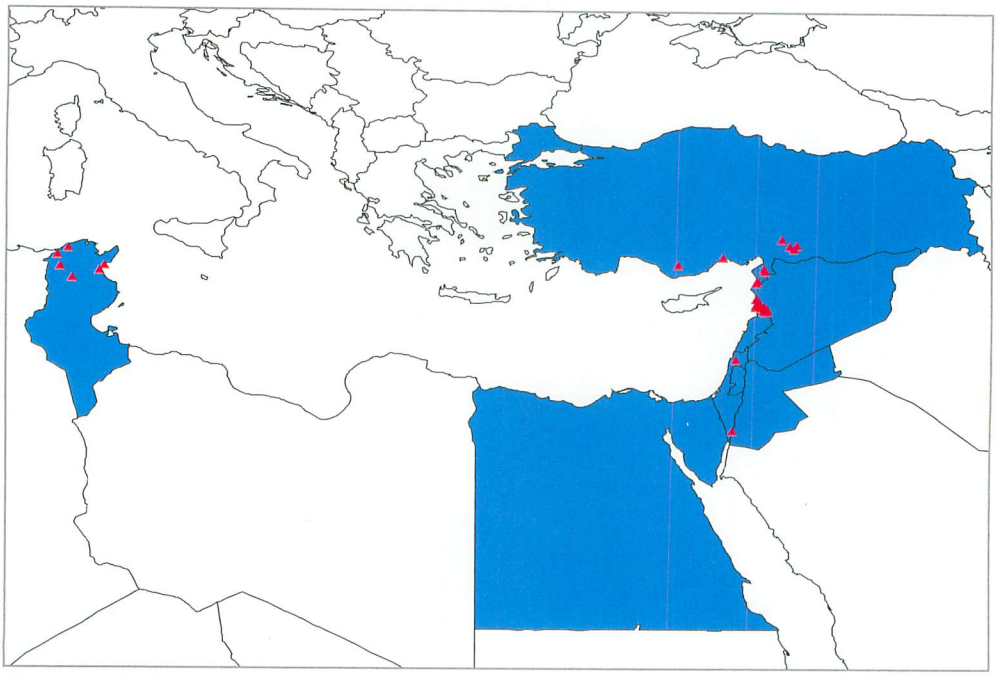

Figure 3.67. Distribution of *Medicago granadensis*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.45 *Medicago sauvagei* Nègre, Comptes Rendus Sèances Soc. Sci. Nat. Maroc 20: 175 (1945).

Annual, herb, 5-40 cm, stem decumbent to ascending, branching at the ground level. Vegetative parts glabrous or sparsely pubescent. Stipules lanceolate, margin dentate or incised. Leaflet 9-20 x 5-10 mm, obovate, apex truncate, base cuneate, margins at upper 2/3 serrate. Peduncle with 1-3 flowers, equal to the corresponding petiole, with terminal cusp. Flower (2-)4-7.5 mm. Pedicle shorter than or equal to

the calyx tube, bract shorter than the pedicel, calyx sparsely pubescent, with appressed simple hairs, shorter than half of the corolla, teeth shorter than tube. Corolla yellow, standard oval, wings considerably shorter than the keel. Pods coiled, glabrous, ash-grey, 5-6 mm, discoid, spiny. Coils 4-6, turning clockwise, loose, 7-10 mm diameter, size decreasing gradually towards first and last coil, last half coils spineless, veins 10-15, S shaped, branching near lateral outer vein, dorsal suture more prominent than the lateral veins. Spines with hooked or with straight tip, 1-2 mm, 23-26 per row, inserted at 135-180 degree to the coil face. Seeds 2.5 x 1.5-2.5 mm, brown to yellow, 1-3 per coil, coat smooth, separated, with thin membrane between them, radicle more than half seed length.

Chromosome number: 16.
Closely related species: It is most likely to be confused with the ubiquitous *M. polymorpha*, the coil face of which has much more reticulated venation and a submarginal vein much closer to the coil edge (Small and Jomphe, 1989).
Habitat: Red clay soils, hillsides and roadsides.
Geographical distribution: Africa: Morocco (N). Asia: Syria (N).
Conservation and threat assessment: Insufficiently known. This species is rarely found (Small and Jomphe, 1989)

Figure 3.69. Distribution of *Medicago sauvagei*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.46 *Medicago laciniata* (L.) Miller, Gard, Dict. ed. 8, *Medicago* no. 5 (1768).

Annual, herb, (5-)10-15(-35) cm, stem procumbent or ascending, branching at the ground level. Vegetative parts glabrous or densely pubescent, with simple hairs. Stipules ovate, margin dentate to laciniate. Leaflet 4-25 x 2-7 mm, obovate, apex truncate to retuse, base cuneate, dorsally glabrous, ventrally densely pubescent, margins at upper third serrate or laciniate. Peduncle with 1-2(-3) flowers, shorter or equal or longer than the corresponding petiole, with terminal cusp. Flower 3-6.5 mm. Pedicle shorter than the calyx tube, bract ± equalling the pedicel, calyx 2-3 mm, densely pubescent, with simple appressed hairs, shorter than half of the corolla, teeth shorter than tube. Corolla yellow, standard oval, wings shorter than the keel. Pods coiled, glabrous or sparsely pubescent (rarely), brown to yellow, 3-8(-10) mm, cylindrical or ovoid or spherical, spiny. Coils 3-7, turning clockwise, (2.5-)3-5(-6) mm diameter, veins 6-16, running to a protruding lateral vein, S shaped, grooves not observable from pod side deep narrow between lateral vein and dorsal suture, dorsal suture steeply elevated in the middle of the coil edges. Spines with the longer often with hooked tip, grooved base, 1-4 mm, 8-16 per row, inserted at 90-180 degree to the coil face. Seeds 2.3-3 x 1.2-1.5 mm, brown to yellow, 1-2 per coil, coat smooth, not separated radicle more than half seed length.

Chromosome number: 16.
Closely related species: It is likely to be misidentified as *M. minima*, which has much hairy foliage, much less dissected stipules, and a sub-marginal vein more remote from the coil margin. *M. laciniata* has notably S-shaped radial veins, little anastomosed.
Habitat: Grassland, pastures, dry river and wadi beds, beaches, cultivated and fallow fields, rocky slopes and hills, valley bottoms, sand dunes, desert and semi-desert.
Geographical distribution: Africa: Algeria (N), Botswana (N), Canary Is (N), Djibouti (U), Egypt (N), Ethiopia (N), Kenya (N), Lesotho (N), Libya (N), Madeira (N), Morocco (N), Namibia-ISO (I), Socotra (N), Somalia (N), South Africa (I), Tanzania (N), Tunisia (N), Western Sahara (N). Asia: Afghanistan (N), India (N), Iran (N), Iraq (N), Pakistan (N). Europe: Corsica (I), Estonia (I), France (N), Italy (N), Spain (I), Ukraine (I). India: Gujarat, Jammu-Kashmir, Punjab, Rajasthan, Uttar Pradesh. Middle East: Bahrain (N), Israel (N), Jordan (N), Palestine (N), Kuwait (N), Lebanon-Syria (N), Saudi Arabia (N), Sinai (N). North America: Canada (U), United States (U). Ukraine: Sumy.
Conservation and threat assessment: Not threatened.
Actual and potential usage: Found to have superior seed yields under adverse conditions of late sowing and grazing (Young et al., 1994). This is useful as an annual forage crop.

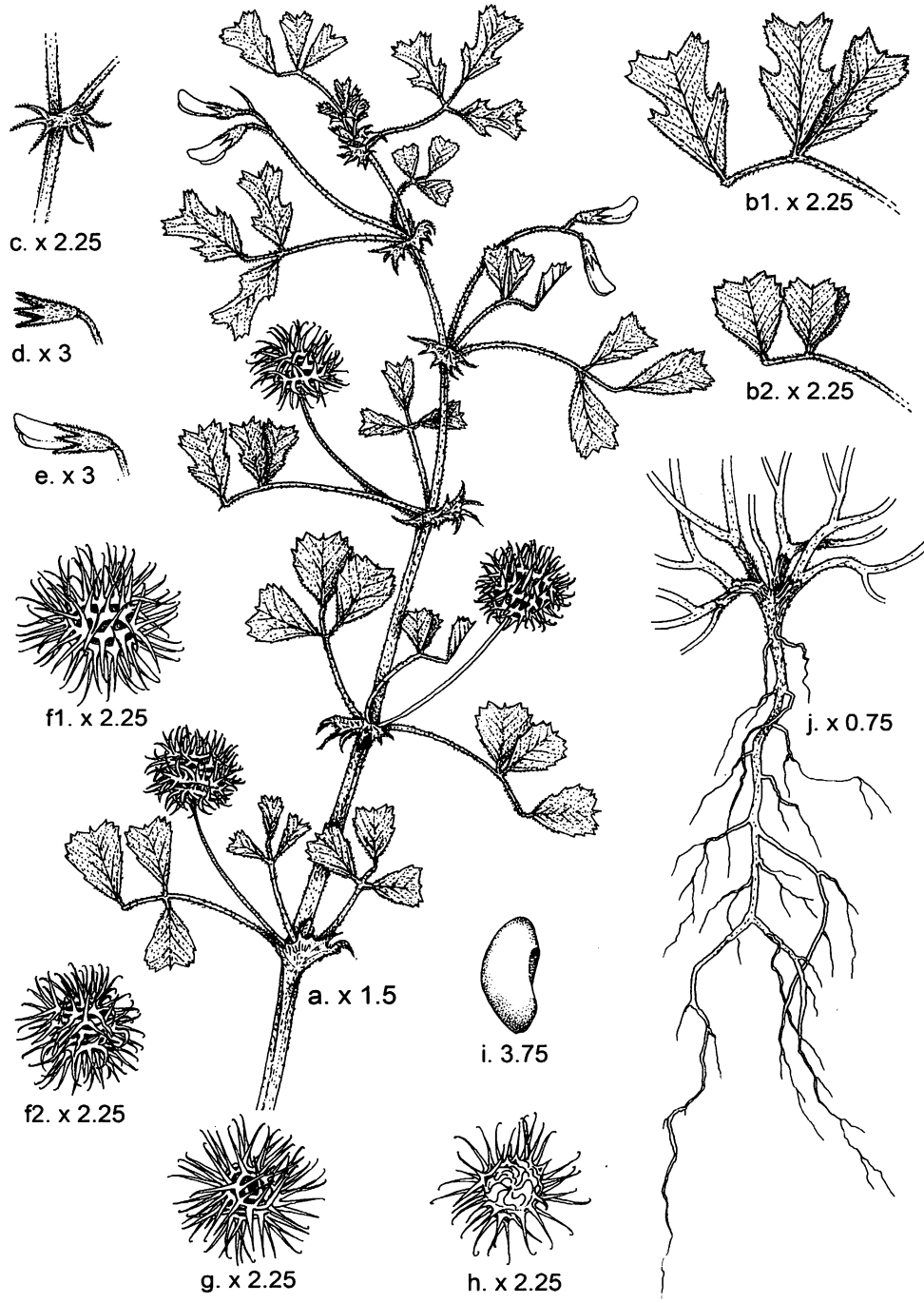

Figure 3.71. *Medicago laciniata*: a, habit (x 1.5), b1, leaflet (x 2.25), b2, leaflet (x 2.25), c, stipule (x 2.25), d, calyx (x 3), e, flower (x 3), f1-f2, pod three dimension view (x 2.25), g, pod tip view (x 2, 25), h, pod venation (x 2.25), i, seed (x 5), j, roots and stem habit (x 0.75).

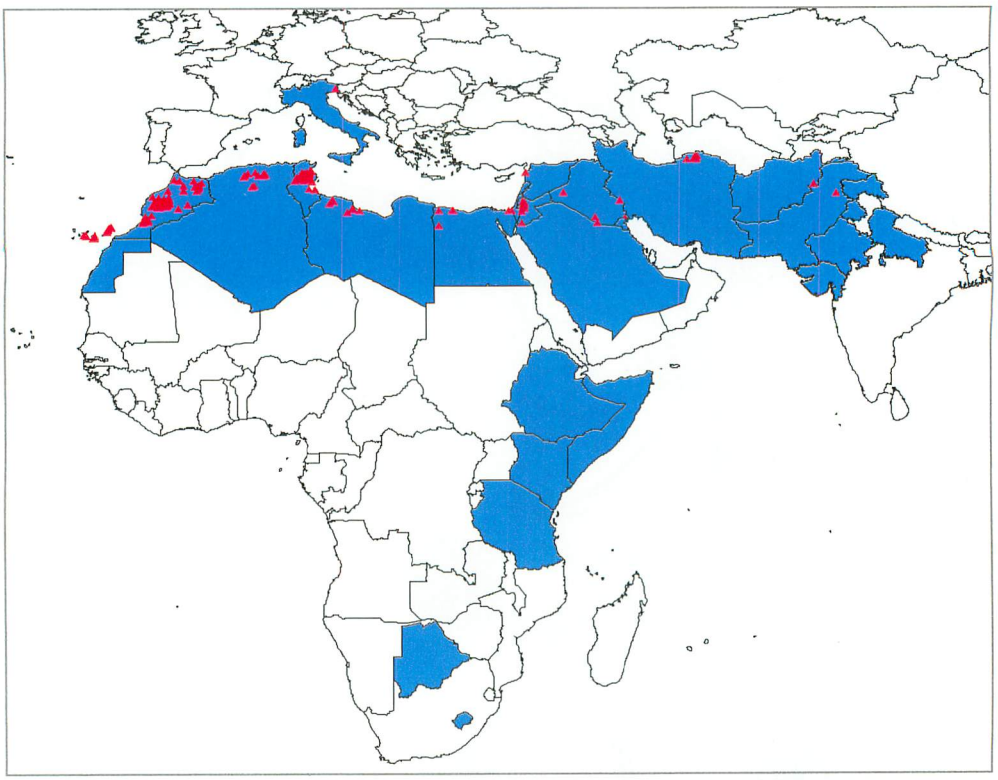

Figure 3.70. Distribution of *Medicago laciniata*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.47 *Medicago minima* (L.) L., Fl. Angl.: 21 (1754).

Synonyms: *Medicago polymorpha* var. *minima* L. Sp. Pl.: 780 (1753); *Medicago hirsuta* (L.) Bart. Cat. Paiant. Siena: 61 (1776); *Medicago hirsuta* (L.) All., Fl. Pedem. 1: 315 (1785); *Medicago mollissima* Roth, Cat. Bot. Abh. Beobacht.: 49 (1787); *Medicago recta* (Desf.) Willd. Sp. Pl. 3: 1415 (1802); *Medicago minima* (L.) Bartal. subsp. *brevispina* Benth., Sowerby Engl. Bot. Suppl. 1: 2638 (1831); *Medicago pulchella* Lowe, Trans. Cambr. Phil. Soc. 6: 547 (1838); *Medicago minima* (L.) Bartal. subsp. *ononidea* de Coincy ex Rouy in Rouy & Fouc. Fl. France 5: 40 (1899).
Annual, herb, (5-)10-60(-90) cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with simple hairs or glandular hairs or simple and glandular hairs. Stipules lanceolate, margin entire or dentate. Leaflet 5-8(-14) x 2-8 mm, obovate, apex rarely emarginate, margins at upper third serrate. Peduncle with 1-7 flowers, flowers gathered in a spike-like raceme, shorter or longer than the corresponding petiole, with or without terminal cusp. Flower 3-6

mm. Pedicle shorter than the calyx tube, bract ± equalling the pedicel, calyx densely pubescent, equalling half of the corolla, teeth ± equalling tube. Corolla yellow, standard obovate, with obcordate apex, wings usually slightly shorter than the keel. Pods coiled, at maturity densely pubescent, with simple and glandular hair, brown, 3-5 mm, discoid or cylindrical to ovoid, spiny or spineless (or with short prickles). Coils 3-5, turning clockwise, loose, 2.5-4(-6) mm diameter, size of the last one smaller than the first, with thin wall, first coil seedless, veins 5-8, entering the lateral vein at 60-70% of radius from the centre, S shaped, grooves wide shallow change to quadrangular between lateral vein and dorsal suture. Spines irregular shape, with hooked tip, grooved to 2/3 from the base, twice as long as the pod diameter 5-12 mm, inserted at 180 degree to the coil face. Seeds 1.7-2.5 x 1-1.3 mm, yellow, 1-2 per coil, coat smooth, separated, with thin membrane between them, radicle more than half seed length.

Chromosome number: 16.
Closely related species: It is most frequently confused with the preceding species, *M. laciniata*, which has less hairy foliage, more dissected stipules, and a sub-marginal vein adjacent to the coil margin. *M. laciniata* also has notably S-shaped radial veins, little anastomosed. *M. minima* produces many small pods with relatively long, soft spines that adapt to animal dissemination.
Habitat: Grows in diverse habitats, moist grassy banks, woodland edges, rocky limestone slopes, steppe, sand dunes, cultivated land, maquis, open coniferous woodland, pasture, and cliff tops. Tolerant of heavy grazing but likes dry soils.
Geographical distribution: Africa: Algeria (N), Canary Is (N), Djibouti (N), Egypt (N), Ethiopia (N), Libya (N), Morocco (N), Socotra (U), Somalia (N), South Africa (I), Sudan (N), Tunisia (N). Asia: Afghanistan (N), Armenia (N), Azerbaijan (N), China (N), Georgia (N), India (N), Iran (N), Iraq (N), Japan (I), Kazakhstan (N), Kirgizstan (N), Pakistan (N), Russia in Asia (N), Tadzhikistan (N), Turkmenistan (N), Uzbekistan (N). Australasia: Australia (I), Tasmania (I). Australia: Australian Capital Territory, New South Wales, Queensland, Victoria, Western Australia. Azerbaijan: Azerbaijan, Nakhichevan. Belarus: Brest, Minsk. Europe: Albania (N), Austria (N), Balearic Is (N), Belarus (I), Belgium (N), Bulgaria (N), Corsica (N), Crete (N), Czech Republic and Slovakia (N), Denmark (N), Estonia (I), former Yugoslavia (N), France (N), Germany (N), Great Britain (N), Greece (N), Hungary (N), Italy (N), Liechtenstein (N), Luxembourg (N), Malta (N), Moldova (N), Netherlands (N), Poland (N), Portugal (N), Romania (N), Russia in Europe (N), Sardinia (N), Sicily (N), Spain (N), Sweden (N), Switzerland (N), Turkey in Europe (N), Ukraine (N). Georgia: Abkhazia, Adzharia, Georgia. India: Jammu-Kashmir, Punjab. Kazakhstan: Alma-Ata, Chimkent, Dzhambul, Mangyshlak. Kirgizstan: Frunze, Issyk-Kul, Osh. Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel-Jordan (N), Lebanon (N), Palestine (N), Saudi Arabia (N), Sinai (N), Syria (N), Turkey in Asia (N). North America: United States (I). Pacific Ocean: Hawaii (I), New Zealand (North) (I), New Zealand (South) (I). Russia in Asia: Checheno-Ingushetia, Dagestan, Kabardino-Balkaria, Karacheyevo-Cherkessia, Krasnodar, Kurgan, Primorye, Severo-Osetia, Stavropol. Russia in Europe:

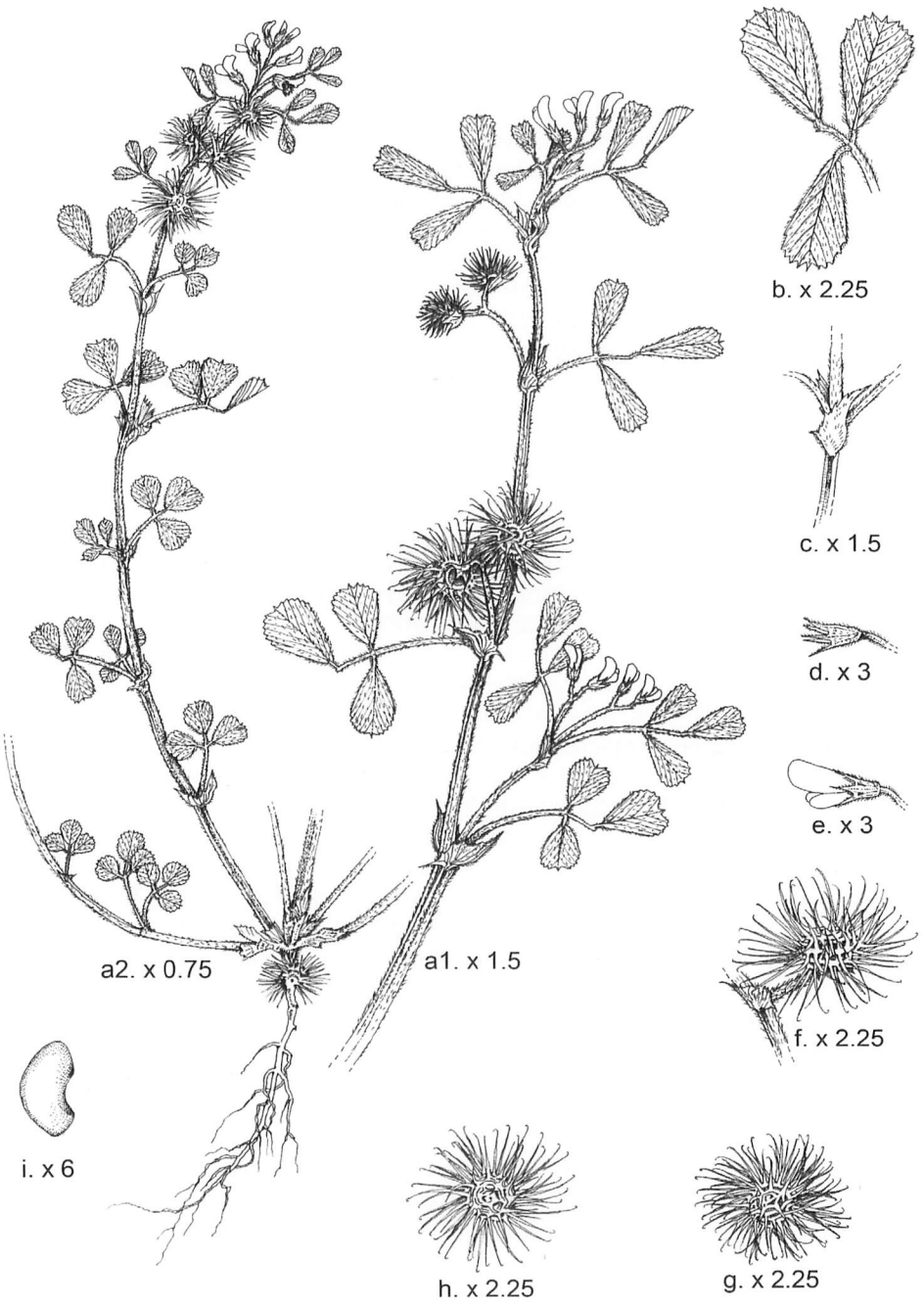

Figure 3.73. *Medicago minima*: a1, habit (x 1.5), a2, roots and stem habit (x 0.75), b, leaflet (x 2.25), c, stipule (x 1.5), d, calyx (x 3), e, flower (x 3), f, pod three dimension view (x 2.25), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 6).

Astrakhan, Bryansk, Orel, Rostov-Don, Saratov, Tataria, Volgograd, Voronezh. Tadzhikistan: Dushanbe, Gorno-Badakshan, Kulyab, Kurgan-Tyube, Leninabad. Turkmenistan: Ashkhabad, Chardzhou, Krasnovodsk, Mary, Tashauz. Ukraine: Dnepropetrovsk, Donetsk, Kherson, Khmelnitski, Kiev, Kirovograd, Krym, Odessa, Vinnitsa. United States: California, Oklahoma, Oregon, Texas. Uzbekistan: Fergana, Kashkadarinskaya, Khorezm, Samarkand, Surhandarinskaya, Tashkent.
Conservation and threat assessment: Not threatened
Actual and potential usage: Forage. This species can survive under unfavourable condition (e.g. drought) and exploit rain when it became available (Fedorenko et al., 1995).

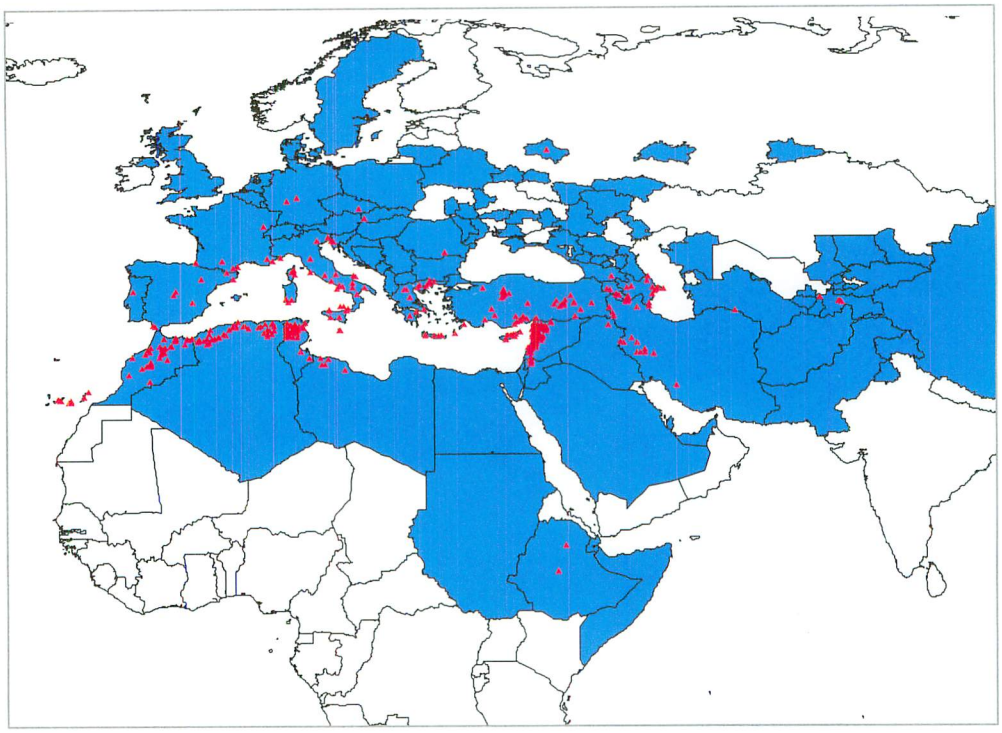

Figure 3.72. Distribution of *Medicago minima*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.48 *Medicago praecox* DC., Cat. Pl. Hort. Monsp.: 123 (1813).

Synonyms: *Medicago pontificalis* Gennari, Nouvo Giorn. Bot. Ital. 2: 132 (1870).
Annual, herb, (5-)10-20(-50) cm, stem decumbent to ascending, branching at the

ground level. Vegetative parts densely pubescent, with simple hairs. Stipules acuminate. Leaflet 2-7(-12) x 2-13 mm, obovate, apex truncate, dorsally glabrous (more or less), ventrally densely pubescent, margins in its apical part serrate. Peduncle with few-flowered 1-2 flowers, shorter than the corresponding petiole, without terminal cusp. Flower 3-4 mm. Pedicle shorter than the calyx tube, bract longer than the pedicel, calyx densely pubescent, with simple hairs, slightly longer than half of the corolla, teeth shorter than tube. Corolla yellow, standard with rounded apex, wings shorter than the keel. Pods coiled, at maturity glabrous or rarely pubescent with simple and glandular hairs, dark brown, 2-4(-5) mm, not subterranean, cylindrical to ovoid, spiny. Coils 2.5-4(-5), turning clockwise, loose, 2-4.2 mm diameter, veins 8-10, strongly curved, anastomosing before entering lateral vein, venation is a net of veins, grooves deep narrow between lateral vein and dorsal suture. Spines with hooked tip, grooved till ± half their length to 2/3 of their length from the base, 1.5-3 mm, at two rows on a coil edge, 10-12 per row, inserted at 90-130 degree to the coil face. Seeds 2- 2.8 x 1-1.3 mm, brown to yellow, 1-2 per coil, coat smooth, separated, with thin membrane between them, radicle equalling half seed length.

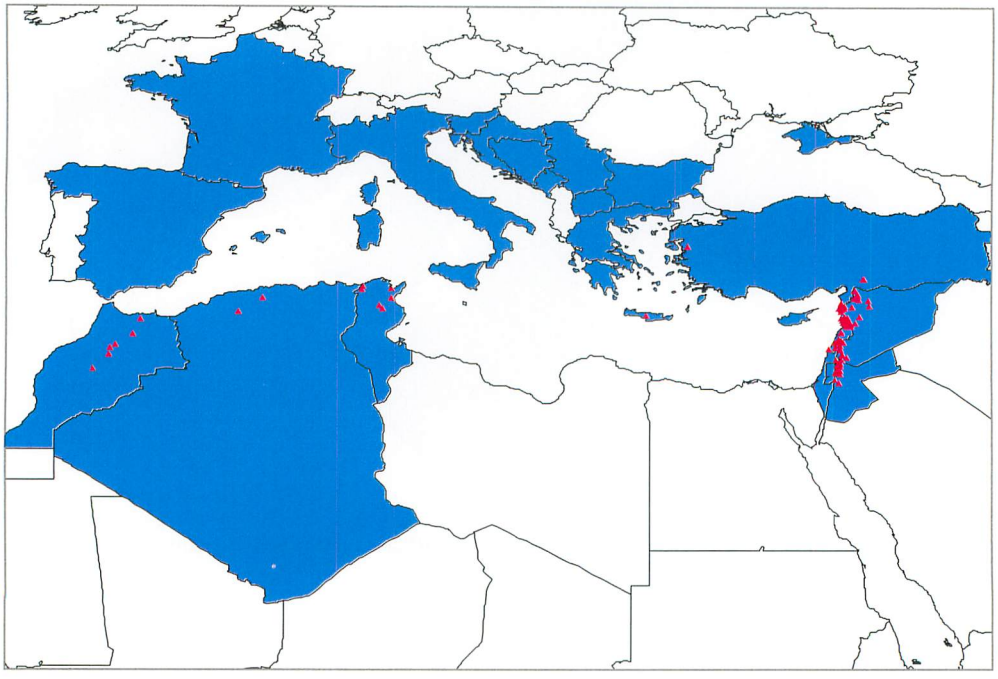

Figure 3.74. Distribution of *Medicago praecox*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

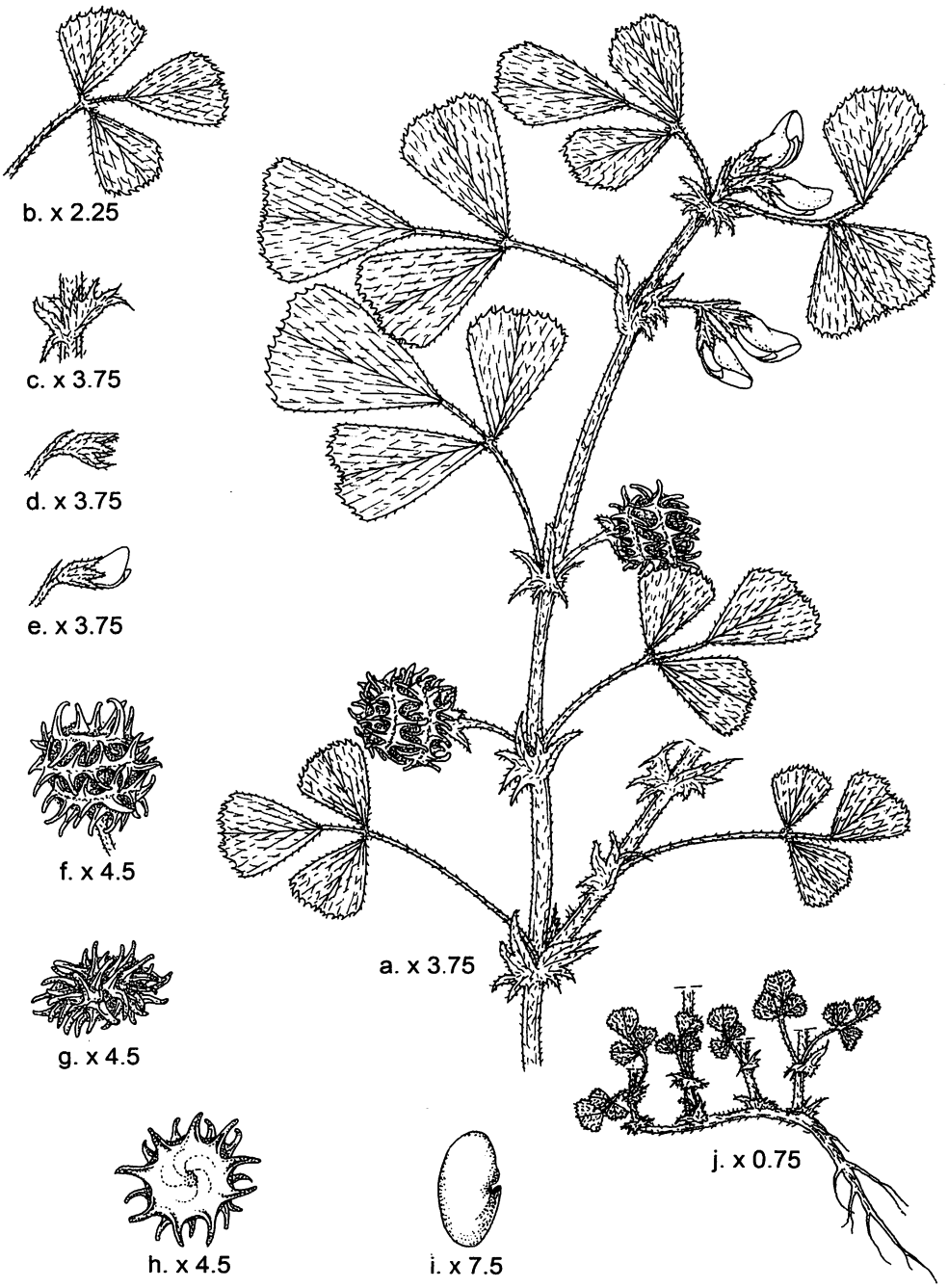

Figure 3.75. *Medicago praecox*: a, habit (x 3.75), b, leaflet (x 2.25), c, stipule (x 3.75), d, calyx (x 3.75), e, flower (x 3.75), f, pod three dimension view (x 4.5), g, pod tip view (x 4.5), h, pod venation (x 4.5), i, seed (x 7.5), j, root and stem habit (x o.75).

Chromosome number: 14.
Closely related species: This species can be confused with *M. coronata* but *M. praecox* normally has less than three flowers per raceme whereas *M. coronata* usually has from 6-12.
Habitat: Hillsides, among rocks, fields and grows in dry sandy, rocky infertile soils.
Geographical distribution: Africa: Algeria (N), Morocco (N), Tunisia (N). Asia: China (I). Europe: Balearic Is (N), Bulgaria (N), Corsica (N), Crete (N), former Yugoslavia (N), France (N), Greece (N), Italy (N), Sardinia (N), Spain (N), Ukraine (N). Middle East: Cyprus (N), East Aegean Is (Greek) (N), Lebanon-Syria (N), Turkey in Asia (N), North America: United States (I). Ukraine: Krym. United States: California.
Conservation and threat assessment: Not threatened

3.49 *Medicago coronata* (L.) Bartal., Cat. Piante Siena: 61 (1776).

Synonyms: *Medicago polymorpha* var. *coronata* L., Sp. Pl.: 780 (1753); *Medicago vermicularis* Cesati. in Friedrichsthal, Reise Neu-Griechenl.: 274. (1838).
Annual, herb, (5-)7-25(-60) cm, stem ascending to erect. Vegetative parts densely pubescent, with simple hairs or simple and glandular hairs. Stipules ovate, margin entire or dentate to laciniate. Leaflet 5-12 x 2-6(-12) mm, obovate, apex truncate to retuse, base cuneate, margins serrate to dentate. Peduncle with (3-)6-12(-16) flowers, flowers gathered in a compact raceme, several times longer than the corresponding petiole, with terminal cusp. Flower 2-5 mm. Pedicle equal to the calyx tube, bract shorter than the pedicel, calyx 1.8-2 mm, densely pubescent, with simple hairs or simple and glandular hairs, teeth shorter or rarely longer than tube. Corolla yellow, standard obovate, wings about the length of the keel. Pods coiled, at maturity glabrous or densely pubescent, with simple hair or simple and glandular hairs, green-brown, 1-4 mm, short cylindrical, spiny. Coils 1-3, turning clockwise, loose, 1.5-4 mm diameter, veins 5-8, curved, branching near lateral outer vein, grooves deep narrow between lateral vein and dorsal suture, dorsal suture is a shallow depression in the middle of the edge. Spines giving a crown-like appearance, conical, with the longest with hooked tip, 1-2.7 mm, at two rows on a coil edge, 10-15 per row, inserted at about 90 degree to the coil face. Seeds 2-2.5 x 1 mm, brown to yellow, bow-shaped, 1-2 per coil, coat smooth, separated, with thin membrane between them, radicle more than half seed length.

Chromosome number: 16.
Closely related species: This species is easily distinguishable and not likely to be confused except with *M. praecox* which normally has less than three flowers per raceme whereas *M. coronata* usually has from 6-12.
Habitat: Stony plains, hillsides, often on limestone, maquis, dry meadows, pastures, fallow fields, steppe, dunes and garrigue, resistance to trampling and grazing, and often associated with calcareous soils.
Geographical distribution: Africa: Egypt (N), Libya (N) Asia: Iran (N), Iraq (N), USSR (U) Europe: Albania (N), Bulgaria (N), Corsica (N), Crete (N), former Yugoslavia (N),

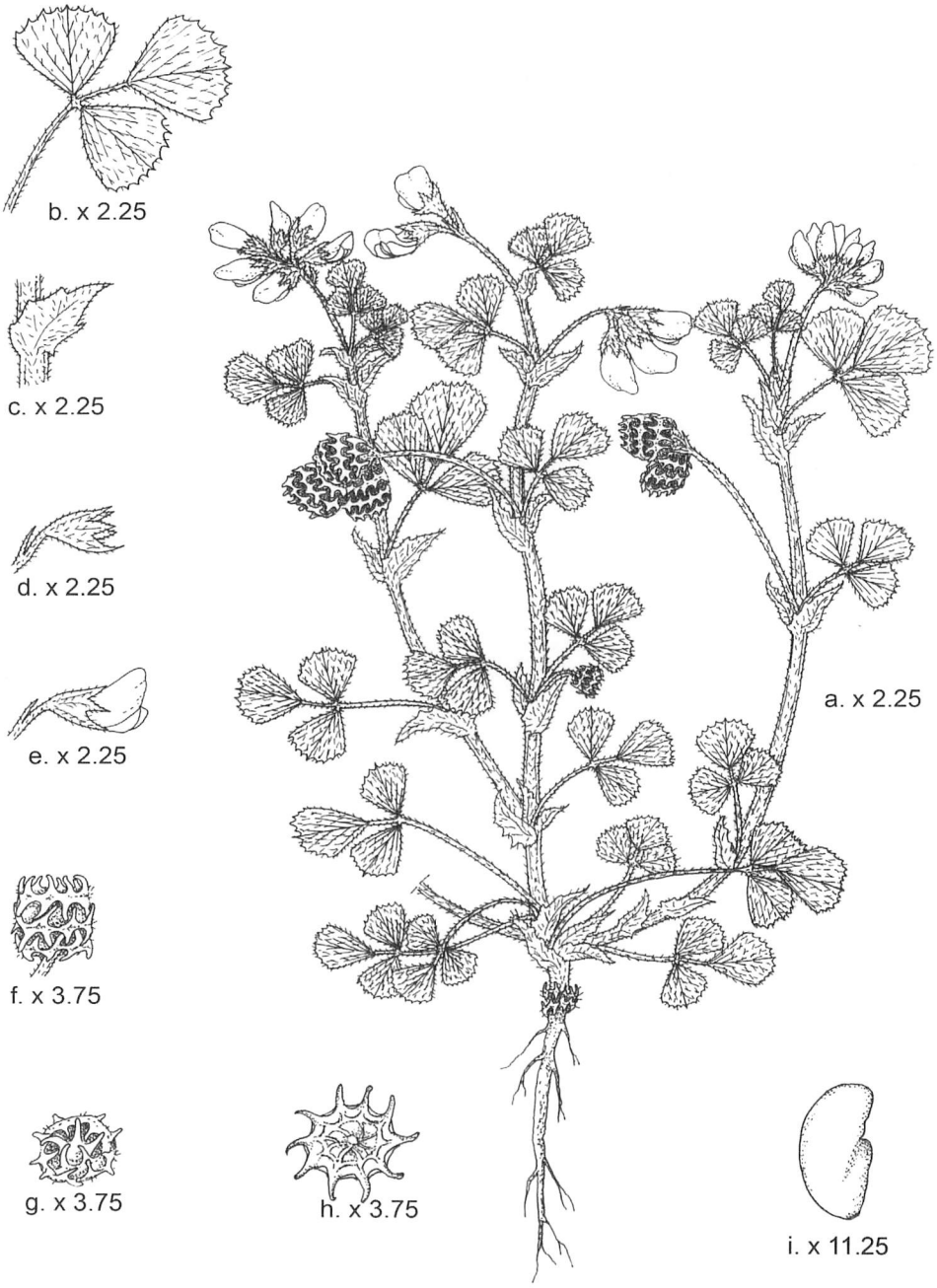

Figure 3.77. *Medicago coronata*: a, habit (x 2.25), b, leaflet (x 2.25), c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 3.75), g, pod tip view (x 3.75), h, pod venation (x 3.75), i, seed (x 11.25).

France (N), Greece (N), Italy (N), Portugal (I), Sicily (N), Spain (N), Turkey in Europe (N) Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel (N), Sinai (N), Syria (N), Jordan (N), Lebanon (N), Palestine (N), Turkey in Asia (N). Turkmenistan: Ashkhabad (U).

Conservation and threat assessment: Not threatened

Figure 3.76. Distribution of *Medicago coronata*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.50 *Medicago polymorpha* L., Sp. Pl.: 779 (1753).

Synonyms: *Medicago nigra* (L.) Krocker. Fl. Siles. 2(2): 244 (1790); *Medicago hispida* Gaertner. De Fruct. Sem. Pl. 2: 349 (1791); *Medicago lappacea* Desr. in Lam., Encycl. Method. 3: 637 (1792); *Medicago apiculata* Willd. Sp. Pl. 3: 1414 (1802); *Medicago denticulata* Willd. Sp. Pl. 3: 1414 (1802); *Medicago terebellum* Willd., Sp. Pl. 3: 1416 (1802); *Medicago pentacycla* DC., Cat. Pl. Hort. Monsp.: 124 (1813); *Medicago reticulata* Benth, Cat. Pl. Pyrénées: 101 (1826); *Medicago polycarpa* Willd. var. denticulata Godr. in Gren. & Godr., Fl. France 1: 390 (1848); *Medicago loretii* Albert, Bull. Herb. Boiss. 1 app. 1: 13 (1893); *Medicago polycarpa* subsp. *retic-*

ulata (Benth.) Coste, Fl. Descr. France 3: 719 (1906); *Medicago polycarpa* subsp. *polymorpha* (L.) Cadev. & Sall, Fl. Catalunya 2: 85 (1913); *Medicago polymorpha* L. subsp. *hispida* (Gaertner) Ponert, Feddes Repert 83: 639 (1973); *Medicago polymorpha* L. subsp. *lappacea* (Desr.) Bonafè, Fl. Mallorca 3: 39 (1979); *Medicago polymorpha* L. subsp. *polycarpa* Romero Zarco, Lagascalia 14: 146 (1986).
Annual, herb, 15-70 cm, stem branching at the ground level. Vegetative parts nearly glabrous. Stipules triangular to acuminate, margin laciniate. Leaflet 8-20 x 7-15(-20) mm, obovate, apex retuse or emarginate (some times), base cuneate or obtuse, ventrally densely pubescent, margins at apical part serrate. Peduncle with 1-10 flowers, shorter or equal to or longer than the corresponding petiole, with or without terminal cusp. Flower 3.5-6 mm. Pedicle shorter than the calyx tube, bract longer than the pedicel, calyx densely pubescent, with simple hairs, shorter than or equalling half of the corolla, teeth ± equalling tube. Corolla yellow, standard obovate, with emarginate apex, wings longer than the keel. Pods coiled, glabrous, black to ash-grey, 2-12 mm, discoid or cylindrical or conical-truncate, spiny or spineless or with tubercles. Coils 1.5-7, turning clockwise, appressed, 3.5-10 mm diameter, veins 6-10, curved, anastomosing before entering lateral vein, more three grooves between lateral vein and dorsal suture. Spines if present slender, fine or stocky, thick, grooved, with the longest with hooked tip, 0.5-4 mm, at two rows on a coil edge, 15-17 per row, inserted at 90-180 degree to the coil face. Seeds 2.5-4 x 1.5-2.2 mm, brown, 1-2 per coil, coat smooth, separated, with thin membrane between them, radicle equalling half seed length.

Chromosome number: 14.
Closely related species: The species most often confused with other species, especially *M. laciniata*.
Habitat: Widely introduced and adventive elsewhere where not limited by cold, drought, and water logging of soil. Habitats include: salt-marsh, dunes, fields, dry meadows, foothills, garrigue and desert.
Geographical distribution: Africa: Algeria (N), Canary Is (N), Djibouti (N), Egypt (N), Ethiopia (N), Kenya (U), Libya (N), Madeira (N), Morocco (N), Socotra (N), South Africa (I), Tanzania (U), Tunisia (N). Asia: Afghanistan (N), Azerbaijan (N), China (N), Georgia (N), India (N), Iran (N), Iraq (N), Kazakhstan (N), Kirgizstan (N), Nepal (N), Pakistan (N), Philippines (I), Russia in Asia (N), Tadzhikistan (N), Taiwan (N), Turkmenistan (N), Uzbekistan (N), Vietnam (I). Australasia: Australia (I), Tasmania (I). Australia: Australian Capital Territory, New South Wales, Northern Territory, Queensland, South Australia, Victoria, Western Australia. Azerbaijan: Azerbaijan. Belarus: Brest, Gomel, Minsk, Mogilev. Caribbean: Dominican Republic (I). Central America: Costa Rica (I), Mexico (North and Central) (I), Mexico (South East) (I). China: Gansu, Guizhou, Yunnan. Europe: Albania (N), Austria (N), Azores (N), Balearic Is (N), Belarus (I), Belgium (I), Bulgaria (N), Corsica (N), Crete (N), Czech Republic and Slovakia (I), Estonia (I), former Yugoslavia (N), France (N), Germany (N), Great Britain (N), Greece (N), Hungary (I), Italy (N), Latvia (I), Malta (N), Netherlands (I), Portugal (N), Romania (N), Russia in Europe (I), Sardinia (N), Sicily

(N), Spain (N), Switzerland (I), Turkey in Europe (N), Ukraine (N). Georgia: Abkhazia, Adzharia, Georgia. India: Bihar, Delhi, Gujarat, Haryana, Himachal Pradesh, Madhaya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal. Indian Ocean: Mauritius (I), Reunion (I). Kazakhstan: Chimkent. Kirgizstan: Osh. Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel (N), Jordan (N), Kuwait (U), Lebanon (N), Palestine (N), Saudi Arabia (U), Sinai (N), Syria (N), Turkey in Asia (N), Yemen (U). North America: Canada (I), United States (I). Pacific Ocean: Chatham Is (I), Hawaii (I), Kermadec Is (I), New Zealand (North) (I), New Zealand (South) (I), Northern Marianas (I). Russia in Asia: Dagestan, Krasnodar. Russia in Europe: Bryansk, Orel. South America: Argentina (I), Bolivia (I), Brazil (I), Chile (I), Ecuador (I), Peru (I), Uruguay (I), Venezuela (I). Tadzhikistan: Dushanbe, Gorno-Badakshan, Kulyab, Kurgan-Tyube, Leninabad. Turkmenistan: Ashkhabad, Krasnovodsk, Mary. Ukraine: Krym. United States: Arizona, California, Texas. Uzbekistan: Kashkadarinskaya, Surhandarinskaya, Tashkent.

Conservation and threat assessment: Not threatened

Actual and potential usage It is a common weed in gardens and cultivated lands but can be used environmentally to help prevent soil erosion. Also used as a food and drink, for medicine and as a forage.

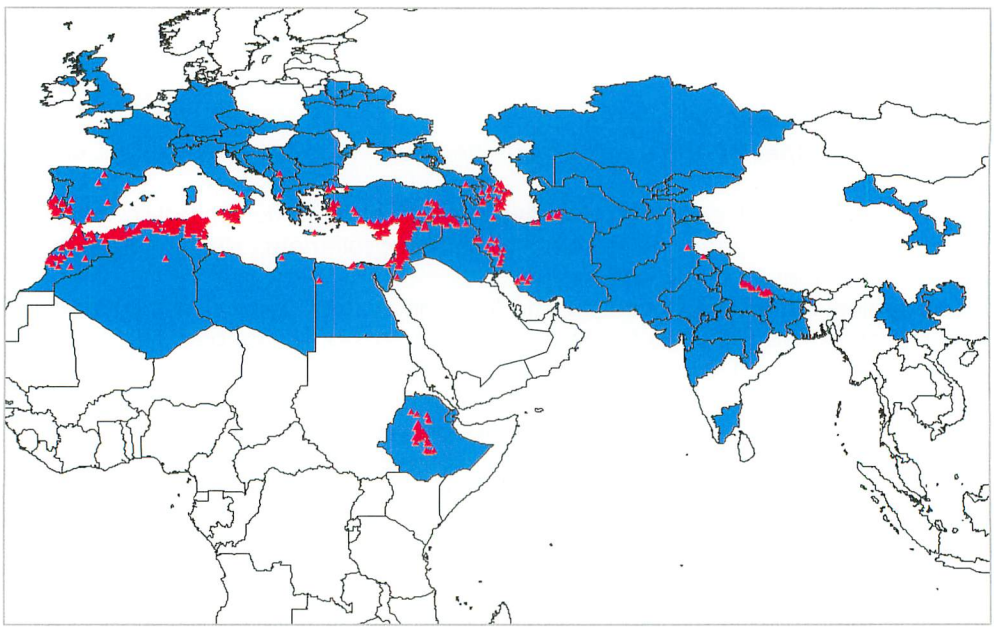

Figure 3.78. Distribution of *Medicago polymorpha*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

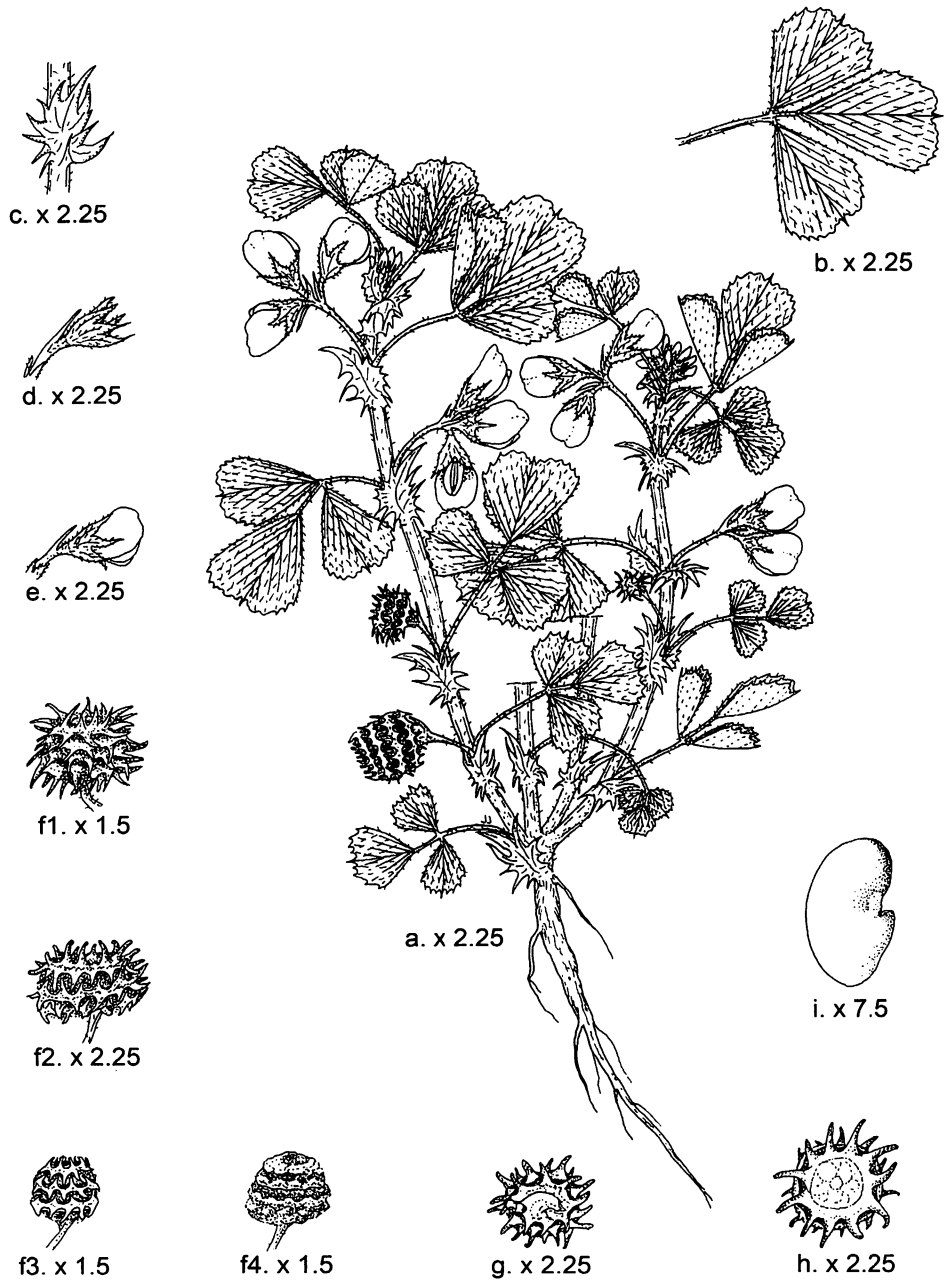

Figure 3.79. *Medicago polymorpha*: a, habit (x 2.25), b, leaflet (x 2.25), c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f1-f3, pod three dimension view (x 1.5), f4, spineless pod three dimension view (x 1.5), g, pod tip view (x 2.25), h, pod venation (x 2.25), i, seed (x 7.5).

3.51 *Medicago laxispira* C.C. Heyn. Fl. Iranica, 266 (1984).

Annual, herb, 20-40 cm, stem decumbent. Vegetative parts glabrous. Stipules lanceolate, margin laciniate. Leaflet 10-15 x 5-10 mm, apex retuse, base cuneate, ventrally densely pubescent, margins serrate. Peduncle with 1-2 flowers. Flower 2-3 mm. Pedicle shorter than the calyx tube, bract shorter than the pedicel, calyx densely pubescent, with simple hairs, shorter than or equalling half of the corolla, teeth ± equalling tube. Corolla yellow, wings longer than the keel. Pods coiled, glabrous, black to ash-grey, 6 mm, not subterranean, cylindrical, spiny, face reticulate, centre with no opening. Coils 3.5-4.5, turning clockwise, loose, 5-6 mm diameter, flat, veins 6-10, curved, anastomosing in the outer part of the pod face, venation darker than the middle of the coil, vein-less zone about 10%-20% of radius, no grooves between lateral vein and dorsal suture. Spines triangular flattened, slender, fine or stocky, thick, with hooked tip, 1-1.5 mm, at two rows on a coil edge, inserted at 90-130 degree to the coil face. Seed 2-3.5x1.5-2.5 mm, brown, 1-2 per coil, coat smooth.

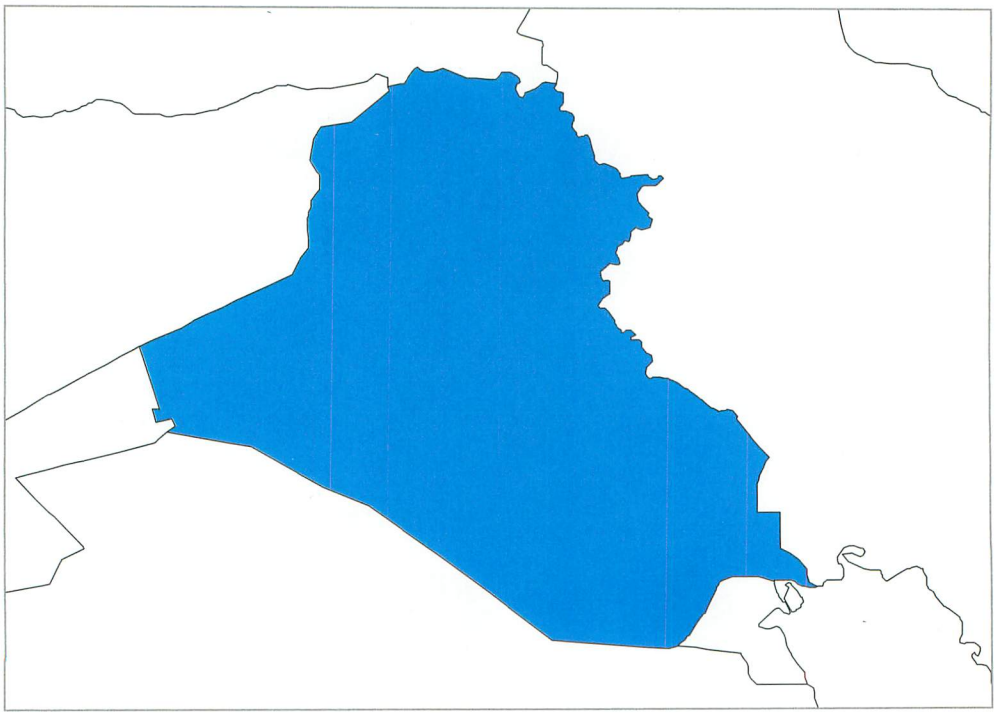

Figure 3.80. Distribution of *Medicago laxispira*. (shading represents native distribution).

Closely related species: It is resembles *M. polymorpha*, and requires careful study to confirm its distinctness (Small and Jomphe, 1989).
Habitat: Described by Heyn (1984) on the basis of three collections from Iraq.
Geographical distribution: Asia: Iraq.

3.52 *Medicago arabica* (L.) Hudson, Fl. Angl.: 288 (1762).

Synonyms: *M. cordata* Desr. in Lam., Encycl. 3: 636 (1792); *M. maculata* Sibth., Fl. Oxon.: 232 (1794); *M. maculata* Willd., Sp. Pl. 3: 1412 (1802); *M. polymorpha* L. var. *arabica* L. Sp. Pl.: 780 (1753).
Annual, herb, 20-65 cm, stem decumbent, branching at the ground level. Vegetative parts densely pubescent, with defuse, simple hairs or simple and glandular hairs. Stipules margin dentate or incised. Leaflet 10-25 x 10-25(-32) mm, obovate, apex retuse to emarginate, base cuneate or obcordate, dorsally glabrous, ventrally densely pubescent, margins apical half serrate, with anthocyanin-coloured patch in the middle. Peduncle with (1-)2-5(-6) flowers, equal to the corresponding petiole, with terminal cusp. Flower 5-6.5 mm. Pedicle shorter than the calyx tube, bract ± equalling or longer than the pedicel, calyx 2.5-3 mm, densely pubescent, with simple or glandular appressed hairs, equalling half of the corolla, teeth ± equalling tube. Corolla yellow, standard oval, wings shorter than the keel. Pods coiled, at maturity glabrous, brown, 5-7 mm, discoid to cylindrical to spherical, spiny or spineless or with tubercles (rare). Coils 3-5(-7), turning clockwise, appressed, 3.5-7 mm diameter, at pod ends flat, with thin wall, veins 5-8, anastomosing in the outer part of the pod face, branching near the ventral suture, venation is a net of veins, four ridges with three grooves between lateral vein and dorsal suture, dorsal suture below the lateral veins, located in a groove (with elevated sides). Spines if present slender, fine, grooved, with hooked tip, 1.5-4 mm, 13-15 per row, arching upwards of the coil. Seeds 2.5-3.5 x 1.2-1.5 mm, brown to yellow, 1-3 per coil, coat smooth, separated, with thin membrane between them, radicle more than half seed length.

Chromosome number: 16.
Closely related species: It is easily distinguished species with the leaflets marking and unlikely to be confused with other species.
Habitat: Wide range of habitats includes grassland, meadow, woodland edge, agricultural land roadsides, and stream sides.
Geographical distribution: Africa: Algeria (N), Egypt (N), Libya (N), Morocco (N), South Africa (I), Tunisia (N). Asia: Armenia (N), Azerbaijan (N), China (I), Georgia (N), Iran (N), Iraq (N), Russia in Asia (N). Australasia: Australia (I), Tasmania (I). Australia: Australian Capital Territory, New South Wales, Queensland, South Australia, Victoria, Western Australia. Azerbaijan: Azerbaijan. Europe: Albania (N), Balearic Is (N), Belgium (N), Bulgaria (N), Corsica (N), Crete (N), Czech Republic and Slovakia (I), Estonia (N), former Yugoslavia (N), France (N), Germany (N), Great Britain (N), Greece (N), Hungary (N), Ireland (I), Italy (N), Luxembourg (N), Malta (N),

Netherlands (N), Portugal (N), Romania (N), Sardinia (N), Sicily (N), Spain (N), Sweden (I), Switzerland (I), Turkey in Europe (N), Ukraine (N). Georgia: Abkhazia, Adzharia, Georgia. Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel (N), Lebanon (N), Palestine (N), Syria (N), Turkey in Asia (N). North America: United States (I). Pacific Ocean: Chatham Is (I), Kermadec Is (I), New Zealand (North) (I), New Zealand (South) (I). Russia in Asia: Dagestan, Krasnodar. South America: Chile (I). Ukraine: Krym. United States: California, Florida, Georgia, North Carolina, Oklahoma, Oregon, South Carolina, Texas.

Actual and potential usage: Environmental, forage, cover crop, green manure. There are several cultivars of this species and it is reported to exhibit tolerance to drought, low pH, heavy soils, salinity and viruses.

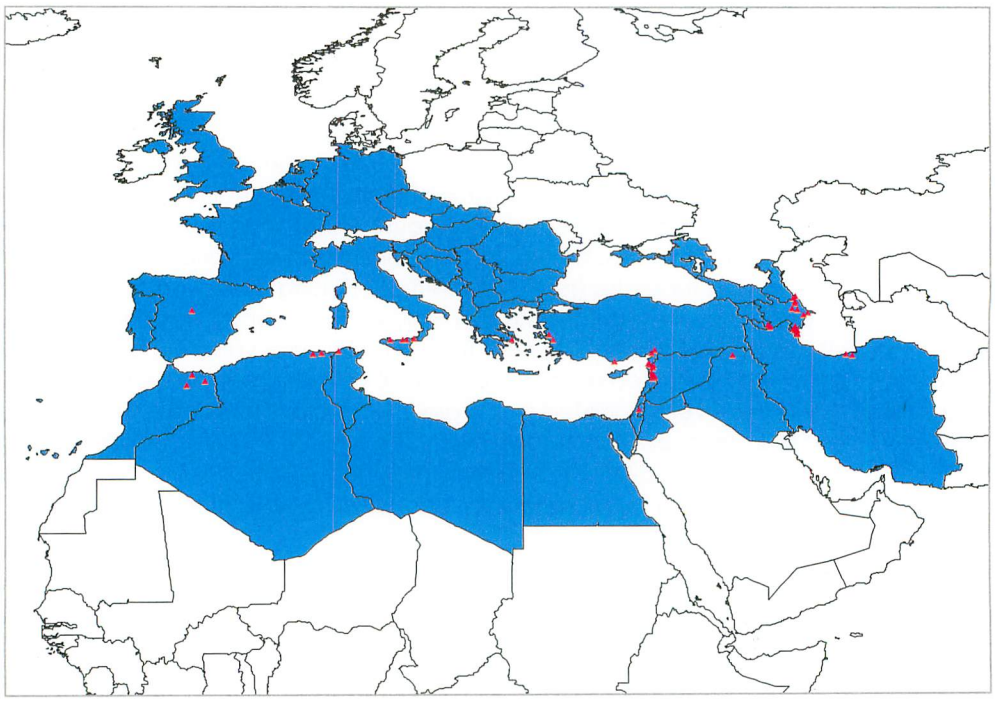

Figure 3.81. Distribution of *Medicago arabica*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

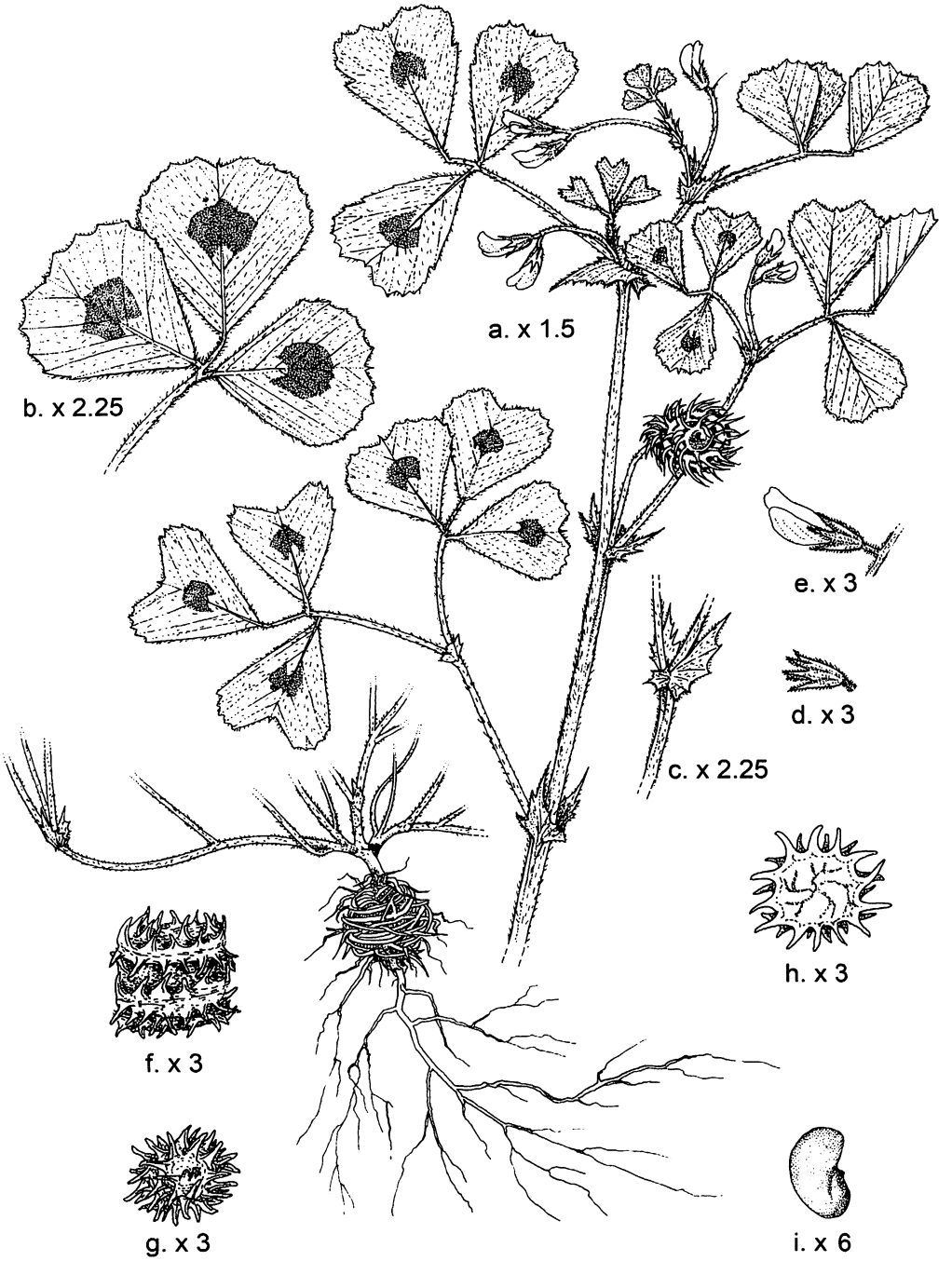

Figure 3.82. *Medicago arabica*: a, habit (x 1.5), b, leaflet (x 2.25) c, stipule (x 2.25), d, calyx (x 3), e, flower (x 3), f, pod three dimension view (x 3), g, pod tip view (x 3) h, pod venation (x 3) i, seed (x 6).

3.53 *Medicago tenoreana* Seringe in DC., Prodr. Syst. Nat. 2: 180 (1825).

Annual, herb, (15-)20-35(-50) cm, stem decumbent, branching at the ground level. Vegetative parts densely pubescent, with defuse, simple hairs or simple and glandular hairs. Stipules margin nearly entire to serrate. Leaflet 6-14 x 3-10 mm, obovate, apex apiculate, base obcordate, dorsally densely pubescent, ventrally densely pubescent, with defuse hairs, margins at apical third serrate. Peduncle with 1-4 flowers, shorter than or longer than the corresponding petiole, with terminal cusp. Flower 4-7 mm. Pedicle shorter than the calyx tube, bract ± equalling the pedicel, calyx densely pubescent, longer than half of the corolla, teeth slender, teeth longer than tube. Corolla yellow, standard with rounded apex, wings slightly shorter than the keel. Pods coiled, before maturity densely pubescent, with simple hair or simple and glandular hairs, brown, 5-7 mm, not subterranean, cylindrical, spiny, with coiled tip. Coils 4-6, turning clockwise, loose, 5-7 mm diameter, with thin wall, sometimes terminal coil spineless, veins about 10, S shaped, branching before entering the vein-less zone, vein-less zone about 20%-35% of the radius (with a groove between it and the coil edge). Spines some with hooked tip, grooved to 2/3 from the base, 1-3 mm, at two rows on a coil edge, 15-25 per row, inserted at 90-130

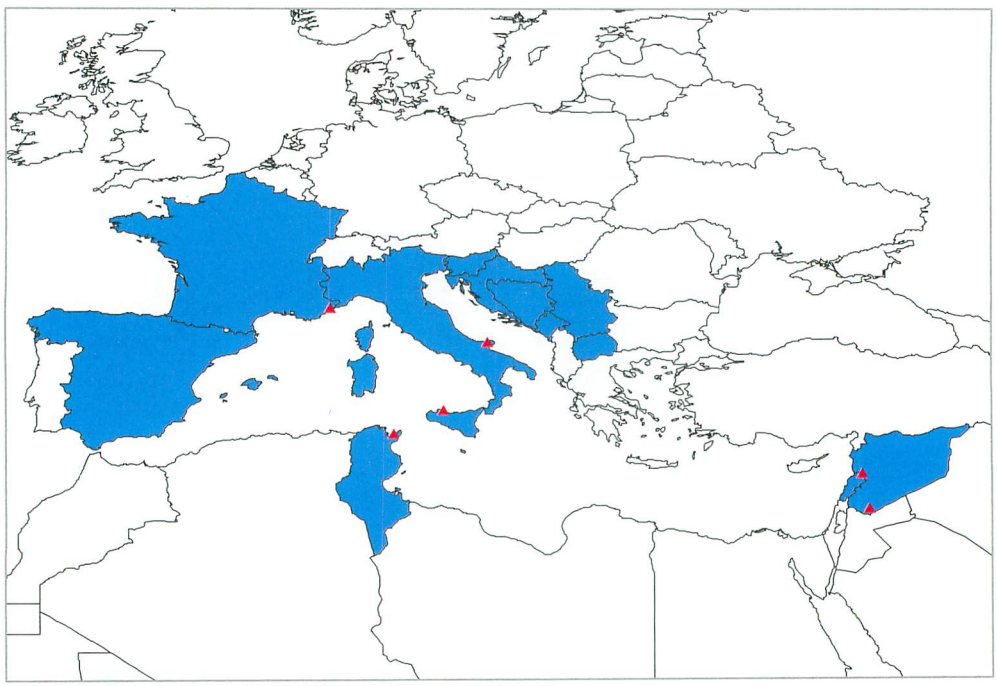

Figure 3.83. Distribution of *Medicago tenoreana*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

degree to the coil face, somewhat arching to opposite direction of the pod coiling. Seeds 2.5-3 x 1-1.3 mm, brown to yellow, 1-2 per coil, coat smooth, separated, radicle more than half seed length.

Chromosome number: 16.
Closely related species: It is may be confused with *M. disciformis* which has spines inserted in the plane of the pod coil but slanted towards the fruit base, however for *M. tenoreana* the insertion is at right angels to the plane.
Habitat: Dry, rocky hill slopes, sand dunes.
Geographical distribution: Africa: Tunisia (N). Europe: Former Yugoslavia (N), France (N), Italy (N), Malta (N), Monaco (N), Sardinia (N), Sicily (N), Spain (N). Middle East: Lebanon (N), Syria (N).

3.54 *Medicago disciformis* DC., Cat. Pl. Hort. Monsp.: 124 (1813).

Annual, herb, 15-25(-70) cm, stem procumbent or decumbent, branching over the ground level. Vegetative parts densely pubescent, with simple and glandular hairs. Stipules margin entire or dentate, teeth at base. Leaflet 4-14 x 3-10 mm, obovate, apex apiculate or truncate (occasionally), base obcordate, margins at apical part serrate. Peduncle with 1-3 flowers, longer than the corresponding petiole, with terminal cusp. Flower 5-7 mm. Pedicle shorter or rarely equal to or longer than the calyx tube, bract shorter than the pedicel, calyx 2.5-3.5 mm, densely pubescent, with simple and glandular hairs, teeth shorter or ± equalling tube. Corolla yellow, standard obovate, with obcordate apex, wings shorter than the keel. Pods coiled, glabrous or densely pubescent, with glandular hair, brown to yellow, 3-5 mm, not subterranean, discoid or cylindrical, spiny. Coils 5-8, turning clockwise, loose, 4.5-7 mm diameter, size decreasing gradually towards first and last coil, with thin wall, apical terminal coil spineless, veins 10-16, entering the vein-less zone with S shaped, vein-less zone about 20%-35% of the radius, grooves deep narrow between lateral vein and dorsal suture. Spines grooved, some with hooked tip and grooved base, 0.5-6 mm, at two rows on a coil edge, 14-16 per row, inserted at 180 degree to the coil face, arching downwards of the coil towards the pod base. Seeds 3.5-3.5 x 1.5-1.8 mm, yellow, 1-2 per coil, coat smooth, not separated radicle more than half seed length.

Chromosome number: 16.
Closely related species: It is similar to the preceding species but in *M. disciformis* the spines are inserted in the coil at right angels to the plane.
Habitat: Rocky hillsides, woodland, meadows, coastal maquis and roadsides.
Geographical distribution: Africa: Libya (N) Europe: Bulgaria (N), Corsica (N), Crete (N), former Yugoslavia (N), France (N), Greece (N), Italy (N), Sicily (N), Spain (N), Turkey in Europe (N) Middle East: Cyprus (N), East Aegean Is (Greek) (N), Lebanon (N), Syria (N), Turkey in Asia (N).
Conservation and threat assessment: Not threatened

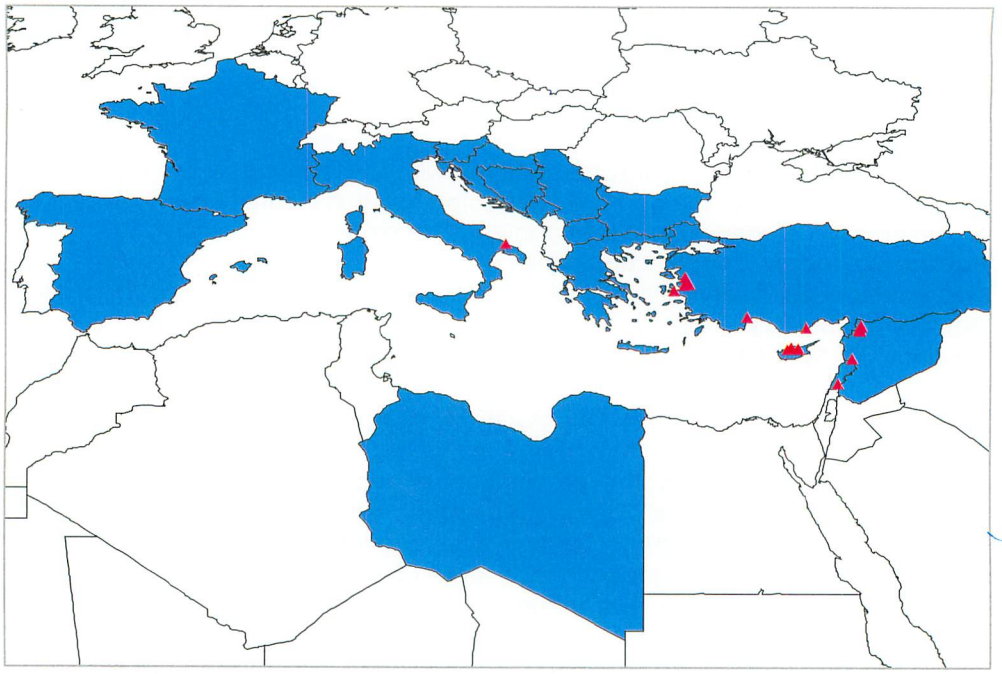

Figure 3.84. Distribution of *Medicago disciformis*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.55 *Medicago lanigera* Winkl. & Fedtschenko, Bull. Jard. Bot. Petersburg 5: 41 (1905).

Annual, herb, 4-8(-25) cm, stem decumbent, branching at the ground level. Vegetative parts densely pubescent, with simple hairs. Stipules margin incised (the uppermost teeth longer than the others). Leaflet 6-10(-15) x 3-6(-9) mm, obovate, apex retuse to obtuse, base cuneate, margins at apical half serrate. Peduncle with 1 flowers, shorter than or equal to the corresponding petiole, with terminal cusp. Flower 1-4 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx densely pubescent, with simple hairs, longer than half of the corolla, teeth slender, teeth ± equalling or longer than tube. Corolla yellow, standard oval, wings slightly shorter than the keel. Pods coiled, at maturity densely pubescent, with celled hairs giving the pod appearance of a small ball of cotton, 2-3 mm, discoid, spineless. Coils 3-4, turning clockwise, 5-8 mm diameter, with thin wall, veins after removing hairs 8-10, S shaped (which at 2/3 from the centre united in a thicker lateral vein). Seeds 3.5-4 x 2 mm, yellow, 1-2 per coil, coat smooth, not separated radicle more than half seed length.

Chromosome number: 16.
Closely related species: *M. lanigera* is a very distinguished species, having spineless pods densely covered with long white hairs.
Habitat: Dry, stony slopes of mid-altitudes mountains, dry meadows, on clay, loess and stony soil.
Geographical distribution: Asia: Afghanistan (N).

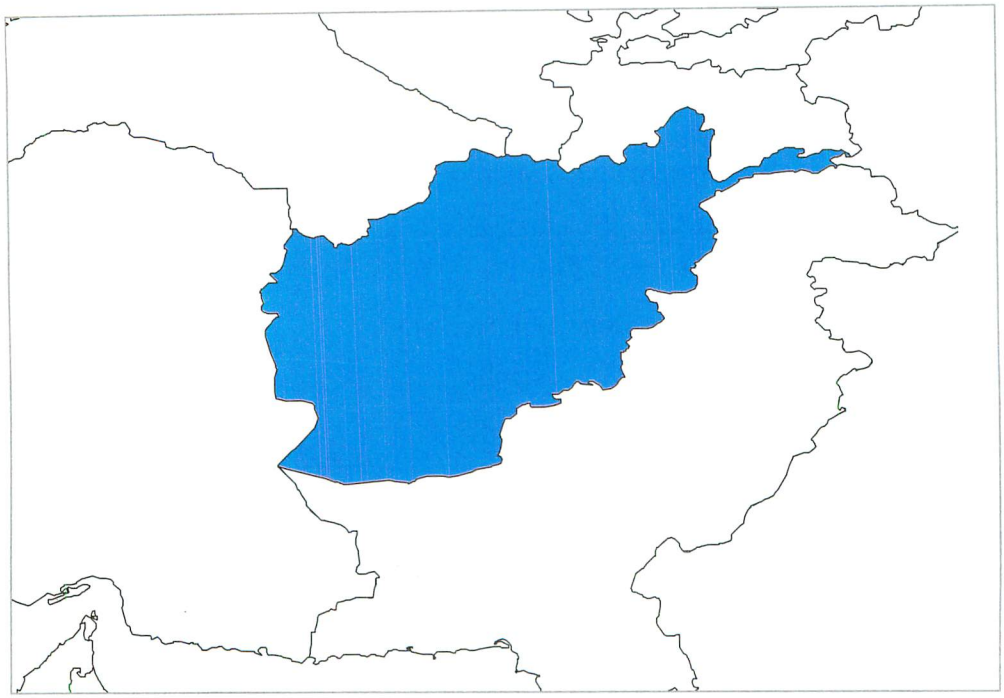

Figure 3.85. Distribution of *Medicago lanigera*. (shading represents native distribution).

3.56 *Medicago hypogaea* E. Small, Taxon 33: 633 (1984).

Synonyms: *Factorovskya aschersoniana* (Urban) Eig, Bull. Inst. Agric. Nat. Hist. 6: 18 (1927); *Trigonella aschersoniana* Urban in Verh., Bot. Vereins. Prov. Brandenburg 23: 67 (1882).
Annual or Perennial herb, 2-15 cm, stem procumbent, branching at the ground level. Vegetative parts glabrous or densely pubescent, with appressed, simple hairs. Stipules lanceolate, margin dentate to laciniate, teeth at base. Leaflet 2.5-4(-6) x 2-4.5 mm, obovate, apex emarginate, base mucronate cuneate, dorsally glabrous, ventrally glabrous or densely pubescent, margins sharply dentate. Peduncle with 1

flowers, several times longer than the corresponding petiole. Pedicle shorter or equal to the calyx tube, bract shorter than the pedicel, calyx 1.5-2 mm, densely pubescent, with simple appressed hairs, shorter or equalling half of the corolla, teeth triangular, teeth shorter than tube. Corolla yellow, standard oval, with retuse apex, wings shorter than the keel. Pods uncoiled, densely pubescent, with appressed simple hair, 6-9 mm, subterranean, ovoid, spineless, not sessile, face smooth. 3-5 mm diameter. Seeds 3-4 x 3-3.5 mm, yellow, compressed ovoid, 2 per pod, coat smooth, deep constricted between them.

Chromosome number: 14.
Closely related species: It is easily distinguished species, it produce its pods underground. The pods are covered with cotton-like hairs.
Habitat: Very dry Mediterranean scrub vegetation, dry trampled grassland, over rocks.
Geographical distribution: Africa: Egypt (N), Libya (N) Asia: Iraq (U) Middle East: Cyprus (N), Israel (N), Lebanon (N), Sinai (N), Palestine (N), Syria (N), and Turkey in Asia (N).
Conservation and threat assessment: Not threatened

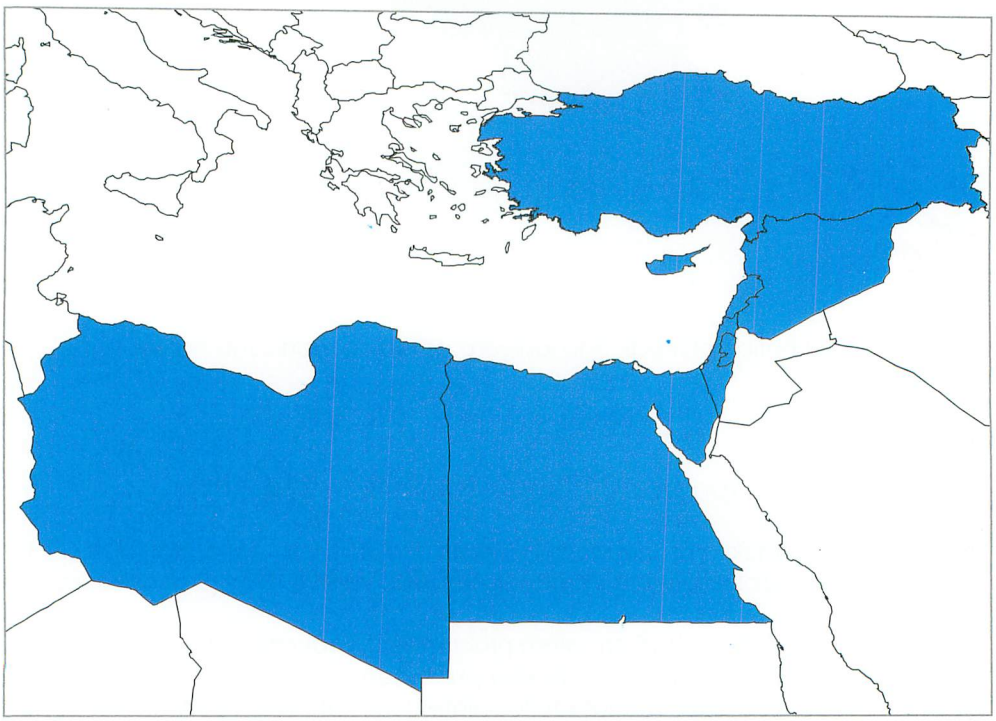

Figure 3.86. Distribution of *Medicago hypogaea*. (shading represents native distribution).

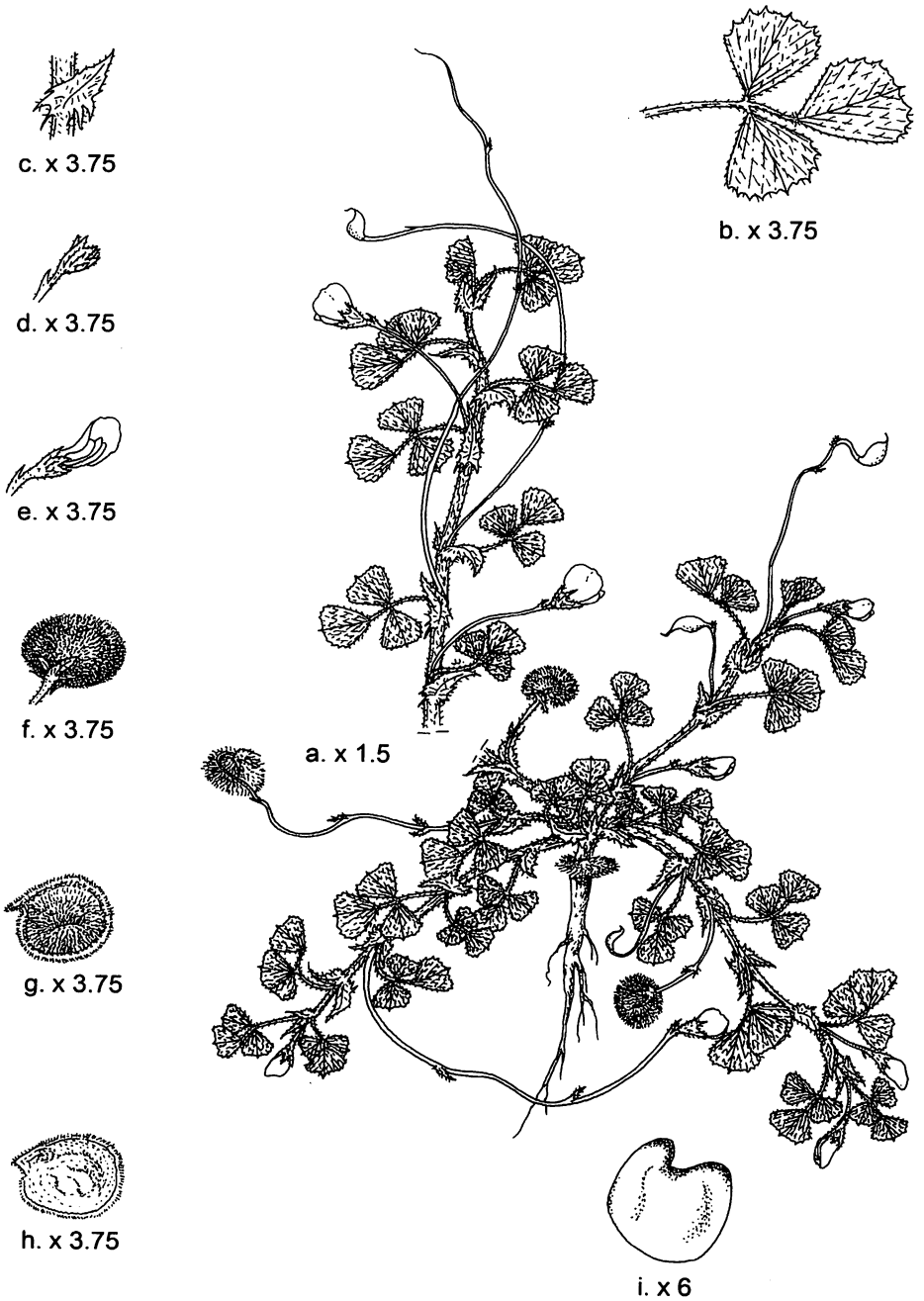

Figure 3.87. *Medicago hypogaea*: a, habit (x 1.5), b, leaflet (x 3.75), c, stipule (x 3.75), d, calyx (x 3.75), e, flower (x 3.755), f, pod three dimension view (x 3.75), g, pod tip view (x 3.75), h, pod venation (x 3.75), i, seed (x 6).

3.57 *Medicago lupulina* L., Sp. Pl.: 779 (1753).

Synonyms: *Medicago wildenowii* Merat., Nouv. Fl. Env. Paris: 296 (1812); *Medicago cupaniana* Guss., Fl. Sicul. Syn 2: 362 (1844); *Medicago lupulina* L. subsp. *cupaniana* (Guss.) Nyman, Consp. Fl. Eur.: 170 (1878); *Medicago lupulina* L. subsp. *eurasiatica* Braun-Blanquet, Bull. Soc. Bot. France 77: 288 (1930).
Annual or Perennial herb, 20-60(-80) cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with appressed or defuse, simple hairs or simple and glandular hairs. Stipules ovate or lanceolate, margin entire or serrate. Leaflet 5-20 x 4-8 mm, ovate to obovate, dorsally densely pubescent, ventrally densely pubescent, margins serrate. Peduncle with 14-24 flowers, flowers gathered in a spike-like raceme, longer than the corresponding petiole, with terminal cusp. Flower 2.5-3.5 mm. Pedicle shorter than the calyx tube, bract shorter or longer than the pedicel, calyx 1.5-2.3 mm, densely pubescent, with simple hairs or simple and glandular hairs, teeth ± equalling tube. Corolla yellow, standard oval, wing shorter than the keel. Pods uncoiled, densely pubescent, with simple hair or glandular hair, ash-grey to black, 2.5(-3) mm, reniforme, spineless, not sessile, with coiled tip, veins 3-5, curved, not changing direction before joining the dorsal suture, branching near lateral outer vein. Seeds 1.7-2 x 1-1.3 mm, yellow, ovoid, 1 per pod, radicle more than half seed length.

Chromosome number: 16, 32.
Closely related species: It is easily distinguished species, except for *M. secundiflora* which have a one-sided raceme of 3-10 flowers; however *M. lupulina* have a compact raceme of 14-24 flowers.
Habitat: Grassland, dry river bed, river and ditch banks, roadsides, pastures and meadows, steppe, open woodlands. Found growing in calcareous substrates, volcanic basalt, limestone, loam, and clay and alluvium soils.
Geographical distribution: Africa: Algeria (N), Canary Is (N), Egypt (N), Ethiopia (N), Kenya (U), Libya (N), Morocco (N), Somalia (U), South Africa (N), Tanzania (U), Tunisia (N). Asia: Afghanistan (N), Armenia (N), Azerbaijan (N), China (N), Georgia (N), India (N), Iran (N), Iraq (N), Japan (I), Kazakhstan (N), Kirgizstan (N), Mongolia (N), Nepal (N), Pakistan (N), Philippines (I), Russia in Asia (N), Tadzhikistan (N), Taiwan (N), Turkmenistan (N), Uzbekistan (N). Australasia: Australia (I), Tasmania (I). Australia: New South Wales, Queensland, South Australia, Victoria, Western Australia. Azerbaijan: Azerbaijan, Nakhichevan. Belarus: Brest, Gomel, Grodno, Minsk, Mogilev, Vitebsk. Caribbean: Bahamas (I), Dominican Republic (I), Haiti (I). Central America: Guatemala (I), Mexico (North and Central) (N), Mexico (South East) (N). Europe: Albania (N), Austria (N), Azores (N), Balearic Is (N), Belarus (N), Belgium (N), Bulgaria (N), Corsica (N), Crete (N), Czech Republic and Slovakia (N), Denmark (N), Estonia (N), Faroe Is (I), Finland (N), former Yugoslavia (N), France (N), Germany (N), Great Britain (N), Greece (N), Hungary (N), Iceland (I), Ireland (N), Italy (N), Latvia (N), Liechtenstein (N), Lithuania (N), Luxembourg (N), Malta (N), Moldova (I), Netherlands (N), Norway (N), Poland (N), Portugal (N), Romania (N),

Russia in Europe (N), Sardinia (N), Sicily (N), Spain (N), Sweden (N), Switzerland (N), Turkey in Europe (N), Ukraine (N). Georgia: Abkhazia, Adzharia, Georgia. India: Bihar, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu-Kashmir, Madhaya Pradesh, Punjab, Rajasthan, Uttar Pradesh, West Bengal. Indian Ocean: Mauritius (I), Reunion (I). Kazakhstan: Aktyubinsk, Alma-Ata, Chimkent, Dzhambul, Dzhezkazgan, Guryev, Karaganda, Kustanai, Kzyl-Orda, Semipalatinsk, Severo-Kazakhstanskaya, Taldy-Kurgan, Uralsk, Vostochno-Kazakhstanskaya. Kirgizstan: Frunze, Issyk-Kul, Osh. Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel-Jordan (N), Lebanon (N), Palestine (N), Saudi Arabia (N), Syria (N), Turkey in Asia (N), Yemen (N). Mongolia: Arkangai, Bayankhongor, Bulgan, Dornod, Govi-Altai, Khenti, Khovd, Selenge, Sukh Baatar, Tuv, Uvs, Uvurkhangai, Zavkhan. North America: Alaska-Aleutian Is (I), Canada (I), United States (I). Pacific Ocean: Chatham Is (I), Hawaii (I), Kermadec Is (I), New Zealand (North) (I), New Zealand (South) (I). Russia in Asia: Altay, Amur, Buryatiya, Checheno-Ingushetia, Chelyabinsk, Chita, Chukot, Dagestan, Gorno-Altaisk, Irkutsk, Kabardino-Balkaria, Karacheyevo-Cherkessia, Kemerovo, Khabarovsk, Khakassia, Krasnodar, Krasnoyarsk, Kurgan, Magadan, Novosibirsk, Omsk, Primorye, Severo-Osetia, Stavropol, Sverdlovsk, Tomsk, Tuva, Tyumen. Russia in Europe: Arkhangelsk, Astrakhan, Bashkiria, Belgorod, Bryansk, Chuvashia, Gorki, Ivanovo, Kalinin, Kaliningrad, Kalmykia, Kaluga, Karelia, Kirov, Komi, Komi-Permyak, Kostroma, Kuibyshev, Kursk, Leningrad, Lipetsk, Mari, Mordovia, Moscow, Murmansk, Novgorod, Orel, Orenburg, Penza, Perm, Pskov, Rostov-Don, Ryazan, Saratov, Smolensk, Tambov, Tataria, Tula, Udmurtia, Ulyanovsk, Vladimir, Volgograd, Vologda, Voronezh, Yaroslavl. South America: Argentina (I), Bolivia (I), Brazil (I), Chile (I), Colombia (I), Peru (I). Tadzhikistan: Dushanbe, Gorno-Badakshan, Kulyab,

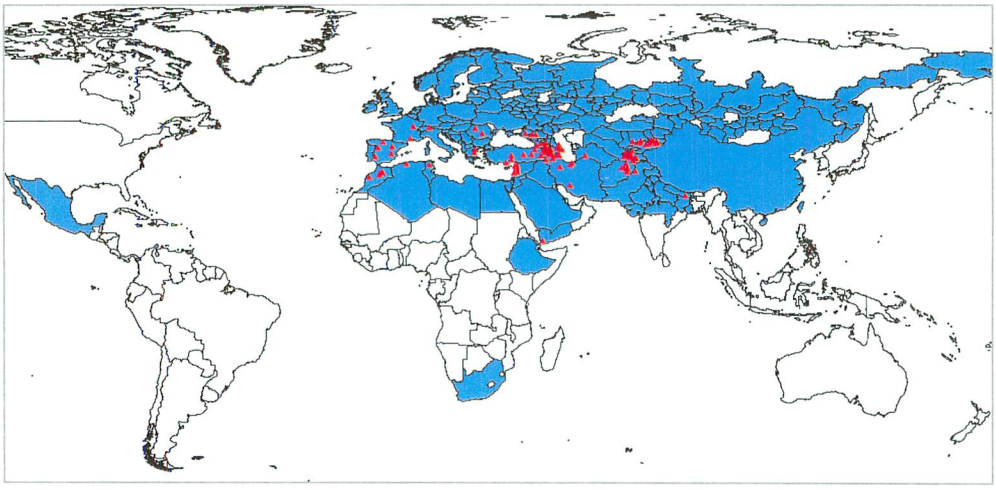

Figure 3.88. Distribution of *Medicago lupulina*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

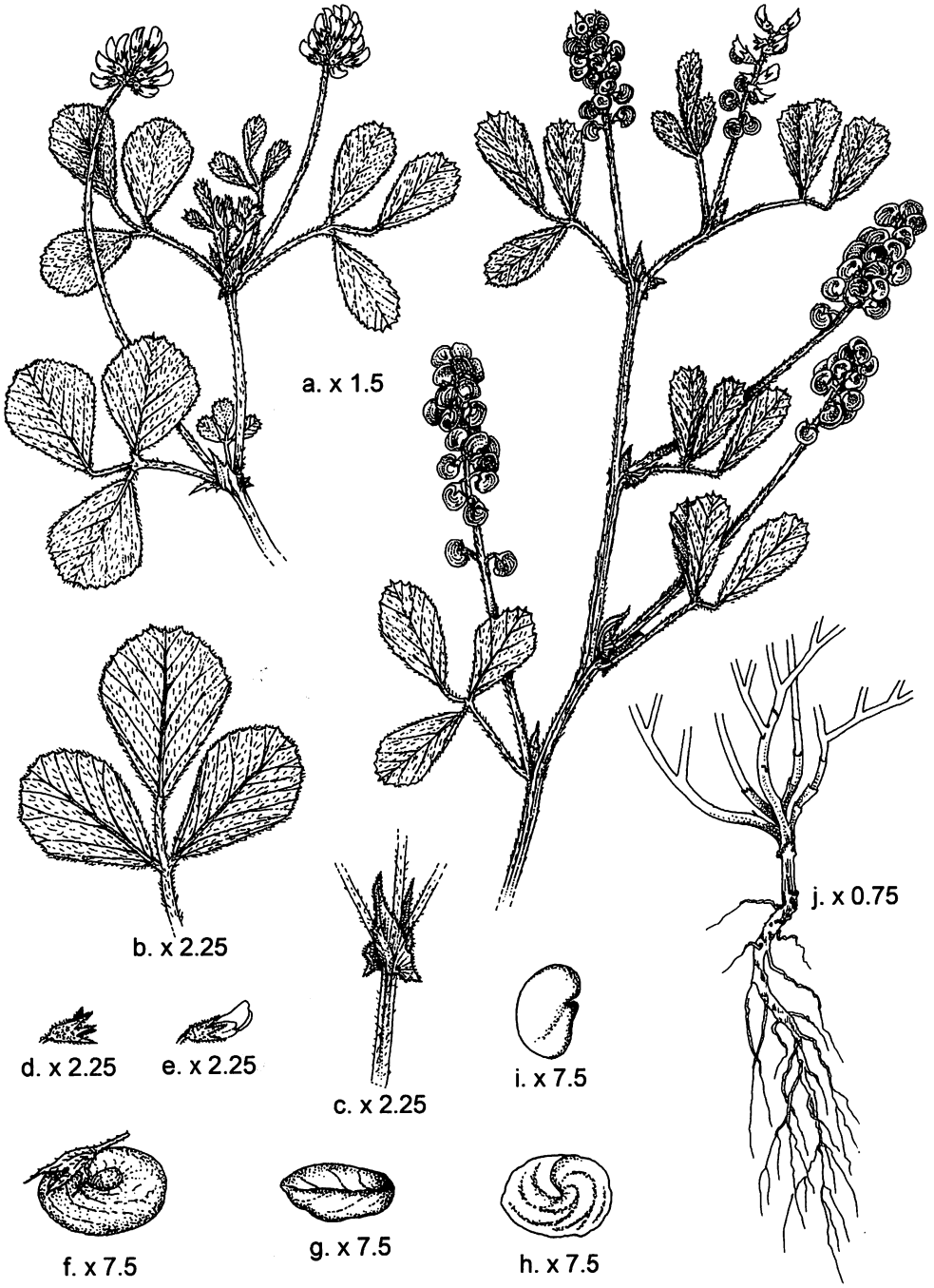

Figure 3.89. *Medicago lupulina*: a, habit (x 1.5), b, leaflet (x 2.25), c, stipule (x 2.5), d, calyx (x 2.5), e, flower (x 2.5), f, pod three dimension view (7.5), g, pod tip view (x 7.5), h, pod venation (x 7.5), i, seed (x 7.5), j, root and stem habit (0.75).

Kurgan-Tyube, Leninabad. Turkmenistan: Ashkhabad, Chardzhou, Krasnovodsk, Mary. Ukraine: Cherkassy, Chernigov, Chernovtsy, Dnepropetrovsk, Donetsk, Ivano-Frankovsk, Kharkov, Kherson, Khmelnitski, Kiev, Kirovograd, Krym, Lvov, Nikolaev, Odessa, Poltava, Rovno, Sumy, Ternopol, Vinnitsa, Volynia, Voroshilovgrad, Zakarpatskaya, Zaporozhye, Zhitomir. United States: Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming. Uzbekistan: Bukhara, Dzhizak, Karakalpakia, Kashkadarinskaya, Surhandarinskaya, Syr-Darya, Tashkent.
Conservation and threat assessment: Not threatened.
Actual and potential usage: Environmental, forage, cover crop, green manure and associated with bees.

3.58 *Medicago secundiflora* Durieu de Maisonneuve in Duchartre, Rev. Bot. Recueil Mens. 1: 365 (1846).

Annual, herb, 15-25 cm, stem round in cross section, procumbent or ascending to erect, branching at the ground level. Vegetative parts densely pubescent, with simple hairs. Stipules triangular, margin dentate, teeth at base. Leaflet 5-12 x 4-10 mm, obovate, dorsally densely pubescent, ventrally densely pubescent, with erect hairs, margins at apical part serrate. Peduncle with 3-10 flowers, flowers in a slender lax raceme, longer than the corresponding petiole, with terminal cusp. Flower 2-2.5 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx 1.8-2 mm, glabrous or sparsely pubescent, with simple hairs, defuse hairs, longer than half of the corolla, teeth slender, and teeth longer than tube. Corolla yellow, standard elliptical, wing shorter than the keel. Pods uncoiled, densely pubescent, with simple hair, green-brown, 6-15 mm, reniforme, spineless, with coiled tip, face reticulate. 4-11 mm diameter, veins changing direction at the edge of the pod, venation darker than the middle of the coil. Seeds 2 x 1.5 mm, red-yellow, rounded on the cotyledon side and straight on the radicle side (almost), 1 per pod, coat smooth, radicle more than half seed length.

Chromosome number: 16.
Closely related species: It is similar to *M. lupulina* but *M. secundiflora* has a one sided raceme with 3-10 flowers.
Habitat: Calcareous slopes.
Geographical distribution: Africa: Algeria (N), Morocco (N), Tunisia (N) Europe: Balearic Is (N), France (N), Italy (U), Sicily (U), Spain (N).
Conservation and threat assessment: Not threatened

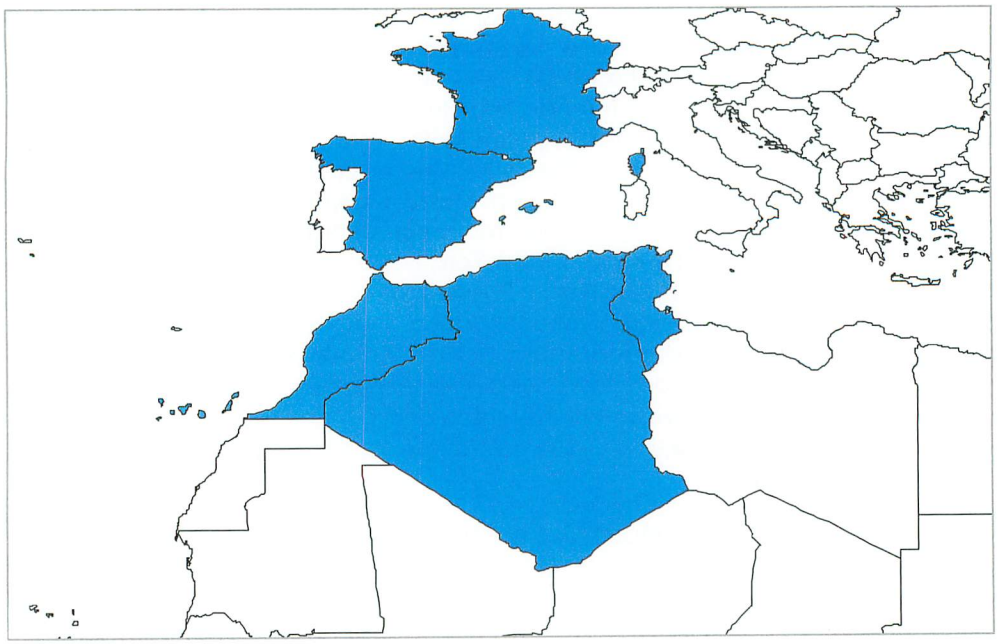

Figure 3.90. Distribution of *Medicago secundiflora*. (shading represents native distribution).

3.59 *Medicago heyniana* Greuter, Candollea 25: 190 (1970).

Annual, herb, 20-45 cm, stem decumbent, branching at the ground level. Vegetative parts sparsely pubescent, with simple hairs. Stipules lanceolate. Leaflet 5-10 x 3-8 mm, obovate, base obcordate, dorsally glabrous, ventrally sparsely pubescent, margins entire. Peduncle with 1-2 flowers, equal to the corresponding petiole. Flower 7-9 mm. Pedicle shorter than the calyx tube, bract shorter than the pedicel, calyx 3-3.5 mm, sparsely pubescent, with simple hairs, teeth ± equalling tube. Corolla yellow, standard obovate, keel slightly longer than the wings. Pods coiled, glabrous, yellow (often with a violet hue), discoid or cylindrical, spiny, face reticulates, centre with no opening. Coils 3-4.5, turning clockwise, not tightly appressed, 9-12 mm diameter, flat, with thin wall, veins 10-12, slender shaped. Spines conical, slender, fine, grooved, with thin tip, and grooved base, 3-4 mm, 17-20 per row, inserted at 150-180 degree to the coil face, arching and interlocking with spines of adjacent coil. Seeds 3 x 2.5 mm, brown to yellow, ovoid, 3-5 per coil, coat verrucose, separated, with thin spongy partition between them.

Closely related species: It is easily distinguished species by its rough seeds.
Habitat: Dry rocky hillsides.

Geographical distribution: Europe: Greece (N), Crete (N). Middle East: East Aegean Is (Greek), Jordan (N), Turkey in Asia.
Conservation and threat assessment: Vulnerable

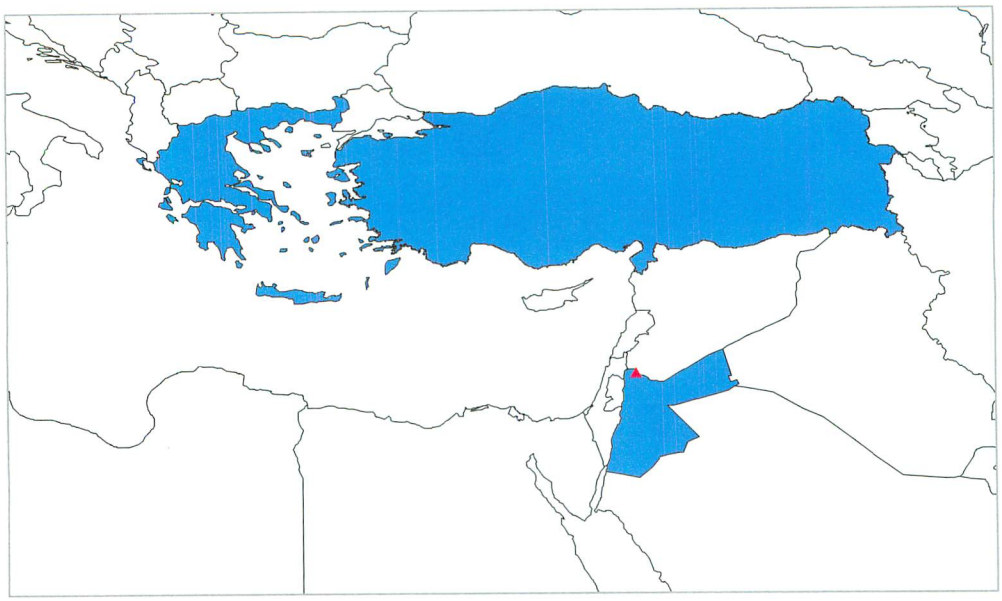

Figure 3.91. Distribution of *Medicago heyniana*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.60 *Medicago orbicularis* (L.) Bartal., Cat. Piante Siena: 60 (1776).

Synonyms: *M. polymorpha* var. *orbicularis* L. Sp. Pl.: 779 (1753); *M. applanata* Willd., Enum. Hort. Reg. Bot. Berol.: 802 (1802); *M. marginata* Willd., Enum. Hort. Reg. Bot. Berol.: 802 (1809); *M. cuneata* J. Woods, Tour. Fl.: 84 (1850); *M. biancae* Tod. in Herb. ex Urb., Verh. Bot. Ver. Brandenburg 15: 60 (1873).
Annual, herb, 10-50(-120) cm, stem procumbent to ascending, branching at the ground level. Vegetative parts glabrous. Stipules ovate or lanceolate, margin laciniate. Leaflet 9-18 x 6-14 mm, obovate, apex retuse, base cuneate, margins except the base serrate. Peduncle with 1-5 flowers, shorter than the corresponding petiole, with terminal cusp. Flower 4-6 mm. Pedicle equal to the calyx tube (or slightly longer). Bract shorter or ± equalling the pedicel, calyx glabrous or densely pubescent, shorter than half of the corolla, teeth triangular, teeth shorter or ± equalling tube. Corolla yellow, standard obovate, with a violet hue on the outer side, wing shorter than the keel. Pods coiled, glabrous or sparsely pubescent, with glandular hair, black or ash-grey, discoid or cylindrical, spineless, face reticulate. Coils 3-7,

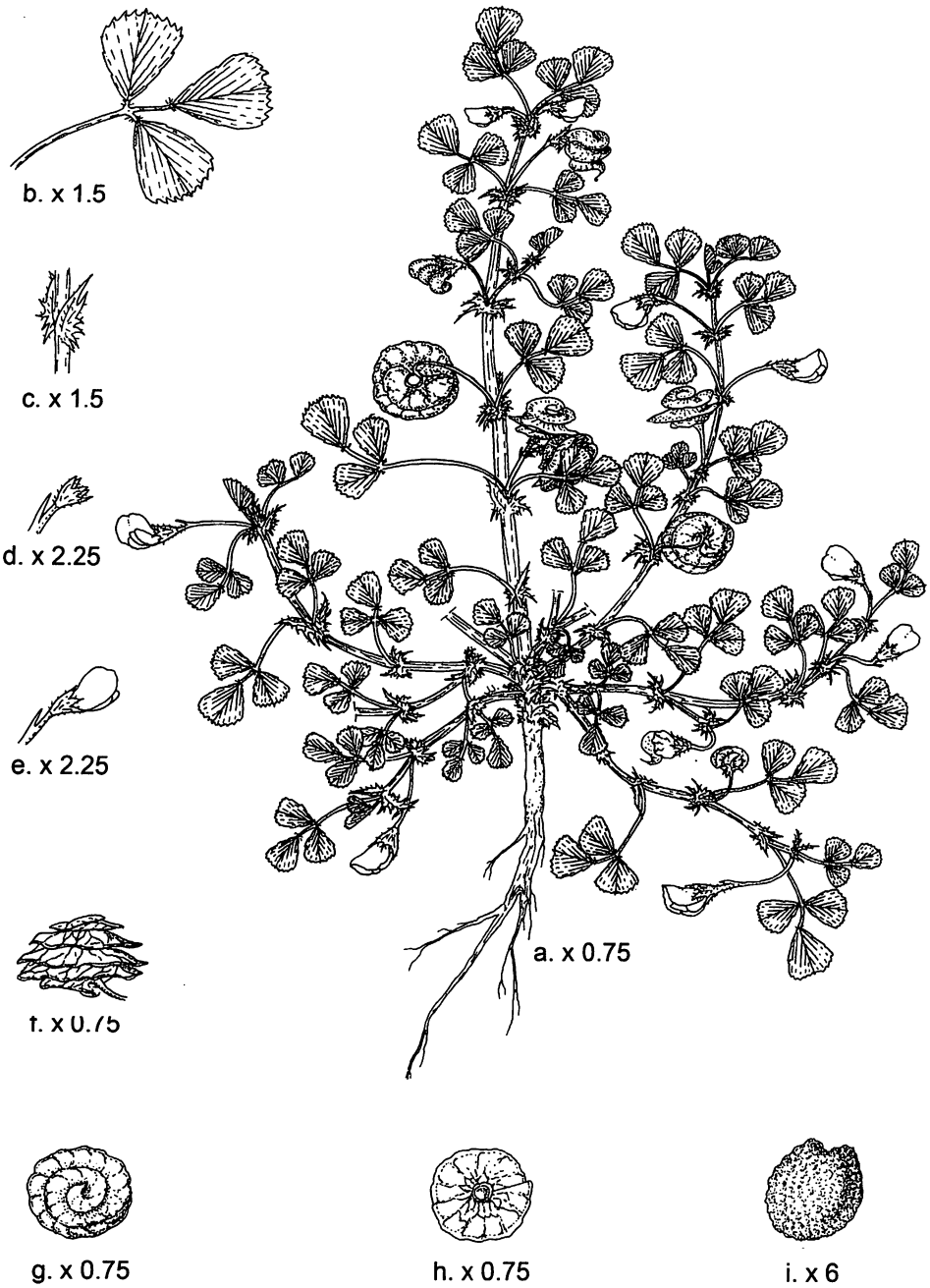

Figure 3.93. *Medicago orbicularis*: a, habit (x 0.75), b, leaflet (x 1.5), c, stipule (x 1.5), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 0.75), g, pod tip view (x 0.75), h, pod venation (x 0.75), i, seed (x 6).

turning clockwise, loose, 9-20 mm diameter, size of the last one smaller than the first, with thin wall, veins 12-16, slender shaped, branching near the ventral suture. Seeds 2.5-3 x 2-2.5 mm, yellow to brown, 3-6 per coil, coat verrucose, separated, with thin membrane between them, radicle equal the seed length.

Chromosome number: 16, 32.
Closely related species: It could be confuse with *M. blancheana* or possibly *M. scutellata*, which can be distinguished by their imbricate, bowl-like coils and smooth seeds.
Habitat: Hills, open forest, agricultural fields and edges, dense maquis, cliffs and steep rocky places, river banks, meadows, pastures, roadsides, dry river beds.
Geographical distribution: Africa: Algeria (N), Canary Is (N), Egypt (N), Ethiopia (N), Libya (N), Madeira (N), Morocco (N), South Africa (I), Tunisia (N). Asia: Afghanistan (N), Armenia (N), Azerbaijan (N), Georgia (N), India (N), Iran (N), Iraq (N), Kazakhstan (N), Kirgizstan (N), Pakistan (N), Russia in Asia (N), Tadzhikistan (N), Turkmenistan (N), Uzbekistan (N). Australasia: Australia (I). Australia: New South Wales, Queensland, South Australia, Victoria, Western Australia. Azerbaijan: Azerbaijan. Europe: Albania (N), Balearic Is (N), Bulgaria (N), Corsica (N), Crete (N),

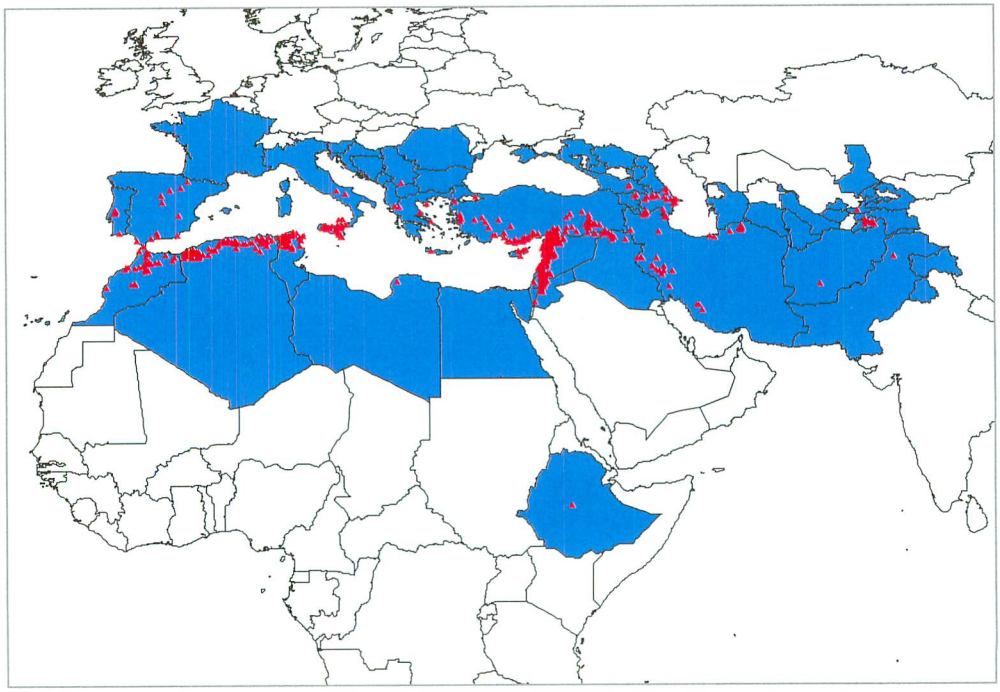

Figure 3.92. Distribution of *Medicago orbicularis*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

former Yugoslavia (N), France (N), Greece (N), Hungary (I), Italy (N), Malta (N), Portugal (N), Romania (N), Sardinia (N), Sicily (N), Spain (N), Turkey in Europe (N), Ukraine (N). Georgia: Abkhazia, Georgia. India: Jammu-Kashmir, Punjab. Kazakhstan: Chimkent. Kirgizstan: Osh. Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel (N), Jordan (N), Lebanon (N), Palestine (N), Oman (I), Saudi Arabia (I), Syria (N), Turkey in Asia (N). North America: United States (I). Russia in Asia: Checheno-Ingushetia, Dagestan, Karacheyevo-Cherkessia, Krasnodar, Stavropol. South America: Chile (U). Tadzhikistan: Dushanbe, Kulyab, Kurgan-Tyube. Turkmenistan: Ashkhabad, Chardzhou, Krasnovodsk, Mary. Ukraine: Krym. United States: Alabama, California, Florida, Georgia, Mississippi, North Carolina, Oklahoma, South Carolina, Texas. Uzbekistan: Fergana, Kashkadarinskaya, Khorezm, Samarkand, Tashkent.

Conservation and threat assessment: Not threatened.

Actual and potential usage: Environmental, forage and cover crop.

3.61 *Medicago radiata* L., Sp. Pl.: 778 (1753).

Synonyms: *Trigonella radiata* (L.) Boiss, Fl. Orient. 2: 90 (1872).

Annual, herb, 10-25(-50) cm, stem ascending, branching at the ground level. Vegetative parts densely pubescent, with defuse, simple hairs. Stipules lanceolate to subulate, margin laciniate, teeth at base. Leaflet 6-10(-25) x 3-5(-15) mm, obo-

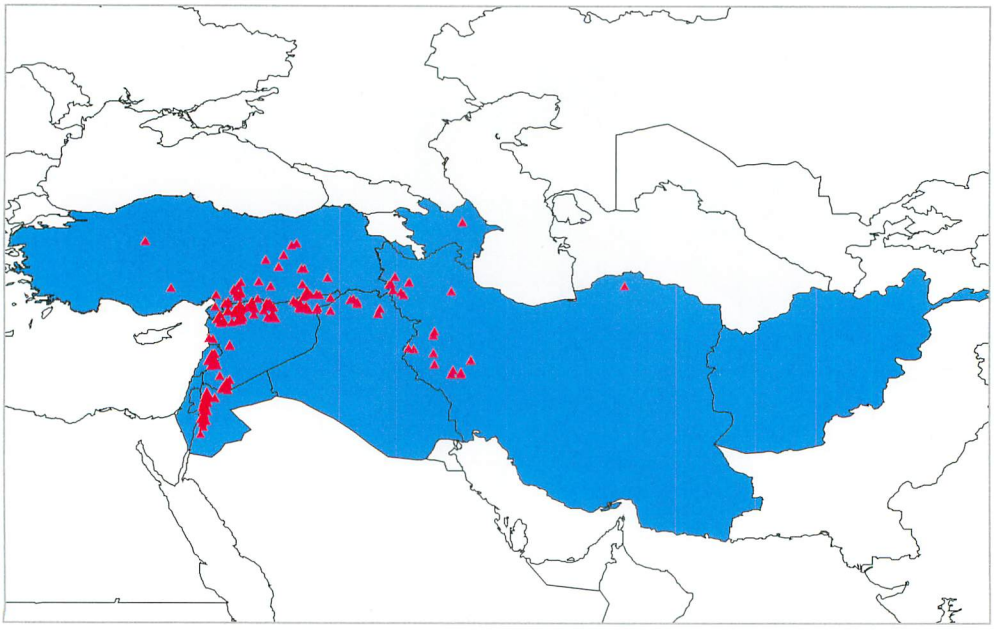

Figure 3.94. Distribution of *Medicago radiata*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

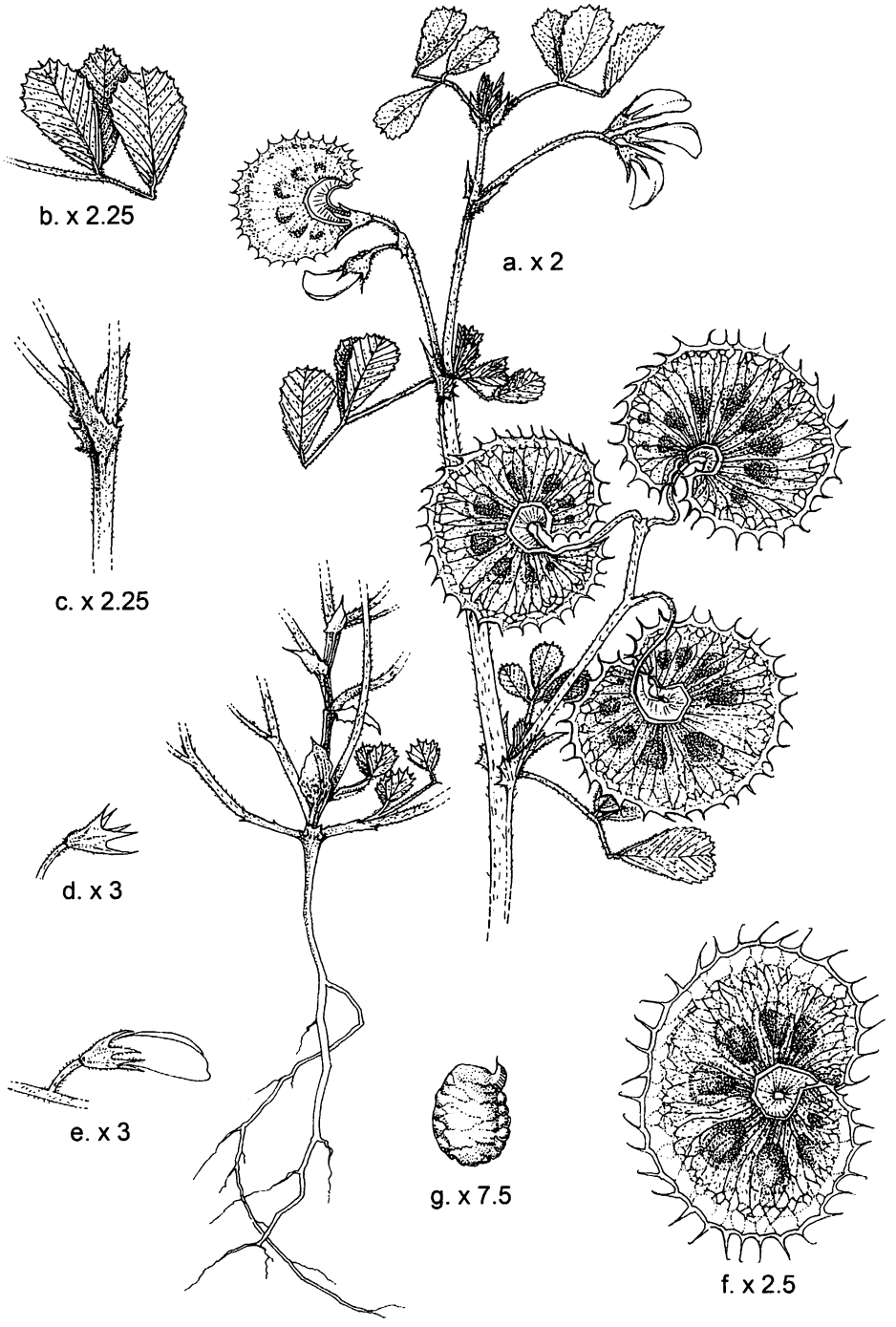

Figure 3.95. *Medicago radiata*: a, habit (x 2), b, leaflet (x 2.25), c, stipule (x 2.25), d, calyx (x 3), e, flower (x 3), f, pod three dimension view (x 2.5), g, seed (x 7.5).

vate or elliptical, margins at apical part serrate or crenate. Peduncle with 1-3 flowers, equal to the corresponding petiole, with terminal cusp. Flower 4-6 mm. Pedicle longer than the calyx tube, bract much shorter than the pedicel, calyx 2.5-3 mm, teeth ± equalling tube. Corolla yellow, standard elliptical to obovate, wings longer than the keel. Pods coiled, glabrous or densely pubescent, with simple hair, discoid, spiny, face reticulate, centre with a large opening. Coils 0.5-1.5 in number, (12-)15-20(-28) mm diameter, convex or concave, convex with fimbriation-winged hairs, with thin wall, veins slender shaped, anastomosing in the outer part of the pod face. Spines slender, fine, not grooved, 1 mm, at one row on a coil edge, inserted at 180 degree to the coil face. Seeds 2.7-3.2 x 2.3-2.7 mm, brown, ovoid, 6-8 per pod, coat ridged, separated, radicle equalling half seed length.

Chromosome number: 16.
Closely related species: It is easily distinguished species, it is large discoid fruits are very distinctive.
Habitat: Dry, rocky hillsides, fallow and cultivated fields.
Geographical distribution: Asia: Afghanistan (N), Azerbaijan (N), Iran (N), Iraq (N). Azerbaijan: Nakhichevan. Europe: France (I), Italy (I) Middle East: Israel (N), Jordan (N), Lebanon (N), Palestine (N), Syria (N), Turkey in Asia (N).
Conservation and threat assessment: Not threatened
Actual and potential usage: Forage.

3.62 *Medicago plicata* (Boiss.) Sirj. Publ. Fac. Sc. Univ. Masaryk, Brno 102: 33 (1928).

Synonyms: *Trigonella plicata* (Boiss. & Bal.) Boiss, Fl. Orient. 2: 90 (1872).
Annual, herb, 5-20 cm, stem ascending to erect, branching at the ground level. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules lanceolate to acuminate, margin entire or dentate. Leaflet 5-9 x 3-9 mm, obovate, apex truncate or emarginate, base cuneate to obcordate, margins dentate. Peduncle with 2-6 flowers, flowers in umbelliform raceme. Flower 4 mm. Pedicle longer than the calyx tube. Calyx 4 mm, sparsely pubescent, longer than half of the corolla, teeth subulate to lanceolate, teeth longer than tube. Corolla yellow, standard with rounded apex. Pods uncoiled, densely pubescent, with simple hair or glandular hair, 10-15 mm, sickle-shaped, spineless, not sessile, without gland-tipped trichomes, face smooth. 5 mm diameter (width), veins 20-30, slender shaped or Y shaped, branching near the ventral suture, venation is a net of veins, vein-less zone absent. Seeds 2.5 x 1.5 mm, ovoid or oblong, 5-6 per pod, coat strongly curved.

Closely related species: It is easily distinguished species as it is the only *Medicago* species with plicate pods.
Habitat: River valleys, stony places.
Geographical distribution: Turkey.

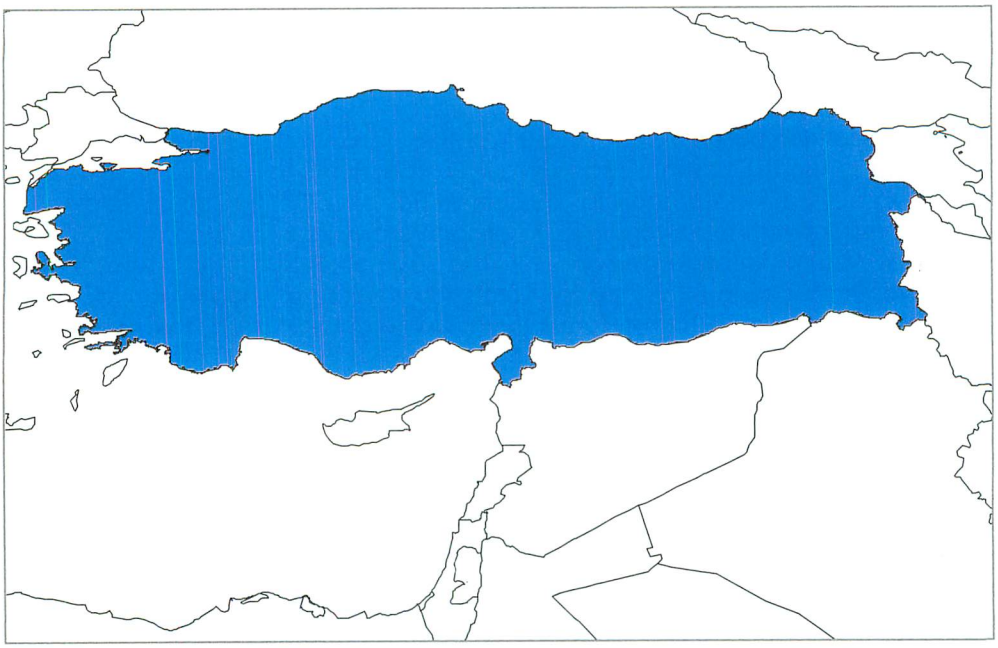

Figure 3.96. Distribution of *Medicago plicata*. (shading represents native distribution).

3.63 *Medicago platycarpa* (L.) Trautv, Acad. Imp. St. Petersburg Bull. Sci. 8: 271 (1841).

Synonyms: *Trigonella platycarpos* L. Sp. Pl.: 776 (1735).
Perennial herb, 40-100 cm, stem arising from the crown, angular in cross section, erect, branching at the ground level. Vegetative parts glabrous. Stipules triangular, margin dentate, teeth at apex part. Leaflet 20-30 x 20-25 mm, elliptical, ventrally sparsely pubescent, margins serrate. Peduncle with 4-7 flowers, flowers in a slender lax raceme, longer than the corresponding petiole, with terminal cusp. Flower 10-13 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx 2-5 mm, sparsely pubescent, with simple hairs, equalling half of the corolla, teeth triangular, teeth shorter than tube with tinged violet-red on the out side. Corolla pale yellow, standard oblong, wings twice as long as the keel. Pods uncoiled, glabrous, black at maturity, 14-22 mm, somewhat curved to straight, spineless, face reticulate. Coil venation obscure, vein-less zone absent, dorsal suture strongly convex, ventral suture weakly convex to straight. Seed 2.5-3x1.8-2 mm, brown to yellow, ovoid, 4-6 per pod, coat smooth.

Chromosome number: 16.
Closely related species: It is similar to *M. ruthenica*, but distinguishable by its rugose seeds and smaller pods.
Habitat: Rocky hillsides, meadows.
Geographical distribution: Asia: China (N), Kazakhstan (N), Kirgizstan (N), Mongolia (N), Russia in Asia (N). China: Xinjiang Uygur. Europe: Russia in Europe (N). Kazakhstan: Alma-Ata, Karaganda, Kokchetav, Pavlodar, Semipalatinsk, Taldy-Kurgan, Vostochno-Kazakhstanskaya. Kirgizstan: Frunze, Issyk-Kul. Mongolia: Dornogovi, Khenti, Khuvsgul, Selenge, Tuv, Uvs, Zavkhan. Russia in Asia: Altay, Buryatiya, Chita, Gorno-Altaisk, Irkutsk, Kemerovo, Khakassia, Khanty-Mansijsk, Krasnoyarsk, Novosibirsk, Tajmyr, Tomsk, Tuva, Tyumen, Ust-Ordynski, Yakutiya. Russia in Europe: Bashkiria, Karelia.
Conservation and threat assessment: Not threatened
Actual and potential usage: Forage.

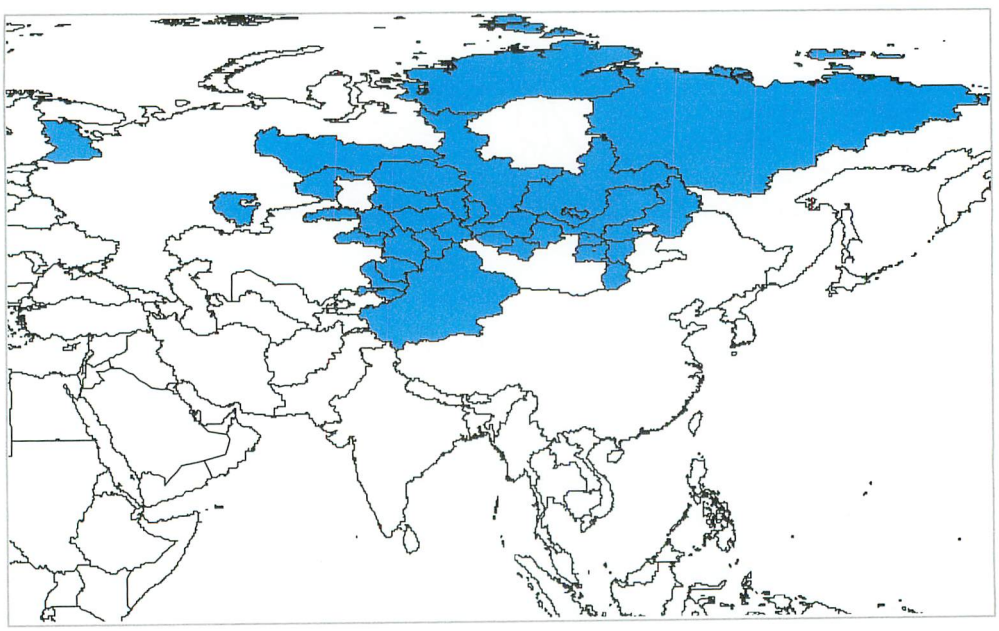

Figure 3.97. Distribution of *Medicago platycarpa*. (shading represents native distribution).

3.64 *Medicago ruthenica* (L.) Ledebour, Fl. Ross. 1: 523 (1842).

Synonyms: *Trigonella ruthenica* L., Sp. Pl.: 776 (1753).
Perennial herb, 30-60 cm, stem arising from the crown, ascending to erect, branch-

ing over the ground level. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules triangular, margin entire or serrate, teeth at base. Leaflet 7-15 x 2-5 mm, obovate to elliptical, dorsally glabrous, ventrally densely pubescent, with appressed hairs, margins serrate at apex. Peduncle with 6-12 flowers, flowers in umbelliform raceme, longer than the corresponding petiole, with terminal cusp. Flower 5-7 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx 2.5 mm, shorter than half of the corolla, teeth triangular, teeth shorter than tube. Corolla yellow, standard oblong, wings as long as the standard. Pods uncoiled, glabrous, 8-12 mm, not subterranean, discoid slightly curved, spineless, not sessile, with hook tip, uncinate, face reticulate. 3.5-4.5 mm diameter (width). Venation is a net of veins, vein-less zone absent, dorsal suture strongly convex, ventral suture weakly convex to straight. Seed 1.8-2.5x1.5-1.8 mm, brown, ovoid, 1-6 per pod, coat verrucose and radicle equalling half seed length.

Closely related species: It is closest to the preceding species *M. platycarpa*, but is distinguished by non-rugose seeds and larger pods.
Habitat: Sunny hillsides, grasses steppes, wood areas, meadows, roadsides sandy river beds and sand dunes.
Geographical distribution: Asia: China (N), Korea (N), Mongolia (N), Russia in Asia (N). China: Gansu, Shandong, Sichuan. Mongolia: Arkangai, Bayankhongor,

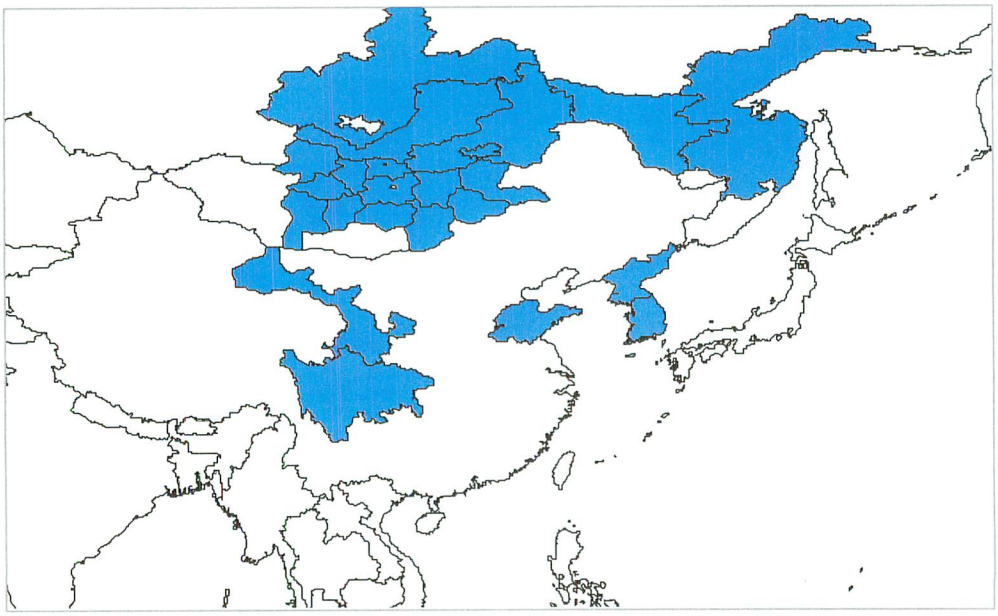

Figure 3.98. Distribution of *Medicago ruthenica*. (shading represents native distribution).

Bulgan, Dornod, Dornogovi, Dundgovi, Khenti, Khuvsgul, Selenge, Sukh Baatar, Tuv, Uvurkhangai. Russia in Asia: Aginskoe, Amur, Buryatiya, Chita, Irkutsk, Khabarovsk.
Conservation and threat assessment: Not threatened
Actual and potential usage: Forage and medicine. This species has a notable ability to survive under mechanical and physiological stress, so it has excellent prospects both, as a forage crop and as a potential source of genes for improving tolerance to abiotic stress in other species.

3.65 *Medicago popovii* (E. Kor.) Sirj., Bull. Misc. Inform. Kew 7: 271 (1928).

Synonyms: *Trigonella popvii* E. Kor., Not. Syst. ex Herb. Hort. Bot. Petrop. 5(11-12): 177 (1914).
Perennial herb, 15-60 cm, stem ascending to erect, branching over the ground level. Vegetative parts sparsely pubescent, with defuse, simple hairs. Stipules lanceolate, margin laciniate, teeth around margin. Leaflet 8-12 x 5-9 mm, elliptical, apex apiculate, base oblique, dorsally glabrous, ventrally sparsely pubescent, with defuse hairs if present, margins dentate. Peduncle with 2-6 flowers, flowers gathered in a spike-like raceme, longer than the corresponding petiole, with terminal cusp. Flower 4-6 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx 2.5-5 mm, sparsely pubescent, with simple hairs if present, equalling half of the corolla, teeth triangular to subulate, teeth longer than tube. Corolla violet or yellow, standard with a violet hue on the outer side. Pods uncoiled, glabrous to sparsely pubescent, yellow, 5-8 mm, not subterranean, discoid to ovoid, spine-

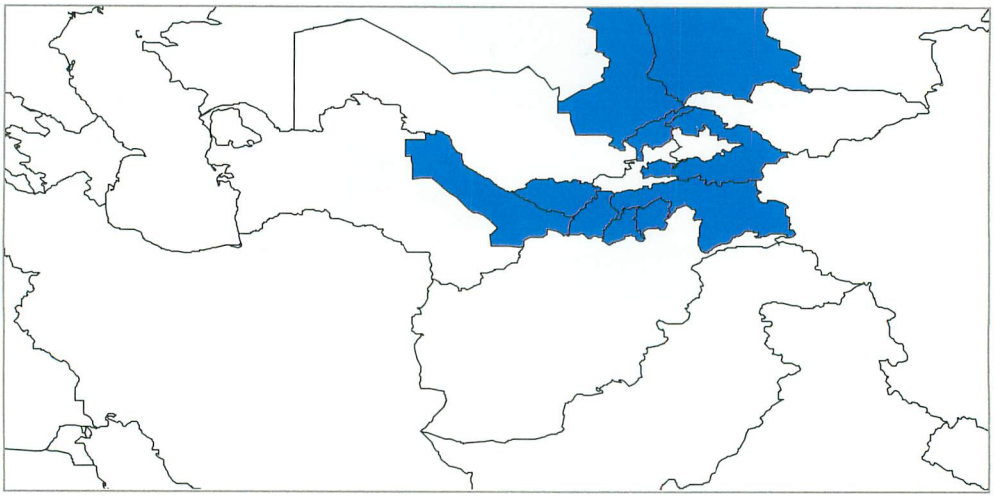

Figure 3.99. Distribution of *Medicago popovii*. (shading represents native distribution).

less, not sessile, with hook tip, uncinate, face reticulate. 3.5-5 mm (width) diameter, coils with woody wall, veins slender shaped, anastomosing in the half distance from the dorsal suture, venation is a net of veins, vein-less zone absent, dorsal suture strongly convex, ventral suture strongly convex. Seeds 2-3 x 1-2 mm, red-yellow, rhomboid, (1-)2-3 per pod, coat smooth.

Closely related species: It is could be confused with *M. platycarpa* from which it can be distinguished by its smaller fruits, also it may possibly be confused with *M. ruthenica* but can be distinguished by the notably convex coil sutures.
Habitat: Clay and stony slopes of upper tree-shrubs zone, river banks and valleys, meadows in sub-alpine zones.
Geographical distribution: Asia: Kazakhstan (N), Kirgizstan (N), Tadzhikistan (N), Turkmenistan (N), Uzbekistan (N), Kazakhstan: Chimkent, Dzhambul. Kirgizstan: Osh. Tadzhikistan: Dushanbe, Kulyab, Leninabad. Turkmenistan: Chardzhou. Uzbekistan: Kashkadarinskaya, Surhandarinskaya, Tashkent.

3.66 *Medicago archiducis-nicolai* Sirj., Bull. Misc. Inform. Kew. 7: 270-271 (1928).

Synonyms: *Trigonella archiducis-nicolai* (Sirj.) Vassilcz., Inst. Bot. Acad. Sci. URSS, Ser. 1, Fasc. 10, 172 (1953).
Perennial herb, 40-80 cm, stem arising from the crown, angular in cross section. Vegetative parts glabrous or sparsely pubescent. Stipules lanceolate, margin dentate, teeth around margin. Leaflet 17-20 x 13-14 mm, elliptical, dorsally glabrous, margins entire or serrate at apex. Peduncle with 4-5 flowers, flowers gathered in a compact raceme, shorter than to equal to the corresponding petiole. Flower 7-8 mm. Bract shorter than the pedicel, calyx 4 mm, sparsely pubescent, with simple hairs, shorter than half of the corolla, teeth triangular to lanceolate. Corolla yellow, standard oval, with rounded apex. Pods uncoiled, glabrous, brown, 7-14 mm, straight to sickle-shaped, spineless, not sessile, without gland-tipped trichomes, face reticulate. 3-5 mm diameter, first coil seedless, veins curved, anastomosing in the outer part of the pod face, branching near the ventral suture, venation is a net of veins, vein-less zone absent, dorsal suture strongly convex, ventral suture weakly convex to straight. Seeds 2-4 per pod, coat smooth, radicle more than half seed length.

Closely related species: It can be confused with *M. platycarpa*; however the pods of *M. platycarpa* are larger than the pods of *M. archiducis-nicolai*.
Habitat: Valleys of rivers and humus rich soil on slopes in spruce forest, steep rocky banks, dry hill slopes, cultivated areas, stony pastures, dry sandy and rocky soils.
Geographical distribution: China: Gansu, Ningxia, Quinghai, Shaanxi, Sichuan, Xizang Zizhiqu.

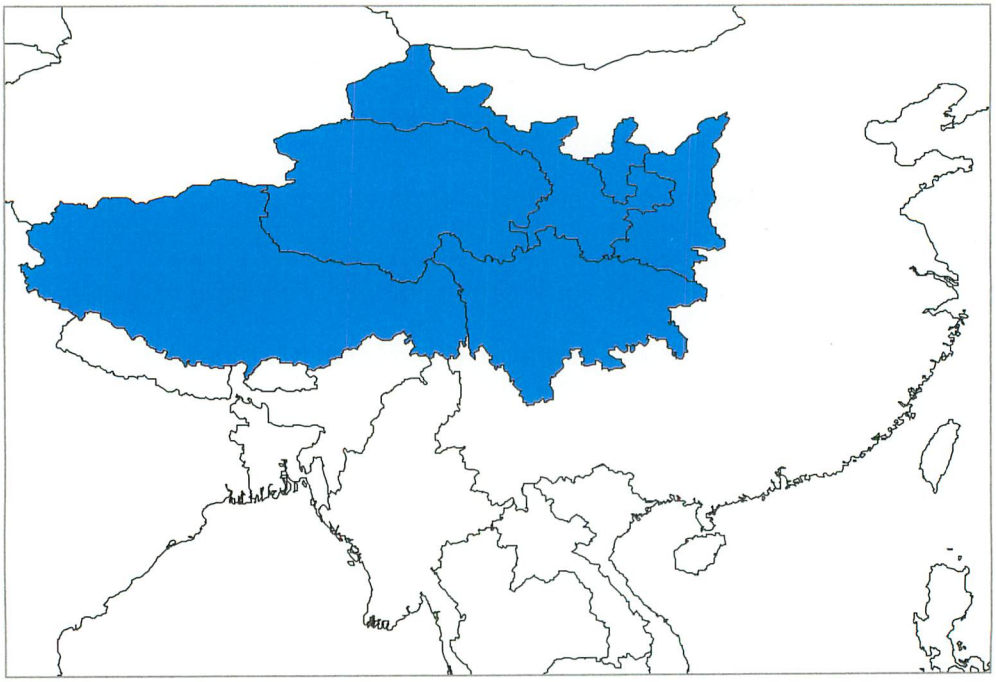

Figure 3.100. Distribution of *Medicago archiducis-nicolai*. (shading represents native distribution).

3.67 *Medicago edgeworthii* Sirj., □esterr. Bot. Z. 87: 123 (1938).

Synonyms: *Trigonella pubescens* Edgew. ex Baker in Hook. F, Fl. Ind. 2: 88 (1876); *Medicago pubescens* (Edgew. ex Baker) Sirj., Publ. Fac. Sci. Univ. Masaryk (Brno) 170: 17 (1933).

Perennial herb. Stem ascending. Vegetative parts sparsely pubescent. Stipules lanceolate to acuminate, margin dentate. Leaflet 10-15 x 4-6 mm, obovate, apex truncate, base attenuate. Peduncle with 2-4 flowers, longer than the corresponding petiole. Flower 5 mm. Pedicle shorter than the calyx tube. Calyx 3-4 mm, densely pubescent, with simple hairs, shorter than half of the corolla, teeth lanceolate. Corolla yellow. Pods uncoiled, glabrous to densely pubescent, brown, 12-16 mm, straight, spineless, not sessile, without gland-tipped trichomes, face reticulate. 4-5 mm diameter, veins anastomosing in the outer part of the pod face, venation is a net of veins, vein-less zone absent, dorsal suture strongly convex, ventral suture weakly convex to straight. Seeds 4-15 per pod, coat smooth, radicle more than half seed length.

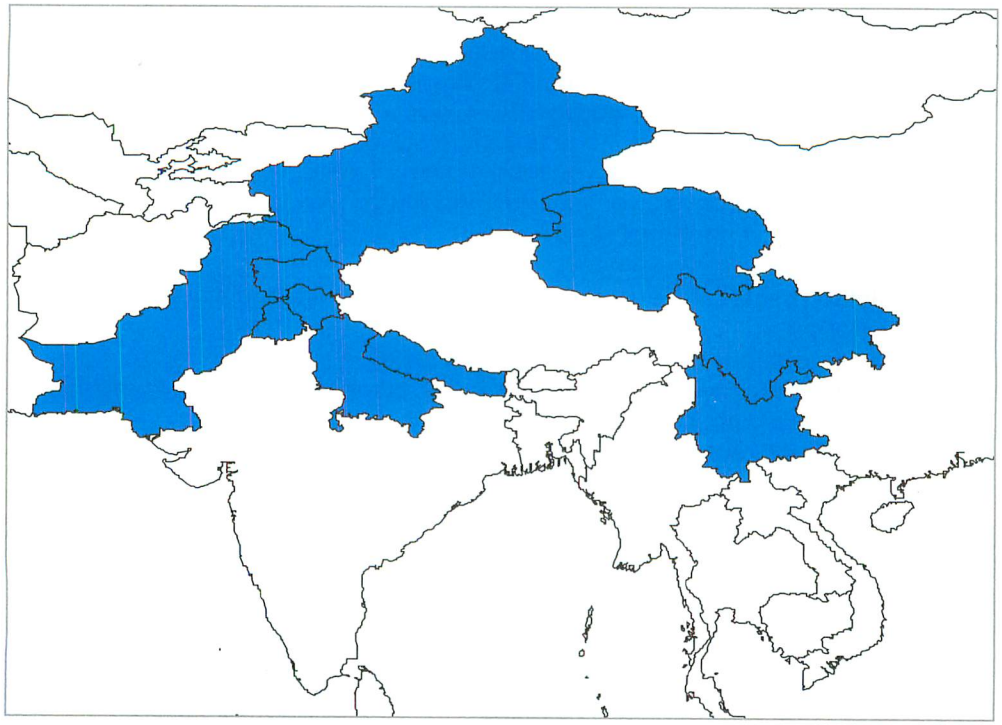

Figure 3.101. Distribution of *Medicago edgeworthii*. (shading represents native distribution).

Closely related species: It is easily distinguished species with its pods straight ventral suture, curved dorsal suture and pubescence.
Habitat: Steep rocky banks, dry slopes, cultivated areas, stony pastures, dry sandy and rocky soils, steep rocky banks, dry hill slopes, cultivated areas, stony pastures, dry sandy and rocky soils
Geographical distribution: Asia: Afghanistan (U), China (N), India (N), Nepal (N), Pakistan (N). China: Quinghai, Sichuan, Xizang Zizhiqu, Yunnan. India: Himachal Pradesh, Jammu-Kashmir, Punjab, Uttar Pradesh.

3.68 *Medicago cretacea* M. Bieb., Fl. Taur. Cauc. 2: 223 (1808).

Synonyms: *Trigonella cretacea* (M. Bieb.) Grossh. in Komarov, Fl. SSSR. 11: 120 (1945).
Perennial herb, 10-25 cm, stems arising from the creeping rootstock, procumbent to decumbent. Vegetative parts glabrous. Stipules lanceolate, margin entire. Leaflet 5-6 x 4-5 mm, obovate, base cuneate, dorsally glabrous, ventrally glabrous, margins serrate. Peduncle with 4-6 flowers, flowers in a slender lax raceme, shorter than or

equal to the corresponding petiole. Flower 4-5 mm. Pedicle longer than the calyx tube, bract shorter than the pedicel, calyx 2-2.5 mm, equalling half of the corolla, teeth subulate, teeth longer than tube. Corolla yellow, standard oblong. Pods uncoiled, glabrous to densely pubescent, 5-6 mm, reniforme, spineless, not sessile, without gland-tipped trichomes, face reticulate. 4-5 mm diameter, veins Y shaped, branching near the dorsal suture, venation is a net of veins, vein-less zone absent, dorsal suture strongly convex, ventral suture weakly convex to straight. Seeds 1-2 per pod, radicle more than half seed length.

Closely related species: It is easily distinguished species with its distinctive reniform pods with 1(2)-seeds.
Habitat: Dry calcareous soils in lower mountain zones.
Geographical distribution: Asia: Russia in Asia (N). Europe: Ukraine (N). Russia in Asia: Krasnodar. Ukraine: Krym.
Conservation and threat assessment: Not threatened

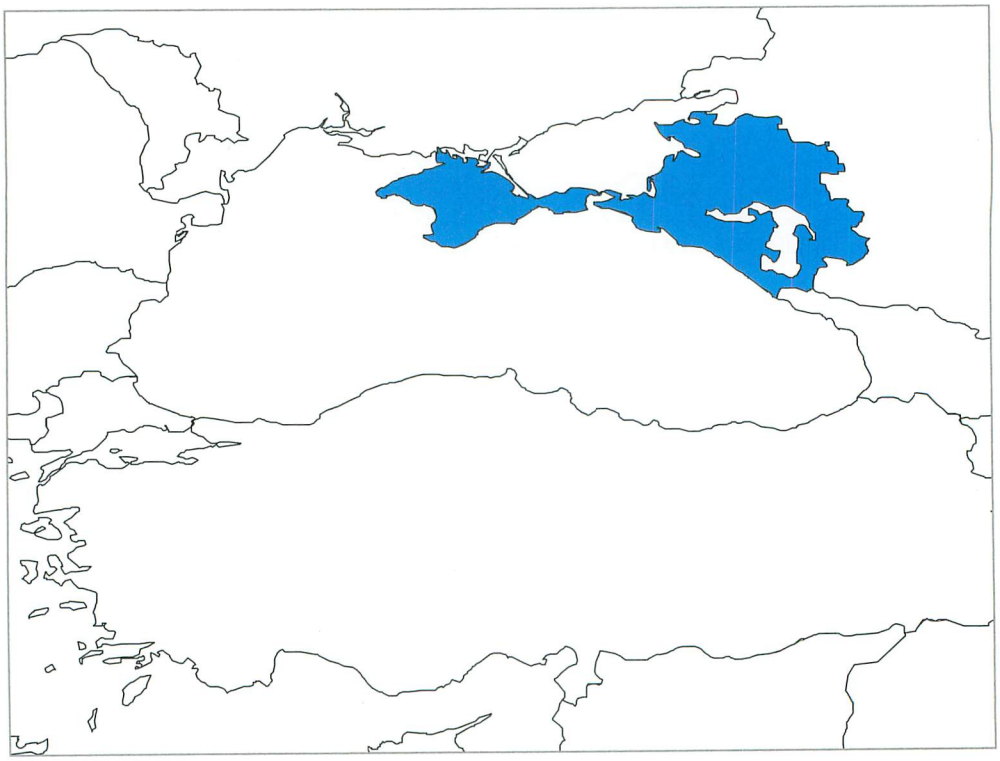

Figure 3.102. Distribution of *Medicago cretacea*. (shading represents native distribution).

3.69 Medicago ovalis (Boiss.) Sirj., Verh. Bot. Vereins Prov. Brandenburg 15: 81 (1873).

Synonyms: *Trigonella ovalis* (Boiss. & Bal.) Boiss, Fl. Orient. 2: 89 (1872).
Annual, herb, 12-17 cm, stems ascending. Vegetative parts densely pubescent. Stipules lanceolate, margin dentate. Leaflet 10-30 x 10-15 mm, ovate, margins at apical part dentate. Peduncle with 3-15 flowers, shorter than the corresponding petiole. Calyx 3-4 mm, densely pubescent, with simple hairs, teeth subulate, teeth ± equalling or longer than tube. Corolla yellow. Pods uncoiled, densely pubescent, green-brown, 8-12 mm, not subterranean, straight to ovoid, spineless, without gland-tipped trichomes, with crescent tip or hook tip, uncinata, face reticulate, veins Y shaped, anastomosing in the half distance from the dorsal suture, venation is a net of veins, vein-less zone absent, ventral suture weakly convex to straight. Seeds 4-15 per pod, coat verrucose, radicle more than half seed length.

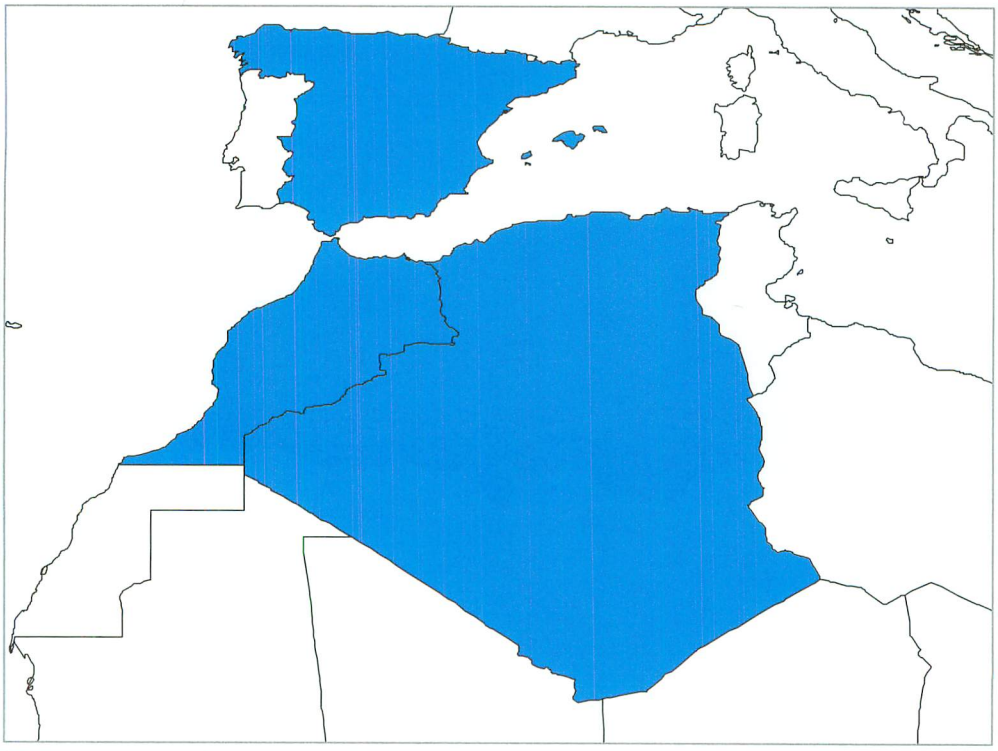

Figure 3.103. Distribution of *Medicago ovalis*. (shading represents native distribution).

Closely related species: It is unlikely to be mistaken as within its range it is the only species with short, broad pods.
Habitat: Dry limestone slopes with sandy soils in lower mountain zones.
Geographical distribution: Africa: Algeria (N), Morocco (N) Europe: Spain (N).
Conservation and threat assessment: Not threatened

3.70 *Medicago rostrata* (Boiss. & Bal.) E. Small, Willdenowia 16(2): 434 (1987).

Synonyms: *Trigonella rostrata* (Boiss. & Bal.) Boiss, Fl. Orient. 2: 89 (1872).
Annual, herb, 5-25 cm, stem ascending, branching at the ground level. Vegetative parts densely pubescent, with appressed or defuse, simple and glandular hairs. Stipules ovate to lanceolate, margin entire. Leaflet 5-10 x 3-6 mm, obovate, base cuneate to obcordate, dorsally densely pubescent, and ventrally densely pubescent, with erect hairs, margins entire. Peduncle with 3-6 flowers, flowers in umbelliform raceme, longer than the corresponding petiole, with terminal cusp. Flower 3-7 mm. Pedicle shorter than the calyx tube. Calyx 5-7 mm, densely pubescent, with simple and glandular hairs, erect hairs, shorter than to equalling half of the corolla,

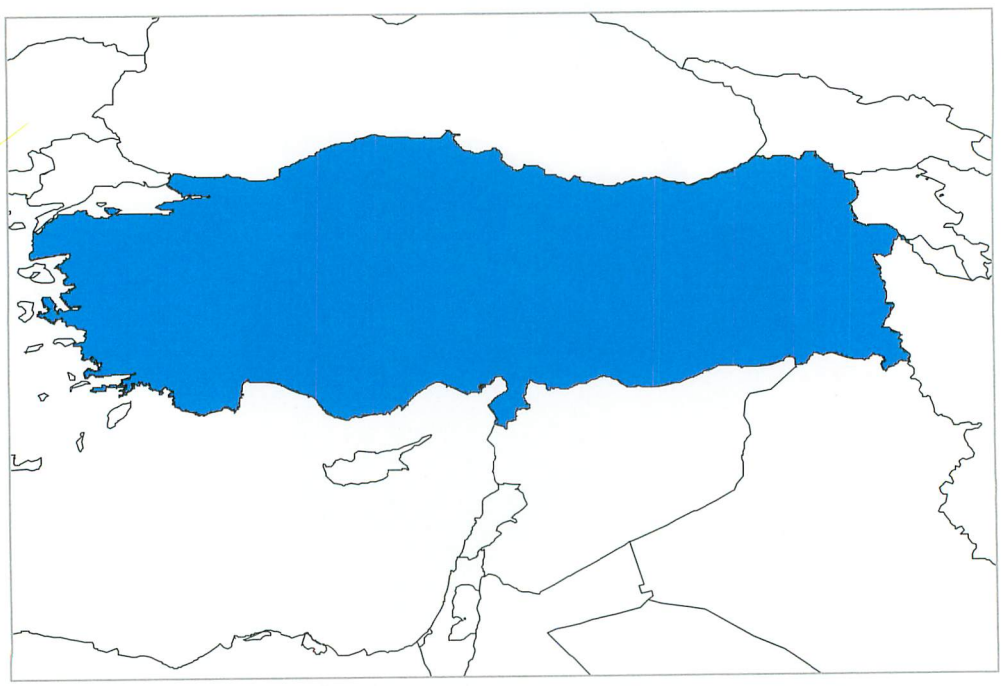

Figure 3.104. Distribution of *Medicago rostrata*. (shading represents native distribution).

teeth subulate to lanceolate, teeth longer than tube. Corolla bright yellow. Pods uncoiled, densely pubescent, with simple and glandular hairs, brown, 7-8 mm, not subterranean, sickle-shaped to reniforme, spineless, with gland-tipped trichomes, with crescent tip, face reticulate. 4-5 mm diameter, veins curved, branching near the dorsal suture, venation is a net of veins, vein-less zone absent, dorsal suture strongly convex. Seeds 2.5 x 1.5 mm, red-yellow, ovoid, 3-5 per pod, coat verrucose, radicle more than half seed length.

Closely related species: It is easily distinguished as it is the only species with lunate pods and gland tipped hairs.
Habitat: Stony slopes, steppes, Pinus nigra forest, fields and field margins, pastures, orchards and valley bottoms.
Geographical distribution: Turkey (N).

3.71 *Medicago biflora* (Griseb.) E. Small, Willdenowia 16(2): 434 (1987).

Synonyms: *Trigonella lunata* Boiss, Diagn. Pl. Orient. 2: 20 (1843); Trigonella biflora Griseb., Spic. Fl. Rumel. 1: 41 (1843).
Annual, herb, 5-35 cm, stems ascending to erect. Vegetative parts densely pubescent, with erect, simple and glandular hairs. Stipules ovate to lanceolate, margin entire or serrate. Leaflet 4-10 x 3-6 mm, obovate, apex truncate, base cuneate to obcordate, ventrally densely pubescent, with erect hairs, margins crenate apical part. Peduncle with 1-3 flowers, flowers in umbelliform raceme, shorter than the corresponding petiole, with terminal cusp. Flower 5-9 mm. Pedicle equal to the calyx tube. Calyx 5-6 mm, densely pubescent, with simple hairs, erect hairs, shorter than to equalling half of the corolla, teeth subulate, teeth longer than tube. Corolla yellow, standard obovate, with retuse apex, standard as long as the wings. Pods uncoiled, densely pubescent, with glandular hair, brown, 15-22 mm, sickle-shaped to reniforme, spineless, with gland-tipped trichomes, with hook tip, uncinate, face reticulate. 8-13 mm diameter, veins slender shaped, not changing direction before joining the dorsal suture, anastomosing in the outer part of the pod face, venation is a net of veins, vein-less zone absent, dorsal suture strongly convex, ventral suture strongly convex. Seeds 2.5 x 1.5 mm, ovoid, 7-10 per pod, coat verrucose.

Closely related species: This species is similar to the preceding species.
Habitat: Limestone scree and slopes, pasture, meadows, fallow, dry, stony slopes, among scattered scrub and trees, in dry river beds, a weed of fallow and cultivated land.
Geographical distribution: Asia: Iran (N), Middle East: Syria (N), Turkey in Asia (N).

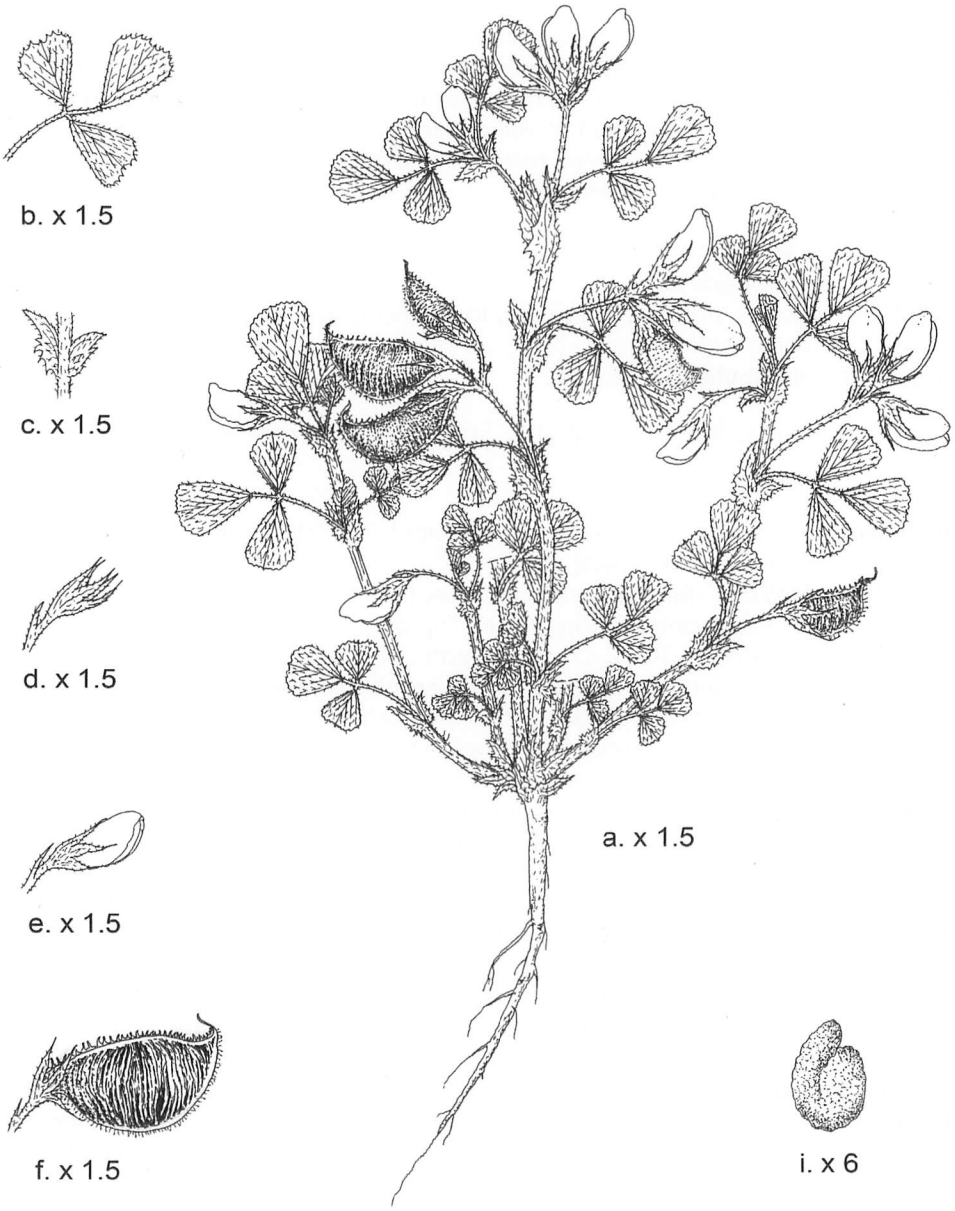

Figure 3.106. *Medicago biflora*: a, habit (x 1.5), b, leaflet (x 1.5) c, stipule (x 1.5), d, calyx (x 1.5), e, flower (x 1.5), f, pod three dimension view (x 1.5), f, pod tip view (x 1.5) f, pod venation (x 1.5), i, seed (x 6).

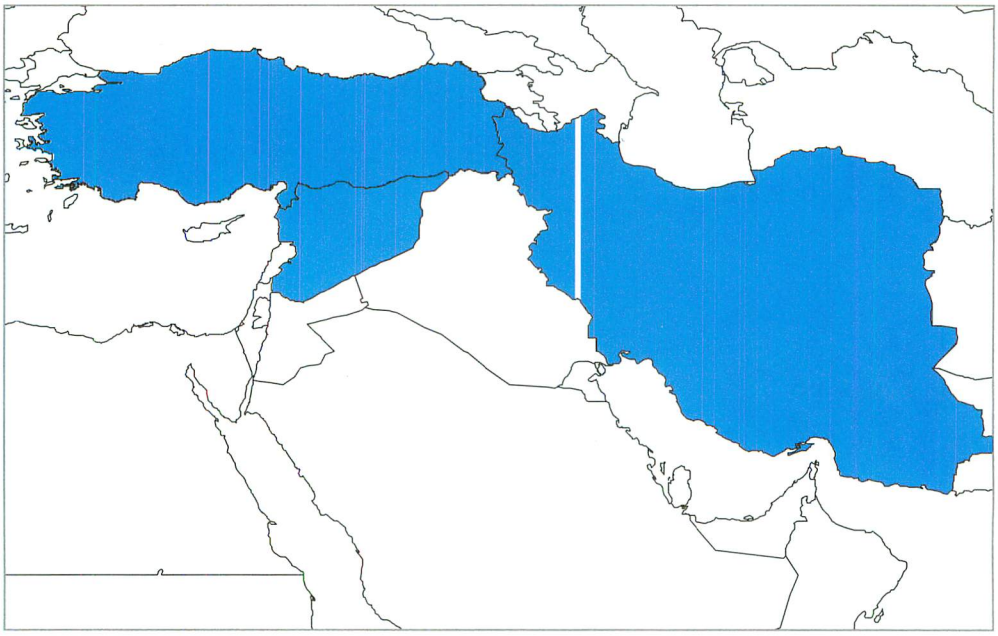

Figure 3.105. Distribution of *Medicago biflora*. (shading represents native distribution).

3.72 *Medicago brachycarpa* M. Bieb, Fl. Taur.-Cauc. 3: 517 (1820).

Synonyms: *Trigonella brachycarpa* (Fisch.) Moris, Mem. Reale Acad. Sci. Torino 36: 190 (1833).

Annual, herb, 3-25 cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, erect, simple hairs. Stipules ovate to lanceolate, margin entire to dentate. Leaflet 7-15 x 3.5-4 mm, obovate, apex obtuse, base cuneate, margins dentate. Peduncle with 10-16 flowers, flowers in elongate raceme, shorter or longer than the corresponding petiole, with terminal cusp. Flower 4-8 mm. Bract shorter than the pedicel, calyx 3 mm, densely pubescent, with simple hairs, defuse hairs, longer than half of the corolla, teeth subulate, and teeth shorter than tube. Corolla yellow. Pods coiled, densely pubescent, with simple hair, green-brown, 4-6 mm, not subterranean, discoid to ovoid, spineless, sessile, without gland-tipped trichomes, with hook tip, uncinate, face reticulate with elevated transversal nerves. Coil venation is a net of parallel veins rarely anastomosing, vein-less zone absent, dorsal suture strongly convex. Seeds 2-2.5 x 1.5 mm, brown, ovoid, 1-2 per pod, coat verrucose, radicle more than half seed length.

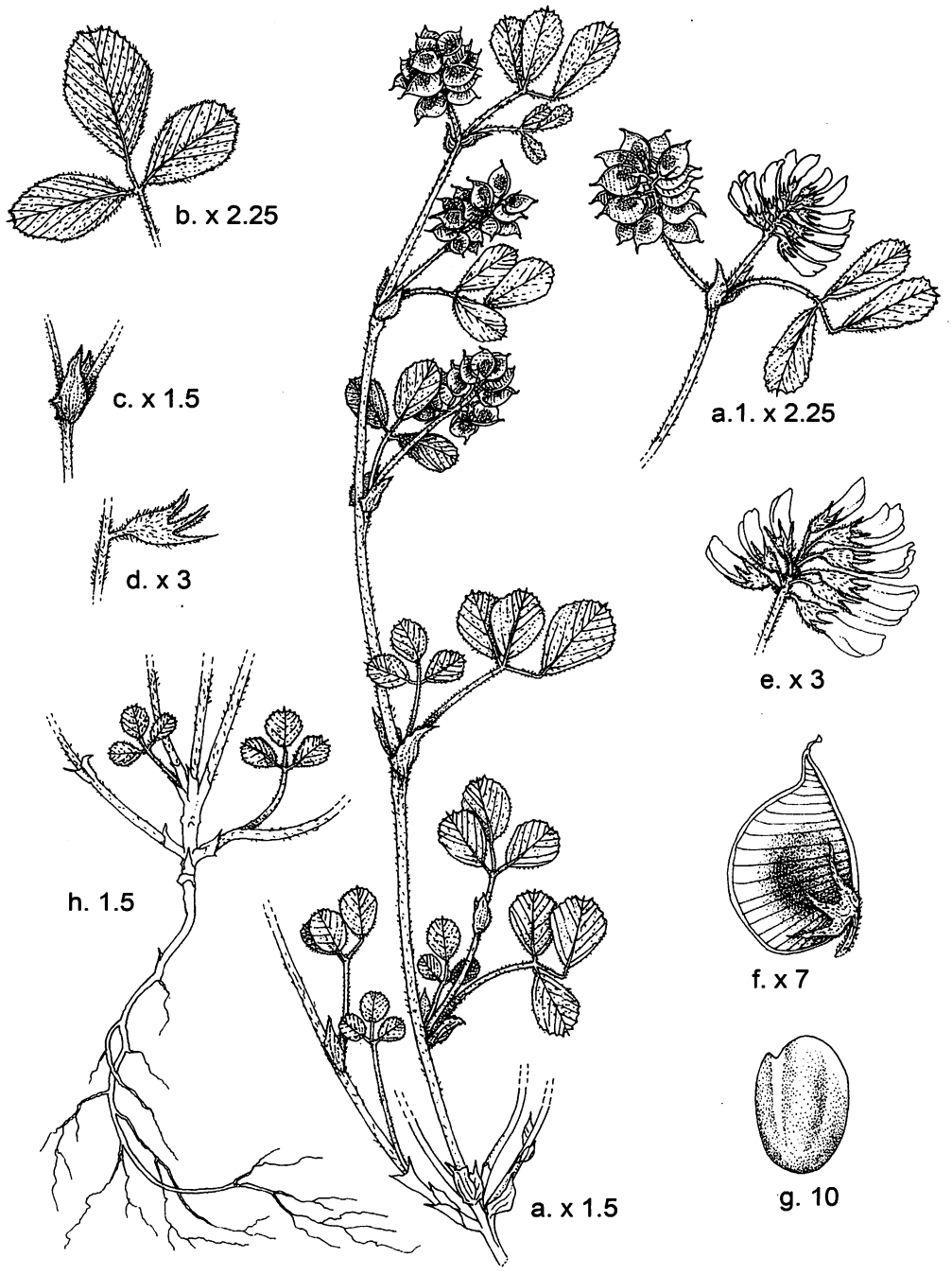

Figure 3.108. *Medicago brachycarpa*: a, habit (x 1.5), a.1 branch (2.25), b, leaflet (x 2.25), c, stipule (x 1.5), d, calyx (x 3), e, flower (x 3), f, pod three dimension view (x 7), g, seed (x 10), h, root and stem (x 1.5).

Closely related species: This species is closest to *M. huberi* and both could be confused with *M. cretacea*, which however has fewer flowers in the raceme and a different fruit shape.
Habitat: Dry open habitats such as, pine forests, oak scrub, steppe, cultivated fields, calcareous slopes, limestone rocks, road verges, grassy and gravely slopes, cultivated and fallow fields.
Geographical distribution: Asia: Azerbaijan (N), Georgia (N), Iran (N), Iraq (N). Azerbaijan: Azerbaijan, Nakhichevan. Europe: Ukraine (U). Georgia: Georgia. Middle East: Lebanon (N), Syria (N), Turkey in Asia (N). Ukraine: Krym.
Conservation and threat assessment: Not threatened

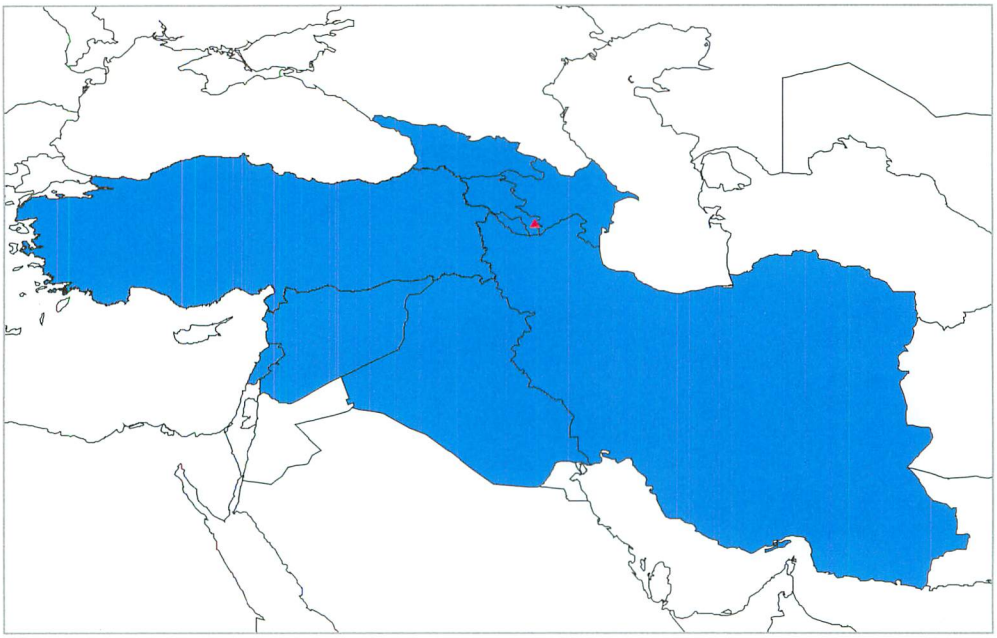

Figure 3.107. Distribution of *Medicago brachycarpa*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.73 *Medicago huberi* E. Small, Willdenowia 10 (2): 434 (1987).

Synonyms: Trigonella sirjaevii Hub.-Mor. in Feddes Rep. 46: 135 (1939).
Annual, herb, 3-6 cm, stem procumbent, branching over the ground level. Vegetative parts densely pubescent, erect, simple hairs. Stipules ovate to lanceolate, margin entire. Leaflet 6-10 x 5-8 mm, obovate, apex truncate, base cuneate to obcordate, dorsally densely pubescent, ventrally densely pubescent, with defuse to erect hairs, margins dentate. Peduncle absent, 10-15 flowers, flowers in

umbelliform raceme. Flower 3-7 mm. Calyx 4-5 mm, densely pubescent, with simple defuse hairs, equalling half of the corolla, teeth lanceolate, teeth ± equalling tube. Corolla yellow. Pods uncoiled, densely pubescent, with simple hair, brown, with beak 8-10 mm, not subterranean, half ovoid to reniforme, spineless, not sessile, without gland-tipped trichomes, face reticulate. 3-4.5 mm diameter, veins slender shaped, not changing direction before joining the dorsal suture, venation is a net of veins parallel veins with few anastomosing, vein-less zone absent, dorsal suture below the lateral veins. Seeds 3 x 2 mm, 1-2 per pod, coat verrucose, radicle more than half seed length.

Closely related species: It is closely related to the preceding species.
Habitat: Pine forests, stony slopes and open scrub.
Geographical distribution: Turkey.

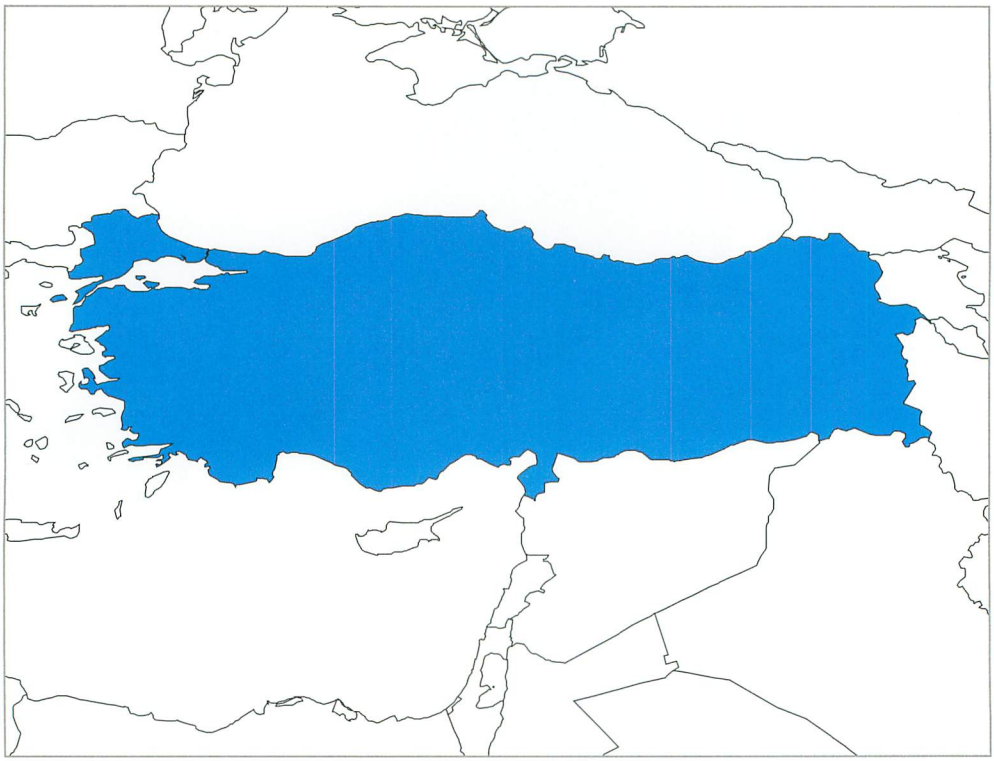

Figure 3.109. Distribution of *Medicago huberi*. (shading represents native distribution).

3.74 *Medicago astroites* (Fischer. & C.A. Meyer) Trautv., Bull. Sci. Acad. Imp. Sci. Saint-Petersburg 8: 271 (1841).

Synonyms: *Trigonella astroites* Fischer. & C.A. Meyer, Index Sem. Hort. Petrop. 1: 40 (1835).

Annual, herb, 5-15(-25) cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with appressed, simple or glandular hairs. Stipules lanceolate to acuminate, margin entire to dentate, teeth at base. Leaflet 3.5-8 x 2.5-8 mm, obovate or obolanceolate, apex retuse, base cuneate, dorsally sparsely pubescent, ventrally densely pubescent, with defuse hairs, margins at upper half dentate. Peduncle with 6-12 flowers, flowers in a head-shape raceme capitates, equal to the corresponding petiole to longer than the corresponding petiole, with terminal cusp. Flower 4-8 mm. Pedicle shorter to equal to the calyx tube, bract shorter than the pedicel, calyx 2-3.5 mm, densely pubescent, with simple appressed hairs, shorter or equalling half of the corolla, teeth lanceolate, teeth ± equalling tube. Corolla yellow, standard oblong, with emarginate apex, wings slightly shorter than the keel. Pods uncoiled, densely pubescent, with simple hair, brown, 10-20 mm, not subterranean, stellate-spreading from the axis, straight to sickle-shaped, spineless, face reticulate with looping veins. 1-2 mm

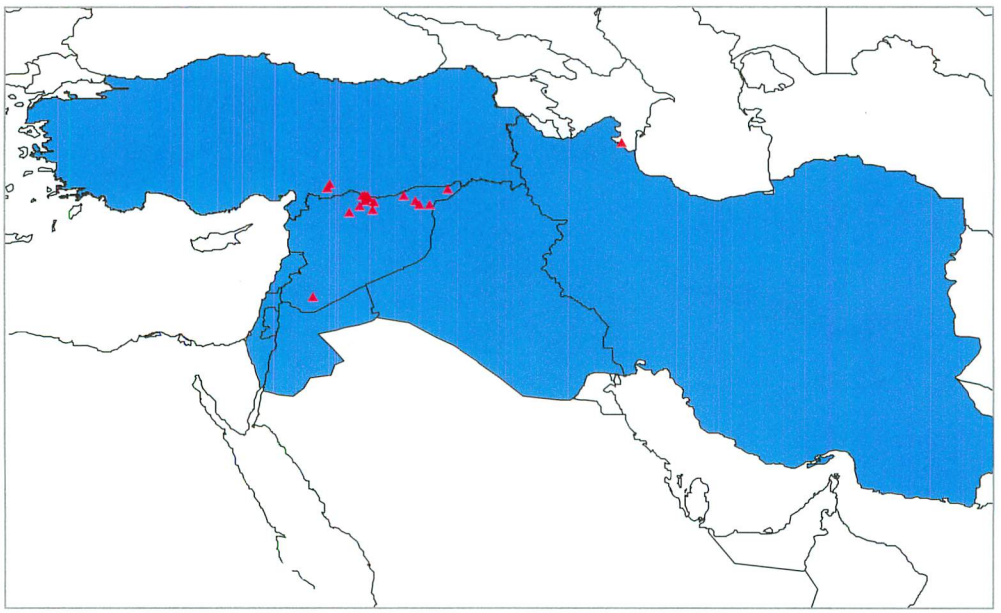

Figure 3.110. Distribution of *Medicago astroites*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

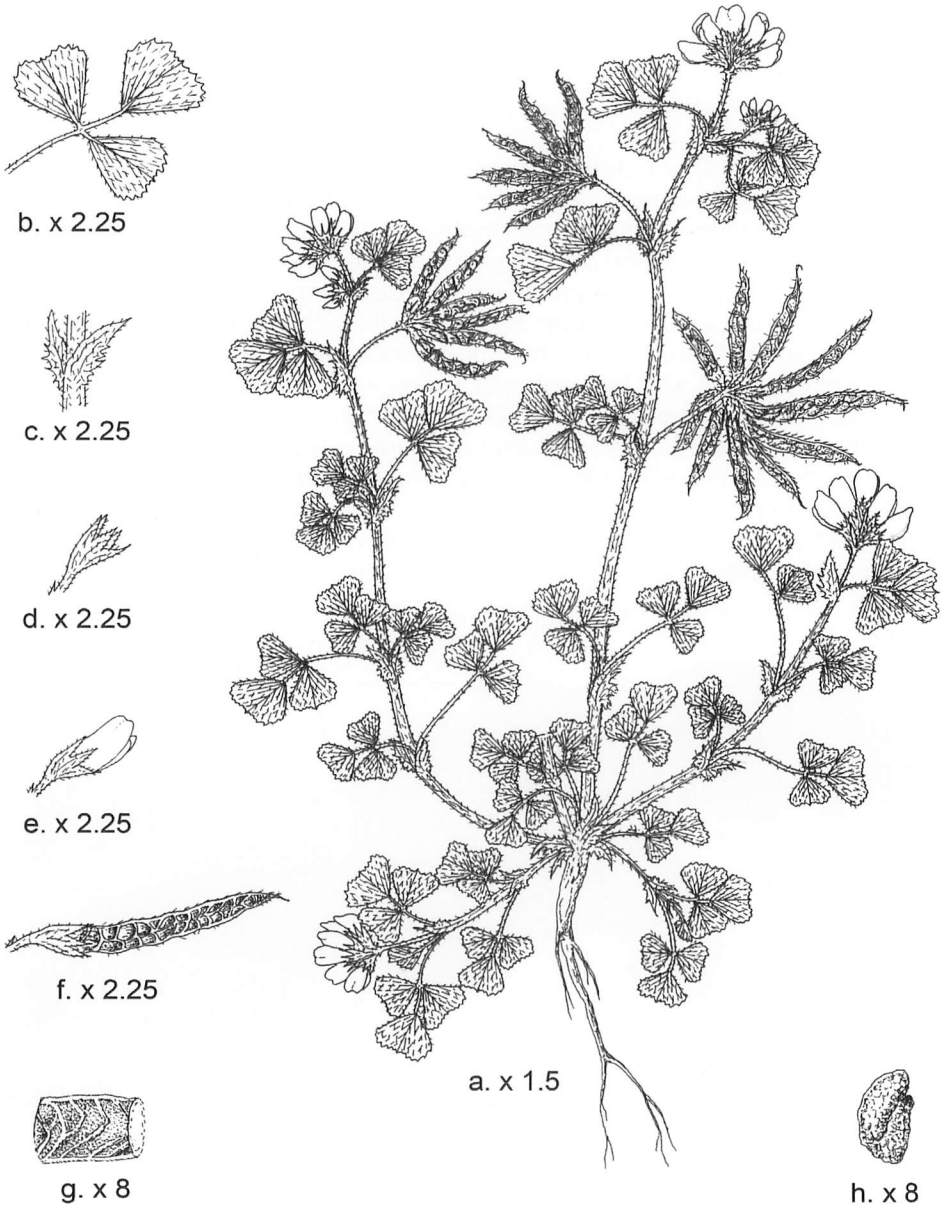

Figure 3.111. *Medicago astroites*: a, habit (x 1.5), b, leaflet (x 2.25), c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 2.25), f, pod tip view (x 2.25), g, pod venation (x 8), i, seed (x 8).

diameter, veins curved, venation appear harder horny substance. Seeds 2 x 0.5-1 mm, brown, cylindrical, 4-6 per pod, coat verrucose.

Closely related species: It is most closely related to *M. halophila*, both have a somewhat sub-undulating dorsal fruit suture.
Habitat: Dry rocky slopes, sands, dry gravely river beds, steppes, among shrubs and in pine forests, in cultivated land, roadsides, dry soils especially sands.
Geographical distribution: Asia: Iran (N), Iraq (N) Middle East: Israel (N), Jordan (N), Lebanon (N), Palestine (N), Syria (N), Turkey in Asia (N).

3.75 *Medicago halophila* (Boiss.) E. Small, Willdenowia 16(2): 433 (1987).

Synonyms: Trigonella halophila Boiss, Diagn. Pl. Orient. ser. 2(5): 78 (1856).
Annual, herb, 3-15 cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with appressed, simple hairs or simple and glandular hairs. Stipules lanceolate to acuminate, margin dentate. Leaflet 2-4 x 2-3 mm, obovate, apex truncate, base cuneate, dorsally densely pubescent, ventrally densely pubescent, with defuse hairs, margins dentate. Peduncle with 6-7

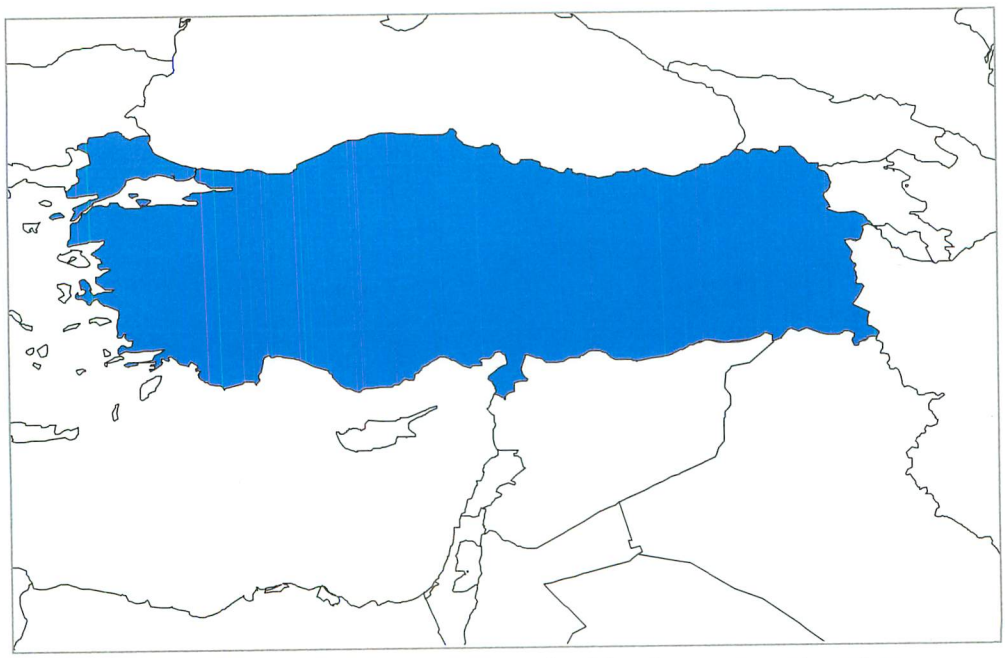

Figure 3.112. Distribution of *Medicago halophila*. (shading represents native distribution).

flowers, flowers in umbelliform raceme, longer than the corresponding petiole. Flower 3.5-6 mm. Calyx 2-2.5 mm, densely pubescent, with simple appressed hairs, shorter than half of the corolla, teeth triangular to lanceolate, teeth shorter than tube. Corolla yellow, wings of corolla entire. Pods uncoiled, densely pubescent, with simple hair or simple and glandular hairs, yellow, 10-13 mm, not subterranean, straight to sickle-shaped, spineless, with connivent tip, face reticulate. 1-1.5 mm diameter, veins curved, branching near the dorsal suture, venation as shoulders siding at 90 degrees. Seeds 2 x 1 mm, brown, oblong, 3-4 per pod, and coat with tubercles.

Closely related species: It is related to the preceding species.
Habitat: Sand dunes near the sea, part of the East Mediterranean floristic element.
Geographical distribution: Turkey.

3.76 *Medicago arenicola* (Huber-Morath) E. Small, Willdenowia 16(2): 433 (1987).

Synonyms: *Trigonella arenicola* Huber- Morath, Notes Roy. Bot. Gard. Edinburgh 29: 322 (1969).
Annual, herb, 3-10 cm, stem procumbent, branching at the ground level. Vegetative parts densely pubescent, with appressed, simple hairs or simple and

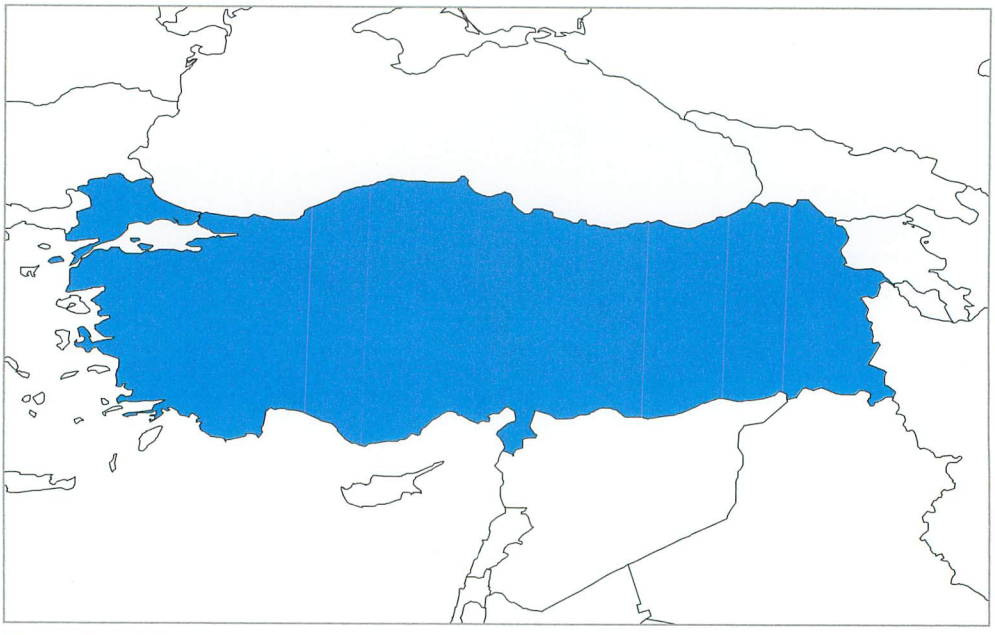

Figure 3.113. Distribution of *Medicago arenicola*. (shading represents native distribution).

glandular hairs. Stipules lanceolate, margin entire or dentate. Leaflet minute 2-5 x 2-4 mm, obovate, base oblique to cuneate, dorsally densely pubescent, ventrally densely pubescent, with defuse hairs, margins dentate at apex. Peduncle with 5-10mm 4-6 flowers, flowers in a head-shape raceme to in umbelliform raceme. Flower 5-7 mm. Calyx campanulate 3 mm, densely pubescent, with simple appressed hairs, shorter than half of the corolla, teeth lanceolate, teeth shorter than tube. Corolla yellow. Pods uncoiled, densely pubescent, with simple or simple and glandular hairs, yellow, 10-15 mm, curved upward straight to sickle-shaped, spineless, face reticulate. 1.5-2 mm diameter, veins curved, venation darker than the middle of the coil, vein-less zone absent, ventral suture weakly convex to straight. Seeds 2 mm brown, oblong, 4-6 per pod, coat verrucose.

Closely related species: This species can be confuses with *M. halophila* but clearly differs in that the legume curves upward, is not stellate-spreading, and has regularly curved sutures.
Habitat: Sand dunes near the sea. Part of the East Mediterranean floristic element.
Geographical distribution: Turkey.

3.77 *Medicago heldreichii* (Boiss.) E. Small, Willdenowia 16(2): 434 (1987).

Synonyms: *Trigonella polycarpa* Boiss. & Heldr. in Boiss, Diagn. Pl. Orient. ser. 2 (5): 78 (1856).
Annual, herb, 10-30 cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with erect, simple hairs. Stipules lanceolate, margin dentate to incise. Leaflet 4-8 x 3-4 mm, obovate, apex retuse, dorsally densely pubescent, ventrally densely pubescent, with defuse hairs, margins dentate. Peduncle with 8-20 flowers, flowers in a head-shape raceme, longer than the corresponding petiole. Flower 5-8 mm. Pedicle shorter than the calyx tube. Calyx 3-4 mm, sparsely pubescent, with simple appressed to defuse hairs, equalling half of the corolla, teeth lanceolate, teeth ± equalling tube. Corolla yellow. Pods uncoiled, densely pubescent, with simple hair, brown, 15-30 mm, erect straight, spineless, with crescent tip, face reticulate. 1-2 mm diameter, veins 6-30, curved, venation is a net of veins anastomosing on the pod face. Seeds 2 x 1 mm, oblong to cylindrical, coat with tubercles.

Closely related species: It is can be confused with *M. carica* which has more transverse veins.
Habitat: Dry calcareous soils, hill slopes, sandy coast, gravely soils, pine forest, near sea level, part of the East Mediterranean element of Turkey.
Geographical distribution: Asia: Turkey (N). North America: United States (I).

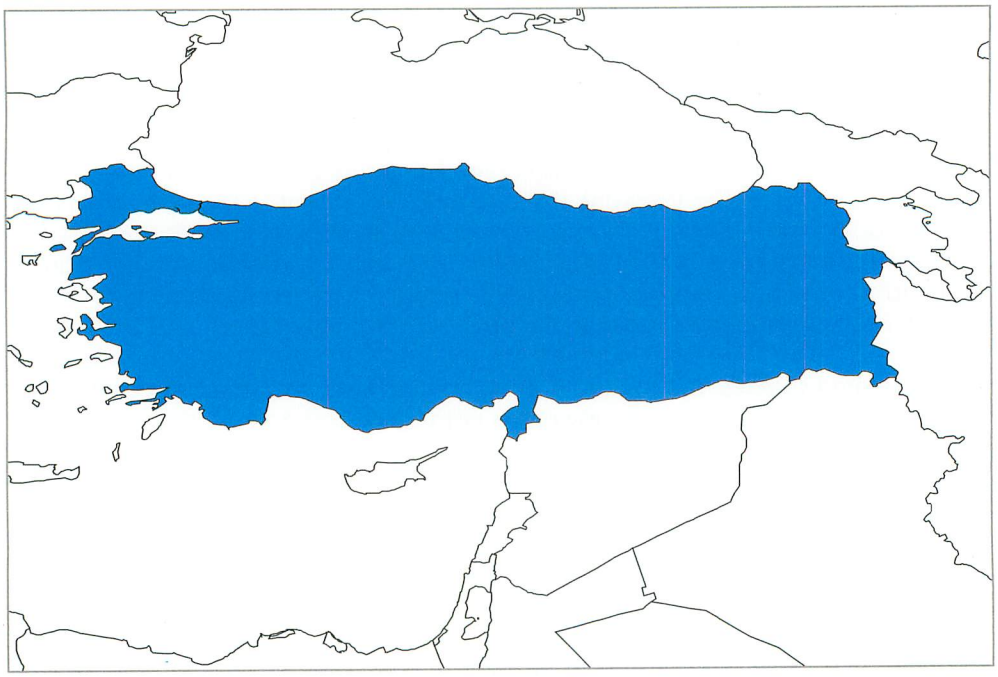

Figure 3.114. Distribution of *Medicago heldreichii*. (shading represents native distribution).

3.78 *Medicago phrygia* (Boiss. & Bal.) E. Small, Willdenowia 16(2): 433 (1987).

Synonyms: *Trigonella aurantiaca* Boiss, Diagn. Pl. Orient. ser. 1(2): 22 (1849); *Trigonella mareschiana* Hand.-Mazz., Ann. Nat. Hofmus. Wien 27: 81 (1913).
Annual, herb, (5-)8-20(-25) cm, stem round in cross section, procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with defuse, simple and glandular hairs. Stipules lanceolate, margin dentate, teeth at base. Leaflet 5-12 x 3-8 mm, ovate to obovate, base cuneate, dorsally sparsely pubescent, ventrally densely pubescent, with appressed hairs, margins sharply dentate. Peduncle with 8-14 flowers, longer than the corresponding petiole, without terminal cusp. Flower (6-)7-10 mm. Bract shorter than the pedicel to ± equalling the pedicel, calyx 3.5-4 mm, densely pubescent, with simple or glandular, appressed hairs, 2.5 times shorter than half of the corolla, teeth subulate to lanceolate, teeth ± equalling tube. Corolla yellow to creamy white, standard oblong to obovate, with emarginate apex, standard exceeding the sub-equal wings and keel. Pods uncoiled, sparsely pubescent, with simple hair, 10-20(-30) mm, straight to sickle-shaped usually, spineless, with connivent tip, face reticulate. Venation scarcely

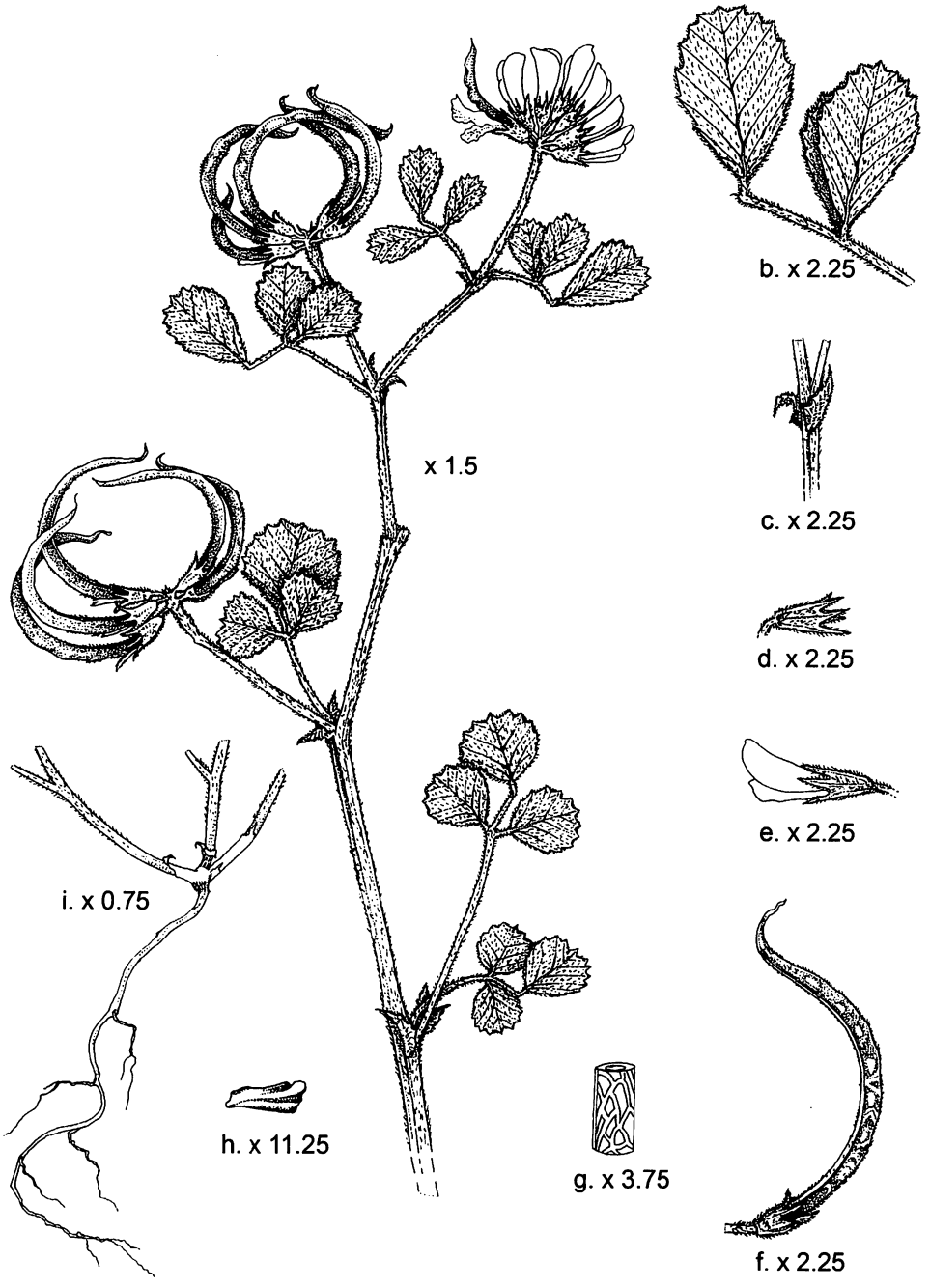

Figure 3.116. *Medicago phrygia*: a, habit (x 1.5), b, leaflet (x 2.25), c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 2.25), g, pod venation (x 3.75), h, seed (x 11.25), i, root and stem habit (0.75).

looping pattern forming is a net of veins. Seed 1.5-2x0.75 mm, brown, oblong to cylindrical, not separated.

Closely related species: It is very similar to *M. persica* and *M. fischeriana*.
Habitat: Roadsides, pastures, steppe, igneous slopes, gravel banks near water, wadis and depressions, woodland and scrub, arable and fallow.
Geographical distribution: Asia: Iran (N), Iraq (N) Middle East: Syria (N), Turkey in Asia (N).
Actual and potential usage: Environmental.

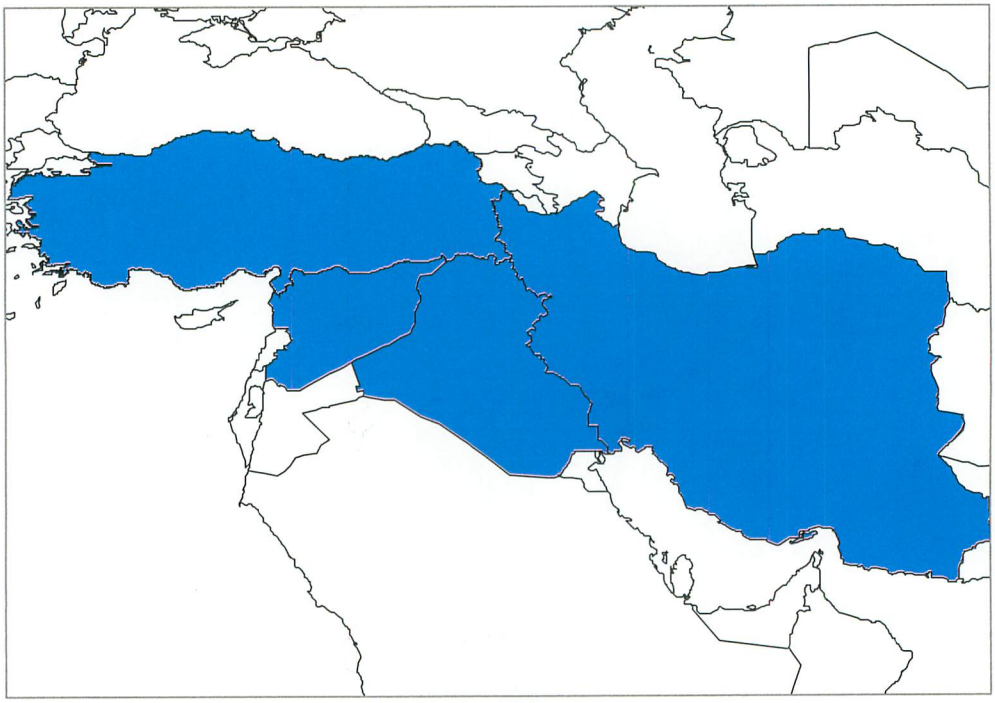

Figure 3.115. Distribution of *Medicago phrygia*. (shading represents native distribution).

3.79 *Medicago fischeriana* (Ser.) Trautv, Bull. Sci. Acad. Imp. Sci. Saint-Petersburg 8: 271 (1841).

Synonyms: *Trigonella fischeriana* Ser. in DC. Prodr. 2: 183 (1825); *Trigonella subracemosa* Boiss., Fl. Orient. 2: 73 (1872).
Annual, herb, (8-)12-20(-30) cm, stem procumbent or ascending, branching at the

ground level. Vegetative parts densely pubescent, with appressed to defuse, simple or glandular hairs. Stipules lanceolate, margin dentate, teeth at base. Leaflet 4-8 x 4-6 mm, ovate to obovate, base cuneate, dorsally densely pubescent, ventrally densely pubescent, with appressed hairs, margins at apical part dentate. Peduncle with 4-10 flowers, flowers short in umbelliform raceme, much longer than the corresponding petiole, without terminal cusp. Flower 5-7 mm. Pedicle equal or longer than the calyx tube, bract ± equalling the pedicel, calyx 4-5 mm, densely pubescent, with simple appressed hairs, shorter than or equalling half of the corolla, teeth subulate to lanceolate, teeth ± equalling or longer than tube. Corolla yellow, standard oblong, with emarginate apex, standard longer than the sub-equal wings and keel. Pods uncoiled, densely pubescent, with simple hair, green-brown, 15-25 mm, spreading straight to sickle-shaped, spineless, sessile, face reticulate. Coil venation is a net of veins forming a looping reticulate pattern, dorsal suture more or less undulate. Seeds 2 x 0.75 mm, brown, oblong to cylindrical, deep constricted between them.

Closely related species: It is similar to the preceding species.
Habitat: Igneous hill slopes, valleys, agricultural fields and fallows, pastures, roadsides, earthy scree, open mixed woodland and scrub.

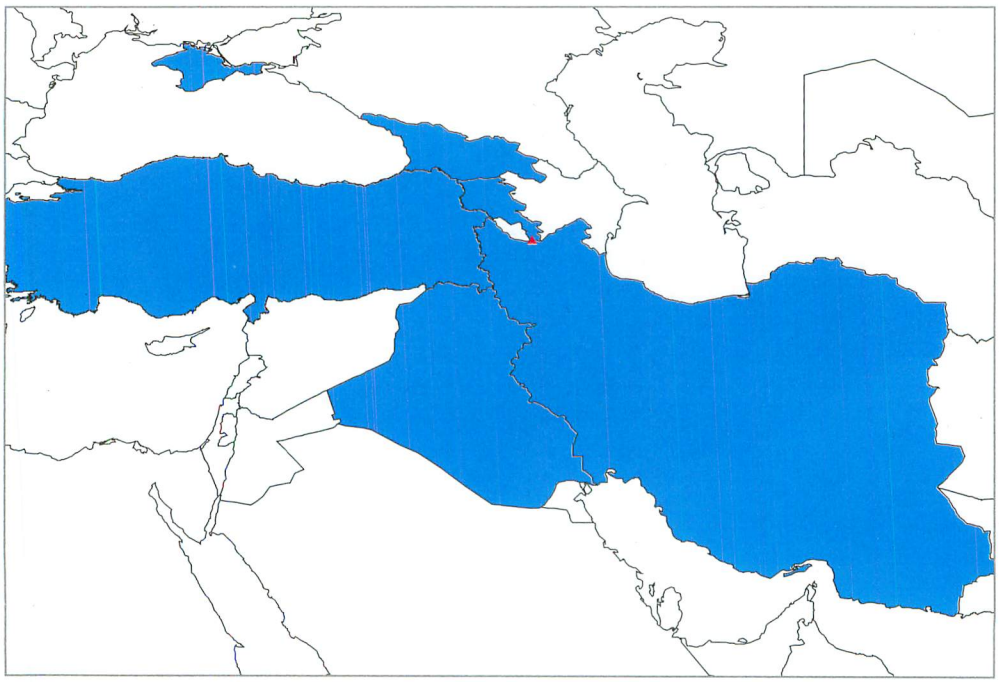

Figure 3.117. Distribution of *Medicago fischeriana*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

Geographical distribution: Asia: Georgia (N), Iran (N), Iraq (N). Armenia (N). Europe: Ukraine (N). Georgia: Georgia. Middle East: Turkey in Asia (N). Ukraine: Krym.
Conservation and threat assessment: Not threatened

3.80 *Medicago persica* (Boiss) E. Small, Willdenowia 16(2): 434 (1987).

Synonyms: *Trigonella persica* Boiss, Diagn. Pl. Orient. Nov. Ser. 1(2): 22 (1843).
Annual, herb, 12-30 cm, stem ascending, branching at the ground level. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules lanceolate, margin dentate, teeth at apex part. Leaflet 3-9 x 2-5 mm, ovate to obovate, apex truncate, dorsally densely pubescent, ventrally densely pubescent, with erect hairs, margins dentate. Peduncle with 1-5(-8) flowers, flowers in umbelliform raceme, longer than the corresponding petiole. Flower (6-)7-10 mm. Calyx 3 mm, sparsely pubescent, with simple defuse hairs, shorter than or equalling half of the corolla, teeth lanceolate, teeth shorter than tube. Corolla yellow, standard oval. Pods uncoiled, densely pubescent, with simple or simple and glandular hairs, green-brown, (20-)30-40 mm, straight to sickle-shaped, spineless, with crescent tip, face reticulate, veins curved, venation is a net of veins. Seeds 3 x 0.5 mm, brown, oblong.

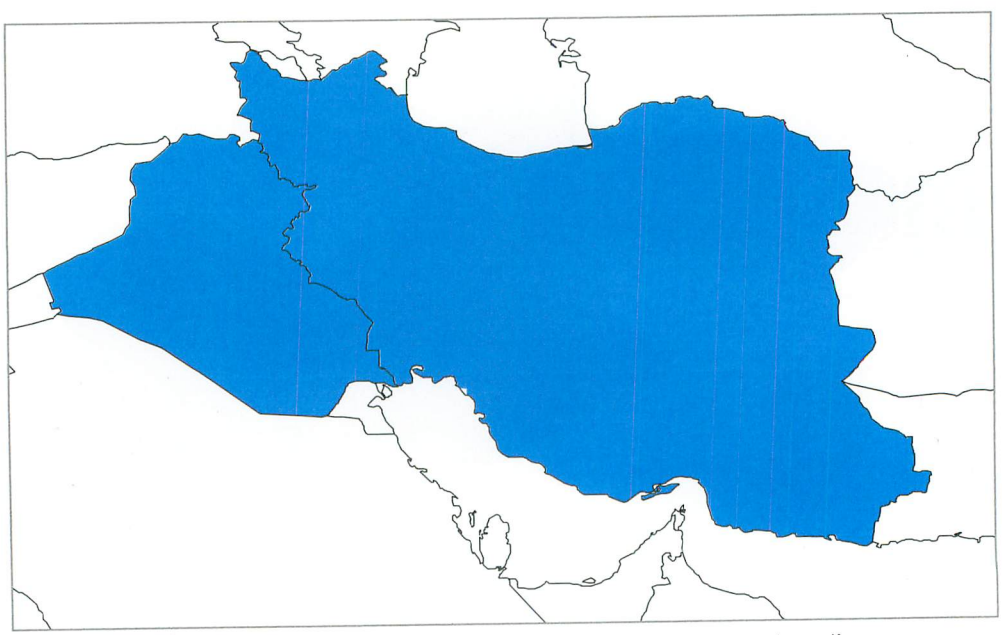

Figure 3.118. Distribution of *Medicago persica*. (shading represents native distribution).

Closely related species: It is similar to both the two preceding species.
Habitat: Hills, ledges on limestone cliffs, rocky slopes, recently disturbed alluvial plains, pebble river beds and stony places.
Geographical distribution: : Asia: Iran (N), Iraq (N).

3.81 *Medicago medicaginoides* (Retz.) E. Small, Willdenowia 16(2): 434 (1987).

Synonyms: *Trigonella striata* L. fil., Suppl. Pl.: 340 (1782); *Trigonella cancellata* Pers., Syn. Pl. 2: 355 (1807); *Trigonella tenuis* Fisch. in Bieb, Fl. Taur.-Cauc. 3: 514 (1819); *Trigonella arcuata* C.A. Meyer, Verz. Pfl. Casp. Meer.: 136 (1831); *Trigonella cancellata* Desf. var. *arcuata* (C. A. Meyer) Sirj., Publ. Fac. Sci. Univ. Masaryk Brno 128: 17 (1930).
Annual, herb, (6-)10-40 cm, stem procumbent or erect, branching at the ground level. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules lanceolate, margin laciniate. Leaflet 5-10 x 3-7 mm, obovate to elliptical, base cuneate, ventrally glabrous or densely pubescent, with defuse hairs. Peduncle with (1-)2-10 flowers, flowers in umbelliform raceme, shorter or equal to the corresponding petiole. Flower 4-6 mm. Pedicle shorter than the calyx tube. Calyx 3-4 mm,

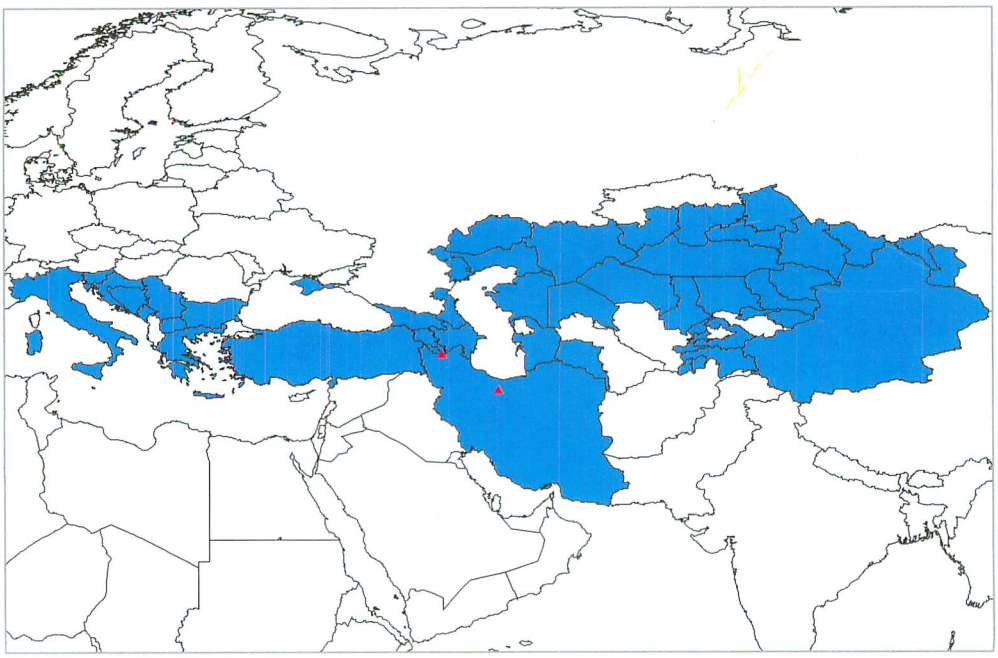

Figure 3.119. Distribution of *Medicago medicaginoides*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

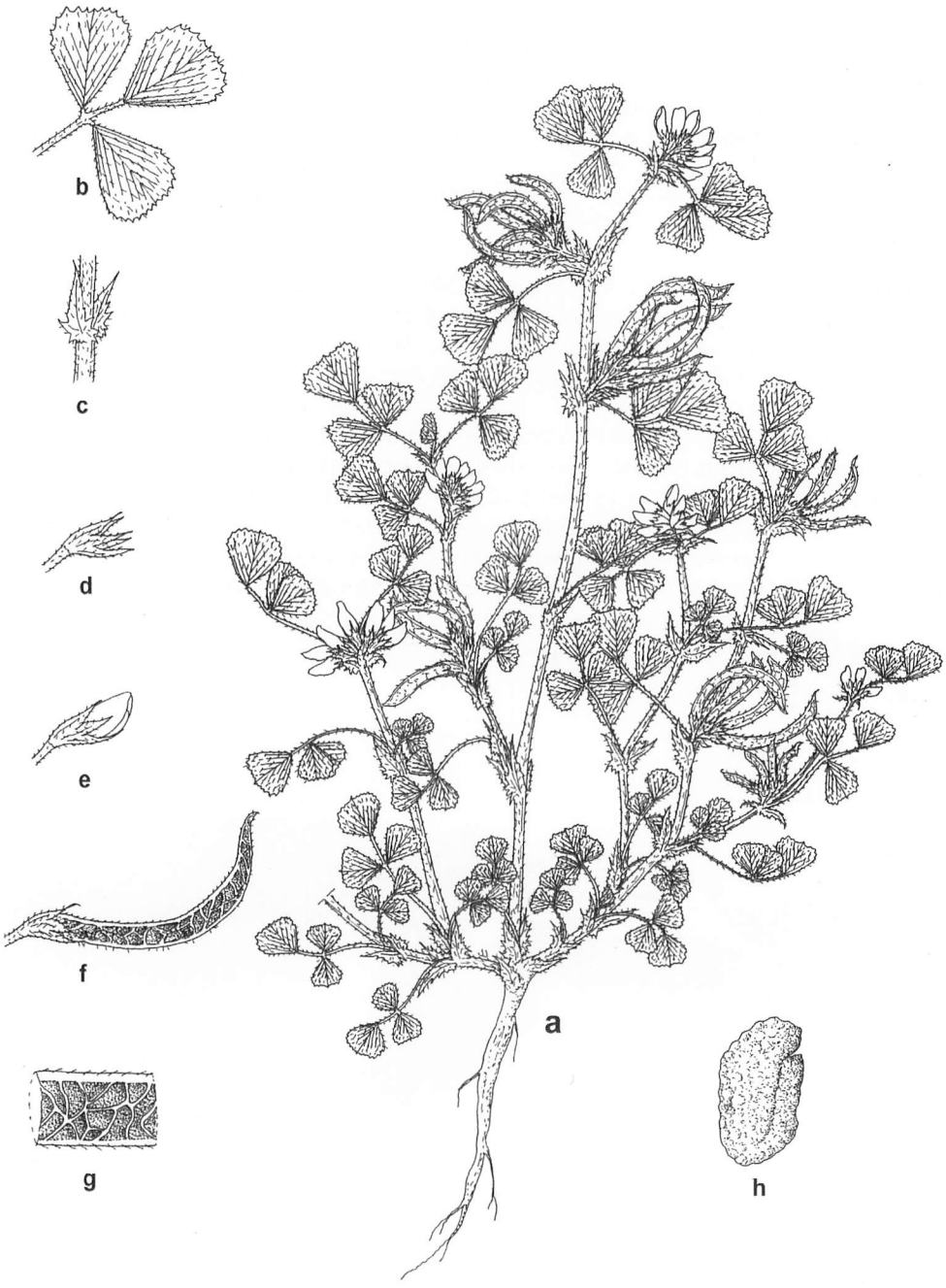

Figure 3.120. *Medicago medicaginoides*: a, habit (x 1.5), b, leaflet (x 2.25), c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 2.25), g, pod venation (x 6), h, seed (x 9).

densely pubescent, with simple defuse hairs, teeth subulate, teeth ± equalling or longer than tube. Corolla yellow. Pods uncoiled, glabrous or densely pubescent, with simple hair, green-brown, 10-30 mm, not subterranean, sickle-shaped, spineless, not sessile, face reticulate with transverse anastomosing veins. 1.3-2 mm diameter, veins many curved, venation is a net of veins. Seeds 2-2.5 x 1-1.2 mm, 7-8 per pod, coat verrucose to tubercles.
Chromosome number: 16.

Closely related species: The peduncle of this species is variable, but unfortunately this character has often been used to split species.
Habitat: Ledges of limestone cliffs, steppe, gravel river terraces, on a variety of soils, stony slopes, weed of pastures, fallow and cultivated fields.
Geographical distribution: Asia: Armenia (N), Azerbaijan (N), China (N), Georgia (N), Iran (N), Kazakhstan (N), Kirgizstan (N), Mongolia (N), Russia in Asia (N), Tadzhikistan (N), Turkmenistan (N), Uzbekistan (N). Azerbaijan: Azerbaijan, Nakhichevan. China: Xinjiang Uygur. Europe: Bulgaria (N), former Yugoslavia (N), Greece (N), Russia in Europe (N), Ukraine (N). Georgia: Georgia. Kazakhstan: Aktyubinsk, Alma-Ata, Chimkent, Dzhambul, Dzhezkazgan, Guryev, Karaganda, Kzyl-Orda, Mangyshlak, Pavlodar, Semipalatinsk, Taldy-Kurgan, Tselinograd, Turgaiskaya, Uralsk, Vostochno-Kazakhstanskaya. Kirgizstan: Frunze, Issyk-Kul, Osh. Middle East: Turkey in Asia (N). Mongolia: Bayan-Ulgi, Khovd. Russia in Asia: Dagestan. Russia in Europe: Astrakhan Volgograd. Tadzhikistan: Gorno-Badakshan, Kulyab, Kurgan-Tyube, Leninabad. Turkmenistan: Ashkhabad, Krasnovodsk. Ukraine: Krym. Uzbekistan: Karakalpakia, Tashkent.
Conservation and threat assessment: Not threatened.
Actual and potential usage: None known.

3.82 *Medicago rigida* (Boiss. & Bal.) E. Small, Willdenowia 16(2): 433 (1987).

Synonyms: *Trigonella rigida* Boiss. & Bal. in Boiss, Diagn. Pl. Orient. ser. 2(5): 79 (1856).
Annual, herb, 13-15 cm, stem procumbent or decumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules lanceolate to acuminate, margin dentate to laciniate. Leaflet 5-8 x 4-7 mm, obovate, base obcordate, dorsally densely pubescent, ventrally densely pubescent, with appressed hairs, margins dentate. Peduncle with 7-12 flowers, flowers in a head-shape raceme, shorter than the corresponding petiole. Flower 3-6 mm. Calyx 3-4 mm, densely pubescent, with simple appressed hairs, longer than half of the corolla, teeth lanceolate, teeth longer than tube. Corolla yellow. Pods uncoiled, sparsely pubescent, with simple hair, 6-10 mm, slightly curved to straight, spineless, with hook tip, uncinate, face reticulate (nerved). 1.5-2 mm diameter, veins curved, venation is a net of veins anastomosing on the pod surface. Seeds 2.5 x 1-1.5 mm, ovoid, 2-3 per pod, coat smooth.

Closely related species: This species is most similar to *M. crassipes* which has larger fruits.
Habitat: Dry limestone slopes, sandy river beds, dry open banks, part of the East Mediterranean floristic element of Turkey.
Geographical distribution: Middle East: Turkey in Asia (N).
Conservation and threat assessment: Insufficiently known

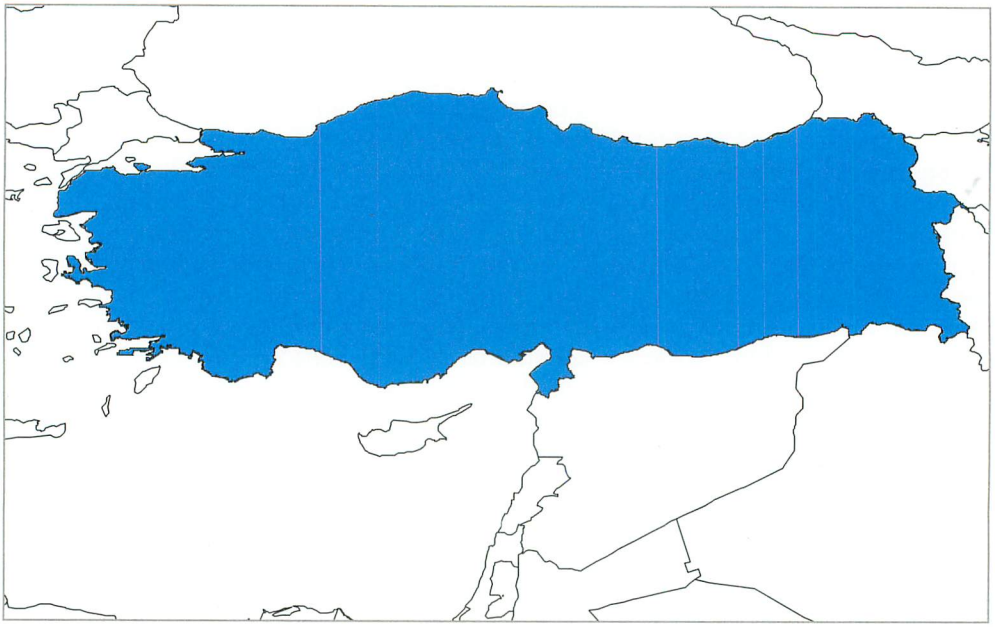

Figure 3.121. Distribution of *Medicago rigida*. (shading represents native distribution).

3.83 *Medicago crassipes* (Boiss.) E. Small, Willdenowia 16(2): 433 (1987).

Synonyms: *Trigonella crassipes* Boiss, Diagn. Pl. Orient. ser. 1(2): 23 (1843).
Annual, herb, 5-20 cm, stem procumbent, branching at the ground level. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules lanceolate to acuminate, margin dentate. Leaflet 5-8 x 3-7 mm, obovate, apex truncate or emarginate, base cuneate, dorsally sparsely pubescent, ventrally densely pubescent, with appressed hairs, margins at apical part dentate. Peduncle with 4-10 flowers, flowers in umbelliform raceme. Pedicle shorter than the calyx tube. Calyx 3.5-4 mm, densely pubescent, with simple defuse hairs, longer than half of the corolla, teeth subulate to lanceolate, teeth ± equalling tube. Corolla yellow. Pods

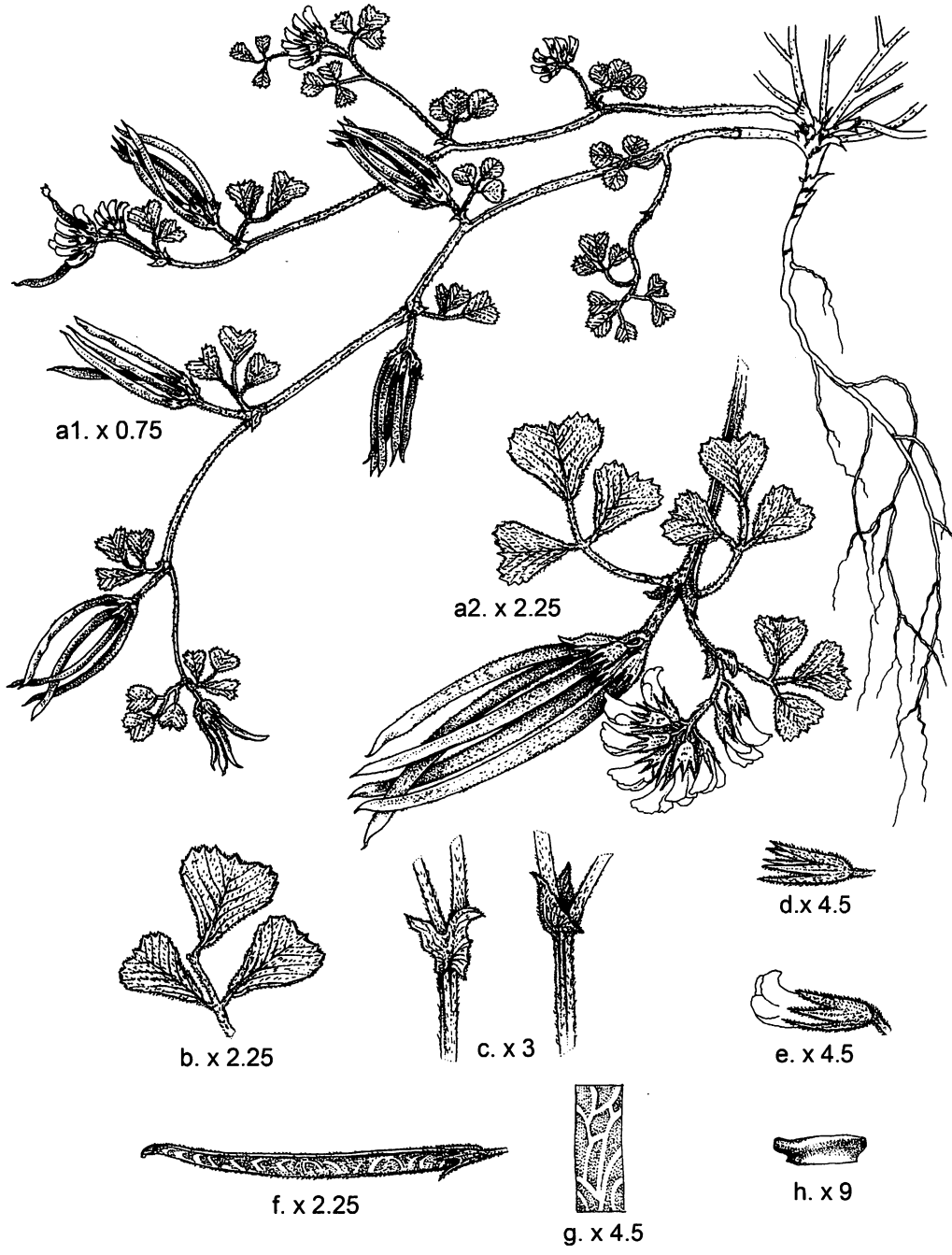

Figure 3.122. *Medicago crassipes*: a1, habit (x 0.75), a2, branch, (2.25), b, leaflet (x 2.25), c, stipule (x 3), d, calyx (x 4.5), e, flower (x 4.5), f, pod three dimension view (x 2.25), g, pod venation (x 4.5), h, seed (x 9).

uncoiled, densely pubescent, with simple and glandular hairs, green-brown, 12-35 mm, in a closed-cluster straight, spineless, not sessile, with hook tip, uncinate, face reticulate. 1-2 mm diameter, veins curved. Seeds 2 x 1.5 mm, oblong or rhomboid, 8-10 per pod, coat verrucose.

Closely related species: It is similar to the preceding species *M. rigida*, but has smaller pods.
Habitat: Scrub, pine forest, steppe, dry slopes, fallow and cultivated land.
Geographical distribution: Asia: Iran (N) Middle East: Lebanon (N), Syria (N), Turkey in Asia (N).

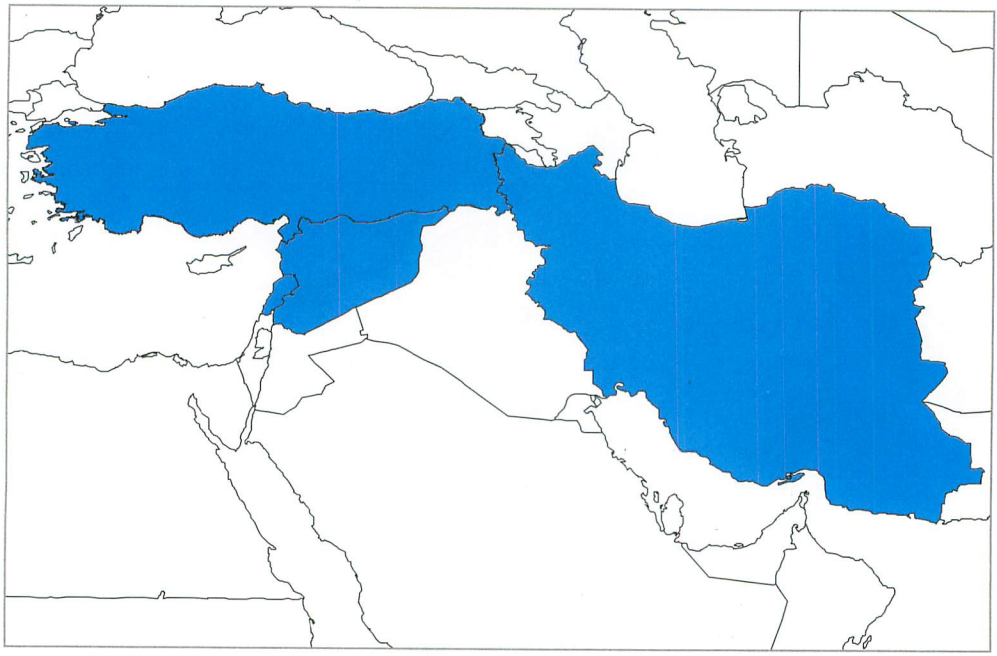

Figure 3.123. Distribution of *Medicago crassipes*. (shading represents native distribution).

3.84 *Medicago pamphylica* (Huber-Mor. & Sirj.) E. Small, Willenowia 16(2): 434 (1987).

Synonyms: *Trigonella pamphylica* Huber-Mor. & Sirj., Feddes Rep. Spec. Nov. Regni Veg. 44: 322 (1938).
Annual, herb, 10-30 cm, stem ascending to erect, branching at the ground level. Vegetative parts densely pubescent, with appressed, simple or glandular hairs.

Stipules lanceolate, margin entire or dentate. Leaflet 3-10 x 3-8 mm, lacerate obovate, base cuneate to obcordate, dorsally sparsely pubescent, ventrally sparsely pubescent, with appressed hairs, margins dentate. Peduncle with 3-6 flowers, flowers in a head-shape raceme, longer than the corresponding petiole. Flower 5-9 mm. Calyx 3.5-4 mm, sparsely pubescent, with simple appressed hairs, equalling half of the corolla, teeth lanceolate to slender, teeth ± equalling tube. Corolla yellow. Pods uncoiled, glabrous, green-brown, 17-30 mm, with undulate suture straight to sickle-shaped, spineless, not sessile, with crescent tip, face reticulate. 1.5-2 mm diameter, veins 70-80, curved, anastomosing near the ventral suture, venation is a net of veins, dorsal suture undulate. Seeds 2 x 1 mm, oblong to rhomboid, 9-11 per pod, coat verrucose, deep constricted between them.

Closely related species: Leaflets are sometimes trifid or rarely pentafid.
Habitat: Scrub and maquis, in Abies forest, part of the East Mediterranean floristic element of Turkey.
Geographical distribution: Turkey.

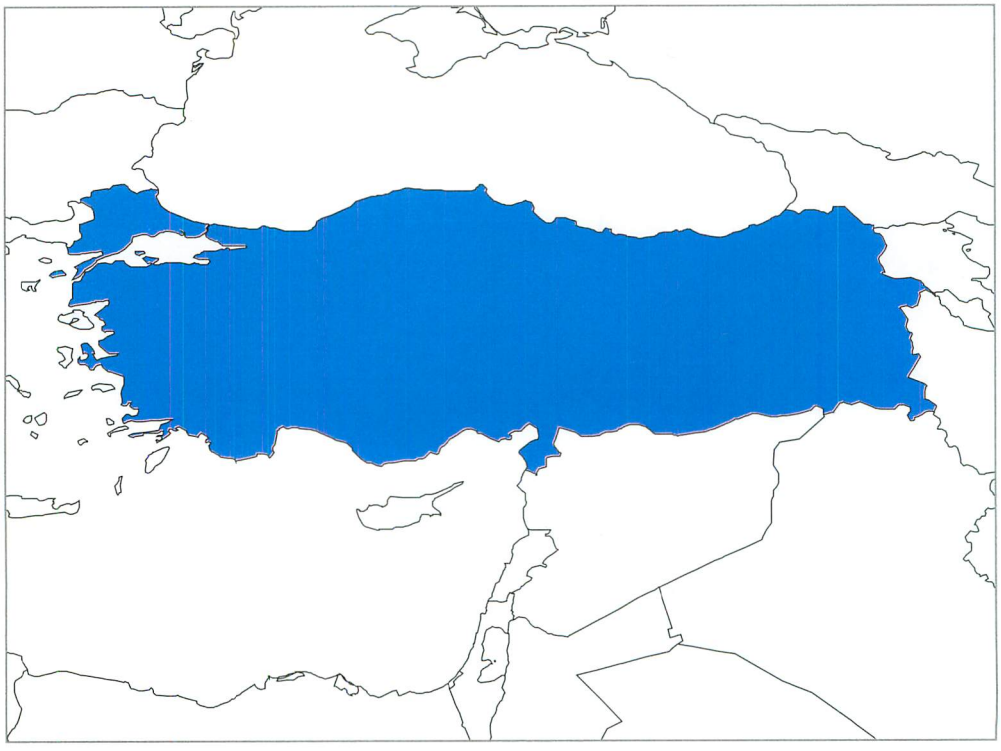

Figure 3.124. Distribution of *Medicago pamphylica*. (shading represents native distribution).

3.85 *Medicago carica* (Huber-Mor.) E. Small, Willdenowia 16(2): 433 (1987).

Synonyms: *Trigonella carica* Huber-Mor, in Bauhinia 2(3): 299 (1965).
Annual, herb, 10-20 cm, stem ascending to erect, branching at the ground level. Vegetative parts densely pubescent, with defuse to erect, simple hairs. Stipules lanceolate, margin dentate to incised. Leaflet 5-9 x 3-7 mm, obovate, apex apiculate, base cuneate, dorsally sparsely pubescent, ventrally densely pubescent, with erect hairs, margins dentate at apex. Peduncle with 2-3 flowers, longer than the corresponding petiole. Flower 8-14 mm. Pedicle shorter than the calyx tube. Calyx 5-6 mm, sparsely pubescent, with simple defuse to erect hairs, longer than half of the corolla, teeth lanceolate, teeth ± equalling tube. Corolla yellow. Pods uncoiled, sparsely pubescent, 20-35 mm, straight, spineless, not sessile, face reticulate. 2-3 mm diameter, veins 100-120, curved, anastomosing near the ventral suture, venation is a net of veins, vein-less zone absent, dorsal suture straight. Seeds 1.5 x 1 mm, oblong, 8-12 per pod, coat verrucose.

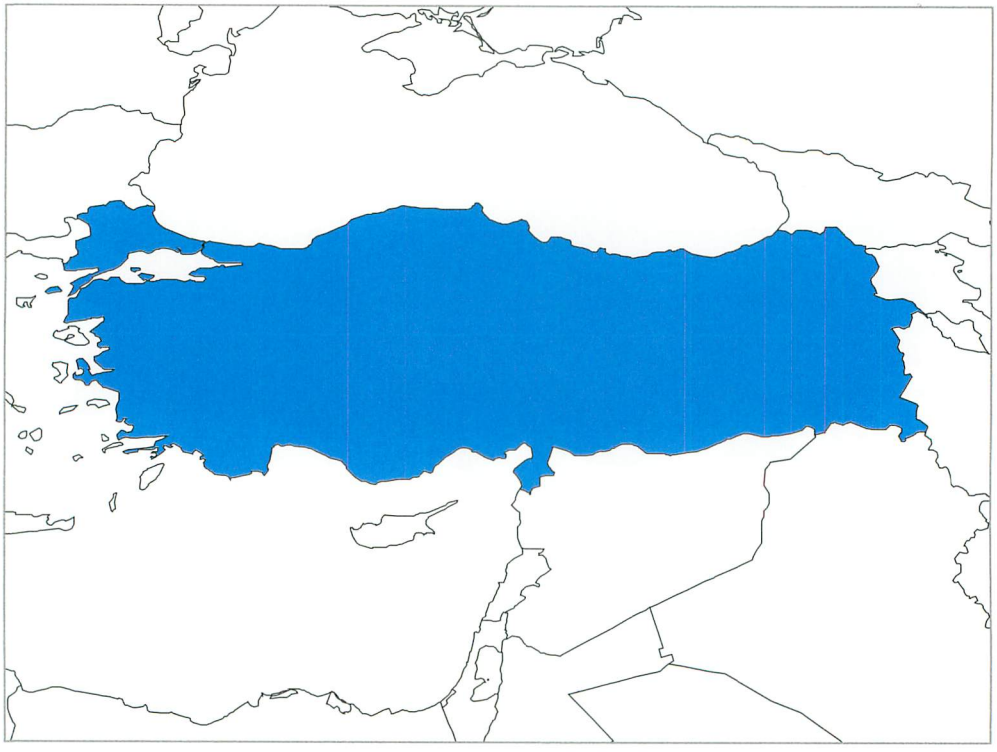

Figure 3.125. Distribution of *Medicago carica*. (shading represents native distribution).

Closely related species: Is similar to the preceding species but can be distinguished by undulating sutures.
Habitat: Rocky slopes, scree, scrub and maquis.
Geographical distribution: Turkey.

3.86 *Medicago monantha* (C.A. Meyer) Trautv., Bull. Sci. Acad. Imp. Sci. Saint-Petersburg 8: 272 (1841).

Synonyms: *Trigonella monantha* C. Meyer. Verz. Pfl. Casp. Meer.: 137 (1831); *Trigonella noeana* Boiss, Diagn. Pl. Orient. ser. 2(2): 11 (1856); *Trigonella monantha* C. Meyer subsp. *noeana* (Boiss.) Huber-Morath, in P.H. Davis, Fl Turkey 3: 475 (1969).
Annual, herb, 5-20(-30) cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with appressed, crisped simple hairs. Stipules accuminate, margin dentate, teeth at base. Leaflet 6-13 x 4.5-9 mm, obovate, apex retuse to obtuse, base cuneate, dorsally glabrous, ventrally densely pubescent, with appressed hairs, margins above dentate sharply. Peduncle with 1-2(-3) flowers, flowers in umbelliform raceme, shorter than the corresponding petiole. Flower 4-8 mm. Pedicle shorter than the calyx tube, bract shorter than the pedicel, calyx 5-6 mm, densely pubescent, with simple appressed hairs, equalling or longer

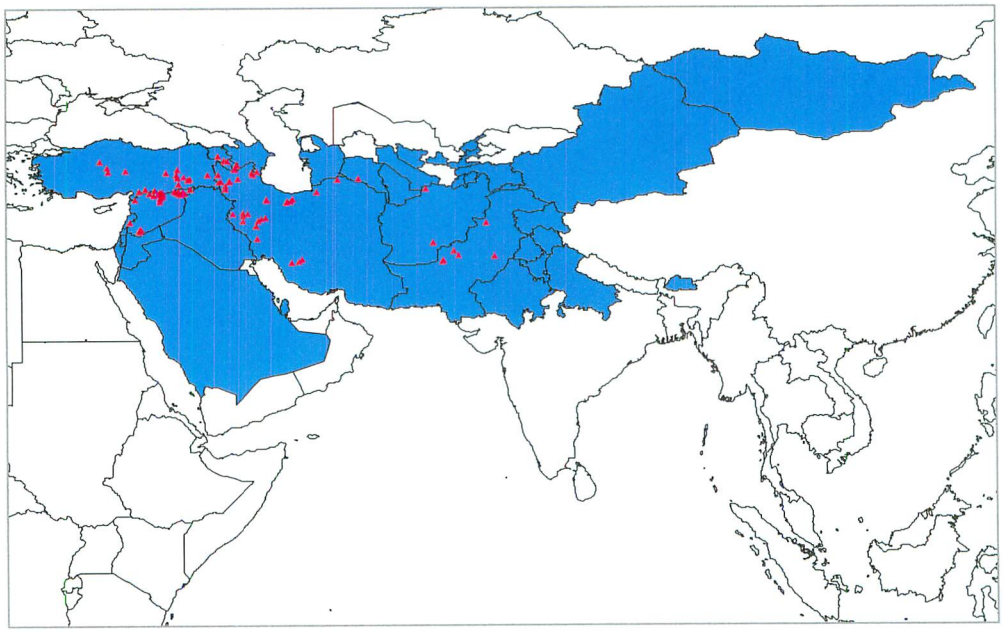

Figure 3.126. Distribution of *Medicago monantha*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

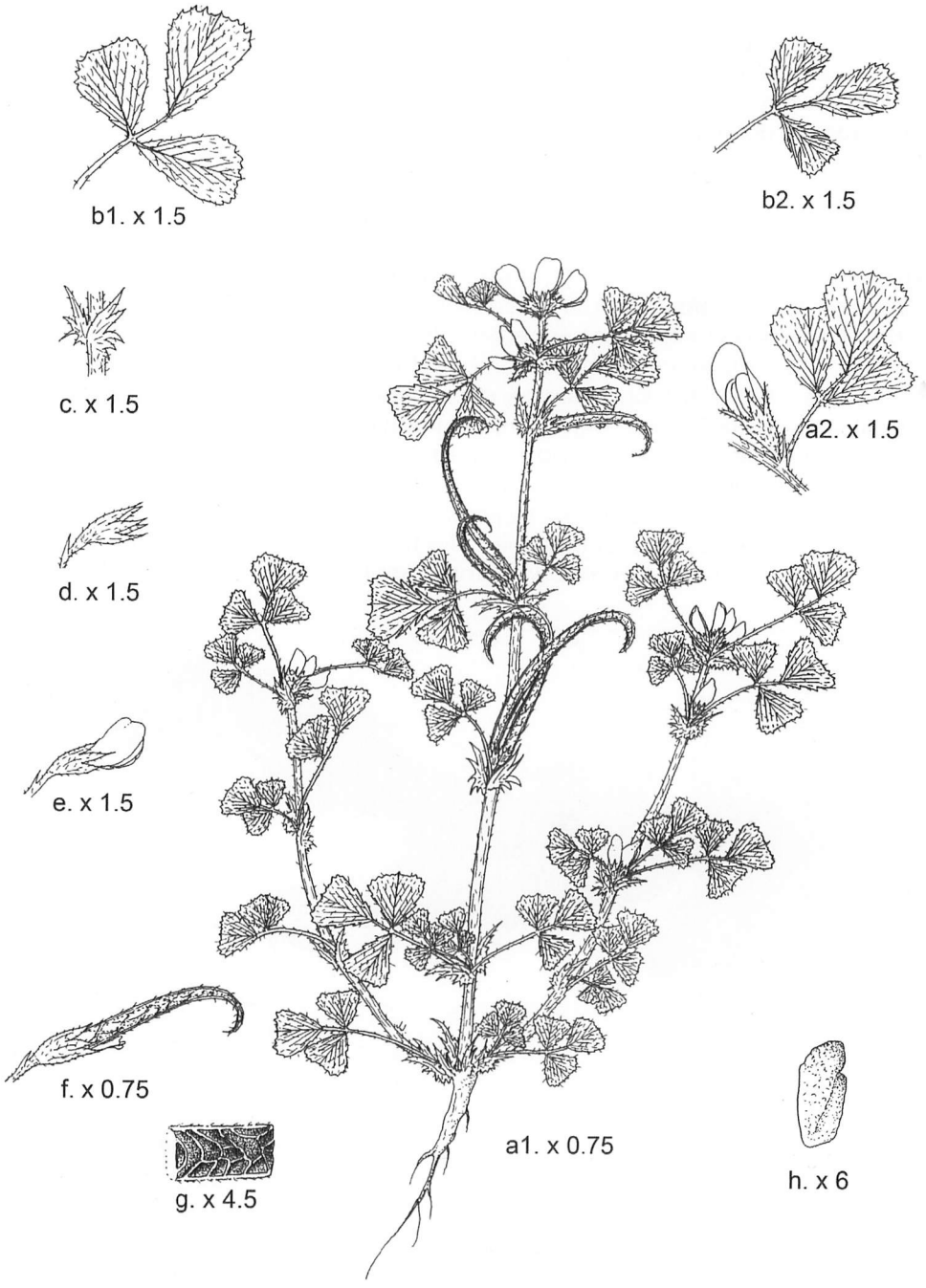

Figure 3.127. *Medicago monantha*: a1, habit (x 0.75), a2, leaflet with flower (x 1.5), b1-b2, leaflet (x 1.5), c, stipule (x 1.5), d, calyx (x 1.5), e, flower (x 1.5), f, pod three dimension view (x 0.75), g, pod venation (x 4.5), h, seed (x 6).

than half of the corolla, teeth subulate, teeth ± equalling tube. Corolla yellow, standard oval to oblong or obovate, with emarginate apex, wings slightly longer than the keel. Pods uncoiled, densely pubescent with appressed-hairs, green-brown, (30-)40-70 mm, sickle-shaped, spineless, with some times hook tip, uncinate, face reticulate. Coil venation is a net of veins forming elongate to sub-quadrate areolae. Seeds 2.5-3.5 x 1 mm, brown to yellow, cylindrical to rhomboid, coat smooth.

Closely related species: Easily distinguished by its long, curved, single or paired pods.
Habitat: Steppe, dry rocky slopes, semi-deserts, fallow and cultivated land, salt marshes, winter flooded depressions, dry river beds, arable land, plains and roadsides.
Geographical distribution: Africa: Kenya (I) Tunisia (U). Asia: Afghanistan (N), Armenia (N), Azerbaijan (N), Bhutan (N), China (N), India (N), Iran (N), Iraq (N), Mongolia (N), Pakistan (N), Tadzhikistan (N), Turkmenistan (N), Uzbekistan (N). Azerbaijan: Azerbaijan, Nakhichevan. China: Xinjiang Uygur. India: Delhi, Haryana, Himachal Pradesh, Jammu-Kashmir, Punjab, Rajasthan, Uttar Pradesh. Middle East: Israel-Jordan (N), Lebanon (N), Palestine (N), Qatar (N), Saudi Arabia (N), Syria (N), Turkey in Asia (N). Tadzhikistan: Dushanbe, Gorno-Badakshan, Kulyab, Kurgan-Tyube, Leninabad. Turkmenistan: Ashkhabad, Chardzhou, Krasnovodsk, Mary. Uzbekistan: Bukhara, Samarkand, Tashkent.
Conservation and threat assessment: Not threatened.

3.87 *Medicago orthoceras* (Karelin & Kir.) Trautv, Turdy. Glaun. Bot. Sada 5: 421 (1877).

Synonyms: *Trigonella orthoceras* Karelin & Kir., Bull. Soc. Nat. Mosc. 15: 399 (1841).
Annual, herb, (6-)10-30 cm, stem procumbent to decumbent, branching at the ground level. Vegetative parts densely pubescent, with appressed, simple hairs. Stipules lanceolate or acuminate, margin dentate, teeth at base. Leaflet 4-12 x 3-8 mm, obovate, base cuneate, dorsally glabrous, ventrally glabrous or densely pubescent, with appressed hairs, margins serrate. Peduncle with 2-5 flowers, shorter than the corresponding petiole. Pedicle equal to the calyx tube, bract shorter than the pedicel, calyx 3-5 mm, densely pubescent, with simple appressed hairs, longer than half of the corolla, teeth subulate, teeth ± equalling or longer than tube. Corolla yellow, standard cuneate oblong, wings longer than the keel. Pods uncoiled, densely pubescent with simple appressed hair, brown to green-brown, 20-35(-50) mm, scarcely compressed, straight, spineless, face reticulate. Coil veins 20-35, curved, venation is a net of veins. Seeds 2 x 0.75 mm, brown, cylindrical, coat verrucose.

Chromosome number: 44.
Closely related species: The acceptance of this taxon as distinct is questionably morphologically but is distinguishable from other species by geography, possibly

chromosome number though it requires further study (Small and Jomphe, 1989).
Habitat: Semi-desert, deserts, pasture, steep hillsides, rocky slopes, bare soils, sandy river beds and sometimes a weed in crop.
Geographical distribution: Asia: Armenia (N), Azerbaijan (N), China (N), Georgia (N), Iran (N), Iraq (N), Kazakhstan (N), Kirgizstan (N), Pakistan (N), Russia in Asia (N), Tadzhikistan (N), Turkmenistan (N), Uzbekistan (N). Azerbaijan: Azerbaijan, Nakhichevan. China: Xinjiang Uygur. Europe: Russia in Europe (N). Georgia: Georgia. Kazakhstan: Aktyubinsk, Alma-Ata, Chimkent, Dzhambul, Dzhezkazgan, Kzyl-Orda, Mangyshlak, Semipalatinsk, Taldy-Kurgan, Turgaiskaya, Uralsk, Vostochno-Kazakhstanskaya. Kirgizstan: Frunze, Issyk-Kul, Osh. Middle East: Lebanon-Syria (I), Turkey in Asia (N). Russia in Asia: Dagestan, Kurgan, Severo-Osetia, Stavropol. Russia in Europe: Astrakhan, Kalmykia, Lipetsk, Saratov, Ulyanovsk, Volgograd. Tadzhikistan: Dushanbe, Gorno-Badakshan, Kulyab, Kurgan-Tyube, Leninabad. Turkmenistan: Ashkhabad, Chardzhou, Krasnovodsk, Mary. Uzbekistan: Surhandarinskaya.
Conservation and threat assessment: Not threatened

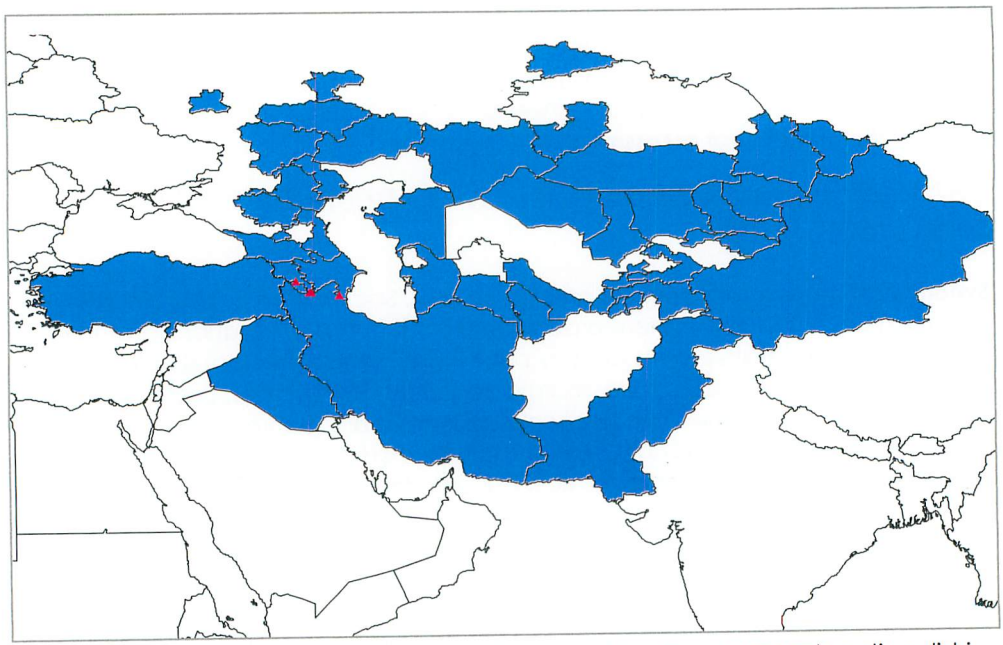

Figure 3.128. Distribution of *Medicago orthoceras*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

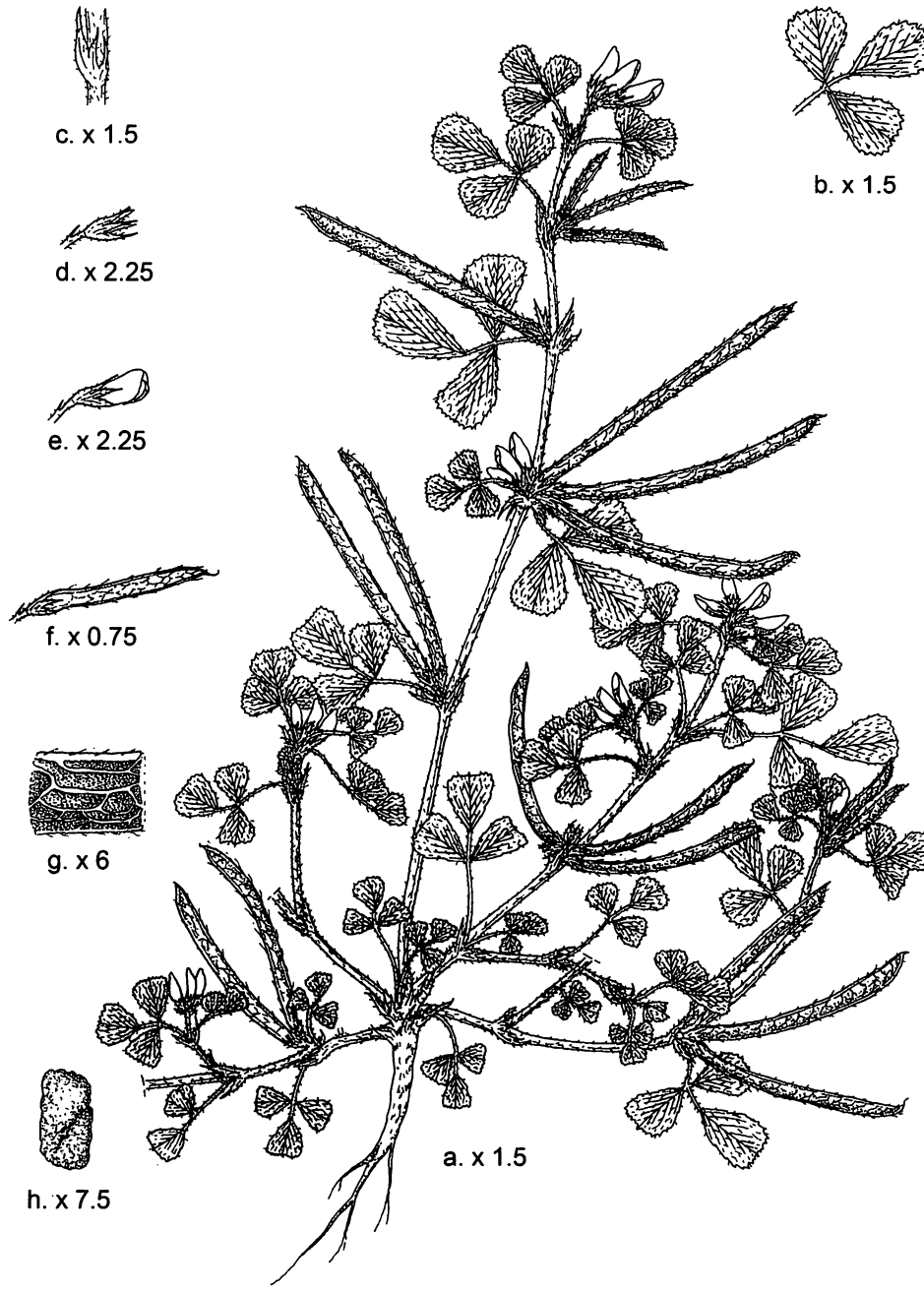

Figure 3.129. *Medicago orthoceras*: a, habit (x 1.5), b, leaflet (x 1.5), c, stipule (x 1.5), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 0, 75), f, pod tip view (x 0.75), g, pod venation (x 6), h, seed (x 7.5).

3.88 *Medicago polyceratia* (L.) Trautv, Bull. Sci. Acad. Sci. Saint-Petersburg 8: 272 (1841).

Synonyms: *Trigonella polyceratia* L, Sp. Pl.: 777 (1753).
Annual, herb, 10-25 cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with defuse, simple hairs or simple and glandular hairs. Stipules margin dentate, teeth at base. Leaflet 3-13 x 2-10 mm, ovate or obovate, base cuneate, dorsally densely pubescent, ventrally densely pubescent, with defuse hairs, margins sharply dentate. Peduncle rarely present, with 1-6(-9) flowers, longer than the corresponding petiole. Flower 4-9 mm, flowers sub sessile, . Bract shorter than the pedicel, calyx 2.5-4 mm, sparsely pubescent, with simple appressed hairs, teeth lanceolate, teeth shorter than tube. Corolla yellow. Pods uncoiled, densely pubescent, with simple hair, (10-)20-50 mm, erect, straight to sickle-shaped, spineless, face reticulate. Coil veins 30-45, slender shaped, venation is a net of veins. Seeds 1.5-2 x 1 mm, yellow, oblong, coat with tubercles.

Closely related species: It may easily be confused with the preceding species when conspecific (Small and Jomphe, 1989).
Habitat: Fields, slopes, mountains and hills, fallow fields.
Geographical distribution: Africa: Algeria (N), Morocco (N), Tunisia (N) Asia: Iran (N) , Pakistan (N). Europe: France (N), Portugal (N), Spain (N) Middle East: Saudi Arabia (N). A disparate distribution that may require further clarification.
Conservation and threat assessment: Not threatened

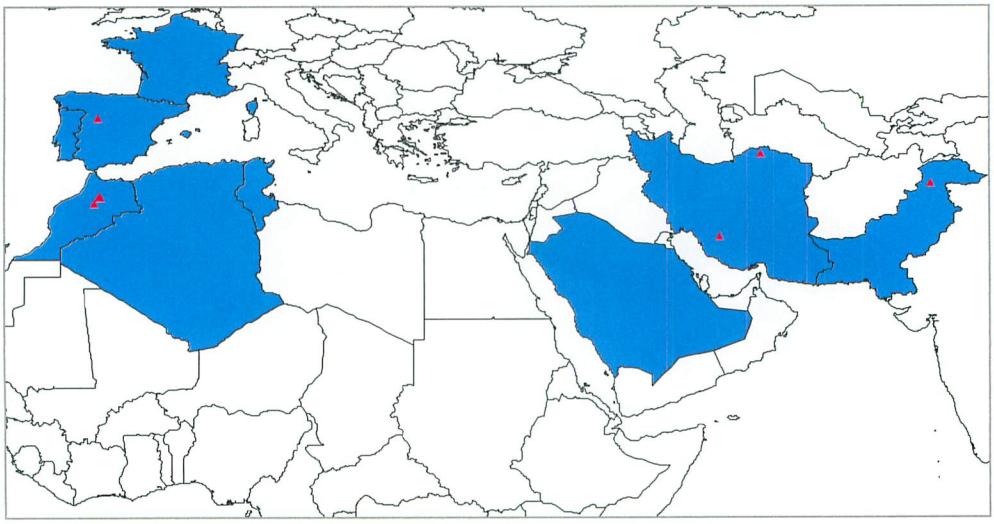

Figure 3.130. Distribution of *Medicago polyceratia*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

3.89 *Medicago retrorsa* (Boiss.) E. Small, Willdenowia 16(2): 43 (1987).

Synonyms: *Trigonella retrorsa* Boiss., Fl. Orient. ii. 78. (1856)
Annual, herb, 5-20 cm, stem decumbent to ascending. Vegetative parts densely pubescent, appressed to defuse, simple hairs. Stipules lanceolate, margin entire or serrate. Leaflet 3-8 x 2-5 mm, obovate, dorsally glabrous, ventrally sparsely pubescent, with appressed hairs, margins serrate to crenate at apical part. Peduncle with 1-2 flowers, shorter than the corresponding petiole, with terminal cusp. Pedicle shorter to equal to the calyx tube. Calyx 3-7 mm, sparsely pubescent, with simple appressed hairs, teeth lanceolate, teeth shorter than tube. Corolla yellow. Pods reflexed, patent uncoiled, sparsely pubescent, with simple or glandular hair, green-brown, 30-55 mm, bent at least 90 degree back from flowering axis straight, spineless, not sessile, face reticulate. Coil veins Y shaped, venation is a net of veins anastomosing and the pods surface forming different shapes. Seeds 3-4 x 1.5-2.5 mm, yellow to red-yellow, rhomboid, 4-8 per pod, coat smooth, not separated.

Closely related species: A distinctive species that has been rarely and inadequately collected (Small and Jomphe, 1989).
Habitat: Not described.
Geographical distribution: Asia: Afghanistan (N)

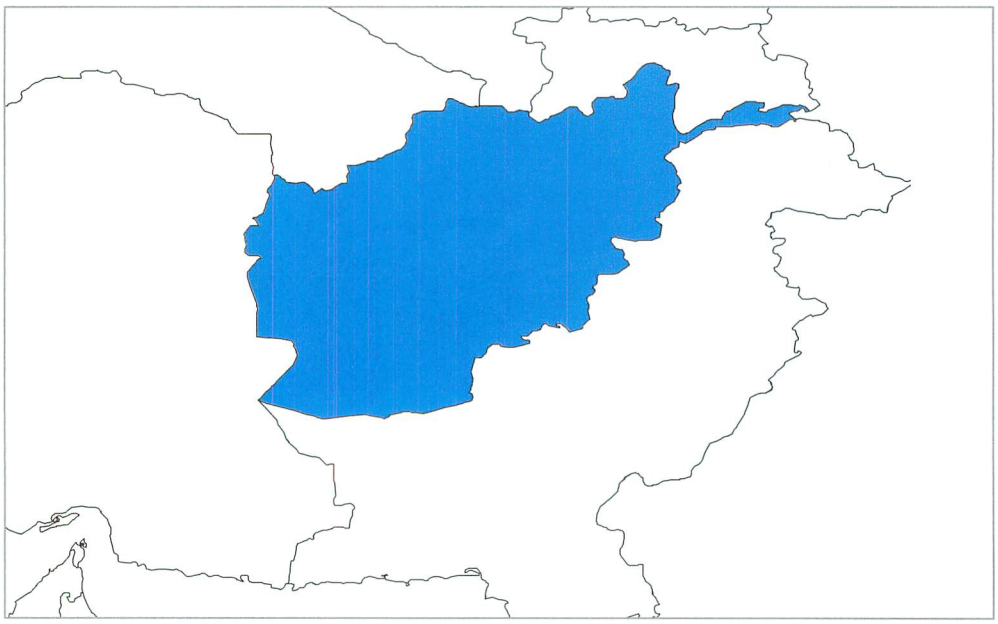

Figure 3.131. Distribution of *Medicago retrorsa*. (shading represents native distribution).

3.90 *Medicago monspeliaca* (L.) Trautv., Bull. Sci. Acad. Sci. Petersb. 8: 272 (1841).

Synonyms: *Trigonella monspeliaca* L, Sp. Pl.: 777 (1753).
Annual, herb, (3-)5-15(-30) cm, stem procumbent or decumbent, branching at the ground level. Vegetative parts densely pubescent, with appressed to defuse, simple hairs. Stipules acuminate, margin dentate to laciniate, teeth at base. Leaflet 4-12 x 3-10 mm, obovate or rhombic, apex apiculate, base cuneate, dorsally sparsely pubescent, ventrally densely pubescent, with defuse hairs to erect hairs, margins at apical part serrate. Peduncle with 4-15(-20) flowers, flowers in a head-shape raceme, shorter than the corresponding petiole, with terminal cusp. Flower 4-6 mm. Pedicle shorter than the calyx tube. Calyx 2-3 mm, densely pubescent, with simple defuse hairs, equalling to longer than half of the corolla, teeth lanceolate, teeth ± equalling or longer than tube. Corolla yellow, standard oblong, with slightly retuse apex, wings slightly shorter than the keel. Pods uncoiled, densely pubescent, with simple and glandular hairs, brown, 8-12(-15) mm, not subterranean, pods stellate-spreading cluster, slightly compressed, straight to sickle-shaped, spineless, deflexed on the pedicle but ascending not sessile, face reticulate, veins curved, venation is a net of veins rarely anastomosing. Seed 1.5 mm brown, ovoid, coat verrucose.

Chromosome number: 16.
Closely related species: It is easily distinguished species by the many-fruited sessile

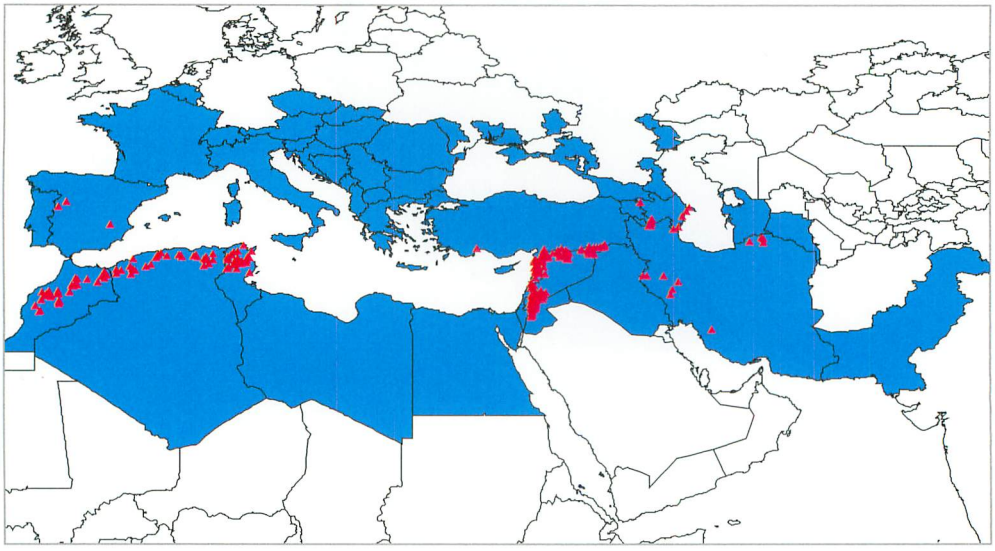

Figure 3.132. Distribution of *Medicago monspeliaca*. (shading represents native distribution, triangle indicates population sample held *ex situ*).

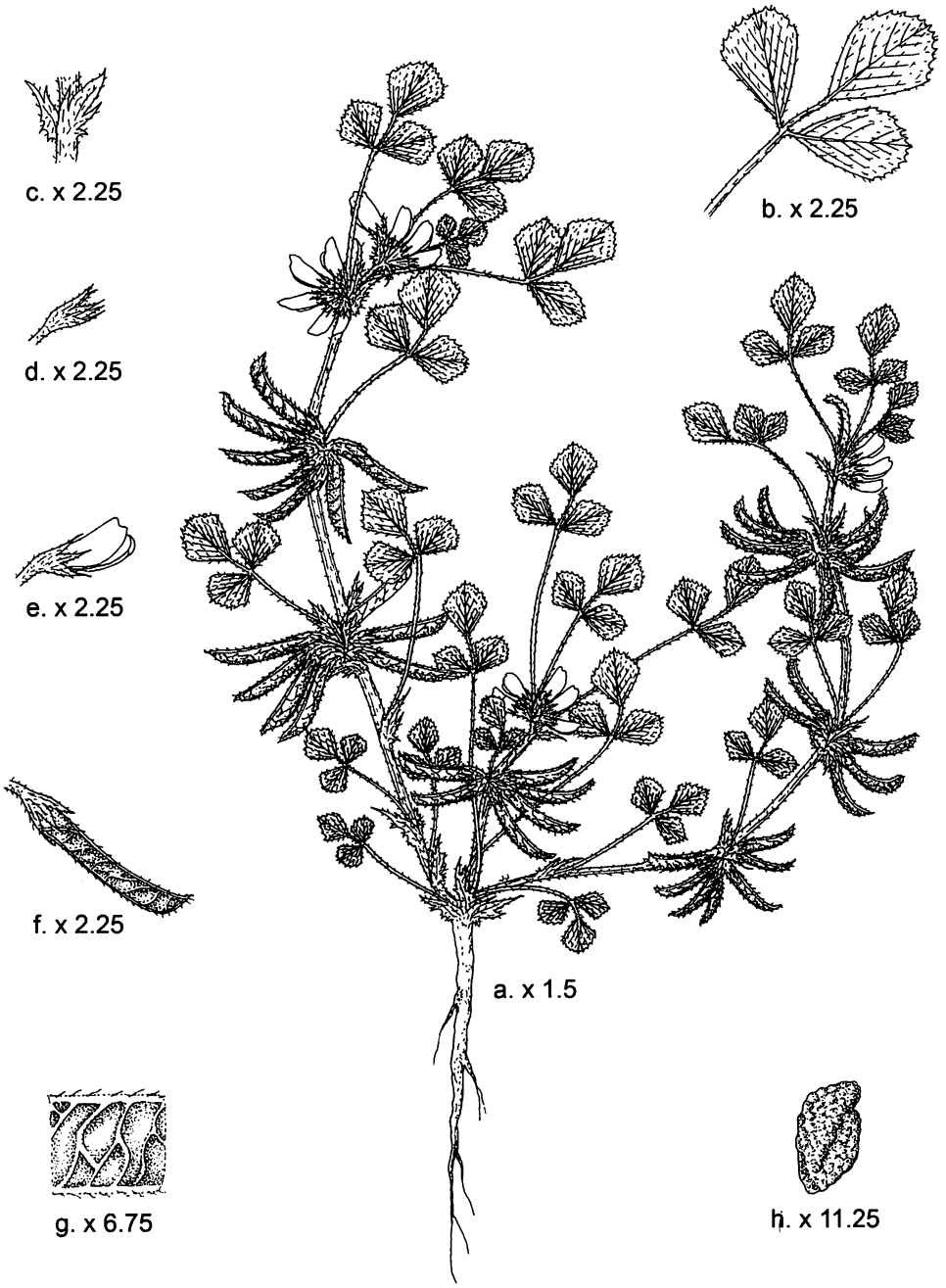

Figure 3.133. *Medicago monspeliaca*: a, habit (x 1.5), b, leaflet (x 2.25), c, stipule (x 2.25), d, calyx (x 2.25), e, flower (x 2.25), f, pod three dimension view (x 2.25), g, pod venation (x 6.75), h, seed (x 11.25).

or sub-sessile racemes which are stellate spreading.
Habitat: Rocky limestone slopes, among gravel, sand dunes, in scrub and forest, a very widespread species of fallow, cultivated fields and roadsides.
Geographical distribution: Africa: Algeria (N), Egypt (N), Libya (N), Morocco (N), Tunisia (N). Asia: Armenia (N), Azerbaijan (N), Georgia (N), Iran (N), Iraq (N), Pakistan (N), Russia in Asia (N), Turkmenistan (N). Australasia: Australia (I). Azerbaijan: Azerbaijan, Nakhichevan. Europe: Albania (N), Austria (N), Balearic Is (U), Belgium (N), Bulgaria (N), Corsica (N), Crete (N), Czech Republic and Slovakia (N), Estonia (I), former Yugoslavia (N), France (N), Greece (N), Hungary (N), Italy (N), Malta (N), Moldova (N), Portugal (N), Romania (N), Russia in Europe (N), Sardinia (N), Sicily (N), Spain (N), Switzerland (N), Turkey in Europe (N), Ukraine (N). Georgia: Abkhazia, Georgia. Middle East: Cyprus (N), East Aegean Is (Greek) (N), Israel (N), Jordan (N), Lebanon (N), Palestine (N), Sinai (N), Syria (N), Turkey in Asia (N). North America: United States (I). Russia in Asia: Dagestan, Krasnodar. Russia in Europe: Astrakhan. South America: Chile (I). Turkmenistan: Ashkhabad, Krasnovodsk. Ukraine: Donetsk, Kherson, Krym, Nikolaev.
Conservation and threat assessment: Not threatened.
Actual and potential usage: None known.

3.91 *Medicago rhytidiocarpa* (Boiss. & Bal.) E. Small, Willdenowia 16(2): 434 (1987).

Synonyms: *Trigonella rhytidiocarpa* Boiss. & Bal. in Boiss, Diagn. Pl. Orient. ser. 2(6): 44 (1859).
Annual, herb, 10-30 cm, stem procumbent to ascending, branching at the ground level. Vegetative parts sparsely pubescent, with defuse, simple and glandular hairs. Stipules lanceolate to acuminate, margin dentate. Leaflet 5-12 x 4-10 mm, obovate, apex truncate, base obcordate to obtuse, dorsally densely pubescent, ventrally densely pubescent, with erect hairs, margins dentate at apex. Peduncle with 4-9 flowers, flowers in umbelliform raceme, longer than the corresponding petiole. Flower 6-11 mm. Pedicle shorter than the calyx tube. Calyx 5-6 mm, densely pubescent, with simple to glandular hairs, longer than half of the corolla, teeth subulate to lanceolate, teeth longer than tube. Corolla yellow. Keel and wing tightly joined. Pods uncoiled, densely pubescent, with simple hair or glandular hair, brown, 20-30 mm, sickle-shaped, spineless, with hook tip, uncinate, face reticulate. Coil veins curved, venation as shoulders joining at 90 degrees, dorsal suture undulate. Seeds 2-2.5 x 1-1.5 mm, violet brown, oblong, 5-8 per pod, coat verrucose, deep constricted between them.

Closely related species: It is the only Medicago species with fruits constricted between the seeds so that the pods are more or less moniliform.
Habitat: Rocky slopes, fallow fields and roadsides.
Geographical distribution: Turkey.

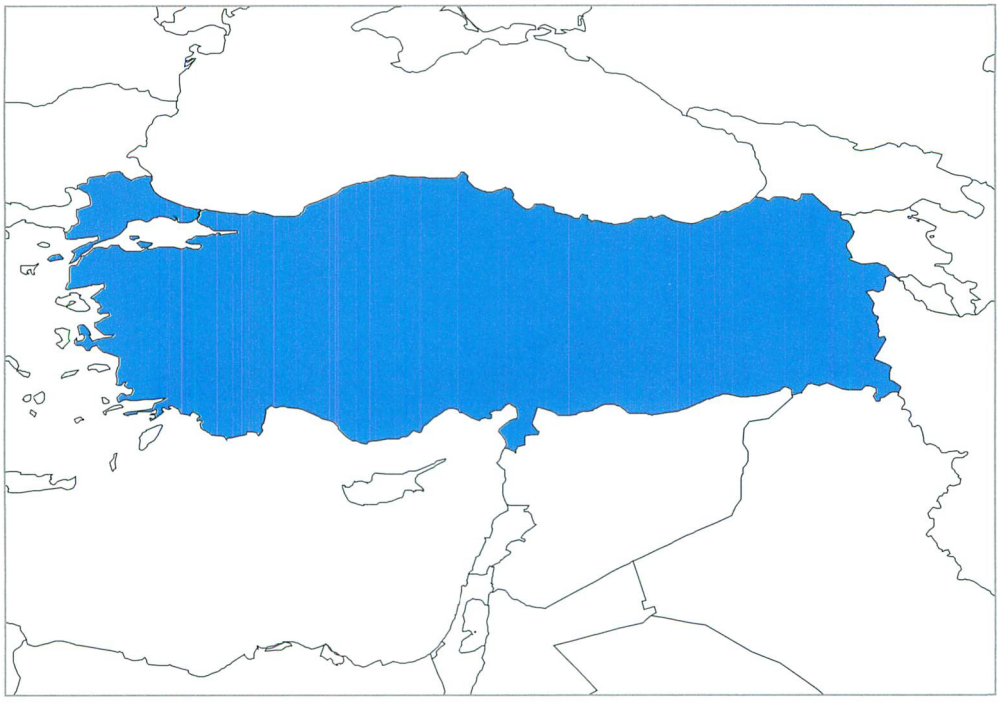

Figure 3.134. Distribution of *Medicago rhytidiocarpa*. (shading represents native distribution).

3.92 *Medicago isthmocarpa* (Boiss. & Bal.) E. Small, Willdenowia 16(2): 433 (1987).

Synonyms: *Trigonella isthmocarpa* Boiss. & Bal. in Boiss, Diagn. Pl. Orient. ser. 2(6): 44 (1859).

Annual, herb, 4-20 cm, stem procumbent to ascending, branching at the ground level. Vegetative parts densely pubescent, with defuse, simple and glandular hairs. Stipules lanceolate to acuminate, margin dentate to incised. Leaflet 4-7 x 2-4 mm, obovate, apex truncate or retuse, margins serrate at apex. Peduncle with 2-6 flowers, flowers in a slender lax raceme, longer than the corresponding petiole. Flower 4-7 mm. Calyx 3-4 mm, densely pubescent, longer than half of the corolla, teeth lanceolate, teeth ± equalling tube. Corolla yellow. Keel and wing tightly joined. Pods uncoiled, densely pubescent, with simple or glandular hair, brown, 10-30 mm, straight slightly curved, spineless, with hook tip, uncinate, face reticulate. Coil veins curved, anastomosing in the half distance from the dorsal suture, venation is a net of veins. Seeds 2 x 1 mm, violet brown, oblong, 2-10 per pod, coat with tubercles, deep constricted between them.

Closely related species: It is easily confused with the preceding species.
Habitat: Rocky igneous slopes, steppe.
Geographical distribution: Turkey.

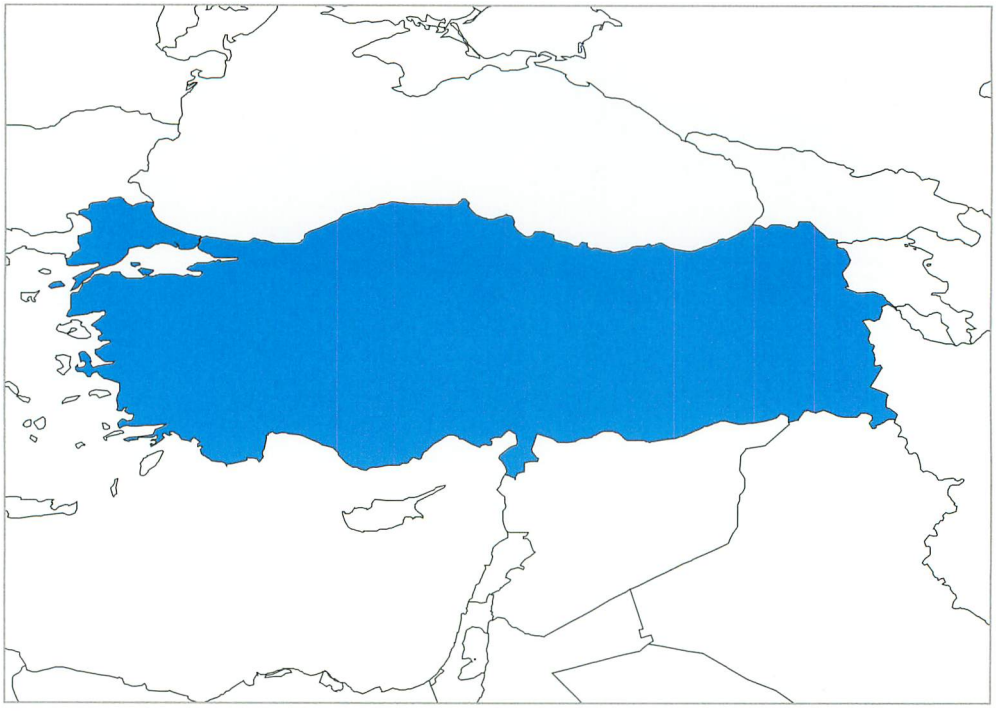

Figure 3.135. Distribution of *Medicago isthmocarpa*. (shading represents native distribution).

3.93 *Medicago rigiduloides* E. Small. Can. J. Bot. 68: 2614 (1990).

Annual, herb, 10-40 cm, stem procumbent to ascending, branching at the ground level. Vegetative parts sparsely pubescent, with erect, simple hairs or glandular hairs. Stipules lanceolate, margin dentate. Leaflet 8-12 x 3-8 mm, obovate, apex retuse or obtuse, margins serrate. Peduncle with 1-3(-4) flowers, longer than the corresponding petiole. Flower 4-6 mm. Pedicle shorter than the calyx tube. Calyx 3-5 mm, densely pubescent, with simple or simple and glandular hairs, longer than half of the corolla, teeth ± equalling tube. Corolla yellow, standard rounded to oval, wings shorter than or very rarely as long as the keel. Pods coiled, usually sparsely pubescent, with simple and glandular hairs, brown, 5-8(-10) mm, discoid to cylindrical or ovoid, spiny or spineless or tubercled, face reticulate, centre with no opening. Coils (4-)5-6.5(-7.5), turning clockwise, not tightly appressed, flat, with hard wall,

veins 7-15, curved, anastomosing before entering lateral vein, venation at maturity obscure. Spines conical, stocky, thick, with hooked tip or with straight tip, 0.5-2.5 mm, at two rows on a coil edge, 10-25 per row, arching upwards of the coil. Seed 3-4x1-2 mm, brown to yellow, 1-2 per coil, coat smooth, separated.

Chromosome number: 14.
Closely related species: It is closely related to *M. rigidula*, from which it can best be distinguished by the substantial presence of 4-pored pollen (mostly 3-pored in M. rigidula), and by fruits with more coils and straighter spine tips. It is also can be confused with *M. doliata* and *M. constricta*.
Habitat: Sandy, clay, volcanic and calcareous soils in low mid-mountain zones, rocky places, woodlands, scrub, pasture, grassland, and steppe.
Geographical distribution: Asia: Afghanistan, Iran, Iraq.

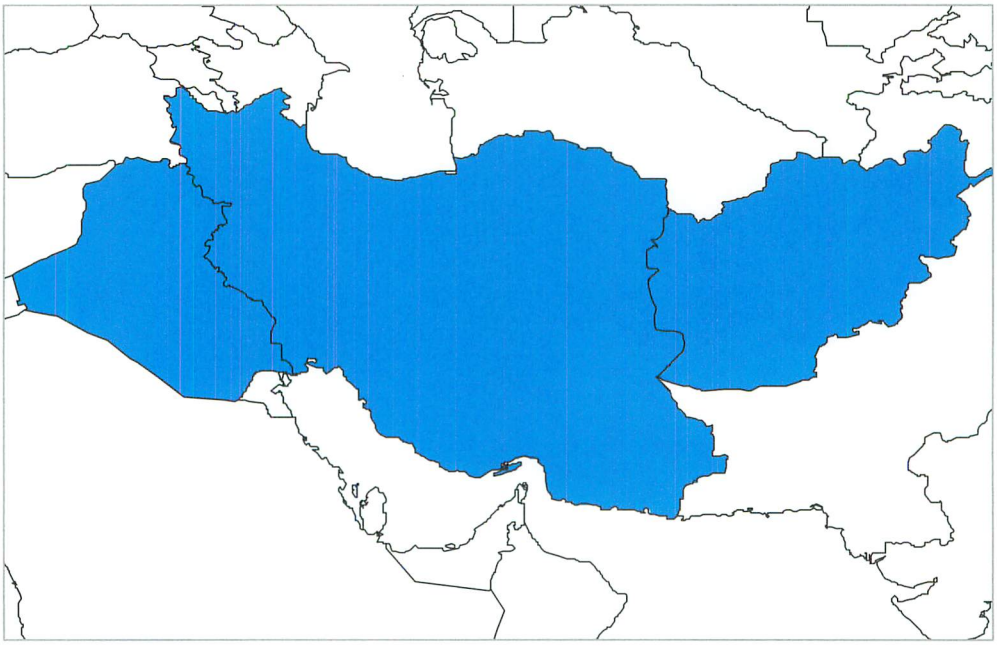

Figure 3.136. Distribution of *Medicago rigiduloides*. (shading represents native distribution).

3.94 *Medicago syriaca* E. Small. Can. J. Bot. 68: 1476 (1990).

Annual, herb, 10-30 cm, stem procumbent to ascending, branching at the ground level. Vegetative parts glabrous or densely pubescent. Stipules margin strongly

laciniate. Leaflet ovate to obovate, apex with terminal tooth and retuse, margins over 50-80% of length serrate. Peduncle with 1-4 flowers. Flower 2.5-4 mm. Calyx glabrous, longer than half of the corolla. Corolla yellow. Pods coiled, glabrous, brown to yellow, 3-7 mm, cylindrical, spiny or spineless or tubercled, without gland-tipped trichomes. Coils 3-6, not tightly appressed with hard wall, veins 8-12, very strongly curved, venation at maturity obscure by spongy tissues, vein-less zone poorly developed or absent, dorsal suture lower the edge margins. Spines inserted at about various angels around 90 degrees to the coil face. Seeds 2-3.5 ovoid to bow-shaped, 1-2 per coil, coat smooth.

Chromosome number: 16.
Closely related species: It is similar to following species *M. murex*, *M. turbinata*, *M. rigidula*, *M. constricta* and *M. doliata*.
Habitat: Mostly arid habitats. .
Geographical distribution: Asia: Iraq, Syria and Turkey.

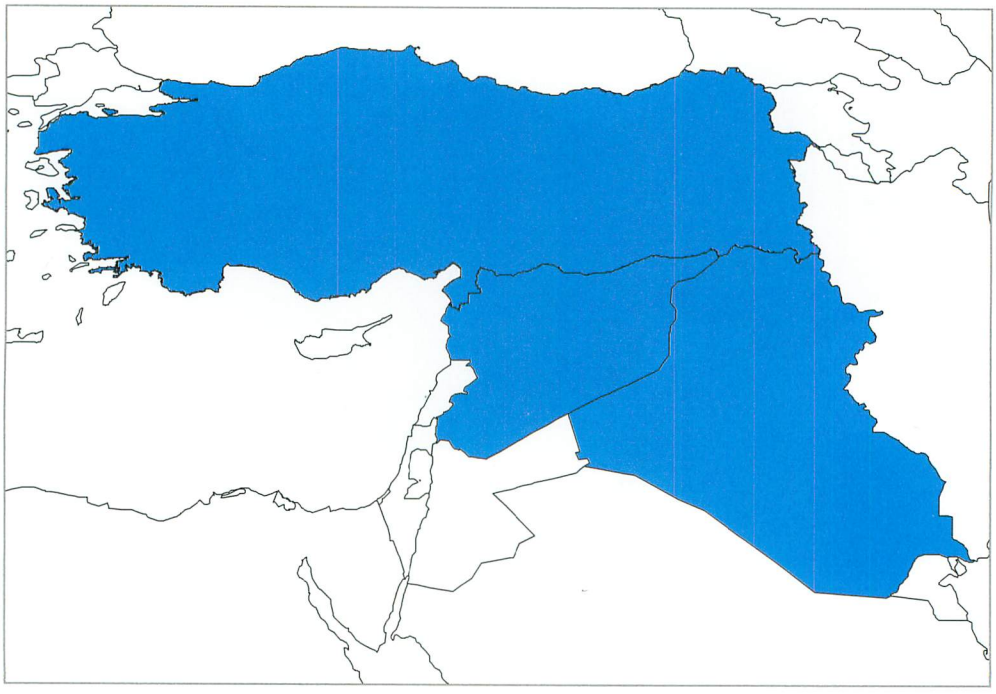

Figure 3.137. Distribution of *Medicago syriaca*. (shading represents native distribution).

4. ECOGEOGRAPHIC ANALYSIS

4.1 Geographical Distribution

The species of the genus *Medicago* are predominantly native to Vavilov's Mediterranean Centre of diversity, though they were widely introduced to each of the semi-arid areas with a Mediterranean climate throughout the world in the 17th century in association with human migration (Prosperi *et al.*, 2001). Unlike related genera such as *Trifolium*, *Vicia* and *Lathyrus*, no *Medicago* species are native to the new world. The ancestral *Medicago* species might have evolved in the tertiary period after the isolation of the New World, but its woody progenitors are likely to have existed earlier. The historical events which succeeded in today's Mediterranean region could explain partially the speciation mechanisms and could have contributed to the extinction of the original progenitors as well as many *Medicago* species.

Some species have a wide distribution, for example *M. polymorpha, M. truncatula, M. orbicularis, M. minima* and *M. lupulina* and these colonisers have been introduced unintentionally to Australia (Cocks *et al.* 1980) and the new world. They are well adapted and now represent an important source of variability and genetic diversity. Other species are more restricted, for example *M. arabica* is commonly found in Corsica, Sardinia and Greece, but is rare in Spain and North Africa while *M. intertexta* is localised in hot and rainy areas of southern Spain, northern Algeria and Sicily, but is only common on the heavy clay, sometimes salty soils, in these regions. *M. doliata* is abundant in North Africa and southern Spain but is rarer in the northern Mediterranean countries where, in similar habitats it is replaced by *M. rigidula*. *M. rugosa* is only found on red to brown clay loam soils and *M. littoralis* and *M. tornata* on sandy, mostly coastal soils (Prosperi *et al.*, 2001). Lesins and Lesins (1979) suggested that the perennial species originated on the northern coasts of the Mediterranean basin rather than the western and central Asia as suggested by other researchers like Balabaev (1934) and Sinskaya (1961) who suggested that *Medicago* started to evolve as a member of a very ancient Arcto-Tertiary flora, that occupied a very large area around a Mediterranean sea (the Tethys sea) much larger than of today. Although most of the species are distributed around the Mediterranean, mainly in mountainous areas, some species are endemic to higher northern latitudes and to East Asia (Table 4.1). *M. marina* as the name suggests is restricted to shoreline habitats.

Alfalfa is also believed to have originated from the Near-Eastern Vavilov centre where it is found in the wild with its sister perennial species in Asia Minor countries (Iran, Iraq, Azerbaijan, Turkmenistan, etc.) and in Eurasia. It is difficult to qualify the first traces of alfalfa domestication (Prosperi *et al.*, 2001). Ivanov (cited in Quiros and Bauchan 1988) suggests that alfalfa was cultivated 8,000 to 9,000 years ago.

Hendry (cited in Bolton 1962) proposes that since 4,000 BC, maybe earlier, the Sumerian merchants transported alfalfa to the western Mediterranean. Sinskaya (1950) suggests that its distribution extended across to the Middle East by 1,000 BC, and from there, extended to China and India. It has spread through human transposition into Europe, North Africa, West Asia and Americas and is now the World most important forage crop (see Figure 4.1). *Medicago* species originated in warm epochs, thus generally adapted to warm Mediterranean environments, although one species, *M. carstiensis* requires winter dormancy. The cultivation of *Medicago* species in colder and wetter environments was facilitated by the selection of winter hardy varieties.

Table 4.1. Basic biodiversity information for *Medicago* species.

Species	Life Form	2n	Distribution Range	Notes
M. lupulina	P, B, A	16 or 32	Europe, most Asia and North Africa	Use in forage mixtures, persists severe grazing
M. secundiflora	A	16	North Africa & South Europe	Morphologically similar to *M. lupulina*
M. carstiensis	P	16	Endemic to eastern coasts of Adriatic Sea	Forage production and winter hardiness
M. platycarpa	P	16	Western Siberia to Lake Baikal	Does not cross with *M. sativa*
M. ruthenica	P	16	From Trans-Baikal to Pacific Ocean	Does not cross with *M. sativa*
M. orbicularis with *M. sativa*	A	16	Mediterranean basin to Western Asia	High variation within species, no hybrids
M. radiata	A	16	Caucasus, Asia Minor to Central Asia	Does not cross with other species
M. heyniana	A	16	Island of Karpathos	Does not cross with other species
M. cretacea	A	16	Endemic to Trans-Caucasia and Crimean regions	-
M. falcata	P	16, 32	From South Germany to coasts of Black Sea ata and M. prostrata	Heat and cold tolerant, highly variable, can hybridize with *M. sativa*, *M. glomer*
M. sativa	P	16, 32	Has evolved around the Caspian sea	Highly variable, may hybridize with *M. falcata*, *M. glomerata*, *M. glutinosa* and *M. prostrata*
M. glomerata	P	16 (32?)	North Africa	Can cross with *M. sativa*
M. glutinosa	P	32	Endemic to Caucasian region	Can cross with *M. sativa*
M. prostrata	P	16, 32	Eastern Austria and Italy Eastern Adriatic Coast of Greece	Can cross with *M. sativa* and *M. falcata* but there are barriers that need to be overcome
M. rhodopea	P	16	Endemic to Mountain ranges of Bulgaria	Can hybridize with *M. saxatilis* and *M. sativa*
M. saxatilis	P	48	Endemic to Crimean mountain	Can cross with *M. sativa*
M. rupestris	P	16	Endemic to Crimean mountain	May hybridize with *M. rhodopea* and *M. sativa*

Table 4.1. (continued)

Species	Life Form	2n	Distribution Range	Notes
M. cancellata	P	48	Southern Europe USSR North Caucasus	Could be crossed with *M. sativa* and *M. saxatilis*, adaptation to snow and dryland
M. daghestanica	P	16	Dagestan mid-mountainous regions	Need to produce tri-species hybrids to transfer genes to *M. sativa*
M. pironae	P	16	Endemic to Eastern Alps	Can cross with *M. sativa*
M. papillosa	P	16, 32	North Eastern Anatolia to adjacent mountains of Trans-Caucasia	Can cross with *M. sativa*
M. arborea	P	32, 48	From canary to Asia Minor	-
M. marina	P		Shores of Mediterranean Sea, Black Sea to Atlantic coasts of Iberia and France	-
M. suffruticosa	P	16	Mountains of the Iberian Peninsula and Morocco	Good self propagation which is desirable for pastures
M. hybrida	P	16	Endemic to the Central and East Pyrenees	Can cross with *M. suffruticosa*
M. rotata	A	16	East Mediterranean	Can cross with *M. bonarotiana*
M. bonarotiana	A	16	East Mediterranean	Can cross with *M. rotata*
M. noeana	A	16	Endemic to Iraq and Turkey	-
M. shepardii	A	16	Endemic to Gaziantep region	-
M. rugosa	A	32	Mediterranean region	-
M. scutellata	A	32	Mediterranean region	-
M. soleirolii	A	16	South East Mediterranean region	-
M. tornata	A	16	West Mediterranean region	Polymorphic species
M. littoralis	A	16	Mediterranean region	Highly variable
M. truncatula	A	16	Mediterranean region	Highly variable
M. rigidula		14	Mediterranean region	Highly variable
M. murex	A	14, 16	Mediterranean region	Highly variable
M. constricta	A	14	East Mediterranean region	-
M. turbinata	A	16	Eastern and Northern Mediterranean region	Four varieties

Table 4.1. (continued)

Species	Life Form	2n	Distribution Range	Notes
M. doliata	A	16	Mediterranean region	Two varieties
M. sauvagei	A	16	Endemic to Morocco	Can cross with *M. laciniata*
M. laciniata	A	16	Southern coast of the Mediterranean sea	-
M. minima	A	16	Mediterranean region to Sweden and Canary Islands	Highly variable, most widely distributed species
M. praecox	A	14	North Mediterranean region	-
M. coronata	A	16	North Mediterranean spreading from I Portuga to Iraq	Highly variable
M. polymorpha	A	14	Mediterranean but spread all over the world	Highly variable
M. arabica	A	16	Endemic to Central Asiatic of USSR	-
M. disciformis	A	16	From Turkey to Spain	-
M. tenoreana	A	16	North-western Mediterranean coasts and islands	-
M. intertexta	A	16 (32?)	Canary island, Portugal, Spain and Italy	Can cross with M. ciliaris and *M. muricoleptis*
M. ciliaris	A	16	North and South Mediterranean sea	Can cross with *M. intertexta*
M. muricoleptis	A	16	Sicily and Southern Italy	Can cross with *M. intertexta* and *M. ciliaris*
M. granadensis	A	16	East Mediterranean	Can cross with *M. intertexta* and *M. ciliaris*

A: Annual, B: Biennial, P: perennial growth habit

Escaped *M. sativa* plants from agriculture are frequent in a variety of open habitats (roadsides, field borders), but *M. sativa* is rare in the wild, with the exception of the Iberian Peninsula and its centre of diversity (Caucasus, Turkey). In other west Mediterranean countries (southern France, Italy, Greece, and North Africa), plants of *M. x varia* are more common. Unlike *M. sativa*, *M. falcata* appears more frequently as a wild species, from north of the Mediterranean Sea (Bulgaria, Greece) to the northern limits of Russia. It is particularly well adapted to hard winters, as well as to the hot and dry summers typical of continental climates.

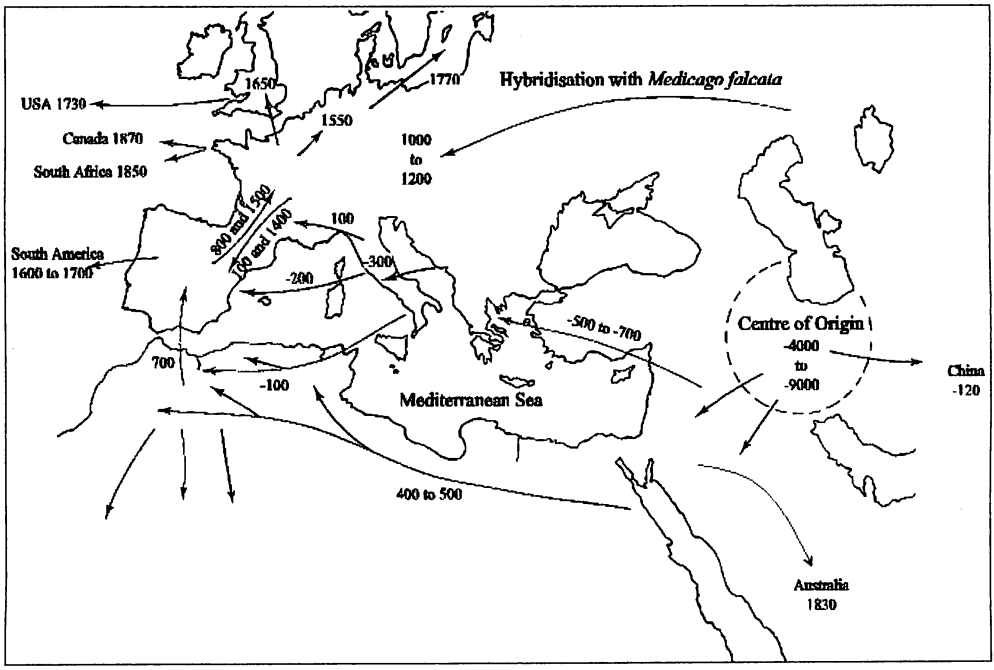

Figure 4.1. Different paths and approximate years BC (-) and AC of migration of *Medicago sativa* from its centre of diversity (Prosperi *et al.*, 2001).

4.2 Centre of Diversity

The ancestral *Medicago* species are thought to be perennial, probably woody, and allogamous species and the annual species would have evolved 6-7 million years ago during the Miocene (Lesins and Lesins, 1979). The Centre of diversity of the genus is the 'fertile' crescent, specifically Turkey, Iraq and Iran, as well as the area south of the Caucasus and the eastern Mediterranean basin (Prosperi et al., 2001), from here species spread throughout the Mediterranean region and then, to the neighbouring steppe regions (Figure 4.2).

4.3 Ecological Distribution

The scientific value of herbarium specimens increases substantially if ecological data is recorded accurately and in details The failure of many past botanical collectors to record the ecological provenance of specimens makes it difficult to draw solid ecological conclusions. The lack of standardisation in habitat type, for example, makes the recording of habitat description by many subjective further thwarts the interpretation of the ecological distribution of the taxa. Thus, the ecological data presented here for Medicago species is largely drawn from floras and other literatures supplemented by the data that was available from herbarium specimen or gene bank accession passport data and personal observation.

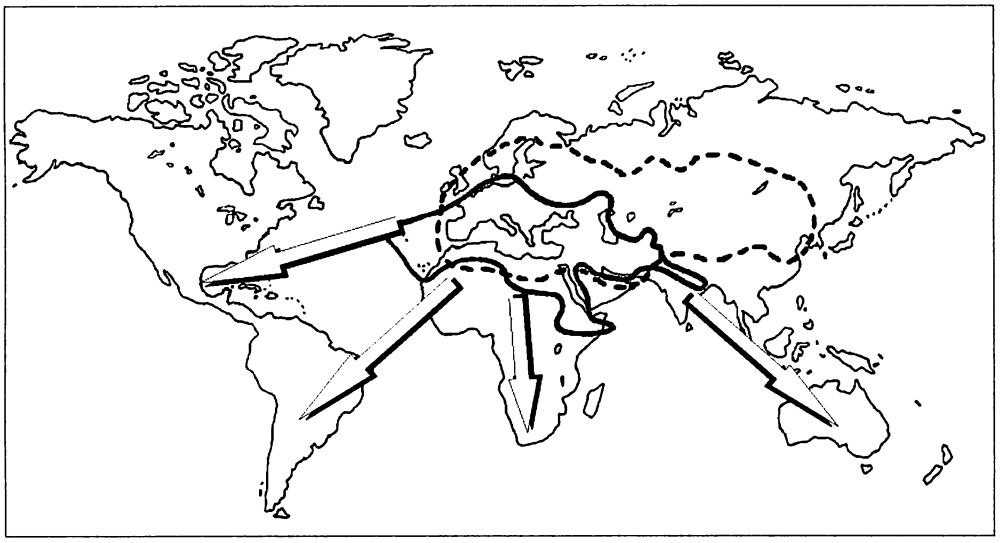

Figure 4.2. Distributional Spread of Annual and Perennial Medicago Species from Their Centre of Diversity (Prosperi *et al.*, 2001).

Annual *Medicago* species generally inhabit dry, open, disturbed and degraded habitats and therefore can be described as early successional species of rocky slopes and agricultural lands. On the other hand, perennial species are more often found in later successional habitats, with more moist, stable, closed communities particularly those of open woodland or woodland edges and maquis scrub of mountain areas. Although some perennial species do not fit in this pattern and *M. arborea*, *M. marina* and *M. cancellata* are found in more dry, open situations. *M. suffruticosa* and *M. papillosa* are found in rocky terrain, but they are also montane species, they are not found in the more arid lowland habitats characterised by the annual species.

The annual species are virtually exclusively self pollinating while perennial *Medicago* species are generally outbreeding, only resorting to inbreeding when there is an absence of pollinators (Lesins and Lesins, 1979). This common reproductive isolation has probably in part allowed the huge speciation in the annual *Medicago* genepool, in particular it has allowed many taxa to develop and coexist with only limited hybridization occurring. However hybridisation can occur, particularly between taxa in subsections *Pachyspireae* and *Rotatae*, thus selfing is the convention not the rule between many taxa however there are reproductive barriers in operation, other than that of self pollination, thus the cross pollination occurs no fertile seeds result or fertility and viability in the F1 generation is much reduced (Lesins and Lesins, 1979). It has been suggested by Lesins and Lesins (1979) that the annual species are predominantly selfing because they evolved in the absence of large populations so being unable to exist as cross breeders under such conditions.

It can be observed that most *Medicago* species and subspecies are associated with calcareous, sandy and clay soils, the majority preference is for soils of the dry type and this can be explained by the fact that the genus is dominated by annual species which can compete their life cycle in one season and are therefore more able to exploit such moisture poor environment. A minority of species require humus rich soils and these are primarily the perennials.

4.4 Genetic Diversity

The evolution of the genus *Medicago* is relatively complex due to large amount of variation within the species (Lesins and Lesins, 1979). It is commonly believed that the perennial woody species are phylogenetically the oldest, followed by the perennial herbaceous species and the annuals. Therefore it is believed that most of the species have turned to self-pollination an insects-facilitated cross-pollination ancestor, which can still be seen in case of some perennials. For example, *M. arborea* is believed to be the oldest species, and it is a shrub and is both self and cross-pollinated species. The isolating mechanisms that can be used to explain the speciation of *Medicago* include the polyploidization and chromosome rearrangements, non lethal chlorophyll deficiency, differences in genomic constitution of endosperm, genetic factors preventing crossing between individuals and environmental stress and geographic isolation. Genetic drift could also explain the phenomena of speciation but there is limited evidence for this hypothesis.

The genus includes diploid and tetraploid species and unusually hexaploid species (*M. cancellata*, *M. saxatilis* and a few populations of *M. arborea*). The basic genomic chromosome number is x = 8 but there are 5 diploid species which have x =14 which could arise from the joining of two chromosomes with a loss of the centromere region of one of the chromosome involved. There are diploid, tetraploid and hexaploid levels among *Medicago* species and some species are present in more than one ploidy level. The tetraploids are often more vigorous and more adapted to varying environments than the diploids for the species which have the

two forms. *M. murex* has 2n = 14 and 2n = 16 forms which have similar morphologies but have developed crossing barriers. No tetraploid species with 2n = 28 are found. Most of the annual medics are diploids except for *M. rugosa* and *M. scutellata* which are tetraploid with 2n = 32 but their diploid progenitors have not yet been identified. A number of perennial species have both diploid and tetraploid forms which can not inter-cross. These tetraploids are thought to have arisen spontaneously from diploids. Two species *M. saxatilis* and *M. cancellata* are hexaploid (2n = 48) and a third species *M. arborea* has both hexaploid and diploid forms which are morphologically similar.

Species affinities and evolutionary relationships are often assessed on the basis of morphological similarities, but now are mainly through chromosome similarities and hybridization by applying and using DNA molecular techniques. The high polymorphism existing for many species have complicated the taxonomic classification of the *Medicago* species (Lesins and Lesins, 1979). All *Medicago* species belonging to section *Falcago* can hybridize readily with *M. sativa* except the two more remote species *M. daghestanica* and *M. pironae* which need to be first crossed together and then the hybrid crossed to *M. sativa* to produce a tri-species. None of the crosses between *M. sativa* with annual *Medicago* species were successful although the cross with *M. rigidula* generated embryos which could not be regenerated. Among other reported hybridizations among *Medicago* species: *M. daghestanica* with *M. pironae*; *M.* papillosa and *M. dzhawakhetica* at the tetraploid level; *M. rhodopea* and *M. rupestris*; *M. saxatilis* with *M. cancellata*. From these findings, the gene pool concept for alfalfa is as follows:

Primary Gene Pool: *M. sativa* subsp. *falcata*, *M. sativa* subsp. x *varia*, in addition to landraces, ecotypes, modern and obsolete cultivars and the cultivated and naturalized and wild forms of *M. sativa* subsp *sativa*;

Secondary Gene Pool: *M. sativa* subsp. *caerulea*, *M. sativa* subsp. *glomerata*, *M. prostrata*, *M. papillosa*, and *M. saxatilis*;

Tertiary Gene Pool: *M. cancellata*, *M. daghestanica* and *M. dzhawakhetica*.
These species in the different gene pools constitute a valuable genetic resource for the further genetic manipulation for crop improvement and phylogenetic studies. Only 15 species are actually cultivated and most of the breeding efforts have concentrated on alfalfa. More work is needed for the domestication of the other species and for determining their values for other uses.

4.5 Exploitation of Diversity

The genus *Medicago* currently contains around 90 species, one third of which are perennials and two third annuals (Small and Jomphe, 1989). About 15 species are actually domesticated and cultivated for different purposes, mainly as animal feed but also in soil improvement, as cover crops, human food as sprouts and juices, and as ornamentals (Table 4.2). The annuals are primarily used as pastures or for-

ages, for soil improvement and as companion crops, while the perennial species are mainly used as forage, except for alfalfa which has the most diverse uses and is also used for human food and medicinal values and *M. arborea*, which is used as ornamentals.

Table 4.2. List of cultivated species and their uses (Adapted from www.ars-grin.gov/npgs).

Species	English common name	Uses
M. arabica	Spotted medic (annual)	Forage
M. italica	Disc medic (annual)	Forage, soil improvement and companion crop
M. littoralis	Strand medic (annual)	Forage, soil improvement and companion crop
M. lesinsii	NA (annual)	Forage, soil improvement and companion crop
M. lupulina	Black medic (annual)	Forage, soil improvement and companion crop
M. minima	Little bur clover (annual)	Forage
M. murex	NA (annual)	Forage, soil improvement and companion crop
M. orbicularis	Button clover (annual)	Forage, soil improvement and companion crop
M. rigidula	Tifton medic (annual)	Forage, soil improvement and companion crop
M. rugosa	Gama medic (annual)	Forage, soil improvement and companion crop
M. scutellata	Snail medic (annual)	Forage, soil improvement and companion crop
M. truncatula	Barrel medic (annual)	Forage, soil improvement and companion crop
M. polymorpha	Toothed medic (annual, biennial, perennial)	Forage, soil improvement and companion crop
M. arborea	Tree medic (perennial)	Forage, ornamental
M. sativa subsp. *sativa*	Alfalfa, Lucerne (perennial)	Forage and fodder, soil improvement, human food-sprouts, medicinal-tea
M. sativa subsp. *falcata*	Yellow lucerne (perennial)	Forage
M. sativa subsp. x *varia*	Sand lucerne (perennial)	Forage

Alfalfa is one of the world's most important forage legumes. Alfalfa is grown in irrigated or dryland conditions across a wide range of environments from the Saudi-Arabian deserts to the sub-tropics of Australia, and through the cold temperate regions of Europe, west and central Asia, and South and North America (Prosperi *et al.*, 2001). Alfalfa or Lucerne, also known as the "Queen of the Forages" is the most widely grown forage for livestock mainly for ruminants and horses all over the world. It is used in pure stand or in a mixture with other forage grasses and legumes. Generally, *M. sativa* subsp. x *varia* is grown in temperate zones while *M. sativa* subsp. *sativa* is grown in drier environments. Alfalfa, in addition to its feed and food values, is used in for the production of bio-fuel, the bioremediation of soils and in producing industrial enzymes such as cellulose, peroxidase, alpha-amylase and phytase and these aspects will require further investigation and research. Among the new investigated uses are for example: production of paper pulp and ethanol and uses for soil nitrate removal and kitty litter.

The annual species of medics are mainly used as pastures (permanent or cut for hey) and as cover crops (green manure or to prevent soil erosion) in the regions with Mediterranean climates; and have potential for sustaining agricultural systems. *M. littoralis*, *M. polymorpha*, *M. rugosa*, *M. Scutellata*, *M. Italica* and *M. truncatula* form the basis of the ley farming system predominantly in the wheat-based system used in Australia. They are also used as companion crops to contribute to weed control, add organic matter, limit soil erosion and procure habitats for wild life.

Alfalfa is suffering from genetic vulnerability due to the narrowing of its genetic base in terms of the commercially release varieties. There are many diseases (anthracnose, aphanomyces root rot, bacterial wilt, common leaf spot, *Fusarium* wilt, *Verticillium* wilt, yellow leaf blotch, etc.), insects (alfalfa weevil, blue alfalfa aphid, potato leafhopper, pea aphid, and others), nematodes (alfalfa stem, root-knot, root-lesion nematodes) which are affecting seriously the productivity and quality of alfalfa. The resistance to these biotic stresses and the need for more winter hardiness and for further improvements in yield along with good regeneration ability will require the introgression of genes from species in different gene pools and more research on transferring genes from other *Medicago* species is required. Among the other desired traits are non-dormancy, improved crown structure, tolerance to low pH and salinity.

In Australia annual medics are important on the alkaline soils of southern Australia, and constitute the basis of sheep production systems in the regions with a Mediterranean climate (Prosperi *et al.*, 2001). Here a farming system based on the cereal-medic rotation (ley-farming) was developed in response to the hardseededness of medic cultivars (Crawford *et al.*, 1989), with self seeding medic replaced the less productive classic fallow in the cereal rotation. Cultivar development in Australia has been largely based on selection and commercialisation of selection introduced from the Mediterranean or Chile (e.g. *M. polymorpha*) and breeding has focused on developing high yielding, aphid resistant cultivars of *M. truncatula* and *M. littoralis* by back-crossing locally adapted 'ecotype' cultivars to aphid resistant material (Prosperi *et al.*, 2001). While in Mediterranean Europe and North Africa medics show great potential given their natural reseeding ability, their prostrate habit, and their tolerance to grazing and drought. Annual medic species, such as *M. rigidula*, *M. truncatula* and *M. polymorpha* are also used as constituents of hardy meadows, and in pastures under grapevines and orchards to control the erosion of the soil (Prosperi *et al.*, 2001). For all these uses, annual medics should have better grazing and cold weather tolerance than the currently available cultivars (Prosperi 1993). Traditionally in North America medics have not been so widely exploited but interest has risen with the development of more sustainable agriculture, and it is perhaps here that there are the greatest potential benefits for nitrogen fixation, green manure or forage production, reduced soil erosion, and weed control, as well as being valuable for inter-cropping systems with wide-spaced row crops such as maize (*Zea mays*) and sunflower (*Helianthus annuus*) (Kandel *et al.*,

1997) and in vineyard and orchard alleyways to provide a low maintenance ground cover (Prosperi, 1993).

The cultivation of Alfalfa in Europe has decreased since the 1960's due to the introduction of intensive land management for animal production mainly based on maize silage. However, now alfalfa is also fed as dehydrated pellets which are used as a nitrogen supplement for feeding dairy animals (ewes or cows) or non-ruminant animals (rabbits, pigs, poultry) (Prosperi 1993). Since 1965 alfalfa breeding programs in Europe have been aimed primarily at increasing tolerance to diseases or pests (Raynal *et al.*, 1977). In North America alfalfa is grown as a forage crop on over 12.25 million ha (Michaud *et al.* 1988) and multiple pest and disease resistance has become a key feature of alfalfa plant breeding (Barnes *et al.* 1988). The Australian cultivation of alfalfa provides a good example of genetic vulnerability of a too narrow genetic base with the devastation losses caused by the introduction of spotted alfalfa aphids and blue-green aphids (Auricht, 1999). Since then Australian breeding efforts have focused on persistence and productivity with a broad adaptation to soils, climate and management (Auricht 1999).

5. CONSERVATION AND THREAT STATUS

5.1 Conserved Diversity

5.1.1 *In Situ* Review

Before any discussion of a conservation strategy and taxon priorities for the genus *Medicago* can be concluded, an evaluation of current attempts to conserve the taxa must be considered (Maxted *et al.*, 1995). Genetic resources can be conserved either *in situ* or *ex situ* or in the ideal situation using both in a complementary manner. There are no *in situ* genetic reserves specifically designated for the conservation of *Medicago* germplasm, however it can be assumed that the protected areas that do exist in the genus's centre of diversity do contain a range of *Medicago* and so are likely to be being conserved *in situ*. The only example targeting the on-farm conservation of alfalfa in the CWANA region is that being implemented in Morocco through the IPGRI-Global *in situ* conservation project on strengthening the scientific basis for on-farm conservation.

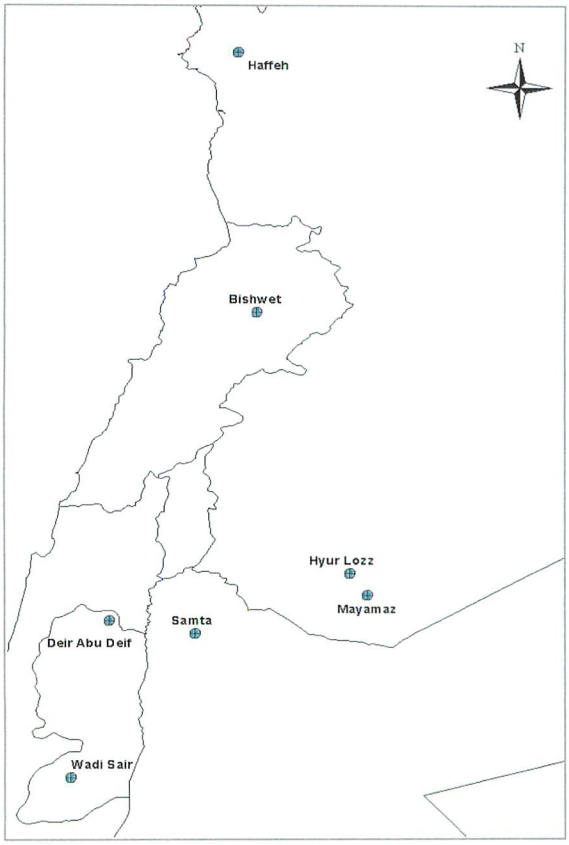

Figure 5.1. Location of Genetic Reserves Established by the West Asia Dryland Agrobiodiversity Project.

Recently the Global Environment Facility funded West Asia Dryland Agrobiodiversity Project which was implemented in two target areas in each of four countries, Jordan, Lebanon, Palestine and Syria. Within the project, the team surveyed the distribution, the frequency and density of these species within selected monitoring areas over the period of 2000-2004 and assessed the major factors causing degradation. The project established eight *in situ* genetic reserves in the four countries (see Figure 5.1) to conserve the Forage Legumes: *Medicago* sp., *Vicia* sp., *Trifolium* sp., *Lathyrus* sp. and *Lens* sp. and the Cereals: *Triticum* sp., *Avena* sp., *Hordeum* sp. and *Aegilops* sp.

The West Asia region contains one of the three major mega-centres of diversity for crop of global significance. Wild relatives of wheat, barley, lentil, chickpea, almond, pistachio, pear and many species of *Lathyrus, Medicago, Trifolium* and *Vicia* are still found under natural habitats in rangelands and forest ecosystems and in field edges. The remaining populations are highly threatened by over exploitation, mainly overgrazing and by natural habitats destruction for agricultural and urbanization purposes. These species constituting valuable gene pools for wealth creation, food security and environmental sustainability in the 21st century and need to be conserved both *ex situ* and *in situ*, but farmers and herders do not always realized this genetic value. Management plans were developed for selected sites to promote *in situ* conservation of these crop wild relative (CWR) species within their natural habitats. These plans were the first of their kind dealing with the management and sustainable use of a designated site to conserve distinct CWR species of global important for food and agriculture. The management plans included technological, institutional and policy options, as well as incorporating community development in terms of helping identify alternative sources of income which will allow full participation of local communities in the conservation and management of local Agrobiodiversity. For some highly threatened species such as *Triticum* and *Lens*, protected areas were designated. A monitoring system was established to assess the long-term changes as well as the effectiveness of the management options on diversity of the target species.

Government and international support are needed to fully implement the proposed management plans if species of global importance are to be safeguarded to overcome environment challenges caused by climatic change and biotic stresses. This contribution will present the approach for the establishment of management plans and the examples developed within the Dryland Agrobiodiversity project in Palestine, Lebanon and Syria.

5.1.2 Ex Situ Review

In the assessment of the present conservation status of the genus, it is far easier to evaluate the role of *ex situ* genebanks, than it is to evaluate the role of *in situ* genetic reserves, primarily due to a lack of species inventories for the latter. The *ex situ* conservation of *Medicago* species began before 1900 in many countries but a degree of magnitude more collections have been made since the establishment of ICARDA in the early 1970s. Not only has ICARDA, jointly with National Program staff, collected *Medicago* species widely but they have stimulated the establishment of national gene banks which themselves have in turn collected *Medicago* species thoroughly. There remains a need to fill gaps in conserved diversity and each year collecting mission are targeting areas not covered by previous expeditions. The total holdings of medic at ICARDA are 9160 accessions, 82 % of which have originated from the CWANA region and 55 % were collected by ICARDA staff (see Table 5.1). Figure 5.2 shows the breadth of collection sitesfor *Medicago* accessions held at ICARDA-Genetic Resources Unit.

As well as the collection held by ICARDA, there are also large collections of *Medicago* accessions held by Australian *Medicago* Genetic Resources Centre (AMGRC), Australia, USDA-ARS, USA and at the Vavilov Institute, Russia. The annual *Medicago* species are reasonable well represented in the large *ex situ* collections, however, perennial *Medicago* species are generally under-represented for most species, other than the *M. sativa* complex, and only a handful of the 23 new *Medicago* species moved from *Trigonella* are available (Prosperi *et al.*, 2001). The AMGRC collection in Adelaide maintains the world's largest annual medic collection with 25,000 accessions along with a further 10,000 accessions of related genera, it introduces an average of 1,000 new accessions each year (Hughes and McLachlan 1999), and the collection data is accessible via www.sardi.sa.gov.au. While the USDA-ARS collection of *Medicago* species is maintained by the USDA National Plant Germplasm System (NPGS) located at the Western Regional Plant Introduction (PI) Station in Pullman, Washington. The current collection (Germplasm Resources Information Network (GRIN), February 2002) contains a total of 7554 accessions with 4108 perennial accessions and 3446 annual accessions (see Table 5.2).

Table 5.1. *Medicago* species accessions held by ICARDA.

Annual Medics		Perennial Medics	
Taxa	**No. Accessions**	**Taxa**	**No. Accessions**
M. aculeate	371	*M. radiate*	156
M. arabica	90	*M. rigidula*	1174
M. astroites	17	*M. rotate*	262
M. blancheana	143	*M. rugosa*	86
M. brachycarpa	3	*M. sauvagei*	7
M. constricta	145	*M. scutellata*	138
M. coronata	93	*M. shepardii*	1
M. disciformis	60	*M. soleirolii*	3
M. fischeriana	1	*M. sp.*	3
M. granadensis	18	*M. tenoreana*	5
M. heyniana	1	*M. tornata*	188
M. hybrida	2	*M. truncatula*	888
M. intertexta	210	*M. truncatula x littoralis*	37
M. laciniata	222	*M. turbinate*	204
M. lanigera	1	*M. agropiretorum*	2
M. littoralis	299	*M. arborea*	1
M. littoralis x truncatula	10	*M. carstiensis*	1
M. lupulina	124	*M. caerulea*	4
M. medicaginoides	2	*M. difalcata*	1
M. minima	487	*M. edgeworthii*	1
M. monantha	101	*M. falcata*	12
M. monspeliaca	257	*M. glutinosa*	3
M. murex	152	*M. hemicycla*	4

Table 5.1. (continued)

Annual Medics		Perennial Medics	
Taxa	**No. Accessions**	**Taxa**	**No. Accessions**
M. muricoleptis	11	*M. sativa*	765
M. noeana	58	*M. synlhetie*	1
M. orbicularis	723	*M. tetrocoerulea*	1
M. orthoceras	1	*M. tianschanica*	2
M. platycarpa	1	*M. transvana*	1
M. polyceratia	11	*M. trautvetteri*	1
M. polymorpha	1505	*M. x varia*	14
M. praecox	75		
		Total	**9160**

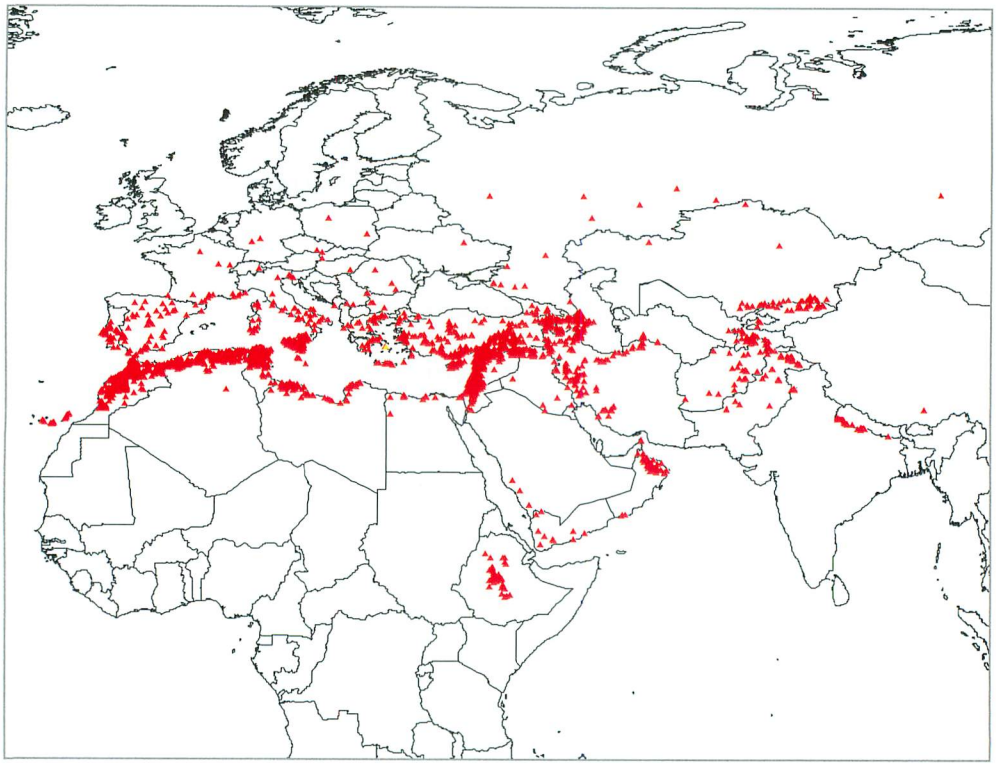

Figure 5.2. Geographical distribution of ICARDA holdings of *Medicago* species.

Table 5.2. *Medicago* species accessions held by USDA, with geographic distribution and conservation status of each species as defined by Prosperi *et al.* (1996).

Taxon	Geographic Distribution	NPGS Accessions	Status[1]
M. arborea	Europe, Turkey	38	B-Cult
M. strasseri	Crete		A
M. sativa subsp. *caerulea*	E. Turkey, Iran, Former USSR	77	B
M. sativa subsp. *sativa*	Possible native range-Middle East, C Asia, now widely distributed	3042	C-CULT
M. sativa subsp. *glomerata*	Balbis. S Europe, N Africa, Caucasus	7	A
M. sativa subsp. *falcata*	S Europe, Former USSR		B-CULT
M. sativa var. *falcata*	N Eurasia	419	-
M. sativa var. *viscosa*	S Europe, N Africa, Caucasus	14	-
M. sativa subsp. x *varia*	Europe, Iran, Syria, Turkey, Caucasus	287	-
M. sativa subsp. x *tunetana*	S Europe, N Africa, Caucasus	6	-
M. papillosa	Turkey, S Russia	8	A
M. papillosa subsp. *macrocarpa*	Turkey	0	-
M. papillosa subsp. *papillosa*	Turkey, S Russia	1	-
M. prostrata	Albania, E Europe, Italy	13	A
M. rupestris	Crimea, W Caucasus	0	A
M. cancellata	European Russia	7	A
M. rhodopea	Bulgaria	2	A
M. saxatilis	Crimea	1	A
M. daghestanica	Dagestan	0	A
M. pironae	Italy	4	A
M. hybrida	France, Spain	1	A
M. suffruticosa	France, Spain, Morocco	17	B
M. marina	S Europe, N Africa, Middle East, Crimea	20	B
M. carstiensis	E Europe	1	A
M. soleirolii	France, Italy, Algeria, Tunisia	11	A
M. italica	Mediterranean Basin	87	B-CULT
M. littoralis	Mediterranean Basin, E Europe, Caucasus	173	V
M. truncatula	Mediterranean Basin, E Europe, Caucasus	320	C-CULT
M. doliata	Italy, Spain, Algeria, Morocco	104	C
M. turbinata	Mediterranean Basin	86	B

Table 5.2. (continued).

Taxon	Geographic Distribution	NPGS Accessions	Status[1]
M. rigidula	Mediterranean Basin, E Europe, Caucasus, Central Asia	148	C-CULT
M. rigiduloides	E Mediterranean, Middle East	192	
M. constricta	E Mediterranean Basin, Iran, Iraq	52	B
M. lesinsii	Mediterranean Basin	9	B-CULT
M. murex	Mediterranean Basin	69	B-CULT
M. rugosa	Mediterranean Basin	43	B
M. scutellata	Mediterranean Basin, Southern Ukraine, Crimea	61	B-CULT
M. blancheana	E Mediterranean	18	B
M. rotata	Cyprus, Iraq, Israel, Jordan, Lebanon, Syria, Turkey	21	B
M. noeana	Iraq, Turkey	19	A
M. shepardii	Ex Boiss. Turkey	4	A
M. intertexta	W Mediterranean Basin	17	B
M. ciliaris	Mediterranean Basin, Iraq	64	C
M. muricoleptis	France, Italy	8	A
M. granadensis	Egypt, Israel, Syria, Turkey	13	B
M. sauvagei	Morocco	5	A
M. laciniata	N Africa, Arabian peninsula, India, Pakistan, Afghanistan	136	B
M. minima	Europe, N Africa, India., Russia	299	C
M. praecox	S and E Europe, Cyperus, Turkey, Crimea	23	B
M. coronata	E Mediterranean Basin, Iran, Iraq	24	B
M. polymorpha	Europe, N Africa, Middle East, Crimea, Caucasus, Central Asia	685	C-CULT
M. laxispira	Heyn. Iraq	0	A
M. arabica	Europe, N Africa, Middle East, Crimea, Caucasus	79	C
M. tenoreana	France, Italy, Yugoslavia	6	A
M. disciformis	Mediterranean Basin	50	B
M. lanigera	Afghanistan, Turkmenistan, Tajikistan	1	A
M. hypogaea	SE Mediterranean	0	A

Table 5.2. (continued).

Taxon	Geographic Distribution	NPGS Accessions	Status[1]
M. lupulina	Europe, N Africa, Middle East, Asia	209	C-Cult
M. secundiflora	S Europe, N Africa	2	B
M. heyniana	Greece	2	A
M. orbicularis	Mediterranean basin, Middle East, Central Asia	322	C
M. radiate	Middle East, Russia, Central Asia	11	C
M. plicata	Turkey	0	UNK
M. platycarpa	Trautv. China, Mongolia, Central Asia	15	A
M. ruthenica	China, Korea, Mongolia, Russia	122	A
M. popovii	Central Asia	1	A
M. archiducis-nicolai	Central China, NE Tibet	0	UNK
M. edgeworthii	Himalayas	3	A
M. cretacea	Russia, Former USSR	2	A
M. ovalis	S Spain, Morocco	0	UNK
M. rostrata	Turkey	0	?
M. biflora	Turkey, Iran, S Trans-Caucasus	1	?
M. brachycarpa	Turkey, Lebanon, Iraq, Trans Caucasia	5	?
M. huberi	SW Anatolia	0	?
M. astroites	E Mediterranean	0	?
M. halophila	S Anatolia	0	?
M. arenicola	Turkey	0	?
M. heldreichii	Turkey	0	?
M. phrygia	Turkey, Syria, Iraq, Iran	0	?
M. fischeriana	Turkey, Iraq, Iran, European USSR	5	?
M persica	Iran, Iraq	0	?
M. medicaginoides	SE Europe, SW USSR, Turkey, Iran, S and C Asia	1	?
M. rigida	S Anatolia	0	?
M. crassipes	Anatolia. Lebanon, N Iraq, W Iran	1	?
M. pamphylica	S Anatolia	0	?
M. carica	S W Anatolia	0	?
M. monantha	Middle East, S and C Asia	38	?
M. orthoceras.	Middle East, S and C Asia	0	?

Table 5.2. (continued).

Taxon	Geographic Distribution	NPGS Accessions	Status[1]
M. polyceratia	W Mediterranean	10	?
M. retrorsa	Afghanistan	0	?
M. monspeliaca	W Europe, N Africa, E Mediterranean, Jordan, Iraq, Iran, USSR, C Asia	12	?
M. rhytidiocarpa	S Anatolia	0	?
M. isthmocarpa	C Anatolia	0	?

[1]Conservation Status : A = Endangered species, endemic or rare, very few available accessions in gene banks; B = Species with threatened diversity due to a rapid modification of its ecosystem or due to its localization in regions subject to an important climate change, few available accessions; C = Species widespread, large number of available accessions, Cult = Genetically improved for agriculture; ? = unknown or undetermined (Adapted from Prosperi *et al.*, 1996).

It can be seen that relative to *M. sativa* (3772 accessions) there are very few collections of other *Medicago* taxa held within USA gene banks. The only taxa that can be considered to be potentially adequately conserved are *M. orbicularis* (322 accessions), *M. minima* (299 accessions), *M. Arabica* (79 accessions), *M. lupulina* (209 accessions), *M. truncatula* (320 accessions) and *M. polymorpha* (685 accessions). However it is not just the case that if a gene banks contains a lot of accessions the species is adequately conserved. It is possible to conserve species adequately with low numbers of accessions providing those accessions represent the genetic variation present within a species, both within and between populations. Assuming gene banks follow good sampling strategies (i.e. collect samples representative of the genetic structure in the population from which they came) the next most significant factor in determining the representativeness of gene bank accessions is how well it has been collecting through out its geographic and ecological range, i.e. the more thoroughly a species has been collected throughout its range the more its genetic variation can be considered to be adequately conserved. This is illustrated by *M. monantha*, this species was originally divided into 4 taxa, however a study carried out by Small and Fawzy (1992) revealed that these 4 taxa actually represented a range of variation that had been unconsciously divided by previous taxonomists into four geographically and morphologically overlapping groups. Thus the conservation of *M. monantha* could not be adequately achieved by collecting missions targeted in only one part of its huge distribution. For all potential variation to be conserved, populations of this species must be sampled throughout its geographical range.

5.2 Genetic Erosion / Factors of Degradation

Genetic Erosion is the loss of genetic diversity, including the loss of the individual genes, and the loss of particular combinations of genes (gene-complexes) such as

those manifested in locally adapted landraces. Ideally this section should discuss the specific, current threat to *Medicago* species and genetic diversity, but there have been no specific studies of this kind, certainly at the genetic level. As is recognised by Stuart *et al.*, (1990) when assessing threats to biodiversity in Africa, the situation in CWANA is under exactly the same threat: the fundamental conflict between supply and demand, in terms of there being a limited supply of the earth's resources and an increasing demand on them to meet the needs of a growing population and the growing aspirations of that population. The problem for biodiversity is when the demand placed upon species and ecosystems out strips natural rates of regeneration. Therefore, the main factors causing loss of biodiversity in the CWANA region are associated with anthropogenic influences; substantial, recent increases in human population have a direct and inverse relationship to plant diversity. These include as summarised in the State of the World's PGRFA report (FAO, 1998): intensification of agricultural systems linked to habitat destruction, lack of sustainable resources management resulting in over exploitation, overgrazing and excessive harvesting of wild plants, reduction of fallow periods, deforestation and land clearance for agriculture crops, many dryland species are threatened by the recurrent drought that can lead to desertification, human population pressure and the resultant urbanization, war and civil strife, governmental policy and legislation negatively impacting on biodiversity, and the changing economic situation of the farmers plying a role in the genetic erosion.

However, threats to biodiversity were studied as part of the Global Environment Facility funded West Asia Dryland Agrobiodiversity Project and it is clear that *Medicago* populations have suffered from many degradation factors which are more or less the same factors that affected the genetic resources as a whole. Primarily threats to *Medicago* populations come from over-grazing firstly then inappropriate cultivation practices (weeding or ploughing at the wrong life cycle stage). Also clearance of native pasture for more intense cultivation and removal of large stones to facilitate ploughing has resulted in habitat destruction for those species that tended to grow between these stones. The farmers 'reclaiming' their land remove the larger stones to the field margin and build retaining walls that do not provide such an appropriate habitat. Stone cutting and quarrying is another cause of local habitat destruction; both in terms of the destruction of the habitat itself but also from the large quantity of dust polluting the surrounding area and negatively impacting on plant growth.

Specifically in relation to *Medicago* it is important to note that the majority of the species (except those of section *Dendrotelis*, *Medicago*, *Carstienses*, and some from section *Platycarpae*) are ephemeral and are more than capable of colonising and thriving in habitats disturbed and degraded by man, but this does not mean that given more ideal conditions these species would not be even better competitors. It does mean that *Medicago* species are in general unlikely to be suffering from serious genetic erosion, unlike other forage legume genera less well

adapted to anthropomorphic environments, such as *Trifolium* or *Lathyrus*. The threatened *Medicago* species recognised by IUCN (2008) is *M. citrina*, but other species known to be threatened or extremely localised in distribution and therefore in need have special conservation consideration are listed in Table 5.3.

Table 5.3. Priority Medicago species currently threatened.

Taxon	Status / Reason For Conservation
M. strasseri	Rare and extremely localised endemic
M. citrina	Rare and localised endemic
M. rupestris	Localise endemic, insufficiently known
M. rhodopea	Rare and local endemic
M. saxatilis	Localise endemic, insufficiently known
M. daghestanica	Localise endemic, insufficiently known
M. pironae	Rare and local endemic
M. syriaca	Status insufficiently known
M. shepardii	Rare and local endemic
M. muricoleptis	Localise endemic, insufficiently known
M. laxispira	Localise endemic, insufficiently known
M. heyniana	Vulnerable and local endemic
M. plicata	Localise endemic, insufficiently known
M. rostrata	Localise endemic, insufficiently known
M. huberi	Localise endemic, insufficiently known
M. halophila	Localise endemic, insufficiently known
M. arenicola	Extremely local, known only from type
M. heldreichii	Localise endemic, insufficiently known
M. rigida	Localise endemic, insufficiently known
M. pamphylica	Localise endemic, insufficiently known
M. carica	Localise endemic, insufficiently known
M. retrorsa	Localise endemic, insufficiently known and poorly collected
M. rhytidiocarpa	Localise endemic, insufficiently known
M. isthmocarpa	Localise endemic, insufficiently known

5.3 Conservation Priorities

5.3.1 *In situ* conservation priorities

The phytogeographical information has shown that the highest concentration of *Medicago* taxa is to be found in eastern Mediterranean region, particularly Turkey, with many of the taxa being extremely restricted endemics. The region, and Turkey specifically, is threatened by extensive genetic erosion (IBPGR, 1985) and therefore there is a clear need to establish reserves throughout the region to conserve all priority forage species (Maxted, 1995), not just *Medicago*. The widespread taxa tend to occupy a wide range of habitats, which they share with other *Medicago* species. These taxa should be relatively easy to conserve with more than one taxa

being protected in each reserve. It is the many narrow endemic species and those with unconventionally habitat requirements that should determine where the reserves need to be set up. If these taxa can not be incorporated into reserves that hold other forage legumes, taxon specific reserves may need to be set up to ensure adequate protection (Bennett *et al.*, 1997). Taxa that require special consideration for *in situ* programmes can be found Table 5.3 upon the geographical distribution of those taxa the highest concentration of potentially threatened taxa are to be found in Turkey, so it is here that there is the highest priority for establishing a genetic reserve for *Medicago* in situ conservation.

5.3.1 *Ex situ* conservation priorities

It has already been concluded the majority of *Medicago* species are well adapted to anthropomorphic environments so the main focus of *ex situ* conservation and collection is likely to be gap filling and the ability to meet the demand for germplasm from international and national forage legumes conservation programmes. However, it was obvious from the review of the gene banks holdings that the majority of *Medicago* taxa are poorly represented if not absent from the main gene banks. The genus *Medicago* represents a considerable native genetic resource, which is not currently being incorporated into *ex situ* conservation programs. The situation has recently been exacerbated by the recent transfer of many *Trigonella* to *Medicago* and the general lack of this material in gene banks. These species may not be directly usable as forages, but they have environment uses and may still contain traits of use in forage legume breeding programmes. For example, some of these taxa shown tolerance to salinity and some inhabit serpentine soils and some like *M. monspeliaca* and *M. monantha* can be used to improve the soil characters in land reclamation programmes.

Future collection activities need to be take into account the arid and semi-arid regions that house *Medicago* diversity, because these regions are the most threatened by genetic erosion. The number of traits that show genetic variability increase with increasing environmental stress i.e. there is a positive correlation between genetic diversity and environmental stress (Herbert *et al.* 1994). Section *Platycarpae* particularly should be targeted for future collecting as some of its species show desirable cultivation traits. For example, the cultivation of *M. ruthenica* is likely to increase in the near future as it is more suitable to low input systems than *M. sativa* (Campbell *et al.* 1997).

6. GENERAL CONCLUSIONS

Wild relatives of cultivated plants have contributed to the breeding of most of our crop plants (Harlan, 1976, Frankel *et al.*, 1995). This is particularly true for forage plants where the difference between cultivated and wild forms is often minimal and at least initially the result of selection. In many cases, gene flow occurs between natural and cultivated forms (Jenczewski *et al.* 1999a, b). Changes in agriculture will continue to be limited by the availability of germplasm and the resources available for its conservation and evaluation. With the need for more sustainable systems, the prospect of transgenic crops and the erosion of natural habitats (climatic changes, industrialisation), the value of documented *ex situ* collections will continue to increase.

Further research on the improvement, management, preservation and use of natural diversity will also be a significant challenge for the next century. *Medicago* is a key genus for these studies, with 85 species, all growing in symbiosis with *Rhizobium*. Wild and cultivated populations within the M. *sativa* complex and among the annual medics are of great agronomic interest, not only as forages, but also potentially for industrial uses as diverse as fibre crops for power generation, to the rehabilitation of degraded ecosystems (NAAIC 1998).

In terms of conservation priorities the need is two fold: first, to address the need for active *in situ* conservation of *Medicago* species in genetic reserves sited in the most species rich locations, and second, the collection of the wild perennial species in the secondary and tertiary germplasm pools, especially those species which are considered threatened. Countries previously under collected where future collections should occur include: the Caucasian republics and Eastern Turkey. While in terms of M. *sativa* collection, there is a need for further collection in Georgia, Crimea and Southern Caucasus mountain regions of the former Soviet Union, the Himalayan region of India, south and north east regions of China, Sudan, Egypt and the Arabian Peninsula, South Africa, Northern Kazakhstan, and adjacent Central Asian countries (i.e. Kyrgyzstan, Uzbekistan, Afghanistan), Iran and Iraq, as reported by the Alfalfa Crop Germplasm Committee Report (2005).

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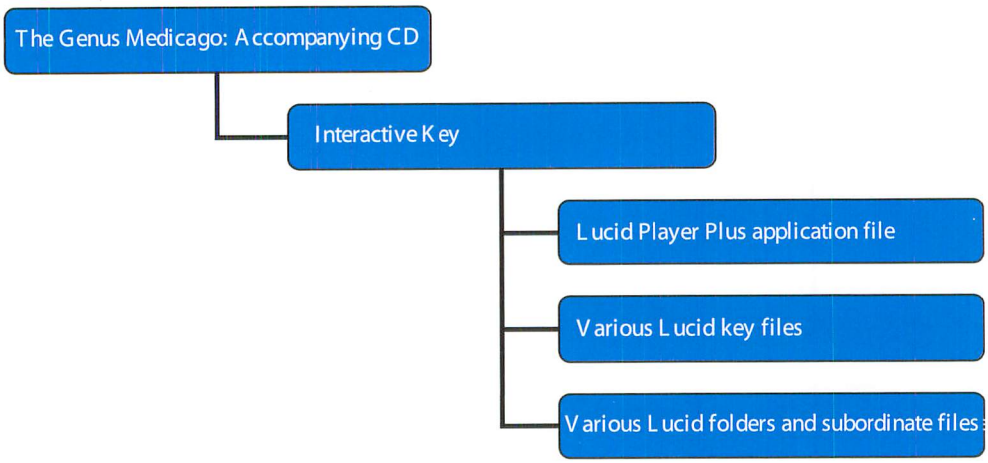
Appendix 1. The Genus *Medicago*: an Interactive Key

The CD that accompanies the Ecogeographic Study contains the Lucid interactive key for *Medicago* species and sub-specific taxa. The various files required to run the key are contained in the subdirectory named Interactive Key as indicated below:



Installing *Medicago* Key

The key can either be run from the CD itself or copies into a directory on a hard drive and run from there.

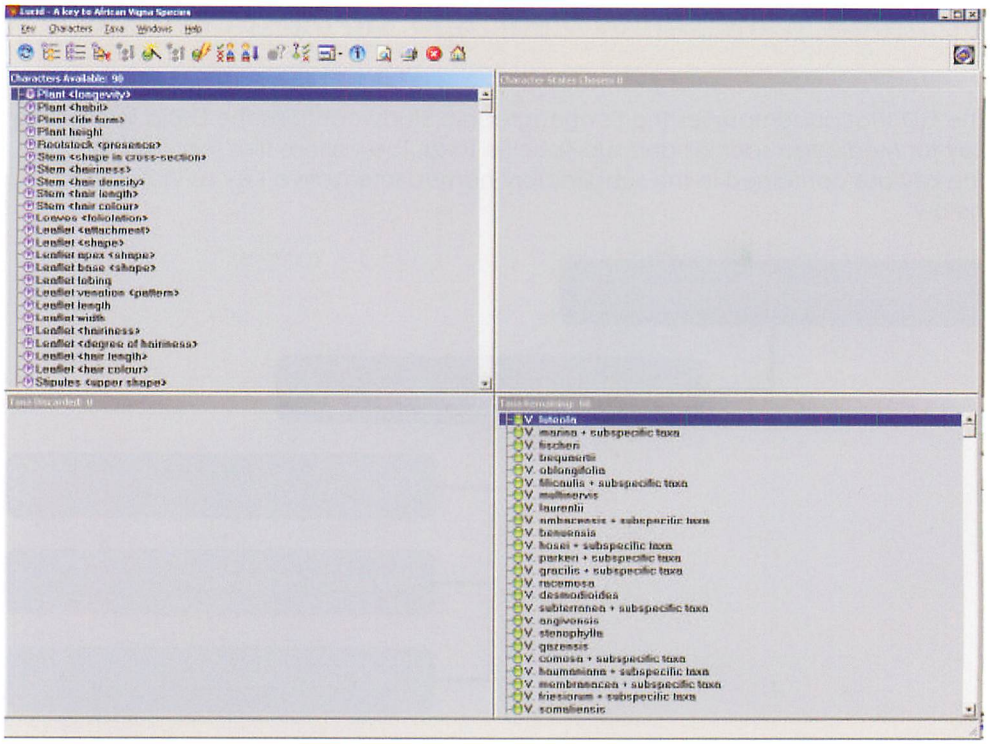
How to Identify *Medicago* Specimens (text adapted from Maslin, 2001)

To start the key:

- Go to the directory that contains the interactive key.
- Double-click on the "A key to the genus Medicago" icon and the front page of the key will appear.
- Click on the Start key at the top left of the window, you will see a screen divided into four windows, with a menu bar and tool bar.

The four windows display four lists:

- Characters Available lists the characters that you may use to describe your specimen to the key; when you first start the key this will show a list of 90 characters.
- Character States Chosen will list the characters and their states as you select them; when you first start the key this window will be empty.
- Taxa Remaining lists the names of the taxa that 'match' your description; when



you first start the key this window shows a list of the entire 94 species and sub-species that are included in *Medicag* data set.

- Taxa Discarded will list all those taxa that do not 'match your description; when you first start the key this window will be empty.

To identify a specimen (i.e. name a Medicago specimen):
Your aim is to match your unidentified specimen against the species descriptions held in the data set. As your description becomes more and more complete the key will progressively narrow down the list in Taxa Remaining until, hopefully, only one taxon remains - you have identified (in other words, named) the taxon to which your specimen belongs.

Characters and states

To select a character that you have chosen to score click on the name of the character in the Characters Available window and it will open to display its states. A character is any attribute referring to form, structure or behaviour which the taxonomist separates from the whole organism for a particular purpose such as comparison or interpretation. These are distinguished from character states which are the actual representation of that character found in a particular specimen. Thus a

character, for example, "Corolla colour", has multiple character states, yellow, pink, white, blue, purple, etc. Within the context of the interactive key there are two basic sorts of characters, multistate and numeric:

To select states of a character:
Multistate character
Click on the character name, which will 'open' the character to show the states, then either double-click the text of the state (e.g. "Corolla colour" in the above example) or drag it with the mouse into the Character States Chosen window; one or more character-states can be chosen in this way. You will now notice that some taxa - those with character-states that do not match your answer - will be moved from Taxa Remaining into Taxa *Discarded*.

As you answer more and more questions the list in Taxa Remaining will get shorter and shorter until, perhaps, only one remains.

Numeric characters
Click on the character name, which will 'open' the character to show the states, then double-click the hash (#) symbol to the right of the orange information button (or drag it into Character States Chosen) and a box will pop up into which you can type the measurement: you can enter either a single number or a numeric range (with the two numbers separated by a hyphen [-]). To view other syntax options click on the blue hyperlink at the bottom of the dialogue box.

Apart from plant height, which is measured in metres, all other numeric measurements for the *Medicago* data set are recorded in millimetres (but you do not have to type 'mm' into the box when you record your measurements). It will increase the likelihood of retaining the correct answer in Taxa Remaining if you enter a range of values (e.g. 3—6).

Which characters should you use?
When you first start the key, all 90 characters will be listed in the Characters Available window. You can answer questions in any order you wish, so you should be able to make an identification of your specimen based on the characters that are available. Use of dichotomous keys often fails because of the need to assess character states for characters that it is not possible to score on your specimen, e.g. seed characters are difficult to score as they are seldom present with a specimen. However, you can also ask the key itself to help by suggesting what is the appropriate character to use next (see Best and Bingo below) or compare descriptive information of the remaining taxa to see if you can match your specimen that way (see Similarities and Differences below) or scroll through the illustrations or photographs of the taxa remaining and see if your specimen matches any of them (see Slide show below).

The key opens with the full set of characters that are available, but it is also possible to select a particular subset of characters, for example, if you only have vegetative material you may wish to use the vegetative characters alone and this may be achieved by selecting the vegetative character set. To select a particular character set click on characters, then click sets and check the small box to the left of the set name; you can load two or more sets simultaneously by checking more than one box. Now click anywhere outside the sets window and the characters contained in the set(s) you have selected will appear in the

Characters Available window.
The following sets of characters are available:

- *All* - This set contains the entire list of characters which are available for use. This is the default set and when starting a new identification it is generally good practice to load this set and run Best (see below).
- *Fast Find* – This character set comprises the characters that are generally easy to score and which have strong discriminating power.
- *Vegetative* - characters relating to the vegetative characteristics of the plant.
- *Inflorescence* - characters relating to the inflorescences.
- *Flower* - characters relating to flowers.
- *Fruit. legume* - characters relating to the fruit.
- *Seed* - characters specific to seeds (including the hilum and aril).

Using Best
If you have a potential choice over which character to score next and are unsure which to choose you can ask for assistance. You do this by invoking the *Best* or *Bingo* options. Click on the Best button located on the toolbar and all characters in Characters Available will be checked to find those that, on average, will give you the shortest list in Taxa Remaining if you choose one of their states. If you can, answer one of these next. When you use the Best option the programme will either sort the characters, placing those with the strongest discriminating power at the top of the list, or find (and highlight) the next best character to use; you can decide which of these options you require by clicking on Characters then Best Options located on the menu bar.

Using Bingo
The Bingo command also helps you to choose which character is appropriate to use next. Click on the Bingo button located on the toolbar and a window will appear showing various characters and their states (these will vary depending upon what taxa are left in Taxa Remaining). If your specimens possess any of the character states which are displayed then you will be left with just a single taxon in Taxa Remaining if you double-click that state.

Using Similarities and Differences
Click on the Similarities and Differences button located on the toolbar and you will see a Similarities and Differences tab. Each tab is divided into two panels: the upper one listing the characters and the lower one showing the taxa listed in Taxa Remaining with their character-state scores. Click on a character in the upper panel and the lower panel will display the states scored for that character for each of the remaining taxa. You can then compare the features of your specimen with the character-states for each taxon. Further options available under Similarities and Differences can be accessed at any time via the Lucid Help menu.

Using Slide Show
When you have reduced the number of taxa in Taxa Remaining to a few you can scroll through illustrations of them to see if any match your specimen. To do this click on the Taxa button located on the menu bar, then click on Slide Show and then All Remaining Taxa. Drawings of the remaining taxa will then automatically scroll on-screen (with a 4-second delay between images). You can control the slide show with the buttons located at the upper right-hand corner of the screen.

Starting a new identification
If you wish to restart the key after having identification a specimen then click the Restart button on the menu bar and this will clear both the Character States Chosen and Taxa Discarded windows. When you click this button a small window will appear, and by opening the drop-down list you will see that there are three options available concerning character sets for your new identification session: select one of these options then click on Restart. The characters that then appear in Characters Available will depend upon your selection.

About Lucid
Lucid is an easy to use knowledge management tool that can be used in the production of interactive identification systems. Lucid was developed by the at the . The Lucid system consists of a number of inter-related that assist with the creation and use of keys (in any) for any group of organisms. The software has standard and is available to either download or purchase. You can learn more about Lucid and the software available from the Lucid website: .

Appendix 2. Characters Used in Medicago Key Construction.

1. Synonyms.
2. Life form: annual; perennial.
3. Plant form: herb; shrub.
4. Plant height: cm.
5. Stem origin: arising from the crown; arising from the creeping rootstock.
6. Stem shape: round in cross section; angular in cross section.
7. Stem growth habit: procumbent trailing or lying flat; decumbent lying on the ground with ascending end; ascending indirectly upwards; erect without climbing.
8. Stem branching distribution along stem: at the ground level near the base; over the ground level from the main stem.
9. Vegetative parts: glabrous; pubescent hairy.
10. Vegetative hairs habit: appressed; defuse; erect.
11. Vegetative hairs kind: simple hairs; glandular hairs; simple and glandular hairs.
12. Stipules shape: triangular; ovate; lanceolate awl-shaped; acuminate.
13. Stipules margin: entire; dentate; laciniate; incised.
14. Stipules teeth distribution: apex only; base only; around entire margin.
15. Leaflet length: mm.
16. Leaflet width: mm.
17. Leaflet shape: ovate egg shaped; obovate apex broader than base; elliptical widest in the middle; rhombic like rhombus; oblanceolate wide at the middle, tapering toward the base.
18. Leaflet apex shape: apiculate end with a short, sharp, flexible point; truncate as if cut off at the end; retuse small notch at the obtuse apex; obtuse blunt, round; emarginate shallow notch at the apex.
19. Leaflet base shape: attenuate; oblique; cuneate; obcordate; obtuse.
20. Leaflet dorsal indumentum: glabrous; pubescent hairy.
21. Leaflet ventral indumentum: glabrous; pubescent hairy.
22. Leaflet with hairs growth habit: appressed hairs; defuse hairs; erect hairs.
23. Leaflet margins: entire; serrate; laciniate; dentate.
24. Leaflet colour: bluish-green; with anthocyanin-coloured patch in the middle; with a red blotch in their basal part; with purple blotch in the leaves.
25. Peduncle number of flowers.
26. Peduncle raceme: compact; lax; spike-like; capitate; umbelliform.

27. Peduncle to petiole length: shorter than corresponding petiole; equal to corresponding petiole; longer than corresponding petiole.
28. Peduncle cusp: present; absent.
29. Flower length: mm.
30. Pedicle to calyx tube length: shorter than calyx tube; equal to calyx tube; longer than calyx tube.
31. Bract to pedicel length: shorter than pedicel; ± equalling pedicel; longer than pedicel.
32. Calyx length: mm.
33. Calyx indumentum: glabrous; pubescent.
34. Calyx hairs: simple; glandular; simple and glandular.
35. Calyx hair habit: appressed; erect.
36. Calyx to corolla length: shorter than half corolla; equalling half corolla; longer than half corolla.
37. Calyx teeth shape: triangular; subulate; lanceolate.
38. Calyx teeth to tube length: shorter than tube; ± equalling tube; longer than tube.
39. Corolla colour: violet; yellow.
40. Standard three dimension shape: tongue-shaped some what wider in the lower mid-region; oval shaped; curved; flat; elliptical; obovate; oblong.
41. Standard apex shape: retuse; emarginate; obcordate; rounded.
42. Standard surface: with reddish-brown veins; without reddish-brown veins; with a violet hue on the outer side.
43. Relative size of petals.
44. Pod coiling: coiled spiral; uncoiled linear.
45. Pod indumentum: glabrous; pubescent.
46. Pod hair kind: simple; glandular; simple and glandular; celled.
47. Pod colour at maturity: black; ash-grey; brown; greenish-brown; yellowish.
48. Pod length: mm.
49. Pod position relative to ground: subterranean; aerial.
50. Pod three dimensional shape: discoid flat, round; straight linear; cylindrical terete; conical-truncate; cup shaped; ovoid; spherical; sickle-shaped oblique, curved, arcuate; reniform; barrel-shape.
51. Pod surface: spiny; spineless; tubercled.
52. Pod base orientation: sessile setting in the axle of the corresponding petiole; not sessile setting on the pedicel; base with calyx remains appressed as a regular five-rayed star.

53. Pod gland-tipped trichomes: present; absent.
54. Pod with tip shape: coiled; crescent; truncate; hook, uncinate; connivent.
55. Pod face surface: reticulate; smooth.
56. Pod on the plant: spiny and spineless on the same plant; spiny pods only; spineless pods only.
57. Pod centre: with no opening; with a small opening; with a large opening.
58. Pod coil number.
59. Pod coil turn direction: clockwise; anticlockwise; not in one direction.
60. Pod coil growth habit: loose; intermediate, appressed.
61. Pod width mm.
62. Pod coil size: decreasing gradually towards first and last coil; the same for all coils; of the last one smaller than the first.
63. Pod coil shape: convex; flat; imbricate like stacked bowls.
64. Pod coil convex shape: towards the pod base only; towards both the base and the apex.
65. Pod coil hairs: with pectinate hairs; with fimbriate-winged hairs.
66. Pod coil wall texture: thin; hard; woody.
67. Pod coil edge margin level: higher the facial plane; same level of facial plane.
68. Pod coil spines d: apical coil spineless; last half coils spineless.
69. Pod coil seed: 2-3 apical coils seedless; first coil seedless.
70. Pod vein number on pod face with.
71. Pod vein shape on coil face: curve shaped; S shaped; slender shaped; Y shaped.
72. Pod vein direction on the pod face: not changing direction before joining the dorsal suture; changing direction at the edge of the pod.
73. Pod veins on the pod face: anastomosing near the ventral suture after leaving it; anastomosing in the half distance from the dorsal suture; anastomosing before entering lateral vein; anastomosing in the outer part of the pod face.
74. Pod veins branching: branching near the ventral suture; branching near the dorsal suture; branching near lateral outer vein; branching before entering the vein-less zone.
75. Pod venation appearance: obscure not clear; appear harder horny substance; as shoulders siding at 90□; darker than the middle of the coil; a net of veins.
76. Pod vein-less zone width to full coil radius: absent; about 10%-20% of radius; about 20%-35% of the radius.

77. Pod groove number of the coil edge: no grooves between lateral vein and dorsal suture on the coil edge; three grooves between lateral vein and dorsal suture on the coil edge; more three grooves between lateral vein and dorsal suture on the coil edge.
78. Pod groove appearance: wide and shallow between lateral vein and dorsal suture; deep and narrow between lateral vein and dorsal suture; between lateral vein and dorsal suture fell of spongy cellular tissue; quadrangular between lateral vein and dorsal suture.
79. Pod dorsal suture level: below the lateral veins; in the same level as the lateral veins; higher than the lateral veins.
80. Pod dorsal suture level: lower the edge margins; in the same level of the edge margin.
81. Pod dorsal suture appearance: steeply elevated in the middle of the coil edges; is a shallow depression in the middle of the edge; located in a groove; strongly convex; undulate; straight.
82. Pod ventral suture appearance: strongly convex; weakly convex to straight.
83. Pod spines shape: triangular flattened; conical; irregular shape.
84. Pod spines thickness: slender; stocky.
85. Pod spines surface: grooved; not grooved.
86. Pod spines tip shape: thin; hooked; straight.
87. Pod spines with base shape: conical; inflated; grooved.
88. Pod spines base: close to the margin of the coil edge; coming off margin of the coil edge.
89. Pod spines grooved length: grooved to ± half their length; grooved to 2.3 their length from the base.
90. Pod spines length: mm.
91. Pod spines rows: one row on a coil edge; two rows on a coil edge.
92. Pod spines number in row.
93. Pod spines inserted at angle of insertion: degree to the coil face.
94. Pod spines arching direction (apical view): upwards; downwards; opposite direction of the pod coiling; interlocking with spines of adjacent coil; pointing in different direction.
95. Seed length: mm.
96. Seed width: mm.
97. Seed colour: brownish; yellowish; greenish-yellow; violet brown; reddish-yellow; black.
98. Seed shape: ovoid; bow-shaped; reniform; curved; rounded on the cotyledon side; straight on the radicle side; oblong; cylindrical; rhomboid.

99. Seed number per coil.
100. Seed number per pod.
101. Seed coat surface: ridged; verrucose; smooth; strongly curved; with tubercles.
102. Seed size in the same pod: same size in the same pod; size varying considerably in the same pod.
103. Seed position in pod: not separated; separated; deep constricted between them.
104. Seed separation partition: with thin membrane between them; with thin spongy partition between them; with thick partition between them; with hard tissue between them.
105. Radicle seen after the coat removal: less than half seed length; equalling half seed length; more than half seed length; equal the seed length.
106. Radicle shape: exclamation mark; round hook.
107. Chromosome number.
108. Uses.
109. Geographical records.

Appendix 3. Classification of *Medicago* Species Applied.

The classification follows Small and Jomphe (1989) with the addition of more recently described Species added.

Section *Dendrotelis* (Vassilcz.) Lassen - *M. arborea* L., *M. strasseri* Greuter, Matthas & Risse., *M. citrina* (Font Quer) Greuter.

Section *Medicago* (section *Falcago* (Reichenb.) Gren. & Godr.) - *M. sativa* L., *M. papillosa* Boiss., *M. prostrata* Jacq., *M. rupestris* M. Bieb., *M. cancellata* M. Bieb. *M. rhodopea* Velen., *M. saxatilis* M. Bieb., *M. daghestanica* Rupr., *M. pironae* Vis., *M. hybrida* (Pour.) Trautv., *M. suffruticosa* Ramond ex DC., *M. marina* L..

Section *Carstienses* Kozukharov - *M. carstiensis* Wulf.

Section Spirocarpos Ser.

Sub-section *Pachyspireae* (Urb.) Heyn - *M. soleirolii* Duby., *M. italica* (Miller) Fiori., *M. littoralis* Rhode ex Lois., *M. truncatula* Gaertn., *M. doliata* Carmign., *M. turbinata* (L.) All., *M. rigidula* (L.) All., *M. constricta* Durieu., *M. lesinsii* E. Small., *M. murex* Willd., *M. rigiduloides* E. Small., *M. syriaca* E. Small.

Sub-section *Rotatae* (Urb.) Heyn - *M. rugosa* Desr., *M. scutellata* (L.) Miller., *M. blancheana* Boiss., *M. blancheana* x *M. rotata*, *M. rotata* Boiss., *M. noeana* Boiss., *M. shepardii* Post.

Sub-section *Intertextae* (Urb.) Heyn - *M. intertexta* (L.) Miller., *M. ciliaris* (L.) Krocker., *M. muricoleptis* Tin., *M. granadensis* Willd.

Sub-section *Leptospireae* (Urb.) Heyn - *M. sauvagei* Negre., *M. laciniata* (L.) Miller., *M. minima* (L.) Bart., *M. praecox* DC., *M. coronata* (L) Bart., *M. polymorpha* L., *M. laxispira* Heyn., *M. arabica* (L.) Huds., *M. tenoreana* Ser., *M. disciformis* DC., *M. lanigera* Winkl. & Fedtsch.

Section *Geocarpa* E. Small - *M. hypogaea* E. Small.

Section *Lupularia* Ser. in DC. - *M. lupulina* L., and *M. secundiflora* Durieu

Section *Heynianae* Greuter. - *M. heyniana* Greuter.

Section *Orbiculares* Urb. - *M. orbicularis* (L.) Bart.

Section *Hymenocarpos* Ser. - *M. radiata* L.

Section *Platycarpae* E. Small - *M. plicata* (Boiss.) Sirjaev., *M. platycarpa* (L.) Trautv., *M. ruthenica* (L.) Ledebour., *M. popovii* (E. Kor.) Sirjaev., *M. archiducis-nicolai* Sirjaev., *M. edgeworthii* Sirjaev., *M. cretacea* M. Bieb., *M. ovalis* (Boiss.) Sirjaev.

Section *Lunatae* (Boiss.) E. Small - *M. rostrata* (Boiss. & Bal.) E. Small., *M. biflora* (Griseb.) E. Small., *M. brachycarpa* M. Bieb., *M. huberi* E. Small.

Section *Buceras* (Ser.) E. Small

Sub-section *Erectae* (Sirjaev) E. Small - *M. astroites* (Fish. & Mey.) Trautv., *M. Halophila* (Boiss.) E. Small, *M. arenicola* (Huber-Mor.) E. Small., *M. heldreichii* (Boiss.) E. Small., *M. phrygia* (Boiss. & Bal.) E. Small., *M. fischeriana* (Ser.) Trautv., *M. persica* (Boiss.) E. Small., *M. medicaginoides* (Retz.) E. Small., *M. rigida* (Boiss. & Bal.) E. Small., *M. crassipes* (Boiss.) E. Small., *M. pamphylica* (Huber-Mor. & Sirjaev) E. Small., *M. carica* (Huber-Mor. &Sirjaev) E. Small., *M. monantha* (C.A. Meyer) Trautv., *M. orthoceras* (Kar. & Kir.) Trautv., *M. polyceratia* (L.) Trautv.

Sub-section *Deflexae* (Sirjaev) E. Small - *M. retrorsa* (Boiss.) E. Small.

Sub-section *Reflexae* (Sirjaev) E. Small - *M. monspeliaca* (L.) Trautv.

Sub-section *Isthmocarpae* (Boiss.) E. Small - *M. rhytidiocarpa* (Boiss. & Bal.) E. Small, and *M. isthmocarpa* (Boiss. & Bal.) E. Small

Appendix 4. General Key to *Medicago* Taxa of the Mediterranean Basin.

1(0)	Pods coiled	2
	Pods uncoiled	137
2(1)	Annual	3
	Perennial	121
3(2)	Vegetative parts glabrous	4
	Vegetative parts pubescent	31
4(3)	Calyx glabrous	5
	Calyx pubescent	7
5(4)	Coils loose	6
	Coils intermediate, vein-less area poorly developed, radial vein strongly curved	*M. syriaca*
6(5)	Pods spiny; seeds coat smooth; veins curve shaped; stipules margin incised	*M. muricoleptis*
	Pods spineless; seeds coat verrucose; veins slender shaped; stipules margin laciniate	*M. orbicularis*
7(4)	Pods spiny	8
	Pods spineless	28
	Pods tubercled, floret with wings longer than the keel	*M. polymorpha*
8(7)	Leaflet margins entire, spines short (0.5-2 mm)at right angle to the face of the coil	*M. rotata*
	Leaflet margins serrate	9
	Leaflet margins dentate	25
	Leaflet margins laciniate, pod cylindrical or disk-shaped with truncate apex and base	*M. muricoleptis*
9(8)	Veins up to 8	10
	Veins 9 to 16	17
10(9)	Stipules margin dentate	11
	Stipules margin laciniate	13
	Stipules margin incised, pod cylindrical or disk-shaped with truncate apex and base	*M. muricoleptis*
11(10)	Calyx teeth shorter than tube; radicle more than half seed length, fruit diameter 3-5(7)mm, leaves often laciniate	*M. laciniata*
	Calyx teeth ± equalling tube; radicle less than half seed length	12
12(11)	Peduncle equal to the corresponding petiole; veins anastomosing in the half distance from the dorsal suture	*M. intertexta*
	Peduncle longer than the corresponding petiole; veins anastomosing in the outer part of the pod face	*M. granadensis*
13(10)	Stipules triangular or acuminate	*M. polymorpha*
	Stipules ovate	14

	Stipules lanceolate 16
14(13)	Calyx teeth shorter than tube; radicle more than half seed length, fruit diameter 3-5(7)mm, leaves often laciniate ..... *M. laciniata*
	Calyx teeth ± equalling tube; radicle less than half seed length 15
15(14)	Peduncle equal to the corresponding petiole; veins anastomosing in the half distance from the dorsal suture ..... *M. intertexta*
	Peduncle longer than the corresponding petiole; veins anastomosing in the outer part of the pod face ..... *M. granadensis*
16(13)	Pods cylindrical; coils loose; coils edge margin higher the facial plane; spines triangular flattened; vein-less zone about 10%-20% of radius ..... *M. laxispira*
	Pods spherical; coils appressed; coils edge margin same level of facial plane; spines conical; vein-less zone about 20%-35% of the radius ..... *M. lesinsii*
17(9)	Calyx teeth shorter than tube 18
	Calyx teeth ± equalling tube 19
18(17)	Seeds not separated; pod up to 6 mm diameter; stipules ovate ..... *M. laciniata*
	Seeds separated; pod 6.1 to 12 mm diameter; stipules lanceolate ..... *M. sauvagei*
19(17)	Coils loose 20
	Coils intermediate ..... *M. italica*
	Coils adpressed 24
20(19)	Venation darker than the middle of the coil, fruit diameter 5-6 mm, coil edge not wild ..... *M. laxispira*
	Venation is a net of veins 21
21(20)	Peduncle equal to the corresponding petiole 22
	Peduncle longer than the corresponding petiole 23
22(21)	Stipules margin dentate or laciniate ..... *M. intertexta*
	Stipules margin incised ..... *M. muricoleptis*
23(21)	Coils size decreasing gradually towards first and last coil ..... *M. granadensis*
	Coils size of the last one smaller than the first ..... *M. muricoleptis*
24(19)	Radicle less than half seed length; no grooves between lateral vein and dorsal suture ..... *M. italica*
	Radicle equalling half seed length; more three grooves between lateral vein and dorsal suture ..... *M. polymorpha*
25(8)	Stem branching at the ground level 26
	Stem branching over the ground level ..... *M. rotate*
26(25)	Calyx teeth shorter than tube; radicle more than half seed length ..... *M. laciniata*
	Calyx teeth ± equalling tube; radicle less than half seed length 27
27(26)	Peduncle equal to the corresponding petiole; stipules ovate ..... *M. intertexta*

	Peduncle longer than the corresponding petiole; stipules triangular ..... *M. italica*
28(7)	Seeds coat verrucose; veins slender shaped ..... *M. orbicularis*
	Seeds coat smooth; veins curve shaped 29
29(28)	No grooves between lateral vein and dorsal suture 30
	More three grooves between lateral vein and dorsal suture ..... *M. polymorpha*
30(29)	Veins up to 8; calyx shorter than half of the corolla; stipules lanceolate ..... *M. lesinsii*
	Veins 9 to 16; calyx equalling half of the corolla; stipules triangular ..... *M. italica*
31(3)	Leaflet margins entire 32
	Leaflet margins serrate 33
	Leaflet margins laciniate 113
	Leaflet margins dentate 116
32(31)	Coils flat; coils with thin wall; seeds coat verrucose; peduncle equal to the corresponding petiole; spines conical ..... *M. heyniana*
	Coils imbricate like stacked bowls; coils with hard wall; seeds coat smooth; peduncle longer than the corresponding petiole; spines irregular shape ..... *M. rotata*
33(31)	Peduncle with up to 5 flowers 34
	Peduncle with 6 to 12 flowers 101
	Peduncle with 13 to 20 flowers ..... *M. italica*
34(33)	Pods spiny 35
	Pods spineless 74
	Pods tubercled 95
35(34)	Coils up to 3 36
	Coils 31 to 7 46
	Coils 71 to 10 67
36(35)	Seed coat ridged; spines in one row, ventral suture with fringed wings ..... *M. radiata*
	Seeds coat smooth 37
37(36)	Calyx glabrous 38
	Calyx pubescent 39
38(37)	Coils loose; venation is a net of veins ..... *M. muricoleptis*
	Coils intermediate; venation obscure ..... *M. syriaca*
39(37)	Calyx teeth shorter than tube 40
	Calyx teeth ± equalling tube 41
	Calyx teeth longer than tube ..... *M. truncatula*
40(39)	Seeds not separated; veins S shaped; radicle more than half seed length; calyx shorter than half of the corolla; peduncle with terminal cusp ..... *M. laciniata*
	Seeds separated; veins curve shaped; radicle equalling half seed length; calyx longer than half of the corolla; peduncle without terminal cusp ..... *M. praecox*

41(39) Coils loose 42
Coils intermediate ..... *M. italica*
Coils appressed 44
42(41) Pods brown ..... *M. minima*
Pods greenish-brown 43
43(42) Stipules margin dentate or laciniate ..... *M. intertexta*
Stipules margin incised ..... *M. muricoleptis*
44(41) Veins branching near the ventral suture; radicle more than half seed length ..... *M. arabica*
Veins branching near lateral outer vein; radicle less than half seed length 45
45(44) Peduncle equal to the corresponding petiole; leaflet dorsally pubescent; dorsal suture below the lateral veins; stipules lanceolate ..... *M. littoralis*
Peduncle longer than the corresponding petiole; leaflet dorsally glabrous; dorsal suture higher than the lateral veins; stipules triangular ..... *M. italica*
46(35) Calyx glabrous 47
Calyx pubescent 48
47(46) Coils loose ..... *M. muricoleptis*
Coils intermediate ..... *M. syriaca*
Coils appressed ..... *M. turbinata*
48(46) Seeds not separated 49
Seeds separated 52
49(48) Stem branching at the ground level 50
Stem branching over the ground level ..... *M. disciformis*
50(49) Calyx teeth shorter than tube ..... *M. laciniata*
Calyx teeth ± equalling tube 51
51(50) Stipules margin dentate or laciniate ..... *M. intertexta*
Stipules margin incised ..... *M. muricoleptis*
52(48) Coils loose 53
Coils intermediate 59
Coils appressed 60
53(52) Calyx teeth shorter than tube 54
Calyx teeth ± equalling tube 55
Calyx teeth longer than tube ..... *M. tenoreana*
54(53) Pod up to 6 mm diameter; peduncle shorter than the corresponding petiole; veins curve shaped; radicle equalling half seed length; calyx longer than half of the corolla ..... *M. praecox*
Pod 6 to 12 mm diameter; peduncle equal to the corresponding petiole; veins S shaped; radicle more than half seed length; calyx shorter than half of the corolla ..... *M. sauvagei*
55(53) Pods brown ..... *M. minima*
Pods greenish-brown 56
56(55) Peduncle equal to the corresponding petiole 57
Peduncle longer than the corresponding petiole 58

57(56) Stipules margin dentate or laciniate ..... *M. intertexta*
Stipules margin incised ..... *M. muricoleptis*
58(56) Coils size decreasing gradually towards first and last coil; seeds with thin spongy partition between them ..... *M. granadensis*
Coils size of the last one smaller than the first; seeds with thin membrane between them ..... *M. muricoleptis*
59(52) Calyx shorter than half of the corolla ..... *M. blancheana*
Calyx equalling half of the corolla ..... *M. italica*
Calyx longer than half of the corolla ..... *M. rigiduloides*
60(52) Radicle less than half seed length 61
Radicle equalling half seed length ..... *M. murex*
Radicle more than half seed length ..... *M. arabica*
61(60) Coil veins curve shaped 62
Coil veins S shaped ..... *M. rigidula*
Coil veins slender shaped ..... *M. truncatula*
62(61) Pods glabrous 63
Pods pubescent 65
63(62) Seeds with thin membrane between them 64
Seeds with hard tissue between them ..... *M. turbinata*
64(63) Dorsal suture below the lateral veins ..... *M. littoralis*
Dorsal suture in the same level as the lateral veins ..... *M. constricta*
Dorsal suture higher than the lateral veins ..... *M. italica*
65(62) Pods black or ash-grey ..... *M. doliata*
Pods brown 66
66(65) Calyx equalling half of the corolla ..... *M. constricta*
Calyx longer than half of the corolla ..... *M. rigidula*
67(35) Radicle less than half seed length 68
Radicle equalling half seed length ..... *M. murex*
Radicle more than half seed length ..... *M. disciformis*
68(67) Coils loose ..... *M. intertexta*
Coils intermediate 69
Coils appressed 70
69(68) Pods glabrous; seeds separated; veins 9 to 16; spines conical; stipules triangular ..... *M. italica*
Pods pubescent; seeds not separated; veins up to 8; spines triangular flattened; stipules ovate ..... *M. ciliaris*
70(68) Veins curve shaped 71
Veins slender shaped ..... *M. truncatula*
71(70) Pods glabrous 72
Pods pubescent 73
72(71) Dorsal suture below the lateral veins ..... *M. littoralis*
Dorsal suture in the same level as the lateral veins ..... *M. constricta*
Dorsal suture higher than the lateral veins ..... *M. italica*
73(71) Seeds reniform ..... *M. constricta*

	Seeds curved	*M. doliata*
74(34)	Calyx glabrous	75
	Calyx pubescent	76
75(74)	Coils intermediate; veinless zone absent; stipules margin incised	*M. syriaca*
	Coils appressed; veinless zone about 20%-35% of the radius; stipule margin dentate	M. turbinata
76(74)	Seeds not separated	77
	Seeds separated	78
77(76)	Pods with simple and glandular hairs; radicle less than half seed length; calyx teeth triangular; stipules margin dentate	*M. rugosa*
	Pods with celled hairs; radicle more than half seed length; calyx teeth slender; stipules margin incised	*M. lanigera*
78(76)	Peduncle shorter than the corresponding petiole	79
	Peduncle equal to the corresponding petiole	81
	Peduncle longer than the corresponding petiole	84
79(78)	Coils with thin wall	80
	Coils with hard wall	*M. doliata*
80(79)	Second to third apical coils seedless; radicle less than half seed length; stem branching over the ground level	*M. scutellata*
	First coil seedless; radicle more than half seed length; stem branching at the ground level	*M. minima*
81(78)	Pods glabrous	82
	Pods pubescent	83
82(81)	Coils with thin wall; veins branching near the ventral suture; radicle more than half seed length; leaflet dorsally glabrous; venation is a net of veins	*M. arabica*
	Coils with hard wall; veins branching near lateral outer vein; radicle less than half seed length; leaflet dorsally pubescent; venation obscure	*M. littoralis*
83(81)	Coils with thin wall; stem branching over the ground level; venation darker than the middle of the coil	*M. scutellata*
	Coils with hard wall; stem branching at the ground level; venation obscure	*M. doliata*
84(78)	Calyx teeth shorter than tube	85
	Calyx teeth ± equalling tube	86
	Calyx teeth longer than tube	93
85(84)	Veins curve shaped; radicle less than half seed length; venation obscure; stipules margin dentate	*M. doliata*
	Veins slender shaped; radicle equalling half seed length; venation is a net of veins; stipules margin laciniate	*M. shepardii*
86(84)	Stipules margin entire	87
	Stipules margin dentate	88
	Stipules margin laciniate	91

87(86) Veins curve shaped ..... *M. italica*
Veins S shaped ..... *M. minima*
Veins slender shaped ..... *M. noeana*
88(86) Coils loose ..... *M. noeana*
Coils intermediate 89
Coils appressed 90
89(88) Coils with thin wall; calyx shorter than half of the corolla; venation is a net of veins ..... *M. blancheana*
Coils with hard wall; calyx longer than half of the corolla; venation obscure ..... *M. rigiduloides*
90(88) Seeds bow-shaped; radicle equalling half seed length ..... *M. murex*
Seeds curved; radicle less than half seed length ..... *M. doliata*
91(86) Veins curve shaped 92
Veins S shaped ..... *M. minima*
Veins slender shaped ..... *M. shepardii*
92(91) Radicle less than half seed length; calyx equalling half of the corolla ..... *M. italica*
Radicle equalling half seed length; calyx longer than half of the corolla ..... *M. murex*
93(84) Veins curve shaped; venation obscure 94
Veins slender shaped; venation is a net of veins ..... *M. soleirolii*
94(93) Pods glabrous ..... *M. turbinata*
Pods pubescent ..... *M. doliata*
95(34) Coils intermediate 96
Coils appressed 97
96(95) Pods glabrous; calyx glabrous; stipules margin incised ..... *M. syriaca*
Pods pubescent; calyx pubescent; stipules margin dentate ..... *M. rigiduloides*
97(95) Radicle less than half seed length 98
Radicle more than half seed length ..... *M. arabica*
98(97) Veins curve shaped 99
Veins slender shaped ..... *M. truncatula*
99(98) Pods glabrous 100
Pods pubescent ..... *M. doliata*
100(99) Seeds with thin membrane between them; peduncle equal to the corresponding petiole; calyx teeth ± equalling tube; seeds 2.5 to 3.5 mm ..... *M. littoralis*
Seeds with hard tissue between them; peduncle longer than the corresponding petiole; calyx teeth longer than tube; seeds 4.5 to 5.5 mm ..... *M. turbinata*
101(33) Coils loose 102
Coils intermediate ..... *M. italica*
Coils appressed 109
102(101) Calyx teeth shorter or longer than tube ..... *M. coronata*

	Calyx teeth ± equalling tube	103
103(102)	Pods spiny	104
	Pods spineless	108
104(103)	Pods brown	*M. minima*
	Pods greenish-brown	105
105(104)	Peduncle equal to the corresponding petiole	106
	Peduncle longer than the corresponding petiole	107
106(105)	Stipules margin dentate or laciniate	*M. intertexta*
	Stipules margin incised	*M. muricoleptis*
107(105)	Coils size decreasing gradually towards first and last coil	*M. granadensis*
	Coils size of the last one smaller than the first	*M. muricoleptis*
108(103)	Pods glabrous; coils with hard wall; veins slender shaped; calyx longer than half of the corolla	*M. noeana*
	Pods pubescent; coils with thin wall; veins S shaped; calyx equalling half of the corolla	*M. minima*
109(101)	Seeds with thin membrane between them	110
	Seeds with hard tissue between them	*M. turbinata*
110(109)	Calyx teeth ± equalling tube	111
	Calyx teeth longer than tube	*M. soleirolii*
111(110)	Radicle less than half seed length	112
	Radicle equalling half seed length	*M. murex*
112(111)	Pods glabrous; calyx equalling half of the corolla; stipules triangular	*M. italica*
	Pods pubescent; calyx longer than half of the corolla; stipules lanceolate	*M. rigidula*
113(31)	Seeds coat ridged; spines in one row, ventral suture with fringed wings	*M. radiata*
	Seeds coat smooth	114
114(113)	Coils loose	*M. muricoleptis*
	Coils intermediate	*M. blancheana*
	Coils appressed	115
115(114)	Calyx teeth ± equalling tube; veins curve shaped; seeds bow-shaped; radicle equalling half seed length	*M. murex*
	Calyx teeth longer than tube; veins slender shaped; seeds reniform; radicle less than half seed length	*M. truncatula*
116(31)	Seeds coat verrucose	*M. brachycarpa*
	Seeds coat smooth	117
117(116)	Radicle less than half seed length	118
	Radicle equalling half seed length	*M. rotata*
	Radicle more than half seed length	120
118(117)	Peduncle equal to the corresponding petiole	*M. intertexta*
	Peduncle longer than the corresponding petiole	119
119(118)	Veins curve shaped; stem branching at the ground level; stipules triangular	*M. italica*

Veins slender shaped; stem branching over the ground level; stipules ovate ..... *M. rotata*

120(117) Dorsal suture steeply elevated in the middle of the coil edges; peduncle with up to 5 flowers; veins S shaped ..... *M. laciniata*
Dorsal suture is a shallow depression in the middle of the edge; peduncle with 6 to 12 flowers; veins curve shaped; pod shape corn-like ..... *M. coronata*

121(2) Peduncle shorter than the corresponding petiole ..... *M. strasseri*
Peduncle equal to the corresponding petiole 122
Peduncle longer than the corresponding petiole 123

122(121) Pods with simple hair; pods reniform; pods spineless; leaflet margins entire; calyx teeth ± equalling tube ..... *M. rupestris*
Pods with glandular hair; pods cylindrical; pods spiny; leaflet margins serrate; calyx teeth longer than tube ..... *M. pironae*

123(121) Radicle less than half seed length ..... *M. marina*
Radicle equalling half seed length 124
Radicle more than half seed length 127

124(123) Pods centre with no opening 125
Pods centre with a small opening ..... *M. sativa* subsp. *glomerata*
Pods centre with a large opening ..... *M. arborea*

125(124) Seeds not separated; peduncle without terminal cusp ..... *M. rupestris*
Seeds separated; peduncle with terminal cusp 126

126(125) Leaflet margins entire; veins curve shaped; seeds 2.5 to 3.5 mm; seeds greenish-yellow; corolla violet ..... *M. daghestanica*
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172(170) Flowers gathered in a compact raceme; veins curve shaped; veins branching near the ventral suture; calyx shorter than half of the corolla; stipules margin dentate ..... *M. archiducis-nicolai*
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Calyx teeth ± equalling tube; venation on pod valve strikingly heterogeneous: veins near ventral suture are parallel, oblique, whereas veins near dorsal suture anastomose to form prominent net ..... *M. hybrida*
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Systematic Field Guide Series. 1.

Conservation Field Guide to Medics

By: Nawwaf Al-Atawneh, Ali Shehadeh, Ahmed Amri and Nigel Maxted

Agrobiodiversity in West Asia and North Africa region and particularly in the Mediterranean and the Fertile Crescent Centres of diversity has a global significance.

Medicago species, with their centre of diversity in the region, are a good example of shared benefits from expansion and exchange of genetic resources throughout the World. Alfalfa (*M. sativa* L.) is the most widely grown forage species in temperate countries and with other *Medicago* species constitute the basis for ley farming systems around the world. The genetic resources collected from the Middle East region and the genetic variability still existing *in situ* are an invaluable germplasm resource for regional and global breeding programs. The potential uses of *Medicago* in soil improvement, bioremediation, cover crops, food and medicines and production of enzymes also offer additional benefits which underlines the necessity to conserve *in situ* and *ex situ* and sustainably use the *Medicago* species richness and its intra-species diversity.

However, conservation of any group of species is often limited by the conservationists own ability to identify the target species in the field, as such this Conservation Field Guide aims to provide a comprehensive means for non-experts to identify *Medicago* in the West Asia region and provide the necessary baseline to facilitate their conservation by national programmes in the CWANA region and other regions.

This Conservation Field Guide is an important output of the GEF funded-ICARDA coordinated West Asia dryland Agrobiodiversity Project and is aimed to help field conservationists, agriculturalists, extension agents, students and teachers identify *Medicago* species in a novel, and contemporary manner.

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