SYSTEMATICS OF PRUNUS SUBGENUS AMYGDALUS
MONOGRAPH AND PHYLOGENY

A Dissertation

Presented to the Faculty of the Graduate School

of Cornell University

in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

by

Mariana Mostafa Yazbek

February 2010

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Mariana Mostafa Yazbek, Ph.D.

Cornell University 2010

Almonds (*Prunus dulcis*) and peaches (*Prunus persica*), two of the most economically important fruit crops in subtropical and temperate climates, are members of the genus *Prunus* L. subgenus *Amygdalus* L. Previous hypotheses of relationships within *Prunus* were either based on one or a few morphological characters, or when molecular data were used, the *Amygdalus* group was represented by only a few species. Furthermore, the latest monograph for *Amygdalus* is more than 150 years old. Here, a monograph of *Prunus* subgenus *Amygdalus* including 24 species is presented. A key to the identification of species within *Amygdalus*, descriptions, diagnostic characters, phenology, habitat, distribution maps and specimens examined are presented. Morphological and molecular sequence data obtained from six chloroplast gene regions (*trnL-trnL-trnF*, *trnS-trnG-trnG, trnH-psbA, rpL16*, *ndhF-rpL32* and partially *trnQ-rps16*) and one nuclear gene, s6pdh, were used in this study to construct a phylogeny from a comprehensive sample of *Amygdalus* species and additional relevant outgroup taxa. A very strongly supported clade of *Prunus* subg. *Amygdalus* was recovered, and includes both almonds and peaches. *Amygdalus* is diagnosed by having pubescent drupes, mostly splitting mesocarp, endocarp pitted or grooved, and sepal margins entire. Based on these results, *P. tenella* and *P. petunikowii* of the section *Chamaeamygdalus* Focke and *P. triloba* and *P. pedunculata* of the section *Louiseania* Carr. should be excluded from subg. *Amygdalus*. Relationships of

Amygdalus with other *Prunus* species remain unresolved because it occurred in a polytomy including section *Chamaeamydalus* and subgenus *Prunus* s.l. Within *Amygdalus*, two clades are strongly supported. The first is section *Persica* Mill, including the six species: *P. persica* (including *P. ferganensis*), P. *kansuensis*, *P. mira* and *P. davidiana*, in addition to P. *tangutica* and *P. mongolica*. The second clade is the almond clade, section *Amygdalus* s.s., within which strongly supported resolution is lacking. Detailed results of individual and combined datasets are presented and character evolution is discussed.

BIOGRAPHICAL SKETCH

Mariana Yazbek, the daughter of Fatme and Mostafa Yazbek, was born and raised in the small village of Hauch El Rafka, in the Bekaa Valley, Lebanon. Her childhood was a happy one. All she knew is that she cannot go to Beirut, an hour and 15 minutes away, because 'there' is war. The village was a big enough of a playground for her, where she played on the 'byedir', a large greenfield where all the farmers in the village, at that time everyone, put their harvested wheat mounds; and she chased butterflies (ha ha!) on the shores of and swam naked (once!) in the Litani river, the longest river in Lebanon, when it used to have water. Her father, who deeply believed in education as the one thing a person should invest in, had sent her and her siblings to the best school in the Bekaa, the Secondary Evangelical School. There she had a parallel life. There she had another kind of friends that spoke a different accent, and had different lifestyle. The mood there was to go to college after school, not to get married as it was in her village. She preferred the former. She moved to Beirut to attend the AUB where war was recently over. She had a much bigger playground now. She studied Agriculure for her BSc. and afterwords went for her Masters degree in Plant breeding. At the same time of her masters she was working in a UNDP project about Agriobiodiversity conservation. The project was so broad and multidisciplinary that she was introduced to many fields among which was the fascinating field of Plant Taxonomy. Eureka! She found her calling. Cornell was the chosen destination. Earlier she had met Nizar Rammal and they had agreed to share a life. They also agreed to not leave Lebanon. He stayed back, and she was in Ithaca, NY for 6 years, and they both shuttled back and forth. In the last year of her studies, they had their baby boy, Nadim Yazbek Rammal. At the time these words were written, they, Nizar and Nadim, were both waiting for her to go back to Lebanon, this time for good.

To Nizar Rammal,
who once sent me a quote which gave me the strength to sail.

“One doesn’t discover new lands
without consenting to lose sight of the shore for a very long time.”
–Andre Gide.

ACKNOWLEDGMENTS

S. Addy, I. Agha, M. Aghawani, M. Alford, S. Borgardt, J. Burke, J. Cohen, W. Crepet, J. Davis, R. Dirig, A. Donmez, J. Doyle, J. Doyle, P. Fraissinet, F. Ghahremaninejad, M. Gandolfo, M. Haidar, H. Hamasheh, H. Hassan, K. Jantz,, A. Khalil, D. Little , M. Luckow, S. Manafzadeh, M. Martinez, I. Murriera, S. Oh, H. Nassif, K. Nixon, F. Plume, D. Potter, J. Salazar, J. Shaw, C. Skema, A. Slaibi, A. Stalter D. Stevenson, S. Straub, R. Sughayyar, S. Vance, P. Welch, Wang Yi.

I would like to thank Dr. I. Al-Shehbaz who was very kind in introducing me to many of my collaborators. I would also like to thank Dr. Jim Reveal, without whom dealing with the nomenclature would have been impossible.

Special acknowledgements are due to the staff of the Hortorium Library and Mann library, and to the staff of all the herbaria who were very kind and helpful during my visits and in sending loans.

Finally I would like to thank the National Science Foundation Doctoral dissertation Improvement Grant and Moore fund at Cornell University for providing the necessary finding to conduct this research.

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CHAPTER I

PHYLOGENY OF PRUNUS SUBGENUS AMYGDALUS

INTRODUCTION

Almonds and peaches are among the most economically important fruit crops in subtropical and temperate climates. Almonds (*Prunus dulcis* (Mill) D.A.Webb) and peaches (*Prunus persica* (L) Batsch) are members of the genus *Prunus* L. subgenus *Amygdalus* L (Rosaceae) (Watkins 1976). The genus *Prunus* s.l., comprising the majority of the subfamily Amygdaloideae (Rosaceae), includes 200 – 250 species distributed worldwide. Members of *Amygdalus,* approximately 24 species, are deciduous shrubs or small trees that are important components of north temperate forests in Asia and Europe, mostly occurring in mountain areas, often between 1000 and 2500 m. Species of *Amygdalus* are found strictly in the Old World, mainly in southwestern and central Asia. The majority is found in Iran and eastern Turkey, with a few species found in countries of SE Europe, the Mediterranean region, and to the east in Mongolia and western China (Irano-Turanian distribution: Browicz, 1989). They occur in a variety of environments, mainly in relatively dry habitats, and sometimes even in deserts (e.g. *Prunus arabica* (Olivier) Meikle), with few occurring in more humid regions (e.g., *Prunus persica*).

Domestication is particularly of importance in *Amygdalus*, since the origins of cultivation of almonds and peaches are still controversial. In peaches, *Prunus persica* is the commonly cultivated species and no wild populations of this species are identified. However, its close relatives, for which you can still find putatively wild populations, are also cultivated locally in northern and NW China, within their areas of natural distribution. These are *P. davidiana* (Carr) Franch, *P. kansuensis* Steel, *P.*

mira Koehne and *P. ferganensis* Kovalev & Kostov (Roach, 1985; Wang, 1985). Cultivated peach appears to have spread from China westward along the ancient silk route (Faust, 1995). When Wang (1985) maintained that wild peaches can still be found in northern China, he was referring to closely related species and not to populations identified at *P. persica*.

On the other hand, the domestication of almonds is controversial concerning the identification of the origin of domestication as well as the closest wild relative of the cultivated species (*P. dulcis*). One theory supports a west Asian domestication, suggesting that almonds were derived from wild forms of *Prunus dulcis* L. (Syn. *Amygdalus communis* L.), which is abundant in the Levant (Syria, Lebanon, Jordan and Palestine and part of northern Iraq) countries. Archeological evidence supports this interpretation (Browicz and Zohary, 1996). The alternative theory denies a Levant origin, and argues that spontaneously growing forms of *P. dulcis* are not "genuinely" wild but feral types that escaped cultivation. This latter theory suggests a central Asian domestication, based on the presence of the greatest number of wild relatives of almonds and the greatest number of natural hybrids in that area (Ladizinsky, 1999).

Due to its agricultural importance, *Amygdalus* receives a great deal of attention, especially from plant breeders and horticulturists, usually to assess the potential for their use in cultivar improvement (Socias i Company and Felipe, 1987; Socias I Company, 1998; Gradziel Tm and et al., 2001).

Historically, the taxonomic status of *Amygdalus* (as genus or subgenus) relative to *Prunus* has been open to question. Based on morphological differences, De Tournefort (1700) recognized *Prunus* and *Amygdalus* as separate genera, and included peaches (which were historically often placed in a separate genus, *Persica* Mill.) in *Amygdalus*. His classification, although not universally accepted, was initially adopted by other workers, including Linnaeus, in his *Species Plantarum* (1753), who treated

Amygdalus and *Prunus* as separate genera. In contrast, Bentham and Hooker (1865) treated *Amygdalus* as a subgenus of *Prunus s.l.* Rehder (1940) divided *Prunus* into 5 subgenera - *Prunus* [= *Prunophora*], *Cerasus*, *Padus*, *Laurocerasus* and *Amygdalus*, and his classification was widely accepted during the second half of the 20th century, especially more recently, with the emerging phylogenetic results using molecular markers. Contemporary botanists, who do not follow Rehder's classification, included Browicz (1989), who continued to recognize A*mygdalus*, *Persica*, and *Prunus* as separate genera. This approach followed Spach's (1843) delimitation of *Amygdalus* (with some infrageneric modifications), and stressed fruit characters such as the dry mesocarp dehiscing along the ventral suture and separating from the hard endocarp in *Amygdalus*, as opposed to a fleshy mesocarp that remains attached to the stone in *Persica* and the rest of *Prunus*. Furthermore, workers recognizing *Amygdalus* as a genus differed in either including the peaches or excluding them as *Persica* (Browicz, 1989). The circumscription of *Amygdalus* as per the revision of Browicz and Zohary (1996) will serve as the hypothesis to be re-examined in this study.

A number of recent studies have recognized that an updated systematic treatment for this group is lacking, as the most recent monograph is more than 150 years old (Spach, 1843). It was also noted that hypotheses of relationships within *Prunus* were either based on one or a few morphological characters, such as in Browicz and Zohary (1996). Consequently a number of molecular studies were conducted in *Prunus* s.l. In a study by Lee and Wen (2001) ITS (internal transcribed spacer) sequence data was used to delimit major evolutionary lineages within *Prunus* s.l. They arrived at two important conclusions: (1) their analysis supported the generic concept of *Prunus* in its broad sense and (2) *Amygdalus* formed a paraphyletic group basal to subgenus *Prunus*. In the formerly mentioned study, *Amygdalus* (*Persica* included) was represented by only two species. Another study, conducted by Bortiri et

al. (2001), also supported a broadly circumscribed *Prunus. Amygdalus* was represented by five species and was recovered as monophyletic. *Amygdalus* was also found monophyletic in later studies based on both chloroplast and nuclear sequence data (Bortiri et al, 2002, Shaw and Small, 2004).

Issues that draw the attention to the need for an updated comprehensive systematic study for *Amygdalus* include 1) the taxonomic controversy, historical and recent, presented above, 2) the discrepancies between the results of recent molecular studies conducted in *Prunus* s.l. which admit the lack of comprehensive sampling of *Amygdalus* species.

The main objective of this study is to complete a comprehensive revision of *Amygdalus* and construct a phylogeny based on molecular data (chloroplast and nuclear loci) as well as morphological data.

Objective I. Phylogeny—Construct a hypothesis of phylogenetic relationships of *Prunus* subgenus *Amygdalus* based on combined cladistic analyses of morphology and DNA sequences. A comprehensive sample of *Amygdalus* species and additional relevant taxa within and outside of *Prunus* were studied (see Material and Methods).

Objective II. Identification of closest wild relatives of almond and peach **-** The intent of this study is not to perform a complete analysis of the origin and domestication of almonds and peaches, which is beyond the scope of this study, but only to provide a phylogenetic basis and foundation for future studies that might focus on almond and peach origins.

MATERIAL AND METHODS

I. CHARACTERS

A. MOLECULAR DATA

1. Selection of Loci

DNA sequences were obtained from six plastid gene regions (*ndhF-rpl32, rpL16, trnH-psbA, trnL-trnF, trnQ-5'rps16. trnS-trnG*) and one nuclear region, *s6pdh*. The nuclear gene, which is a single copy in *Prunus* (Bortiri et al., 2002), would provide more characters since it has higher variability, and an independent line of evidence of relationships.

The choice of these gene regions was based on previous studies conducted in *Prunus* (Bortiri et al., 2001; Bortiri et al., 2002; Potter et al., 2002; Shaw and Small, 2004; Shaw et al., 2005; Shaw and Small, 2005; Bortiri, Heuvel, and Potter, 2006; Shaw et al., 2007) in which they have proved to be informative. In addition, there is a growing library of sequences for these regions in *Prunus s.l.* This study will enhance the growth of that library and make possible more comprehensive analyses in the genus.

For each locus, sequencing from multiple individuals was attempted and was successful for the majority of taxa. In case only one population was available, these two individuals were selected from the same population; otherwise, they were from different populations. Herbarium specimens from various herbaria were used for DNA extractions, with the permission of the herbarium in charge, when suitable material could not be obtained from the wild.

Previously published sequences in GenBank, especially in for outgroups, were also used in the analysis and cited (Table 1.2).

2. Molecular Techniques:

a. Extraction - DNA was extracted from 0.02 – 0.03g of leaf material dried in silica gel, or in few cases from herbarium specimens for the taxa for which material was not available. DNeasy Plant Mini kit (Qiagen, Valencia, California, USA) was used for silica-dried material. For the material removed from herbarium specimens the CTAB (Doyle and Doyle, 1987) method was used.

b. Amplification: Primers and PCR protocols - Polymerase chain reaction (PCR) was performed using an Eppendorf Mastercycler thermocycler. Except for s6pdh, for which 50 µL reactions were used, 25 µL reactions were prepared to amplify the chloroplast gene regions with the following components: 2.5 µL of 10x buffer, 1-2 µL of each primer (10 µmol/L), 0.25 units *Taq* polymerase, 1.5 mmol/L $MgCl_2$, and 2 µL of template DNA. In addition, ExTaq HS kit was used, following the protocol of the kit. (PanVera/TaKaRa, Madison, Wisconsin, USA).

The primers used for amplification and sequencing as well as protocols are given in Table 1.1.

Table 1.1. Chloroplast and nuclear gene regions sequenced and primers used for the amplification and sequencing of the relative regions.

Region	Primer name and sequence 5' – 3'	Protocols*
trnH-psbA	$trnH^{GUG}$ - CGC GCA TGG TGG ATT CAC AAT CC psbA - GTT ATG CAT GAA CGT AAT GCT C	denaturation step at 95° for 1 min annealing at 48° for 1 min and extension at 65° for 3 mins, final step of extension at 65° for 4 mins
trnS-trnG	$trnS^{GCU}$ - AGA TAG GGA TTC GAA CCC TCG GT $trnG^{UUC}$ - GTA GCG GGA ATC GAA CCC GCA TC trnG2G - GCG GGT ATA GTT TAG TGG TAA AA trnG2S - TTT TAC CAC TAA ACT ATA CCC GC $trnG^{UUC}$ - GAA TCG AAC CCG CAT CGT TAG $trnS^{GCU}$ - AAC TCG TAC AAC GGA TTA GCA ATC	following (Shaw et al., 2005) combined annealing and extension in one step - Denaturation at 95° for 1 min, annealing and extension at 64° -66° for 4 mins, final extension step at 66° for 10 mins
trnL-trnF	$trnL^{UAA}$F (TabC) - GA AAT CGG TAG ACG CTA CG $trnF^{GAA}$ (TabF) - ATT TGA ACT GGT GAC ACG AG $trnL^{UAA}$R (TabD) - GGG GAT AGA GGG ACT TGA AC $trnL^{UAA}$R (TabE) - GGT TCA AGT CCC TCT ATC CC	denaturation at 95° for 1 min annealing at 48° -50° for 2 mins, extension at 72° for 1 min 30 secs final extension step at 72° for 10 mins
rpL16	rpL16F71 - GCT ATG CTT AGT GTG TGA CTC GTT G rpL16R1516 - CCC TTC ATT CTT CCT CTA TGT TG	denaturation step at 95° for 1 min annealing at 48° for 1 min extension at 65° for 3 mins final step of extension at 65° for 4 mins
ndhF-rpl32	rpL32-R - CCA ATA TCC CTT YYT TTT CCA A ndhF - GAA AGG TAT KAT CCA YGM ATA TT	denaturation step at 95° for 1 min annealing at 50° for 1 min 30 sec extension at 65° for 3 mins final step of extension at 65° for 5 mins
trnQ-5'rps16	$trnQ^{UUG}$ - GCG TGG CCA AGY GGT AAG GC rpS16 - GTT GCT TTY TAC CAC ATC GTT T	denaturation step at 95° for 1 min annealing at 51° for 1 min 30 sec extension at 65° for 3 min final extension step at 65° for 5 mins
s6pdh	s6pdh-k - AGC TCA TTA CAA GAG TGA AGC AGA CGT TGG s6pdh-p - AGA GTG GTC CTG GAT TTC TTA TCT A s6pdh-h - AGA CCA ATG CTG CGA ACT AAG CCC s6pdh-c - TTT GGA ATT CAG ACC ATG GGC ATG	denaturation step at 95° for 30 sec annealing at 52° for 1 min extension at 72° for 3 min final step of extension at 72° for 7 mins

* Protocols were: 1 cycle of 80° for 5 min; 30 cycles of denaturation, annealing and extension (below); and 1 cycle of final step

c. Sequencing - Sequences for s6pdh, were obtained from both direct sequencing of PCR and cloning. The PCR reactions were checked on 0.8 - 1% agarose gels before cleaning using either the QIAquick PCR Purification Kit (Qiagen) or ExoAP-IT (USB, Cleveland, Ohio, USA). The same primers used for amplification were also used for sequencing in addition to internal primers were used in *trnL-trnF* and *trnS-trnG* (Table 1.1). The BigDye Terminator Cycle Sequencing Ready Reaction Kit, v. 2.0 or 3.1 (Perkin-Elmer/Applied Biosystems, Foster City, California, USA), electrophoresed and detected on an ABI Prism 3100 automated sequencer done in The Cornell University Life Sciences Core Laboratories Center (CLC).

3. Alignment:

Sequencher 3.1 and 4.8 (Gene Codes Corporation, Ann Arbor, Michigan, USA) was used for editing and assembling complementary DNA strands, and for doing preliminary alignment by eye to double check the chromatograph when base pair changes suggesting any grouping information were detected. Alignments were redone using the online version of MUSCLE (Edgar 2004) and adjusted by eye as needed. Total length of aligned sequences and parsimony informative characters (PIC) ware reported (Table 1.4)

4. Indels:

Indels were coded as separate characters based on the simple gap coding method (Simmons and Ochoterena 2000), using SeqState v.1.4 (Muller, 2005).

Table 1.2. List of voucher specimens and sequences . DPRU – accessions from the USDA National clonal Germplasm Repository, Davis. * Herbarium specimen.

Species	Voucher
Prunus Subgenus Amygdalus	
Section Amygdalus	
Prunus arabica var. arabica	M. Yazbek 23
P. arabica var. scoparia	A. Donmez 14114
	Dpru 2224.1
	A. Donmez 14114b
	A. Donmez 12603
P. dulcis	M. Yazbek 05
	M. Yazbek 11
	A. Donmez 12462
P. trichamygdalus	A. Donmez 12378
P. bucharica	Al-Shehbaz & Hisoriev 601
P. haussknechtii	A. Donmez 14117
	K. H. Rechinger 47822 *
P. fenzliana	Fayvush 509
	Al-Shehbaz & Hisoriev 654
	A. Donmez 5145
P. webbii	A. Donmez 12614
	A. Donmez 12164
	A. Donmez 3145
P. x balansae	A. Donmez 12609
P. kuramica	DPRU 1467.4
P. argentea	A. Donmez 12606
	M. Yazbek 09
	A. Donmez 4379
P. kotschyi	Iranshahr & Terme 12677e *
	K. H. Rechinger 49085 *
P. discolor	A. Donmez 4299
P. carduchorum	A. Donmez 10761
P. lycioides	A. Donmez 14125
	A. Donmez 5085
	A. Donmez 14104
P. spinosissima	A. Donmez 14125
	A. Donmez 14106
	A. Donmez 14104b
P. eburnea	DPRU 2226.8
P. erioclada	A. Donmez 14161
	A. Donmez 14169
Section Persica	
P. persica	DPRU 1586
	M. Yazbek 61
	DPRU 2495.1
P. davidiana	DPRU 2325.3
	DPRU 2494.1
	M. Yazbek & Y. Wang 15
	DPRU 2583.2
P. mira	DPRU 2232
	M. Yazbek & Y. Wang 50

Table 1.2. (Continued)

P. kansuensis	M. Yazbek & Y. Wang 25
	DPRU 0582
P. tangutica	DPRU 2327.1
	M. Yazbek & Y. Wang 28
	M. Yazbek & Y. Wang 30
P. mongolica	M. Yazbek & Y. Wang 01
	M. Yazbek & Y. Wang 02
Section Chamaeamygdalus	
	Thomas Barta 2005-237 *
P. tenella	Thomas Barta 2005-239 *
	DPRU 2225.7
	E. Vitek
P. petunikowii	---------
Prunus subgenus Emplectocladus	
P. eremophila	Prigge 10219
P. fasciculata	Dxp 752
Prunus subgenus Prunus	
Section Louiseania	
P. triloba	M. Yazbek 65
	M. Yazbek & Y. Wang 04
P. pedunculata	DPRU 2328.4
	M. Yazbek & Y. Wang 09
Section Penarmeniaca	
P. fremontii	DPRU 2097
	Dxp 754
P. andesonii	----------
P. havardii	Spelleberg, Brozka And Light Foot 9685
Section Armeniaca	
P. armeniaca	
P. mume	M. Yazbek 49
P. sibirica	M. Yazbek & Y. Wang 56
Sections Prunus	
P. domestica	
P. spinoa	Dpru 0473
Section Piloprunus	
P. texana	
P. maritima	
P. hortulana	
P. angustifolia	
P. nigra	
P. umbellata	
Physocarpus amurensis	

B. MORPHOLOGICAL DATA

Morphological data was collected and used to construct a matrix used in cladistic analysis individually and combined with molecular data matrices. The data were gathered simultaneously as data were collected for the monograph. At least 30 individuals (herbarium specimens) of each putative species (in some species more than 100 specimens were scored) were examined. Observations were also made on living material and during field trips. Any missing morphological data were completed from the literature, even though this was a rare situation. (see Table 1.3 for List of morphological characters and scores).

II. TAXON SAMPLING

Molecular data were obtained for 22 species out of 24 described in the monograph. *Prunus brahuica* (Boiss) Aitch. & Hemsl and *P. elaeagnifolia* (Spach) Murray could not be collected, and DNA extraction from herbaria specimens was not successful. Ingroup and outgroup taxa included in the analyses are listed in Table 1.2. Outgroups include representatives from other subgenera of *Prunus* s.l. and other genera Rosaceae (Table 1.2). Most collections were obtained from wild populations. Collections were also obtained from USDA, ARS, National Genetic Resources Program. Herbarium specimens are deposited at the L. H. Bailey Hortorium Herbarium at Cornell University (BH), and duplicates of all collections are deposited at the herbaria in the countries of origin.

Table 1.3. Characters list and scores: Morphological characters used in the cladistic analysis. Length, CI and RI from the analysis of the total evidence matrix are listed.

	Character name	Character states and scores	Length	CI	RI
Character	0. Habit:	shrub = 0; tree = 1.	4	0.25	0.5
Character	1. Spinescence:	non-spinescent = 0; sub-spinescent or spinescent = 1.	9	0.11	0.55
Character	2. Leaves on short shoots:	yes = 0; no = 1.	3	0.33	0.5
Character	3. Leaves in bud:	convolute = 0; conduplicate = 1.	3	0.33	0.75
Character	4. Carpel number:	1 = 0; more than 1 = 1.	Uninf		

Character	5. Hypanthium shape	campanulate = 0;
		cylindrical = 1;
		urceolate = 2;
		funneliform = 3.
			2	1	1

Character	6. Hypanthium pubescence:	yes = 0; no = 1.	5	0.2	0.2
Character	7. Sepals margin:	entire - ciliate = 0; toothed = 1.	3	0.33	0.71
Character	8. Fruit type:	Follicle = 0; Capsule = 1; drupe = 2.	Uninf		
Character	9. Fruit pubescence:	no = 0; yes = 1.	4	0.25	0.62
Character	10. Mesocarp splitting:	no = 0; yes = 1.	5	0.20	0.63
Character	11. Endocarp ornamentation present:	no (smooth) = 0; yes (ornamentation present) = 1.	4	0.25	0.78

Character	12. Endocarp ornamentation:	pits = 0;
		furrows = 1;
		pits and furrows = 2;
		rugose = 3.
			8	0.37	0.5

Character	13. Petiolar glands:	Absent = 0; Present = 1.	4	0.25	0.3
Character	14. Terminal winter bud:	abscent = 0; present = 1.	2	0.5	0.87
Character	15. Axillary bud:	one = 0; two or three = 1.	1	1	1
Character	16. Pedicel pendulant:	no = 0; yes = 1.	4	0.25	0.62

III. DATA ANALYSIS

Data matrices were constructed and manipulated using Winclada (Nixon 2000) and analyzed using TNT (Goloboff et al 2000).

A. COMBINED ANALYSIS

Data obtained for the morphological characters was combined in a simultaneous analysis with molecular data (chloroplast and nuclear).

B. PARSIMONY

TNT was used to search for the most parsimonious trees. Conventional searches as well as the parsimony ratchet (Nixon 1999), drift, tree fusion and sectorial searches (Goloboff, 2004) were employed. Even though drift and sectorial searches were explored, conventional searches, in combination with the parsimony ratchet were sufficient. Parsimony uninformative characters were deactivated (xi;) in all analysis. All characters were equally weighted and treated as non-additive. Ambiguously supported nodes were collapsed ("col3"). Swapping was conducted for all matrices using (TBR) swapping ("mult*1000") followed by Ratchet (200 iterations). One thousand replicates were conducted holding up to 20 trees per replicate ("h/20"), perturbing 10% of the informative characters with a probability of 5 for up–weighting and 5 for down–weighting. (''ho20000; rat:it200upf5dow5numsubsX; mu_rep1000ho20rat;'' where X _ 10% of the number of informative characters). Then trees were swapped to completion using TBR (''ho1000000; bbreak_tbr;''). One thousand bootstrap resamplings (Felsenstein 1985) were conducted using WinClada and NONA. Resampled matrices were searched using: 100 replicates, swapped with TBR holding up to 20 trees per replicate, and followed with 200 iterations of ratchet.

For each iteration, the strict consensus of the MPTs was saved. Using WinClada, the frequencies of clades were mapped onto the strict consensus of the MPT obtained.

RESULTS

In this section, the properties of individual and combined matrices will be presented. Length of aligned sequences, parsimony informative characters (PIC), indels, resolution and topologies will be compared. Topologies used for results and discussion are the strict consensus trees of the MPTs constructed from the analyses.

A. INDIVIDUAL MATRICES.

1. *ndhF-rpL32* – Thirty two taxa were included in this dataset. The total aligned length was 999bp, with 20 PICs. The number of MPTs obtained was 428 with a length of 26 steps and CI of 0.84 and RI of 0.92. The total % of collapsed nodes was 83.3%. Twenty five (25) additional PICs resulted and the % nodes collapsed decreased to 70% when indels were simple coded (Simmons and Ochoterena, 2000) (Table 1.4).

Amygdalus was not recovered as monophyletic in this analysis. However, two clades of importance were recovered. The first one included three taxa of the *Persica* group (*Prunus persica* and *P. kansuensis*). The second one included 3 species (P. *lycioides*, *P. erioclada* and *P. spinosissima*) which where put in subgenus *Dodecandrae* by Browicz and Zohary (1996). (Figure 1.1)

2. *rpL16* – This region sequenced more easily and consequently data was produced for more taxa in this dataset (41 taxa). The total aligned length was 978 bp with 17 PICs. Twenty two MPTs resulted fro mthe analysis with a length of 22 steps, and a CI of 0.81 and RI of 0.95. Coding idels (14) decreased the percent of collapsed

Table 1.4. Summary of characteristics on individual and combined matrices and analyses statistics.

Matrix number	Matrix name	Terminals	Characters				Length	Trees	% nodes collapsed			% CI	% RI
			Aligned length	PIC	% PIC	% missing			Total[a]	Lack of data[b]	Conflict[c]		
1	*ndhF-rpl32*	32	999	20	2.0	13	26	428	83.3	60.0	23.3	84	92
	ndhF-rpl32 + indels	32	1055	45	4.3	-	78	6882	70	33.3	36.7	60	77
2	*rpL16*	41	978	17	1.7	12	22	22	79.5	71.8	7.7	81	95
	rpL16 + indels	41	1018	31	3.0	-	52	40	56.4	43.6	12.8	61	86
3	*trnH-psbA*	43	519	9	1.7	38	13	727	100.0	82.9	17.1	76	93
	trnH-psbA + indels	43	563	23	4.1	-	42	81	78.0	53.7	24.4	57	81
4	*trnL-trnL-trnF*	41	1050	18	1.7	17	22	7	76.9	69.2	7.7	90	95
	trnL-trnL-trnF + indels	41	1076	23	2.1	-	33	114	76.9	66.7	10.3	75	88
5	*trnQ-5'rps16*	30	519	13	2.5	10	14	1	82.1	82.1	0.0	92	95
	trnQ-5'rps16 + indels	30	526	13	2.5	-	14	1	82.1	82.1	0.0	92	95
6	*trnS-trnG-trnG*	42	1491	35	2.3	21	42	626	65.0	55.0	10.0	83	93
	trnS-trnG-trnG + indels	42	1567	66	4.2	-	105	13430	65.0	32.5	32.5	62	81
	Plastid	45	5556	112	2.0	29	148	5	51.2	44.2	7.0	79	91
	Plastid+indels	45	5805	201	3.5	-	359	396	32.6	7.0	25.6	57	77
7	(i) *S6pdh* + ms	37	1268	52	4.1	10	97	294	54.3	45.7	8.6	60	85
	(ii) *S6pdh* – ms	37	1196	50	4.2	-	93	284	54.3	45.7	8.6	61	86
	(iii) *S6pdh* - ms + indels	37	1297	75	5.8	-	145	948	54.3	31.4	22.9	56	81
	(iv) *S6pdh* + ms + indels	37	1391	83	6.0	-	164	102	42.9	22.9	20.0	54	79
	Molecular*	49	6824	164	2.4	30	254	3543	48.9	34.0	14.9	69	87
	Molecular+indels**	49	7102	276	3.9	-	523	500	48.9	10.6	38.3	55	77
	Morphology	44	17	15	88.2	20	39	106	64.3	38.1	26.2	46	83
	Total *	50	6841	179	2.6	32	317	1560	33.3	18.7	14.6	61	84
	Total+indels**	50	7119	291	4.1	-	595	442	41.7	10.4	31.3	51	75

ms = microsatellites region (72 bp). * Matrix (i) was used in this combined matrix; ** matrix (iii) of s6pdh this these combined matrices.
% nodes collapsed: a = total nodes collapsed in strict consensus on MPTs; b = total nodes collapsed in MPTs; c = b – a. (i.e. a subtracted from b)

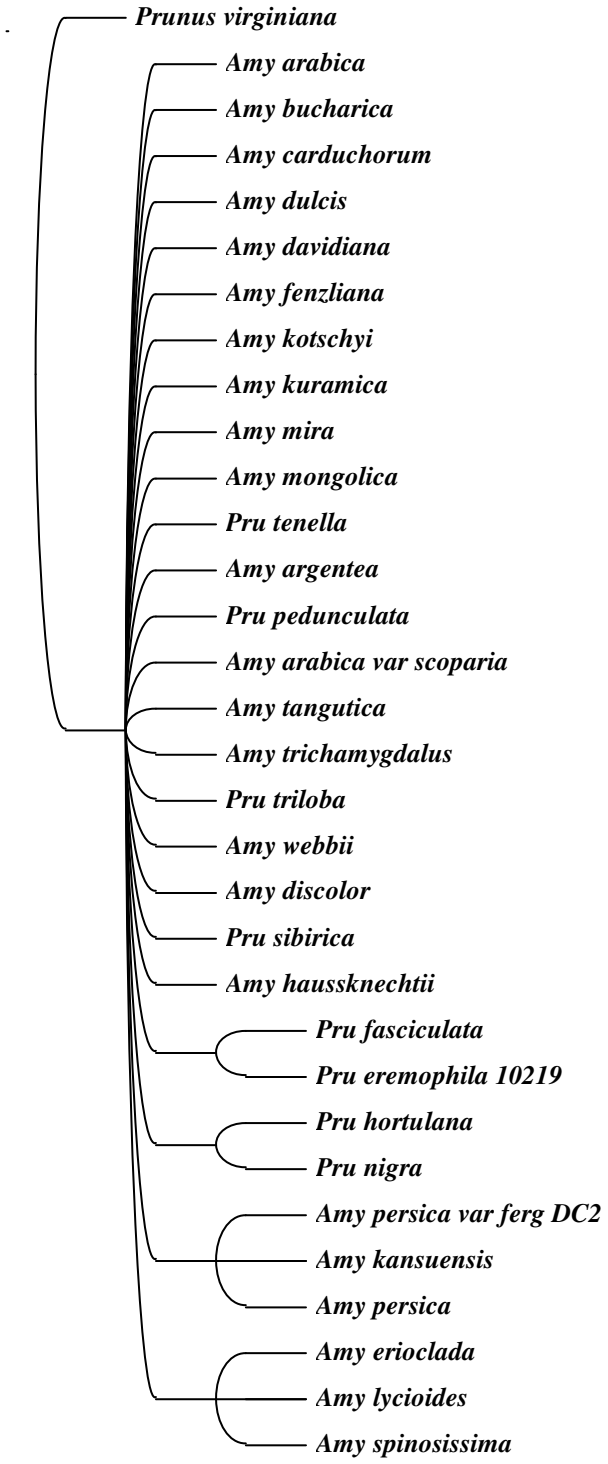

Figure 1.1. Strict consensus of 428 most parsimonious trees from the analysis of *ndhF-rpl3* sequence data. Tree statistics are given in Table (1.4).

nodes from 79.5% to 56.4% (Table 1.4). *Amygdalus* was recovered as monophyletic in this analysis. Within *Amygdalus*, *Prunus persica* and *P. kansuensis* formed a clade. *Prunus tenella, P. triloba* and *P. pedunculata* were recovered outside *Amygdalus* (Figure 1.2).

3. *trnH-psbA* – This dataset had the highest number of taxa since this region was the easiest to sequence as a result of its relatively short length (519 bp). This fact made it easy to obtain sequences from herbarium specimens. However it had the least percent of PIC (1.7%) as compared to the other regions sequenced. The number of MPTs was 727 with a length of 13 steps and a CI of 0.76 and RI of 0.93 (Table 1.4). It is important to note that *psbA-trnH* which included sequences for 43 terminals, had indels that were relatively long, and this was reflected in the highest percent of missing data in this matrix (38%), and which was also the cause for the high percentage of missing data in the subsequent combined matrices from plastid regions (29%) and molecular (30%) datasets. *trnH-psbA* yielded a bush with 100% nodes collapsed (Figure1.3).

4. *trnL-trnF* – Forty one taxa were sequenced for this region. The total aligned length was 1050 bp. The percent PIC was 1.7% similar to *trnH-psbA* and *rpL16*, which is the lowest obtained among plastid regions. Analysis of this matrix yielded 7 MPTs with a length of 22 steps and a CI of 0.90 and RI of 0.95. The total percent of collapsed nodes in the MPT (76.9) was lower than what was obtained from analyses of most matrices second only to *trnS-trnG*. Indels coded in this matrix (26) were all uninformative (Table 1.4).

Amygdalus was not recovered as monophyletic in the strict consensus tree. However, consistent with the *rpL16*, and *ndhF-rpl32*, a *Persica* clade was recovered and a clade including most but not all of the species that belong to section *Amygdalus* was also recovered (Figure 1.4).

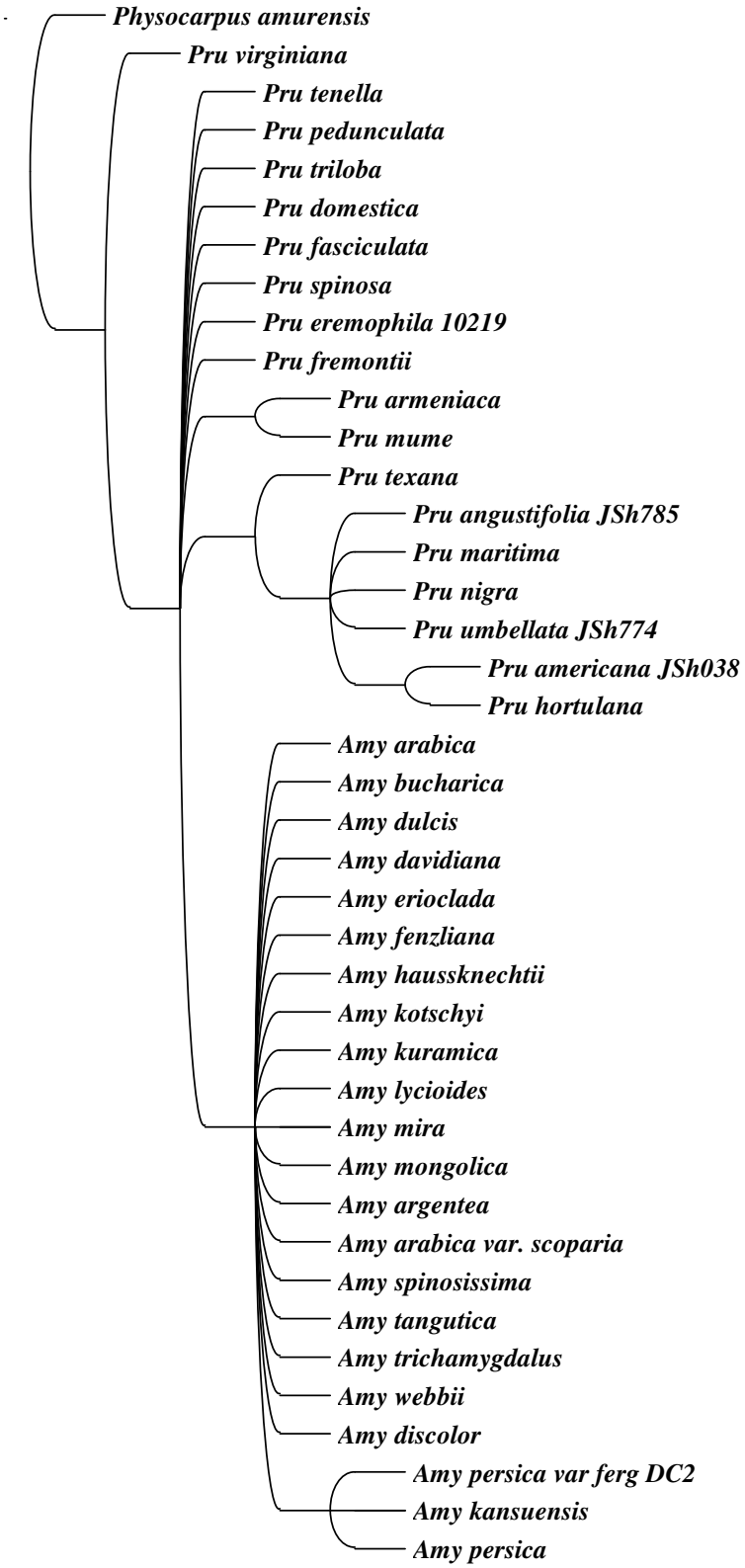

Figure 1.2. Strict consensus of 22 most parsimonious trees from the analysis of *rpL16* sequence data. Tree statistics are given in Table (1.4).

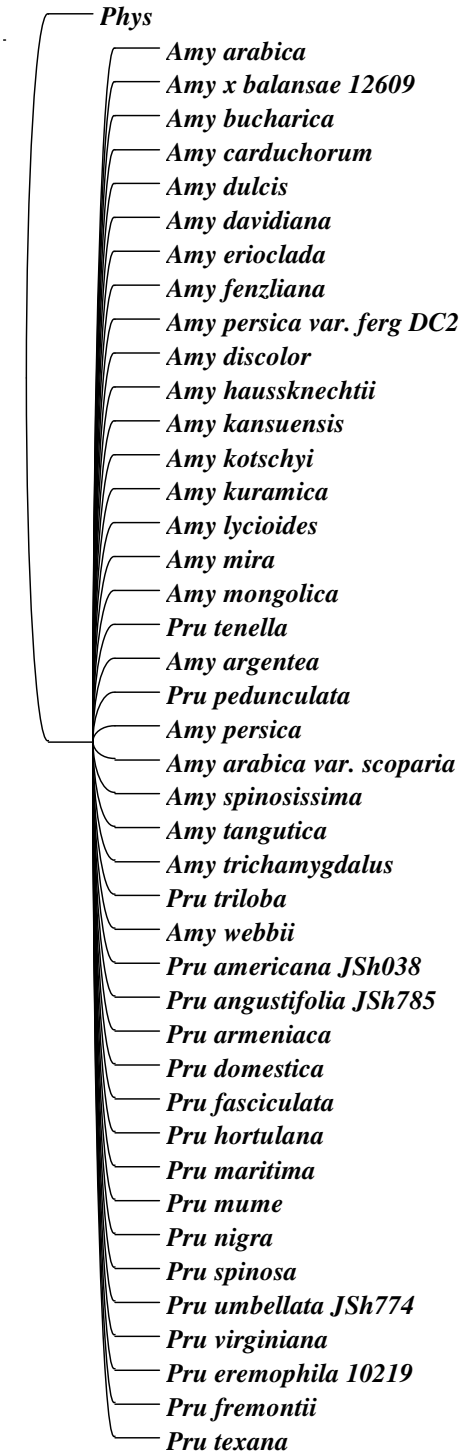

Figure 1.3. Strict consensus of 727 most parsimonious trees from the analysis of *trnH-psbA* sequence data. Tree statistics are given in Table (1.4).

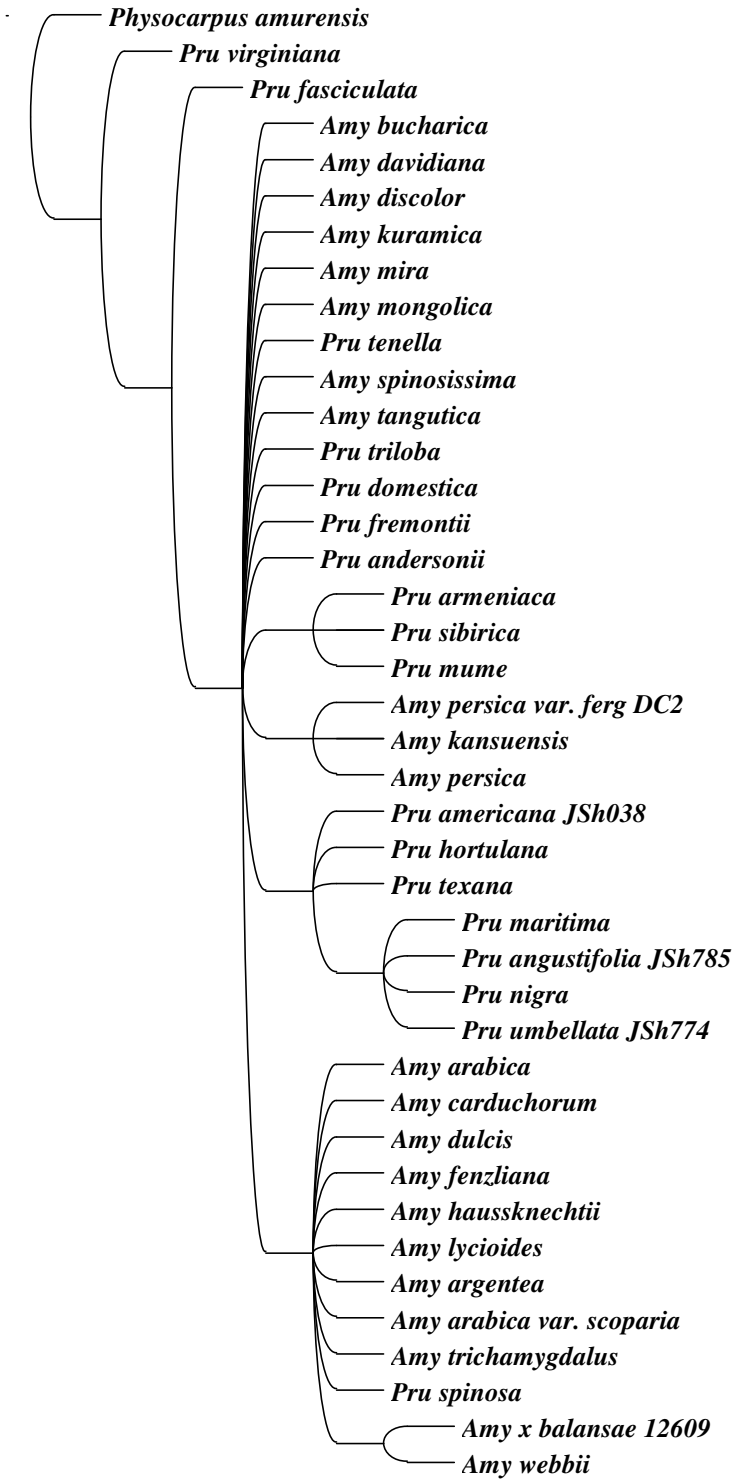

Figure 1.4. Strict consensus of 7 most parsimonious trees from the analysis of *trnL-trnL-trnF* sequence ata. Tree statistics are given in Table (1.4).

5. *trnQ-5'rps16* – Partial sequences were obtained for this region as it was more difficult to sequences than other plastid regions. The total aligned length used in this matrix was 519 bp with the highest percent of PICs (2.5%) of all plastid regions. Sequences were obtained for only 30 taxa. Analysis yielded only one most parsimonious tree with a length of 14 steps and a CI of 0.92 and RI of 0.95. No informative indels were obtained when gap coding was conducted (Table 1.4). Similar to *trnH-psbA*, the tree was least resolved with 82.1% of the nodes collapsed. This region had a 178 bp insertion in only one terminal, *Prunus virginiana,* and it was deleted to avoid inflating missing data in the matrix.

Amygdalus was not recovered as monophyletic in this one most parsimonious tree. However, and similar to trnL-trnF, a clade including most but not all section *Amygdalus* species was recovered. In addition, *Prunus pedunculata* and *P. triloba* (section *Louiseania* Carr.) were recovered as sister to *Amygdalus* (Figure 1.5).

6. *trnS-trnG* – Forty two taxa were sequenced for this region. The total aligned length was 1491 with the second highest PIC (2.3%) of all plastid regions. Analysis yielded 626 MPTs with a length of 42 steps, CI of 0.83 and RI of 0.93. In terms of resolution, among all plastid gene regions, *trnS-trnG* provided the highest resolution with a percent of collapsed nodes being the least (65%).The strict consensus constructed from this analysis did not recover a monophyletic *Amygdalus*. However, the clades that were resolved in this analysis are also recovered in the strict consensus constructed from the simultaneous analysis. Most important of these clades are: a) a clade with *Prunus davidiana, P. tangutica* and *P. mongolica*; b) a clade of *P. triloba* and *P. pedunculata*; c) a clade with *P. kansuensis* and *P. persica*; and d) a clade with *P. webbi* and *P. x balansae* (Figure 1.6).

7. *S6pdh* (nuclear) – In this dataset, four different matrices were examined: matrix (i) microsatellite region (72bp) kept and indels not coded, matrix (ii)

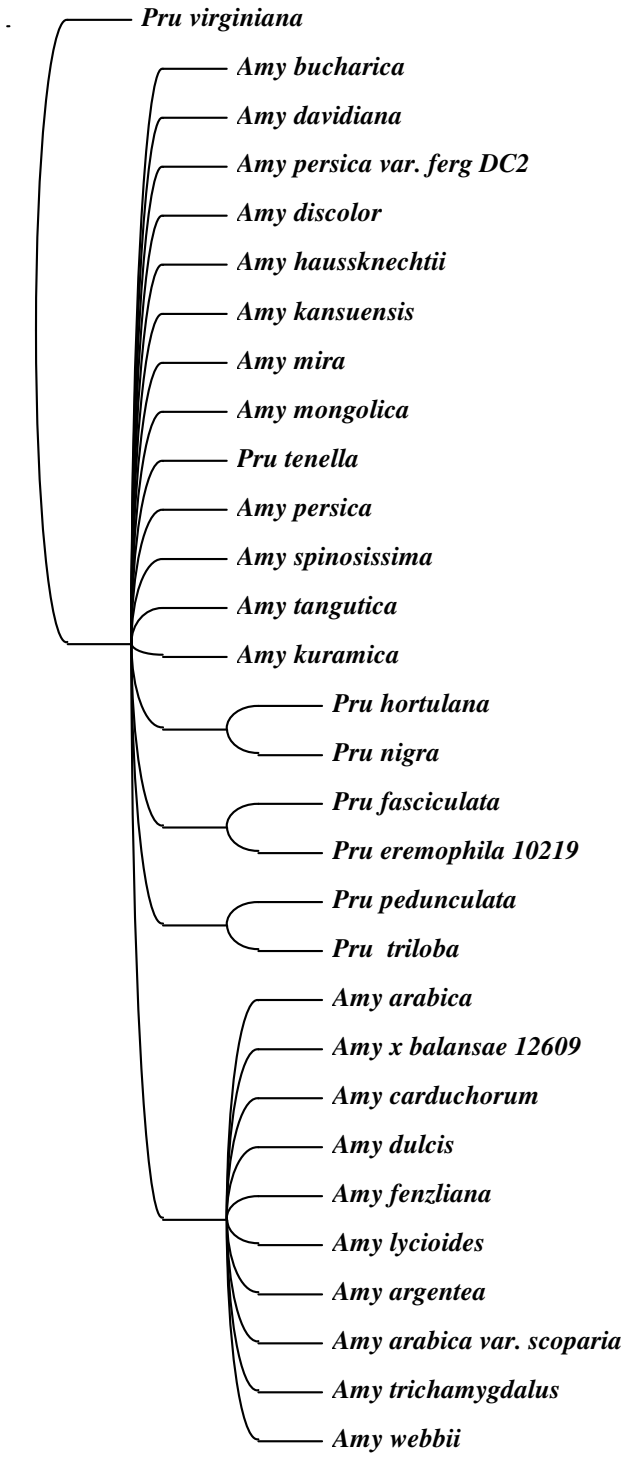

Figure 1.5. One most parsimonious tree from the analysis of *trnQ-5'rps16* sequence data. Tree statistics are given in Table (1.4).

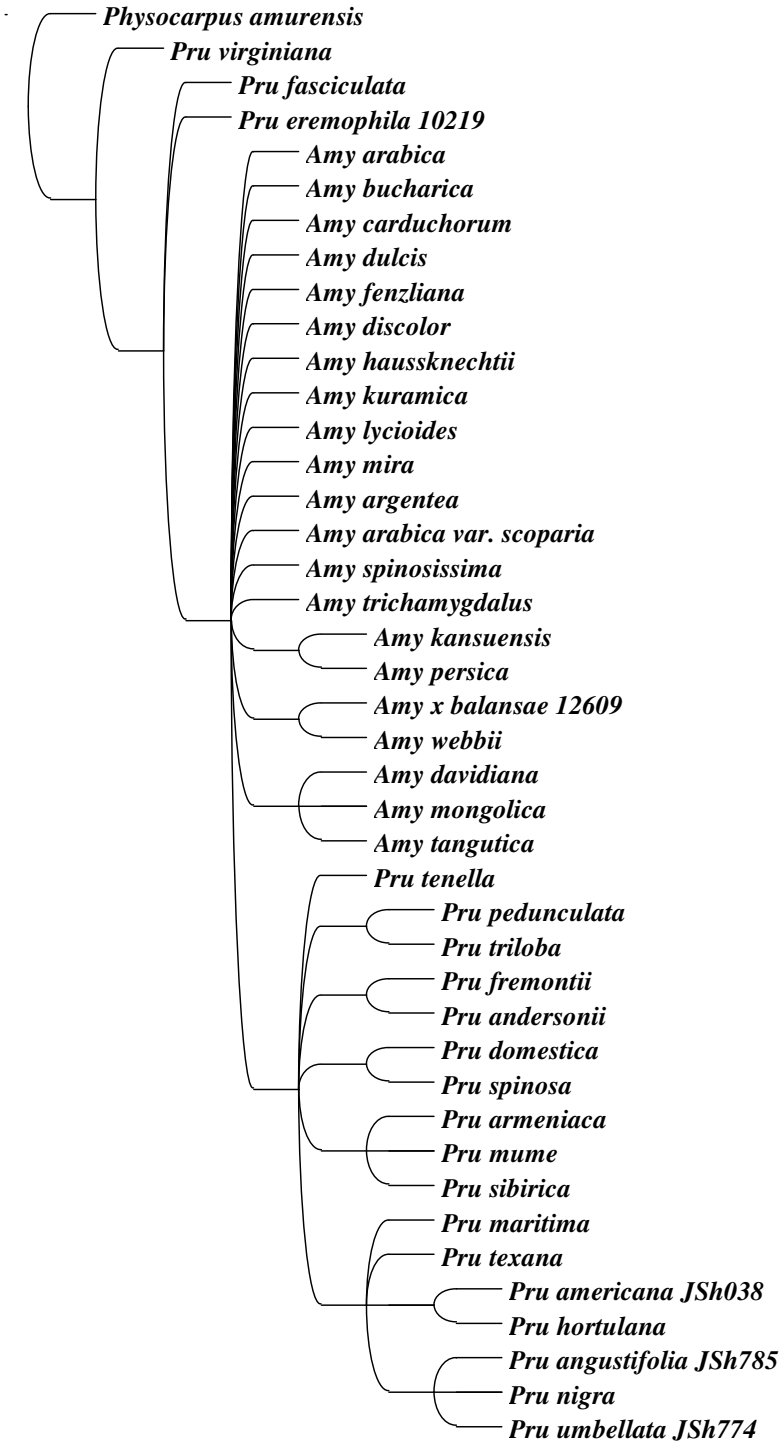

Figure 1.6. Strict consensus of 626 most parsimonious trees obtained from the analysis of *trnS-trnG* sequence data. Tree statistics are given in Table (1.4).

microsatellite region deleted and indels not coded, matrix (iii): microsatellite region deleted and indels coded, and matrix (iv) microsatellite region kept in, and indels coded. The first three datasets yielded the same strict consensus topology, but not the fourth (Appendix I.). When the indels were not coded, the microsatellites had no effect on the results.

Matrix (i) is the one that was included in the successive combined analyses. This matrix had a total aligned length of 1268 bp with 4.1% PICs, which is higher percentage than any other plastid matrix. The analysis yielded 294 MPTs with 97 steps, CI of 0.60 and RI of v85.

The nuclear gene *s6pdh*, yielded the highest resolution and had total collapsed nodes of 54.3%. The majority of the collapsed nodes were due to lack of data (45.7%) and not to conflict (8.6%) (Table 1.4).

Amygdalus was recovered as monophyletic in this analysis. More over, section *Amygdalus* was recovered as monophyletic and part of sect *Persica* (*Prunus persica* and *P. kansuensis* fomed a clade). *Prunus davidiana*, *P. tangutica* and *P. mongolica*, were unresovled in a polytomy sister to section *Amygdalus* and rest of section *Persica*. Another worth highlighting result is the recovery of *P. triloba* and *P. pedunculata* well nested within the outgroups and *P. petunikowii* sister to *P. fasciculata*. (Figure 1.8)

8. Morphology – The Morphological data matrix (Appendix II) included 44 taxa and 17 characters, 15 of which were parsimony informative. The analysis yielded 106 MPTs with 39 steps, CI of 0.46 and RI of 0.84. The total percent of nodes collapsed (64.3%) was comparable to that obtained in other individual gene region matrix. However, and as expected, the collapsed nodes due to conflict (26.2%) was the highest amongst all datasets.

There was considerable conflict between the topology of the molecular dataset and that of the morphology. In the latter, *P. petunikowii, P. tenella, P. triloba and P.*

pedunculata were recovered nested within *Amygdalus*. Morphological characters that supported this clade were toothed sepal margin and rugose endocarp. This agrees with treatments that have relied solely on morphology which include some (Browicz and Zohary, 1996) or all (Lu and Bartholomew, 2003) of these species in *Amygdalus*. Furthermore, three species of the new world *Prunus* section *Emplectocladus, P.fasciculata, P. fremontii,* and *P. eremophila* were recovered nested within *Amygdalus*. These taxa have been once suggested to be the closest North American relatives of *Amygdalus* (Mason, 1913) (Figure 1.10).

B. COMBINED ANALYSES.

1. Plastid – Five MPTs were constructed from this analysis with length of 148 steps, CI of 0.79 and RI of 0.91. The simultaneous analysis of the plastid datasets yielded more resolution than individual datasets with total collapsed nodes of 51.2% (32.6% when indels were coded) (Table 1.4).

Amygdalus was recovered as monophyletic in the strict consensus. Within *Amygdalus*, two strongly supported clades were recovered, section *Persica*, and section *Amygdalus*. The topology of the plastid region is very similar to the total evidence strict consensus topology. The results will be presented in more details in the latter section (Figure 1.7).

Comparing the phylogenies obtained by plastid (Figure 1.7) and nuclear (Figure 1.8) genes, the tree topologies did not differ considerably. The plastid dataset had more taxa and more resolution was obtained. Concerning species that are included in a monophyletic *Amygdalus*, the species *Prunus tenella* (not represented in s6pdh), *P. petunikowii, P. triloba and P. pedunculata* were recovered outside a monophyletic *Amygdalus* in both datasets. Furthermore, an interesting and novel clade containing the *Persica* group in addition to *Prunus tangutica* and *P. mongolica*, was recovered in the

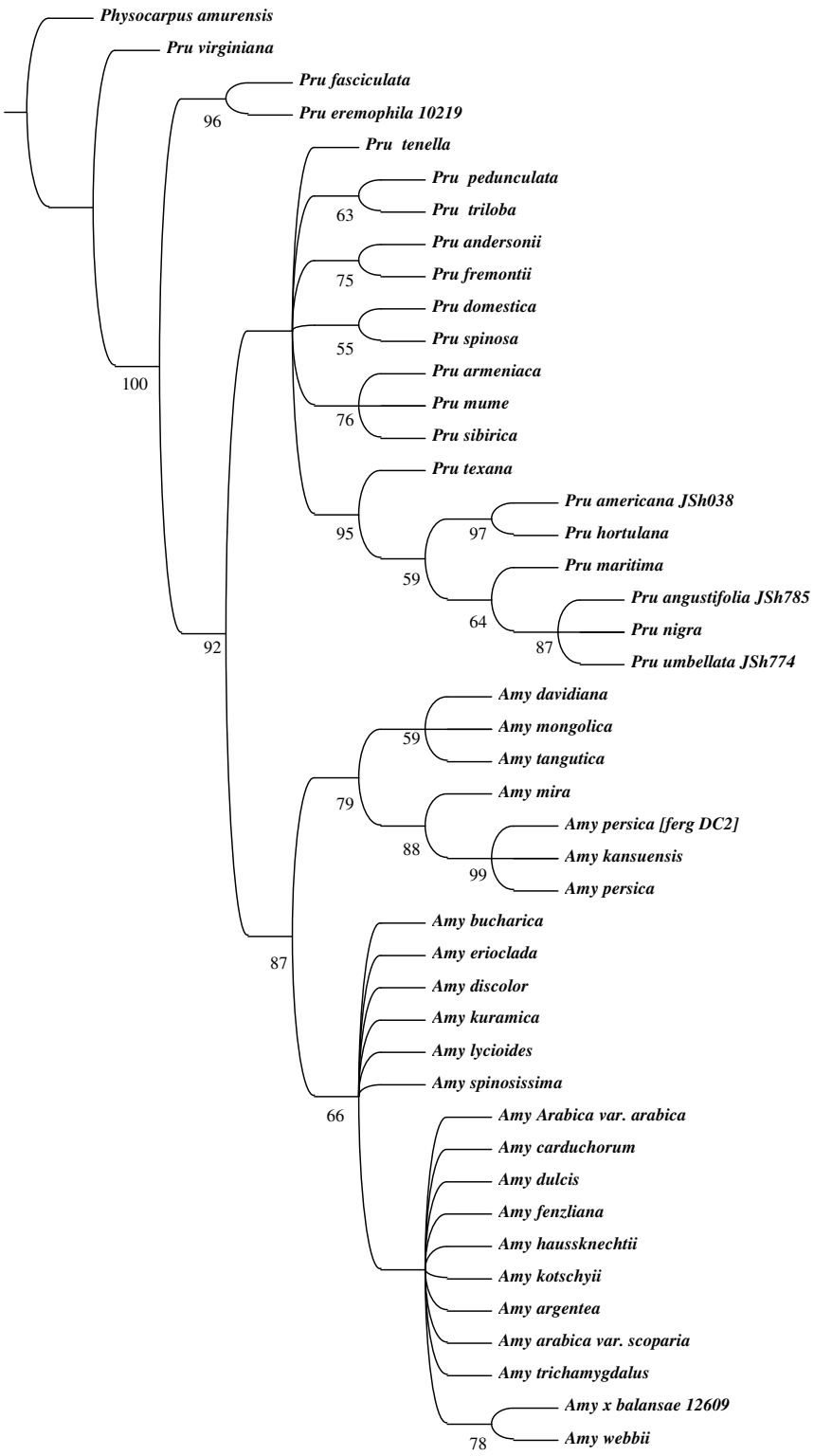

Figure 1.7. Strict consensus of 5 MPTs of plastid sequence data analysis (*ndhF-rpl3, rpL16, trnH-psbA, trnL-trnF, trnQ-5'rps16, trnS-trnG*). Statistics are given in Table (1.4). Numbers below branches are bootstrap frequencies above 50%.

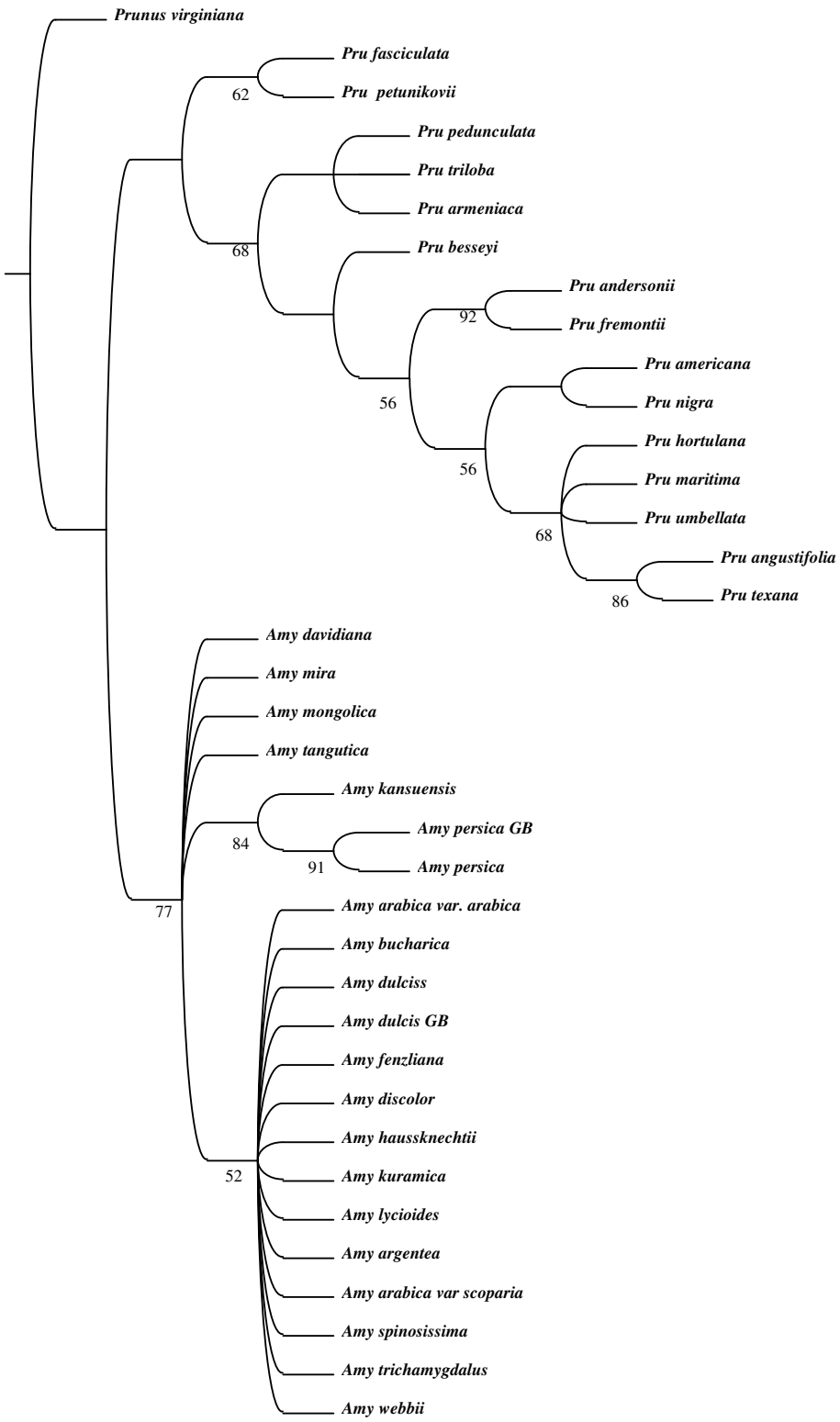

Figure 1.8. Strict consensus of 294 most parsimonious trees from the analysis of nuclear s6pdh sequence data. Tree statistics are given in Table (1.4). Numbers below branches are bootstrap frequencies above 50%.

plastid dataset, but not in the s6pdh. However it was not conflicted in the latter since *P. tangutica*, *P. mongolica*, *P. mira* and *P. davidiana* were unresolved in a polytomy. The polytomy also included two clades: one including the rest of the *Persica*, and a second large clade including the rest of the *Amygdalus* species. Both plastid and nuclear datasets resulted in a strongly supported clade including most of the *Amygdalus* species, or section *Amygdalus*.

2. Molecular (plastid + nuclear) – With a total aligned length of 6824 bp and 164 PICs, the analysis of this matrix yielded 3543 MPTs with a length of 254 steps, CI of 0.69 and RI of 0.87. When the plastid dataset was combined with the nuclear s6pdh, the molecular matrix resulted in even more resolution with the percentage of total collapsed nodes decreased further (48.9%). (Table 1.4)

The molecular matrix recovered an additional clade that included *Prunus spinosissima*, *P. lycioides* and *P. erioclada*, a group that was traditionally recognized by Browicz and Zohary (1996) as the subg. *Dodecandrae* (Figure 1.9).

3. Total Evidence (Molecular + Morphology) – A total of 1560 MPTs were constructed, with 317 steps and a CI of 0.61 and RI of 0.84. The total evidence analyses resulted in more resolution than the molecular dataset only with only 33.3% of total nodes collapsed. Adding the morphology dataset also resulted in the least (18.7%) nodes collapsed due to lack of data of all datasets. The addition of the morphology to the molecular data also added to the resolution resulting with the least (33.3%) percent total nodes collapsed in the total evidence matrix. This percentage went up to 41.7% when indels were coded. Unlike all previous cases, the total evidence matrix was the only case where coding indels decreased resolution. Based on this, topologies of the strict consensus trees recovered from the matrices of combined plastid, nuclear, molecular, and total evidence data excluding indel coding, will be

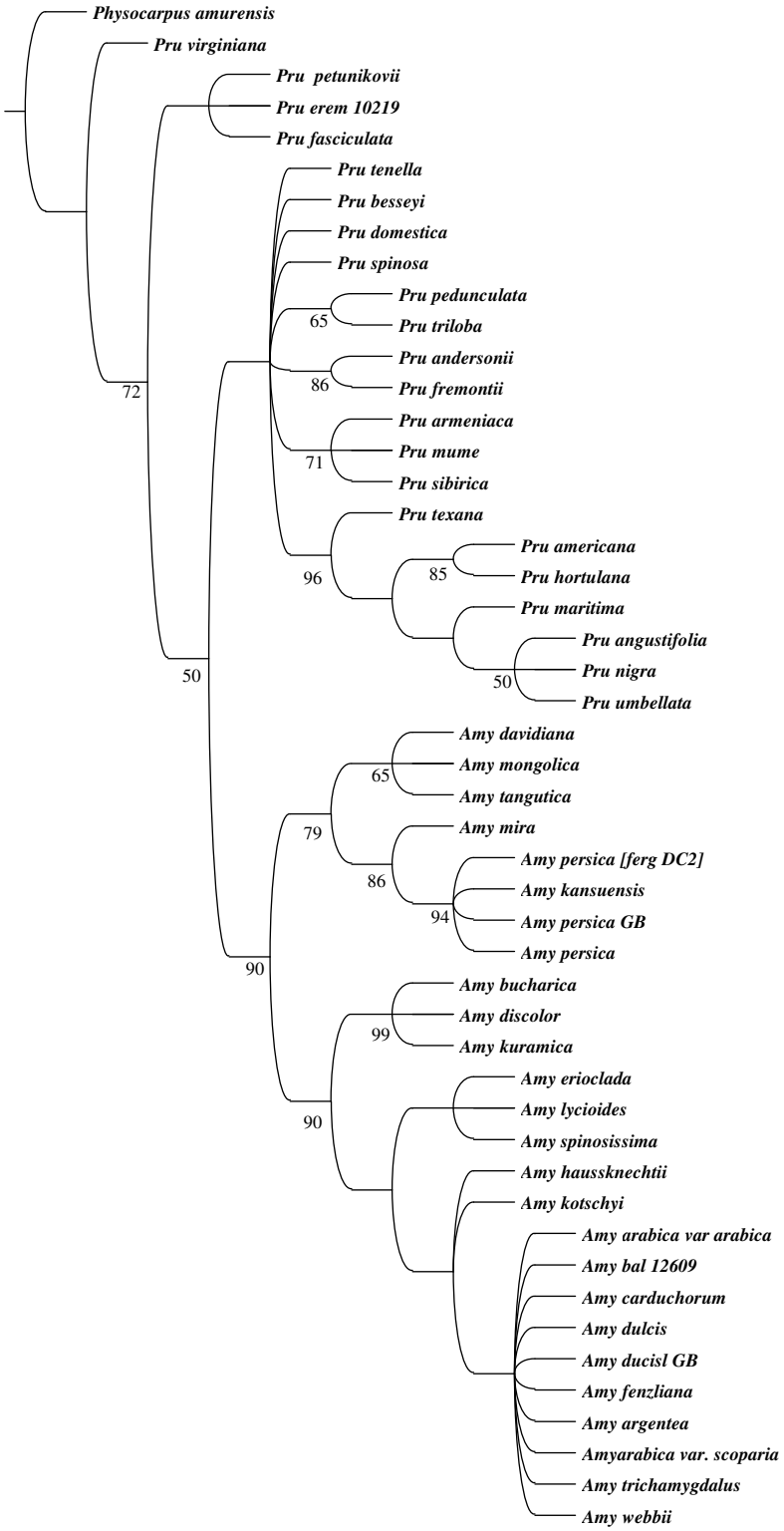

Figure 1.9. Strict consensus of 3543 parsimonious trees from the analysis of molecular (combined plastid and nuclear) sequence data. Tree statistics are given in Table (1.4). Numbers below branches are bootstrap frequencies above 50%.

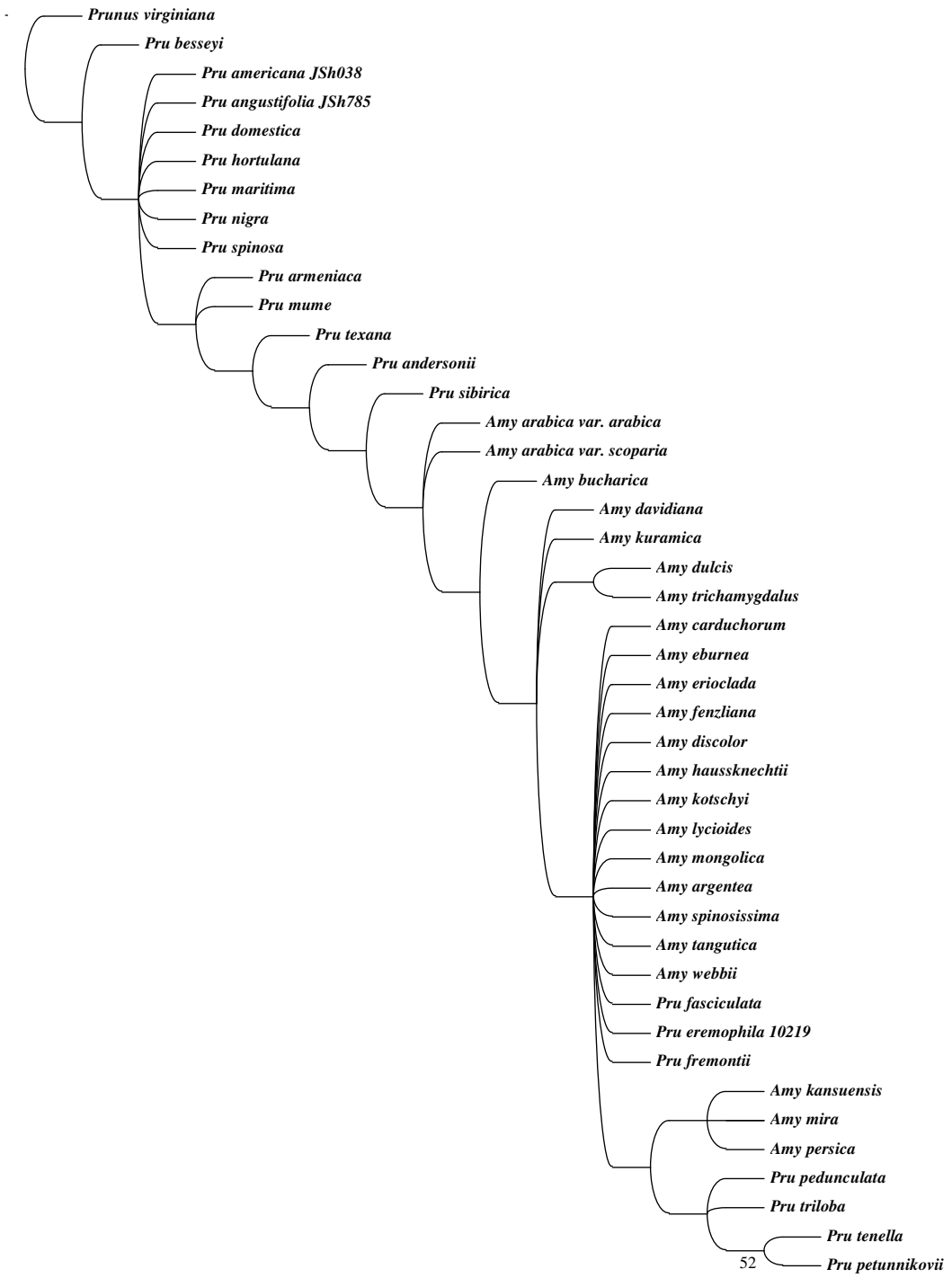

Figure 1.10. Strict consensus of 106 most parsimonious trees from the analysis of morphological data. Tree statistics are given in Table (1.4). Numbers below branches are bootstrap frequencies above 50%.

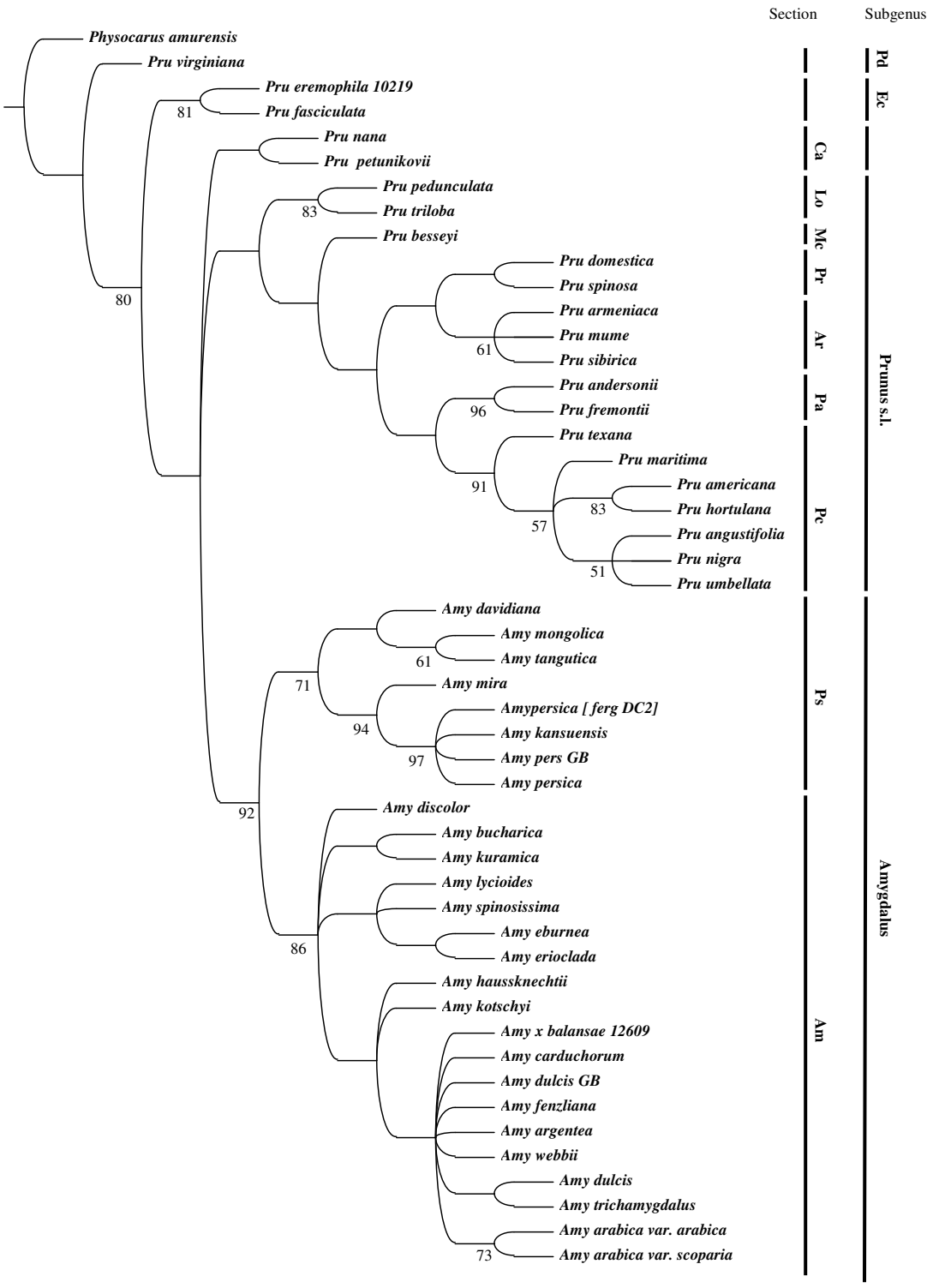

Figure 1.11. Strict consensus of 1560 MPTs of total available evidence (molecular & morphological) analysis. Statistics are given in Table 1.4. Boot-strap frequencies above 50% are below branches. Pd=Padus; Ec = Empleco-cladus; Ca=Chamaeamygdalus; Lo=Louiseania; Mc=Microcerasus; Pr=Prunus; Ar= Armeniaca; Pa=Penarmeniaca; Pc=Prunocerasus; Ps=Persica; Am=Amygdalus.

used in the rest of our results and discussion. (See Appendix I. Topologies recovered from matrices with indel coding). (Figure 1.11)

From this point on, all results and discussion are based on the total evidence strict consensus tree, unless otherwise mentioned.

a. Outgroups – *Prunus* s.l. The total evidence strict consensus tree was rooted with *Physocarpus amurensis*. In earlier studies (Shaw and Small, 2004; Bortiri, Heuvel, and Potter, 2006; Wen J and et al., 2008) two major clades were supported strongly in Prunus s.l. a) the *Padus-Pygeum-Laurocerasus-Maddenia* clade represented in this analysis by only *P. virginiana*; b) the *Prunus-Cerasus-Amygdalus* clade, where sampling in this research was focused. The two species, *P. eremophila* and *P. fasciculata* (*Emplectocladus* Torr.), were recovered as sister to the rest of the *Prunus-Cerasus-Amygdalus* clade which were in turn a polytomy of three clades. Clade 1 - included two species, *P. tenella* and *P. petunnikowii*, traditionally put in *Amygdalus* sect. *Chamaeamygdalus* Spach; clade 2 - included subg. *Prunus,* (with sections *Microcerasus*, *Prunus*, *Armeniaca*, *Penarmeniaca*, and *Pruncocerasus*) and the two sister species, *P. triloba*, and *P. pedunculata*; and clade 3 - was *Prunus* subg. *Amygdalus*.

b. *Prunus* subg. *Amygdalus*. A very strongly supported clade of *Amygdalus* (bootstrap 92 %) was recovered (Figure 1.11). However, the subgenus *Amygdalus* that will be circumscribed according to the phylogeny presented here does not correspond to the genus *Amygdalus* sensu Browicz and Zohary (1996). It mainly differs by including the *Persica* (4 species) group and by excluding the *Chamaeamygdalus* (4 species) group species. The circumscription presented in this study also differs from the circumscription presented in Flora of China (Lu and Bartholomew, 2003) by not including either *Chamaeamygdalus* group (represnted by only 1 species in China) or *Louiseania* group (2 species).

Within subg. *Amygdalus,* two very strongly supported clades were recovered within *Amygdalus*.

i) The first clade is the *Persica* clade or section *Persica*. This included the peaches or species traditionally circumscribed within *Persica* Mill, in addition to *Prunus tangutica* and *P. mongolica*. These two species were unexpectedly recovered as sister to *Persica* group, and not within a section *Amygdalus* group. This result was strongly supported by the plastid dataset (Figure 1.7), and was not conflicted by the nuclear dataset, *s6pdh* (Figure 1.8). In *s6pdh, P.tangutica* and *P. mongolica* were recovered unresolved and paraphyletic to the rest of subg. *Amygdalus* (Figure 1.8). Furthermore, *P. davidiana* is more closely related to these two species than it is to the rest of the peaches.

ii) The second clade is the *Amygdalus* clade, or section *Amygdalus.* This includes the rest of the species of subg. *Amygdalus*. Within sect *Amygdalus*, little resolution was strongly supported. Only one group of species, corresponding to the classification of Browicz and Zohary (1996) was recovered. This was section *Lycioides* Spach (also subg. *Dodecandrae* (Spach) Browicz) with four species. It was recovered by molecular data, and further supported by morphological data. A strongly supported clade (99% bootstrap support) including *P. bucharica*, *P. graeca* and *P. kuramica* was recovered in the molecular tree but not the total evidence (Figures 1.9 and 1.11) as sister to the rest of section *Amygdalus*. The rest of the sect *Amygdalus* species were completely unresolved.

DISCUSSION

I. OVERVIEW OF THE UTILITY OF MOLECULAR MARKERS.

The use of multiple gene regions, preferably both chloroplast and nuclear, is necessary to provide a sufficient number of informative characters, especially when working at low taxonomic levels, (Shaw and Small, 2004; Mort et al., 2007). Including multiple gene regions also tests for the presence of incongruence between different datasets, such as organellar versus nuclear, that may reflect different underlying histories (Wendel and Doyle 1998).

Among the chloroplast regions, *trnS-trnG* had the highest PICs (35), almost twice or twice as much as any other region such as *ndhF-rpl32* (17) and *trnL-trnF* (18). This is consistent with all studies conducted in *Prunus* that used *trnS-trnG* (Shaw and Small; 2004; Shaw et al., 2005). On the other side of the spectrum, the partial *trnQ-rps16*, which did not provide many PICs (13), supported another clade (*Prunus triloba – P. pedunculata*) strongly (Figures 1.5 and 1.11). Due to resource limitations sequences from only six chloroplast regions were obtained.

On the other hand, the nuclear gene region provided more PICs (52) than any other chloroplast marker and about 27 % of the PICs in the total evidence matrix. It was however, more homoplastic than plastid regions, with a CI of 0.60 and RI of 0.85. This was not easy to sequence.

Bortiri et al (2002) reported that *s6pdh* is a low-copy gene in species of the polyploid subgenera *Padus* and *Laurocerasus* and most likely single-copy in diploid species of subgenera *Emplectocladus*, *Prunus*, and *Amygdalus*. Obtaining direct sequences and clones for this region was relatively unproblematic. Sequences of several clones of and repeating PCR on some accessions did not show paralogous genes, and TC repeat were found in all of the sequences.

The chloroplast and nuclear regions used in this study provided sufficient resolution throughout *Prunus*, however not within subgenus *Amygdalus* section *Amygdalus* (more about this in the section below).

II. PRUNUS SUBG. AMYGDALUS

Based on our analysis, *Prunus* subg. *Amygdalus* is best circumscribed to include both almonds and peaches. This classification is not accepted by most taxonomists and workers of the old world who usually synonymize "*Amygdalus*" with "almond", most prominent of which is Browicz (Browicz, 1974, 1991; Browicz and Zohary, 1996). Browicz instead kept peaches in genus subgenus *Persica* Mill (see below for the section *Persica* circumscription according to this study).

A. SECTION *PERSICA*

Prunus subg. *Amygdalus* is comprised of two clades that are strongly supported this study. The first clade, hereafter referred to as sect. *Persica*, includes six species: *P. persica* (including *P. ferganensis*), P. *kansuensis*, *P. mira* and *P. davidiana*, in addition to P. *tangutica* and *P. mongolica* (Figure 1.11). Section *Persica* is in turn was divided into 2 clades. One includes *Prunus persica*, the cultivated peach, in addition to *P. mira* and *P. kansuensis*. All three species have a fleshy mesocarp, unlike species that formed the second clade. The second clade includes *P. davidiana*, *P. mongolica* and *P. tangutica*, all having a dry mesocarp which splits in *P. mongolica* and *P. tangutica*. The splitting mesocarp is a character that has been used by taxonomists to support the species placement with the rest of *Amygdalus* s.s., with the exception of Kovalev and Kostina (1935), who suggested that *P. tangutica* is more closely related to the peaches when they included it in genus *Persica*. Besides this work, no one has previously suggested a close relationship of any of the *Amygdalus*

sensu Browicz and Zohary (1996) species to *Persica*. Furthermore, *P. davidiana* fruit, which has a dry and usually non-splitting mesocarp, even though a splitting suture was recorded in one of the herbarium specimens examined (voucher - *Liu Jimeng 1277* (MO))), diverges as sister to the 'Tangutica-Mongolica clade', and seems to represent a transition between a fleshy-non-splitting and dry-splitting mesocarp. The nuclear data keeps the door open for other possibilities, since the relationships of 'Mongolica-Tangutica' with the rest of the species is not resolved and having more nuclear data might show some incongruence with the plastid phylogeny, which in that case could be a result of cytoplasmic introgression (Wendel and Doyle, 1998). Data from other nuclear gene regions would be necessary to gather clearer insights on the current plastid phylogeny. Without other incongruent evidence, the plastid phylogeny will be assumed to reflect the phylogenetic divergence of the species. This is particularly important in terms of shedding light on the domestication of peaches and the identification of the closest wild relatives of the cultivated group.

B. SECTION *AMYGDALUS*

Relationships within this group lack sufficient resolution in this study. There is weak support for a clade containing the highly morphologically uniform thorny 'lycioides-related' species. However, relationships among the rest of the species are completely unresolved (Figure 1.11). These unresolved taxa (section *Amygdalus* Figure 1.11) have been pooled into the "communis group" by Browicz and Zohary (1996). They are a group of species that are very similar to each other and to the cultivated *Prunus dulcis*.

The lack of resolution can be explained by the low taxonomic level and presumed low level of genetic divergence. Whether we are working with taxa at the species level or below species level is a question that is under study. Delimiting

species for the monograph presented here showed the difficulty in species delimitation and the lack of unambiguous diagnostic characters for these species. Browicz and Zohary (1996; p_ 233) noted that "*Amygdalus L.* contains 5 natural groups, each representing a cluster of taxonomically closely related, largely vicarious species ("semispecies" sensu Grant 1981, p_ 71). Within each such natural group, member species seem to be fully (or almost fully) interfertile -- but they occupy separate geographic territories". Other studies, such as by Potter et al (2002), have attributed the short branches in their analyses to rapid radiation. Ladizinsky (1999; p_144) in his study on the origin of almonds, states that "the free gene flow between the various taxa of *Amygdalus*, makes them all members of one big polymorphic biological species". If this is true, then more variable molecular markers, such as simple sequence repeats, and analytical methods that are suitable for reticulate relationships should be utilized to get a better comprehension of relationships within *Amygdalus*.

The phylogeny reconstructed using morphology was very different from that recovered from molecular data (Figures 1.9 and 1.10). Some of the grouping information from morphology does overlap with the grouping information of molecular data, especially in Sections *Chamaeamygdalus* and *Louisanea* (Figure 1.10). Morphological characters are more homoplastic than molecular characters (CI = 46 and RI = 83), which is consistent with results obtained by Bortiri et al. (2006).

III. SYNAPOMORPHIES OF PRUNUS SUBGENS AMYGDALUS

The delimitation of subgenera within *Prunus s.l.* has been a controversial question since De Tournefourt (1700) published his generic concepts. De Candolle (1825) stated that diagnostic characters are trivial, and non-distinct, but he nonetheless recognized genera following tradition. However, tradition is not sufficient to provide a workable and viable classification. As Browicz (1989) argues, dealing with *Prunus* in

its broad sense as a genus, with more than 250 species necessitates creating a system of subgeneric divisions. For this system to be of greater utility, highlighting morphological character(s) that would facilitate species identification is necessary.

The only way to identify species circumscribed within subgenus *Amygdalus* is to use a combination of homoplasious morphological characters (Norup et al., 2006). Rehder (1949) distinguished *Amygdalus* as having pubescent, sulcate fruit, axillary buds in threes with the lateral ones bearing flower buds, presence of terminal bud, and conduplicate leaves. In this study, *Amygdalus* is diagnosed by having pubescent drupes, mostly splitting mesocarp, endocarp pitted or grooved, and sepal margins always entire and never toothed.

Based on the phylogeny presented here, the only morphological character that supports a monophyletic *Amygdalus* is the entire sepal margin. Although all species within *Amygdalus* have an entire sepal margin, not all species of *Prunus* with entire sepal margin are within subgenus *Amygdalus*. At least two other species, *Prunus domestica* and *P. fremontii* have independently evolved that character state.

IV. CHARACTER EVOLUTION

The main diagnostic characters that have been used traditionally in the classification of *Prunus* and *Amygdalus* show homoplasy on the total evidence tree that was constructed in this study. When emphasized or used alone to reflect relationships within *Prunus*, (Browicz and Zohary, 1996), they produced classification schemes not consistent with those implied by molecular data. Below is the discussion of some of the most important of these morphological characters. (See Figure 1.12 for splitting mesocarp and endocarp ornamentation within *Amygdalus*).

Figure 1.12 Mesocarps and endocarps within *Amygdalus*. a. Prunus dulcis. b. P. trichamygdalus. c. P. kuramica. d. P. bucharica. e. P. fenzliana. f. P. webbii.

Figure 1.12 (Continued)

Figure 1.12 (Continued)

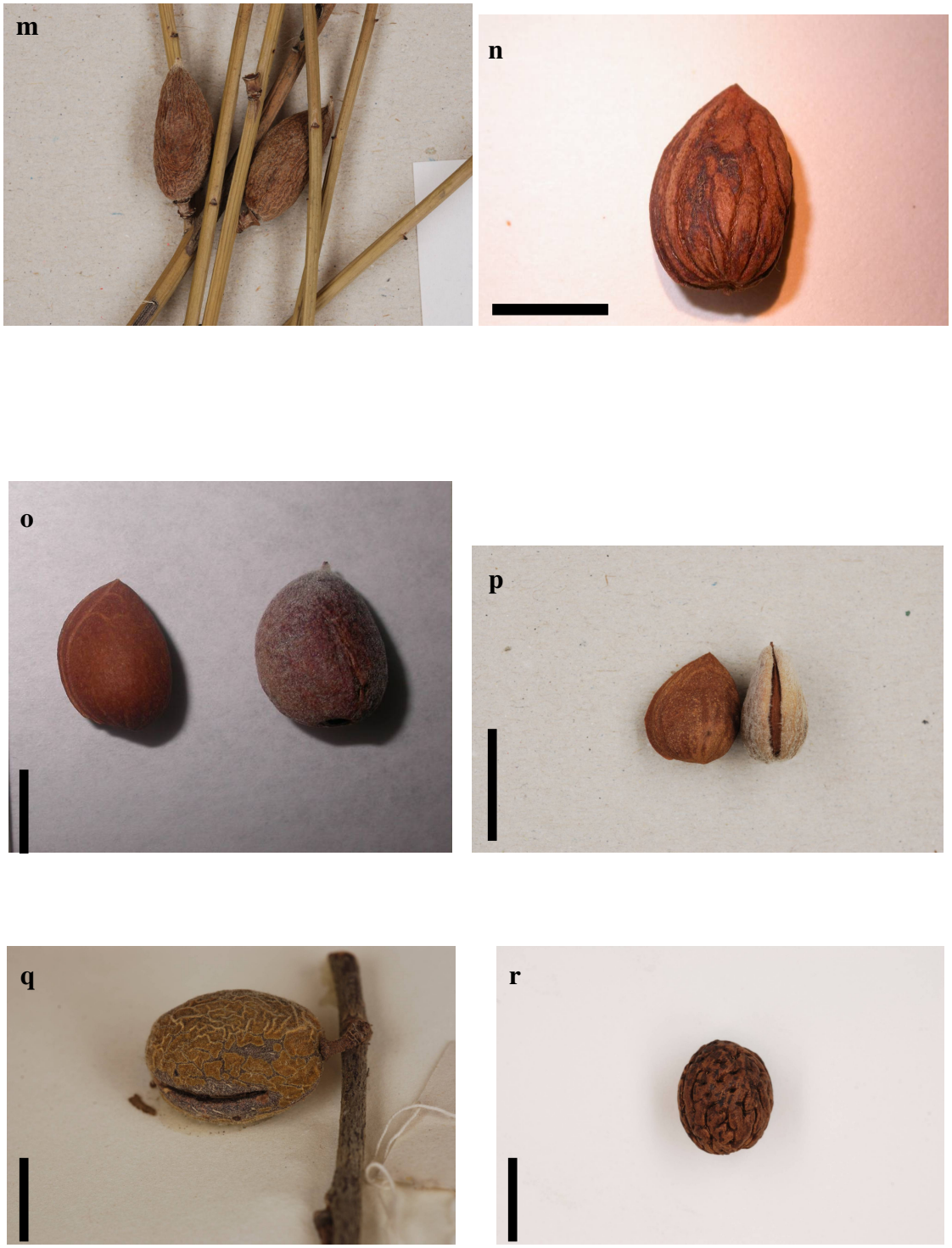

Figure 1.12 (Continued)

A. Splitting Mesocarp

Perhaps the character most widely used to diagnose *Amygdalus* is a mesocarp that dries and splits when mature (Browicz 1969,1991; Browicz and Zohary 1996), keeping in mind that drying is a prerequisite for splitting, so a drying mesocarp may or may not split, while a fleshy mesocarp usually does not split. This character undoubtedly has evolved more than once. Species outside *Amygdalus* that have been confirmed to have this character state include: 1. *Prunus andersonii* and *P. fremontii* (sect. *Penarmeniaca*), 2. *P. sibirica* (sect. *Armeniaca*), 3. *P. pedunculata* and *P. triloba* (sect. *Louiseania*), 4. *P. tenella* and *P. petunikowii* (sect. *Chamaeamygdalus*), and 5. *P. fasciculata* (sect. *Emplectocladus*). Missing data concerning this character for *P. eremophila* (sect. *Emplectocladus*) and *P. texana* (sect. *Prunocerasus*) could not be scored from specimens available or from the literature, which could mean that they most likely do not having a splitting mesocarp, otherwise it would have been mentioned. Most of the previously listed species occur in dry environments, especially sect. *Emplectocladus* and *Penarmeniaca* that occur in the southwestern deserts of North America. This suggests that a drying and splitting mesocarp is correlated with

arid or semi-arid regions, and that it is an adaptation (Vander Wall, 2001) that has evolved multiple times (Figure 1.11).

The distribution splitting mesocarp within *Amygdalus* might suggest a different interpretation of its evolution. Not all species within subg. *Amygdalus* have a splitting mesocarp. It is worth stressing that sect. *Persica* is divided into two clades in the molecular studies presented here. The first clade includes *Prunus mira*, *P. kansuensis* and *P. Persica*, all characterized by having a fleshy mesocarp. The second clade includes *P. davidiana*, *P. mongolica* and *P. tangutica*. *Prunus davidiana* which has always been included in *Persica*, is distinguished from the rest of the peaches by having a dry however non-splitting mesocarp, except in one specimen (voucher - *Liu Jimeng 1277* (MO)) that shows a splitting suture. *P. davidiana* is placed in the phylogeny as a sister to a clade including *P. mongolica* and *P. tangutica*, both with splitting mesocarp. *Prunus tangutica* and *P. davidiana,* both with dry and or dry and splitting mesocarp, occur in wet areas, though, which refutes the assumption that a dry and splitting mesocarp in *Amygdalus* evolved as an adaptation to dry areas. Which makes the only species of *Amygdalus* that have a fleshy mesocarp are *P. persica*, *P. mira* and *P. kansuensis*, eventhough they occur in similar environemts to *P. tangutica* and *P. davidiana*, however the latter two have a fleshy splitting mesocarp. It appears that domestication and selection for a fleshy mesocarp in these species could be a plausible explanation. *Prunus mira* and *P. kansuensis* have been suggested to be only feral types of the cultivated *P. persica* (Wang 1985). This might suggest that within subg. *Amygdalus*, the loss of a dry splitting mesocarp might have happened as a result of the selection for a fleshy mesocarp.

B. ENDOCARP ORNAMENTATION

Endocarp ornamentation is a character that is consistently used as diagnostic of *Amygdalus*. However, the characters states ascribed to *Amygdalus* have varied depending on which species were included or excluded. The three forms of ornamentation that can be found on the stone (if it is not smooth) are a) pitted, b) grooved, and c) rough or rugose. When the peaches (sect. *Persica*) were included in *Amygdalus*, the character state was typically described as "pitted and / or grooved". This was what Linnaeus (1754) stressed even though he did note the differences in endocarp ornamentation between *Amygdalus* (pitted) and *Persica* (furrowed). So did Du Jussieu (1789) and Bentham and Hooker (1865) who preferred lumping and consequently preferred the character state of having ornamentation on the endocarp to group them, rather than using ornamentation to separate them. Workers who preferred splitting section *Persica* from *Amygdalus* emphasized the difference in type of ornamentation as opposed to presence or absence or ornamentation. An example of this was Miller (1754), the first to describe *Persica* as a separate genus based on a deeply furrowed stone which distinguished it from *Amygdalus* s.s.. This treatment was followed by Condolle (1825) and Spach (1843), among others. In this analysis, endocarp ornamentation was split into two characters. The first one was the presence/absence of endocarp ornamentation and the second one was the type of ornamentation present (Table 1.3). Coding this characters as one multistate character (smooth, rugose, pitted, furrowed), could result in a loss of phylogenetic information. While coding them as separate characters (endocarp ornamentation: present, absent i.e., smooth and endocarp ornamentation type: rugose, pitted, furrowed) would make the primary homology statement that the presence of ornamentation is homologous in all taxa possessing it, which is a conclusion supported in this study.

A clade consisting of subgenera *Prunus*, *Amygdalus*, *Emplectocladus* and section *Microcerasus* (formerly in subgenus *Cerasus*) is characterized by having axillary buds organized in groups of three, two of which give rise to flowers or inflorescences and one to a vegetative shoot.

V. TAXA THAT SHOULD BE EXCLUDED FROM PRUNUS SUBGENUS AMYGDALUS

A. *CHAMAEAMYGDALUS*

Prunus tenella and *P. petunikowii* are two taxa, comprising sect. *Chamaeamygdalus*, which should be excluded from *Amygdalus* based on the total evidence analysis which places them in a polytomy with the rest of *Prunus* s.l. This disagrees with the classification of Browicz and Zohary (1996), who consider *Chameamygdalus* a section within *Amygdalus*, based on the splitting mesocarp. The discrepancies in the placement of *P. tenella* and *P. petunnikowii* as a result of the inclusion/exclusion of morphological characters have been noted earlier by Bortiri et al (2006). In their maximum likelihood analysis, excluding morphology, *P. tenella*/*P. petunnikowii* was placed as sister to *Prunus* s.l., while their parsimony or Bayesian analysis, including morphology, placed *P. tenella*/*P. petunnikowii* as sister to *Amygdalus*. When *Chamaeamygdalus* was recovered as sister to *Amygdalus*, the support was weak, as in the result obtained by Shaw and Small (2004) who obtained a monophyletic subg. *Amygdalus*, with sect. *Chamaeamygdalus* and sect. *Amygdalus*. However, the placement of *P. tenella* was unresolved in the bootstrap analysis, leaving only support for a monophyletic sect. *Amygdalus*.

Excluding sect. *Chamaeamygdalus* from *Amygdalus* is not a novelty in the taxonomic history of subg. *Amygdalus*. Focke (in Engler and Prantl, 1888) was the

first to imply that almonds (sect. *Amygdalus*) are more closely related to peaches (sect. *Persica*) than they are to the shrubby dwarf-almonds (sect. *Chamaeamygdalus* Spach) when he recognized subg. *Amygdalus* (including sect. *Persica*) along with subg. *Chamaeamygdalus* (Spach) Focke. Similarly, Koehne treated *Chamaeamygdalus* as a subgenus and distinguished it from subg. *Amygdalus* by having tubular or funneliform hypanthia rather than hemispheric or campanulate.

B. *LOUISEANIA*

Prunus triloba and *P. pedunculata* should be excluded from *Amygdalus*. The exclusion, which is supported by the combined analysis of this study, agrees with what has been suggested by Browicz (Browicz, 1991). Carriere (1862) who accepted *Amygdalopsis* and proposed a new species, *A. lindleyi(= Prunus triloba* Lindl), considered *Amygdalopsis* as distinct from *Prunus* "by the aspect and the nature of its fruits, it appears to have to enter the genus *Amygdalus*" but, on the other hand "the multiplicity of its carpels, and the shape of its foliage move away from there". Accordingly, he suggested *Amygdalopsis*, as a genus (Carriere, 1862).

VI. SISTER TAXON OF *AMYGDALUS*

Prunus subg. *Amygdalus* was recovered in a polytomy with the rest of *Prunus* s.l. which makes the identification of the sister taxon difficult with the current results. However, examining the most parsimonious trees individually showed two possible sister taxa to *Amygdalus*. The first one is section *Chamaeamygdalus* (*P. tenella* and *P. petunikowii*). When *Chamaeamygdalus* was not sister to *Amygdalus*, it formed a clade with the rest of subgenus *Prunus* s.l., and this latter clade was sister to *Amygdalus* . In none of the MPTs was *Emplectocladus* recovered sister to *Amygdalus*. Historically, subg. *Emplectocladus*, which has North American distribution, has been suggested as

sister to *Amygdalus* by Mason (1913), who disagreed with two contemporary workers, Abram (1910) and his student, Wight (1913). Wight actually recognized these North American species within *Amygdalus*, and accordingly made the necessary nomenclatural combinations. Wight (1913) also maintained that species of *Emplectocladus* "cannot be separated" from *Amygdalus*, and that "…In fact, the Asiatic species apparently show a gradual but complete transition from this North American group to the species of *Amygdalus* common in cultivation." As our results show, *Emplectocladus*, represented by *Prunus fasiculata* and *P. eremophila*, are recovered as sister to a clade including both *Amygdalus* and *Prunus s.l.*, which does not support this suggested relation. Furthermore, the results do not in any way support the taxonomic decision made by Wen et al (2008) of including these species within *Prunus* subg. *Amygdalus*.

CONCLUSION

Prunus subgenus *Amygdalus* should be recognized as a subgenus of a broadly defined genus *Prunus.* Any other treatment would necessitate the recognition of at least four other genera (*Emplectocladus, Prunus s.s. Cerasus and Padus/ Laurocerasus/ Pygeum/ Maddenia*). This is not recommended becasue it would create difficult to identify groups without clear diagnostic morphological characters. Other species belonging to sections *Louiseania*, *Emplectocladus* and *Penarmeniaca* should be excluded from *Amygdalus*. Two sections, *Amygdalus* s.s. and *Persica*, were recovered with the subgenus. Species relationships with *Amygdalus* s.s. are not resolved and there is a need to obtain more data from more variable molecular markers to fully evaluate relationships at this low taxonomic level. *Amygdalus* is diagnosed by having pubescent drupes, mostly splitting mesocarp, endocarp pitted or grooved, and sepal margins entire. The position of *Chamaeamygdalus*, a putative sister taxon to *Amygdalus*, is still not resolved and need further studies.

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CHAPTER II

MONOGRAPH OF PRUNUS SUBGENUS AMYGDALUS

INTRODUCTION

In this treatment, 24 species are recognized and described. *Prunus* subgenus *Amygdalus* (Rosaceae) includes the cultivated almonds (*Prunus dulcis*) and their wild relatives and the cultivated peaches (*Prunus persica*) and their wild relatives.

Members of *Amygdalus* are distinguished by a combination of characters including pubescent drupes, mostly splitting mesocarp (but not always), mostly furrowed and/or pitted endocarps (but not always), and an entire sepal margin.

Amygdalus has a strictly old world distribution, occurring between West and Central Asia, extending to southeastern Europe with most species occurring in the area from Turkey to Iran.

Most species of *Amygdalus*, including many endemics occur in Iran, and this was a limitation for this study, since collection, field observations, and herbarium visits and loans were not possible. Instead, this study had to rely completely on the European herbarium collections of the Iranian flora. Fortunately, the European collections are extensive, especially in Vienna, which was the base of publication for Flora Iranica (Schneider 1969). This solved the problem of obtaining loans or access to herbarium specimens to a great extent. However, no matter how extensively herbarium specimens are studied, field observations always provide additional information, and this was missing in the current work for some Iranian endemic species.

TAXONOMIC HISTORY

Pre-Linnean

Almonds and peaches, two of the most important cultivated crops, some with medicinal properties, are plants that have been studied by herbalists and botanists since the beginning of systematic botany. Theophrastus discussed the properties of almond oil as a vehicle of perfumes, and Dioscorides in "De Materia Medica" listed the properties of almonds in treating spots on the face caused by sun.

Much later, in the early 17th century, Caspar Bauhin (1623) recognized *Pomiferae Arbores* wherein he accepted *Persica* and *Amygdalus* as two separate genera along with *Prunus*, *Armeniaca* and *Cerasus*. Bauhin listed species he recognized and their synonyms. Most of his names were binomials, some of which, such as *Amygdalus sativa* and *Persica amygdaloides*, were validated by later authors.

Half a century later, John Ray (1686) accepted *Persica* and *Amydalus* as distinct genera which he assigned to his "Pruniferous trees" based on such characters as inflorescence type, length of pedicels, pubescence and shape of fruits, shape of leaves and ornamentation of the endocarp. In a dichotomous key he distinguished these two genera by their fleshy/dry pericarp.

De Tournefout's landmark work (De Tournefout 1700) established the generic concepts used by many subsequent workers. He recognized six genera: *Prunus* (having stone tapering on both sides), *Armeniaca* (fruit longitudinally sulcate, and stone frequently compressed), *Persica* (fruit nearly globose and stone with deep excavations), *Cerasus* (fruit subrotund and cordiform), *Amygdalus* (fruit bony or with strong skin), and *Laurocerasus* (soft cerasiformis fruit and subrotund stone). *Amygdalus* and *Persica* were distinguished by ornamentation on the endocarp and differed from each other by their pericarp. Later, Tournefort (1716) reported on the medicinal properties of peaches (which loosen the belly, purge very gently and destroy

worms), sweet almonds (effective in easing child delivery and the pain of colic) and bitter almonds (a treatment for deafness). He also provided recipes for preparation of these medicines and recommended dosages.

Linnaeus

In *Hortus cliffortianus*, Linnaeus (1738) recognized four genera: *Prunus* (including *Armeniaca*), *Cerasus*, *Padus* (including *Laurocerasus*), and *Amygdalus* (including *Persica*). This view was repeated in *Hortus upsaliensis* (Linneaus, 1748). However, in *Species plantarum*, Linneaus (1753) formally recognized only two genera. He combined *Cerasus* and *Padus* with *Prunus* L. and assigned *Persica* to *Amygdalus* L. Three species were validated under *Amygdalus*: *Amygdalus persica* L. (peach), *Amygdalus communis* L. (almond), and *Amygdalus nana* L. (dwarf Russian almond). Later, in *Genera plantarum*, Linnaeus (1754) listed the characteristics by which he distinguished *Amygdalus* from the other genera as having a pubescent, longitudinally sulcate drupe and a reticulately sulcate and pitted stone, although he noted the endocarp differences between *Amygdalus* and *Persica* in his observation note at the end of his description.

Post Linnaeus

The first valid description of *Persica* Miller was in the fourth edition of *Gardener's Dictionary* (Miller, 1754) Here Miller put forward a generic diagnosis of *Persica*, and stated that it has a "…rough rugged stone, which is deeply furrowed, by which it is distinguished from the almonds". He also recognized *Amygdalus* as a separate genus following tradition. Even so he acknowledged that members of the two genera could be successfully grafted onto each other. On the other hand, Miller provided justification for keeping *Armeniaca* Scop. (even though he did give it a

validating diagnosis or description), *Padus* Mill., *Cerasus* Mill. and *Prunus* as distinct genera because these taxa could not be grafted or budded on each others' stock. Hence in this work, in addition to *Persica*, *Cerasus* and *Padus* were also validated. Unlike De Tournefort (1700) and Linnaeus (1753), Miller placed the dwarf almond with both single and double flowers in *Persica,* implying that these almonds are more closely related to peaches than they are to other almonds.

De Jussieu (1789), in *Genera Plantarum*, followed Tournefort's classification with the exception of including *Persica* in *Amygdalus*. The characters he used in his circumscription of *Amygdalus* were mainly the numerously pitted or irregular excavations on the endocarp, in addition to a pubescent drupe.

In his *Prodromus*, De Candolle (1825), stated his opinion about the concept of the five genera he recognized in the tribe *Amygdaleae* DC. He recognized *Amygdalus* and *Persica* as separate genera with *Amygdalus* characterized by a dry splitting pericarp with a pitted or smooth stone, while *Persica* had a fleshy, velutinous or glabrous epicarp, and a reticulate, sulcate stone. In addition to these characters used by previous workers, De Candolle also used leaf development in the bud to differentiate the genera.

In his *Amygdalaceae* Marquis, Endlicher (1840) went back to Linnaeus' concepts and recognized only *Prunus* (including *Armerniaca*, *Cerasus* and *Prunus*) and *Amygdalus*; the latter was split into two, unranked groups, *Amygdalophora* Necker ex Endl., and *Persica* Mill. ex Endl.

One of the landmark works in the systematics of *Amygdalus* was a monograph undertaken by Spach (1843). He stated the diagnostic characters of the genus *Amygdalus* as a stone that was very frequently pitted or grooved, and a pericarp that dries out and eventually splits. Spach's delimitation of *Amygdalus* did not include *Persica* as he excluded *Amygdalus persica* and recognized it as *Persica vulgaris* Mill.

He was the first to subdivide *Amygdalus* into series and sections. His first series, *Icosandrae*, characterized by stamens 20 or more, was divided into 4 sections: *Spartioides* Spach, *Chamaeamygdalus* Spach, *Leptopus* Spach, and *Amygdalus* (as *Euamygdalus*). The second series, *Dodecandrae*, was characterized by stamens fewer than 20, and had two sections, *Lycioides* Spach and *Scorpius* Spach. In his monograph, Spach described 11 new species of the 19 recognized.

In his *Familiarum naturalium regni vegetabilis synopses monographicae*, Roemer (1847) prepared a treatment of the family *Amygdalaceae* and recognized 12 genera. One of his tribes, *Amygdaleae*, included three genera, *Persica*, *Amygdalus*, and a new genus *Amygdalopsis* M. Roem. According to Roemer, these genera shared characteristics such as the rugose, foraminose (furrowed – pitted) endocarp but he felt that additional characters were sufficient to separate them into different genera. These characteristics were non-splitting exocarp in *Persica* versus splitting in *Amygdalus* and *Amygdalopsis*, the latter two being distinguished by stamen number and shape of the calyx base, which were previously highlighted by Spach (1843).

Bentham and Hooker (1865) were the first to include all previously recognized genera as sections within a broadly defined *Prunus*, adopting Linnaeus's circumscription of *Amygdalus* as including *Perisca* Mill. Similar to previous workers, they used the characters of a pitted and/or furrowed endocarp to distinguish section *Amygdalus* from other sections within *Prunus s.l.* They also recognized *Amygalopsis* (Carr) Benth. & Hook. as an additional section.

Amygdalopsis Carr.

Carriere (1862) accepted Bentham and Hooker's section *Amygdalopsis* as a genus and proposed a new species, *A. lindleyi*, a nomenclaturally superfluous name as he based the name on *Prunus triloba* Lindl (1857). Carriere considered *Amygdalopsis*

as distinct from *Prunus* based on fruit characteristics and related it to *Amygdalus,* but distinguished it from *Amygdalus* based on multiple carpels and leaf shape. Accordingly he suggested *Amygdalopsis*, as a genus or at least a subgenus.

Focke's important treatment of *Rosaceae* Juss. was published in 1888 (Focke, 1888). Focke argued that the characteristics of only one species, *Amygdalus communis*, were emphasized by Linnaeus in separating *Amygdalus* from *Prunus*, notably the furrowed and pitted endocarp. He maintained that these characteristics were not even consistent among the different 'varieties' of almonds nor the hardly separable peach, which according to him differed only in 'subordinate characteristics' such as having a juicy, non-dehiscing drupe. Focke argued that it is prefered to treat *Prunus* as a single, broadly defined genus divided into several subgenera, whose typical representatives in characteristics and habit deviate substantially from each other. Those characteristics were leaf vernation, pericarp juiciness, ornamentation on the endocarp, and the length of pedicel in flower and fruit stages. Accordingly, he recognized subg. *Amygdalus* (including *Persica*) along with subg. *Chamaeamygdalus* (Spach) Focke, based on *Amygdalus* sect. *Chamaeamygdalus* Spach (1843). By doing this, he was one of the first to imply that almonds are more closely related to peaches than to the shrubby dwarf-almonds (sect. *Chamaeamygdalus* Spach).

Koehne (1893) followed Bentham and Hooker in recognizing a broadly defined *Prunus*, composed of seven subgenera. Characters he used to separate the subgenera included leaf vernation (previously pointed by Bentham and Hooker,1865), inflorescence type, time of flowering relative to appearance of leaves, hypanthium shape, pubescence and juiciness of fruit and ornamentation of the stone. In addition, he used the number of axillary buds (solitary or in threes) as a character. Similar to Focke, Koehne treated Spach's section *Chamaeamygdalus* as a subgenus, and also recognized *Amygdalus* as a subgenus. According to Koehne, subg. *Chamaeamygdalus*

was distinguished from subg. *Amygdalus* by having a tubular hypanthium rather than a hemispheric one.

Based on inflorescence characters, Schneider (1906), in his treatment of the woody members of *Rosaceae*, recognized the genera *Prunus*, *Padus* and *Laurocerasus*. He further subdivided *Prunus* into three subgenera, *Euprunus*, *Cerasus*, and *Amygdalus*. He characterized *Amygdalus* as having mostly dry and pubescent fruits, and almost sessile flowers and fruits. Within *Amygdalus*, Schneider recognized five sections namely *Spartioides*, *Amygdalus* (as *Euamygdalus*), *Chamaeamygdalus* and *Lycioides*. All had been recognized by previous workers although occasionally at different ranks or under other genera. However, unlike others, Schneider recognized sect. *Emplectocladus* (Torr.) C.K. Schneid. within *Amygdalus*. In his brief description of sect. *Emplectocladus*, he mentioned that it is much reminiscent of the dwarf cherries, but with drying fruit. This implies that *Emplectocladus* is more similar to almonds, but in the footnote he noted that he had not seen living material of this similar, yet distinguishable group of *Prunus*.

Emplectocladus was described by Torrey (1851) as a monospecific genus containing only *E. fasciculatus*. Schneider (1906), recognizing it as a section within subg. *Amygdalus* extended the section to include seven species, six of which (*Prunus hookeri* C.K. Schneid., P. *fremontii* S. Watson, *P. andersonii* A. Gray, *P. fasciculata* A. Gray, *P. microphylla* Hemsl., and *P. minutiflora* Engelm.) have North American distribution in addition to *P. pedunculata* Maxim. of East Asia. This was probably the first indication of the close relationship of this North American group to species of Old World *Amygdalus*.

Abrams (1910), working also with North American species, moved *Emplectocladus fasciculatus* Torry to *Amygdalus* which he recognized it as a genus,

and hence made the new combination *Amygdalus fasciculata* (Torr) Abrams, as well as *Amygdalus fremontii* (S. Wats.) Abrams.

In 1913, William Franklin Wight, a student of Abrams, and following his advisor's lead, expanded the the concept of North American *Amygdalus*, hence making four new combinations (*A. andersonii* (A. Gray) W. Wight, *A. havardii* (S.C. Mason) W. Wight, *A. minutiflora* (Engelm) W. Wight, and *A. texana* (D. Dietr.) W. Wight).

Wight (1913) maintained that *Amygdalus* may not have prominent diagnostic characters to separate it from *Prunus*, but for reasons of nomenclatural convenience he recognized *Amygdalus* as a separate genus expanded to include the North American species.

The twentieth century work on *Amygdalus* reflected a split between, as Browicz (1991) put it, western European and North American botanists from one side, and Russian and ex-Soviet botanists from the other side. This is reflected in two different tendencies in the treatment of *Amygdalus*.

North American botanists mainly followed Rehder (1940) who followed Koehn's (1893) treatment of *Amygdalus* L. as a subgenus of a broadly defined *Prunus*. His treatment is of special importance as it was followed by most subsequent workers in North America. The characters Rehder used to distinguish subg. *Amygdalus* are no different from those of previous workers. According to Rehder (1940), *Amygdalus* resembled other subgenera of *Prunus* by characters such as pentamerous perianth and one carpel with a terminal style. In addition he noted a combination of a pubescent, sulcate fruit, axillary buds in threes with the lateral ones bearing flower buds, terminal bud present, and conduplicate leaves. Within *Amygdalus*, he recognized two sections, *Amygdalus* and *Chamaeamygdalus*.

The tendency of recognizing *Amygdalus* as a genus by European botanists is fairly represented by one main botanist, namely Kazimierz Browicz. Browicz, who as a professor at the Institute of Dendrology in Kórnik, Poland, had undertaken the treatments of *Amygdalus* of several major Asian floras such as *Flora Iranica* (Browicz 1969) and *Flora of Turkey* (Browicz 1994). Browicz's views were summarized in his "Conspect and chorology of the genera *Amygdalus* L. and *Louiseania* Carr." published in 1989, as well as in a later article (Browicz & Zohary 1996). Browicz defended treating *Amygdalus* as a genus in the narrow sense by noting that dealing with *Prunus* in its broad sense as a genus, especially with more than 250 species, would necessitate creating a very complicated system of subgeneric divisions. Splitting *Prunus* s.l. into smaller genera is more practical, not denying that there are difficulties in separating those genera.

Browicz (1991) defined *Amygdalus* as a genus following Spach's (1843) treatment, excluding species Spach placed in *Persica*, with the main diagnostic character of *Amygdalus* being a dry pericarp dehiscing along the ventral suture. Unlike Spach, Browicz excluded *Amygdalus pedunculata*, assigning it to the genus *Louiseania* and therefore accepting the combination *Louiseania pedunculata* (Pall.) Eremin & Yushev (Eremin & Yushev, 1985). Browicz was not fully convinced of these exclusions, since even though the leaves of this species are typical of *Louiseania*, the fruit has a dehiscing pericarp, which is diagnostic for *Amygdalus*.

Louiseania Carr

The name *Louiseania* was first suggested by Carriere (1872) to include mainly two species, *L. ulmifolia* and *L. triloba.* The latter, previously described and named from cultivation by Lindley as *Prunus triloba* (1857), was indicated as the type for the genus. Carriere distinguished the genus from the rest of *Prunus* and *Amygdalus* by

leaves serrate or doubly serrate and sometimes deeply lobed, and a dry pericarp that is not dehiscent.

This genus was reviewed by Pachomova (1959) where new combinations were made for some *Amygdalus* species within the genus *Louiseania*. Later, Eremin and Yushev (1985), moved *Amygdalus pedunculata* Pall (with a dehiscent pericarp from the literature, not observed yet) to *Louiseania* based on leaf characters.

Aflatunia Vassil.

The name *Aflatunia* was suggested by Vassilczenko (1955) with only one species described in this genus, and the new combination *Aflatunia ulmifolia* appeared in the same publication.

MATERIALS AND METHODS

Observations were made on herbarium and living collections to produce a taxonomic monograph of *Amygdalus*, including species circumscriptions, parallel descriptions, complete nomenclatural synonymy, and identification keys to species of *Prunus* subg. *Amygdalus*, as well as geographic distributions, photographs, and ecological notes. This new monograph aimed at (1) Delimiting species by reassessing overlapping and continuous characters conventionally used to delimit species (e.g., Zohary & Browicz, 1996); (2) Defining terminal taxa to be used in the phylogenetic reconstruction within *Amygdalus* and within *Prunus*. (3) Providing full descriptions of morphological characters of defined species and highlighting those that aid in their identification in the field.

The monograph will be the first comprehensive treatment of the species of *Amygdalus*, utilizing an integrated database approach that provides relationally linked specimen,

character, distribution and image data in addition to a hardcopy revision that can be utilized in the field.

Morphological characters and measurements for the description of the species were obtained from herbarium specimens and occasionally from observation of living material in the field. Herbaria visited included Paris (P), Vienna (W) and Vienna University (WU), Kew (K), Komarov (LE), Missouri (Mo) and Post (P). Furthermore, loans were requested from Geneva (G), Germany (JE), Italy (FI), Harvard (AA). Character selection was based in part on previously utilized characters obtained from the literature, but new characters were also added as study of specimens progressed. All character data were entered directly into relational data tables (MySQL) relationally linked to specimen records through interactive web-based forms. From these data tables, parallel "base" descriptions were generated, and further edited to improve readability. Tables were also generated and included in the monograph (and online) indicating sample sizes, means and standard deviations for all quantitative characters. Data tables used in descriptions were also used for generating diagnostic matrices used in electronic and (paper) dichotomous keys.

Specimen data was georeferenced as far as possible, and a system to automatically generate distribution maps using both Google Earth and Microsoft Virtual Earth is already in place (Encino: www.plantsystematics.org). For some specimens, only the village, nearest city and province information was available. Altitudinal distributions were obtained from herbarium labels as well as direct GPS/altimeter readings in the field.

HYBRIDS

It has always been assumed and suspected that hybridization is rampant in subg. *Amygdalus* as it is in the rest of the *Prunus*. Browicz and Zohary (1996) list 11 named hybrids between wild species and 8 (6 named) hybrids between cultivated almonds and wild species. As noted by the authors, they are all rare and of sporadic occurrence (For a list of Hybrids see Table 2, page 231 of Browicz and Zohary, 1996.)

Unfortunately, insufficient material of herbarium specimens for morphological studies (for most hybrids not even one specimen) and leaf material for molecular studies was available for further verification of these described hybrids. The scarcity of the available material is partially explained by the fact that they are, as mentioned above, already rare and sporadic and for some they were only known from one specimen. Another difficulty that made the study of the hybrids unfeasible is the fact that almost half of them (7 out of 19) were described in Iran, a country where field work and loans from herbaria was not permitted. The others were described in central Asian countries such as Afghanistan and Pakistan where field work was not conducted.

The one hypothetical hybrid for which leaf material was available and was included in the phylogenetic analysis was *Amygdalus* ×*balansae*, described by Boissier (1859) as a hybrid between *Prunus dulcis* and *P. argentea*. The molecular results always placed this taxon as sister to *P. webbii*, which was a further reason to undertake a more detailed study of these hypothetical hybrids, especially utilizing molecular tools, for the purpose of verifying them.

EXPLANATION OF CLASSIFICATION PRESENTED

The monograph presented here was undertaken simultaneously with construction of a molecular phylogeny of *Prunus* subg. *Amygdalus*. Morphological data and molecular sequence data obtained from 6 chloroplast gene regions (*trnL-trnL-trnF*, *trnS-trnG-trnG, trnH-psbA, rpL16*, *ndhF-rpL32* and partially *trnQ-rps16*) and one nuclear gene, s6pdh, were used to construct a hypothesis of phylogenetic relationships of *Prunus* subgenus *Amygdalus.* Based on the results of the cladistic analysis, some taxa were excluded from *Amygdalus* even though their description is provided under Excluded Taxa section in this monograph, such as *Prunus tenella*, *P. petunikowii*, *P. triloba* and *P. pedunculata. Prunus* subg. *Amygdalus* species recognized here were are recovered within a monophyletic *Amygdalus* in the cladistic analyses, as were all of the sections recognized (sect. *Amygdalus* and sect. *Persica*; Figure 1.11).

SPECIES CONCEPTS. A phylogenetic species concept as outlined by Wheeler and Platnick (2000) was utilized throughout this study. Under this concept, derived originally from Cracraft (1983) and further developed by Nixon and Wheeler (1990), a species is the aggregation of populations or individuals diagnosable by a unique combination of characters. Operationally and functionally, the phylogenetic species concept usually produces species equivalent to the commonly used morphological species concept of the last century. A phylogenetic species concept is empirical and does not require monophyly of species. Although it has been confused with monophyletic species concepts, in contrast a phylogenetic species concept is logically consistent, since it does not require a phylogeny to be applied prior to determination of species boundaries.

RATIONALE FOR SPECIES SEQUENCE PRESENTED. The order in which the species are described in the monograph is in accordance with the order these species are listed in the latest revisions of *Amygdalus* (Browicz and Zohary 1996) and in floristic treatments (Flora of Turkey, 1994; Flora Iranica, 1969). This sequence starts with the most common and widespread species (*Prunus dulcis*) and moves sequentially through morphologically similar species. Morphologically similar, but not necessarily most closely related taxa are listed after each other. The first 18 species are in section *Amygdalus*, and the last six species are in section *Persica*.

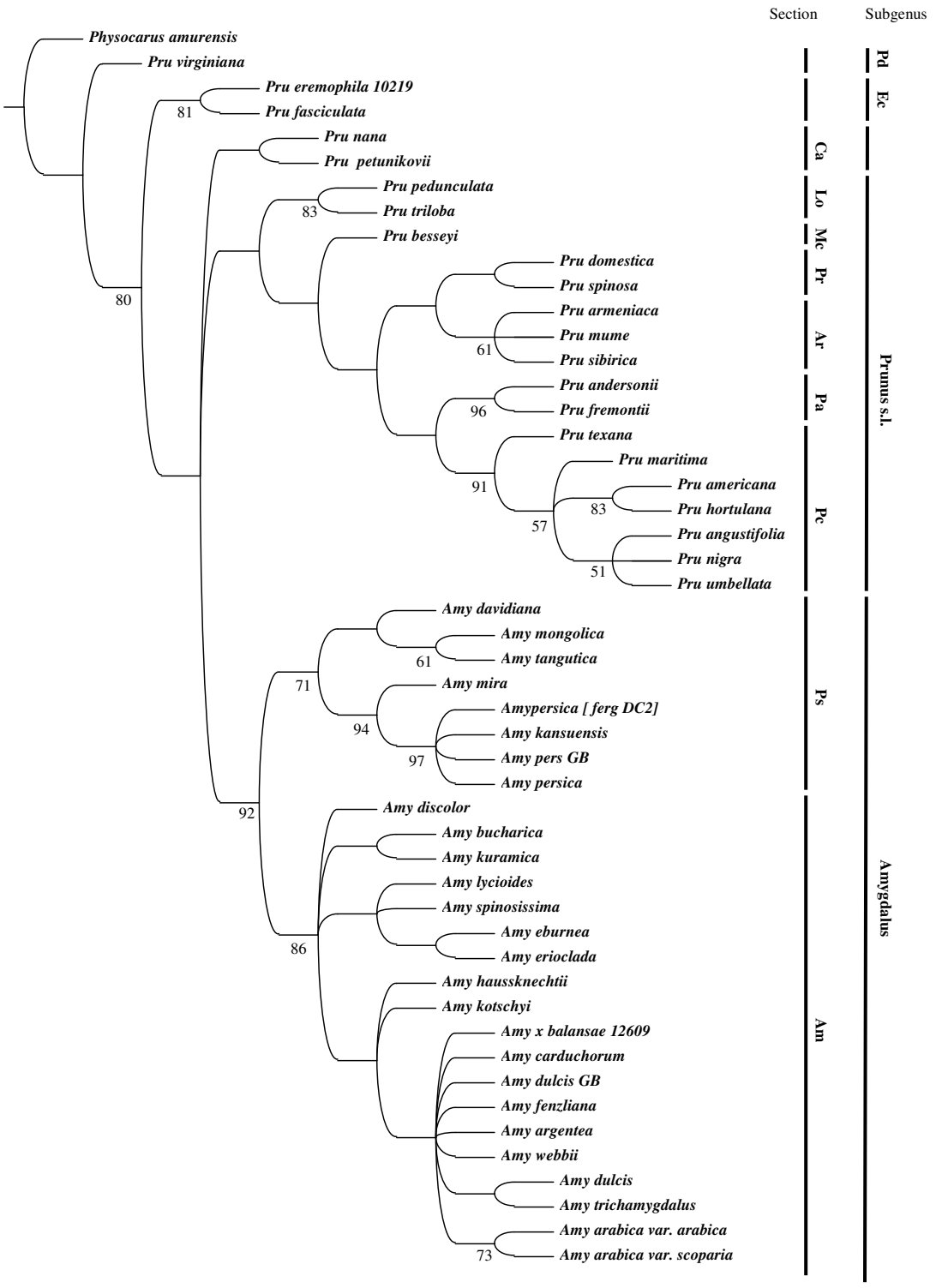

Figure 1.11. Strict consensus of 1560 MPTs of total available evidence (molecular & morphological) analysis. Statistics are given in Table 1.4. Boot-strap frequencies above 50% are below branches. Pd=Padus; Ec = Empleco-cladus; Ca=Chamaeamygdalus; Lo=Louiseania; Mc=Microcerasus; Pr=Prunus; Ar= Armeniaca; Pa=Penarmeniaca; Pc=Prunocerasus; Ps=Persica; Am=Amygdalus.

Prunus subgen. Amygdalus (L.) Focke, Die Naturlichen Pflanzenfamilien. 1894.

Amygdalus L. Sp. Pl. 1: 472. 1753. – Type: Herb. Clifford, Amygdalus, No. 2. (Lectotype: BM! [Digital Image]).

Persica Mill. Gard. Dict. Abr., ed. 4. 1754. – Lectotype: Herb Linn, No. 639.2 (LINN! Digital Image])

Amygdalopsis M.Roem. Syn. Monogr. iii. Rosifl., 4, in clavi, 15. 1847. non *Amygdalopsis* Carriere, Rev. Hort. 91. 1862.

Trees or shrubs, with spreading or upright crown. Bark brown, grey, or whitish grey. Branches thornless or thorny; one year old twigs green, brown or pale brown, sometimes exposed side is reddish, glabrous, glabrescent or pubescent; short shoots present or lacking. Axillary buds usually brownish, glabrous or pubescent; Leaves conduplicate or convolute in bud, usually fascicled on short shoots and alternate on annual twigs; stipules linear, often caducous; petioles sessile to 30 mm long, glabrous or pubescent; petiolar glands absent or up to 7; blades color variable, shape variable margin usually toothed, with glandular teeth but not always, leaves glabrous or pubescent. Inflorescences usually fascicled on short shoots; pedicels glabrous or pubescent. Flowers with hypanthium reddish or greenish, mostly campanulate or narrow cylindrical outside usually glabrous, rarely pubescent; sepals reddish or greenish, margin always entire, margin pubescent or glabrous, petals color variable base mostly tapering, apex usually notched, stamens 10 – 35; style length relative to stamens is variable. Fruits usually with short pedicels, glabrous or pubescent; drupes usually green, sometimes reddish on exposed side, compressed or not compressed, surface densely pubescent; mesocarp splitting at maturity or not splitting; endocarp brown to light-brown, surface pitted, furrowed, pitted and furrowed or smooth.

ARTIFICIAL KEY TO SPECIES OF PRUNUS SUBGENUS AMYGDALUS

1. Mesocarp fleshy or rarely dry, not splitting when mature

    2. Endocarp smooth, or only with shallow furrows; surface not pitted

        3. Sepals externally pubescent or rarely subglabrous; endocarp subglobose, longitudinally and transversely shallowly furrowed, apex obtuse..... **20. *P. kansuensis***

        3. Sepals externally glabrous; endocarp compressed ovoid-globose, inconspicuously and longitudinally sparsely shallowly furrowed only on dorsal and ventral sides, apex acute..... **22. *A. mira***

    2. Endocarp with deep longitudinal and transverse furrows; surface pitted

        4. Leaf blade 50 – 144 mm long x 13 – 40 mm wide, abaxially glabrous; calyx outside glabrous; mesocarp thin and dry; endocarp usually not laterally compressed, apex obtuse……..... **21. *A. davidiana***

        4. Leaf blade 66 – 150 mm long x 19 – 35 mm wide, abaxially sparsely pubescent in vein axils, rarely glabrous; calyx outside pubescent; mesocarp thick and succulent; endocarp compressed, apex acuminate..... **19. *A. persica***

1. Mesocarp dry, splitting when mature

    5. Branches thornless

        6. Branches very rigid, at times seemingthorny……..……**8. *P. carduchorum***

        6. Branches not rigid, not seeming thorny

7. Shrubs 1 - 1.5 m tall; Short-shoots absent, Leaves deciduous early in season ……..……..**13. *P. arabica***

7. Trees or shrubs, (2.)3 - 6(.8) m tall; Short-shoots present; Leaves not deciduous early in the season

8. Endocarp smooth, branchelets tomentose, leaves ovate, elliptic ……...**4. *P. bucharica***

8. Endocarp pitted and with or without shallow furrows; leaves ???

9. Endocarp round, subglobose, round apex…….….**3. *P. kuramica***

9. Endocarp long ovate, with acuminate apex

10. Petiole 1.2(.3) cm; leaf blade lanceolate to elliptic-lanceolate, margin serrate-crenate ..... **1. *P. dulcis***

10. Petiole 4 – 9 mm long, leaf blade elliptic, lanceolate, or oblanceolate, margin crenulate …….……**2. *P. trichamygdalus***

5. Branches thorny

11. Hypanthium narrowly cylindrical, usually inflated at base. Stamens less than 20. Leaves convolute when young

12. Young thorns and older branches white tomentose …….……..**18. *P. erioclada***

12. Young thorns glabrous, young branches glabrous or grey puberulent

13. Hypanthium pubescent ……..…….….**16. *P. eburnea***

13. Hypanthium glabrous

14. Endocarp reticulately furrowed, ornamentation conspicuous in drupe ….**17. *P. brahuica***

14. Endocarp smooth in part or slightly sulcate, ornamentation not conspicuous in drupe

15. Leaves linear lanceolate, 9 – 32 mm long x 1 – 4 mm wide ....…….**14. *P. lycioides***

15. Leaves spathulate, obovate, elliptic or lanceolate , 11 – 28 long x 3 – 9 mm wide…….….**15. *P. spinosissima***

11. Hypanthium campanulate, stamens 20 or more, leaves conduplicate when young,

16. Leaves densely pubescent on one or both sides

17. Pubescence silver- or white-tomentose

18. Leaves densely white-tomentose abaxially and adaxially ……..…**9. *P. argentea***

18. Leaves white-tomentose abaxially, glabrous dark green adaxially …….**10. *P. discolor***

17. Pubescence yellowish grey

19. Leaves lanceolate, oblong lanceolate or rarely oblanceolate; 20 – 40 mm long x 5 – 15 mm wide; base cuneate to deccurent…..……...…….…….**12. *P. kotschyi***

19. Leaves elliptic to oblong, 11 – 21 mm long x 5 – 8 mm wide, base round to broadly cuneate …….…….**11. *P. elaeagnifolia* var. *elagnifolia***

16. Leaves sparsely pubescent or glabrous

20. Endocarp furrowed

21. Branchlets glabrous; leaf blade long elliptic, oblong, or obovate-oblanceolate, 30 – 52 mm long x 5- 16 mm wide; secondary veins 5 – 8 on either side of midvein; drupe subglobose to ovoid-globose, 15 – 23 mm long x 11 – 20 mm wide ..... **23. *P. tangutica***

21. Branchlets pubescent; leaf blade broadly elliptic, suborbicular, or obovate, 8 – 18 mm long x 6 – 16 mm wide; secondary veins ca. 4 on either side of midvein; drupe broadly ovoid-globose, 11 – 15 mm long x 9 – 12 mm wide .....**24. P. *mongolica***

20. Endocarp pitted

22. Leaves distinctly petiolate, petioles 5 -20 mm long

23. One year old twigs reddish on side exposed to sun; sepals reddish to purple, sepal margin glabrous, ciliate or with band of pubescence.…….**5. *P. fenzliana***

23. One year old twigs green or brown – green; sepals green, sepal margin with curly pubescence……...…….**6. *P. webbii***

22. Leaves sessile or subsessile, petioles 0 – 4 mm long

24. Shrubs or small trees 1-2 m high; leaf base cuneate; petiolar or leaf base glands present and usually pubescent ……..……**7. *P. haussknechtii***

24. Trees 3-4 m high; leaf base round or broadly cuneate; petiolar and leaf base glands absent ……..**11. *P. elaeagnifolia* var. *leiocarpa***

1. Prunus dulcis (Mill.) D.A.Webb, Feddes Repert., 74: 24. 1967. *Amygdalus dulcis* Mill., Gard. Dict., ed. 8. n. 2. 1768. *A. communis* var. *dulcis* (Mill.) Borkh. ex DC., Flore Française. 3rd ed. 4: 486. 1805. *P. amygdalus* Batsch var. *dulcis* (Mill.) Koehne, Deut. Dendrol. 315. 1893. *P. communis* var. *dulcis* Farw., Druggists' Circ. 61: 173. 1917. – Type: Miller (BM).

Amygdalus communis L., Sp. Pl. 1: 473. 1753, non *Prunus communis* Huds. Fl. Angl. (Hudson), ed. 2 1: 212. 1778 ≡ *P. domestica* L.; also non *A. communis* Bunge, Enum. Pl. Chin. Bor. 21. 1833, nom. illeg. ≡ *P. persica* (L.) Batsch. *P. amygdalus* Batsch, Beytr. Entw. Gewächsreich 1: 30. 1801, a new name for *A. communis* L. – Type: Herb. Clifford 186, Amygdalus No. 2, (Lectotype: BM! [Digital Image]). LT designated by Jafri, Fl. Libya 31: 12 (1977).

Amygdalus sativa Mill., Gard. Dict. (ed. 8) no. 3. 1768. *Prunus amygdalus* var. *sativa* (Mill.) Focke, Synopsis der Deutschen und Schweizer Flora 1: 728. 1892. – Type: Miller (BM).

Amygdalus fragilis Borkh., Vers. Forstbot. Beschr. Holzart. 201. 1790. *Amygdalus communis* var. *fragilis* (Borkh.), Ser. Prodr. 2: 531. 1825. *Prunus amygdalus* var. *fragilis* (Borkh.) Focke, Syn. Deut. Schweiz. Fl. (ed. 3) 1: 728. 1892. *Prunus dulcis* (Mill.) D.A.Webb var. *fragilis* Buchheim. Zander Handworterbuch Pflanzennamen: 741. 1972. - Type: unknown.

Prunus amygdalus Batsch, Beytr. Entw. Gewachsreich 1: 30. 1801, non *P. amygdalus* Stokes, Bot. Mat. Med 3: 101. 1812, nom. illeg. *Amygdalus amygdalus* Frye & Rigg Northw. Fl. 134. 1914. – Type: unknown.

Amygdalus communis var. *amara* , Ludwig ex DC, Fl. France 4: 486,1805. *Amygdalus amara* (DC) Hayne, Getreue Darstell. Gew. 4: 39, pl. 39, f. 1. 1816. *Prunus amygdalus* var. *amara* (DC) Focke, Syn. Deut. Schweiz. Fl. (ed. 3) 1: 728.

1892. *Prunus dulcis* (Mill.) D.A.Webb var. *amara* (DC) Buchheim Zander, Handworterbuch Pflanzennamen 741. 1972. – Type: unknown.

Amygdalus stocksiana Boiss. Diagn. Pl. Orient. ser. 2, 2: 45. 1856. A. communis var. stocksiana Browicz. Fl. Iranica 66: 169. 1969. Type - Nichara, 1851, *J. E. Stocks* (K!).

Amygdalus communis L. var. *microphylla* Post, Flora Syria 302. 1898. – Type: Post (P).

Prunus korshinskyi Hand.-Mazz., Ann. Nat. Hofmus. Wien, 27: 71. 1913. *Amygdalus korshinskyi* (Hand.-Mazz.) Bornm., Beih. Bot. Centrbl. 31, 2: 212. 1914. – Type: Lebanon/Syria. In Mount Hermon. Alt. 5600 ft. Jun 1855. *Th. Kotschy 580* (W!) or Type: Lebanon. Between Deir el Ahmar and Aineta, 1600 – 1800 m 27 – 28 May 1910. J and F. Bornmuller 11756 (holotype: B; Isotype: W!).

Amygdalus communis L. var. *mucronulata* Fed. & Takht. Trans. Armen. Branch Acad. Sc. USSR, Biol. ser., 2: 197. 1937. – Type: Armenia. Schamschadin, near Kyzkala, 1932. *M. Thumanian* (ERE).

Amygdalus communis L. var. *obtusata* Fed. & Takht. Trans. Armen. Branch Acad. Sc. USSR, Biol. ser., 2: 197. 1937. – Type: Armenia. Meghri, near Pusckan. 22 Oct 1934. (ERE).

Amygdalus korshinskyi (Hand.-Mazz.) Bornm var. *bornmuelleri* Browicz, Arbor. Kórnickie 19: 18. 1974. – Type: Lebanon. Between Deir el Ahmar and Aineta, 1600 – 1800 m 27 – 28 May 1910. J and F. Bornmuller 11758 (holotype: B; Isotype: W!).

Prunus dulcis (Mill.) D.A.Webb var. *spontanea* (Korz.) Buchheim. Zander, Handworterbuch Pflanzennamen 742. 1972. – Type: Turkestania.5 Jun 1899. *Litvinow* (LE!).

Trees up to 8 m tall, with spreading crown. **Bark** brown, grey brown to black with age. **Branches** thornless; one year old twigs brown-green, sometimes reddish on exposed side, glabrous; older twigs brown, glabrous; short shoots many. **Axillary buds** brownish, ovoid, 3–5 mm, glabrous or sometimes pubescent; scales margin entire, apex round. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules linear, up to 11 mm long, margins toothed glandular, glabrous, often caducous; petioles 10 - 30 mm long, glabrous; petiolar glands 1 – 4 or sometimes up on the base of the leaf; blades green, ovate-lanceolate or elliptic, (15) 25 – 70 (100) mm long, 8 - 30 mm wide, base round to broadly cuneate, margins shallowly densely serrate to crenate-serrate, teeth glandular, apex acute to shortly acuminate, when young abaxially sometimes sparsely pubescent, adaxially glabrous, when mature, abaxially and adaxially glabrous. **Inflorescences** usually fascicled on short shoots; pedicels green, 2-4 mm long, glabrous. **Flowers** with hypanthium reddish, campanulate to long-campanulate or cylindrical, 3-9 mm long, 3-8 mm wide, outside glabrous; sepals reddish, ovate or oblong, 3 – 8 mm long; margins entire, pubescent or glabrous, apex round; petals white or pink, broadly obovate, 10 – 21 mm long, base tapering, apex round-notched, sometimes deeply; stamens 20 – 35; style longer than stamens. **Fruits** with pedicel 4 - 10 mm long, glabrous; drupes green, ovate, ovate oblong or ellipsoidal, compressed, 20 – 35 mm long, 14 – 20 mm wide , 10 – 15 mm deep, base round, asymmetric, apex acute to round, surface densely pubescent; mesocarp splitting at maturity, 2 – 3 mm thick; endocarp brown to light-brown, ovate to ellipsoid, 16 – 32 mm long, 13 – 19 mm wide, 10 – 14 mm deep, base round, asymmetric, apex acute to round, ventral suture acutely keeled, surface pits present, furrows absent or sometimes short shallow furrows from base or along keel present; seed “sweet” (non bitter) or bitter. Figure 2.1.1.

Phenology. Flowering: Mar - Apr; fruiting: May – Jul.

Distribution. S.W. and C. Asia, and in addition cultivated in S. Europe. Figure 2.1.2

Habitat. In oak and cedar forest, in abandoned orchards or orchard borders, open shrub lands and among rocks where sheltered, on dry slopes, with limestone and metamorphic rocks. Native and naturalized. Growing at elevations between 150 – 2000 m.

Discussion

Prunus dulcis is the cultivated almond. The specific epithet is frowned upon by many workers since it implies that it is the sweet almond while many 'spontaneously growing' populations that are included in this species have bitter seeds. In fact, many workers believe that is just the cultivated almond, and that whatever is found 'spontaneously growing' has reverted to the feral stage after escaping cultivation. Ladizinsky (1999) believes not only it is just the cultivated species, but he also concludes that even closely related species such as *P. webbii* are feral types. Being of such agricultural importance, a vast amount of research has been conducted on it and slightly variable forms were split into different varieties or species based on continuous and non uniform characteristics. Some authors (such as Browicz and Zohary, 1996) have maintained that truly wild almonds do still exist and accordingly recognized 3 subspecies: *Amygdalus communis* L. subsp. *communis* (the cultivated form), *A. communis* L. subsp. *spontanea* (Korsh) Browicz & Zohary (the feral and weedy form) which they actually note that it is undistinguishable from the previous subspecies, and a third subspecies, *A. communis* L. subsp. *microphylla* (Post) Browicz & Zohary (which was originally described as a variety by Post (1984) and diagnosed by smaller leaf and fruit). As noted above, the diagnostic characters for the subspecies are either non-existent or continuous and unreliable. The situation with the cultivated species of almond is, in fact, very complex, and it is complicated by two main factors.

One factor is that cultivated forms are actually very variable and can be very dependent on the environmental conditions in which they exist and the other is that the putative 'wild' forms have yet to be verified as wild. Based on field observations, literature and communications with colleagues working in the field, I have concluded that truly wild forms of the cultivated almond species do not exist anymore and the spontaneous forms that can be found in the field are either feral types that have escaped cultivation or remnants of historical orchards. The issue of identifying cultivated almonds and distinguishing them from truly wild closest relatives and whether those truly wild closest relatives belong in *Prunus dulcis* or they are actually another species is the subject of another study that is being conducted in collaboration with colleagues from the University of Montpellier (France).

In this treatment two varieties are recognized within this species, and can be easily distinguished by the seed bitterness.

KEY TO VARIETIES OF PRUNUS DULCIS

1. Seed "sweet" or non-bitter …….. **a. Prunus dulcis**

1. Seed bitter ..... **b. Prunus dulcis var. spontanea**

a. Prunus dulcis (Mill.) D.A.Webb, Feddes Repert., 74: 24. 1967. *Amygdalus dulcis* Mill., Gard. Dict., ed. 8. n. 2. 1768. *A. communis* var. *dulcis* (Mill.) Borkh. ex DC., Flore Française. 3rd ed. 4: 486. 1805. *P. amygdalus* Batsch var. *dulcis* (Mill.) Koehne, Deut. Dendrol. 315. 1893. *P. communis* var. *dulcis* Farw., Druggists' Circ. 61: 173. 1917. Type: Miller specimen in BM

b. Prunus dulcis (Mill.) D.A.Webb **var. spontanea** (Korz.) Buchheim. Zander, Handworterbuch Pflanzennamen 742. 1972. – Type: Turkestania. 5 Jun 1899. *Litvinow* (LE!).

REPRESENTATIVE SPECIMENS EXAMINED.

Afghanistan. LOWGAR: Tchar Bassin. Dasht [Dast] Omay, 14 Sep 1967, *P. Lalande* (W). **Algeria.** KHENCHELA: Slope E of Mount Tougour, near Batna, 21 May 1852, *Gallerand 948* (K). **Armenia.** ARARAT: Ardas versus Besehklissa, 19 Jul 1889, *O. Stapf 1341* (W). **Cyprus.** LARNACA: Ayios Epiphanios, *Phillis & Della 2788* (K); Mennoya, 1 Mar 1988, *Phillis & Della 2740* (K); NICOSIA: Apliki, 9 Mar 1988, *Phillis & Della 2781* (K); Palekhori, 9 Mar 1988, *Phillis & Della 2786* (K). **Greece.** ACHAIA: Peloponnes, near Kalavryta, 13 May 1926, *J. Bornmuller 595* (W); KORINTHIA: Spontanea in planitic maritima Corinthiae prope taso copiose, 24 Mar 1888, *Th. de Heldreich* (W). **Iran.** Bagh-e-Khan, 2 Jun 1950, *H. Sabeti 375* (W); AZARBAYJAN-E GHARBI: near Qushchi between Shahpur and Rezaiyeh, 13 Jun 1971, *K. H. Rechinger 41878* (W); FARS: Abarqu [Abar Kuh], 2 Apr 1964, *Martin L. Grant 15398* (W); Shiraz, 28 Feb 1965, *Martin L. Grant 17146* (W); Shiraz, 9 Mar 1964, *Martin L. Grant 15243* (W); KERMAN: Rahbur, 29 Jul 1892, *J. Bornmuller 3480* (W); KERMANSHAH: Sarob Nelufar, 25 Km W. of Kermanshah, 4 Apr 1960, *A. Bent & H.E. Wright 404-104* (W); LORESTAN: Cham Chid, 21 Feb 1941, *Walter Koelz 17094* (W); SISTAN AND BALUCHESTAN: without locality, *Stocks 914* (k); ZABUL: after Qalat, 17 Apr 1958, *H. Pabot* (G); ZANJAN: Slope S of Mont Elvend, 10 Jun 1959, *H. Pabot* (G). **Iraq.** ARBIL: Mt. Sefin near Arbil, 12 May 1893, *J. Bornmuller 1033* (W); Sefin Dagh, Shaqlawa, 9 Apr 1958, *O. Polunin 5038* (K); DAHUK: between Zawita and Atrush, 12 Jun 1955, *R. Baltaxe W1468* (K). **Jordan.** Duarus, Moab, 25 Apr 1945, *P.*

H. Davis 8711 (K); Wadi Herdan, Moab, 26 Apr 1945, *P. H. Davis 9572* (K); AL-KARAK: Karak, 17 Jan 1955, *Kasapl 1860.247* (G); AZ-ZARQA: Zarqa, 14 May 1955, *Kasapl 2719.248* (G). TAFILAH: Hamad bin Jazi Forest, near Sahla spring, 5 km S. of Tafila, 03 Jun 2001, *K. Abu Leila & M. van Slageren MSKA1141* (K); TAFILAH: Rachadiya, 11 Mar 1955, *Kasapl 2178.248* (G). **Lebanon.** BEKAA: 3 km SE of Ainata coming from Deir el Ahmar, 07 Aug 2003, *S. Khairallah & M. van Slageren MSSK1497* (K); between Aynata and Deir Al-Ahmar, 27-28 May 1910, *J. Bornmuller 11756* (W); MONT-LIBAN: Ain Zhalta, 7 Apr 1934, *P. Mouterde 2973* (G); Nahr El-Kalb, 4 Mar 1880, *E. Peyron 763* (G); Ain Zhalta, 19 Jun 1910, *J. Bornmuller 11748* (G). **Pakistan.** BALOCHISTAN: Bandgah Nala (rises in Raskoh Range and grows NW to Padag), 16 Apr 1954, *H. Crookshank 138* (K); Fort Sandeman, 6 May 1897, *Harsukh 20530* (K); Mastung, 17 Jun 1957, *Jafre & Akbar 1725* (K); Lan Leq, May 1902, *Brandis* (K); [CO-TYPE] Nichara, 1851, *J. E. Stocks* (K). **Palestine.** Upper Galile, Wadi Hindaj or Wadi Nabe El Balat, 31 Aug 1967, *M. Zohary* (K); Wadi Tabor, 17 Jul 1994, *A. Michael* (K); HAIFA: Mt. Carmel, 2 Mar 1912, *F. S. Meyer & J. E. Dinsmore B398* (G). **Syria.** Mount Tabor, Apr 1863, *B. T. Lowne* (K); AS-SUWAYDA: Tell Abou Qouleib, 31 Oct 1953, *H. Pabot* (G); RIF-DIMASHQ: Mount Zabdani, 11 Jul 1936, *P. Mouterde 5475* (G). **Turkey.** AMASYA: Amasia, 10 Apr 1889, *J. Bornmuller 1531* (K); ARTVIN: Ardanuc - Artvin. Vil Artvin, 22 Jun 1961, *Kerck 42/10* (W); BALIKESIR: Bigadic, 21 Mar 1956, *P. H. Davis 25149* (K); ERZICAN: Ilic, Yakuplu Koy, Han Dere, 31 May 1979, *S. Yildirimli 1860* (G); HATAY: Senkoy, 31 Mar 1985, *Friederike Sorger 85-4-32* (W); ISTANBUL: Yedicule, 4 Oct 1892, *G. V. Aznavour 817* (G); KUTAHYA: 10 -1 15 km N of Kutahya to Eskisehir, 7 Jul 1962, *P. H. Davis 37012* (K); MALATYA: Malatya, 5 Oct 1932, *V. Ajtai-Kovach* (W); MARDIN: near Mardin, Apr 1867, *C. Haussknecht* (W). **Turkmenistan.** Kisil Arwat, Karakala, near Sumberki in valley of river Sumbar, 25 Jun 1901, *J. Freyn 1951* (W).

Uzbekistan. TOSHKENT: W. Tian-Shan. Basin of river Ugam . Valley of river Kon-Sai. , 31 Sep 1946, *D. A. Linchesky* (LE).

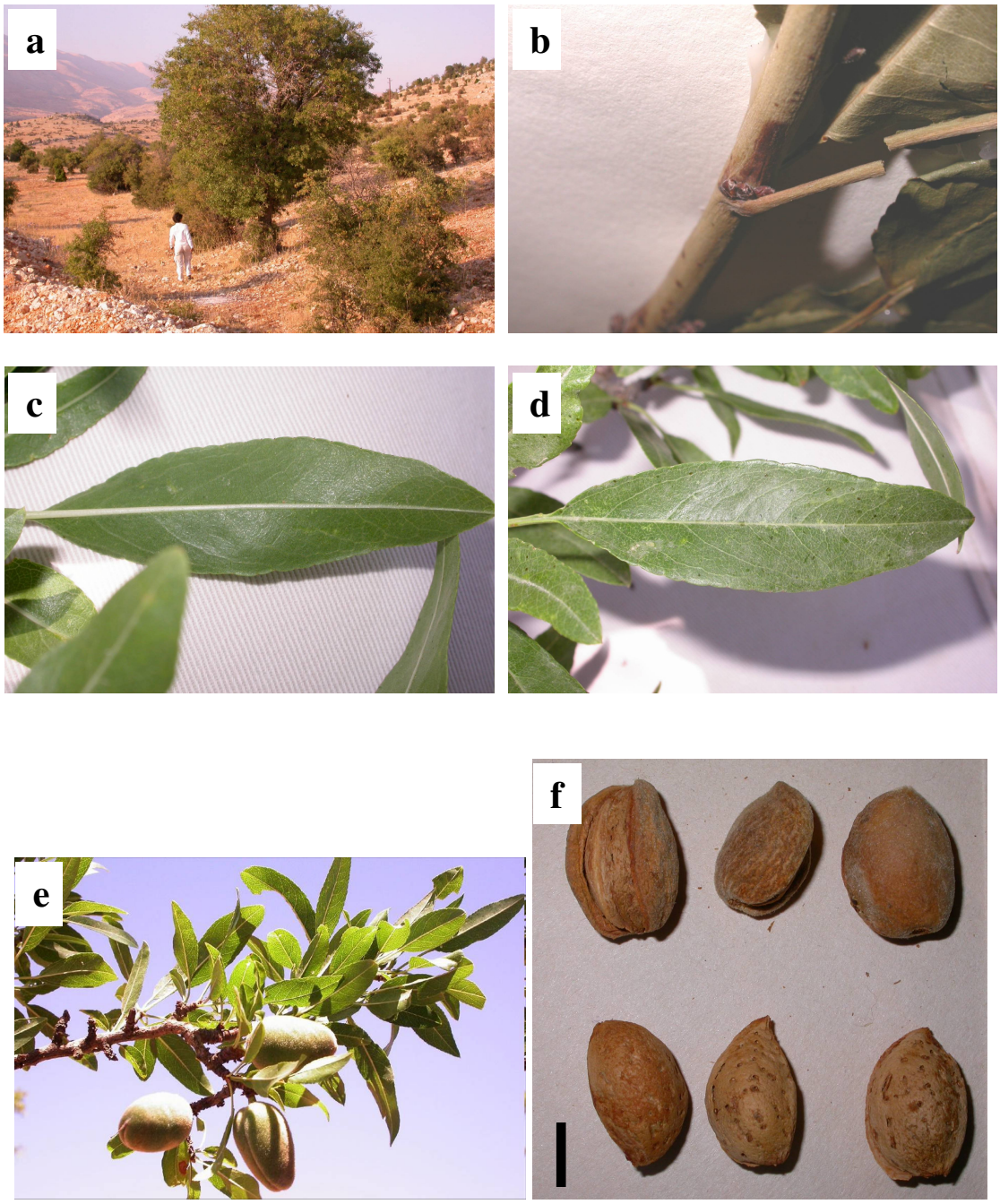

Figure 2.1.1. ***Prunus dulcis***. a. habit and habitat; b. axillary buds in 3s; c. leaf, abaxial; d. leaf, adaxial; e. branch with fruits; f. fruits, splitting mesocarp and endocarps. [Scale bar = 1cm.]

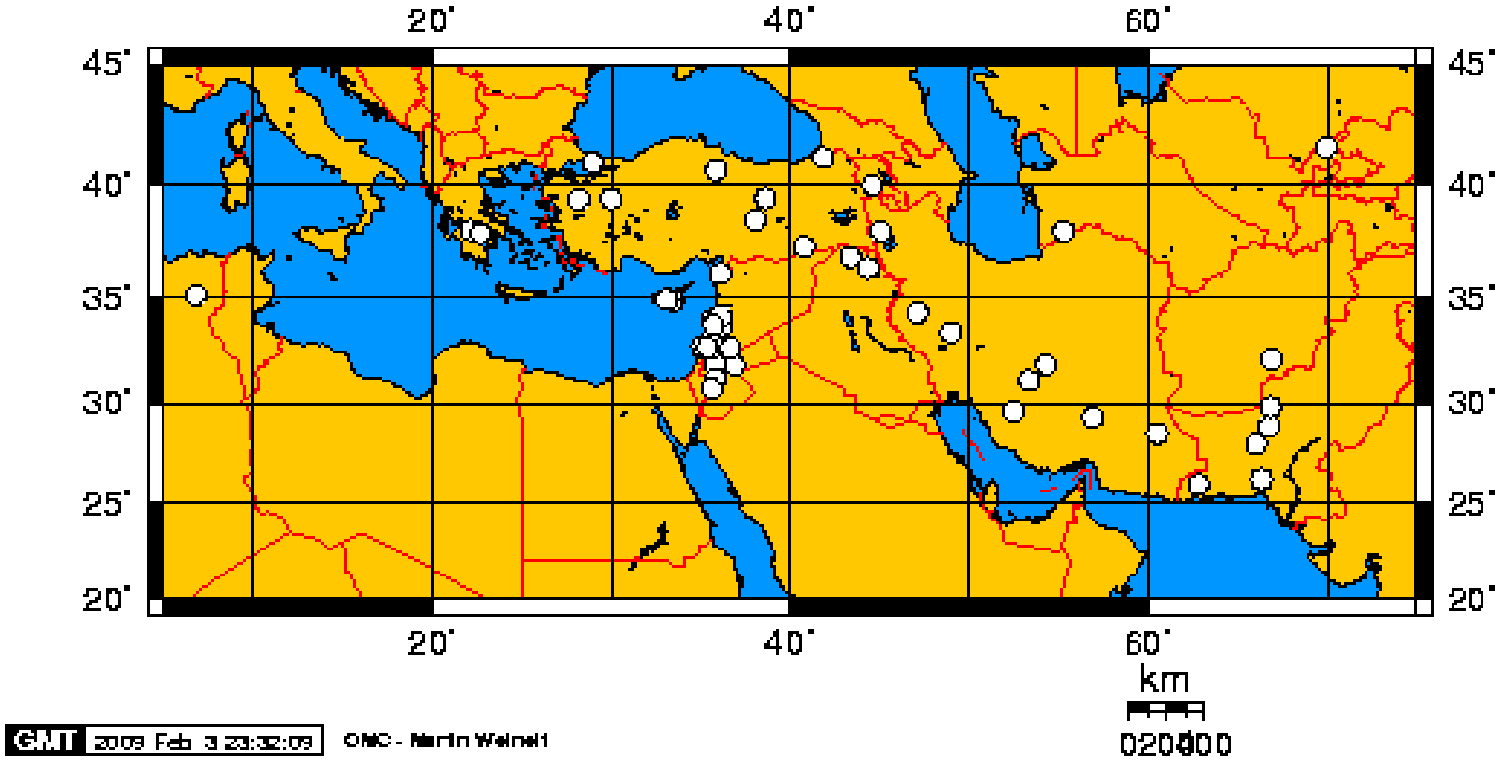

Figure 2.1.2. Distribution of *Prunus dulcis* [S.W. and C. Asia, and in addition cultivated in S. Europe]

2. **Prunus trichamygdalus** Hand.-Mazz., Ann. Nat. Hofmus. Wien, 27: 70. 1913.

Amygdalus trichamygdalus (Hand-Mazz.) Woronow, Bull. Appl. Bot. Pl. Breed. (Leningrad), 14: 49. 1925. – Type: Turkey. C7 Adiyaman, Mount Nimrud Dagh near Kjachta district, Mamuret-ul-Asis, in valley near Urik, 2 Jul 1910, *Hand-Mazz 2134* (holotype: WU!).

Amygdalus trichamygdalus Hand-Mazz. var. *elongata* Browicz, Notes Roy. Bot. Gard. Edinburgh, 31. 2: 321. 1972. – Type: Turkey. C 10 Hakkari, near junction of the Van-Hakkari/Yuksekova roads, 1700m, Jun 1966, *Davis 44651* (holotype: E; isotype: K!).

Shrubs 2 – 3 m tall, with spreading crown. **Bark** brown. **Branches** thornless; one year old twigs greenish, glabrous or pubescent; older twigs brown to grey-brown, glabrous; short shoots present. **Axillary buds** brownish, scales 3 – 5 mm long, pubescent allover or sometimes only margin; scales margin entire, apex round, apiculate, splitting when dry. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules linear, 3 - 6 mm long, margin toothed-glandular, glabrous, not caducous; petioles yellowish, 4 - 9 mm long, glabrous; petiolar glands 2, apparently glands of the leaf base that are low on the petiole; blade green, elliptic, rarely lanceolate or oblanceolate, 27 – 43 mm long, 11 - 23 mm wide, base, round, glands of the basal teeth 1- 5 larger and darker than upper teeth, sometimes intergrading into petiolar glands, margins crenulate, teeth distinctly glandular, apex acute mucronate, when young or mature abaxially sparsely pubescent, mainly along midvein, adaxially glabrous. **Inflorescences** solitary or fascicled on short shoots; pedicels less than1 mm long, glabrous. **Flowers** with hypanthium deep

red, campanulate, 4-5 mm long, 4-5 mm wide, outside glabrous; Sepals deep red, ovate , 4 – 5 mm long, margin entire, apex acute; Petals pink, obovate, 13 – 16 mm long, base cuneate, apex round notched; Stamens 25 – 30; Style nearly as long as stamens. **Fruits** with pedicel, 0.8 – 1.5 mm long, glabrous; Drupes green, ovate to long ovate, in cross section, asymmetric, compressed or slightly so, 19 – 36 mm long, 15 – 23 mm wide , 11 – 16 mm deep, base round sometimes asymmetric, apex acute to round, asymmetric, mucronate, sometimes mucronae curved to one side, surface short velutinous; Mesocarp splitting at maturity, thickness when dry 4-5 mm; Endocarp brown to light brown, ovate to long ovate, compressed, 16 – 31 mm long, 14 – 20 mm wide, 6 – 10 mm deep, base round, asymmetric, apex acute to round, sometimes shortly acuminate, and mucronate, ventral suture keeled, surface pits present, and grooved pits present especially along the keel, furrows absent. Figure 2.2.1.

Phenology. Flowering: Apr; fruiting: Jun – Aug.

Distribution. Turkey Endemic: Adiyaman, Bitlis, Elazig, Erzincan, Hakkari. Figure 2.2.2.

Habitat. On limestone and igneous soils, on cliffs and rocky places, particularly along gorges. Growing at elevations between 950 – 2500 m.

Discussion

This species is very similar to the commonly cultivated *Prunus dulcis*, especially in the drupe and the endocarp. It can be distinguished by its relatively shorter petiole, and smaller leaves with many crenulate teeth. Two varieties have been described *P. trichamygdalus* Hand-Mazz var. *trichamygdalus,* having broadly ovate drupes and endocarp with indistinct furrows or grooved pits along the keel and an apex that has erect mucronae (Fig 2.2.1 - e), and *Amygdalus trichamygdalus* Hand-Mazz. var. *elongata* Browicz (Browicz, 1972), with a long ovate drupe (Fig 2.2.1 - f),

an endocarp lacking grooved pits, and with a curved mucronate apex. Not much is known about the uniformity of these characteristics and their correlation with the geographic range of the species, so these varieties are not recognized in this work.

REPRESENTATIVE SPECIMENS EXAMINED.

Turkey. ADIYAMAN: Kurdistania occidentalis: Taurus Cataonicus. In Monte Nimrud Dagh prope vicum Kjachta districtus Mamuret - ul - Asis, locis lapidosis in valle circa Urik, 2 Jul 1910, *Dr. Heinz. Frh. v. Handel-Mazetti 2134* (WU); Golbasi, around Yukaricoplu village, 18 Apr 2001, *A.A. Donmez 8577* (HUB); BITLIS: Adilcevaz, 25 Aug 1954, *Davis 24622* (K); Tatvan, around Resadiye, 8 Sep 1996, *A.A. Donmez 5643* (HUB); ELAZIG: Hadji Fatma Dagh in Ditione Kharput, 22 Sep1865, *Haussknecht* (JE); ERZINCAN: Kemah, 10 km from Kemah to Ilic, 25 Jun 2005, *A.A. Donmez 12378* (HUB); HAKKARI: From Cukurca-Hakkari riad junction to Van 16 km, 14 Jul 2001, *A.A. Donmez 9764* (HUB); Yuksekova, Jul 1965, *E. M. Rix 262* (K); Zap Gorge 23 km from Hakkari to Van, 24 Jun 1966, *Davis 45487* (K); nr junction of the Van-Hakkari/Yuksekova roads, 10 Jun 1966, *Davis 44651* (K); Yilanli Dagh, 16 Apr 1996, *A.A. Donmez 5208* (HUB).

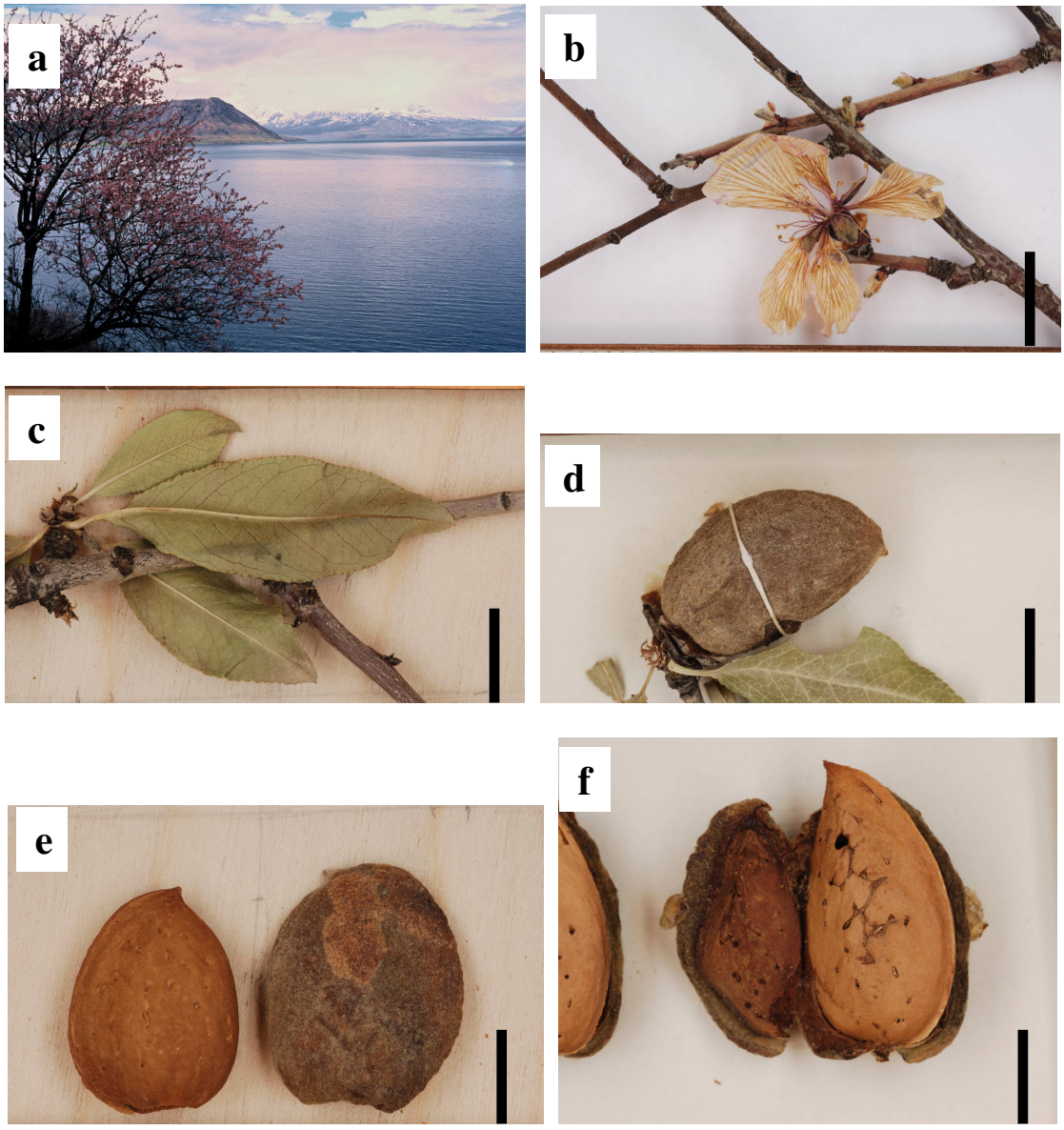

Figure 2.2.1. ***Prunus trichamygdalus***. a. habit and habitat; b. flower; c. leaf; d. fruit; e. fruit and endocarp; f. endocarp. [Scale bar = 1cm.]

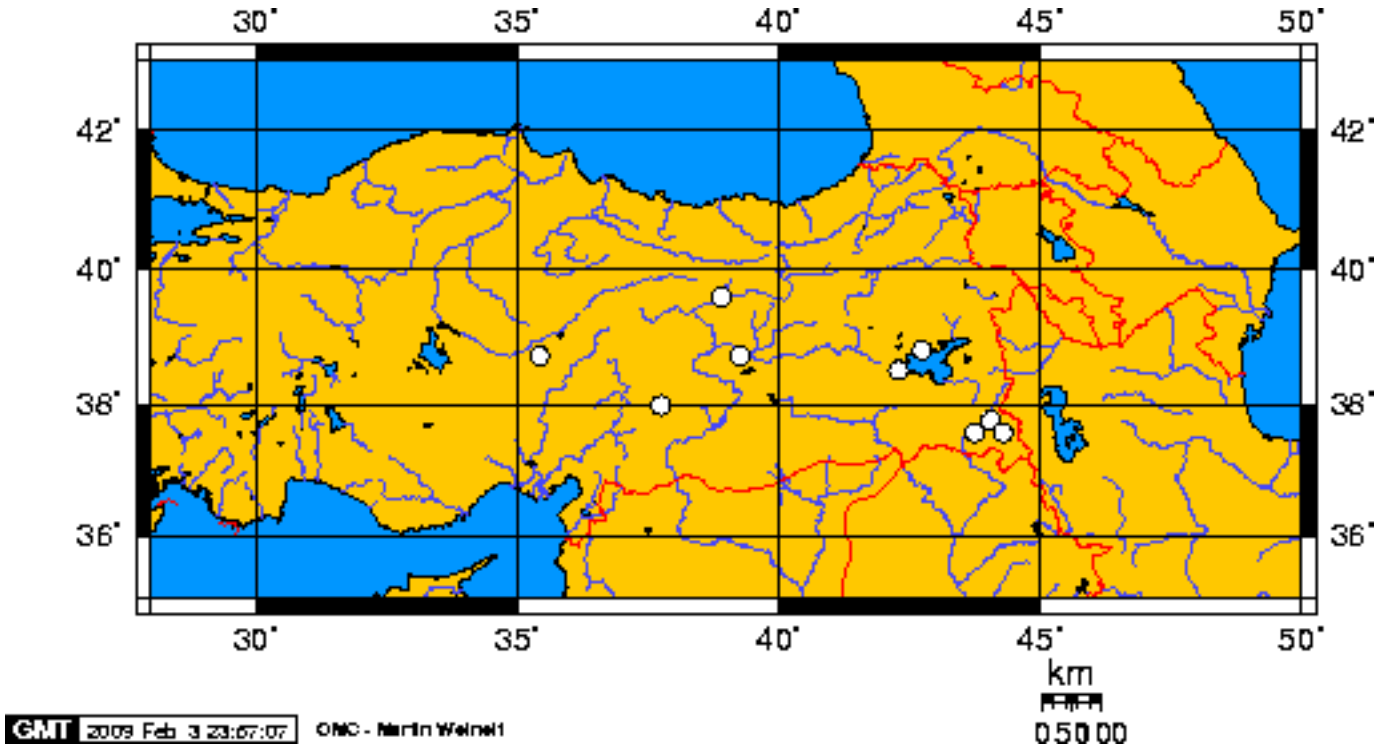

Figure 2.2.2. Distribution of *Prunus trichamygdalus* [Turkey].

3. Prunus kuramica (Korsh.) Kitam., Fl. Afghan. 2: 179. 1960. *Amygdalus kuramica* Korsh., Bull. Acad. Petersb. ser. 5, 14: 93. 1901. – Type: Afghanistan. Kurrum [Kuram] valley. *Aitchison 419* (holotype: LE!).

Amygdalus aitchisonii Korsh., Bull. Acad. Petersb. ser. 5, 14. 94. 1901. *Prunus aitchisonii* (Korsh.) Kitam., Fl. Afghan. 2: 177. 1960. *Amygdalus kuramica* subsp. *aitchisonii* (Korsh) Browicz, in K.H. Rechinger, Fl. Iranica, Lief 176: 170. 1969. – Type: Afghanista. Kurrum [Kuram] valley. *Aitchison 852* (holotype: LE!).

Trees or dense shrubs, 1–5 m tall, with spreading crown. **Bark** brown to dark brown. **Branches** thornless; one year old twigs green, glabrous, older twigs green-brown, glabrous; short shoots present. **Axillary buds** scales 3 – 5 mm long, margin entire and pubescent, apex round and pubescent. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules linear, with a wide base, 7 – 9 mm long, margins toothed-glandular, glabrous, often caducous; petiole reddish 4 - 20 mm long, glabrous; petiolar glands 1 – 4; blade green, lanceolate, elliptic, and less often broadly elliptic, (11) 30 – 72 mm long, 8 - 30 mm wide, base, round, glands of the basal teeth 1- 2 (4) larger and darker than upper teeth, sometimes cannot be distinguished from the petiolar glands, margins serrate, serrate-crenate to minutely serrate-crenate, teeth glandular, apex acuminate, acute, to round, sometimes mucronate, when young abaxially sparsely pubescent or glabrous, adaxially glabrous, when mature, abaxially and adaxially glabrous. **Inflorescences** solitary; pedicels green, 1-5 (7) mm long, glabrous. **Flowers** with hypanthium completely or partly reddish-purple, campanulate to broadly campanulate, 4-7 mm long, 5-8 mm wide, outside glabrous; sepals reddish-purple, ovate, 4 – 5 mm long, margins entire

pubescent with a tuft of hair towards the apex, apex acute; petals white or pink, round to broadly obovate, 10 – 17 mm long, base tapering, apex round-notched; stamens 20 – 30; style shorter than the longest stamens. **Fruits** with pedicels 3 - 10 mm long, glabrous; drupes green, subglobose, round-oblong or round-ellipsoidal, compressed, 13 – 21 mm long, 11 – 16 mm wide, 8 – 11 mm deep, base round, slightly asymmetric, apex round, slightly asymmetric; surface with yellowish pubescence; mesocarp splitting at maturity; endocarp light-brown, subglobose, round-oblong or round-ellipsoidal, slightly asymmetric, compressed, 11 – 18 mm long, 10 – 15 mm wide, 7 – 10 mm deep, base round, asymmetric, apex acute to round, ventral suture with acute or obtuse keel, surface pits and grooved pits present, 2 long furrows along the keel, and short furrows start from the base, sometimes becoming reticulate towards the apex. Figure 2.3.1.

Phenology. Flowering: Early Mar – Late May; fruiting: Late May – Aug.

Distribution. Afganistan, and N.W. and W. Pakistan: Chitral and Kurram. Figure 2.3.2.

Habitat. In *Quercus ballota* forests, dry cliffs and rocky mountain slopes with limestone, often in ravine. Growing at elevations between 1800 – 2850 m.

Discussion

This species is very closely related to *Prunus dulcis*, and might be confused with it if only vegetative material is available for comparison. The main diagnostic character that distinguishes it from the previous species is drupe shape, which is subglobose, round oblong or round ellipsoidal, and always round apex in this species as compared to the ovate, ovate-oblong drupe, commonly with an acute apex, in *Prunus dulcis.* In addition, there is almost no overlap in the size of the drupes in the two species, with *P. kuramica* reaching 13 – 21 mm long, 11 – 16 mm wide, 8 – 11

mm deep at most, as compared to the drupe in *P. dulcis* that is 20 – 35 mm long, 14 – 20 mm wide , 10 – 15 mm deep. Fedorov et al. (Fl. USSR, 1941) suggested that *P. kuramica*, and *P. aitchisonii* (Korsh.) Kitam and *P. tangutica* are closely related to *Amygdalus* L. and *Persica* L. There is no molecular evidence that supports such a position for *P. kuramic*, while there is for *P. tangutica* (See *P. tangutica* discussion).

REPRESENTATIVE SPECIMENS EXAMINED.

Afghanistan. BAGHLAN: Panjshir, 3 Jun 1949, *M. Koie 4002* (W); GHAZNI: in the mount, W. of Yalayarkheyl, 19 May 1969, *S. S. Serafimov Afgh 4* (LE); GHORAT: below Parjuman (Partchuman), 30 Jul - 1 Aug 1962, *K. H. Rechinger 19048* (W); ca. 3km E Parjuman (Partcheman), 1 Aug 1962, *K. Lindberg 19120b* (W); KABUL: Ghorband valley, 14 Apr 1950, *H. F. Neubauer 499* (W); Kabul, 21 May 1969, *S. S. Serafimov* (LE); mountain Paghman, W of Istalif, 27 Apr 1951, *A. Gilli 1790* (W); Paghman, 19 May 1950, *A. Gilli 1791* (W); Paghman, 12 May 1937, *Walter Koelz 11401* (W); Paghman, 12 May 1937, *Walter Koelz 11394* (W); Paghman, W of Kabul, 4098, *H. F. Neubauer 4098* (W); Sanglakht supra Jalrez, 1962, *K. H. Rechinger 18030* (W); Sarobi [Sarubi], 28 Jun 1951, *Prof Dr. O.H. Volk 1567* (W); Sarubi, 29 May 1951, *Prof Dr. O.H. Volk 1616* (W); Sarubi, Gilli, *Prof Dr. O.H. Volk 2489* (W); village Paghman, 12 km from Kabul, 10 May 1969, *S. S. Serafimov Afgh 7* (LE); village Paghman, 12 km from Kabul, 5 Apr 1969, *S. S. Serafimov* (LE); village Paghman, 12 km from Kabul, 5 Apr 1969, *S. S. Serafimov* (LE); KHOST: Narai Kotal, 5 Jun 1967, *K. H. Rechinger 35594* (W); LAGHMAN: Range Laghman, in 2 km above village Laghman, 14 Jun 1974, *I. Gibanov, V. Pavlov, & M. Ch. Younos 4* (LE); LOWGAR: Nozi = Kolangar, 22 Jun 1937, *Walter Koelz 12032* (W); Syohkoh Valley. Sepest vil, 1 Sep 1967, *Lalande R 1044-E2* (W); NURESTAN: NE: Zentral Nurestan.

Anden fel shangen des unteren kurder-tales bei der Mundung desselben in das Petsch-Tal [Pech valley], 4 Jun 1935, *A. Scheibe 85* (W); NURESTAN: Nuristan [Nurestan], Chetras, Jul 1949, *L. Edelberg 2040* (W); between Waigel [Waygal] and Nischai, 12 Aug 1951, *H. F. Neubauer 741* (W); Gusalak, 9 Mar 1948, *L. Edelberg 137* (W); SAR-E POL: Ghorband, 26 Aug 1948, *M. Koie 2907* (W).

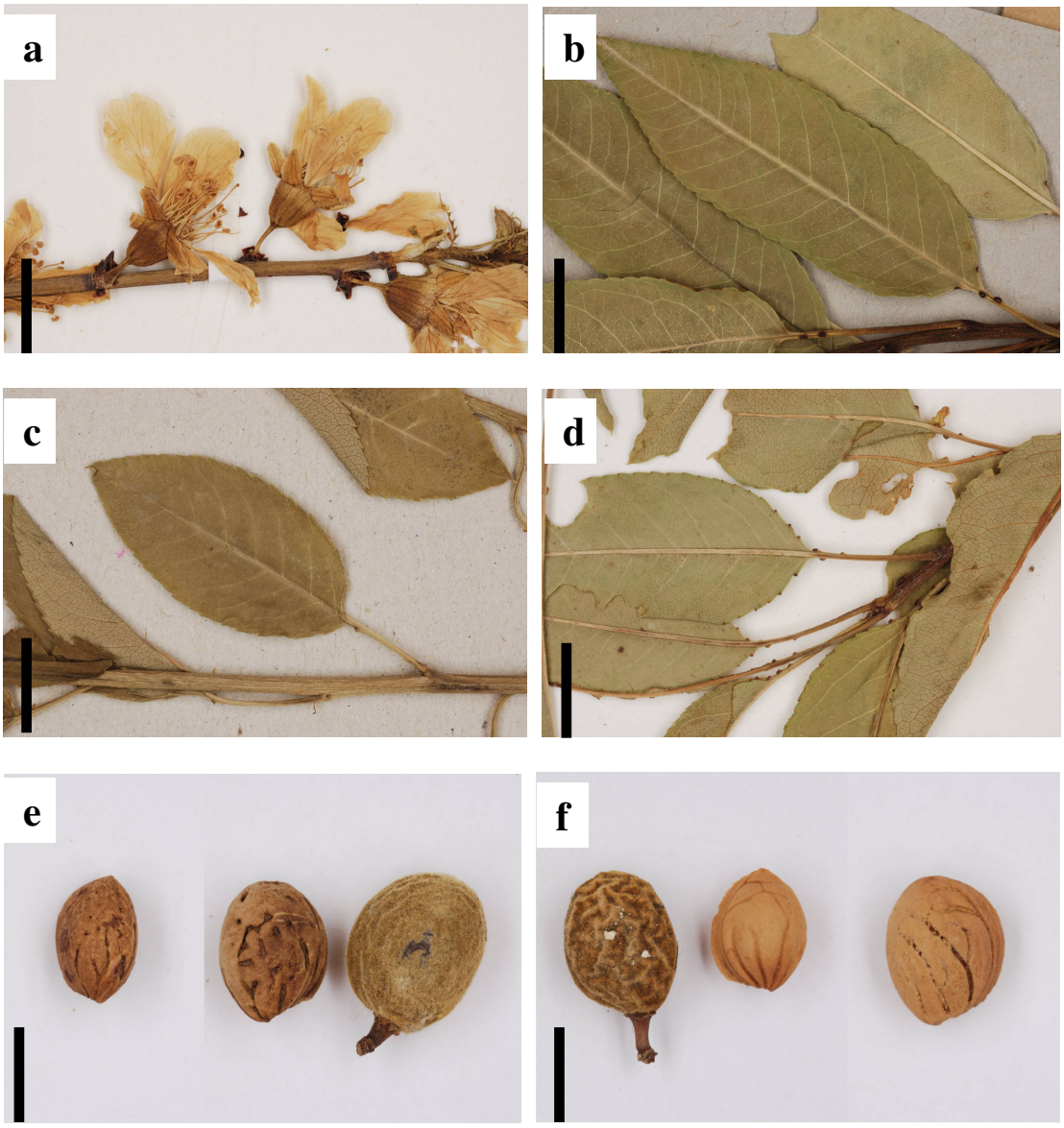

Figure 2.3.1. ***Prunus kuramica***. a. flower; b, c, d, leaves; also showing petioles and petiolar glands; e, f. fruits and endocarp. [Scale = 1 cm.]

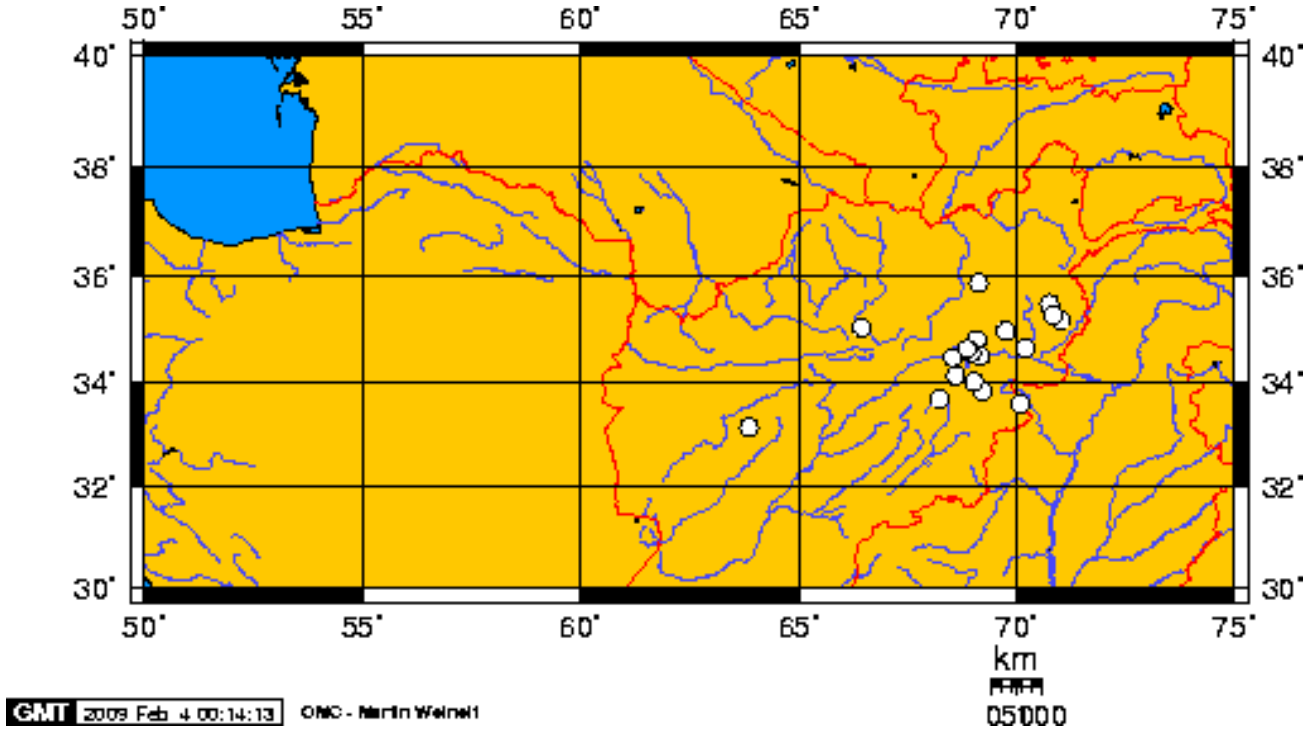

Figure 2.3.2. Distribution of *Prunus kuramica* [Afganistan, and N.W. and W. Pakistan].

4. Prunus bucharica (Korsh.) hand-Mazz, Ann. Naturhist. Mus. Wien., 27: 70. 1913.

Amygdalus bucharica Korsh. Bull. Acad. Petersb., ser. 5, 14: 92. 1901. – Type: Uzbekistan. Mont Daschty-Kozy, valley Zerawschan, alt, 4000 ft, 31 May 1869. *O. Fedczenko* (LE!).

Prunus amygdalus Batsch var. *ovalifolia* Franch., Ann, Sci. Nat. ser. 6, 16: 281. 1883. – Type: Turkestan. Pskeme, on the rocks, to Vorou (Kohistan). 8 Jul. *Franchet 402* (P).

Shrubs or small trees (1.5) 2 – 4 (6) m tall, with upright or spreading crown. **Bark** grey to dark grey or brown grey. **Branches** thornless; one year old twigs green, white tomentose, older twigs brown, white tomentose, glabrous or glabrescent; short shoots numerous. **Axillary buds** with scales 4 – 7 mm long, margin entire, with white pubescence especially near apex, apex round mucronate. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules linear branched [fimbricate], 3- 6mm long, margins toothed glandular and pubescent, often caducous; petioles 10 - 30 mm long, pubescent; petiolar glands 1 – 7, sometimes some of them (1 – 2) are higher up on the leaf base; blade pale-green, broadly elliptic, broadly ovate or broadly lanceolate, 20 – 60 (72) mm long, 13 - 33 mm wide, base round, rarely truncate, margins crenate to crenate-serrate, teeth glandular, apex acute to round mucronate, when young or mature abaxially pubescent or sparsely so mainly along midvein, rarely glabrous, adaxially mostly glabrous. **Inflorescences** fascicled on short shoots; pedicels 0.5-2 mm long, pubescent or glabrous. **Flowers** with hypanthium reddish, campanulate to broad cylindrical, 5-8 mm long, 4-6 mm wide, outside glabrous; Sepals reddish , ovate to oblong, 5 – 8 mm long, margin entire, with very long pubescence, apex acute to round; Petals pale pink, obovate to broadly obovate, 14 – 18 mm long, base tapering, apex round deeply notched; Stamens 20 – 30; Style

nearly as long as the longest stamens. **Fruits** with pedicel 1 - 3 mm long, pubescent or glabrous; drupe green, long ovate, ellipsoidal, oblong, asymmetric, strongly compressed, 17 – 39 mm long, 12 – 22 mm wide , 9 – 13 mm deep, base round asymmetric, apex acute, round or acuminate asymmetric, surface densely white-pubescent; mesocarp splitting at maturity, ca. 3mm thick; endocarp light brown, long ovate asymmetric, compressed, 13 – 23 mm long, 11 – 15 mm long, 7 – 9 mm deep, base round, asymmetric, apex acute to acuminate, asymmetric, surface smooth, pits absent, furrows absent. Figure 2.4.2.

Phenology. Flowering: Mar - Apr; fruiting: May - Jul.

Distribution. C. Asia: Afghanistan, Kyrgystan, Tajikistan, Uzbekistan, Turkmenistan. Figure 2.4.1.

Habitat. Growing on deep clay soils, and stony slopes, in open forest with *Pistacia vera, Acer regekuu, Crataegus pontica,* and *Cercis greffithi*. Growing at elevations between 500 – 1500 m.

Discussion

Even though considered to be closely related to *Prunus dulcis* and similar species that are usually large thronless trees with large petiolate leaves and relatively large drupes, this species is easily distinguishable and cannot be confused with anything else. It is diagnosed by its broadly ovate leaves, the reason that Franchet (1883) described it as *Prunus amygdalus* Batsch var. *ovalifolia* Franch. However, that is not the only character that sets it apart from *Prunus dulcis* (=*Prunus amygdalus*), since it almost always has white, tomentose current year twigs, and most importantly a smooth endocarp that lacks any pits or furrows (Fig 2.4.1 e and f), and this latter character is very atypical in *Prunus* subg. *Amygdalus.*

REPRESENTATIVE SPECIMENS EXAMINED.

Afghanistan. BALKH: Chashma-e Shafa, 5 Jun 1962, *K. H. Rechinger 16230* (G); N. slope of Koh-i-Alburz, 7 km S. Pul-i-Imambukri, 11 May 1977, *D. Podlech & K. Jarmal 30038* (G); KATAGHAN: Paigah Kotal between Pul-i Khumri and Haibak, 5 May 1967, *K. H. Rechinger 33874* (G); SAR-E POL: 30 km E. of Hyabak, 26 Oct 1958, *H. Pabot* (G); E. of Hyabak, 5 May 1958, *H. Pabot A895* (G); TAKHAR: Farkhar Tal, Hange SW of Farkhar, 26 May 1972, *O. Anders 9231* (G). **Kyrgystan.** Pamiro-Alai occidentalis. Montes Kara-Tyube near Gazarma -Saj, 18 Jun 1951, *M. Pachomova 4375* (JE); OSH: distr. Frunze, range Alay, village Ak-Terek, 6 Mar 1963, *Ubukeeva & Gorbanova* (LE). **Tajikistan.** 17 km S. of Dushanbe, near Fakhrabad, 25 May 1974, *V. Vasak 172587* (G); ca. 80 km S of Dushanbe, 4 km S of Vakhsh River, 2 km S of Karatosh village, at Surho Mt. range, 1 Sep 1989, *Sperling 6993* (MO); Dushanbe Botanical Garden, 28 Jun 1968, *La Dinv Moi 408* (JE); Gissar mountain by river Kondara, 1 Apr 1909, *La Dinv Moi 281* (MO); Gissar mountain by river Kondara, 25 Aug 1909, *La Dinv Moi 355* (MO); Gissar mountain by river Kondara, 3 Apr 1969, *La Dinv Moi 286 & 275* (MO); Gissar mountain ridge, N of valley of river Varzob or river Talob, Apr 1953, *J. Tenberg* (MO); Mt. Hissarski Khrebet, 50 km E. of Dushanbe, in valley of river Kafarnigan, 24 May 1974, *V. Vasak 145668* (G); Mt. Hissarski Khrebet, distr. Dushanbe, near Chorbet, in valley of river Varzob, 23 May 1974, *V. Vasak 158579* (G); Range Alay, from Modi to Langar, 26 Jun 1901, *anonymous* (LE); Range Alay, village Modi, 26 Jun 1901, *anonymous* (LE); KUHISTONI BADAKHSHON: W. Pamiro Alay, uppercoarse of the river yakkabarg-dara, near village Tash-Kurgan, 27 Jun 1936, *B. Bochansev & A. Butkov 430* (LE). **Turkmenistan.** Montes Kuhitang borealis, ad pag. Chodzha-i-Pil (Chodzha-fil-Ata) [Kodzha], 12 Jun 1975, *N. Belianina & G. Proskuriakova 152* (MO). **Uzbekistan.** N.

slope of the mountain Narataw, ravine Gurdara, village Sarimsak, 22 Jun 1971, *V. B. Bochansev & R. V. Kamelin 282* (LE); N. slope of the mountain Narataw, ravine Gurdara, village Sarimsak, 23 Jun 1971, *V. B. Bochansev & R. V. Kamelin 309* (LE); FARG ONA: above K. Mady, Taryk, 26 Jun 1901, *Alexeenko 1506* (LE); valley, N slope of Alaj mt ridge, Jul 1915, *V. Drobov 6503* (MO); village Skobelevsky, Sari Kamish, *G. I. Dolenko* (LE); village Taryk, lower Karchagai, 31 Jul 1903, *V. I. Lypsky 3086* (LE); SAMARQAND: Mt Malbguzaro, ravine Sharalal, 14 Jun 1917, *A. I. Michelson* (LE); Mt Zeravshanski khrebet, W of Aman Kutan, 21 May 1974, *V. Vasak 220954* (G); range Zeravshan, Passing of Aman-Kutan, 1960, *S. Sazatov, N. Abdukhamidov & K. Khodgimatov 924-36000-58* (LE); TOSHKENT: Zeravshan valley, on the road between Tashkent and Termez , 5 Apr 1920, *Mirjakhin* (MO).

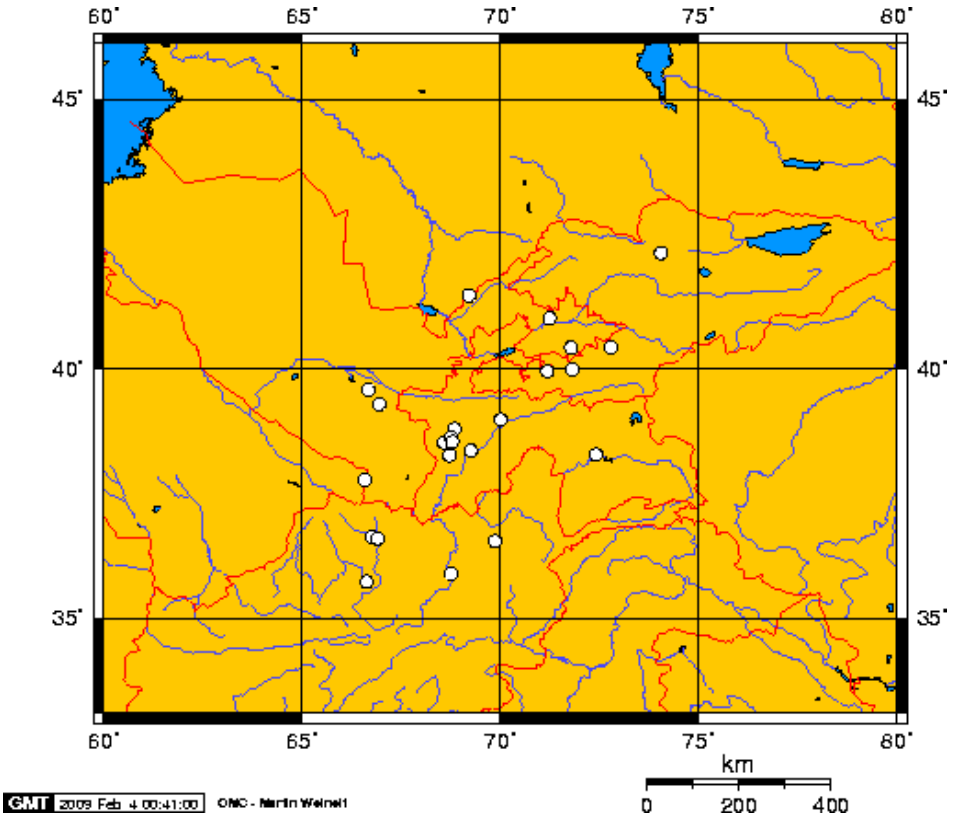

Figure 2.4.1. Distribution of *Prunus bucharica* [C. Asia: Afghanistan, Kyrgystan, Tajikistan, Uzbekistan, Turkmenistan]

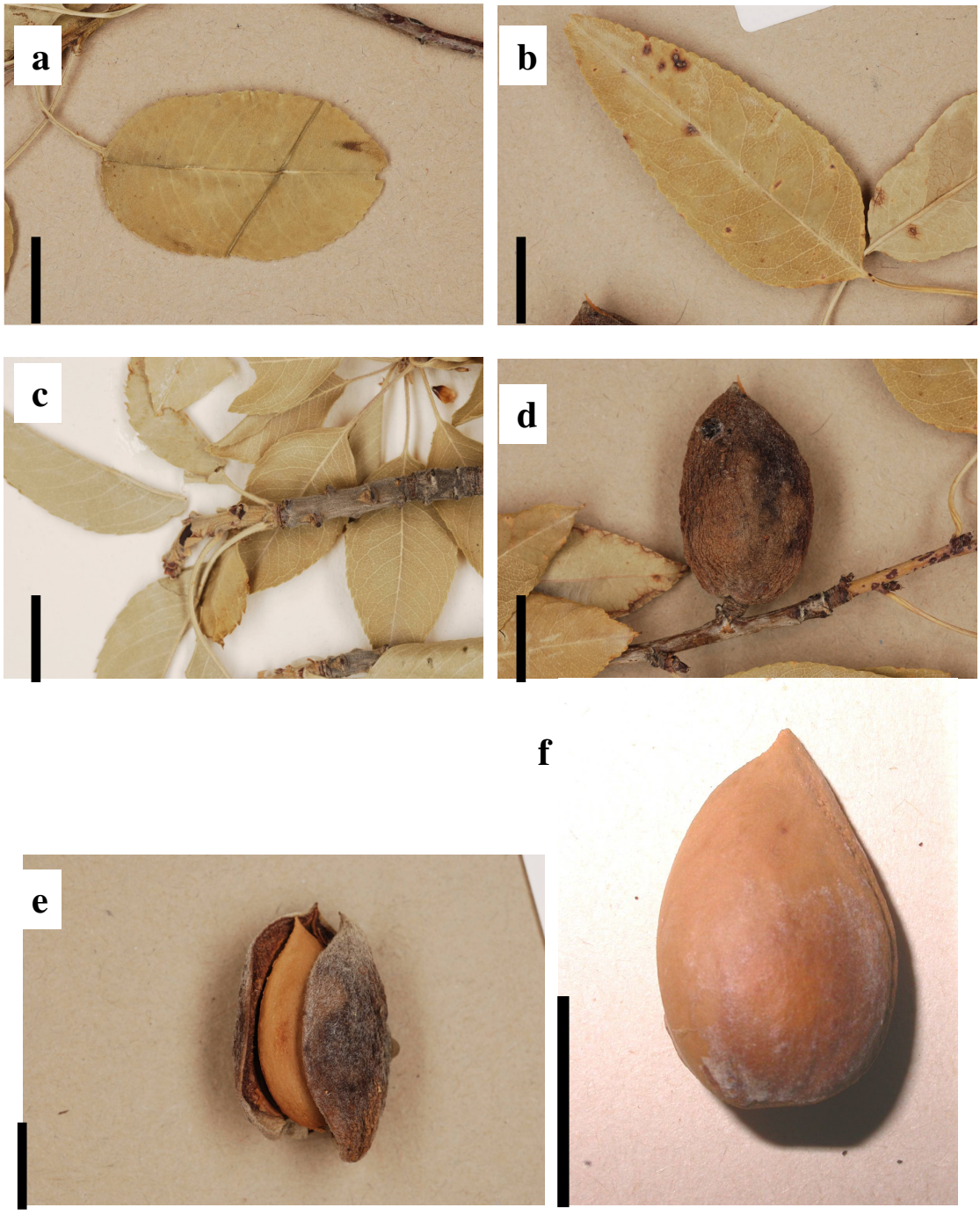

Figure 2.4.2. ***Prunus bucharica***. a, b. leaves; c. current year and previous year twigs; d. fruit; e. splitting mesocarp; f. endocarp. [Scale = 1 cm.]

5. Prunus fenzliana Fritsch, Sitzungsb. Akad. Wiss. Wien ci. vii heft, jahrg. 2: 632. 1892. *Amygdalus fenzliana* (Fritsch) Korsh. Bull. Acad. Petersb. ser. 5, 14: 91. 1901. – Type: Azerbaijan [Armenia]. Karabagh. *Hohenacker* (GZU! Digital Image]).

Amygdalus nairica Fed. & Takht. Repert. Spec. Nov. Regni Veg. 40: 288. 1936. – Type: Armenia. Syunik, near Mount Megri, 20 Sep 1934. *Takhtadzhian* (holotype: ERE; isotype: LE!).

Amygdalus pseudopersica (Tamamsch.) Fed. & Takht., Trans. Armen. Branch Acad. Sc. USSR, Biol. Ser., 2: 199. 1937. *A. urartu* Tamamsch. subsp. *pseudopersica* Tamamsch., Repert. Spec. Nov. Regni Veg. 38: 166. 1935. – Type: Armenia. Erevan. 4 Aug 1933. *Tamamschian & Takhtadjan* (isotype: LE!).

Amygdalus urartu Tamamsch. Repert. Spec. Nov. Regni Veg. 38: 166. 1935. – Type: Armenia. Yerevan, facing Gjarny - Mount Eranos, 31 May 1931, *S. Tamamschjan* (ERE).

Amygdalus gjarnyensis Tamamsch. Repert. Spec. Nov. Regni Veg. 38: 391. 1935. – Type: Armenia. Near Basch-Gjarny, 13 Aug 1934. *Tamamschjan* (ERE).

Amygdalus grossheimii Tamamsch. Repert. Spec. Nov. Regni Veg. 38: 391. 1935. – Type: Armenia. Near Djantlu facing Mount Eranos, 22 Apr 1935. *Tamamschjan* (holotype: ERE).

Amygdalus zangezura Fed. & Takht. Trans. Armen. Branch Acad. Sc. USSR, Biol. ser., 2: 198. 1937. – Type: Armenia. Syunik, near Lischkvas and Puschkak, 23 Sep 1934, *A. Takhtajan* (holotype: ERE; isotype: LE!).

Shrubs or small tree up to 2 (4) m tall, with divaricate branches. **Bark** dark brown. **Branches** somehow thorny [subspinescent]; one year old twigs green, reddish on exposed side, mostly glabrous, rarely pubescent, with whitish lenticels, older twigs

grey pealing to shown brown, glabrous; Short shoots present. **Axillary buds** in 3s, ovoid, 3- 6 mm, pubescent all over or only margin of scales and apex densely, giving it a distinctive appearance, apex acute; scales ca. 4 mm long, pubescent allover or only margin, margin entire, densely pubescent, apex round mucronate. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules intrapetiolar, linear wide at the base, 5 – 9 mm long, margin toothed-glandular, glabrous, often caduceus leaving behind ca. 3 mm; petiole reddish, sometimes with lenticels, 5 – 20 (26) mm long, glabrous; petiolar glands 1 – 6; blade abaxially greenish, adaxially dark green lanceolate, narrow lanceolate or elliptic, (16) 30 – 67 (95) mm long, (6) 9 - 21 mm wide, base, round, rarely broadly cuneate, glands of the basal teeth 1- 4 larger and darker than upper teeth, but sometimes not different from the petiolar glands, sometimes down on the petiole; margins crenate to serrate-crenate, teeth glandular, apex acute to slightly acuminate, when young or mature abaxially glabrous or rarely with few hairs on midvein, adaxially glabrous. **Inflorescences** solitary, fascicled on short shoots; pedicels green, less than 1 mm long, glabrous. **Flowers** with hypanthium reddish to reddish-purple, campanulate, 4-7 mm long, 4-6 mm wide, outside glabrous; sepals reddish to reddish-purple, ovate to triangular, 4 – 5 mm long, margins entire, rarely obscurely and minutely toothed, glabrous, ciliate or with broad band of pubescence, apex acute; petals pink, broadly obovate to round, 11 – 15 mm long, base tapering, apex round notched, sometimes deeply; Stamens 25 – 30; style shorter than stamens. **Fruits** with pedicel 0.5 - 2 mm long, glabrous; drupe greenish with yellowish pubescence, oblong, obovate, ellipsoidal, wider above mid point, compressed, 14 – 23 mm long, 10 – 18 mm wide, 7 – 12 mm deep, base round asymmetric, apex round asymmetric, surface velutinous, yellowish. mesocarp splitting at maturity; endocarp brown to light-brown, oblong, obovate, ellipsoidal, wider above mid point, compressed, 14 – 22 mm long, 10 – 15 mm wide, 6 – 9 mm deep, base round,

asymmetric, apex round, asymmetric, ventral suture with acute or narrow keel, surface pits and grooved pits present, 2 long furrows along keel and irregularly and shallowly furrowed mainly towards apex. Figure 2.5.1 and Figure 2.5.2.

Phenology. Flowering: Mid Mar – Late Apr; fruiting: Early May – Late Aug.

Distribution. Armenia, Azerbaijan, Iran, Turkmenistan. Figure 2.5.3

Habitat. In forests and shrub lands, mostly on rocky slopes and cliffs, and frequently in ravine. Growing at elevations between 1400 – 3500 m.

REPRESENTATIVE SPECIMENS EXAMINED.

Armenia. Karskaya, 30 Apr 1914, *S. J. Turkevicz* (LE); Getarta, ravine of river Garni, 9 Sep 1953, *Stamamilian* (LE); ARMAVIR: Dar Alages, mount Jaxia - Dolduran, 26 Jul 1934, *A. Takhtajan* (LE); Dargalu, Daralagez, village Kuzi [Kuzigidan], upper part of the river Arpa, , *Doruckanov, L. Mekushyan* (LE); ARARAT: Montes Gegamski Khrebet, between ruins near Khosrov and Akhkenng, SE river Khosrov, 11 Oct 1974, *V. Vasak 158477* (G); Alagez, near Nyshnykoza Bulat, in ravine Ampert, 31 Jul 1932, *E. A. & N. A. Bush* (LE); ravine of river Garni, 3 Oct 1934, *A. Takhtajan* (LE); KOTAYK: Abovian distr. c. 18 km E of Yerevan, Garni, valley of river Azat E of Garni, 19 Jun 2002, *G. Fayvush 1218* (W); Abovian distr. near v. Gehard, Azat river, 22 Jun 1961, *A. Takhtajan, E. Gabrielian, V. Avetisyan, & V. Agababyan* (W); Montes Gegamski Khrebet, distr. Abovyan, between monasterium Gehard and Mountain Gokht, 20 Jul 1975, *V. Vasek 158478* (W); near monasterium Kogwart, flr 12 - 25 Apr 1907 ; frt 19 Jul 1907, *E. Koenig 208* (LE); SYUNIK: District Meghrin, near village Tashtun, 21 Jul 1954, *Tamamschjan & Denisova* (LE); near Lishk, 23 Sep 1934, *A. Takhtajan* (LE); Drivail, along the river Araksa [Araz], 20 May 1914, *G. Woronow 13955b* (LE); Karchevan, 20 May 1914, *G. Woronow 13955* (LE);

Shvanidzor, 15 May 1948, *A. Ivanov* (LE); Mountain Megrin, 3 May 1934, *A. Takhtajan* (LE); between Meghri and Mt. Vank, 7 Aug 1932, *J. Karjagin* (LE); VAYOTSDZOR: Yeghegnadzor distr., NNE of Yeghegnadzor between village Yeghegis and castle Smataberd, 17 Aug 2005, *E. Vitek 05-1659* (W); YEREVAN: prope monasterium Geghard, , 9 May 1911, *E. Koenig* (LE); near Djanatlu in mountain Yeranos, 12 Apr 1936, *S. Tamamschjan 492* (LE); Shaumyansky village, *anonymous* (LE); mountain Yranos, 11 May 1934, *S. Tamamschjan* (LE). **Azerbaijan.** Dar Alagez, 15 May 1935, *Fedorov* (LE); Ravin of the river Ganjilai near Zurnabad, 21 Jun 1909, *anonymous* (LE); NACHITSCHEWAN: village Bichenak, District Shakhbuz, 29 May 1947, *A. A. Grossgeim. I. A. Ilinsky, M. I. Kirpichnikov* (LE); village Bichenak, District Shakhbuz., 27 May 1947, *A. A. Grossgeim, I. A. Ilinskaya, M.I. Kipichnikov* (LE); village Yaidien, [Norashen], *A. A. Grossgeim, I. A. Ilinskaya, M. I. Kipichnikov* (LE); XIZI: Kars, distr. Raghyzuian, near Kiul - orghly, 5 Jun 1913, *G. Woronow 12403* (LE). **Iran.** ARDABIL: 35 - 39 km NW Ardabil, 15 May 1960, *H. Pabot 2868* (G); AZARBAYJAN**-**E GHARBI: 62.5 km S. Mahabad, 16 Oct 1960, *H. Pabot 12980E* (W); 90- 95 km S of Mahabad, 16 Oct 1960, *H. Pabot 5517* (G); in valley of river Qotur W. Khvoy versus Turcicas, 11 Jun 1971, *W. Rechinger 41746* (W); khor to Shapour, 15 Oct 1948, *E. Behboudi & P. Aellen 5712E* (W); Khoy-Shahpur, 15 Oct 1948, *H. Sabeti 370* (W). **Turkmenistan.** Kopetdagskiy Zapovednik, 23 May 1968, *T. I. Zhilenko & 139* (JE);

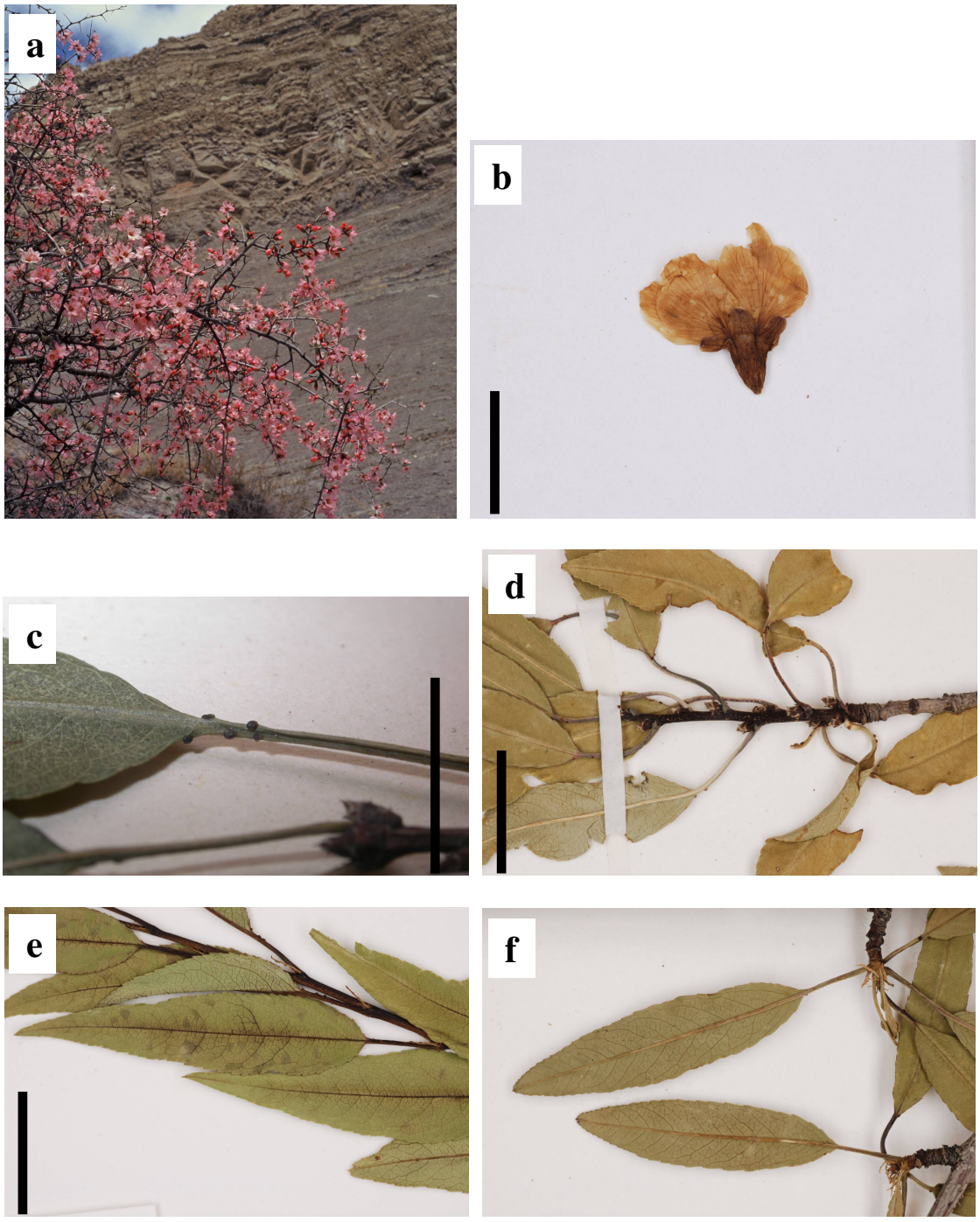

Figure 2.5.1 ***Prunus fenzliana***. a. habitat and flower; b. flower; c. petiolar glands; one year old twig with axillary buds; e, f. leaves. [Scale = 1 cm.]

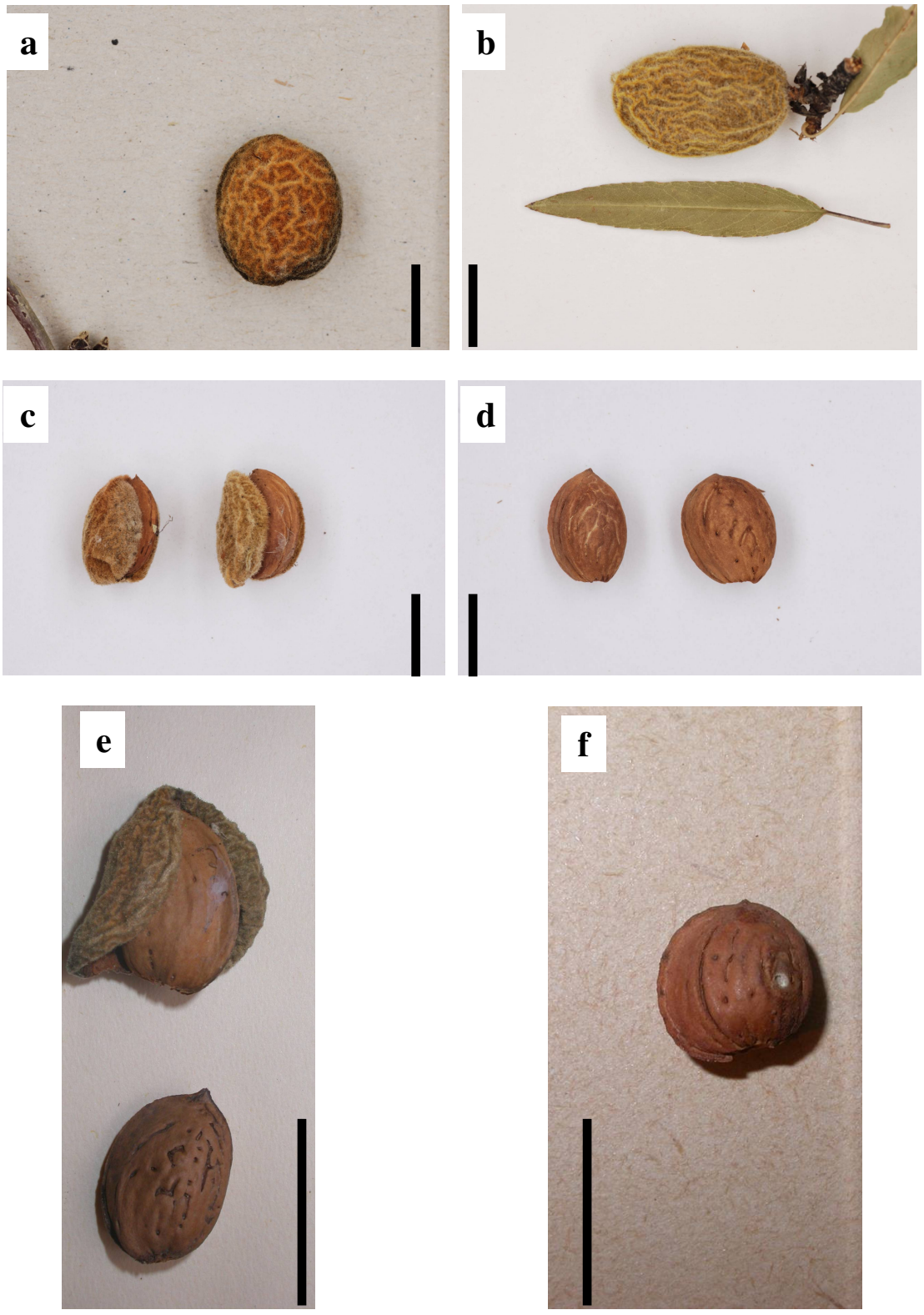

Figure 2.5.2. ***Prunus fenzliana***. a, b. fruits; c, e. splitting mesocarp; d, e, f. endocarps. [Scale = 1 cm.]

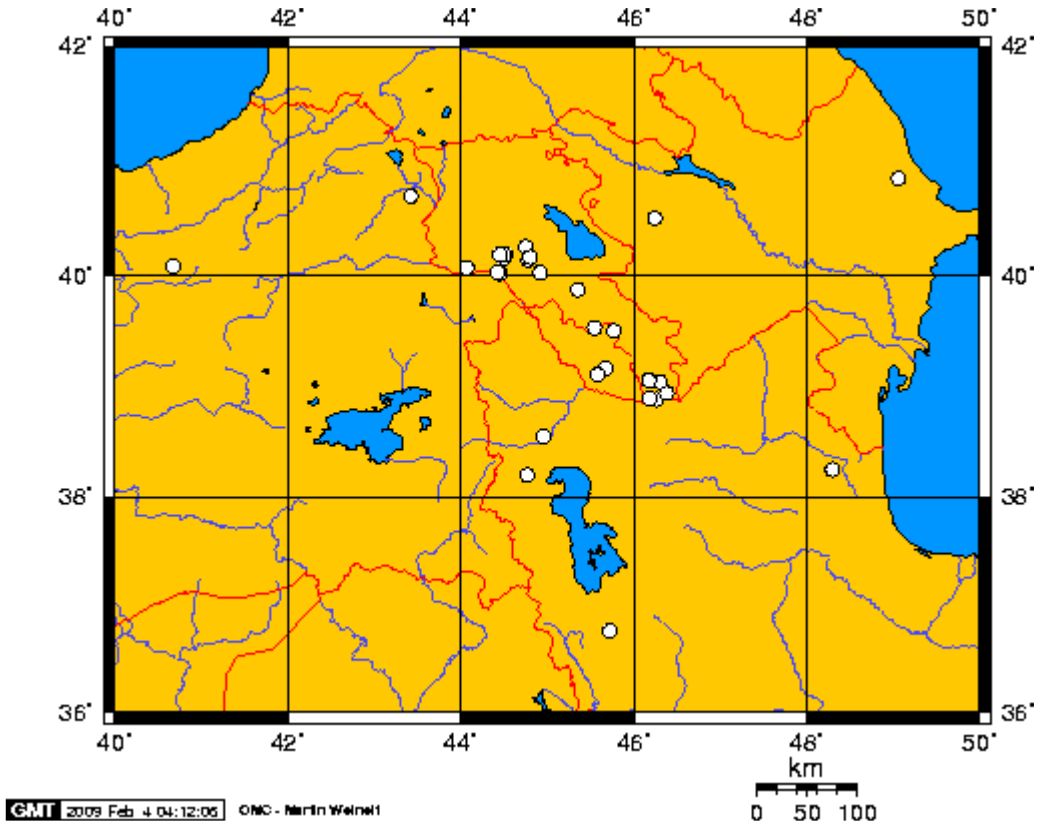

Figure 2.5.3. Distribution of *Prunus fenzliana* [Armenia, Azerbaijan, Iran, Turkmenistan.]

6. Prunus webbii (Spach) Vierhapper, Oesterr. Bot. Zeitschr. 65: 21. 1915.

Amygdalus webbii Spach, Ann. Sci. Nat. ser. 2, 19: 117. 1843. – Type: Turkey. Canakkale, at foot of hill Bonarbaschi (Bunarbahce), near Kirk Ghios, (Webb); Asia Minor, *Aucher-Eloy 1426* (P!, G!).

Amygdalus salicifolia Boiss. & Balansa in Diagn. Ser. 2, 6: 71. (1845). *A. webbii* Spach var *salicifolia* Boiss., Fl. Orien. 2: 642. (1872). – Type: Turkey. Usak, Ouchak [Usak], 31 Jul 1857, B. *Balansa 1290* (G!; Isotype P!).

Dense shrubs or small trees, with spreading crown. **Bark** brown. **Branches** thorny; one year old twigs brownish green, glabrous, older twigs grey-brown, glabrous; short shoots present, 2 – 6 mm long. **Axillary buds** with scales 2 – 5 mm long, margin entire, with curly pubescence, apex round, mucronate, splitting when dry. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules linear, 5 - 6 mm long, margins toothed-glandular, glabrous, often caducous; petiole 3 - 12 mm long, glabrous; petiolar glands absent; blade green or slightly abaxially greenish and adaxially dark green, narrow elliptic, sometimes narrow lanceolate, 23 – 76 mm long, 6 - 17 mm wide, base cuneate, glands 1 – 4, sometimes look like they are the glands of the basal teeth larger and darker than upper teeth, sometimes lower on the petiole, margins minutely crenate-serrate, teeth glandular, apex straight to acute, mucronate, when young or mature abaxially and adaxially glabrous. **Inflorescences** solitary; pedicels green, 1-2 mm long, glabrous. **Flowers** with hypanthium campanulate, 3-7 mm long, 3-6 mm wide, outside glabrous; sepals ovate to oblong, 3 – 5 mm long, margin entire, with curly pubescence, apex acute to round; petals white or pink, obovate to round obovate, 10 – 16 mm long, base tapering, apex round deeply-notched; stamens 20 – 30; style nearly as long as stamens. **Fruits** with pedicel, 1 - 4 mm long, glabrous; drupes green, ovoid to ellipsoidal,

slightly asymmetric, compressed, 16 – 29 mm long, 11 – 17 mm wide, 7 – 12 mm deep, base round sometimes asymmetric, apex acute to round, sometimes asymmetric, surface velutinous; mesocarp splitting at maturity; endocarp light brown, ovate to ellipsoidal, compressed, 14 – 28 mm long, 10 – 16 mm long, 6 – 11 mm deep, base round, asymmetric, apex acute to round, ventral suture with keel, surface pits present, furrows absent. Figure 2.6.2.

Phenology. Flowering: Mar - May; fruiting: Late Apr – Jun.

Distribution. Bulgaria, Croatia, Greece, Macedonia, Montenegro, Russia, Turkey. Figure 2.6.1.

Habitat. In rocky, stony limestone slopes, mainly in ravines or valleys. Growing at elevations between 50 – 1200 m.

REPRESENTATIVE SPECIMENS EXAMINED.

Bulgaria. VIDIN: Supra Rabrovs, distr. Dorian, 21 Apr 1918, *J. Bornmuller 3995* (JE). **Croatia**. Kastellberg, 20 May 1911, *J. Bornmuller* (JE). **Greece.** Abdera, 1885, *C. Haussknecht* (JE); Mt. Kerata, Apr 1885, *C. Haussknecht* (JE); ACHAIA: near Kalavryta, 13 Jun 1926, *J. Bornmuller 592* (JE); Peloponnes, near Kalavryta, 13 Jun 1926, *J. Mattfeld 1767* (MO); ATTIKA: near Phalron, 20 May 1885, *C. Haussknecht* (JE); KEFALLINIA: Insula Cephalonia, in montis Aenos, above Valsaue atta, 17 May 1926, *J. Bornmuller 591* (JE); LOANNINA: 20 km S Joannina, 12 May 1961, *K. H. Rechinger 23268* (MO); TRIKALA: Kalampaka between Murgani Chan and Wutades, 1 Jun 1896, *P. Sintenis 499* (JE); Klinovos, 24 Jul 1885, *C. Haussknecht* (JE). **Macedonia.** Drenovo, 14 May 1918, *J. Bornmuller 3981* (JE); Drenovo, near Klisura, 11 May 1918, *J. Bornmuller 3982* (JE); DEMIR KAPIJA: Demir Kapija, 24 Apr 1918, *J. Bornmuller 3991* (JE); Demir Kapija, 4 Jun 1918, *J. Bornmuller 3994* (JE); near

Demir Kapija, 1 Jul 1936, *O. Behr 93* (JE); VELES: Topolka river , 2 May 1918, *J. Bornmuller 3989* (JE); Veles, Apr 1918, *H. Burgeff 898* (JE). **Montenegro.** Cattaro on the way to Kastell, 18 May 1897, *C. Baenitz* (JE). **Russia.** Terek [Tergi], 1867, *C. Haussknecht* (JE). **Turkey.** AFYONKARAHISAR: near Afyonkarahisar, 8 Jun 1899, *J. Bornmuller 4473* (G); CANAKKALE: Canakkale to Ezine , Thymbra am Skamander, 4 Apr 1985, *M. Nydegger 40018* (G); Thymbra, in valley Scamandri, 1 Apr 1883, *P. Sintenis 31* (G); IZMIR: Smyrna, 1854, *B. Balansa* (G); KASTAMONU: Kastambul, 14 Aug 1892, *P. Sintenis 3980* (JE); USAK: [TYPE] Ouchak [Usak], 31 Jul 1857, *B. Balansa 1290* (G).

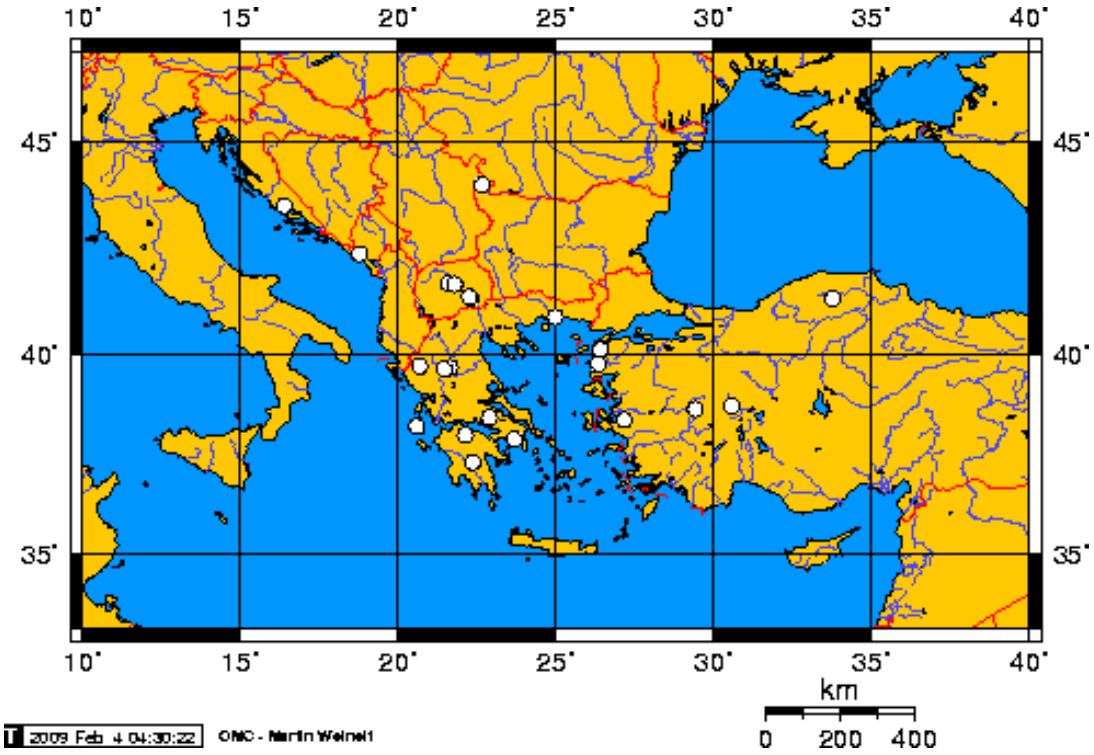

Figure 2.6.1. Distribution of *Prunus webbii* [Bulgaria, Croatia, Greece, Macedonia, Montenegro, Russia, Turkey]

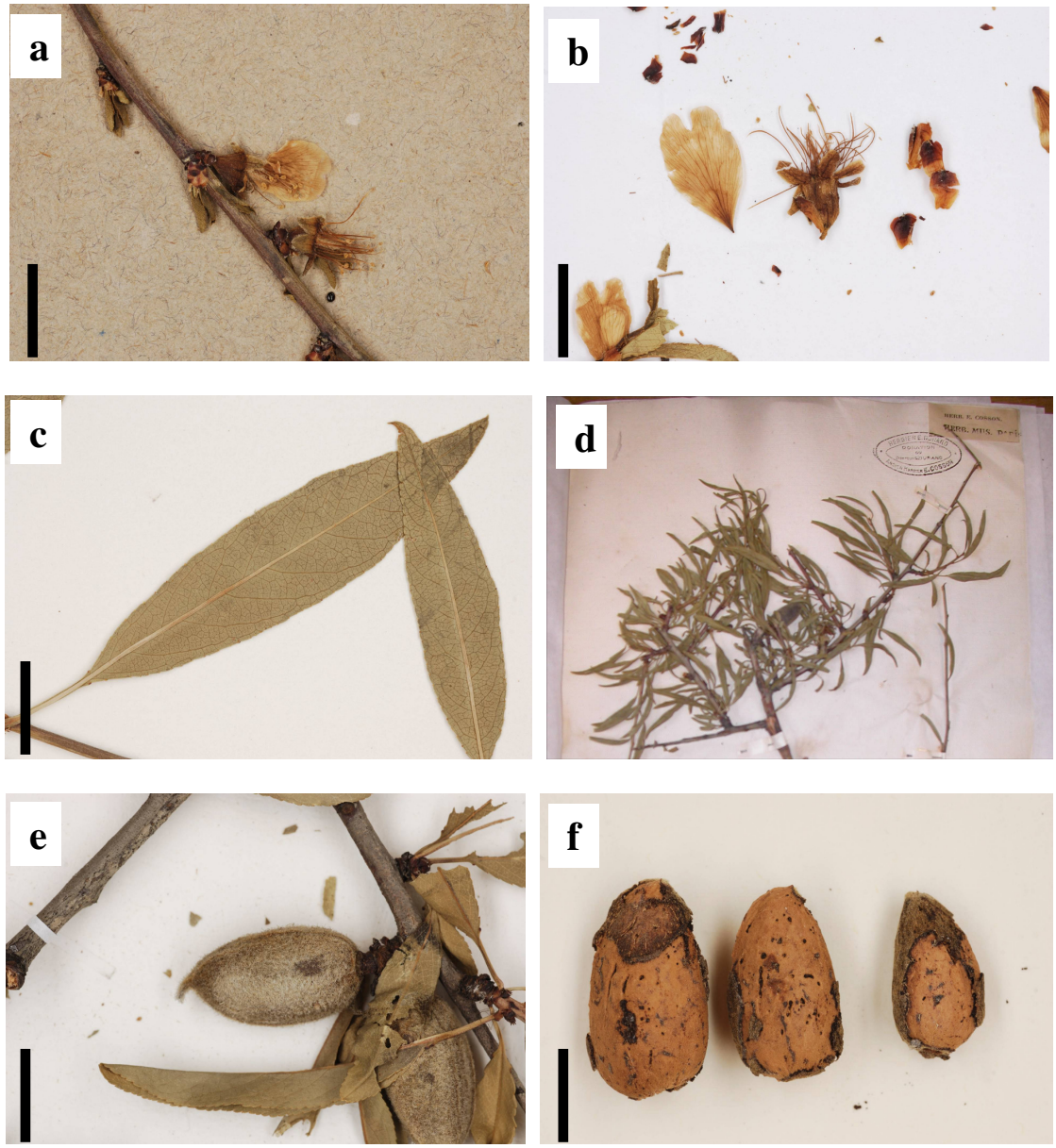

Figure 2.6.2. ***Prunus webbii***. a, b. flowers; c, d, leaves; e. fruits; f. endocarp. [Scale = 1 cm.]

7. Prunus haussknechti C.K. Schneid, Ill. Handb. Laubholzk. 1: 592. 1905.

Amygdalus haussknechtii C.K.Schneid. (Bornm.), Beih. Bot. Centralbl. 58B: 254, in obs. 1938. – TYPE: Iran. Mount near Sultanabad, 1890. Th. Strauss (holotype: W!; isotype: JE!).

Amygdalus webbii Spach var. *reticulata* Bornm. Beih. Bot. Centrbl., 19, 2: 251. 1905. – TYPE: Iran. Schuturan-kuh, 19 Jun 1889. *Th. Strauss* (holotype: JE!).

Dense shrubs or small trees 1–2 (4) m tall, with spreading crown. **Bark** grey. **Branches** thorny; one year old twigs green brown, glabrous or pubescent, with tiny pale lenticels, older twigs brown or grey, glabrous, pubescent or glabrescent; short shoots present. **Axillary buds** adaxially flattened, scales 3 – 4 mm long, margins entire, ciliate, apex round. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules linear, 2 - 3 mm long, margins toothed glandular and glabrous, rarely entire ciliate or toothed and ciliate, often caducous; petiole 0.5 - 3 mm long, glabrous or pubescent; petiolar glands usually 2, sometimes absent, sometimes on the base of the leaf, usually covered with pubescence; blade green, elliptic to narrow elliptic, rarely obovate, 14 – 27 (37) mm long, 4 – 11 (14) mm wide, base cuneate, other than glands of the basal teeth larger and darker than upper teeth, not different from the petiolar glands, but some of them are sometimes go down on the petiole, margins looks entire but obscurely serrate, can see the glands at tip of teeth, apex acute, sometimes mucronate, when young or mature abaxially and adaxially. **Inflorescences** solitary or fascicled; pedicels green, up to 3 mm long, glabrous. **Flowers** with hypanthium reddish, campanulate to broadly campanulate, 3-5 mm long, 4-6 mm wide, outside glabrous; sepals reddish, ovate to oblong, 2 – 4 mm long, margins entire and pubescent, apex acute to round; petals pink, round, 8 – 10 mm long, base tapering, apex round slightly notched; stamens 20 – 30; style as long as

stamens. **Fruits** with pedicel 2 - 5 mm long, glabrous; drupes green, ovate to long ovate, oblong or ellipsoidal, asymmetric or slightly so, strongly compressed, 17 – 26 mm long, 11 – 18 mm wide, 7 – 10 mm, base round sometimes asymmetric, apex acute to round, asymmetric, surface pubescent; mesocarp splitting at maturity; endocarp brown, ovate, asymmetric, compressed, 22 mm long, 15 mm long, 9 mm deep, base round, apex acute to acuminate, ventral suture not keeled, surface pits present, an grooved pits present, furrowed absent. Figure 2.7.1.

Phenology. Flowering: Late Feb – Mid May; fruiting: Early May – Mid Aug.

Distribution. Iran endemic. Figure 2.7.2

Habitat. Growing near waters, whether banks of rivers or base of high mountains (>4000 m), to get water from melting snow, in oak woodlands, growing on limestone and gravelly and rocky slopes. Growing at elevations between 1200 – 3600 m.

VARIETIES OF PRUNUS HAUSSKNECHTII

a. Prunus haussknechti *C.K. Schneid, Ill. Handb. Laubholzk. 1: 592. 1905.*

Amygdalus haussknechtii C.K.Schneid. (Bornm.), Beih. Bot. Centralbl. 58B: 254, in obs. 1938. – TYPE: Iran. Mount near Sultanabad, 1890. *Th. Strauss* (holotype: W!; isotype: JE!).

Amygdalus webbii Spach var. *reticulata* Bornm., Beih. Bot. Centrbl., 19, 2: 251. 1905. – TYPE: Iran. Schuturan-kuh, 19 Jun 1889. *Th. Strauss* (holotype: JE!).

One year old twigs glabrous, older twigs, glabrous. petiole 0.5 – 2mm, glabrous; leaf blade 18 – 25 (36) mm long, 4- 9 mm wide, surface abaxially and adaxially glabrous

b. Prunus haussknechtii C.K.Schneid. var **pubescens** (Bornm) comb. nov.

Amygdalus webbii var *pubescens* Bornm. Beih. Bot. Centrbl. 19: 251. 1905.

Amygdalus webbii Spach var. *pubescens* Bornm. Beih. Bot. Centrbl. 19, 2: 251.

1905. *Amygdalus haussknechtii* Bornm. var *pubescens* (Bornm.) Bornm. Beih. Bot. Centrbl. 28. 2: 226. 1911. – TYPE: Iran. In Mount near Sultanabad. 17 Aug 1890. *Th. Strauss* (holotype: JE! isotype: W!).

One year old twigs pubescent, sometimes densely, older twigs, pubescent or glabrescent. petiole 1 – 3 mm, pubescent; leaf blade (14) 20 - 37 mm long, (4) 8 – 12 mm long, surface abaxially and adaxially pubescent allover or at least along midvein.

REPRESENTATIVE SPECIMENS EXAMINED.

Iran. CHAHAR MAHALL AND BAKHTIARI: Kuhrang, near the dam, 30 May 1959, *Wendelbo 941* (W); ESFAHAN: 30 miles W Esfahan, 30 Apr 1961, *Howard C. Stutz 841* (W); Esfahan, Bakhtiarri, Zard Kuh, Khoge (Tal), 18 Aug 1950, *Hakimi 5723E* (W); Saadatabad, S of Esfahan, 26 Mar 1967, *Tregubov 129* (W); FARS: 45 mils SE of Shiraz, 1 mile S of road to Firuzabad, Muk road., 1 Mar 1971, *C. Grey - Wilson & T. F. Hewer 44* (W); Kuh-i-Sabzpuchan, 28 mi S. of Shiraz., 26 Feb 1971, *C. Grey - Wilson & T. F. Hewer 30* (W); ILAM: Ilam, 6 Jun 1950, *H. Sabeti 374* (W); KERMANSHAH: 40 km SW of Shahabad, inter Shahabad et Ilam, 2 Jun 1960, *A. Bent & H.E. Wright 602-505* (W); KHUZESTAN: Chah-Bazan [Shahbazan], 28 May 1937, *M. Koie 1537* (W); KOHGILUYEH AND BUYER AHMAD: Kharun, 3 Jun 1937, *M. Koie 1536* (W); LORESTAN: Damavar, Bakhtiari, 5 May 1940, *Walter Koelz 15175* (W); Daresbar [Dar Aspar or Darreh Esbar], 24 May 1941, *Walter Koelz 17772 & 17773 & 17759* (W); Dorud, 21 May 1940, *Walter Koelz 15660* (W); Dorud, 3 May 1941, *Walter Koelz 17421 & 17422* (W); between Dorud et Azna, E of Dorud, 30 May 1960, *A. Bent & H.E. Wright 930-203* (W); Mountain Khali Kuh 50 - 60 km ab Aligudarz merideim versus, 12 - 14 Jun 1974, *K. H. Rechinger 47893* (W); Nijiu, 25 km SW of

Khorramabad, 10 May 1937, *M. Koie 523* (W); MAZANDARAN: In mountain Kohrud, 20 Jun 1904, *Th. Strauss* (JE); ZANJAN: Slope S of Mont Elvend, 10 Jun 1959, *H. Pabot 12976E* (W).

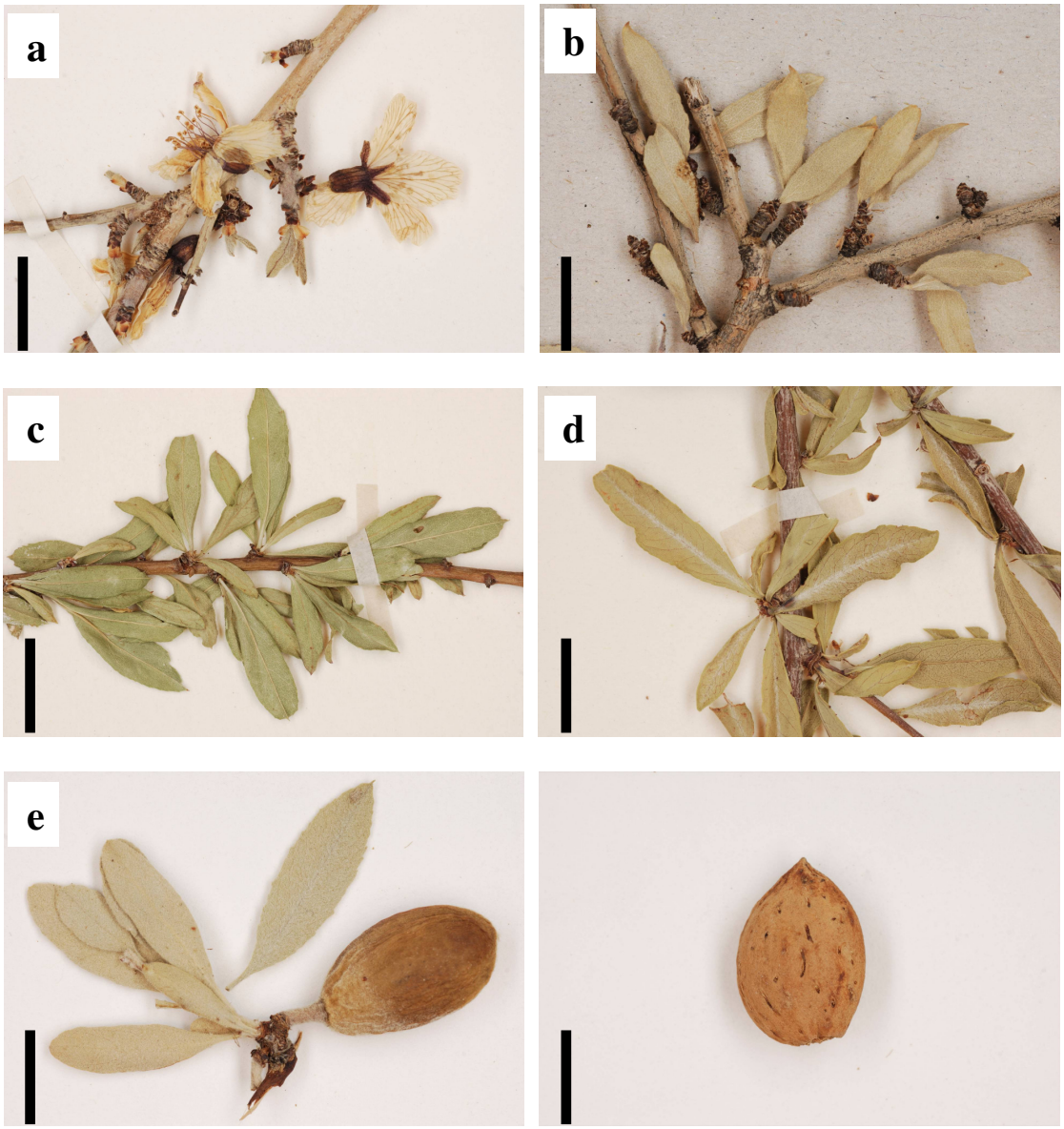

Figure 2.7.1 ***Prunus haussknechtii***. a. flowers; b, c, d. leaves; e. fruit; f. endocarp. [Scale = 1 cm.]

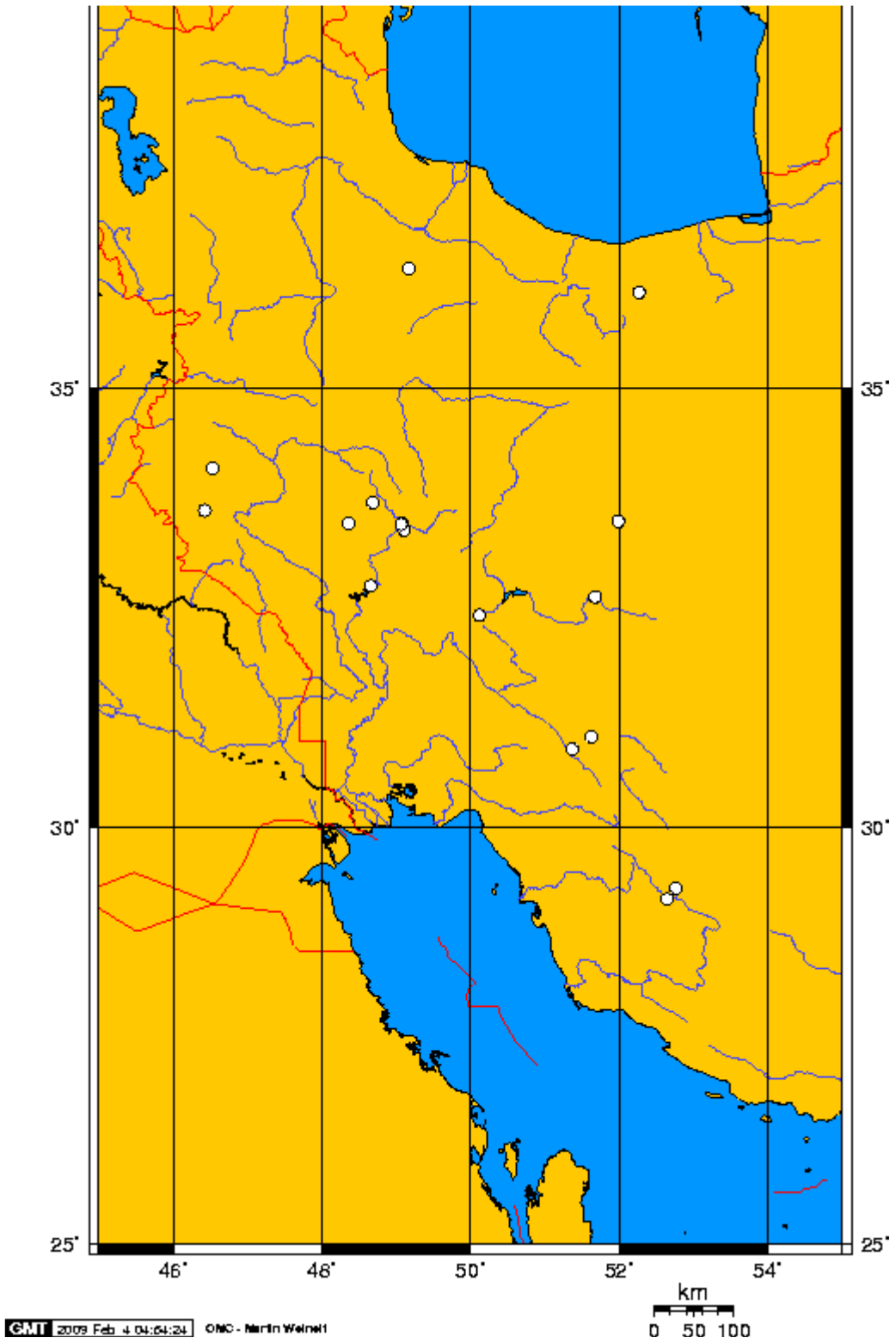

Figure 2.7.2. Distribution of *Prunus haussknechtii* [W. Iran].

8. Prunus carduchorum (Bornm.) Meikle, Kew Bull. 19: 229. 1965. *Amygdalus carduchorum* Bornm. Beih. Bot. Centralb. 58B. 257. 1938. – TYPE: Iraq. Riwanduz, on Mt. Sakri-Sakran, 26 Jun 1893. *Bornmuller 1042* (holotype: JE!)

Amygdalus carduchorum Bornm. var. *glabra* Bornm., Beih. Bot. Centralbl. 58B. 258. 1938. – TYPE: Iraq: Riwanduz, on Mt. Sakri-Sakran, 2000 m. 26 May 1893, *J. Bornmuller 1043* (JE!).

Amygdalus carduchorum Bornm. subsp. *serrata* Browicz, Notes Roy. Bot. Gard. Edinburgh, 31, 2: 321. 1972. – TYPE: Turkey. Hakkari: Cilo Dagi, between Varegoz and Sat Golu, 2400-2500 m, *Davis 45522* (holotype: E).

Amygdalus carduchorum Bornm. subsp. *serrata* var. *macrocarpa* E.Hadac & Chrtek, Candollea 35, 1: 314 (1980). – TYPE: Turkey. Mount Pontine, 1900 m. 20 Jun 1961. *E. Hadac 6090* (PR).

Dense shrubs 0.5– 1.2 m tall, with spreading crown. **Bark** brown or grey-brown. **Branches** thornless, but very rigid they might appear thorny; one year old twigs green-brown, glabrous or pubescent, with pale lenticels, older twigs brown-grey to yellow-grey, glabrous; short shoots present. **Axillary buds** with scales 2 – 4 mm long, margin entire, pubescence on margin only or allover, apex round. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules linear, ca. 4 mm long, margin toothed glandular or entire, glabrous or pubescent, often caducous; petiole 1 - 2 mm long, glabrous or pubescent; petiolar glands absent; blade green, linear-lanceolate, less often lanceolate, or rarely oblanceolate, 14 – 33 (37) mm long, 3 – 7 (14) mm wide, base cuneate, glands of the basal teeth 1- 4 larger and darker than upper teeth, glands pubescent, margins entire or appears to be so with obscure serrations, and rarely serrate, teeth glandular or non-glandular, apex straight to acute, when young abaxially and adaxially pubescent, when mature, abaxially and

adaxially glabrous or pubescent. **Inflorescences** solitary; pedicels green, 1-2 mm long, glabrous. **Flowers** with hypanthium long-campanulate, sometimes constricted at rim, 3-4 mm long, ca. 3 mm wide, outside glabrous; sepals ovate, ca. 3 mm long, margin entire, glabrous, apex acute; petals pink, oblong or obovate, 7 – 8 mm long, base cuneate to tapering, apex round deeply notched; stamens ca. 25; style longer than stamens. **Fruits** with pedicel, 1 - 2 mm long, glabrous; drupe green, globose to subglobose, less often ovoid or oblong, barely compressed, 14 – 17 mm long, 9 – 12 mm wide , 9 – 11 (15) mm deep, base round, sometimes slightly asymmetric, apex round, surface with velutinous-grey pubescence; mesocarp splitting at maturity, ca. 0.8 mm thick; endocarp brown to light brown, oblong to subglobose, barely compressed, 14 - 16 mm long, 8 – 10 (12) mm long, 8 - 11 mm deep, base round, apex round, ventral suture indistinctly keeled, surface pits and grooved present, furrow absent or indistinct. Figure 2.8.1.

Phenology. Flowering: Apr - May; fruiting: Jun - Jul.

Distribution. N. Syria, N. Iraq, N.W. Iran and E. Turkey. Figure 2.8.2.

Habitat. On rocky slopes with limestone or metamorphic ricks, in *Astragalus* zones, or open degraded forest. Growing at elevations between 1500 – 3000 m.

Discussion

This species is poorly known, and rare in distribution. It superficially resembles *Prunus lycioides*, however, it differs by having a campanulate hypanthium and lackingthorns, even though it looks thorny because of its rigid branchelets. It can also be differentiated by its pitted endocarp. The pubescent form might be confused with *P. kotschyi*, but the pubescence in *P. carduchorum* is very sparse and lanuginose, while it is dense and tomentose in *P. kotschyi*. Two subspecies have been described in this species, *Amygdalus carduchorum* Bornm. subsp. *serrata* Browicz (Browicz,

1972) and *Amygdalus carduchorum* Bornm. subsp. *serrata* var. *macrocarpa* Hadac & Chrtek (Hadac & Chrtek, 1980). These do not appear to have any taxonomic importance and there is very little information available and a lack of specimens to verify these subspecific varieties.

REPRESENTATIVE SPECIMENS EXAMINED.

Iran. AZARBAIJAN E-GHARBI**:** Return from Groomah [Orumiyeh] through Kurdistan mountains, 1954, *Guest* (K); 85 Km S. Mahabad, 16 Oct 1960, *H. Pabot 5513* (G); Gardaneh-ye Zamziran Pass S. Mahabad towards Sardasht, 8 Jul 1974, *K. H. Rechinger 49087* (G). **Iraq.** ARBIL: Aljind dagh above Darband, *Gillett 9622* (K); ENE Seri Hasan Bek, 24 Jul 1932, *Guest 2915* (K); Mt. Qandil, in E. slope near Pishta shan, 28 Jul-1 Aug 1957, *K. H. Rechinger 11081* (G); AS-SULAYMANIYAH: Hawraman mountain, 22 - 26 Jun 1961, *Alizzi, Nuri, Rawi, Chak 19743* (K); Hawraman, Northern slopes nr Tawela, Karai Goran., 25 Jun 1973, *Weinert & Mousawi* (MO); BABIL: Rustam, 18 Sep 1956, *Husham 15853* (K); DAHUK: Baski Hawran Mt. on the roadside, 29 Jul 1957, *A. Rawi & Serhang 23961* (K). **Turkey.** HAKKARI: Cilo Dagh (Taurus) above Diz Deresi, 7 Aug 1954, *P. H. Davis 23947* (K);

Figure 2.8.1. ***Prunus carduchorum***. a, b. leaves; c. fruit; d. endocarp. [Scale = 1 cm.]

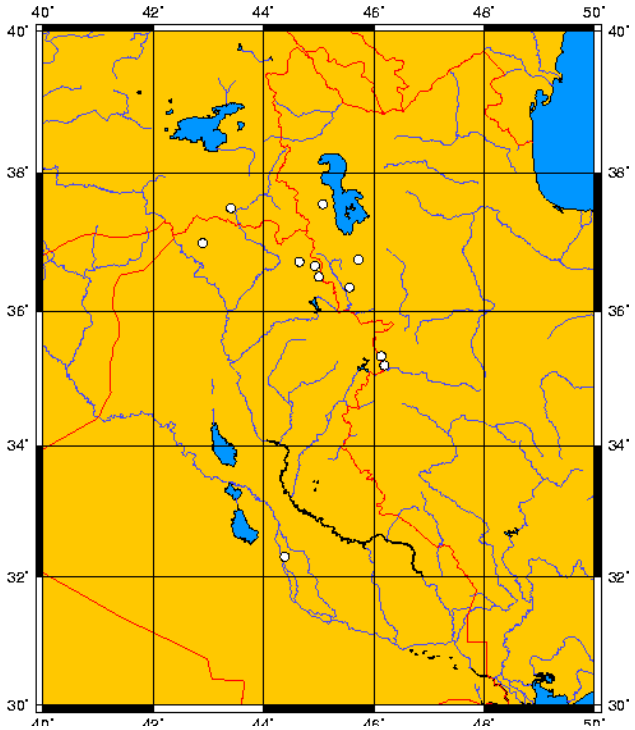

Figure 2.8.2. Distribution of *Prunus carduchorum* [N. Syria, N. Iraq, N.W. Iran and E. Turkey].

9. Prunus argentea (Lam.) Rehder, J. Arnold. Arbor. 3: 27. 1922. *Amygdalus argentea* Lam., Encycl., 1, 1: 103. 1783.

Amygdalus orientalis Duham., Traite Arb. Arbust., 1: 48. 1755. *Prunus orientalis* (Duham.) Koehne, Dendr. 315. 1893, non *P. orientalis* Walp. Repert. Bot. Syst., 2, 5: 911. 1843.

Amygdalus zielinski Browicz, Karaca Arb. Mag., 1, 4: 126. 1991. – Type: Turkey. Icel, Halkali, between Abanoz and Ermenek, 50 km to Ermenek, calcareous rocks, 1400-1450 m. 29 May 1991. *Boratynski*, *Browicz*, *Zielinski 6944* (holotype: KOR)

Shrubs 0.5 - 3 m tall, with erect or spreading crown. **Bark** brown or grey, rough. **Branches** thorny; one year old twigs white tomentose, older twigs grey - brown, pubescent, glabrous or glabrescent; short shoots present, 2 – 13 mm long. **Axillary buds** with scales 2 – 3 mm long, margin entire, pubescent, apex round, mucronate. **Leaves** fascicled on short shoots and alternate on annual twigs; stipules linear, 1 - 6 mm long, margin usually entire and pubescent, rarely toothed glandular and glabrous, often caducous; petiole 1 – 5 (8) mm long, white tomentose; petiolar glands 1- 4 or absent sometimes higher up on the leaf base, covered with pubescence; Blade silvery white because of the pubescence, elliptic, lanceolate, and less often obovate, oblanceolate or spathulate, 10 – 44 mm long, (3) 10 - 23 mm wide, base cuneate, glands of the basal teeth 1- 4 larger and darker than upper teeth, not different from the petiolar glands, but some down on the petiole; margins entire or sometimes obscurely crenate-serrate, teeth glandular, apex acute to round, when young or mature abaxially and adaxially white tomentose. **Inflorescences** solitary; pedicels 1-3 mm long, white tomentose. Flowers: hypanthium red, funnel shaped, 3-5 mm long, 2-4

mm wide, outside glabrous; sepals red, ovate to oblong, 3 – 4 mm long, margin entire pubescent, apex acute, sometimes round; Petals pink to pale pink, obovate, 7 – 12 mm long, base tapering, apex round notched; stamens 20 – 25. style nearly as long as stamens. **Fruits** with pedicel, 2 - 7 mm long, pubescent; drupe silvery white because of pubescence, ovate to narrow-ovate or ellipsoidal, compressed or slightly so, 10 – 26 mm long, 7 – 16 mm wide , 6 – 12 mm deep, base round, asymmetric, apex acute to round, surface densely silvery-white tomentose; mesocarp splitting at maturity; endocarp brown to light-brown, ovate to narrow-ovate, compressed, 9 – 24 mm long, 6 – 15 mm wide, 5 – 11 mm deep, base round, sometimes asymmetric, apex acute to round, sometimes mucronate, ventral obtusely keeled, surface pits sometimes present, 2 long furrows along the keel and short furrows start from the base becoming shallow and disappearing towards apex. Figure 2.9.1 and Figure 2.9.2.

Phenology. Flowering: Mar - May; fruiting: May – Jul.

Distribution. Lebanon, Syria, Turkey, Iraq and W. Iran. Figure 2.9.3.

Habitat. Common in open grazed oak forest, on rocky limestone sloppy hillsides, also on dry silt and on steep river stream banks. Growing at elevations between 500 – 2000m.

Discussion

Prunus argentea is easy to identify, having diagnostic characters that are unambiguous and obvious. It is a thorny bush that is heavily white-tomentose, and can be recognized from a distance. Leaves, stems, and fruits are all covered with the white – silvery pubescence. Species that might be confused with it include *P. kotschyi* which is also very thorny and densely covered with yellowish pubescence, not white-silvery pubescence. Seeing specimens of both species together makes the difference very obvious.

REPRESENTATIVE SPECIMENS EXAMINED

Iran. KERMANSHAH: Route Kermanshah - Qasr-e-Shirine, 19 km NW of Shahpasand, 24 Jun 1965, *H. Pabot* (G); ZANJAN: 52 km SW Zanjan towards Bijar, 30 Jun 1971, *K. H. Rechinger 42391* (G). **Iraq**. Kantur, 10 May 1947, *A. Rawi 8613* (K); ARBIL: Kurdistania: (Assyria Orient): In montis Kuh-Sefin. reg. supra pagum Schaklava (ditiones Erbil), 11 May 1893, *J. Bornmuller 1038* (WU); near Razan, 25 Apr 1951, *H. F. Mooney* (K); Jarmo, (as from Diyana-Rowanduz distr.), 22 May 1955, *H. Helbaek 1861* (K); Kurdistania: (Assyria Orient): In montis Kuh-Sefin. reg. supra pagum Schaklava (ditiones Erbil), 10 May 1893, *J. Bornmuller 1039* (WU); AS-SULAYMANIYAH: Ameret near Qara dagh, 21 Jun 1957, *R. W. Haines 1128* (K); Hawraman mt. (Hamara Birza), 24 Jun 1960, *Rawi, Husham & Nuri 29528* (K); Hawraman mt. above Darimar, 6 Aug 1948, *Gillett 11880* (K); Kamarspa (on the road between Halabja & Tawela), 18 Jun 1957, *A. Rawi 22197* (K); Qara Dagh ridge, May 1958, *M.E.D. Poore 601* (K); Qarachitan, 18 Apr 1947, *Gillett 7731* (K). **Lebanon.** BEKAA: above Hermel, Jbab Homr, 12 Sep 1957, *H. Pabot 12038* (G); Baalbeck, 15 Jun 1947, *H. Pabot 8998* (G); Ras Baalbeck, 8 Jun 1938, *H. Pabot 6433* (G); Rashayya, Mt Hermon, 24 Sep 1950, *E. Chapman 47* (K); MONT-LIBAN: Wadi al Karm, 26 Mar 1954, *H. Pabot* (G); Wadi al Karm, 26 Mar 1954, *H. Pabot* (G). **Syria.** AL-HASAKA**:** : Mesopotamia: Prope vi ci ruinas Gharra in medio perdis septentrionalis. Montium Dschebel Abd el Asis, 21 Jun 1910, *Handel-Mazzetti 1716* (WU); Mount Abd el Aziz, 17 May 1955, *H. Pabot* (G); ALEPPO: Aleppo, 4 Apr 1037, *H. Pabot 5922* (G); Aleppo, 4 Apr 1937, *H. Pabot 5923* (G); Ouroum es-Soughra, 19 Mar 1957, *H. Pabot* (G); Route of Aafrine, after Qatima, 18 Mar 1956, *H. Pabot* (G); IDLIB: between Idlib and Eriha, 20 Oct 1953, *H. Pabot* (G); Idlib, Mar 1940, *H. Pabot DL174* (G); Idlib, May 1951, *H. Pabot DL240* (G); Kafer Rouma, 23 Apr 1954, *H.*

Pabot 11077 (G); Maaret An-Nouman, 17 Apr 1952, *H. Pabot* (G); Mhannbel, between Jisr As-sughour and Eriha, 15 Feb 1956, *H. Pabot* (G); RIF-DIMASHQ**:** Ad Dimas, 18 Mar 1888, *E. Peyron 1631* (G); Mount Qasiyun, 3 Feb 1953, *H. Pabot* (K); Mount. Maaloula, 1 May 1951, *H. Pabot* (G); Mount. Qasiyun, 21 Mar 1952, *H. Pabot 92* (G); Qasiyun, 21 Mar 1952, *H. Pabot* (G); Qasiyun, 3 Apr 1954, *H. Pabot* (K); Qornet el Massadi, N. of Qtaife, 15 May 1953, *H. Pabot* (G). **Turkey.** *Aucher-Eloy 4470* (K); Marash, 13 Sept 1884, *Post, George 7830* (BEI); Marash, 1889, *Post, George 7827* (BEI);: Mardin, 1881, *Post, George 7832* (BEI); River Oronte, 4 Jul 1936, *H. Pabot 5419* (G); ADANA: between Ulukishla to Pozanti, 6 Apr 1934, *E. K. Balls 645* (K); ANKARA: Angora, 2 May 1933, *E. K. Balls 207* (K); Ankara steppe, 12 Apr to 28 May 1932, *W. Kolte* (K); Hajikadun valley m. Kecioren, 9 Jul 1941, *P. H. Davis 13160* (K); ANTALYA: [Province Antalya]. Dist. (Celaiz) Pisidia: Kozlu-dere N. of Bozburun Dag., 27 Jul 1949, *P. H. Davis 15756* (K); GAZIANTEP ILI: Gaziantep, 21 Apr 1934, *E. K. Balls 813* (K); ISPARTA: village Sarkikaragac before Cicelpiuar, 30 Mar 2002, *A. Charpin 26602* (G); KAHRAMANMARAS: Ahir Dagh, 2 May 1957, *Davis 27469* (K); NIGDE: Ulukisla - Pozanti, 2 Apr 1957, *Davis 26295* (K); SANLI URFA: [Birejik]. Seidun - Baghtsche, 2 Dec 1889, *P. Sintenis 124* (K).

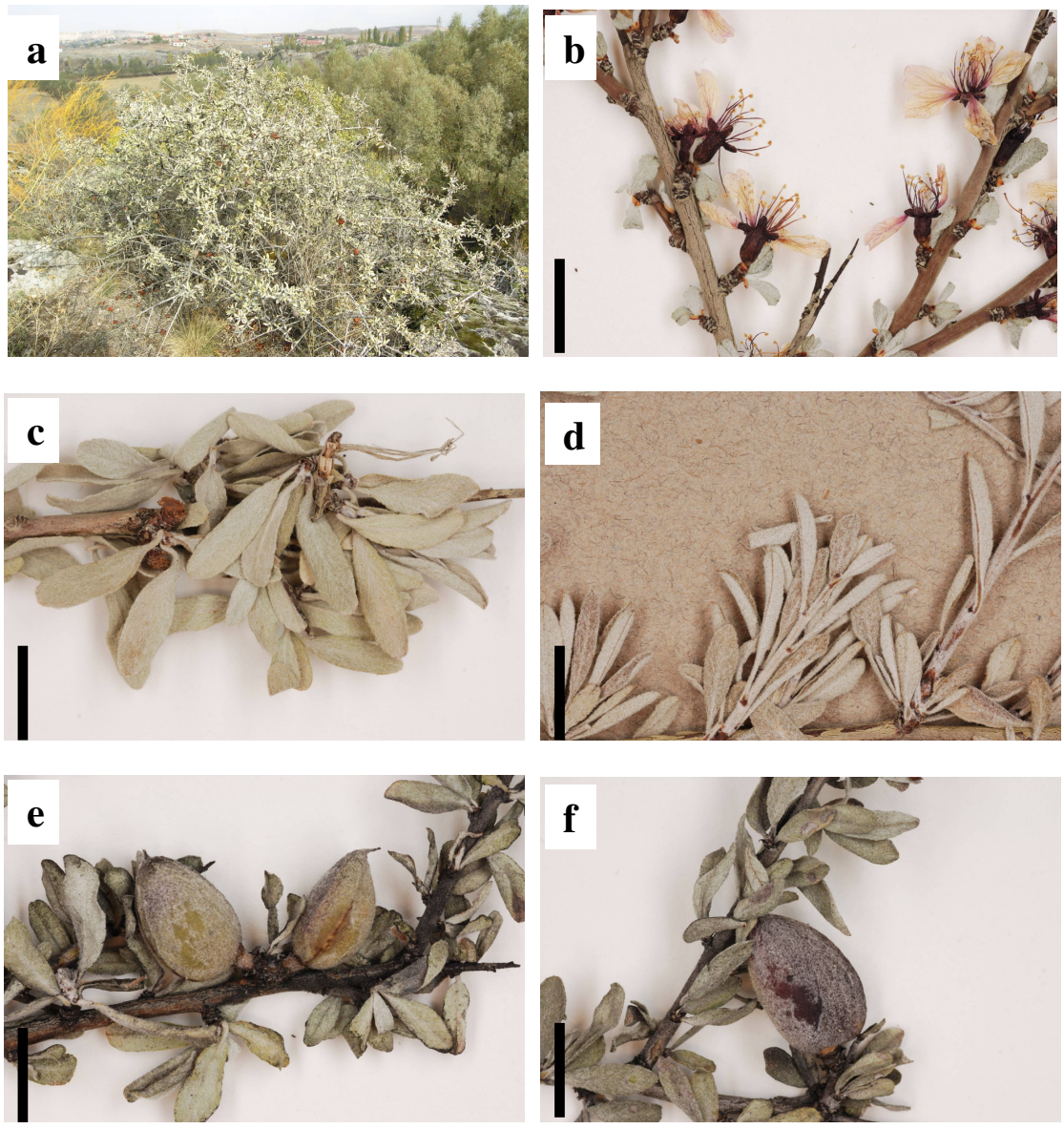

Figure 2.9.1 ***Prunus argentea***. a. habit; b. flowers; c,d, leaves; e.f. fruits. [Scale = 1 cm.]

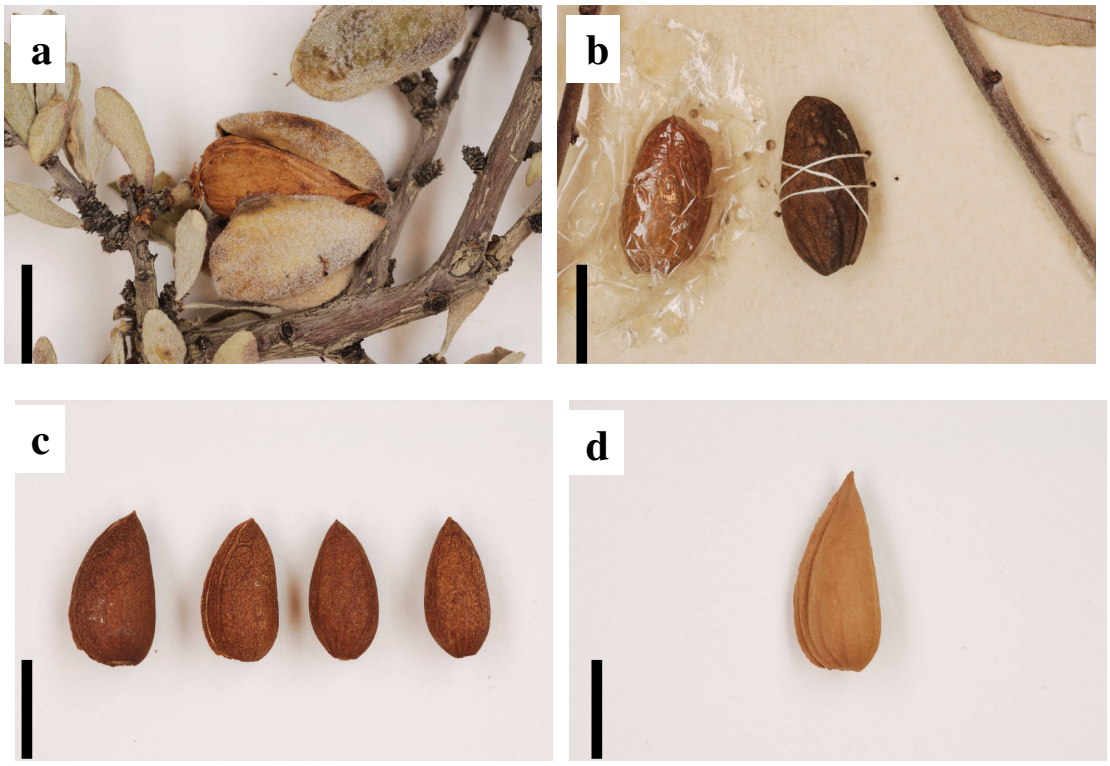

Figure 2.9.2. ***Prunus argentea***. a. splitting mesocarp; b,c,d. endocarp. [Scale = 1 cm.]

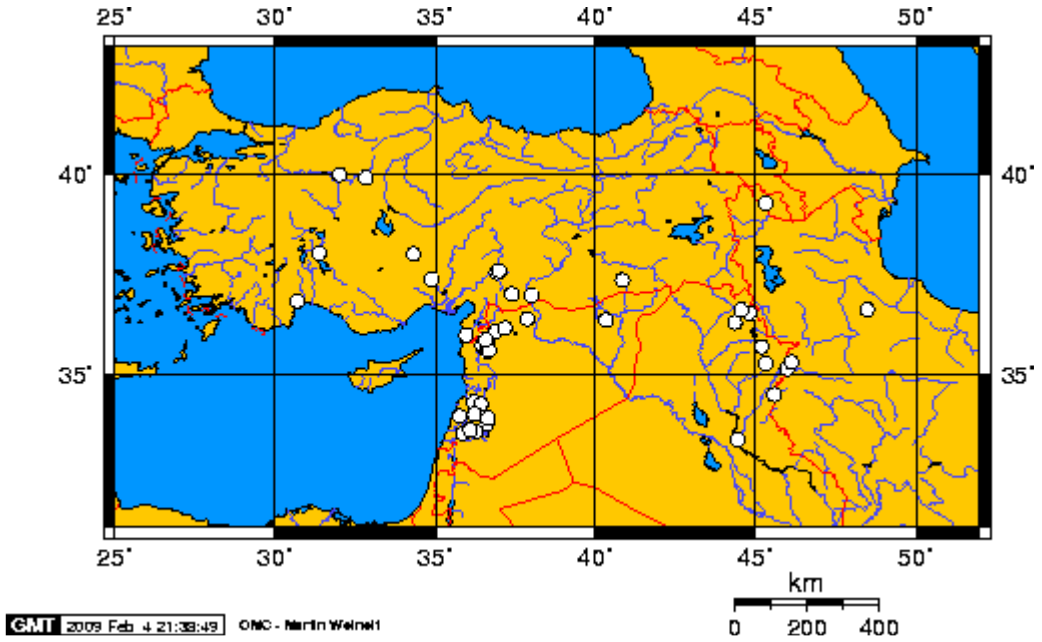

Figure 2.9.3. Distribution of *Prunus argentea* [Lebanon, Syria, Turkey, Iraq and W. Iran].

10. Prunus discolor (Spach) Schneider, Ill. Handb. Laubholzk. 1: 591 1905.

Amygdalus discolor (Spach) Roemer, Fam. Nat. Syn. Monog, 4: 12. 1847.

Amygdalus orientalis Mill. var. *discolor* Spach, Ann Sci. nat., Bot. ser. 2. 19: 119. 1843. – TYPE: "Plant. Exsicc., cum *Amygdalo orientali*, sub *n. Aucher Eloy 1427"* (P!).

Amygdalus graeca Lindley, in Sibth. & Smith. Fl. Graec. 10: 71. 1840. – TYPE: Turkey. Izmir, Bursa, between Smyrna (Izmir) and Brussa (Bursa), *Sibthorp* (K!), non: *Prunus graeca* Desf. ex Steud., Nomencl. Bot., 2: 403. 1841- nom. illeg. nom. superfl.

Shrubs 1 -2 m tall, with spreading crown. **Bark** dark grey-brown. **Branches** densely thorny; one year old twigs white tomentose, older twigs grey-brown, white tomentose, glabrescent; short shoots present. **Axillary buds** with scales 1 – 2 mm long, margin entire, pubescent, apex round, mucronate. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules linear, ca. 2 mm long, margin toothed glandular, sometimes sparsely pubescent or glabrous, often caducous; Petiole 1- 3 mm long, white tomentose; petiolar glands absent; Blade abaxially densely white tomentose, adaxially dark green and glabrous, obovate, rarely oblanceolate or spathulate, 12 – 20 mm long, 5 - 9 mm wide, base, cuneate, glands of the basal teeth 2-3, larger than glands of the upper teeth, purplish, margins looks entire, but sometimes obscurely crenate, teeth glandular, apex acute to round, sometimes retuse, when young or mature abaxially densely white tomentose, adaxially only midvein white tomentose. **Inflorescences** fascicled on short shoots; pedicels green, 1-2 mm long, white tomentose. **Flowers** with hypanthium campanulate, 3 4 mm long, 2 - 5 mm wide, outside glabrous; sepals green, triangular, 2- 4 mm long, margin entire, entirely pubescent or only at margin and apex, apex acute; petals pink

becoming whitish, obovate to round, 7 – 13 mm long, base cuneate to tapering, apex round notched; stamens 20 – 25; style nearly as long as stamens. **Fruits** with pedicel, 1 - 3 mm long, pubescent; drupes green, ovoid slightly asymmetric, compressed or not, 13 – 17 mm long, 7 – 12 mm wide , 7 – 9 mm deep, base round, apex acute to round, surface covered with white pubescence, becoming glabrescent; mesocarp 0.7 – 1.2 mm, splitting at maturity; endocarp brown, ovate, slightly asymmetric, compressed or slightly so, 13 – 16 mm long, 6 – 10 mm wide, 7 – 8 mm deep, base round, slightly asymmetric, apex acute to round, ventral suture obtusely keeled, surface pits absent, 2 furrows along the keel and reticulate furrows allover present, deep or shallow. Figure 2.10.1.

Phenology. Flowering: Jan - Mar; fruiting: Jun – Sep.

Distribution. Greece, N.W., C. & S.W. Turkey. Figure 2.10.2.

Habitat. In *Quercus* scrubs and openings, on limestone on rocky hillsides. Growing at elevations between 10 – 600 (850) m.

Discussion

Prunus discolor is a very distinctive shrub that is not easily confused with any other species. Its diagnostic character, of leaves that are densely white tomentose only on the abaxial side, while dark green and glabrous on the adaxial side, makes it one of the easiest species of the *Amygdalus* group to identify.

Amygdalus graeca was first described in Flora Graeca (1840), by Lindley who emended nomenclature in the index, where the diagnosis can be found. Its name and diagnosis was based on an illustration of a plant collected by Sibthorp from Turkey between Izmir and Bursa (Flora Graeca 5:61, t. 477).

In 1843, Spach described what he suspected is a variety of *Amygdalus orientalis* var. *discolor*, based on two collections, one near Aleppo, Syria (Halep) by Conquebert de

Montbret (Herb. Cl. Webb) and one by Aucher Eloy (Plant. Exsicc., cum *Amygdalo orientali*, sub n. 1427, in Herb. Mus. Par). Roemer (1847) recognized Spach's variety as a species, *Amygdalus discolor*. Finally, when Schnieder (1906) recognized *Amygdalus* within *Prunus*, he reviewed and cited both Spach and Roemer, and agreed with the latter that it is "sufficiently" distinct to merit a specific rank and made the new combination *Prunus discolor*. Spach. Roemer and Schneider did not review Lindley's *Amygdalus graeca* or cite it.

REPRESENTATIVE SPECIMENS EXAMINED.

Greece. Insular Rhodos. mountain Marmara prope Lindos, 25 Jun 1935, *K. H. and F. Rechinger 8457* (K). **Turkey.** ANTALYA: Konya Alti, 24 Jan 1936, *T.A. Tengwall 68* (K); Kumluca, Altinyaka road, Gozeren village, 12 Feb 1995, *A. A. Donmez 4299* (BH); Kumluca, Altinyaka road, Gozeren village, 12 Feb 1995, *A. A. Donmez 4301* (BH); ad Duden prope Elmalu, 3 Jun 1860, *E. Bourgeau* (W); BURDUR: In rupestribus ad Duden prope Elmalu, 3 Jun 1860, *E. Bourgeau 123* (K); DENIZLI: 20 km SE Serigol, 6 Apr 1983, *P. Buchner B83-46-5* (W); Afyon province border, around Acigol, Kiyalik, 23 May 2001, *A. A. Donmez 8913* (BH); ISPARTA: near ruins of Aryleanda, 25 Apr 2000, *A. Charpin 26279* (G); Sutculer, between Candir and Alibenli, 29 Aug 2003, *A. A. Donmez 3980* (BH); Sutculer, between Candir and Alibenli, 29 Aug 2003, *A. A. Donmez 3978* (BH); IZMIR: Kemalpasa, 1 May 1966, *H. Pesmen 813* (G); MANISA: Salihli, Adali village, 4 Apr 2001, *A. A. Donmez 8357* (BH); MUGLA: Zwischen Knidos u Datca, 19 Apr 1984, *Friederike Sorger 84-8-40* (W); Fethiye, Gocek maden yolu, 10 Mar 1968, *Meyer, H. Pesmen, G. Oguz, S. Oflas, E. Leblebici 47061* (G); Fethiye, Kaya. 50 m Phrygana on hillsides, *Davis 25443* (K);

Marmaris, Cumali to Resadiye, 17 Apr 1965, *Davis 41257* (K); TRABZON: Molah [Mula], *Aucher 1833* (W).

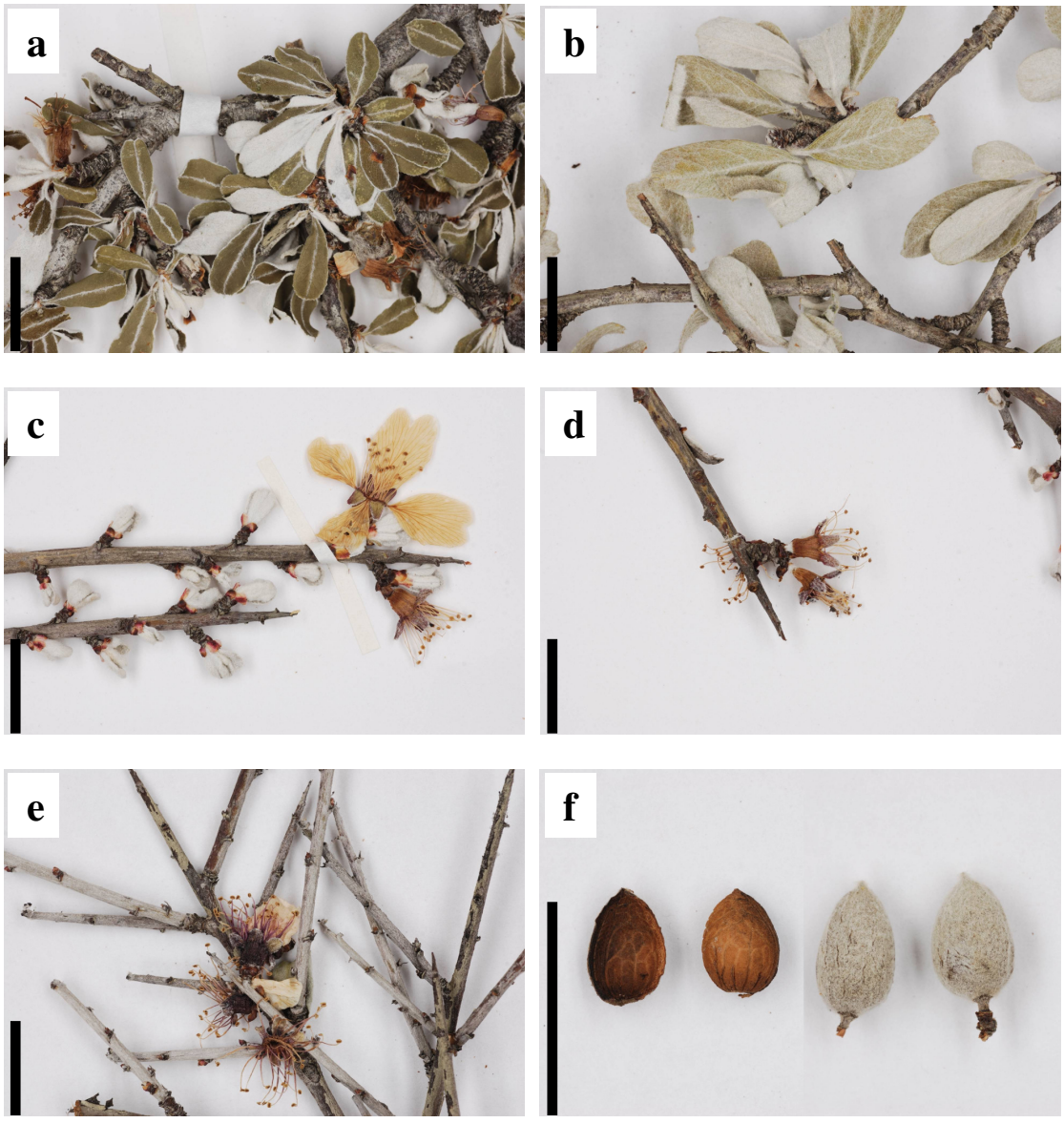

Figure 2.10.1. *Prunus discolor*. a, b, leaves; c, d, e. flowers; f. fruits and endocarp. [Scale = 1 cm.]

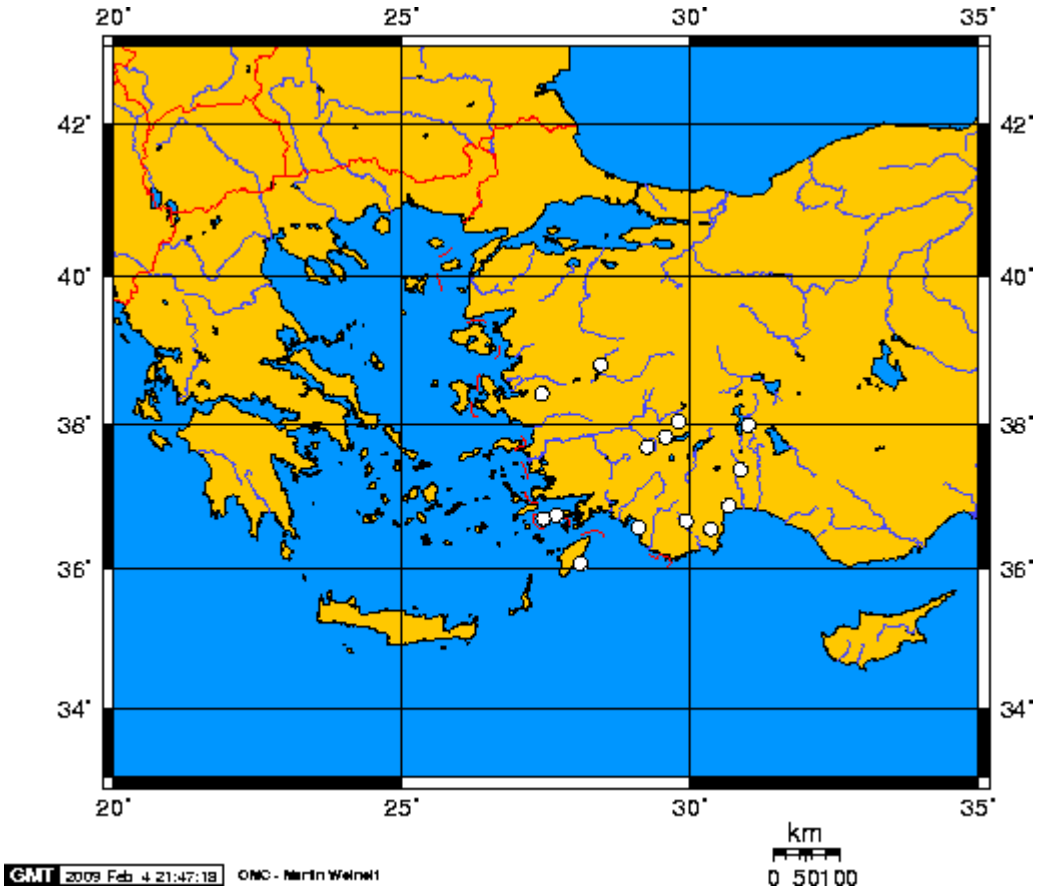

Figure 2.10.2. Distribution of *Prunus discolor* [Greece, N.W., C. & S.W. Turkey].

11. Prunus elaeagnifolia (Spach) A.E.Murray, Kalmia 1: 30. 1969. *Amygdalus elaeagnifolia* Spach. Ann. Sci. nat., Bot. ser 2: 120. 1843. – Type: Iran. Khorasan: Mount Pere-zend [Birjend], Jun 1838, *Aucher-Eloy 4470A* (P!). *Amygdalus leiocarpa* Boiss., Diagn. Pl. Orient., ser. 1, 6: 52. 1846. *Amygdalus elaeagnifolia* Spach subsp. *leiocarpa* (Boiss.) Browicz, in K. H. Rechinger, Fl. Iranica. Lief. 175. 1969. – TYPE: Iran. Near ruins Persepolis, 16 Apr 1842, *Th. Kotschy 243* (G!; K!; LE!).

Shrubs or trees 3 – 4 m tall, with spreading crown. **Bark** grey - brown. **Branches** somehow thorny; one year old twigs green sometimes reddish on exposed

side, pubescent or glabrous, older twigs grey pealing to show yellowish-brown, pubescent, glabrescent or glabrous; Short shoots present. **Axillary buds** with scales 1 – 2 mm long, margin entire, ciliate, apex round mucronate. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules intrapetiolar, linear, 1 - 2 mm long, margin entire, pubescent, often caducous; petiole 1 - 4 mm long, pubescent or glabrous; petiolar glands absent; blade green, mostly elliptic to oblong, rarely obovate to oblanceolate, or ovate-lanceolate, 11 – 21 (29) mm long, 5 – 8 (11) mm wide, base round to broadly cuneate, glands of the basal teeth 1- 3, larger and darker than upper teeth, margins looks entire but obscurely toothed, teeth glandular, apex acute to round, mucronate, when young or mature abaxially pubescent or glabrous, adaxially pubescent, sparsely so, or glabrous. **Inflorescences** solitary; pedicels green, ca. 1 mm long, pubescent or glabrous. **Flowers** with hypanthium reddish, campanulate, 3 – 5 mm long, 3 – 4 mm wide, outside glabrous; sepals reddish, ovate, 2 – 3 mm long, margin entire, ciliate or sometimes pubescence only towards apex or glabrous, apex acute; petals pink, obovate to broadly obovate, 8 – 12 mm long, base tapering, apex round notched; stamens 20 – 25; style shorter than stamens. **Fruits** with pedicel 2 – 3 mm long, pubescent or glabrous; drupes green, long-ovate to oblong, asymmetric, compressed, 14 – 25 mm long, 11 – 15 mm wide, 7 – 10 mm deep, base round, asymmetric, apex round, asymmetric, surface pubescent, very rarely glabrescent; mesocarp splitting at maturity; endocarp brown to light brown, long-ovate to oblong asymmetric, compressed, 13 – 24 mm long, 9 – 14 mm wide, 6 – 9 mm deep, base round, asymmetric, apex acute to round, asymmetric, ventral suture keeled, surface pits and grooved pits present, short furrows sometimes from base and along keel disappearing. Figure 2.11.1. and Figure 2.11.2.

Phenology. Flowering: Mar - Apr; fruiting: Late Apr – Aug.

Distribution. W and S. Iran. Figure 2.11.3.

Habitat. In semi deserts and degraded forest areas, on rocky mountain slopes and in valleys in calcareous soils. Growing at elevations between 1600 – 2300 m.

Discussion

Prunus elaeagnifolia is not easy to distinguish from *P. argentea* and *P. kotschyi*, with the latter originally described as a variety of *P. elaeagnifolia* by Spach (1843) and later split from it as a species by Meikle (1966). The leaf shape is mostly broadly elliptic, which makes it similar to *P. argentea;* and the color of pubescence (yellowish) makes it easily confused with *P. kotschyi*. Meikle (1966) recognized *P. argentea* var. *elaeagnifolia*, a decision that seems very well justified. In this treatment, *P. elaeagnifolia* is still recognized as a species since a final decision is not possible only based on the literature, and the available herbarium specimens. No field observations were made in this study of this species, and it requires further work for a final determination. Browicz, in Flora Iranica (1969), recognized Boissier's (1846) species *Amygdalus leiocarpa* Boiss, as a variety of *P. elaeagnifolia*. This form is glabrous, and can be easily differentiated from the densely pubescent *P. argentea* and *P. kotschyi*; however, it might be confused with the sympatric *P. haussknechtii*. See the discussion under *P. haussknechtii* for differentiating characters.

REPRESENTATIVE SPECIMENS EXAMINED.

Iran. CHAHAR MAHALL AND BAKHTIARI: 40 km S Gandoman, Dorahun, 8 Jul 1959, *H. Pabot 2261* (G); Rehehel-Gurd, after tunnel Kuh-Rang, 6 Jul 1959, *H. Pabot 2153* (G); FARS: 43 Km E. Kazerun, summit of Kotal Rortar, 10 May 1959, *H. Pabot 987* (G); 50 km W. Shiraz, 29 Apr 1961, *H. Pabot 6150* (G); 68 km NE Persepolis, 12 Jul 1959, *H. Pabot 2380* (G); 75 km NW. Ardakan, 14 Jul 1959, *H. Pabot 2433* (G); 77

km W. Shiraz, summit of Kotal - Rorhtar, 29 Apr 1961, *H. Pabot 6131* (G); 82 km NW Ardakan, 14 Jul 1959, *H. Pabot* (G); near Lake Neiriz [Niriz, Neyriz], *Gauba 396* (W); Niriz [Neyriz], 29 Mar 1940, *Walter Koelz 14707* (W); 58 km W of Shiraz, 16 Apr 1964, *Martin L. Grant 15535* (W, MO); Near ruins Persepolis, 16 Apr 1842, *Th. Kotschy 243* (K); KERMAN: 69 km S. Deh Bid, 26 Apr 1961, *H. Pabot 5948* (G); Amirabad, between Jiroft and Deh Bakri, 22 Jun 1960, *Dadashzadeh 380* & *381* (G); E. of Baft, between Bezenjan and Rahbur, 7 Jul 1960, *Dadashzadeh* (G); Mt. Kuh-i Hasar, inter Kerman et Bandar Abbas, 11 Aug 1892, *J. Bornmuller 3489* (W); mt. Kuh-i Nasr, 24 May 1892, *J. Bornmuller 3484 & 3485* (W); N. of Jiroft, Chemaran, after Deh Bakri, 21 Jun 1960, *Dadashzadeh* (G); NW of Baft, Bideshk, 8 Jul 1960, *Dadashzadeh 378* (G); route of Baft, 6 Jul 1960, *Dadashzadeh* (G); in monte Kuhe Dschupar [Jupar], 7 Jun 1892, *J. Bornmuller 3484* (W); in mt Kuh-i Nasr, 24 May 1892, *J. Bornmuller 3486* (K); KHORASAN: Mount Pere-zend [Birjend], Jun 1838, *Aucher-Eloy 4470* A (P); LORESTAN: Chagini, 15 Jun 1950, *H. Sabeti 371* (W); Dorud, 18 Mar 1941, *Walter Koelz 17153* (W); TEHERAN: Kumarlu [Qumarlu], Apr 1868, *Haussknecht* (K);

Figure 2.11.1. ***Prunus elaeagnifolia***. a. leaves; b. flowers; c. fruits; d. endocarp.

Figure 2.11.2. ***P.elaeagnifolia***. a. leaves; b. fruits; c, d. endocarps. [Scale = 1 cm.]

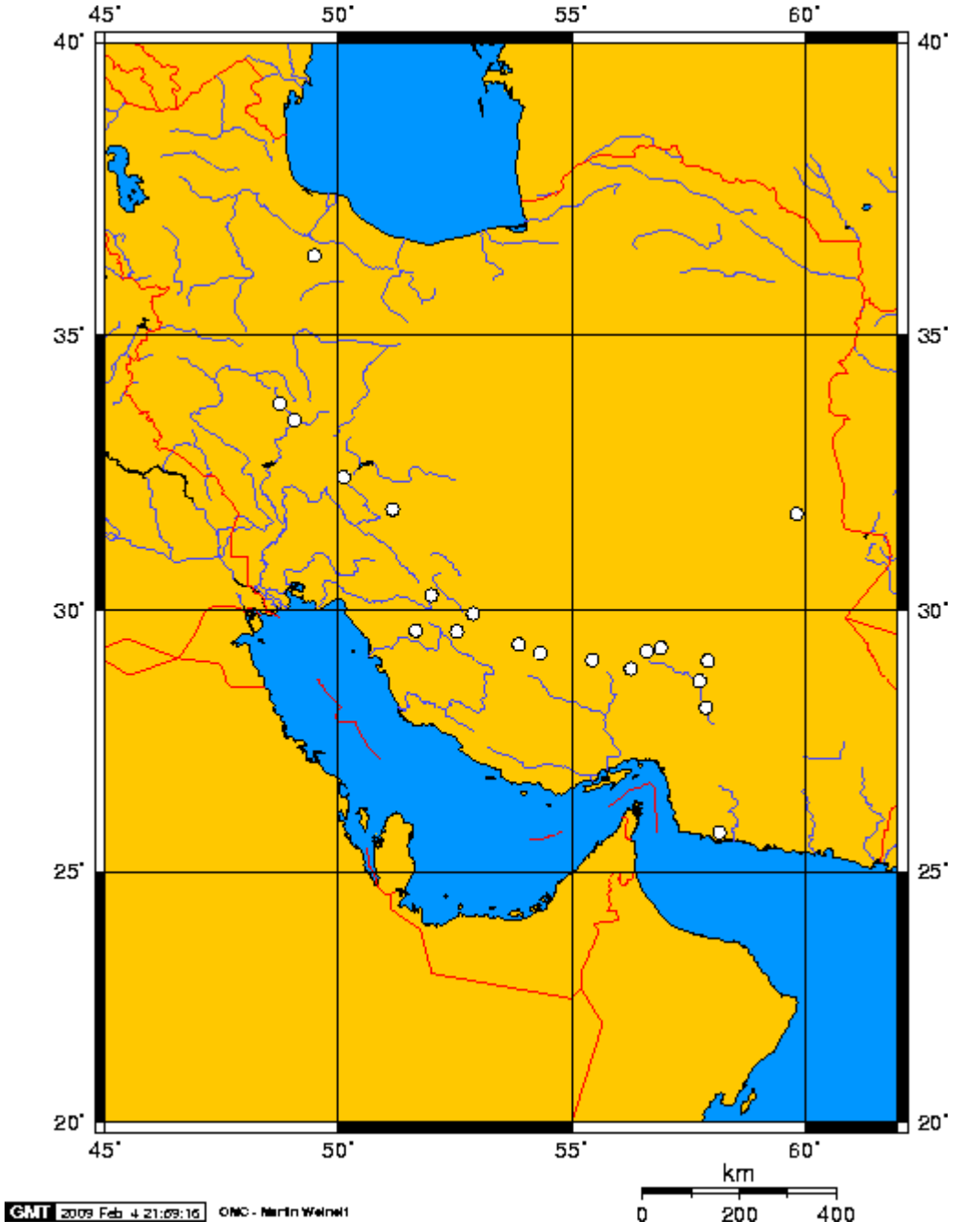

Figure 2.11.3. Distribution of *Prunus elaeagnifolia* [W and S. Iran.].

12. Prunus kotschyi (Hohen. Ex Spach) Meikle, Kew Bull. 19: 229. 1965. *Amygdalus kotschyi* Boiss. & Hohen., Ky. Pl. exs. 1841. *Amygdalus kotschyi* Hohen. ex Spach, Ann. Sci. Nat., Bot. ser. 2, 19: 117. 1843. *Amygdalus elaeagnifolia* Spach var *kotschyi* (Hohen. Ex Spach) Boiss., Fl. Orient.: 643 1872. – Type: Kurdistan, Mount Gara, 27 Jul 1841, *Th. Kotschy 338* (W! P! MO! G! LE! K!).

Dense shrubs up to 1.2 m tall, with spreading crown. **Bark** brown-grey. **Branches** somehow thorny; one year old twigs brown-green, densely pubescent, older twigs brown-grey, pubescent, glabrescent or glabrous; short shoots present. **Axillary buds** with scales 2 – 3 mm long, pubescent all over or only at margin, margin entire, apex round. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules linear, wide at base, 2 – 5 mm long, margin entire, pubescent, sometimes caducous; petiole 1 – 2 mm long, pubescent; petiolar glands absent; blade green but looks grayish because of pubescence, lanceolate, oblong-lanceolate, rarely slightly oblanceolate, (13) 20 – 40 (50) mm long, 5 – 15 mm wide, base, cuneate or decurrent, glands of the basal teeth 1 – 2, but rarely apparent because of dense pubescence, margins looks entire but obscure teeth glandular, apex acute, mucronate, when young or mature abaxially and adaxially yellowish-grey tomentose. **Inflorescences** usually fascicled in pairs with a vegetative shoot in the middle; pedicels 1 – 5 mm long, pubescent. **Flowers** with hypanthium reddish, campanulate, 3 – 5 mm long, 3 – 4 mm wide, outside glabrous; sepals reddish, ovate, 2 – 4 mm long, margin entire, ciliate, apex acute; petals pink, oblong to obovate, 6 – 10 mm long, base cuneate to tapering, apex round notched; stamens 20 – 25; style nearly as long as stamens. **Fruits** with pedicel, 2 – 5 mm long, pubescent or glabrous; drupes green but looks grey because of pubescence, long ovate to ellipsoidal, slightly asymmetric, sometimes slightly compressed, 13 – 19 (25) mm long, 9 – 12 (15) mm wide , 8 – 10

(13) mm deep, base round, apex round, surface with yellowish - grey pubescence; mesocarp splitting at maturity; endocarp brown, ellipsoidal asymmetric, compressed, 12 – 17 mm long, 8 – 10 mm wide, 7 – 9 mm deep, base round, asymmetric, apex acute to round asymmetric, ventral suture indistinctly keeled, surface smooth or pits present, or with short shallow furrows. Figure 2.12.1.

Phenology. Flowering: Early Apr – End May; fruiting: Jun – Jul.

Distribution. N.E. Iraq, W. Iran. Figure 2.12.2.

Habitat. Oak forest and woodlands, growing on rocks on limestone slopes and mountain ridges. Growing at elevations between 1400 – 2450 m.

Discussion

Prunus kotschyi is easily recognized for having a very thorny habit and a densely pubescent leaves, stems and fruits with the pubescence being yellowish, which differentiates it from *P. argentea* characterized by a white silvery dense pubescence.

REPRESENTATIVE SPECIMENS EXAMINED.

Iran. AZARBAYJAN-E GHARBI: 34.5 km S. Mahabad, 16 Oct 1960, *H. Pabot 5488* (G); 81/83 km S. Mahabad, 16 Oct 1960, *H. Pabot 5507* (G); Azerbaijan, 8 Jul 1884, *J. A. Knapp 1022* (WU); Gardaneh-ye Zamziran Pass S. Mahabad towards Sardasht, 8 Jul 1974, *K. H. Rechinger 49085* (G); CHAHAR MAHALL VA BAKHTIARI: 13 S. Dorahun, 9 Jul 1959, *H. Pabot 2302* (G); HAMADAN: Aq Bolagh, 90 km N. Hamadan, Spring-Summer 1960, *H. Pabot AB258* (G); Aq Bulaq, ca. 100 km N. Hamadan, 15 Apr - 1 Jul 1960, *Rioux & Golvan 258* (W); KERMANSHAH: near Bisitun, 24 Apr 1903, *Th. Strauss* (JE); 40 km SW Shahabad, between Shahabad and Ilam, 2 Jun 1960, *A. Bent & H.E. Wright 602-506* (W); LORESTAN: Safed Kuh, 21 May 1941, *Walter Koelz 17521* (W); MAZANDARAN: M. Elburs, 01 Jul 1971, *S. C. Klein 1720* (W). **Iraq.**

ARBIL: Kurdistania: (Assyria Orient): In montis Kuh-Sefin. reg. supra pagum (ditiones Erbil), 21 May 1893, *J. Bornmuller 1037* (WU); Mount Handren near Rawanduz, Jun 1952, *C. Regel 17* (G); Mount Gara, 27 Jul 1841, *Th. Kotschy 338* (P); Pir Omar Gudrun, 19 Apr 1947, *Gillett 7799* (K); Pir Omar Gudrun, Jun 1867, *Haussknecht 354* (JE); Sefin Dagh, Shaqlawa, 9 Apr 1958, *O. Polunin 5016* (K).

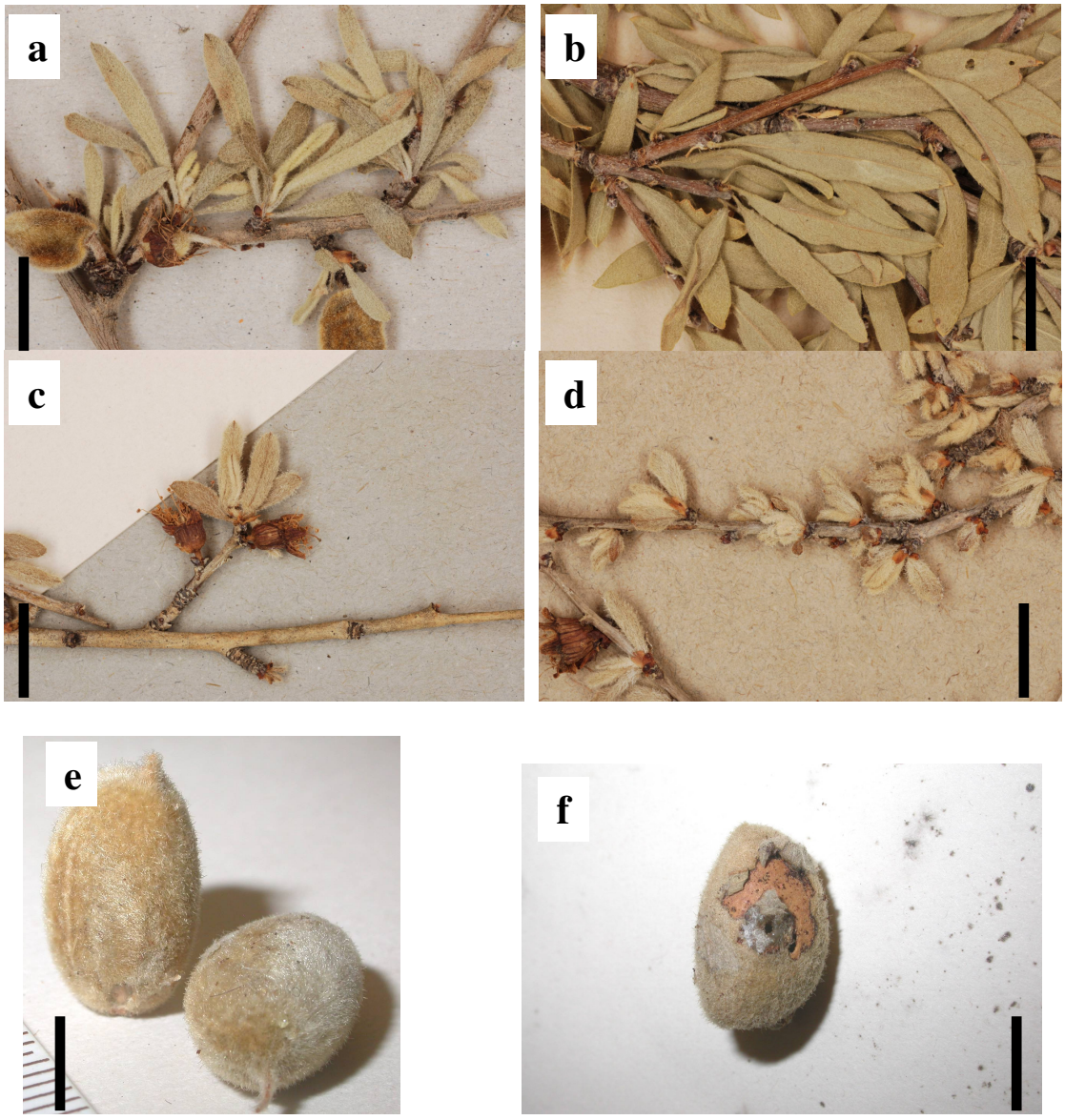

Figure 2.12.1. ***Prunus kotschyi***. a, b, leaves; c. flower; d. leaves; e,f. fruits; f. endocarp. [Scale = 1 cm.]

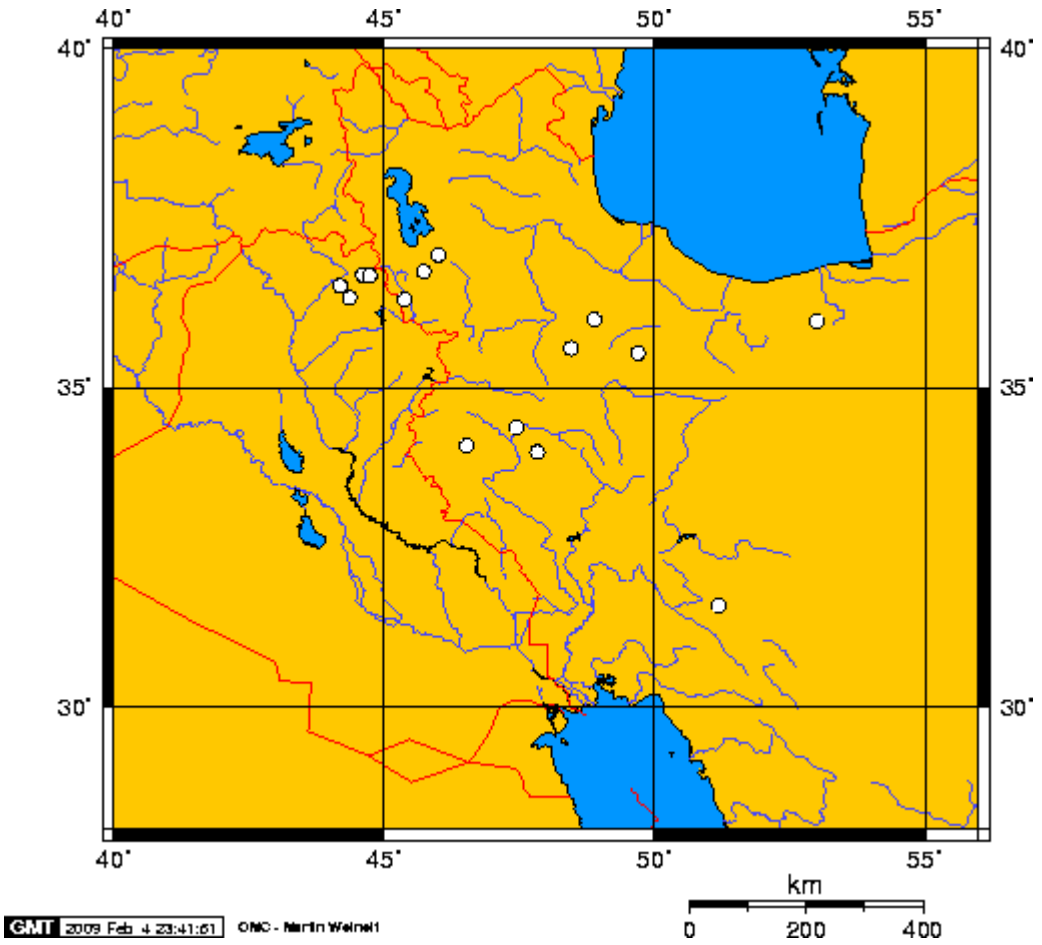

Figure 2.12.2. Distribution of *Prunus kotschyi* [N.E. Iraq, W. Iran].

13. Prunus arabica (Olivier) Meikle, Kew Bull. xix. 229. 1965. *Amygdalus arabica* Olivier, Voy. t. 47. 1807 – Type: Iraq. In Arabic desert near Euphrate, not at all unconnected with Anah, Olivier, 1806 (P!)

Amygdalus spartioides Spach, Ann. Sci. Nat. ser. 2, 19: 108. 1843. *Prunus spartioides* Schneid., Ill. Handb. Laubholzk. i. 590. 1905. – Type: Lebanon, near Zahle Labillardiere, (FI) [I have seen only one specimen collected by Labillardiere, it says: *Amygdalus arabica* H. Poiret de Syria. Labillaridiere], and also Iraq, Aucher Eloy, 1425 (P!), and Coquebert de Monbret (FI); Iran, Pire Zend, not at

all unconnected with that from city Shiraz, Aucher Eloy, Plant Exsicc. N. 4472 (P!)

Amygdalus agrestis Boiss., Diagn. ser. 1, 10. x. 1. 1846. *Prunus agrestis* Jord. & Fourr. In Brev. Pl. Nov. 2: 37. 1868. See also Jord, Icon. Fl. Eur. 1: 56, t. 155. 1868. *A. spartioides* Spach var. *arrests* (Boiss) Post, Fl. Syr. Palest. Sinai. 302. 1896. – Type: Syria. Between Baalbeck and Zahle [in Bekaa, Lebanon], June 1846. Boissier (P!)

Broomlike shrub 1- 3 (4) m tall, with upright (ascending) crown. **Bark** brown. **Branches** thornless; one year old twigs green, glabrous, older twigs green, glabrous, short shoots absent. **Axillary buds** one, brown, ovate, adaxial side flat, apex convex to round, (2) 4-5 (6); scales (2) 4 – 5 mm long, margin entire, pubescent, apex round, mucronate, splitting when dry, usually persistent at base of fruit. **Leaves** conduplicate in bud, alternate only, not fascicled, deciduous early in the drought season; stipules sometimes branched, 2 – 5 mm long, with wide base, margin toothed-glandular, linear towards the apex, glabrous, often caducous; petioles to 6 (8) mm long, green, glabrous; petiolar glands absent; blade green, narrow-lanceolate, narrow-elliptic to linear, sometimes narrow-oblanceolate, 15 – 46 mm long, 2 – 8 (10) mm wide, base, cuneate, decurrent, glands of the basal teeth 1 – 3 (5) larger and darker than upper teeth, margins serrate-crenate, more often obscurely so, teeth glandular, apex acute, mucronate, when young or mature, abaxial surface sparsely pubescent on midvein, adaxial surface glabrous. **Inflorescences** solitary; pedicels green, up to 3 mm long, glabrous. **Flowers** with hypanthium dark-red, broadly campanulate to hemispheric, 2 – 5 mm long, 3 – 7 mm wide, glabrous; sepals dark red externally, green internally, 2 –

5 (6) mm long, margin entire, densely pubescent, pubescence curly, apex acute; petals white, pale pink, or pink, round, broadly oblong or obovate, 5 – 13 mm long, base cuneate, apex round notched; stamens 20 – 35; Style longer than stamens, lower part pubescent, often persistent in fruit. **Fruits** with pedicel, up to 5(6) mm long, glabrous; drupe ovate, long-ovate, or round in cross-section, compressed or slightly so, 11 – 20 mm long, 8 – 13 mm wide, 7 – 10 mm deep, base round, sometimes slightly asymmetric, apex acute to round, surface glabrescent as drupe matures; mesocarp splitting at maturity; endocarp brown to light brown, ovate, long-ovate or round in cross-section, compressed, 13 – 19 mm long, 8 – 11 mm long, 7 – 9 mm deep, base round, asymmetric, apex acute to round, ventral suture with acute or obtuse keel, surface pits absent, furrows 2 along suture, and sometimes shallow furrows start from the base becoming shallower and disappear. Figure 2.13.1 and Figure 2.13.2.

Phenology. Flowering: Early Mar to Mid May; fruiting: April – Early July.

Habitat. In arid and semi arid regions, on limestone and volcanic rocky slopes, mountains and savannas; often along riversides, and gorges, dry gullies and ravines. Growing at elevations between 500 – 2700 m.

Below are the two varieties recognized within *Prunus arabica.*

KEY TO THE VARIETIES OF PRUNUS ARABICA

1. Shoots terete, Petal shape tend to be more round, Drupe ovate or long ovate……**b. P. *arabica*** var**. *scoparia***

1. Shoots angular, Petal shape tend to be more elongate, obovate to oblong , Drupe ovate, globose or subglobose……...**a. *P. arabica*** var. ***arabica***

a. *Prunus arabica* var**. *arabica***

Broomlike shrub 0.75 - 2m tall. **Branches** older than 1 year often angular; **Axillary buds** with scales 2 -3 mm. **Leaves** with petiole up to 5 (8) mm, leaf blade linear, narrow-lanceolate or narrow-oblanceolate, 15 – 44 mm long, 3-10 mm wide, margins teeth glandular. **Flowers** with pedicel up to 3 mm; hypanthium 2-3 mm long, 3-5 mm wide; sepals 2 – 4 mm long; petals oblong or obovate, 5 – 8 mm; stamens 25. **Fruits** pedicel to 6 mm; drupe ovate, long-ovate, or round, 11 – 19 mm long, 8 – 13 mm long, 8 – 10 mm deep; endocarp brown, ovate to round in cross section, length 11 mm, width 11 mm, depth 9 mm, furrows 2 along ventral suture, and short furrows starting from base, becoming shallower.

Phenology. Flowering: March - April; fruiting: April – Early July

Distribution. Lebanon, Syria, S. Turkey, N. Jordan, N. Iraq, E. Iran. Figure 2.13.3.

b. *Prunus arabica* var**. *scoparia*** stat. nov. *Amygdalus scoparia* Spach, Ann. Sc. Nat. ser. 2, 19: 109. 1843. *Prunus scoparia* (Spach) Schneider, Ill. Handb. Laubholzk. i 590. 1905. – Type: IRAN. Laristan, [current Hormozgan province]. Mountains. February 1838. *Aucher Eloy, plant exsicc. N. 4471*. (holotype: P! isotype: W!).

Broomlike shrub 1- 3 (4) m tall. **Branches** older than 1 year often terete; **Axillary buds** with scales 4 – 5 mm long. **Leaves** with petiole to 5 (6) mm long; leaf blade, linear-lanceolate, 17 – 46 mm long, (2) 4-6 (8) mm wide, margins teeth glandular. **Flowers** with pedicels to 2mm long; hypanthium 3-5 mm long, 3-7 mm wide; sepals 3 – 6 mm long; petals round, broadly oblong or obovate, 7 – 15 mm long; stamens 20 – 35. **Fruits** with pedicel to 4 mm long; drupe ovate or long ovate, 12 – 20 mm long, 8 – 13 mm wide, 7 – 10 mm deep; endocarp brown to light brown, ovate

in cross section, 13 – 19 mm long, 8 – 11 mm long, 7 – 9 mm, furrows 2 along ventral suture.

Phenology. Flowering: Early Mar to Mid May; fruiting: late Apr to late Jun.

Distribution. Iran general. Endemic. Figure 2.13.4.

Discussion

Prunus arabica can be easily distinguished from all other species within *Prunus* subg. *Amygdalus*. It has a distinctive broomlike habit, with early deciduous leaves during drought season and the lack of short shoots.

Prunus arabica and *P. scoparia* have always been recognized as separate species, however in this treatment they are considered as a single species and below is the justification.

This species has been variously split to up to 5 species. In the monograph of *Amygdalus* done by Spach (1843), A. *spartioides* Spach and *A. arabica* Olivier were recognized as two species. Later, Schneider (1906) had a new combination *Prunus spartioides* (Spach) Schneider and *P. scoparia* (Spach) Schneider, and suggested that *A. arabica* is very similar to *Prunus spartioides*, but it was Meikle (1966) who made that decision, making the new combination *P. arabica* (Olivier) Meikle, with *A. arabica* as a basionym and *A. spartioides* as a synonym. *P. arabica* and *P. scoparia* have never been lumped together, even though they have always been recognized to be very similar. The morphological differences between these two species are so small that errors have often been made in their identification of herbarium specimens.

One morphological character was emphasized to differentiate *Prunus arabica* and *P. scoparia*. It was suggested that the stem is distinctly angular in *P. arabica* while it is circular or terete in *P. scoparia*. This, however, was not always as obvious as one might think.

In his revision of this *Amygdalus* section *Spartioides*, Browicz (1969) points that the first reason for the difficulty is distinguishing these two species apart is simply an artifact of the pressing of herbarium specimens, and he suggested that one should always try to look for this character on the shoots that are more than one year old, as one year old twigs, looks angular in all specimens of both *Prunus arabica* and *P. scoparia*. However based on the examination of specimens, this did not help in placing specimens unambiguously in one or the other species, and many specimens could hold both valid arguments to be placed in either.

Another important note made by Browicz (1969) is that those specimens that are difficult to place occur mainly in southwest Iran, which is the region of contact between the two hypothesized species. Based on my observations, this was not strictly the case. Specimens with either strongly angular or somehow angular stem form, occur across the distribution region of *Amygdalus scoparia*, reaching central, southeast Iran. On the other hand, forms with circular stems occur in the area of distribution of *Prunus arabica*, have been recognized as a separate species by Boissier (1846) under the name of *Amygdalus agrestis* Boiss. There are very few collections made for the latter species, and little is known about it. There is no evidence to recognize this as a separate species. The morphological variation falls under the normal variation within a broadly circumscribed *P. arabica*.

Another species that was described in this section is *Amygdalus glauca* Browicz, to be distinguished by its glaucous leaves and stems (Browicz, 1969). Again there is very little known about this, even by Browicz himself (1969).

One character used by Schneider to differentiate *Prunus arabica* and *P. scoparia* is the shape of the petal, where it tends to be more round in *P. scoparia*, while it is more elongate in *P. arabica*. This was verified according to my

observations, this character is used in the key to identify the varieties within *A. arabica*.

REPRESENTATIVE SPECIMENS EXAMINED.

Iran. 80 mi N Ebedeh [Abadeh], 29 Apr 1961, *Howard C. Stutz 811* (W); Bieheh, 25 May 1937, *M. Koie 1527* (W); C: Kavir protected region. In montibus aridissimis in ditione Chashmeh-ye Safid Ab, *K. H. Rechinger 46422* (W); C: Kavir protected region. Siah Kuh. In refugii Karavan - Serai Shah Abbas, 23 May 1974, *K. H. Rechinger 46189* (W); Montes Elburs centr.: in ditione oppidi Kerej. In montibus ad pagum Kalak, 19 May 1937, *K. H. Rechinger 213* (W); Montes Elburs centr.: in ditione oppidi Kerej. In montibus Kuh-e Safid, 1 Jun 1937, *K. H. Rechinger 613* (W); Pr. Rischun, 1849, *F. Buhse* (W); Siah Kuh: In ditione refugii Karavan-Sarai Shah Abbas, 20 Apr 1975, *K. H. Rechinger 50131* (W); Siah-Kuh: Umgebung von Ain - ar - Rashid, 130 km subostlich Tehran, 28 & 29 Nov 1948, *P. Aellen 1711* (W); CHAHARMAHAL AND BAKHTIARI: Cheshmaghirin [Cheshmeh ghirin], 14 May 1940, *Walter Koelz 15334* (W); ESFAHAN: Taleghan, ca. 30 km SW of Ardestan, 15 May 1974, *P. Wendelbo & H. Foroughi 11537* (W); FARS: 30 mi W of Lar (road from Qir), 4 Mar 1971, *C. Grey-Wilson & T. F. Hewer 70* (W); 5 km NW of Firuzabad, 8 Nov 1963, *Martin L. Grant 15031* (W); 67 mi SE of Shiraz on the road to Firuzabad, 1 Mar 1974, *C. Grey-Wilson & T. F. Hewer 47* (W); Ad Lacum Niriz, 11 Jul 1949, *F. Starmuehlner 20* (W); entre Abadeh et Daulatabad, 26 Apr 1956, *F. Schmid 5291* (W); entre Abadeh et Daulatabad, 26 Apr 1956, *F. Schmid 5290* (W); Firouzabad [Firuzabad], Tanguab, Apr 1951, *Kashkouli 5709 E* (W); In Montis pr. Kaserun [Kazerun], 6 Feb 1842, *Kotschy 145* (W); Murgab [Murghab], *Haussknecht* (W); Persia austro: Inter Kerman et [Niriz], ad Beshua, 1 Oct 1892, *J. Bornmuller 3476*

(W); Sarvestan inter Shiraz et Lar, *Gauba 395* (W); Shiraz, 15 Mar 1940, *Walter Koelz 14512* (W); Shiraz, 5 Apr 1940, *Walter Koelz 14739* (W); Tange Saadatabad prope Shiraz, *Gauba 394* (W); Tanghe Hamini E de Shiraz, 26 Mar 1967, *Tregubov 130* (W); GILAN: Kham Radar [Radar Khumeh], 28 May 1885, *Stapf 442* (WU); HORMOZGAN: Inter Hadjiabad prope Tarum et Bandar Abbas. Ad jugum Guhra, 29 Apr 1948, *K. H. et F. Rechinger 3374* (W); KERMAN: 15.9 mi N of Sabzaveran [Sabzvaran] - Bam road, 12 Mar 1971, *C. Grey-Wilson & T. F. Hewer 143* (W); 90 km south Sirjan, 22 Mar 1972, *F. Kasy 546* (W); Darzin, Morghak, on the road to Giroft, 15 Apr 1975, *H. Foroughi 15937* (W); Kuh-e Doihupar, 7 May 1892, *J. Bornmuller 3478* (W); Kuh-e Husainabad [Hoseynabad], East of Kerman, 28 Mar 1966, *J. C. Archibald 1166* (W); Kuh-e Jupar, 12 Apr 1975, *P. Wendelbo & H. Foroughi 15878* (W); KERMANSHAH: Kuh Jamal Bariz, 3 May 1956, *Bobek 105* (W); Rijab, 20 Jun 1968, *IranShahr 13048* (W); Bisitun [Bisotun]. Northern & Western Iran, 16 Apr 1963, *M. Jacobs 6237* (W); KHORASAN: 12 - 18 km W. Deyhuk, 11 May 1975, *K. H. Rechinger 51641* (W); 13 km N Kashmar versus Rivash, 4 May 1975, *K. H. Rechinger 51180* (W); Inter Asfak (34 05 N 47 06 E) et Deh-e Mohamad (33 59 N 56 55 E), W. Bushruyeh, 12 May 1975, *K. H. Rechinger* (W); Ad radices montium a Birjand meridem versus, substr. schist., 31 May 1977, L. K. Runemark 56061 (W); 94 km NW of Tebas (=17 km E. Robat i-Kahn), 16 Mar 1965, Martin L. Grant 17161 (MO); Roadside; about 20 km before Kashmir (Nearest biggest city) on the road from Neyshabur; to the right side of the road. A river on the left side., 21 Jun 200 5, Mariana Yazbek 58 (FAR); On the way to Birjand; roadside., 20 Jun 2005, Mariana Yazbek 55 (FAR); KHUZESTAN: Takht Darreh, Chahbazan [Shahbazan], 12 Jun 1950, *H. Sabeti 365* (W); KORDESTAN: Riwandos ad fines pers. montis Sakri-Sakran ad pagum Galale, 22 Jun 1893, *J. Bornmuller 1035* (JE); LORESTAN: 2 km E. of Milavil inter Khorramabad et Andimishk, 20 Apr 1960, *A. Bent & H.E. Wright 420-103* (W);

Dorud, 2 May 1941, *Walter Koelz 17394* (W); Gosha [Gusheh], 21 May 1942, *Walter Koelz 18606* (W); Khorramabad to Dizful, 22 Mar 1962, *P. Furse 1143* (W); Malavi, 6 Jun 1950, *H. Sabeti 364* (W); SISTAN AND BALUCHESTAN: 9 mi W.S.W. of Birjand road to Ushad, 4 Apr 1971, *C. Grey-Wilson & T. F. Hewer 387* (W); Dehak, 12 km on Jalgh road, 13 Mar 1974, *H. Foroughi 10826* (W); Espakeh, 32 km - Nikshahr road, 1 Mar 1974, *A. Shirdelpur 10627* (W); In Panitie lapidosa 74 - 100 km a bifurcatione viae Khash - Iranshahr versus Bazman , 29 Apr 1977, *K. H. Rechinger 54961* (W); Teftan prope Torshab, 26 Apr 1977, *K. H. Rechinger 54771* (W); Teftan prope Torshab, 26 May 1977, *M. Assadi 54803* (W); TEHRAN: In valle supra Vardavard, c. 30 km W. Tehran, 8 Apr 1977, *K. H. Rechinger 54446* (W); Siah Kuh, c. 150 km south of Tehran, May 1937, *anonymous* (W); YAZD: 15 km W Chah Malek (33 46 N 54 42 E) versus Chupunum (33 33 N 54 19 E), 16 May 1975, *K. H. Rechinger 51897* (W); In m. Schir kuh [Shir kuh], Ditiones Yesd [Yazd], 7 May 1892, *J. Bornmuller 3479* (WU). **Iraq.** *Anders 2217* (W); ARBIL: Bakhmada, 2 May 1957, *Rawi* (G); Mountain valley between Salahuddin and Chuklawa, 31 Mar 1964, *Himat Abbas & Fred A. Barkley 7068* (W); KIRKUK: 5 km east of stone bridge on the River Tawukshi, Kirkuk Liwa, 7 Apr 1962, *Fred A. Barkley & Jumaa Brahim 1502* (W); NINAWA: Mosul : Zawita, in Mosul Liwa, 17 Mar 1956, *Polunin & A.K. Khudairi* (W); Mosul; Ad confines Turciae Prov. Hakkari, in ditione oppidi Zakho, 2-4 Jul 1957, *K.H. Rechinger 12138* (W); Ad confines Turciae Prov. Hakkari, inter Mosul et Zakho. 103 km, 2 Jul 1957, *K.H. Rechinger 10653* (W); In montibus Dschebel Sindschar inter vicum Dscheddale et lacum el Chattunije, Wadi Schilu, *Handel-Mazzetti 1564* (W). **Jordan.** ZARQA: 500 m west Qasr Amra, Wadi Butm, 17 Apr 1998, *M. Stadinger J10/3* (W); SW Qasr Amra, Wadi Butm, 17 Apr 1998, *M. Staudinger* (W); Qasr Amra by channeled wadi, 18 Apr 1963, *Gillett 15706* (G). **Lebanon.** BEKAA: Baalbeck, Baalbeck, 21 Apr 1878, *Post, George 709* (BEI); Wadi Yahfoufa, Apr 1891, *Post,*

George 7808 (BEI); Baalbek plain, 20 Apr 1878, *Post, George* (BEI); Champs au N. de Baalbeck, 5 Aug 1955, *Pabot* (G); Entre Rayak et Baalbeck, Mar 1951, *Napoleon 37* (G); Entre Rayaq [Riyaq] et Baalbeck, 6 Jun 1949, *F. Napoleon NP28* (G); Entre Rayaq [Riyaq] et Baalbeck, 16 Aug 1959, *Mouterde 12245* (G); Norde de Baalbeck, Jul 1955, *Pabot 536* (G); MONT LIBAN: E. Ouadi El Karm, 24 May 1953, *H. Pabot* (G); Ouadi El Karm, 24 May 1953, *P. Mouterde 10762* (G); Antilibani, 22 Jun 1881, *anonymous* (P). **Saudi Arabia.** AL HUDUD ASH SHAMALIYAH: 30 km NW of Ar'ar in bed of Wadi Ar'ar, 3 Jul 1964, *J. Mandaville 252* (W). **Syria.** AL LADHIQIYAH: Kurdistania: Mardin: Kasmin, 21 June 1888, *P. Sintenis 1106* (WU); DAMASCUS: Mount Kasiun, 24 Apr 1878, *Post, George 7810* (BEI); HIMS: Inter Kafer-Aya et Brutan, 27 May 1881, *E. Peyron 1256* (G); Ouadi au N. De Bir Alyanie. Piste de Plamyra a Sabaa Biar, 2 May 1955, *M. Pabot 812* (G); RIF DIMASHQ: circa Zabadan prope Damascum, 6 Jun 1855, *Th. Kotschy 72* (W); Euphrates, Apr 1889, *Post, George 7813* (BEI). **Turkey.** Marash, Mar 1889, *Post, George 7809* (BEI); Marash. Achyrdagh, 19 Jul, *Carl Haussknecht* (JE); Rum Kalaa [Halfeti], 10 Apr 1888, *P. Sintenis 276* (G); Mardin. In rupe. calc. mt. Aoroniarch schohu, , *Haussknecht* (JE); 4 km E. of Mardin, 25 May 1957, *Davis et Hedge* (G); Mardin hill, July, *Post, George 148* (BEI); ELAZIG: Kurdistania occidentalis: Taurus Catonicus, Prope vicum Kjachta districtus Mamuret - ul- Asis [or Mamuretulaziz: Variant name of Elazıg], 11 Jul 1910, *Handel-Mazzetti 2003* (WU).

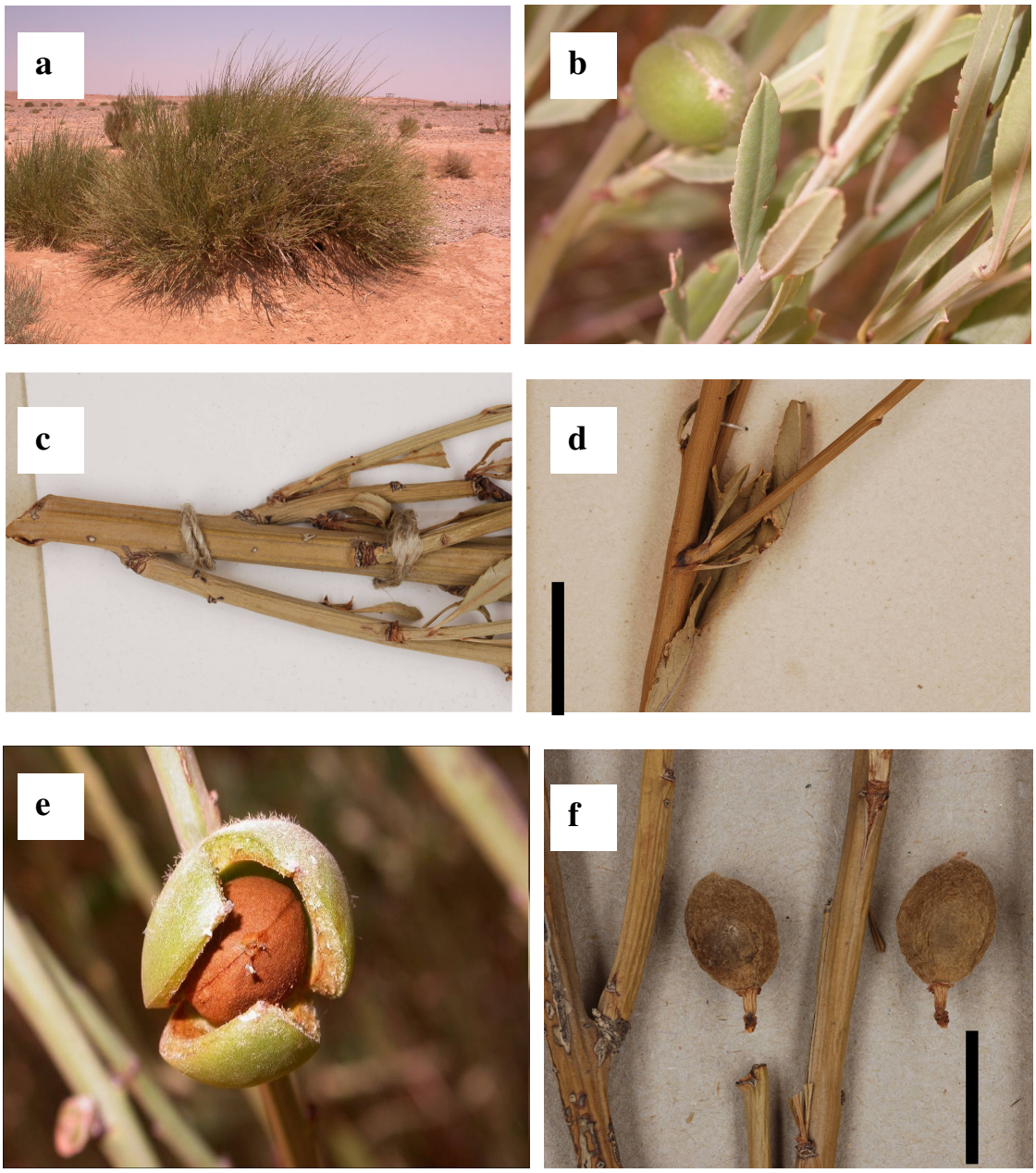

Figure 2.13.1 ***Prunus arabica***. a. habit and habitat; b. fruit and leaves; c. d. stems; e. mesocarp splitting and endocarp; f. fruits. [Scale = 1cm.]

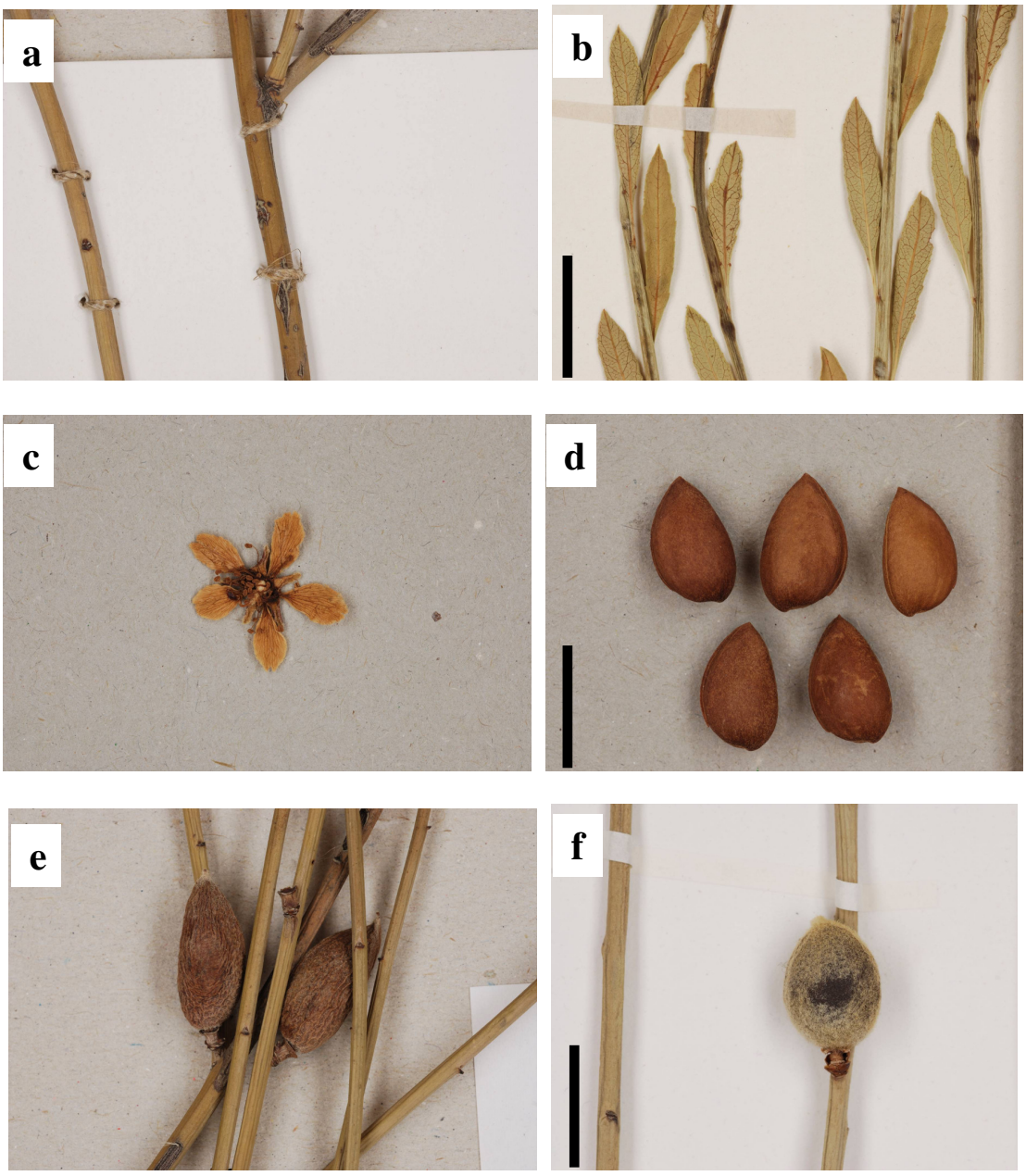

Figure 2.13.2. ***Prunus arabica*** **var.** ***scoparia***. a. stems; b. leaves; c. flower; d, endocarp; e, f. fruits. [Scale = 1 cm.]

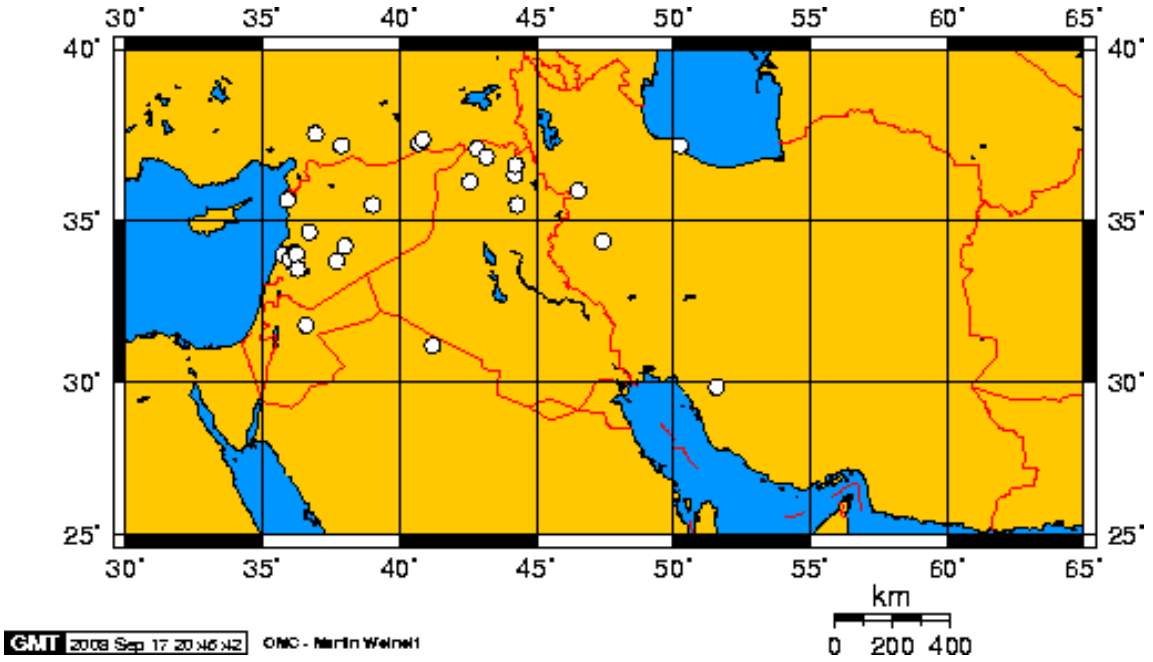

Figure 2.13.3. Distribution of *Prunus arabica* var. *arabica* [Iran, Iraq, Jordan, Turkey, Syria, Lebanon].

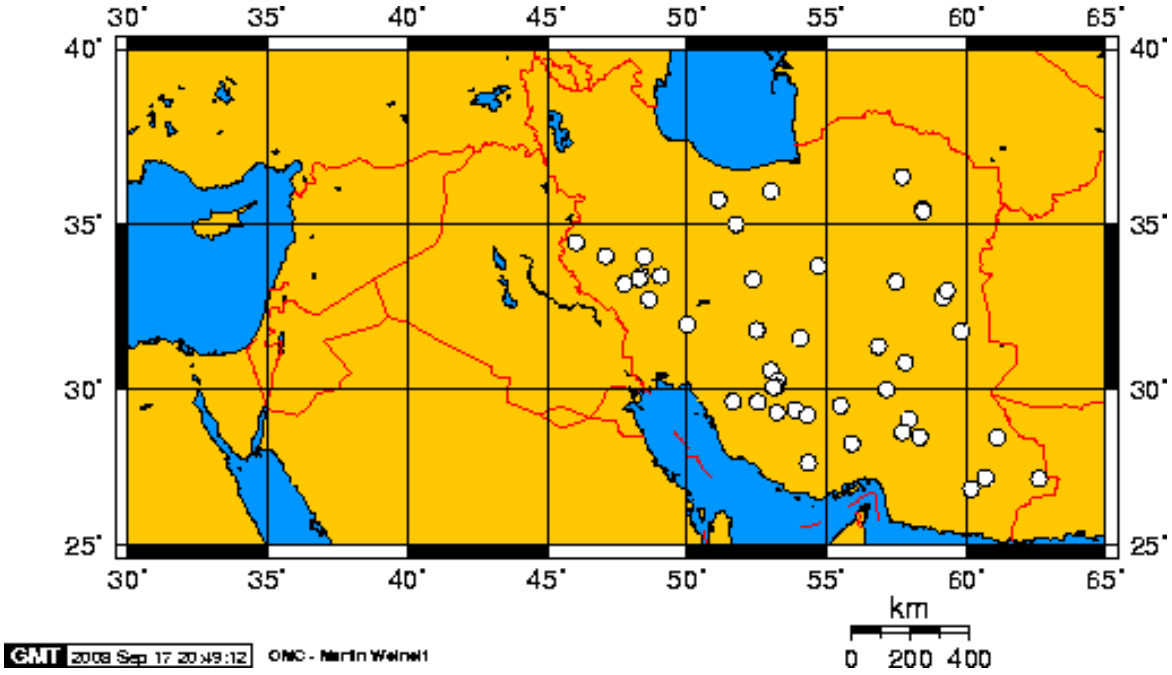

Figure 2.13.4. Distribution of *Prunus arabica* var. *scoparia* [Iran general].

14. Prunus lycioides (Spach) C.K.Schneid. Ill. Handb. Laubholzk. 1: 600. 1906.

Amygdalus lycioides Spach, Ann. Sci. Nat., Bot. ser. 2, 19: 120. 1843. *Amygdalopsis lycioides* (Spach) M. J. Roem., Fam. Nat. Syn. Monogr, 4: 15. 1847. – TYPE: Asia minor. *Aucher Eloy 1426* ex parte (holotype: P!).

Amygdalus horrida Spach, Ann. Sci. Nat., Bot. ser. 2, 19. 121. 1843. *Amygdalopsis horrida* (Spach) M. J. Roem., Fam. Nat. Syn. Monogr, 4: 15. 1847. *Amygdalus lycioides* var. *horrida* (Spach) Browicz, in K. H. Rechinger, Fl. Iranica, Lief 176. 183. 1969. – TYPE: Iran. Fars, between Kazeran and Yezdkhast, *Aucher Eloy* (holotype: P!).

Amygdalus horrida Spach var. *reuteri* Boiss, Fl Orient. 2. 645. *Amygdalus reuteri* Boiss. & Buhse, Nouv. Mem. Soc. Imp. Naturalistes Moscou, 12: 79. 1860. – TYPE: Iran. Shahrud, 22 May 1858. *Al Bunge* (holotype: P!).

Very dense shrub 0.6 – 1.2 m tall, with spreading crown. **Bark** grey. **Branches** very thorny, one year old twigs reddish side and pale green side, glabrous, older twigs grey, glabrous; Short shoots present, 3 – 6 mm long. **Axillary buds** with scales 2 – 3 mm, long margin entire, pubescent, apex round, mucronate. **Leaves** convolute in bud, alternate and fascicled; stipules caducous; petiole sessile; blade green, linear, linear – lanceolate, or linear – oblanceolate,, 9 – 32 mm long, 1 – 4 (7) mm wide, base, cuneate, glands of the basal teeth sometimes 1 – 2 (4), larger and darker than glands of upper teeth, margins looks entire but minutely serrate – crenate, teeth glandular, apex acute, mucronate, mucronae reflexed towards abaxial side, when young or mature, abaxial surface glabrous, rarely sparsely pubescent on midvein, adaxial surface glabrous. **Inflorescences** fascicled on short shoots; pedicels 0 – 1.5 mm long, glabrous. **Flowers** with hypanthium deep-red to purple, cylindrical, inflated at base, 3 – 7 mm long, 1 – 3 mm wide, glabrous; sepals deep-red to purple, 1 – 3 mm long,

pubescent, margin entire, apex acute or round, glands absent; petals pink to deep pink, obovate or wedge – shaped, 4 – 8 mm long, base cuneate, apex round, sometimes slightly notched; stamens 10 – 15 (20), sometimes looks 5 because only 1 whorl is exerted from hypanthium and other whorls is inserted; style shorter than exerted stamens. **Fruits** with pedicel, 1 – 3 mm long, glabrous; drupe ovate, broadly ovate, or often oblong – ovate in crossection, often asymmetric, strongly compressed, 10 – 17 mm long, 7 – 14 mm wide, 5 – 10 mm deep, base round, almost always asymmetric, apex acute to round, sometimes slightly mucronate, surface glabrescent; mesocarp splitting at maturity; endocarp light-brown or dark-brown, ovate or broadly-ovate in cross – section, strongly compressed, 10 – 16 mm long, 8 – 13 mm wide, 6 – 10 mm deep, base round, strongly asymmetric, apex acute to round sometimes asymmetric, ventral suture with very thin keel, surface pits absent, furrows mostly 2 along ventral suture, and furrows start from the base becoming reticulate towards apex, could be deep or shallow. Figures 2.14.1 and 2.14.2.

Phenology. Flowering: Late Jan to Early May; fruiting: Late Mar – Mid July

Distribution. Widely spread throughout Iran and Turkey, with few records in N. Syria. Figure 2.14.3.

Habitat. In dry and semiarid areas, on limestone, clay, gravelly, rocky slopes and hillsides. Sometimes near rivers. Growing at broad elevation ranges of between 450 – 2200 m.

Discussion

Browicz (1969) described two varieties within this *Prunus lycioides.* He lumped the two species described by Spach (1843), *Amygdalus lycioides* Spach and *A. horrida* Spach together, and made the combination *A. lycioides* var. *horrida* (Spach) Browicz. Since then, and following him, two varieties have been recognized in this species; *A. lycioides* var. *lycioides* having slightly bigger drupes and endocarps with narrow keels, and *A. lycioides* var *horrida* with smaller drupes and endocarps with broader keels. These morphological differences are ambiguous and greatly variable and overlapping. Therefore there is not sufficient information to maintain the two varieties.

Prunus lycioides can be confused with four other species. These are *Prunus spinosissima*, *P. eburnean, P. brahuica* and *P. erioclada* (Refer to the Table 2.14.1 for diagnostic characters and how to distinguish them from each other.

A brief historical background is outlined below for this group of morphologically uniform taxa:

Boissier (1846) described a new species *Amygdalus spathulata* Boiss. He placed it in Section *Scorpius* Spach, and mentioned that it is similar to *A. eburnea*, but differs from it by having bark that becomes white with age, and branches that are thin with needle like apices that do not become hardened with age.

Roemer (1847) recognized species of section *Lycioides* as they were described by Spach, but he put them in a new genus, *Amygdalopsis* Roemr, making all the necessary combinations.

In 1852, Bunge describes a new species *Amygdalus spinosissima* from material of merely two specimens, that are imperfect, lacking flowers, and have few drupes, and apparently worn out according to him. He put it in affinity with *A. horrida* Spach, but differs from the latter diagnosis and description by characters such as color of branches (white in *A. spinosissima* and white grey in *A. horrida*), shape of leaf (linear

oblong in *A. spinosissima* and linear lanceolate in *A. horrida*), and shape of drupe (semi ovate strongly compressed in *A. spinosissima* and ovoid or subglobose in *A. horrida*).

Interestingly, Bunge (1852) noted that *A. spinosissima* is similar to *A. pedunculata*, but it differs from it by the shape of the leaf and the fact that is glabrous. However, differences between these two species are more than the mentioned characteristics.

In 1860, Boissier and Buhse, described another species, *Amygdalus reuteri*, which they placed in affinity with *Amygdalus lycioides* Spach, except that it differs from it by having ten stamens instead of 15, the endocarp somewhat obtuse not reticulate sculptured.

In 1872, in his Flora Orientalis, Boissier recognizes 4 species in section *Lycioides* which corresponded to both sections *Lycioides* and *Scorpius* of Spach. In that treatment, Boissier re-considered his *A. reuteri*, and recognized it as a variety of *Amygdalus horrida*, and reconsidered his earlier described species *A. spathulata*, and recognized it as a variety of *A. eburnea*. He also synonimized *A. scorpius* with *A. eburnea*, and recognized *A. furcata* Spach, that has a glabrous calyx, as a variety of *A. eburnea* Spach ß *leiocalyx* Boiss), whose distinctive character is having a pubescent calyx.

Furthermore, Boissier (1872) described a new species, *Amygdalus brahuica*, with puberulent leaves on both sides, and glabrous calyx, but with a distinctive character of having flowers sub fascicled on short shoots.

Aitchison (1887) in his travels in Afghanistan, listed the *Amygdalus* species he collected, and described some of the variation of form he noticed. He described *Prunus eburnea* which corresponded to *Amygdalus eburnea* Spach var. *floribus solitariie*. As the name implies, it differs from Spach's by having solitary flowers. He

also described another variety of *Prunus eburnea* Aitch & Hemsl. var. *fructu flavor*, again as the name implies with fruits becoming yellowish, not ruling out that it could be an infected fruit by an insect. They also describe *Prunus brahuica* Aitch & Hemsl., var calyce omnino glabro, which differs from *Amygdalus brahuica* Boiss by not having ciliate margin of calyx.

Schneider (1906) treated *Amygdalus* as a subgenus in *Prunus*, and made all the necessary combinations. Within the section *Lycioides*, he recognized four species, based on leaf size, shape and exertion or insertion of stamens. *Amygdalus brahuica* Boiss. was not mentioned anywhere in his treatment. *Amygdalus erioclada* was also not mentioned, since it was described that same year by Bornmuller, so he probably had not known about.

Bornmuller (1910) described a variety *Amygdalus spinosissima* var. *urumiensis* Bornm, characterized by having "sub smooth" brown branches, thorns sticking out, leaves linear lanceolate, fairly long, with glabrous petioles. Earlier, in 1906, he had published his flora of the Elburs Mountains, north of Persia. There he collected a very thorny *Amygdalus* with a peculiar clothing: young leaves and branches, as well as older ones were hispid tomentose; Even though Bornmuller described this new species as *Amygdalus erioclada*, he affiliated it with either *A.horrida* Spach or *A. eburnea* Spach, and maintained that it could be a variety of either one of these species, but he could not designate it to either for lack of flowers and fruits. It was another 50 years, before Bornmuller received flowering material from his friend Gauba, collected by Tenge Saadatabad that looked very similar to the material he collected earlier, which set him finally to sketch the new species, *Amygdalus erioclada*, and placed it in section *Lycioides*.

REPRESENTATIVE SPECIMENS EXAMINED.

Iran. Baghe Khan, 2 Jun 1950, *H. Sabeti 369* (W); C Shahrud – Bustam (Turan Protected Area). In calcareous mountain NE Qale Bala, 27 Apr 1975, *K. H. Rechinger 50394* (W); Kuh Jamel Bariz, 25 May 1956, *H. Bobek 162* (W); Northern and Western Iran. , 21 Apr 1963, *M. Jacobs 6342* (W); AZERBAIJAN EAST: In Mount Kaflan Kuh near Mianeh, 2 Jun 1971, *K.H. Rechinger 40861* (W); Northern and Western Iran; Region Tabris, 8 Apr 1963, *M. Jacobs 6142* (W); rivi Qezel Uzan (Zizil Uzum); 10 – 24 km ENE Mianeh, 14 Jul 1971, *K.H. Rechinger 43250* (W); ESFAHAN**:** Kashan (Mooteh Protected region). In mount Muteh (Mooteh), 31 May 1974, *K. H. Rechinger 46894* (W); GILAN: Roudbar, Chombol, 20 May 1967, *Abai 12875 E* (W); Rudbar, *Gauba 397* (W); HAMADAN: Aq Bulaq, ca. 100 km N Hamadan, 15 Apr – 1 Jul 1960, *Rioux et Golvan 257* (W); HORMOZGAN: S. Par Abedin (Bandar Abbas, Sirjan), 24 Apr 1939, *A. Parsa 92* (K); KERMAN**:** in Mount near Qariet ul Arab, 9 Jul 1892, *J. Bornmuller 3474* (W); Deh Bakri, 27 Jan 1940, *Walter Koelz 14289* (W); KERMANSHAH: 10 miles NE Kermanshah, 17 May 1961, *H. C. Stutz 1327* (W); from Geharvari to Kuzeran, 20 Sep 2006, *A. A. Donmez 14125* (HUB); from Kamyaran to Senendaj, around Gavsan dam, 20 Sep 2006, *A. A. Donmez 14128* (HUB); between Kermanshah and Sanadaj. 73 km NNW Taq – i Bustan [Taq – e Bostan], 29 Aug 1957, *K.H. Rechinger 14658* (W); Qasr Shirin , 31 Mar 1051, *Scharif 5710E* (W); W Kermanshah, 45 km a Kermanshah towards west, 21 Mar 1965, *K.H. Rechinger 27099* (W); KHORASAN: without locality, 14 May 1956, *H. Sabeti 368* (W); Mashhad, Kelat road, Babahan, 11 Sep 2006, *A. A. Donmez 14104* (HUB); Mashhad, Kelat road, Goceki village, 11 Sep 2006, *A. A. Donmez 14103* (HUB); KHORESAN E **–** RAZAVI: Sabsevar – Sabri, 15 Oct 1956, *H. Sabeti 367* (W); LORESTAN: Dorud, 4 Mar 1941, *Walter Koeltz 17108* (W); Kebara, 15 Jun 1941, *Walter N. Koelz 18235* (W); Oshtoran

Kuh: Saravand, 20 km SE Dow Rud, 16 Jun 1974, *K. H. Rechinger 48099* (W); MAZANDARAN: Montes Elburs centr. In ditione oppidi keredj. In montibus Kuh – e Dasht., 2 May 1937, *K.H. Rechinger 355* (W); QAZVIN: Jugi Kuhin versus Manjil, 13 May 1971, *K.H. Rechinger 39474* (W); Keredj, in montibus ad pagum kalak, 13 Apr 1948, *K.H. et F. Rechinger 2728* (W); QOM: 20 mi SW Ghom [Qom], 27 Apr 1961, *Howard C. Stutz 753* (W); SEMNAN: Inter Sorcheh province Semnan et Gardane Bashm, 15 Apr 1948, *K.H. Rechinger 2819* (W); SOUTH KHORESAN: Takhtejan village; 90 km to the east from Birjand (nearest biggest city), 20 Jun 2005, *Mariana Yazbek 56* (FAR); TEHRAN: 15 miles North Tehran, 7 May 1961, *Howard C. Stutz 1056* (W); Karadj – Eshtehard, Tabareh, 22 May 1968, *Terme 13034E* (W); Darake village; about 3 km from Tajreesh square, N Tehran, 14 Jun 2005, *Mariana Yazbek 50* (FAR); ZANJAN**:** 52 km SW Zanjan versus Bijar, 30 Jun 1971, *K.H. Rechinger* (W); Kuh Anguran: Tashvir, inter Manjil et Zanjan, 1 Jun 1971, *J. Lamond & M. Iranshahr 40951* (W). **Turkey**. near Aintab, 28 Apr 1865, *anonymous* (W); Aintabb, 1834, *Montbret 1982* (W); SANLIURFA: C7 Urfa: Halfeti, Bulakli village, 21 Mar 1996, *A. A. Donmez 8085* (HUB); ILI: C6 Gaziantep: 10 km from Nizip to Gaziantep, 10 Apr 1998, *A. A. Donmez 5944* (HUB); KILIS: C6 Kilis: around Radar, 8 Apr 1998, *A. A. Donmez 5868* (HUB).

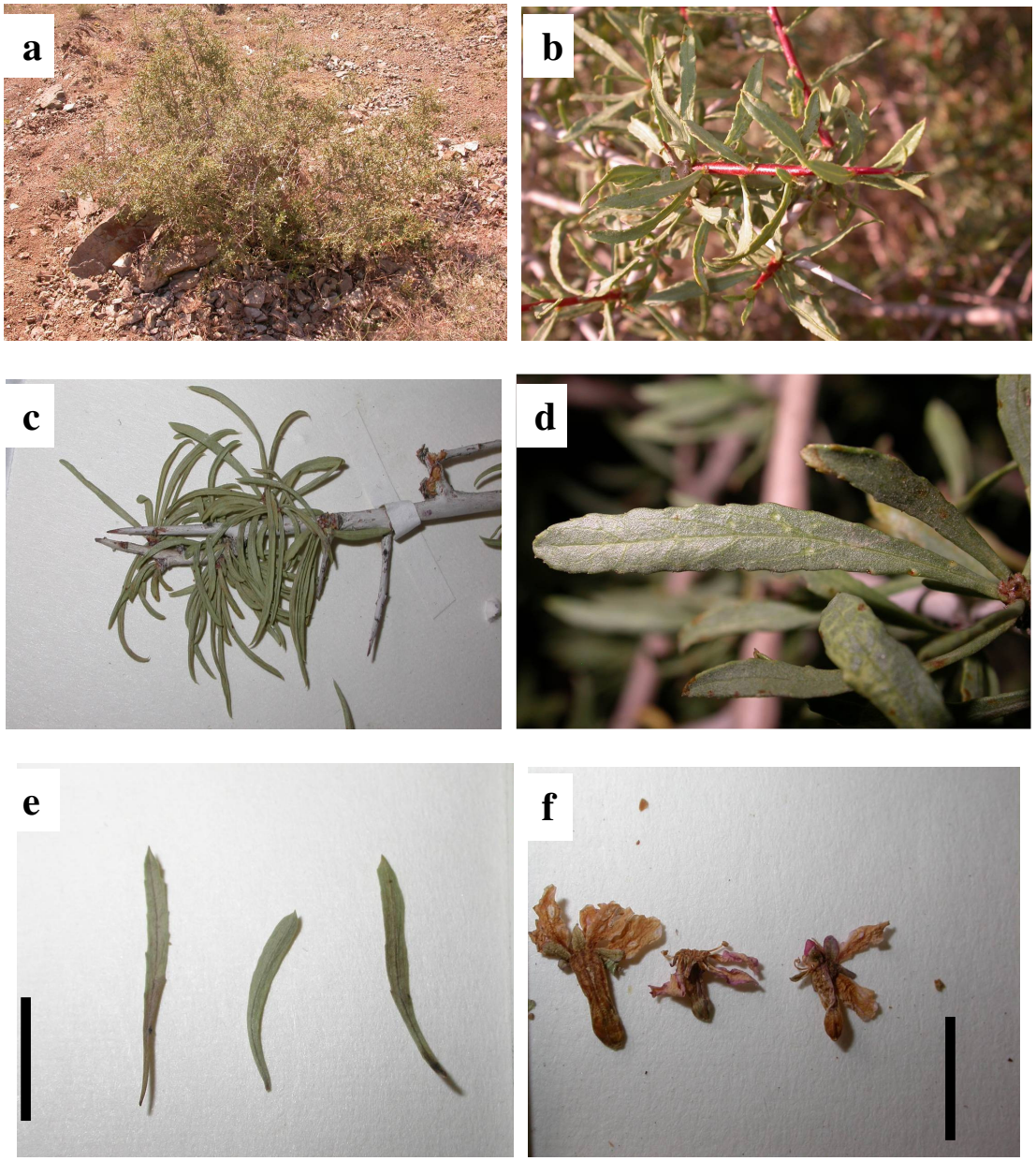

Figure 2.14.1 ***Prunus lycioides***. a. habit; b, c, d, e, leaves; f. flowers. [Scale = 1 cm.]

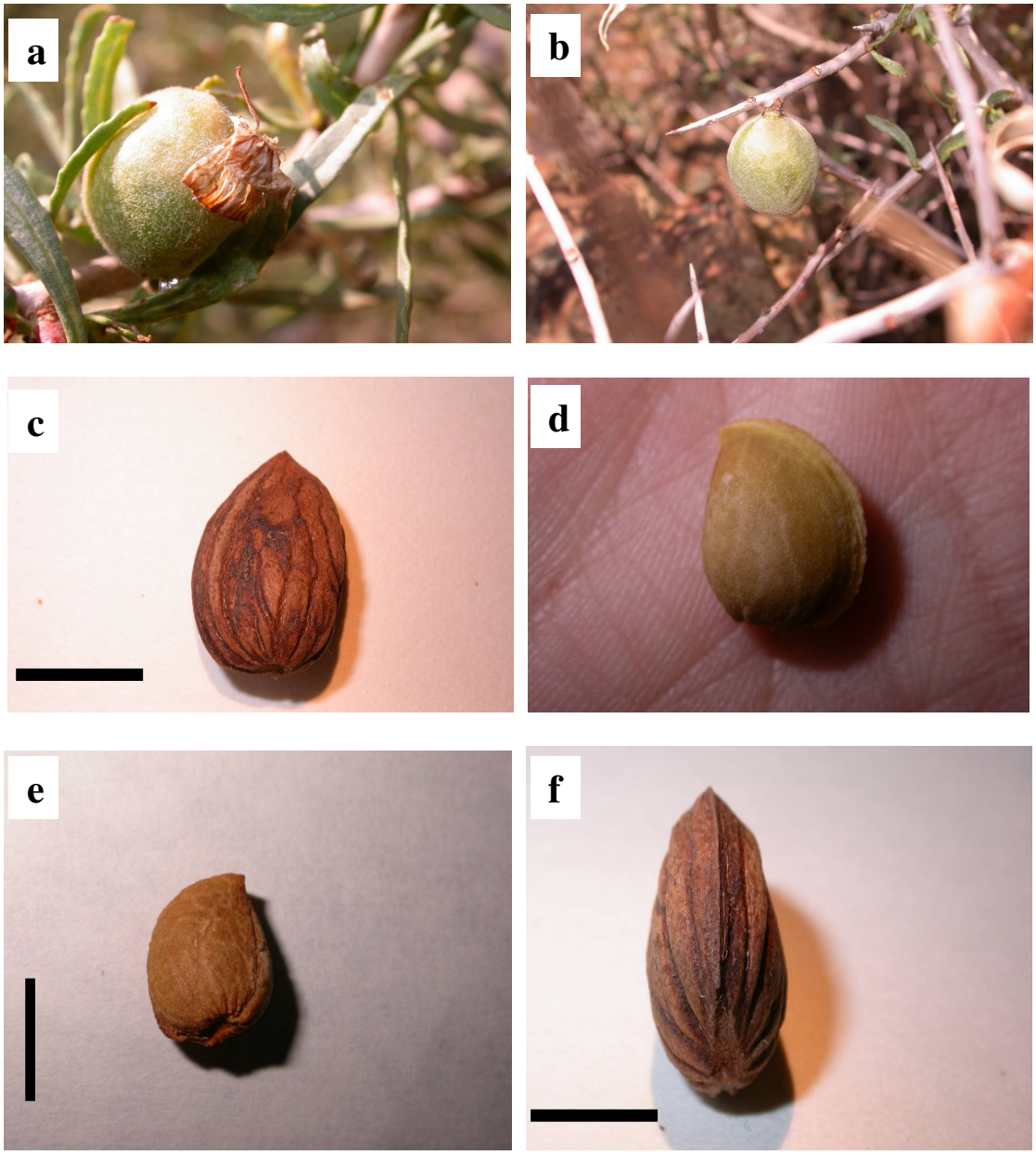

Figure 2.14.2. ***Prunus lycioides***. a, b. fruits; c, d, e, f. endocarp. [Scale = 1 cm.]

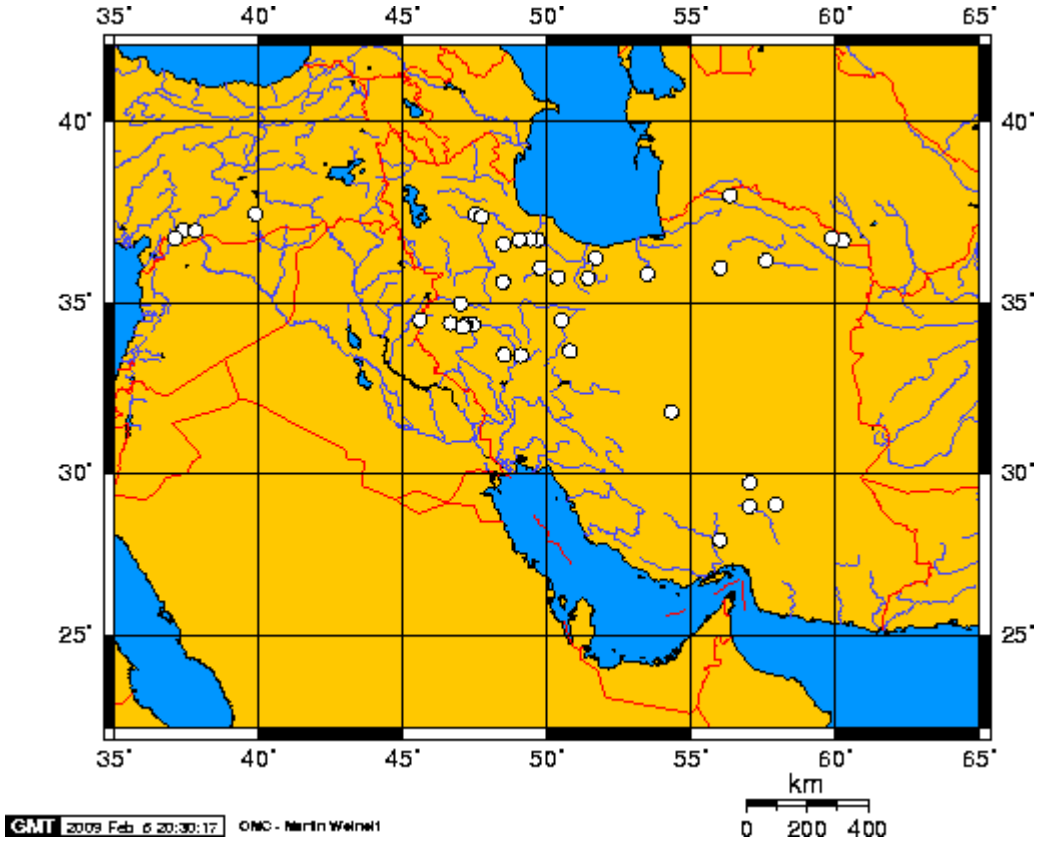

Figure 2.14.3. Distribution of *Prunus lycioides* [Iran and Turkey, and N. Syria].

Table 2.14.1. Characteristics used to differentiate *Prunus lycioides*, *P. spinosissima*, *P. eburnea*, *P. erioclada* and *P. brahuica.*

	shoots	leaves	Hypanthium	Endocarp
P. erioclada	***one year old twigs whitish because covered by dense white pubescence, white tomentose, older twigs grayish, white tomentose***	white tomentose, linear oblanceolate to linear elliptic, 9 – 17 x 2 – 5 (8) mm	Glabrous	broadly ovate, 15 – 16 mm x 8 – 12 mm x 6 – 9 mm, surface pits absent, furrows 2 along ventral suture, and shallow furrows from base then disappearing
P. eburnea	one year old twigs reddish brown, glabrous, older twigs grey, glabrous	spathulate to linear spathulate, rarely obovate or linear oblaneolate, 7 – 20 x 2-5 mm	***Pubescent***	ovate, less often oblong ovate, 9 – 13 mm x 8 – 11 mm x 7 – 8 mm, surface pits absent, furrows 2 along ventral suture, and shallow furrows from base, sometimes reticulate furrows allover, could be deep or shallow
P. brahuica	one year old twigs reddish brown on one side and green on the other, glabrous or hispidulous, older twigs brown – grey to whitish grey, glabrous or glabrescent hispidulous.	oblanceolate, linear – oblanceolate, linear – spathulate, or obovate, 9 – 22 x 3 – 7 mm	Glabrous	***endocarp furrows reticulate, and conspicuous in drupe***
P. lycioides	one year old twigs twigs reddish side and pale green side, glabrous, older twigs grey, glabrous;	***linear, linear – lanceolate, or linear – oblanceolate,*** 9 – 32 x 1 – 4 (7) mm	Glabrous	ovate or broadly ovate, strongly compressed, 10 – 16 mm x 8 – 13 mm x 6 – 10 mm, surface pits absent, furrows 2 along ventral suture, ***and furrows start from the base becoming reticulate towards apex***, could be deep or shallow
P. spinosissima	one year old twigs deep reddish, glabrous, rarely pubescent, older twigs brown-grey to white-grey, glabrous	***spathulate, obovate, elliptic or lanceolate,*** (11) 18 – 28 (30) x 3 - 9 mm [broad compared to *P. lycioides*]	Glabrous	Ovate, strongly compressed, 13 – 14 mm x 9 – 17 mm x 7 – 9 mm, surface pits absent, furrows 2 along ventral suture, and shallow furrows from base becoming shallower and disappear towards apex, or reticulate furrows allover, could be deep or shallow

15. Prunus spinosissima (Bunge) Franch, Ann. Sci. Nat., Bot. ser. 6, 16: 281. 1883. *Amygdalus spinosissima* Bunge, Beitr. Fl. Russl.: 106. 1852. – TYPE: Iran. Kerman, everywhere on the dry rocks to Zarafschan, as on the Mount Karatau, Aug-Sept, 1841. *A. Lehmann 427* (holotype: LE!).

Amygdalus turcomanica Lincz. in Komarov, Fl. URSS, 10. 542, 639. 1941. *Prunus turcomanica* (Lincz.) Kitam., Fl. Afghanistan, 2: 180. 1960, non *P. turcomanica* (Pojark.) Gilli, Feddes Repert., 72: 51. 1966 [≡ *Cerasus turcomanica* Pojark. Fide Czerepanov, S. K. Sosudistye Rasteniia SSSR 1981]. *Amygdalus spinosissima* subsp. *turcomanica* (Lincz.) Browicz in K. H. Rechinger, Fl. Iran., Lief 176: 180. 1969.– TYPE: Turkmenistan [Uzbekistan]. Badghys, Pul-i-Khatun, in sloping mountain, 2 May 1895, *S. I. Korshinsky 841* (holotype: LE!).

Amygdalus spinosissima var. *urumiensis* Bornm., Verh. Zool. Bot. Ges. Wien 60: 109. 1910; Feddes Repert. 12: 330. 1913. *Prunus urumiensis* (Bornm.) A. E. Murray, Kalmia, 1: 31. 1969. *Amygdalus urumiensis* (Bornm.) Browicz, in K. H. Rechinger, Fl. Iranica., Lief. 176. 1969. – TYPE: Iran. Azerbaijan, between Dilima and Urumia. *Knapp* (JE!).

Shrubs (0.5) 1 – 2 m tall, with spreading crown. **Bark** grey, with black lenticels. **Branches** very thorny; one year old twigs deep-reddish, glabrous or rarely pubescent, older twigs brown-grey to white-grey, glabrous; short shoots present. **Axillary buds** with scale margin entire, pubescent, apex round. **Leaves** convolute in bud, fascicled; stipules intrapetiolar, often caducous; petiole up to 1.5 mm long, green, glabrous; petiolar glands absent; blade green, spathulate, obovate, elliptic or lanceolate, (11) 18 – 28 (30) mm long, 3 – 9 mm wide, base, cuneate, and partly decurrent, glands of the basal teeth (0) 1 – 2 (3), larger and darker than upper teeth, margins looks entire but serrate, more often obscurely so, and more towards apex,

teeth glandular, apex acute to round, mucronate, and mucronae reflexed towards abaxial side, sometimes it looks retuse, when young or mature, abaxial surface glabrous, rarely sparsely pubescent, adaxial surface glabrous. **Inflorescences** fascicled on short shoots; pedicels green, 1 mm long at most, glabrous. **Flowers** with hypanthium reddish, cylindrical, inflated at base, 3 – 8 mm long, 1 – 3 mm wide, glabrous; sepals reddish from outside and green from inside, 1 – 2 mm long, margin entire, pubescent, apex acute, glands absent; petals pink to deep pink, oblong, obovate or wedge-shaped, 5 – 7 mm long, base cuneate or tapering, apex round, mostly notched; stamens 8 - 18; style longer than stamens. **Fruits** with pedicel 0.5 – 3 mm long, glabrous; drupe reddish from one side and green from the other, ovate in cross section sometimes subglobose, sometimes wider than long, compressed, 9 – 15 mm long, 9 – 16 mm wide, 8 – 10 mm deep, base asymmetric round sometimes slightly beaked, apex round or acute, sometimes slightly asymmetric, surface pubescent; mesocarp splitting at maturity; endocarp very light-brown to yellow-brown, asymmetric ovate in cross-section, strongly compressed, 13 – 14 mm long, 9 – 17 mm wide, 7 – 9 mm deep, base round, asymmetric, sometimes beaked, apex acute to round, ventral suture acute with very thin keel, surface pits absent, furrows mostly 2 along ventral suture, and shallow furrows start from the base becoming shallower and disappear towards apex, sometimes reticulate furrows allover, could be deep or shallow. Figures 2.15.2 and 2.15.3.

Phenology. Flowering: Late Feb to Late Apr; fruiting: Early May – Mid Aug.

Distribution. Afghanistan, Eastern Iran and South Turkmenistan. Figure 2.15.1.

Habitat. In semi arid regions, on clay, limestone and volcanic rocky mountain slopes. Growing at elevations between 700 – 1900 m.

Discussion

Please see discussion paragraph for *Prunus lycioides* and Table 2.14.1 for diagnostic characters.

Afghanistan. BADAKHSHAN: Daraim [Darayem], 9 Aug 1937, *Walter Koelz 13020* (W); FARAH: without locality, 25 Feb 53, *Prof. Dr. O. H. Volk Wurzburg 2915* (W); Dilarum, 1 Mar 1949, *M. Koie 3501* (W); GHOWR: Kala Nau - Murghab [Morghab], 28 Mar 1949, *M. Koie 3540* (W); HERAT: 300 km WNW Girishk, ad viam novam versus Shindand, 22 Jul 1965, *K. H. Rechinger 32490* (W); Montes Paropmisus, Cashma Obeh (Tscheschme Obeh), 5 Aug 1962, *K. H. Rechinger 19214* (W); KABOL: near Kabul, W. slope mountain bottom, south of Darwasah, perpendicularly dropping cliff, 6 Apr 1950, *A. Gilli* (W); Lataband pass [Lateh band pass], 28 May 1951, *A. Gilli* (W); KANDAHAR: Near Kandahar. Pirzad [Pirzadeh], 24 Feb 1949, *M. Koie 3426* (W). **Iran.** KHORASAN: Route a Moghan pres Meshhad, 18 Mar 1947, *K. Lidberg 114* (W); 17 miles N of Torbat - e - Heydariyeh road to Mashhad, 8 Apr 1971, *C. Grey - Wilson & T. F. Hewer 428* (W); In collibus 15 km a bifurcatione viae Mashhad - Sarakhs versus Salehabad, substr. Tonschiefer, 26 May 1977, *K. H. Rechinger 55757* (W); In montibus serpentinicis prope Robat-e Sefid inter Mashahd and Torbat Heydariyeh, 29 Jun 1977, *J. Renz & H. Runemark 55998* (W); In prolongatione occidentalis montium Paropamisus in jugo interJannatabad et Malu, 27 Jun 1977, *K. H. Rechinger 55845* (W); interbonjurd et Shirvan , 20 Apr 1967, *K. H. Rechinger 33189* (W); Kuhe Ahangaran: Ad versuras argillosas prope pagum Zaidan, 2 Jun 1977, *K. H. Rechinger 56162* (W); Montes Kopet Dagh inter Kucan et Lutfabad: In jugo Allah Akbar, 14 - 15 Jul 1937, *K. H. Rechinger 1753* (W); 28 km S of Chenaran (Nearest biggest city); Freizi village; 4-5 km E from the village, 19 Jun 2005, *Mariana Yazbek 51* (FAR); 28 km S of Chenaran (Nearest biggest city); Freizi village; 4-5 km SW from the village, 19 Jun 2005, *Mariana Yazbek 54* (FAR); 28 km S of Chenaran

(Nearest biggest city); Freizi village; 4-5 km SW from the village, 19 Jun 2005, *Mariana Yazbek 52* (FAR); After Atayih village; 72 km on the road from Neyshabur to Kashmir(nearest biggest city); Kuh-e-Sorkh (the red mountain), 21 Jun 2005, *Mariana Yazbek 57* (FAR). **Turkmenistan.** AHAL: Ashgabat, Regio Transcaspica, 13 Apr 1900, *P. Sintenis 89a* (G); Welayaty: Regio transcaspica; Aschabad [Ashgabad]. In montibus supra pagum nephton, 4 May 1900, *P. Sintenis 89b* (W); Eastern Kopetdag, canyon Shamli, 12 Jun 2004, *D. Kurbanov 2459* (MO).

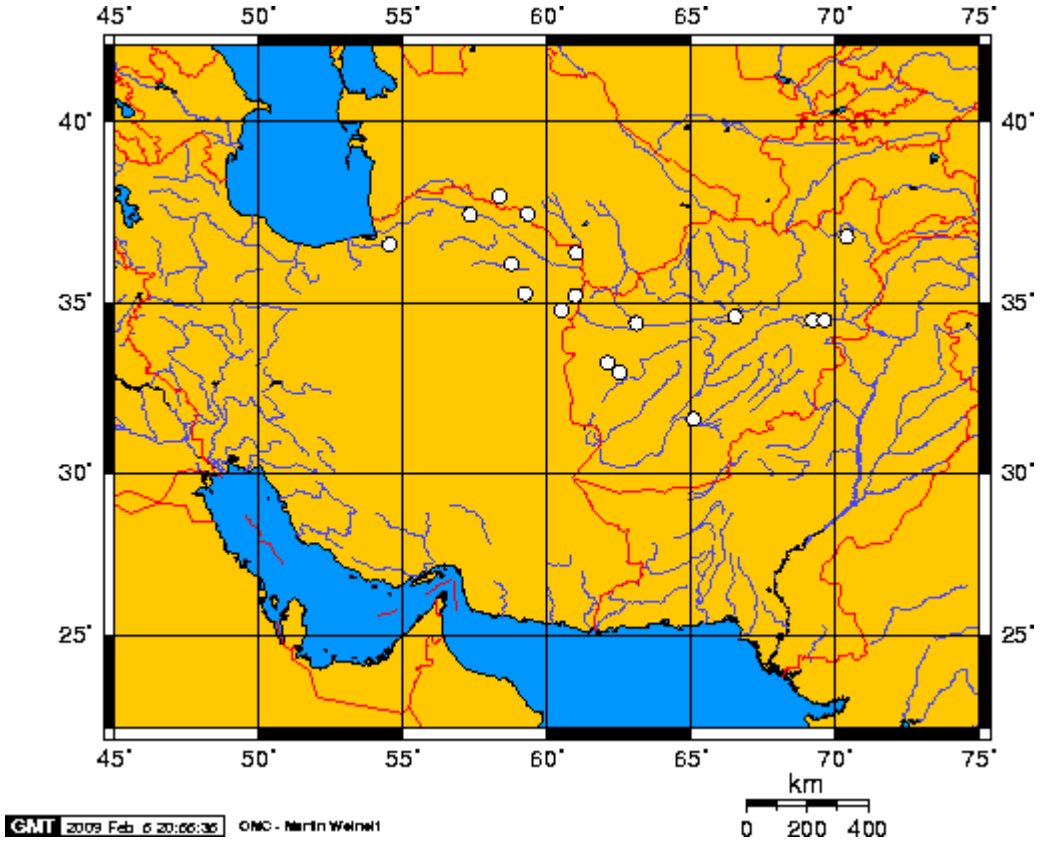

Figure 2.15.1. Distribution of *Prunus spinosissima* [Afghanistan, Eastern Iran and South Turkmenistan].

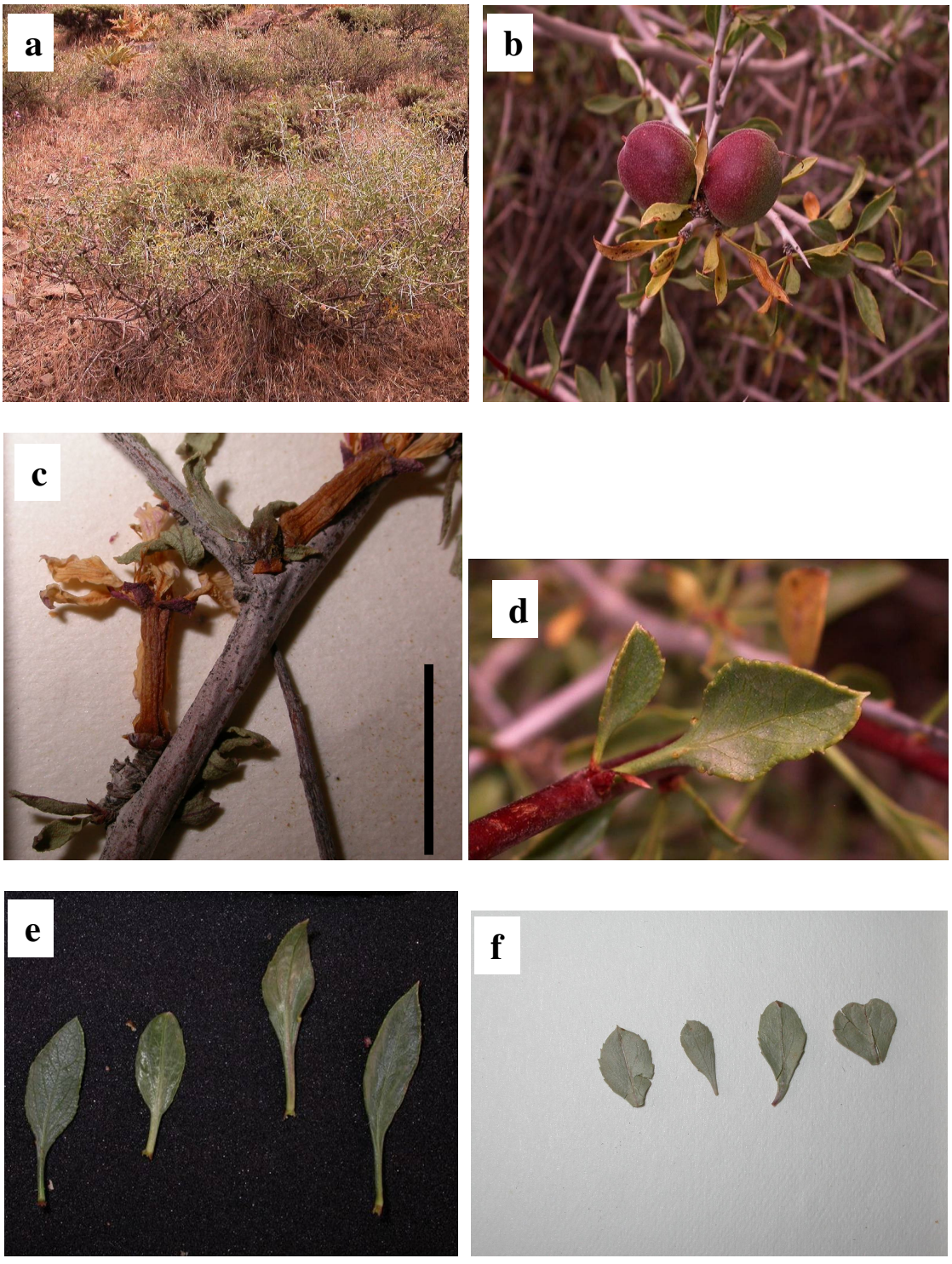

Figure 2.15.2 ***Prunus spinosissima***. a. habit; b. fruit; c. flower; d, e, f. leaves. [Scale = 1 cm.]

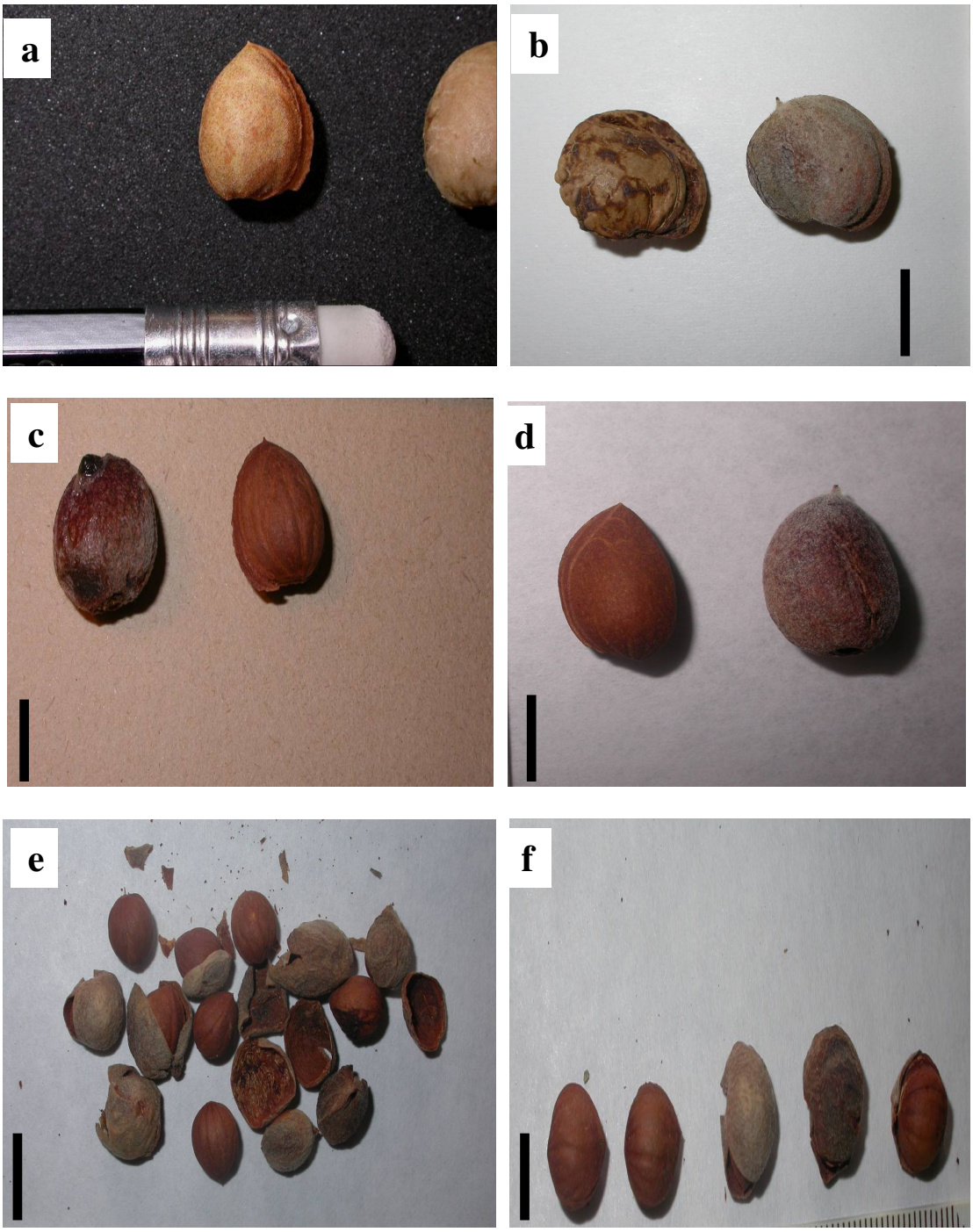

Figure 2.15.3. ***Prunus spinosissima***. a-f. fruits and endocarps. [Scale = 1 cm.]

16. Prunus eburnea (Spach) C. K. Schneider. Ill. Handb. Laubholzk, 1, 5: 599. 1906.

Amygdalus eburnea Spach, Ann. Sci. Nat., Bot. ser. 2, 19: 123. 1843. *Amygdalopsis eburnea* (Spach) M. J. Roem., Fam. Nat. Syn. Monogr, 4: 16. 1847. – TYPE: Iran. Khorasan, Pire Zend. *Aucher Eloy 4477* (holotype: P!; isotypes: G!, LE!, W!)

Amygdalus scorpius Spach, Ann. Sci. Nat., Bot. ser., 2, 19: 122. 1843. *Amygdalopsis scorpius* (Spach) M. J. Roem., Fam. Nat. Syn. Monogr, 4: 15. 1847. – TYPE: Iran. Laristan, June 1838, *Aucher Eloy* (holotype : P!).

Amygdalus furcatus Spach Ann. Sci. Nat., Bot. ser. 2, 19: 124. 1843. *Amygdalopsis furcata* (Spach) M. J. Roem., Fam. Nat. Syn. Monogr, 4: 16. 1847. – TYPE: Iran. Fars, in mountains near Pire-zind, and around Shiraz, Feb 1838, *Aucher Eloy 4476* (holotype: P!)

Amygdalus spathulata Boiss., Diagn. Pl. Orient., ser. 1, 6: 53. 1845. – TYPE: Iran. Fars, near Mount Dalechi between Abuschir and Schiraz, *Th. Kotschy 174* (holotype: K!; isotype: W!)

Dense shrub (0.3) 0.6 – 1.5 m tall, spreading or upright. **Bark** grey. **Branches** very thorny, thorns mostly perpendicular to branches; one year old twigs reddish-brown, glabrous, older twigs grey, glabrous; short shoots present. **Axillary buds** in threes, brown, 2 mm long; scales 2 mm long, margin entire, pubescent, sometimes densely, apex round, mucronate. **Leaves** convolute in bud, fascicled on short shoots and alternate on annual twigs; stipules pubescent, often caducous; petiole ca. 0 mm long; blade green, spathulate to linear-spathulate, rarely obovate or linear-oblanceolate, 7 – 20 mm long, 2-5 mm wide, base cuneate, glands of the basal teeth 1-2, larger and darker than upper teeth glands, margins looks entire but minutely dentate- serrate, especially towards the apex, teeth glandular, apex acute to round,

shortly mucronate, mucronae reflexed towards abaxial side so sometimes it looks retuse, when young abaxial and adaxial surface mostly glabrous, sometimes pubescent, adaxial surface mostly glabrous, rarely pubescent, when mature, abaxial and adaxial surface glabrous. **Inflorescences** fascicled on short shoots; pedicels 1 mm long at most, glabrous. **Flowers** with hypanthium red, cylindrical, inflated at base, 4-8 (10) mm long, 1-3 mm wide, pubescent; sepals green, (1) 2 – 3 (5) mm long, margin pubescent. entire, apex acute, glands absent; petals pink to pale-pink, obovate or wedge-shaped, 4 – 9 mm long, base cuneate, apex round, mostly notched; stamens 10, only one whorl of 5 is exerted from hypanthium; style shorter than exerted stamens. **Fruits** with pedicels, ca. 1.5 mm long at most, glabrous; drupe ovate, less often oblong-ovate, or round-ovate in cross-section, compressed or slightly so, 9 – 14 mm long, 7 – 11 mm wide, 7 – 9 mm deep, base round, sometimes slightly asymmetric, apex acute to round, sometimes slightly asymmetric, surface pubescent; mesocarp splitting at maturity; endocarp light-brown, ovate, less often oblong-ovate or round-ovate in cross-section, compressed, 9 – 13 mm long, 8 – 11 mm wide, 7 – 8 mm deep, base round, sometimes asymmetric, apex acute to round, sometimes asymmetric, ventral suture obtuse with very thin keel, surface pits absent, furrows mostly 2 along ventral suture, and shallow furrows start from the base becoming shallower and disappearing towards the apex, sometimes reticulate furrows all over, could be deep or shallow. Figure 2.16.1

Phenology. Flowering: Mid Feb to End Apr; fruiting: Mid Mar – End July

Distribution. Iran General. Endemic. Figure 2.16.2.

Habitat. In dry and semi desert areas, on calcareous clay, silt or sandy soils and stony slopes, in oak woodlands. Growing at elevations between 980 – 1820 m.

Discussion

The main diagnostic character of *Prunus eburnea* is the pubescent hypanthium which is not found in any of the other species. However, this character is only useful when flowers are present or when the hypanthium or parts of it are persistent at the base of the fruit; When not in flower, it can be easily misidentified specially with *P. lycioides*, that has a similar leaf shape, and no other vegetative or fruit distinguishing characters. It can be distinguished from *P. erioclada* by the heavily pubescent shoots of the latter, from *P. spinosissima* by the oblanceolate shape of leaves of the latter, and from *Prunus brahuica* by the distinctly furrowed endocarp that can be seen even through the mesocarp in the latter. See discussion paragraph for *Prunus lycioides* and Table 2.14.1 for more information about diagnostic characters and taxonomic history

REPRESENTATIVE SPECIMENS EXAMINED.

Iran: ESFAHAN: 27.4 km S. Esfahan, 24 Apr 1961, *H. Pabot 5754* (G); FARS: 43 mi SE of Shirazon road to Firuzabad, 28 Feb 1971, *C. Grey-Wilson & T. F. Hewer 43* (W); 5 km NW of Schiraz, 8 Mar 1965, *Martin L. Grant 17154* (W); between Daleki and Kazerun, 14 Mar 1937, *Koie 1534* (W); between Murgab and Schiraz, Mar 1968, *Carl Haussknecht* (JE); near mountain Dalechi between Abuschir and Schiraz, *Th. Kotschy 174* (W); Maharlu, 31 Mar 1936, Gauba (w); near Murgab, Mar 1968, *Carl Haussknecht* (JE); near Persepolis, Mar 1968, *Carl Haussknecht* (JE); NW Jahrom, 30 May 1961, *H. Pabot 12982E* (W); Takhti-Jamshid [Deserted settlement], 11 Mar 1940, *Walter Koelz 14417* (W); GLIAN: Schericht bu Khane Radar, 28 Apr 1885, *Stapf 432* (WU); HORMOZGAN: Inter jugum Cah Coghuk (Cafut) et Tarum; Prov. Kerman et Fars, 28 Apr 1948, *K.H. Rechinger 15868* (W); KERMAN: 19 km SW Nosratabad Sipi, 27 Mar 1965, *K. H. Rechinger 27193* (W); entre Sirjan et Hajabad, pres de Kafriz, 2

Jun 1960, *Dadashzadeh 384* (G); Inter Saidabad (Sirdjan/Sirjan) et Jugum Cah Coghuk (Cafut), 28 Apr 1948, *Gilli 3509* (W); KERMANSHAH: without locality, 8 Jun 1948, *Behbid 287* (W); Inter Qasr Shirin et Kermanshah; 50 km E of Qasr-e Shirin versus Kerind, , *K.H. Rechinger 14602* (W); Ridjab [a natural region west of Iran], 24 Jul 1967, *Iranshahr 12874E* (W); Ridjab [Rigjub], 19 Jun 1968, *Iranshahr 13051E* (W); KHORASAN: Ostrand der GroBen Kawir. Ozbah-kuh (Ozbagu). Kuh-e Safid, 19 Apr 1964, *anonymous* (W); KHUZESTAN: NW Lar.: entre Chahbahar a est et Behbahan a ouest, 12 Feb 1964, *G. Popov 215* (G); LORESTAN: 19 km S. of Khorramabad, inter Khorramabad et Andimishk, 7 May 1960, *A. Bent & H.E. Wright 507-701* (W); SISTAN AND BALUCHESTAN: 4 km SW of Nosratabad, 25 Mar 1964, *M. L. Grant 15312* (W); 90 km on Khash to Iranshahr road, 26 Feb 1974, *A. Shirdelpur 10625* (W); Khash (Gelije), 16 Feb 1949, *Scharif 318E* (W); Inter KHash (Vasht), Kwash et Iranshahr (Bampur), Montes Karvandar, 16-17 May 1948, *K. H. Rechinger 4003* (W); Iranshahr to Khash (gelige), 21 Feb 1949, *Scharif 447E* (W); Karevandar, 10 Apr 1951, *Manushehr 5711E* (W); TEHERAN: Ghorogh [Qoroq], 10 Oct 1949, *Vaezi 1987E* (W); Inter Tehran et Kom [Qom], 28 Feb 1892, *J. Bornmuller 3472* (W).

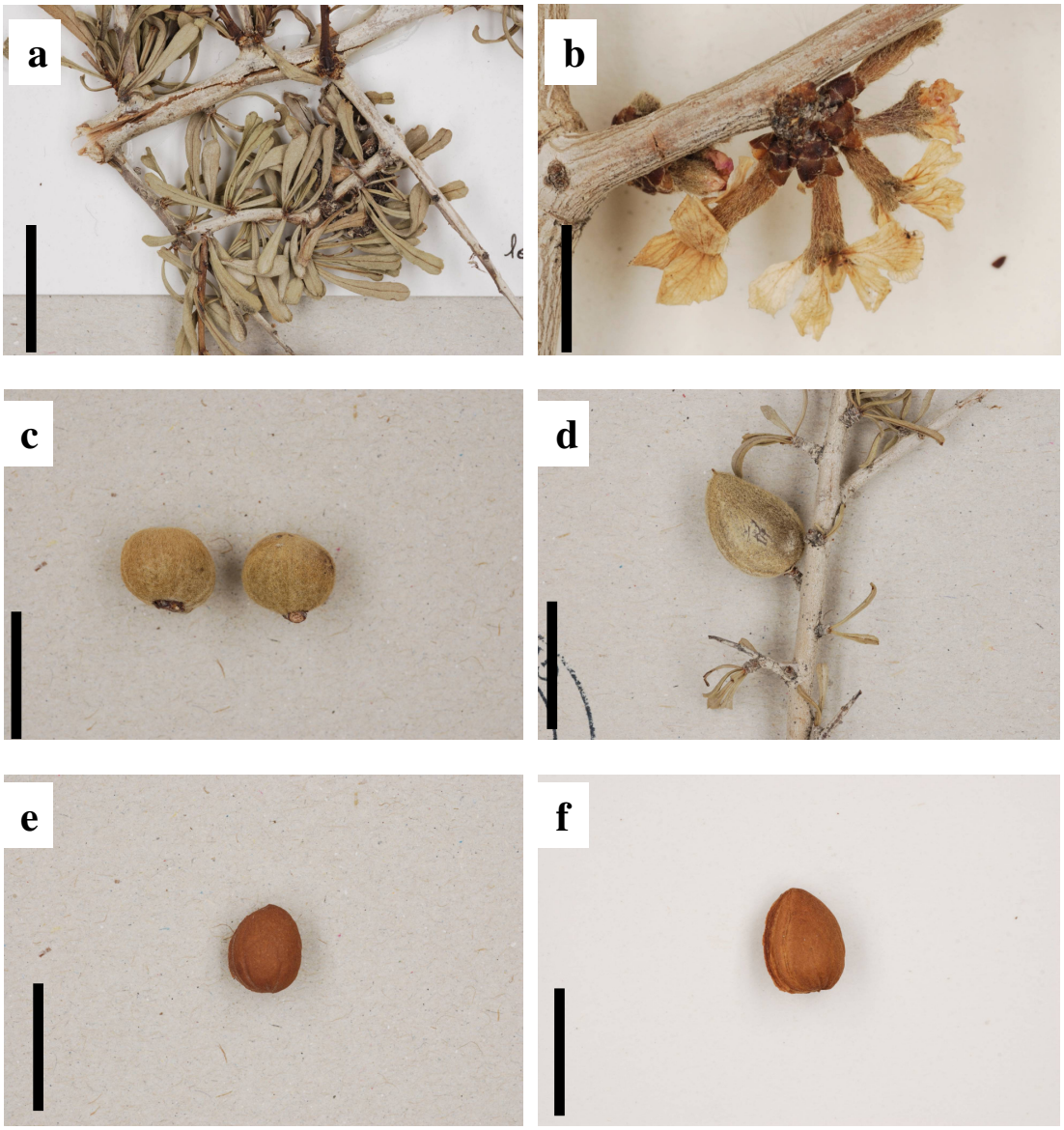

Figure 2.16.1. ***Prunus eburnea***. a. leaves; b. flowers; c, d. fruits; e, f. endocarp. [Scale = 1 cm.]

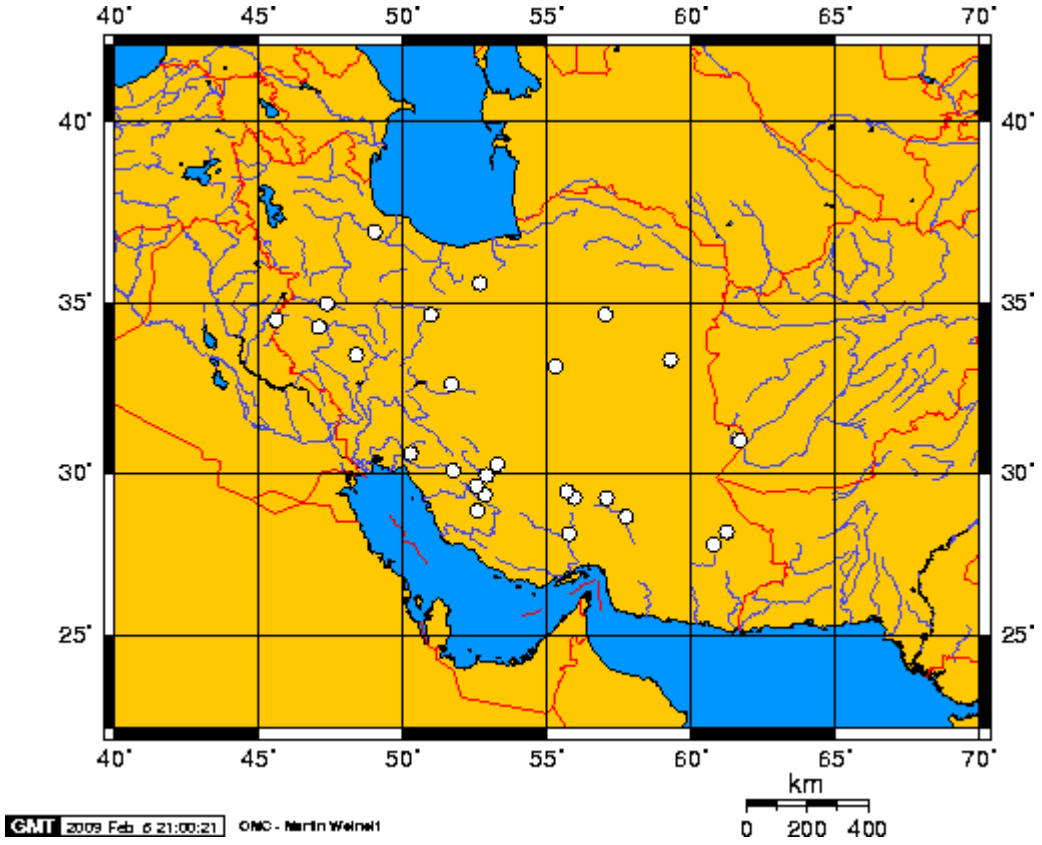

Figure 2.16.2. Distribution of *Prunus eburnea* [Iran].

17. Prunus brahuica (Boiss) Aitch. & Hemsl., Trans. Linn. Soc., Bot. ser. 2, 3: 62. 1886. *Amygdalus brahuica* Boiss. Fl. Orient. 2. 645. 1872. – TYPE: Pakistan. In Mount Hurbab and Chehel Beluchistan, alt. 7000' – 10000', *Stocks* (K!)

Amygdalus afghanica Pachom., Bot. Mater. Gerb. Inst. Bot. Akad. Nauk Uzbeksk. SSR. 16: 50. 1961. *Amygdalus brahuica* subsp. *afghanica* (Pachom.) Browicz, in K. H. Rechinger, Fl. Iranica, Lief 176: 182. 1969. – TYPE: Afghanistan**.** Kurum Valley, 18 Apr 1879, *Aitchison 108* (holotype: K!).

Dense shrub (0.3) 1.5 – 2.5 m tall, with upright or prostrate crown. **Bark** brown – grey; **Branches** very thorny, one year old twigs reddish-brown from one side and green from the other side, glabrous or hispidulous, older twigs brown – grey to whitish grey, glabrous or glabrescent-hispidulous; short shoots present. **Axillary buds** ine ones or fascicled in 3s, brown, 2 mm long; scales margin entire, ciliate, apex round, mucronate, splitting. **Leaves** fascicled on short shoots and alternate on annual twigs; stipules not seen, caducous; petiole 0 – 1.3 mm long. blade green, oblanceolate, linear – oblanceolate, linear – spathulate, or obovate, 9 – 22 mm long, 3 – 7 mm wide, base, cuneate, sometimes glands of the basal teeth 1 – 2 (3), larger and darker than upper teeth, margins looks entire but obscurely serrate – crenate, teeth glandular, apex acute to round, mucronate, mucronae reflexed towards abaxial side, when young or mature abaxial surface mostly hispidulous or sometimes glabrous, adaxial surface hispidulous or sometimes glabrous. **Inflorescences** fascicled on short shoots; pedicels 1 mm long at most, glabrous or pubescent. **Flowers** with hypanthium tinged with red, cylindrical, inflated at base, 4 – 7 mm long, 1 – 3 mm wide, glabrous; sepals tinged with red, 2 – 4 mm long, margin entire, ciliate; apex acute, glands absent; petals pink or cream, oblong or obovate, 3 – 7 mm long, base cuneate or tapering, apex round, mostly notched; stamens 10 – 12, only one whorl of 5 stamens is exerted from

hypanthium; style shorter than exerted stamens. **Fruits** with pedicel, 0.5 – 2 mm long, glabrous; drupe ovate, long-ovate, or round – ovate in cross – section, asymmetric, strongly compressed or slightly so, (7) 11 – 19 mm long, 9 – 13 mm wide, 3 – 9 mm deep, base round, asymmetric, apex acute to round, asymmetric, surface pubescent; mesocarp splitting at maturity; endocarp not seen, however, endocarp furrows reticulate, all over, and conspicuous in drupe. Figure 2.17.1.

Phenology. Flowering: Mid Feb to Mid May; fruiting: Mid May – Mid July

Distribution. Afghanistan, Pakistan. Figure 2.17.2.

Habitat. In mountainous and hilly, rocky slopes with limestone or volcanic soil. Growing at elevations between 1500 – 2800 m.

Discussion

Two subspecies have been recognized within this species (Browicz, 1969). One is *Prunus brahuica* subsp. *brahuica* which has puberulent young branches, leaves and pedicels, and with a drupe that is slightly compressed. The other subspecies is *P. brahuica*, subsp. *afghanica*, originally describe by Pachomova (1961) which has glabrous young shoots, leaves and pedicels, and the drupe is strongly compressed. No varieties are recognized in this treatment. See discussion for *Prunus lycioides* and Table 2.14.1 for diagnostic characters.

REPRESENTATIVE SPECIMENS EXAMINED.

Afghanistan: Kurrum Valley, Dec 1879, *Griffith & Aitchison 1212 or 108* (K). BADGHIS: Badghis, 18 Mar 1885 & 20 May 1885, *J.E.T. Aitchison 133* (K); BAGHLAN: 2 mi W of Banu, 3 mi W of Deh Salah, 7 May 1969, *T. F. Hewer 1050* (K); GHAZNI: 32 km W Ghazni, 33 33 N, 68 28 E versus Sariab 33 44 N 68 08 E, ad viam

versus Dasht – i Nawar,, 17 Jul 1967, *K. H. Rechinger 37148* (G); GHOWR: : Hari – rud valley, 1885, *J.E.T. Aitchison 1151* (K); KABUL: ca 12 km S. Kabul an der Strasse nach Ghazni, , 13 Apr 1970, *A. Dieterle 112* (G); Ruvirous de Kabul, 11 Feb 1952, *Mme. G. Frumkin 106* (G); KANDAHAR: route de Girisk a Kandahar, environ 60 km avent Kandahar, 15 Apr 1958, *H. Pabot 444* (G); KONAR: Wali Tangi Quella [Walo Tangi Kalay], 3 May 1985, *A. Ghafoor & Rizwan Yusuf 1147* (G); PAKTIA: In jugo Sata Kandao, inter Gardez (33 37 N 69 09 E) et Khost (33 22 N 70 01 E), substr. Ton schiefer, 8 Jul 1965, *K. H. Rechinger 32108* (K); Inter Said [Sayyed] Karam et Ahmad Khel, 9 Jul 1965, *K. H. Rechinger 32176* (G); Urgun, In Jugo Mizakai Kotal, 33 10 N 69 20 E, 9 Jun 1967, *K. H. Rechinger 35856* (K); PARWAN: Panjir Tal oberhalb Ghurja, 26 May 1973, *O. Anders 9946* (G); Ghorband, In declivibus orientalibus jugi Shibar, 12 Jul 1967, *K. H. Rechinger 36903* (MO). **Pakistan:** BALOCHISTAN: Mashelakh range, 2 – 10 May 1957, *R. R. Stewart 28386a* (K); Urak, 2 – 10 May 1957, *R. R. Stewart 28386b* (K); Ziarat, 24 Jun 1957, *Jafre & Akhar 2084* (K); Ziarat, 2 – 10 May 1957, *R. R. Stewart 28381* (K); Ziarat, 23 May 1945, *S. J. H. Santapau 6448* (K); Erval or Erwal, 11 May 1887, *J. H. Lace* (K).

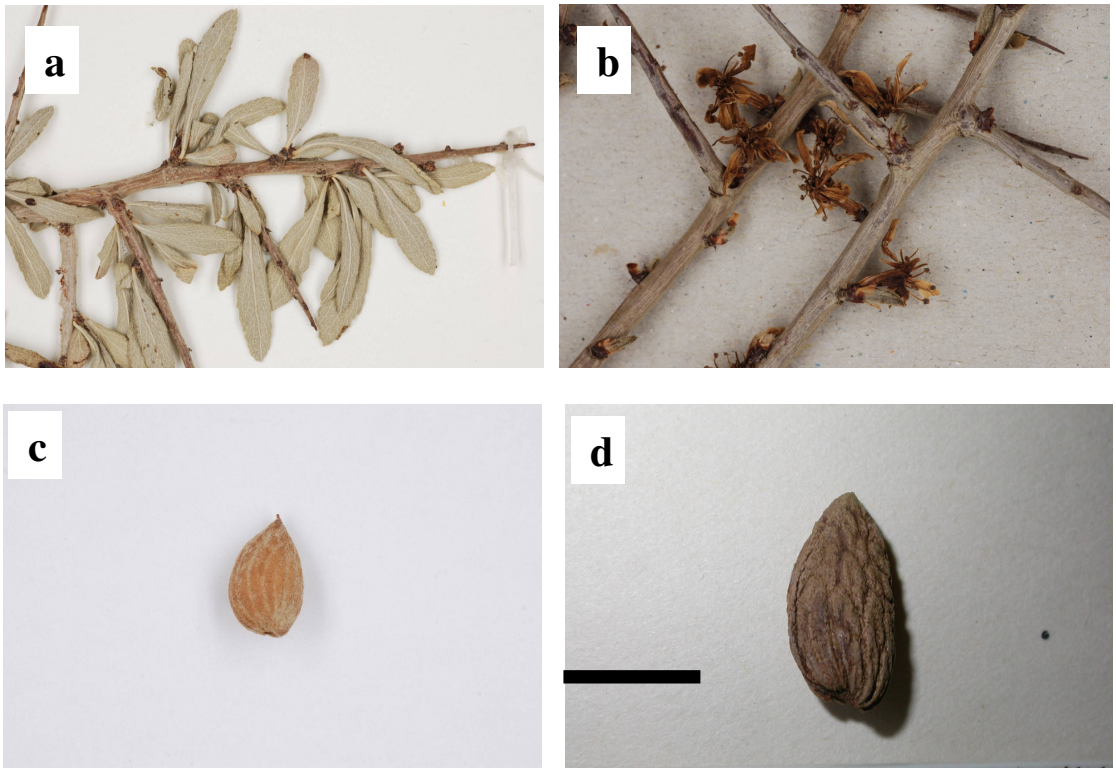

Figure 2.17.1. ***Prunus brahuica***. a. leaves; b. flower; c. fruit; d. endocarp. [Scale = 1 cm.]

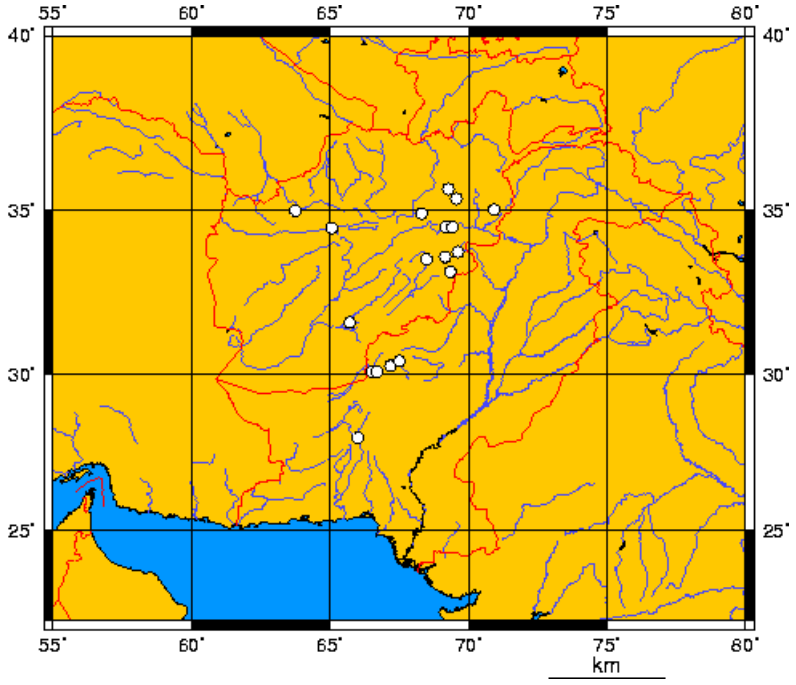

Figure 2.17.2. Distribution of *Prunus brahuica* [Afghanistan, Pakistan].

18. **Prunus erioclada** (Bornm) Yazbek comb. nov. *Amygdalus erioclada* Bornm., Nom. inval. nom. Prov., Bull. Herb. Boissier, Ser. 2, 6: 605. 1906. *Amygdalus erioclada* Bornm., in Bornm. & Gauba, Repert. Spec. Nov. Regni Veg. 49: 256. 1940. – TYPE: Iran. Fars, Shiraz, near Persepolis, 1900m, 3 Oct 1892. *J. Bornmuller 3462* (holotype: B!).

Shrubs 0.2 – 1.2 m tall, with prostrate crown. **Bark** grey to whitish-grey; **Branches** very thorny; one year old twigs whitish because covered by dense white pubescence, white tomentose, older twigs grayish, white tomentose; Short shoots present. **Axillary buds** with scales margin entire and pubescent, apex acute to round, mucronate. **Leaves** fascicled on short shoots and alternate on annual twigs; Stipules often caducous; petiole 0 – 1.5 mm long. blade white tomentose, linear-oblanceolate to linear-elliptic, 9 – 17 mm long, 2 – 5 (8) mm wide, base cuneate, rarely slightly round, glands of the basal teeth 1 – 2, larger and darker than upper teeth, margins looks entire but obscurely serrate – crenate, teeth glandular, apex acute, when young or mature abaxial and adaxial surface white tomentose. **Inflorescences** fascicled on short shoots; pedicels ca. 0 mm long. **Flowers** with hypanthium red – purple, cylindrical, inflated at base, 5 – 8 mm long, 1 – 2 mm wide, glabrous; sepals red – purple, 1– 3 mm long, margin entire, sometimes sparsely ciliate, apex acute, glands absent; petals deep-pink to pale-pink, obovate or wedge – shaped, 4 – 6 mm long, base cuneate, apex round sometimes notched; stamens 10 – 15, only one whorl of 5 is exerted from hypanthium; style shorter than exerted stamens. **Fruits** with pedicel 1 mm long at most, glabrous; drupe broad – ovate or ellipsoidal-ovate in cross – section, compressed, 11 – 16 mm long, 9 – 13 mm wide, 7 – 10 mm deep, base round, apex acute to round, surface pubescent; mesocarp splitting at maturity; endocarp brown, broadly ovate, in cross – section, slightly asymmetric, compressed, 15 – 16 mm long, 8 – 12 mm wide, 6 – 9

mm deep, base round, apex acute to round, ventral suture keeled, surface pits absent, furrows mostly 2 along ventral suture, and shallow furrows start from the base either disappearing or becoming shallower towards apex. Figure 2.18.1.

Phenology. Flowering: Late Feb to Early May; fruiting: Mid Apr – End May.

Distribution. Afghanistan and Iran. Figure 2.18.2.

Habitat. In semi desert areas, on limestone, alluvial and ravine, and clay soils and stony slopes, in forest and shrub lands. Growing at elevations between 1700 – 3000 m.

Discussion paragraph

See discussion paragraph in *Prunus lycioides* and Table 2.14.1. for diagnostic characters and taxonomic history.

REPRESENTATIVE SPECIMENS EXAMINED.

Afghanistan. GHAZNI: 15 to 20 km N. of Ghazni, 18 Apr 1958, *H. Pabot* (G); 30 mi NW of Ghazni, road to Dasht – i – Nawar [Navar, Dasht – e], just beyond village of Talla Bagum, NW track, 1 May 1971, *Grey Wilson & TF Hewer 680* (W); 65 km S. of Ghazni, 6 km W of the route, village Shir, , *H. Pabot XIC* (G); Kaeas: Shinai, 2 Mar 1953, *Prof. Dr. O.H. Volk Wurzburg* (W); N. of Ghazni, 11 Apr 1958, *H. Pabot A155* (G); KANDAHAR: 18 km WSW von Maruf at the road after Arghestan, 26 Mar 1971, D. Podlech 20116 (G); NW of Kandahar, road to Shah – Maqsud, 16 Apr 1958, *H. Pabot A527* (G); South Afghanistan, near Kandahar, also on lime mountains south of Kandahar, 25 February 1951, Gilli 1799 (W); TIRIN: 20 – 25 km S. Tirin versus Kandahar, 23 May 1967, *K. H. Rechinger 35081* (G); ZABUL: 20 km from Hokumat Shenkay, 26 Mar 1971, *D. Podlech 20097* (G); 45 km ostlich Qalat i Ghilzai at the road after Shenkay, 25 Mar 1971, D. Podlech 20085 (G). **Iran**. FARS: 36 km S. Deh

Bid, 26 Apr 1961, *H. Pabot 5919* (G); 39 km N Persepolis, 26 Apr 1961, *H. Pabot 5970* (G); 41 km S Deh Bid, 26 Apr 1961, *H. Pabot 5943* (G); Kazerun, region of Shiraz, May 1959, *Remondiere 131* (G); Niriz [Neyriz], Mar 1940, *Walter Koeltz 14699* (W); Pasargade, 6 Mar 1964, *Martin Grant 15241* (W);

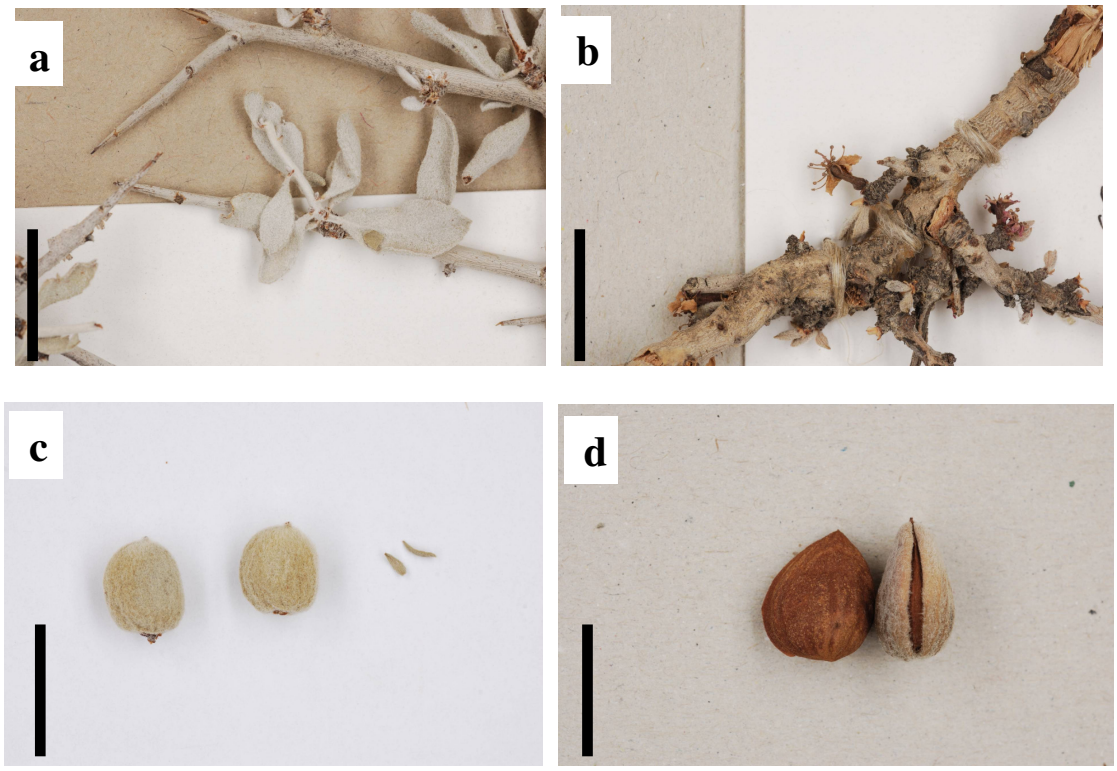

Figure 2.18.1. ***Prunus erioclada***. a. leaves and stems; b. flowers; c. fruits; d. splitting mesocarp and endocarp. [Scale = 1 cm.]

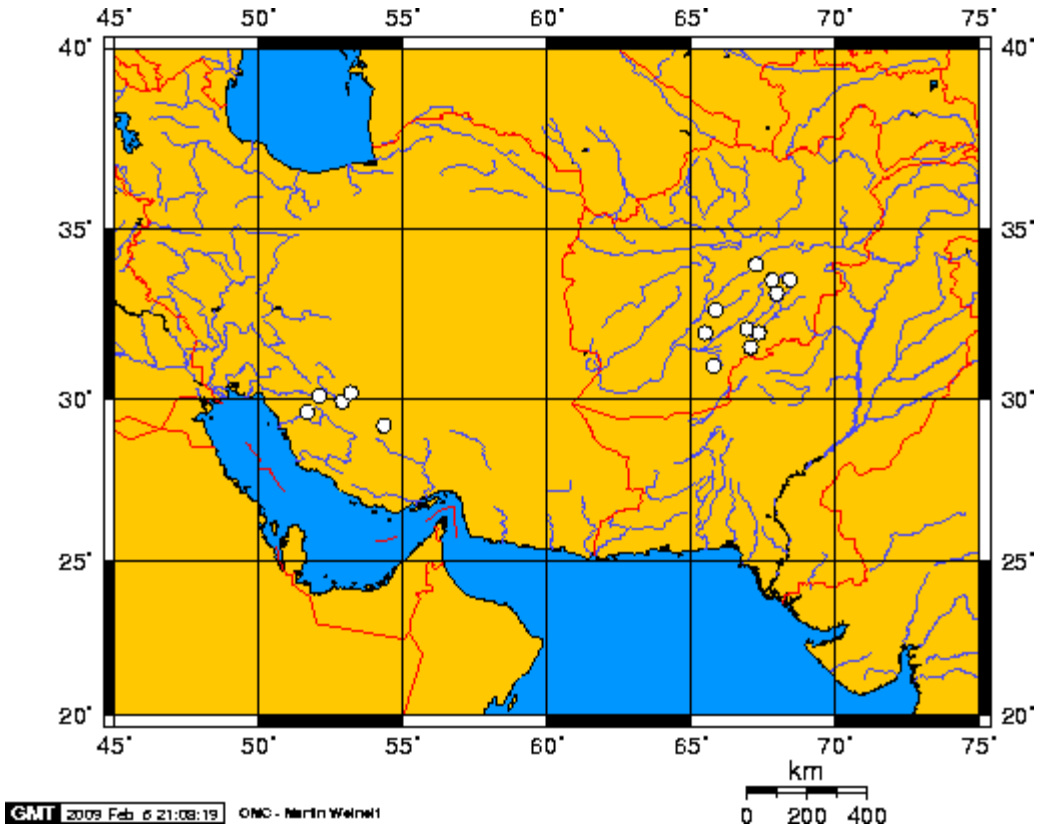

Figure 2.18.2. Distribution of *Prunus erioclada* [Afghanistan and Iran].

19. Prunus persica (L.) Batsch, Beytr. Entw. Gewächsreich.: 30. 19 Apr 1801.

Amygdalus persica L. Sp. Pl. 1: 472. 1 Mai 1753. Lectotype: Herb. Linn. No. 639.2 (LINN! [Digital Image]). [designated by Blanca & Díaz de la Guardia in Cafferty & Jarvis, Taxon, 51: 541. 2002.]

Persica amygdalus Mill., Gard. Dict., ed. 8: [unpaged] Persica n. 3. 16 Apr 1768.

Persica vulgaris Mill. Gard. Dict., ed. 8: [unpaged] Persica n. 1. 16 Apr 1768.

Amygdalus persica L. var. *nectarina* Aiton, Hort. Kew. 2: 161. 1789. *Persica vulgaris* Mill. var. *nectarina* (Maxim.) Holub bis, Vedecke Prace Ovocnarske, 6, 305. 1977.

Persica ferganensis Kostina & Riab. in Bull. Appl. Bot., Leningrad, Ser. VIII. No. 4, 75 (1935), nomen. *Prunus ferganensis* (Kost. & Rjab.) Y.Y.Yao in Fl. Desert. Reipubl. Popul. Sin., 2: 158 (1987).

Amygdalus persica L. var. *plena* Aiton, Hort. Kew. 2: 161. 1789.

Trees 3–8 (10) m tall, with a broad and ± horizontally spreading crown. **Bark** brown, or dark brown to black, scabrous and squamose with age. **Branches** thornless; one year old twigs green reddish on exposed side, glabrous, lustrous, with many small lenticels, older twigs brown, glabrous; short shoots present. **Axillary buds** often 2 or 3 in a fascicle, conical, pubescent, apex obtuse; scales 3 – 6 mm long, pubescent, margin entire, apex round. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules linear, 5 - 12 mm long, margin toothed glandular, glabrous, often caducous; petiole (6) 10 - 20 mm long, glabrous; petiolar glands 1 – 4 or absent; blade abaxially greenish, adaxially dark green oblong-lanceolate, elliptic-lanceolate, or obovate-oblanceolate, 66 – 150 mm long, 19 - 35 mm wide, base, round, broadly cuneate, glands of the basal teeth 1- 4, larger and darker than upper teeth, not different from the petiolar glands, sometimes down on the petiole, margins finely to coarsely serrate, teeth glandular, apex acuminate to long acuminate, when young or mature abaxially pubescent or sparsely so, mainly along midvein, adaxially glabrous. **Inflorescences** solitary, axillary; pedicels green, 1 – 2 mm long, glabrous. Flowers: hypanthium green with a red tinge, campanulate to broadly campanulate, 4 – 6 mm long, 5 – 7 mm wide, outside pubescent or rarely subglabrous; sepals green with a red tinge, ovate to oblong, 4 – 6 mm long, margin entire, entirely pubescent or with broad band of pubescence along margin, apex round; petals white, pink, or deep reddish pink, oblong-elliptic to broadly obovate, 10 – 19 mm long, base tapering, apex round notched; stamens 20 – 35, anthers purplish red.; style nearly as long as stamens. **Fruits**

with pedicel 2 – 5 mm long, glabrous; drupe greenish white to orange-yellow, usually with a red tinge on exposed side, ovoid, broadly ellipsoid, or subglobose, compressed or slightly so, 17 – 30 mm long, 10 – 25 mm wide , 14 – 18 mm deep [(30) 50 – 70 (120) mm long and usually as wide when cultivated], base round sometimes asymmetric, apex acute, acuminate or round, surface densely pubescent, very rarely glabrescent, ventral suture conspicuous; mesocarp white, greenish white, yellow, orangish yellow, or red, succulent, not splitting at maturity; endocarp brown to light brown, ellipsoid to suborbicular, compressed, 13 – 25 mm long, 8 – 20 mm long, 10 – 14 mm deep, base round, asymmetric, apex acute to acuminate, surface pits sometimes present, deeply longitudinally and transversely furrowed.

Phenology. Flowering: Mid Feb - Apr; fruiting: Jul – Sep.

Distribution. Worldwide. Fig 2.19.2

Habitat. Cultivated in orchards or escaped from cultivation, along roadsides, field borders, forest edges, grasslands, waste fields, and hills and mountainsides. Growing at elevations between 500 – 2700 m.

Discussion

This species is the cultivated peach. If found growing spontaneously, most likely in abandoned orchards. It might be confused with closely related species, especially *Prunus kansuensis*. To distinguish it from the latter, as well as from *P. davidiana* and *P. mira*, kindly refer to the discussion paragraphs under those species.

A quick search on IPNI (2009) of the genus *Persica*, will list almost a 100 names, and this is not a complete list. Names have been suggested for cultivated varieties that differed in the slightest ways. Differences in characters such as whether the fruit is compressed or not, color of exocarp, color of mesocarp, pubescence of exocarp, and adnation of mesocarp to endocarp to name few, have been used to

differentiate cultivars and give them names. In one publication by Poiteau and Turpin (1846), 38 names have been validly published.

Whether or not the other species (*Prunus kansuensis, P. davidiana* and *P. mira*) that are very closely related to *P. persica*, are genuinely wild species or they are populations that escaped cultivation and diverged slightly from the currently cultivated species, remains controversial (Roach, 1985; Wang 1985).

REPRESENTATIVE SPECIMENS EXAMINED.

China. Shillong, 22 Mar 1892, *Prains 64* (G); Nan Yue (Heng mountain); road side, 5 May 1995, *Xia Jianglin 124* (MO); GUANDONG: Sai lin Shan village, Sin-fung district, 1-16 Apr 1938, *Y. W. Taam 514* (G); Suen To, 6 Mar 1925, *F. A. McClure 13226* (G); GUIZHOU**:** Daozhen: Baiji mountain, Huilong., 15 May 1996, *Liu Zhenyu 19502* (MO); HAINAN: Hainan prov., 12 Dec 1933, *C. W. Wang 35340* (G); HEBEI**:** Fangshan: Doulv Si, Jul 1935, *Liu Ying 10518* (MO); DaSha Ping, 7 Aug 1928, *H. C. Cheo 18231* (G); Xuan'en : Maobatang village, 8 Jun 1958, *Li Hongjun 2504* (MO); HUNAN: Dalin: Liling City; near the valley, 7 May 1999, *Chen Dehuan 6888* (MO); Paishan: Anren, Tianyuan mountain, 15 Aug 1999, *Chen Dehuan 8987* (MO); Shegang: Near the valley, Liuyang City, 20 Apr 1999, *Chen Dehuan 6255* (MO); JIANGXI**:** Anfu**,** Changyuan village, Dabu, 1 May 1998, *Ye Cunsu 7199* (MO); Zixi, Shixia, Near the mountain river, 23 May 1999, *Zou Huanning 818* (MO); SHANDONG: Hua Dong Shan, Fuk Lung monastery, Sin-Fung ditrict, 1-19 Jun 1938, *Y. W. Taam 869* (G); Li Chuan, Tsing Tao, 17 Jun 1930, *C. Y. Chiao 2549* (G); SHANDONG: Ts'ung-shue village, Ho Yuan, 5-30 May 1938, *W. T. Tsang 24938* (G); SHANXI**:** Qinyuan, the measuring center (Ce Liang Tai), near Mapao Spring, 28 Jun 1957, *Liu Jimeng 1469* (MO); Yang, Youshui, in the shrub in the mountain side, 16 Apr 1998,

Q. W. Wang 115 (MO); SICHUAN: Mt S. of Ching Chuan beyong Kiang. In gorge of Fu Kiang, Mar 1925, *J. F. Rock 12055* (A); Chengkou, 15 Apr 1958, *Dai Tianlun 160054* (MO); XIZANG: Tsakchuhonh, Lower Po-Tsangpo valley, 27 Feb 1947, *F. Ludlow, G. Sherriff, & H. H. Elliot 12263* (A); YUNNAN: Between Likiang Fu and Yunnan Fu, via Youngpei, Hwaping, Magai, and Wuting, Mar 1924, *J. F. Rock 11718* (A); Eastern Slopes of Likiang Snow range, Yangtze watershed, Apr 1923, *J. F. Rock 9825* (A); Feng Chen Ling, *A. Henry 10113b* (A); Kau Ho Ten, between Tengyueh and Likiangfu, via Swheshanting, Kantingai, Feilungkiao-Yunlung, Lanping, Chienchuan, and Likiang, Mar 1923, *J. F. Rock 8160* (A); N. of Yunnan Fu, by Xiao Ma Kai, 7 Mar 1014, *C. Schneider 242* (A); Nguluk, Eastern Slopes of Likiang Snow range, Yangtze watershed, 1923-24, *J. F. Rock 8504* (A); on hill of Wat Nowng Kam, between Muang Hua and Muang Hai, 13-15 Feb 1922, *J. F. Rock 2431* (A); Shung-Ning Hsien, Feb 1936, *C. W. Wang 71942* (A); Shung-Ning Hsien, Feb 1936, *C. W. Wang 71884* (A); Shweli [Chuan Chiang] river drainage basin and environs of Tengyueh, Feb 1923, *J. F. Rock 7981* (A); Shweli [Chuan Chiang] river drainage basin and environs of Tengyueh, Feb 1923, *J. F. Rock 7919* (A); ZHEJIANG: in front of a minor temple, which is right to Zhaoming Chan Si (Zhaoming Temple), east of Dong Tian Mu Mountain, 15 May 1957, *He Xianyu 21694* (MO); in the valley of Zhe Ling (Zhe mountain), 25 Apr 1959, *Pu Cha Dui 25627* (MO); roadside of northerst of Xi Mao Peng, Tiantai Mountain, 16 Jun 1959, *Pu Cha Dui* (MO); Hangzhou: Roadside of Xi mountain., 17 Mar 1959, *Zhang Shaoyao 1936* (MO); Hangzhou city**,** Chao mountain roadside, 8 Jul 1965, *Zhou Hiuxin 674* (MO); Hangzhou city**,** cultivated - Bihu Mountain, 4 Apr 1959, *Zhang Shaoyao 2036* (MO); Hangzhou city**,** Cultivated; Qianjiang orchard (Qianjiang Guoyuan), 29 Mar 1959, *Zhang Shaoyao 2006* (MO); Longquan, Hukou; Fengyang mountain;, 21 Apr 1959, *Zhang Shaoyao 4690* (MO); Lonqguan city, Fengyan mountain, 28 Apr 1959, *Zhang Shaoyao 4803*

(MO); Xiaofeng**,** Daxi village,, 7 Jun 1957, *He Xianyu 24334* (MO). Iran**:** GOLESTAN**:** Bandar-e Gaz, 19 Mar 1901, *P. Sintenis 1451* (G). **Lebanon.** MONT-LIBAN: Furn El Shebak, 25 May 1942, *P. Mouterde* (G); Furn El Shebak, 26 Feb 1942, *P. Mouterde* (G). **South Korea.** CHEJU-DO**:** quelpart, 25 Mar 1908, *Taquet 4637* (G). **Turkey.** ISTANBUL**:** Pisani, Therapia, 29 Jun 1890, *G. V. Aznavour 815* (G).

Figure 2.19.1. ***Prunus persica***. Reproduced from Prof. Dr. Thomé, Otto Wilhelm: Flora von Deutschland, Österreich und der Schweiz Band 3 Tafel 77. 1885.

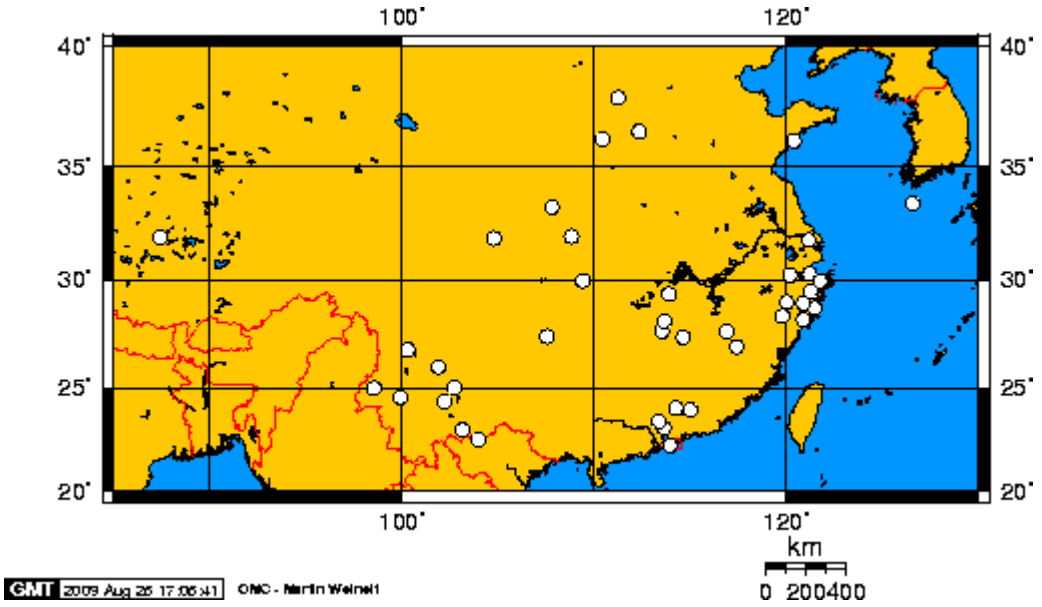

Figure 2.19.2. Distribution of *Prunus persica* [within area of distribution of wild relatives].

20. Prunus kansuensis Rehder, J. Arnold Arbor. 3: 21. 1922. *Amygdalus kansuensis* (Rehder) Skeels, Proc. Biol. Soc. Wash. 38: 87. 1925. *Persica kansuensis* (Rehder) Kovalev & Kostina, Bull. Appl. Bot., Leningrad, ser. 8, 4: 75. 1935. – TYPE: USA, California, Chico, 11 Aug 1921. *Thomas S.P.I. No. 40004* (A!) [notes on Type specimen: "China. Gansu, Wild peaches occurring as tall shrubs in loess cliffs at the Tibetan frontier at altitudes 6,000 to 8,000 ft."]

Trees or shrubs 3–7 m tall, with upright and spreading crown. **Bark** brown. **Branches** thornless; one year old twigs greenish brown with reddish brown on exposed side, glabrous, with indistinct small lenticels; short shoots present. **Axillary buds** in twos or threes, ovoid to long-ovoid, glabrous, apex ± obtuse; scales margin entire, ciliate, apex round. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules not seen; petiole 5 – 10 mm, glabrous; petiolar

glands usually absent; blade abaxially greenish, adaxially dark green oblong-lanceolate to lanceolate, 50 – 120 mm long, 15 – 35 mm wide, base broadly cuneate, margins sparsely finely, teeth glandular or nonglandular, apex acuminate, when young or mature abaxially pubescent or sparsely so, mainly along midvein, adaxially glabrous. **Inflorescences** solitary; pedicels nearly 0 mm long. **Flowers** with hypanthium purplish, campanulate, 4 – 5 mm long, 2 – 3 mm wide, outside pubescent or rarely subglabrous; Sepals purplish, ovate to ovate-oblong, 4 – 5 mm long, margin entire, outside pubescent or rarely subglabrous, apex round; petals white or pinkish, suborbicular to broadly obovate, 12 – 14 mm long, base tapering, margin sometimes undulate or shallowly incised, apex round. stamens 20–30, shorter than petals. style longer than stamens. **Fruits** with pedicel, 4 – 5 mm long, glabrous; drupe yellowish-green, ovoid-globose to subglobose, compressed, 19 – 25 mm long, 16 – 20 mm wide , 9 – 12 mm deep, base round, apex round, surface velutinous; mesocarp fleshy not splitting at maturity; endocarp brown, subglobose, compressed, 14 – 20 mm long, 11 – 14 mm long, 7 – 9 mm deep, base round to subtruncate, apex round, surface pits absent, surface longitudinally and transversely shallowly furrowed.

Phenology. Flowering: Mar–Apr, fruiting Aug–Sep.

Habitat. Mountain areas; Growing at elevations between 1000 - 2300 m.

Distribution. China: Gansu, Hubei, Qinghai, Shaanxi, Sichuan and Guizhou. Figure 2.20.1.

Discussion

Prunus kansuensis can be easily confused with the cultivated species *P. persica* for good reasons. When Rehder (1922) described this species and decided it was different enough from *Prunus persica*, he pointed few differences such as the numerously and finely toothed margin, pitted stone, pubescent winter buds and shorter

styles in *P. persica*, as compared to fewer teeth per cm, only furrowed stone, never pitted, glabrous winter buds and longer style in *P. kansuensis*. It is more likely that this variation represents variation within species and not two different species. However, in this treatment, the two species are maintained merely because of the economic and agricultural importance of *P. persica* and since any variation within this species is worth highlighting as it might be a target for conservation efforts for its importance in plant breeding programs.

REPRESENTATIVE SPECIMENS EXAMINED.

China. GANSU: 1 Aug 1995, *Yongshan Lian 95112* (MO); Kang county, 8 Aug 1996, *Yongshan Lian 96458* (MO); Kang**,** No 1 valley (Yihao Gou), forestry center, 1 Aug 1995, *Lian Yongshan 95112* (MO); Kang, Xujia River (Xujia He), Anmenkou, 8 Aug 1996, *Lian Yongshan 96458* (MO); GUIZHOU: Muli, near Lamasery, 24 Aug 1937, *T.T.Yu 14092* (A); SICHUAN: Kangding county, 24 Apr 1981, *Zhao Zhen-Ju 113351&* (A); Kangding county, 7 Jun 1981, *Zhao Zhen-Ju* (A); YUNNAN: Yunnan province, *T. T. Yu 5540* (A).

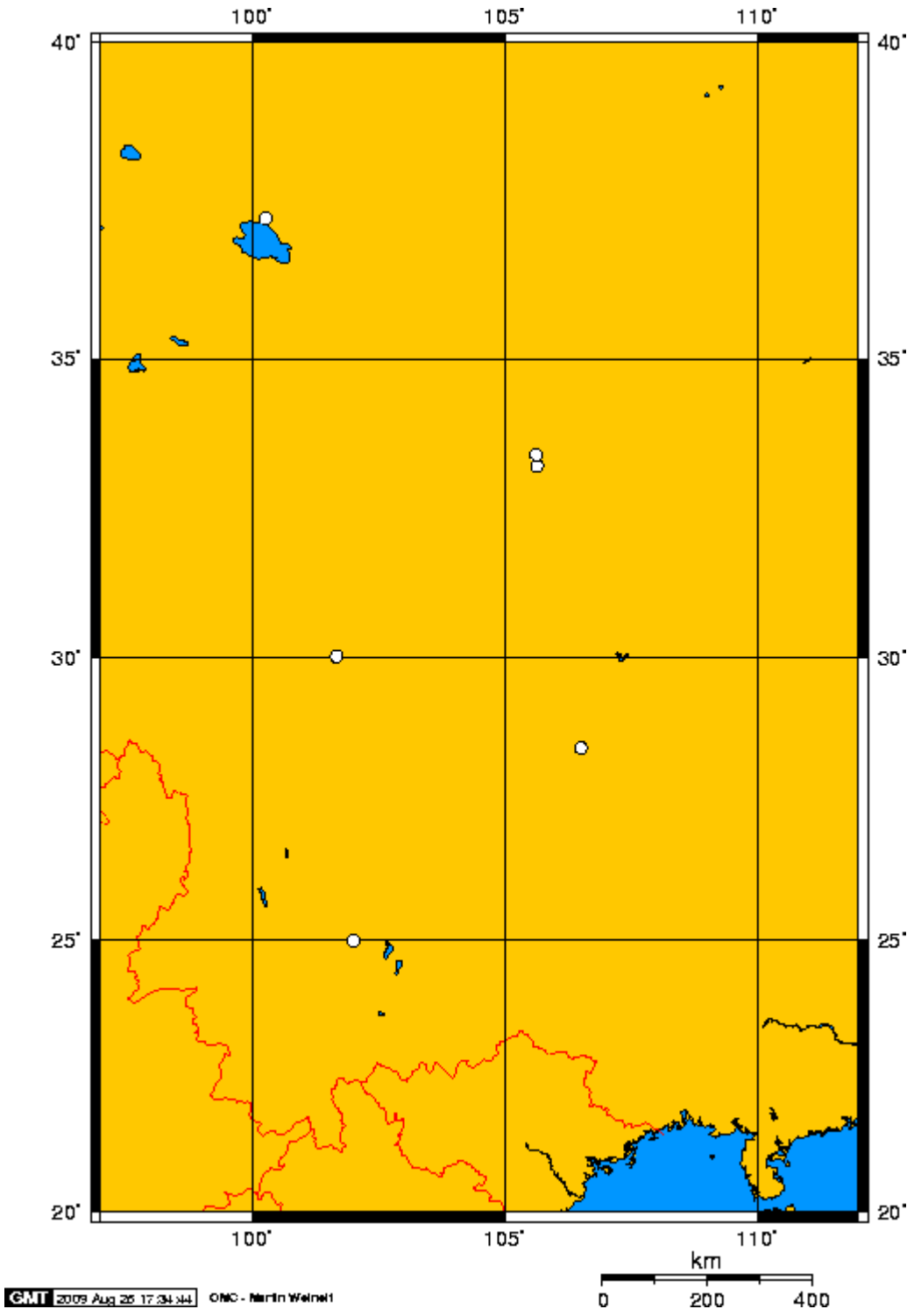

Figure 2.20.1. Distribution of *Prunus kansuensis* [China: Gansu, Hubei, Qinghai, Shaanxi, Sichuan and Guizhou].

21. Prunus davidiana (Carrière) N.E.Br. Suppl. Johnson's Gard. Dict., 991. 1882. *Persica davidiana* Carr., Rev. Hortic. 74. 1872. Type: unknown

Shrubs or trees 2–5 (10) m tall, with spreading crown. **Bark** dark-brown to purplish red. **Branches** thornless; one year old twigs green, reddish on exposed side, glabrous, with dark reddish lenticels, older twigs grey peeling to show smooth brown, glabrous, terete; short shoots present. **Axillary buds** in ones or threes, reddish brown, ovoid, adaxially flattened, 2–5 mm, glabrous, apex acute; scales 3 – 4 mm long, margin entire, ciliate, apex acute to round. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual twigs; stipules linear, 7 – 13 mm long, margin toothed glandular, glabrous, often caducous; petiole reddish, 6 – 20 (25) mm long, glabrous; petiolar glands reddish, 1 – 3 or absent; blade abaxially greenish, adaxially dark-green, lanceolate or ovate-lanceolate, 50 – 144 mm long, 13 – 40 mm wide, base round to cuneate, glands of the basal teeth 0 – 3, not different from the petiolar glands, sometimes down on the petiole, margins finely to coarsely serrate, teeth glandular or not, apex acuminate to long acuminate, when young or mature abaxially and adaxially glabrous. **Inflorescences** solitary; pedicels nearly 0 mm long. **Flowers** with hypanthium purplish-red, campanulate, 4 – 6 mm long, 5 – 6 mm wide, glabrous; sepals purplish-red, ovate to ovate-oblong, 3 – 5 mm long, margin entire, sometimes ciliate, apex round; Petals white or pink, obovate to suborbicular, 10 – 13 mm long, base tapering, apex round rarely slightly notched; stamens 25 – 30; style longer or ± as long as stamens. **Fruits** with pedicel, 1 – 5 mm long, glabrous; drupe green but looks yellowish due to dense yellowish pubescence, ellipsoid, subglobose, and less often globose or oblong, slightly compressed, 16 – 33 mm long, 14 – 25 mm wide , 11 – 17 mm deep, base round, apex round, rarely broadly acute, surface densely pubescent,

pubescence yellowish, ventral suture asymmetric, one side higher than the other; mesocarp not splitting at maturity; endocarp brown, globose, subglobose, ellipsoid, or oblong, not compressed, 16 – 25 mm long, 14 – 18 mm wide, 13 – 16 mm deep, base round to truncate, apex round, rarely acute, surface pits present, longitudinally and transversely furrowed. Figures 2.21.1 and 2.21.2.

Phenology. Flowering: Mar - Apr; fruiting: May – Sep.

Habitat. Growing in forests and valleys and in waste fields and mountainsides at elevations between 800-3200 m.

Distribution: China endemic. Beijing, Gansu, Hebei, Hunan, Shanxi, Zhejiang, Nei Mongol, Shaanxi Heilongjiang, Qinghai, Shandong, Sichuan, Yunnan. Figure 2.21.3

Discussion

Prunus davidiana can be distinguished from closely related species *P. persica, P. kansuensis* and *P. mira* by having a globose to subglobose drupe and a mesocarp that dries out without splitting unlike the others that have a mesocarp that is fleshy and does not dry out. *Prunus davidiana* is of specific importance due to a number of factors. Morphologically, it is the only species of the *P. persica* related group that has a dry mesocarp and in fact in one of the specimens (voucher - *Liu Jimeng 1277* (MO)) a splitting mesocarp was noticed. Molecularly, and based on chloroplast sequence data, it forms a clade with two other species, *P. tangutica*, and *P. mongolica*, and they are more closely related to the rest of the peaches than they are to the rest of the almonds. It is important to mention that these 3 species, as well as the rest of the peach group that they are related to, occur in China, and they do not spread towards central Asia where the rest of the *Prunus* subg. *Amygdalus* sect. *Amygdalus* (the almond group) occurs. Another important morphological character is that *P. tangutica* and *P.*

mongolica, like the rest of the almonds have splitting mesocarp. They all occur in Gansu, although they have not been known to co-occur in the same locations.

Two varieties have been described and recognized in this species according to Flora of China (Lu and Bartholomew, 2003), *Prunus davidiana* var *davidiana* and *P. davidana* var *potanini*. One main difference between the two varieties is the shape of the drupe being subglobose to globose in *P. davidiana* var. *davidiana* versus ellipsoid to oblong in *P. davidiana* var *potanini*. The other difference is quantitative and overlapping which is cuneate in the former varieties versus broadly cuneate leaf base in the latter. Even though, the variation in drupe shape is highlighted within this species, these varieties are not recognized here.

REPRESENTATIVE SPECIMENS EXAMINED.

China: BEIJING**:** Huzhu, Miaoer Wa, back of Miaofeng mountain, 7 May 1953, *Zhao Fu 74* (MO); GANSU: Kongdong Shannatai, Ping Liang, 31 Aug 1994, *X.L. Chen 94166* (MO); HEBEI: Jin Mountain, West suburb of Beijing., 9 May 1953, *Zhao Fu 0088* (MO); Neiqiu : Xiyan Gelao, Xiao Lingdi village, 14 Jul 1950, *Liu Ying 13064* (MO); HUNAN**:** Gang, Liuyang Community, 20 Apr 1999, *Chen Dehuan 6253* (MO); Guidong**,** Sidu Village, Bamian Mountain, in the ravine, 2 Aug 1999, *Xiong Bin 8450* (MO); Pingjiang**,** Siyuan village; Jiayi, 20 Jul 1998, *Ye Cunsu 7578* (MO); Shidu, Yanling, 16 May 1999, *Xiong Bin 7163* (MO); Zixing**,** Penghshi village, in the ravine, 17 Jul 1999, *Xiong Bin 7845* (MO); JIANGXI**:** Fending –Mountain, Shihu village; nearest city: Yichun, 4 May 1998, *Ye Cunsu 7259* (MO); Guixi, Longhu Mountain; Mountain Roadside, 8 May 1999, *Zou Huanning 084* (MO); Yifeng, Tanshan, 4 Jul 1959, *Ye Cunsu 4542* (MO); Zixi, Forestry Center; Matou mountain, near the mounain river, 31 May 1999, *Zou Huanning 1044* (MO); SHANXI: Hsi Fou Tou, 10 Jul 1014, *F.*

N. Meyer 1837 (P); Mountain NE of Taiyuanfu, 10 Oct 1914, *R. P. Licent 937* (P); Taihangshan, 19 Jun 1915, *R. P. Licent 1201* (P); Taihangshan, Toukoutwei, 21 Jun 1915, *R.P. Licent 1220* (P); Ji mountain & Shengwang mountain & Shiba Pen (Shiba Basin), 12 May 1959, *Ma Sai 51* (MO); on the way from Yangjia He (Yangjia River) to Yunmeng mountain, 16 May 1959, *Bao & Yan 105* (MO); Prope Wu li Tsun, 24 Jul 1912, *Harry Smith 6261* (MO); Chieh Hsiu Hsien**,** Cho Mei Shan, 24 Jun 1912, *Harry Smith 5614* (MO); Jiexiu, around Yunfeng Temple, Mian Mountain, 11 May 1993, *Liu Xinyuan 5016* (MO); Jiexiu, Yuzha, South of Jiexiu basin, 19 Jun 1957, *Liu Jimeng 1277* (MO); Jishan, on the way from North of Shikou to Yunmeng mountain, 31 May 1959, *Ma Sai 273* (MO); Lingchuan, Sai Ma Schuan, Xizhashui Forestry Center, 6 Jul 1980, *Liu Tianwei & Li Caigui 011* (MO); Lvliang, Kecheng Community, 7 Dec 1993, *Ma Sai 447* (MO); Pu, Changdian Gou, Kecheng Village, 14 Jul 1993, *Liu Zeng 1445* (MO); Qinshui, Dong Mountain, Zhong Village, 20 Feb 1984, *Shanxi Team 22546* (MO); Qinshui West ravine of Shengwang ping; Xiachuan community, 13 Jun 1983, *Huang Tudui 00218* (MO); Xia : Shenlie Gou, Taikuan River, Sijiao village, 1 Jul 1962, *Liu Tianwei 398* (MO); Xiangning**,** Jiayunkong Gou (Valley), Guanwang Miao (Temple), 12 Jul 1959, *Ma Sai 114* (MO); Yuanqu, West Ravine, 28 Apr 1980, *Liu Tianwei* (MO); Zhongyang, near the Hoggery (Pig-raising factory), 3 Sep 1959, *Ma Sai 962* (MO); Zhongyang County, Baiyu Mountain, Slope, 29 Dec 1993, *Ma Sai 5537* (MO); ZHEJIANG**:** Longquan, Ang Mountain, 3 Apr 1959, *Zhang Shaoyao 4520* (MO).

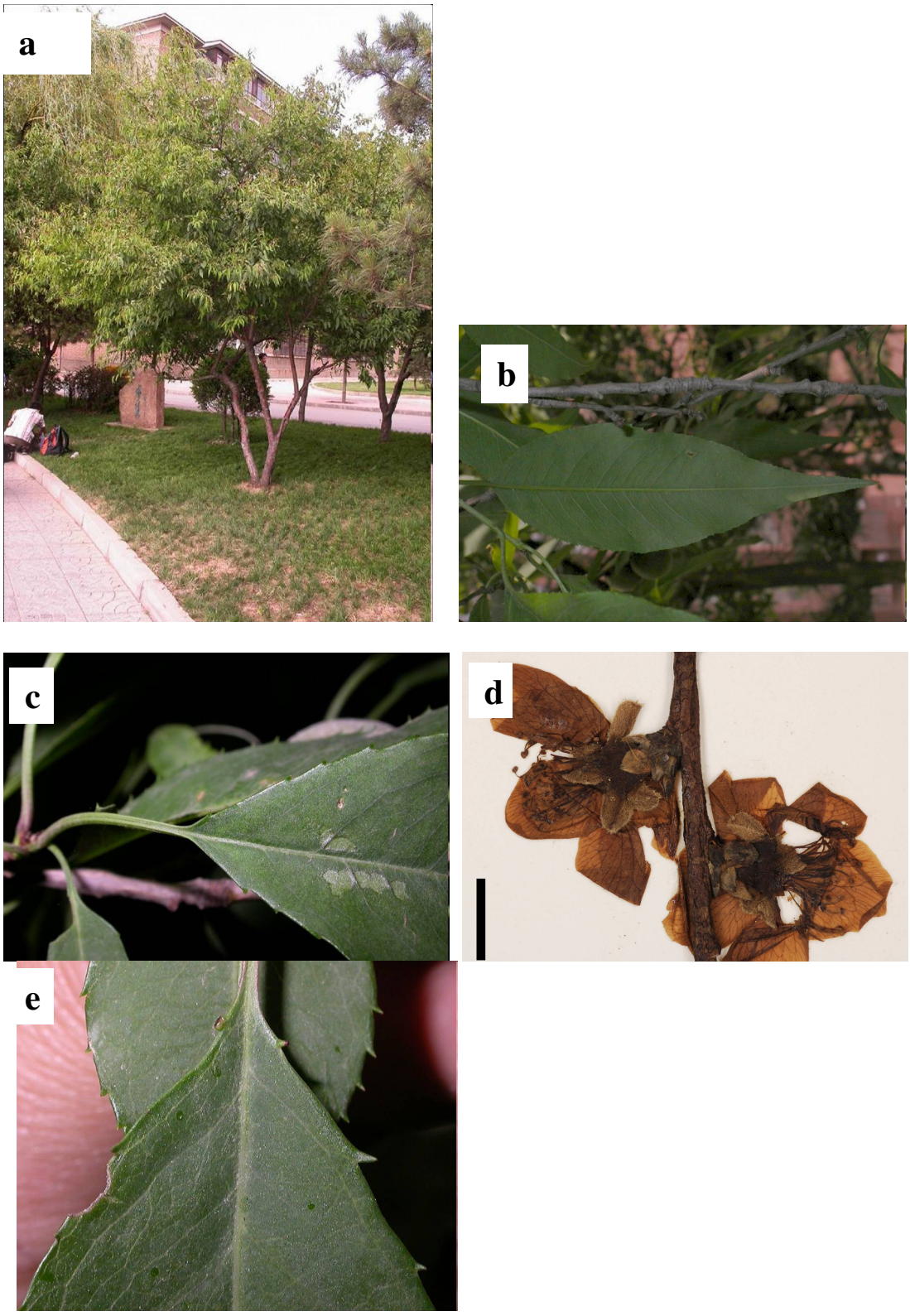

Figure 2.21.1. ***Prunus davidiana***. a. habit; b. leaf blade shape; c, e. leaf base shape; d. Flower. [Scale = 1 cm.]

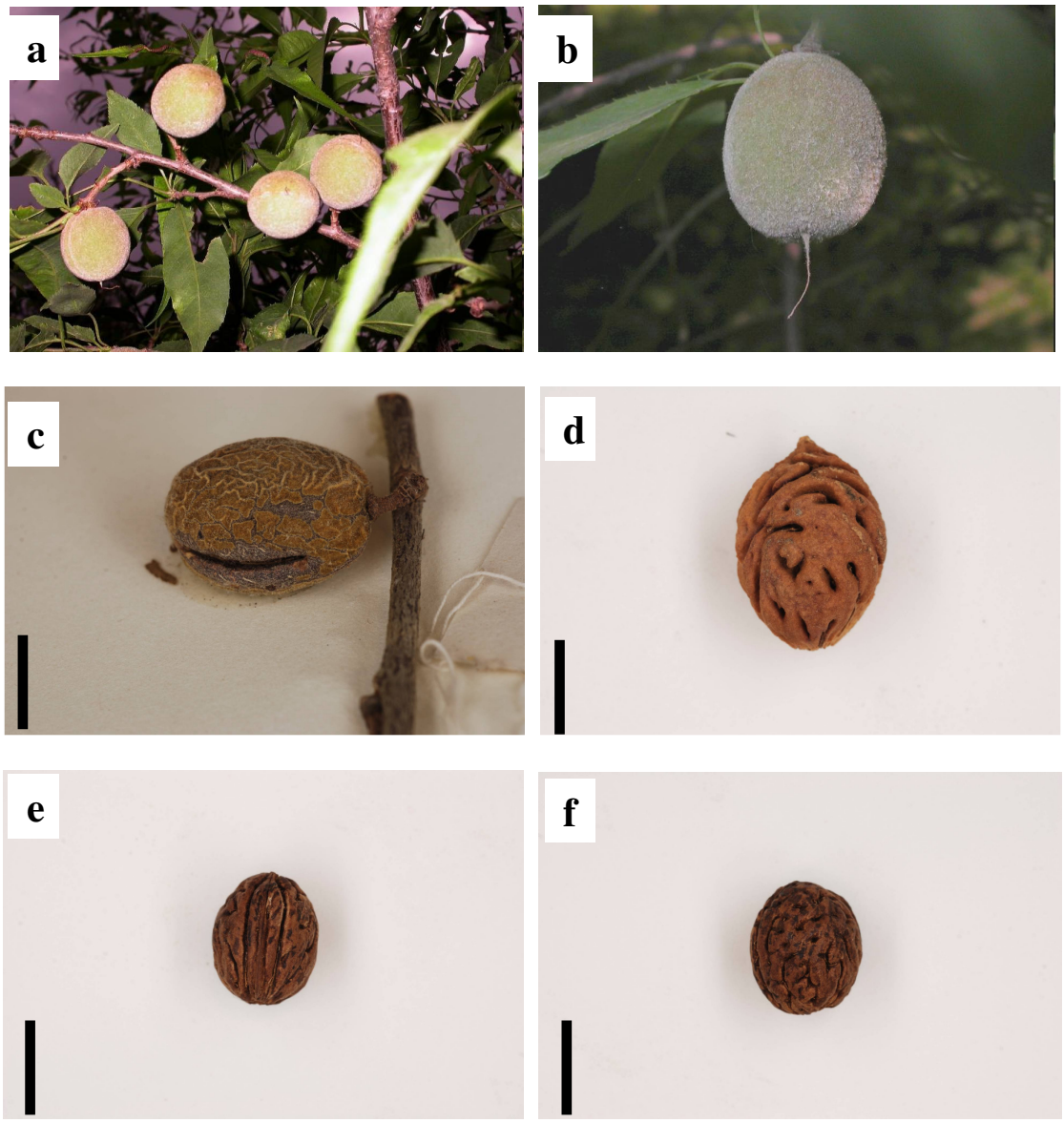

Figure 2.21.2. ***Prunus davidiana***. a, b, c. fruit. d, e, f. endocarp. [Scale = 1 cm]

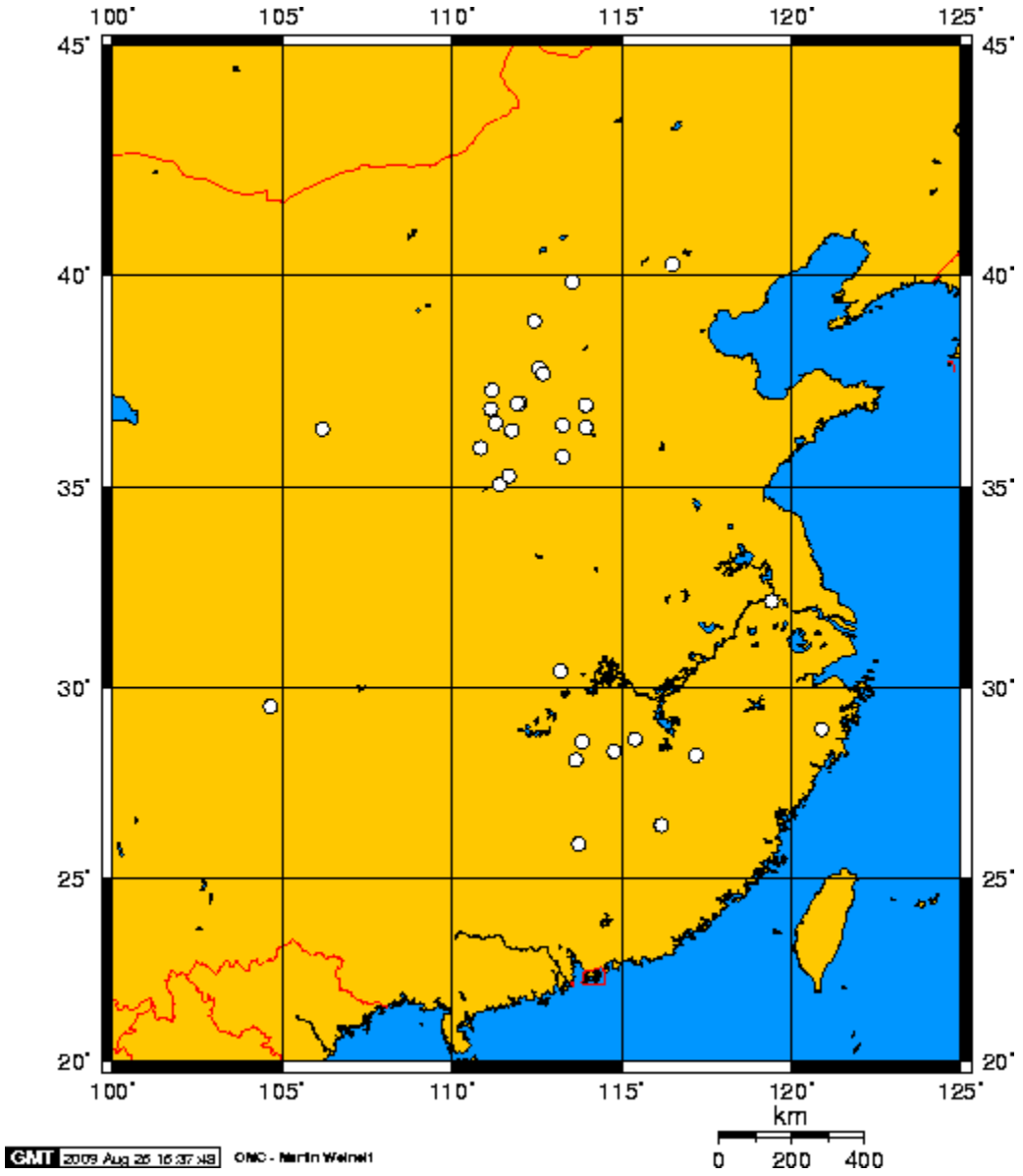

Figure 2.21.3. Distribution of *Prunus davidiana* [China endemic. Beijing, Gansu, Hebei, Hunan, Shanxi, Zhejiang, Nei Mongol, Shaanxi Heilongjiang, Qinghai, Shandong, Sichuan, Yunnan].

22. Prunus mira Koehne, Sargent, Pl. Wilson. i. 272. 1912. *Persica mira* (Koehne) Kovalev & Kostina, Bull. Appl. Bot., Leningrad, ser. 8, 4: 33. 1935. *Amygdalus mira* (Koehne) T.T.Yü & L.T.Lu. Fl. Reipubl. Popularis Sin. 38: 23. 1986. – Type: China. Sichuan, 2 miles N. of Tashien Lu, alt. 8000ft. 10 Oct 1910-11. *E.H.Wilson, 4205* (isotype: A!).

Persica mira (Koehne) Kovalev & Kostina subsp. *nepalensis* Serafimov, Dokl. Bolg. Akad. Nauk, 27, 6: 835. 1974. *Prunus mira* Koehne subsp. *nepalensis* (Serafimov) H.Hara, Enum. Fl. Pl. Nepal, 2: 142. 1979. TYPE: Unkown.

Trees 3– 10 m tall, with spreading crown. **Bark** brown. **Branches** thornless; one year old twigs green, glabrous, with purplish brown small lenticels, older twigs grey pealing to show brown, glabrous; short shoots present. **Axillary buds** purplish brown, ovoid, 3–6 mm, glabrous, apex acute; scales margin entire, with dense curly pubescence, apex round. **Leaves** conduplicate in bud, alternate on annual twigs; stipules not seen, often caducous; petiole 8 – 15 mm long, glabrous; petiolar glands often flattened purplish red, 1 – 3, sometimes look higher up on the leaf base; blade abaxially greenish, adaxially dark green lanceolate to ovate-lanceolate, 50 – 132 mm long, 15 – 40 mm wide, base, broadly cuneate to round, glands of the basal teeth 1 – 3, not different from the petiolar glands, but some of them are sometimes go down on the petiole, margins shallowly crenate-serrate, becoming entire towards apex, teeth glandular, apex acuminate, when young abaxially pubescent or sparsely so, mainly along midvein, adaxially glabrous, when mature, abaxially pubescent along midvein, adaxially glabrous. **Inflorescences** solitary; pedicels green, 1 – 3 mm long, glabrous. **Flowers** with hypanthium purplish-brown, campanulate to broadly campanulate, 4 – 5 mm long, 5 – 7 mm wide, glabrous; sepals purplish-green, ovate to narrowly ovate, 4 – 5 mm long, margin entire, sometimes slightly ciliate along margin, apex round

sometimes slightly retuse; petals pink to red, broadly obovate to round, 10 – 15 mm long, base tapering, apex round notched; stamens mostly 30, much shorter than petals; style longer or ± as long as stamens. **Fruits** with pedicel, 2 – 5 mm long, glabrous; drupe not seen; endocarp not seen.

Phenology. Flowering: Mar - Apr; fruiting: May – Sep.

Distribution: China: Sichuan, Xizang, and Yunnan, Russia and Nepal. Figure 2.22.1.

Habitat. In regions of temperate forests, mountain slopes, valleys and ravines edges. Growing at elevations between (700 m cultivated) 2000 – 4000 m.

Discussion

According to the description (Wilson, 1912) of this species, it can be easily distinguished from the rest of the species in sect. *Persica* by having an endocarp that has a smooth surface and with few longitudinal shallow furrows only on dorsal and ventral sides, which is very atypical of the species in sect. *Persica* that have very deep and reticulate furrows allover the endocarp surface. Vegetatively this species can be easily confused with *Prunus kansuensis* and *P. davidiana*, and the only way to distinguish them is based on the endocarps. It has been reported in Flora of China (Lu and Bartholomew, 2003) that this species is cultivated for fruits and seeds which means that it sometimes has sweet seeds. That is why it is doubted whether it is genuinely wild or just escaped cultivation and became spontaneous.

REPRESENTATIVE SPECIMENS EXAMINED.

China: GUIZHOU: [Cultivated] Zinzhou; Zheng'an city, 5 Apr 1996, *Liu Zhenyu 16358* (MO); [Cultivated] Daozhen, Baiji mountain, Huilong, 20 Mar 1996, *Liu Zhenyu 19505* (MO); SICHUAN: Prope castellum Kwapi ad septentr. oppidi Yunyuen, 22 May

1914, *Dr. Heinz . Frh. v. Handel-Mazetti 2496* (A); Waloho village, 14 Jun 1914, *C. Schneider 1548* (A); YUNNAN: Ad confines Tibeticas sub jugo Dokerla, 16 Sep 1915, *Dr. Heinz . Frh. v. Handel-Mazetti 8062* (A); High plateau between Talifu and Lichiang, 6-11 May 1922, *J. F. Rock 3302* (A); near Lichiang, Oct 1914, *C. Schneider 3190* (A); Si Muli, near city, 4 Sep 1937, *T. T. Yu 14166* (A); Yu long shan, Li kiang Hsien, Oct - Nov 1935, *C. W. Wang 71763* (A). **Nepal**: Manduwe, 29 Apr 1974, *J. F. Dobremez 2850* (G); TeTang, 18 May 1974, *J. F. Dobremez 3024* (G);

23. Prunus tangutica (Batalin) Koehne, Pl. Wilson. 1(2): 276. 1912. *Amygdalus communis* var. *tangutica* Batalin, Trudy Imp. S.-Peterburgsk. Bot. Sada 12(1): 163-164. 1892. *Amygdalus tangutica* (Batalin) Korsh., Bull. Acad. Petersb. ser. 5. 14: 94. 1901. *Persica tangutica* (Batalin) Kovalev & Kostina, Bull. Appl. Bot., Leningrad, ser. 8, 4: 75. 1935.– Type: China. Gansu, in Valley Hei-ho. 22 Jul 1885. *Potanin* (K!).

Prunus dehiscens (Batalin) Koehne, Pl. Wilson. 1, 2: 271-272. 1912. – Type: China. Sichuan, Songpan Ting, 2000-2900 m, Oct. 1910. *E.H. Wilson 4028* (A!).

Shrubs 1- 2.5 (4) m tall, with spreading crown. **Bark** dark brown. **Branches** thorny; one year old twigs reddish brown, glabrous or puberulent, older twigs dark brown, glabrescent; short shoots present. **Axillary buds** with scales 3 mm long margin entire, pubescent, apex round, mucronate. **Leaves** conduplicate in bud, fascicled on short shoots, and alternate on annual twigs; stipules linear, 2 - 3 mm long, with wide base, margin toothed glandular, linear towards the apex, glabrous, often caducous; petioles 5 - 13 mm long, reddish, glabrous; petiolar glands absent; blade abaxially greenish, adaxially dark green, elliptic, oblong, or obovate-oblanceolate, (15) 30 – 52 mm long, 5 – 16 mm wide, base, cuneate, glands of the basal teeth sometimes 1- 2,

larger and darker than upper teeth, margins crenate, teeth glandular, 20 – 30 on each side, apex acute, mucronate, when young or mature, abaxially and adaxially. **Inflorescences** solitary, axillary; pedicels nearly 0 mm long. **Flowers** with hypanthium color not seen, campanulate to broadly-campanulate, 3 – 5 mm long, 4 – 6 mm wide, glabrous; sepals color not seen, long-elliptic, 3 – 4 mm long, margin entire, rarely obscurely serrate, glabrous, apex round; petals pink to white, obovate, 7-14 mm long, base cuneate, apex round notched; stamens 25 – 30; style not seen. **Fruits** with pedicel, to 1 mm long at most, glabrous; drupe subglobose to globose, ovate in cross section, compressed or slightly so, 15 – 23 mm long, 11 – 20 mm wide, 7 – 13 mm deep, base round, sometimes slightly asymmetric, apex round, sometimes slightly asymmetric, surface densely velutinous; mesocarp splitting at maturity; endocarp light brown, broadly ovate in cross-section, compressed, ca. 16 mm long, ca. 15 mm wide, ca. 12 mm deep, base round or subtruncate, apex round, ventral suture with thin broad keel, surface pits absent, furrows reticulate allover surface, deeply or shallowly. Figures. 2.23.1 and 2.23.2

Phenology. Flowering: Apr - May; fruiting: Jun – July.

Distribution. China, S Gansu, NW Sichuan. Figure. 2.23.3.

Habitat. In dry rocky hillsides and slopes; especially along river banks and stream sides. Growing at elevations between 1500 – 3400 m.

Discussion

Prunus tangutica can be confused with *P. fenzliana* and to a lesser extent with *P. webbii*, especially when there is only vegetative material available. It can be distinguished from them for having a drupe that is globose or subglobose and an endocarp that has grooves and furrows, a characteristic typical to the cultivated peach, *P. persica* (Fig. 2.23.2). *Prunus tangutica* along with *P. mongolica* come out in the

phylogeny as closely related to the cultivated peaches. The only remark to this relationship has been made by Kovalev and Kostina (1935) in their revision of *Amygdalus* while searching for gene pool available for almond and peach breeding. They were the first and last to suggest that *P. tangutica* should belong in genus *Persica* and made the needed nomenclatural combination *Persica tangutica* (Batalin) Kovalev & Kostina.

REPRESENTATIVE SPECIMENS EXAMINED.

China: Gansu: Choni distr., Sep-Oct 1025, *J. F. Rock 13555* (P); Kar Ching Kou, near Old Taochow, 26-31 Aug 1923, *R. C. Ching 831* (A); Minchow, 10 May 1914, *Wm. Purdom 1029* (A); Tao Basin River: over the rocky hillsides of Choni, May 1925, *J. F. Rock 12095* (A); Tao river basin, Aug-Sep 1926, *J. F. Rock 14889* (W); Tao river basin: mts of Choni, May 1925, *J. F. Rock 12143* (P); **Sichuan**: 20 km from Song Pan on the right side of the road, along the riverside in Mou Ni Gou Valley, 18 Jun 2006, *M. Yazbek & Y. Wang 35* & *36*(BH); Shi Ba Zi village. on the right side of the road, along the riverside in Mou Ni Gou Valley, 18 Jun 2006, *M. Yazbek & Y. Wang 38 & 40* (BH); Jiou Zhai Gou: 7.5 km on the way from Jiou Zhai Gou ti the Forest Garden (Protected Nature Reserve), on the right side of the road, 17 Jun 2006, *M. Yazbek & Y. Wang 27, 28, 29, & 30* (BH); Jiou Zhai Gou: On the slope infront of the management Office of the Forest Garden (Protected Nature Reserve), on the right side of the road, 17 Jun 2006, *M. Yazbek & Y. Wang 31 & 33* (BH).

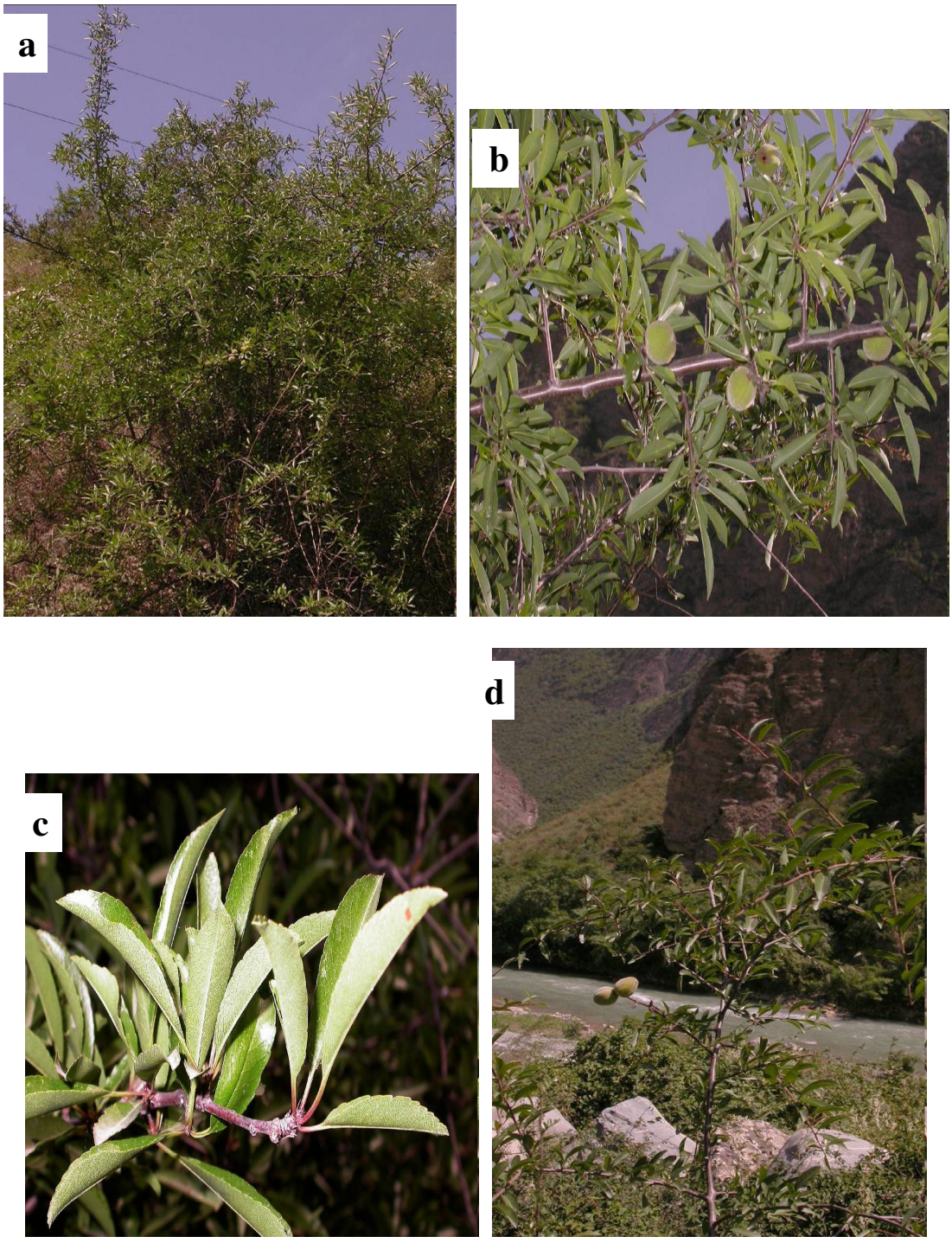

Figure 2.23.1. ***Prunus tangutica***. a, b, d. habit and habitat. c. shoots and leaves.

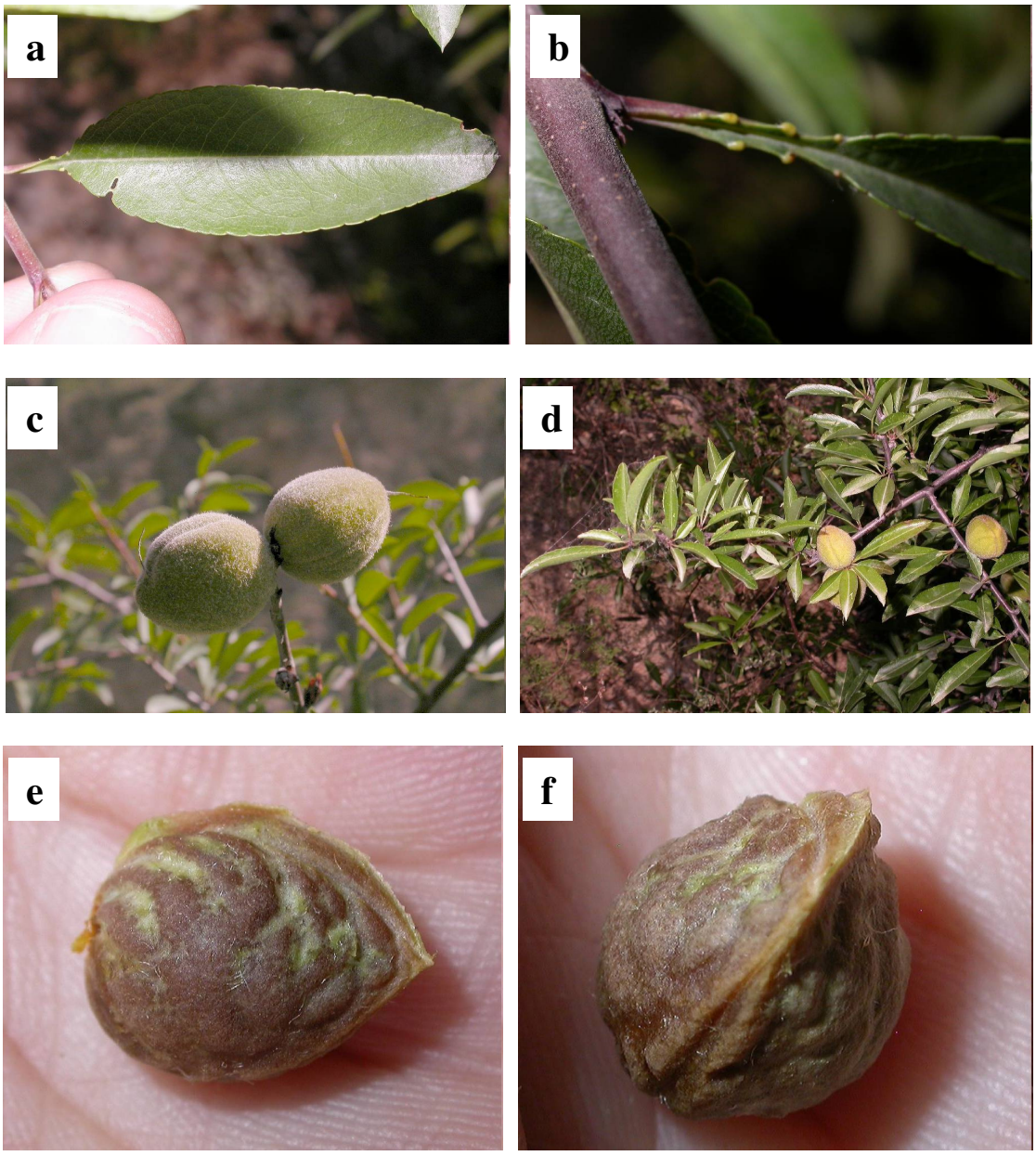

Figure 2.23.2. ***Prunus tangutica***. a. leaf blade shape. b. leaf base glands. d, e. drupes. e, f. endocarp.

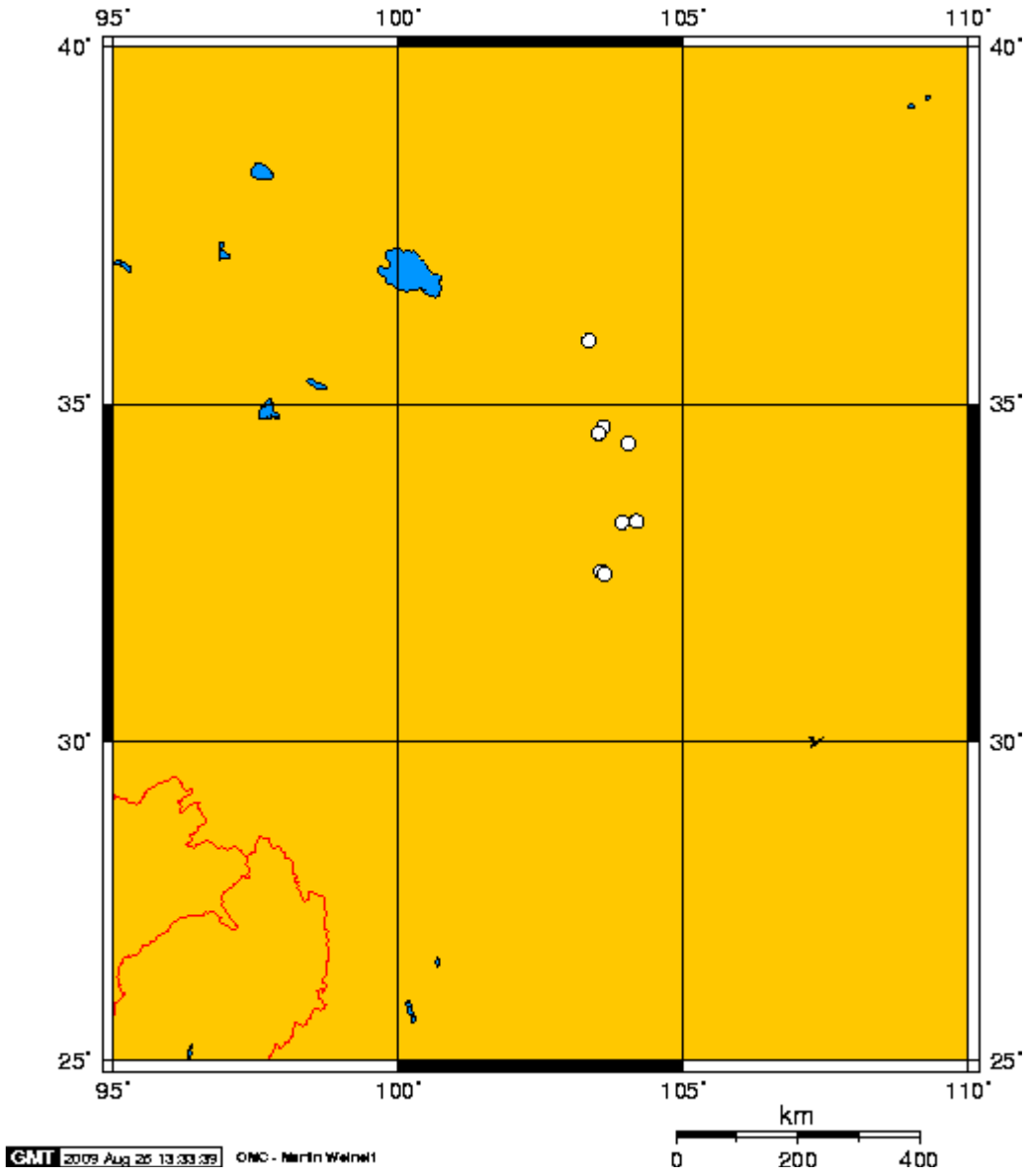

Figure 2.23.3. Distribution of *Prunus tangutica* [China, S Gansu, NW Sichuan].

24. Prunus mongolica Maxim., Bull. Soc. Imp. Naturalistes Moscou 54: 16. 1879. *Amygdalus mongolica* (Maxim.) Ricker, Proc. Biol. Soc. Wash. 30: 17. 1917. – Type: Mongolia. Mount Muni-Ula, 21 Apr 1872. *N. M. Prezwalski*. (holotype:LE! Isotype: K!)

Shrub (0.3) 1 – 2 m tall, with spreading crown. **Bark** brown. **Branches** thorny, often at the tip; one year old twigs reddish brown, hispidulous, older twigs grey brown, glabrescent, terete; Short shoots present. **Axillary buds** not seen. **Leaves** conduplicate in bud, fascicled on short shoots and alternate on annual branches; stipules linear, 1 – 2 mm long, with wide base, margin toothed glandular, linear towards the apex, glabrous, sometimes caducous; petiole 3 – 7 mm long, green, glabrous; petiolar glands absent; blade green elliptic, suborbicular, or obovate, 8 – 18 mm long, 6 – 16 mm wide, base, cuneate, glands of the basal teeth one, larger and darker than upper teeth, margin shallowly serrate, crenate-serrate or crenate, more towards the apex teeth glandular, apex round, mucronate, when young or mature, abaxially and adaxially glabrous. **Inflorescences** solitary, sometimes fascicled on short shoots; pedicels green, ca. 0 mm long. **Flowers** with hypanthium green, campanulate, sometimes slightly constricted at the, 3 – 4 mm long, 3 – 4 mm wide, glabrous; sepals color not seen green, oblong, 3 – 4 mm long, margin entire, glabrous, apex round, sometimes mucronate; petals pink to deep pink, obovate, 5 – 7 mm long, base cuneate, apex round notched; stamens 20; style not seen. **Fruits** with pedicel, up to 1 mm long, glabrous; drupe broadly ovoid-globose, or ellipsoidal, slightly compressed, 11 – 15 mm long, 9 – 12 mm wide, 8 – 9 mm deep, base round asymmetric, apex acute to round, sometimes asymmetric, surface long yellowish pubescence; mesocarp splitting at maturity; endocarp light-brown, ovate in cross-section, slightly compressed, 8 – 13 mm long, 7 – 10 mm long, 7 – 8 mm deep, base

round, asymmetric, apex acute to round, mucronulate, ventral suture with flattened keel, surface pits absent, furrows present, shallow. Figure. 2.24.2.

Phenology. Flowering: Early Apr - Jun; fruiting: Early Jun – Sep.

Distribution: China: Gansu, Inner Mongolia, Qinghai; Mongolia, Russia: Katun Belki, region near NW Mongolia. Figure. 2.24.1.

Habitat. In very dry rocky mountainsides, and grasslands often in dry gullies. Growing at elevations between 1000 – 2400 m.

Discussion

This is a species that is very easy to distinguish from the rest of *Prunus* subg. *Amygdalus* by the shape of leaves. It has a blade that is elliptic or most commonly suborbicular and does not get large in size varying between 8 – 18 mm in length and between 6 - 16 mm in width. The distribution of this species also makes it very easy to identify since its range doesn't overlap with anything that is even remotely similar to it. Its habit is reminiscent of the very thorny and low shrubs of the *P. lycioides* related species, especially when extensively overgrazed, which is usually the case; however, it can be distinguished from those very easily by the shape of the leaves. It can also be distinguished from other spinescent species such as *Prunus argentea* and *P. discolor* by the absence of pubescence in addition to the shape of the leaves. *Prunus mongolica* is an endangered species in China and Mongolia, with its habitat being destructed and being heavily over grazed, in addition to an already vulnerably dry climate.

REPRESENTATIVE SPECIMENS EXAMINED.

China. GANSU: 18 Jun 1958, *M. P. Petrov* (K); Jinchang city; Longshou mountain, 6 Jul 1993, *Liu Yingxin & Zhang xiufu 93069* (MO); INNER MONGOLIA: 30 km from

Huhehaote city to the NW on the way to Tu Mote Zuo Qi. On the slope of Da Qing mountain-Bai Shi Tou, 10 Jun 2006, *M. Yazbek & Y. Wang 05 & 10* (BH); Wu Ye Hsien [Wu-yuan-hsien], 2-13 Apr 1923, *R. C. Ching 9* (P); Wuhai county. 3 km to the E of Wuhai city. slope of Zhuo Zi Mountain., 9 Jun 2006, *M. Yazbek & Y. Wang 01& 02* (BH); [ISOTYPE] Mountains Muni- Ula [=Ulashan], 4 Sep 1890, *N.M.Przewalski* (K); Hilan mountain, 20 Jun 1962, *S.D. Zeng 26* (MO); QINGHAI: Mongolia borealis: ad Fluv. Kemtschin, Aug 1896, *A. Adrianow* (K). **Mongolia.** HENTIY: Ta-Tsing-Chan [Thetsen Khan], May 1866, *A. David 2640* (P). **Russia.** West of Gatun Bologai [Katun Belki], 1925, *R. W. Chaney 36* (MO);

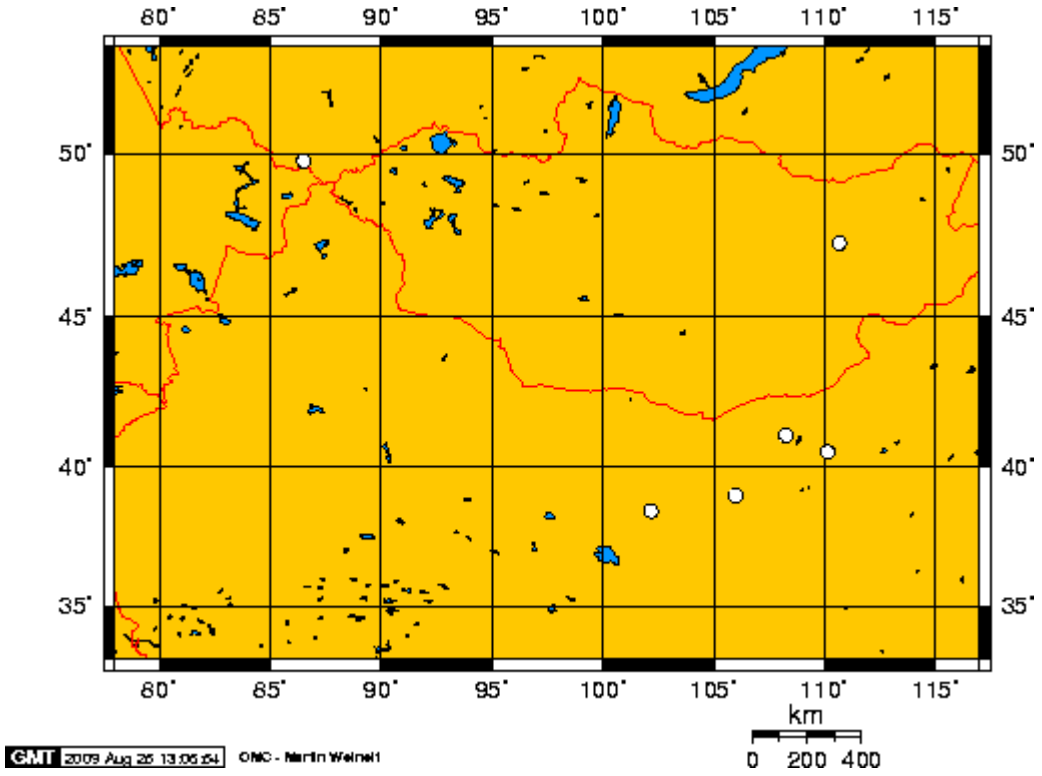

Figure 2.24.1. Distribution of *Prunus mongolica* [China: Gansu, Inner Mongolia, Qinghai; Mongolia, Russia: Katun Belki, region near NW Mongolia].

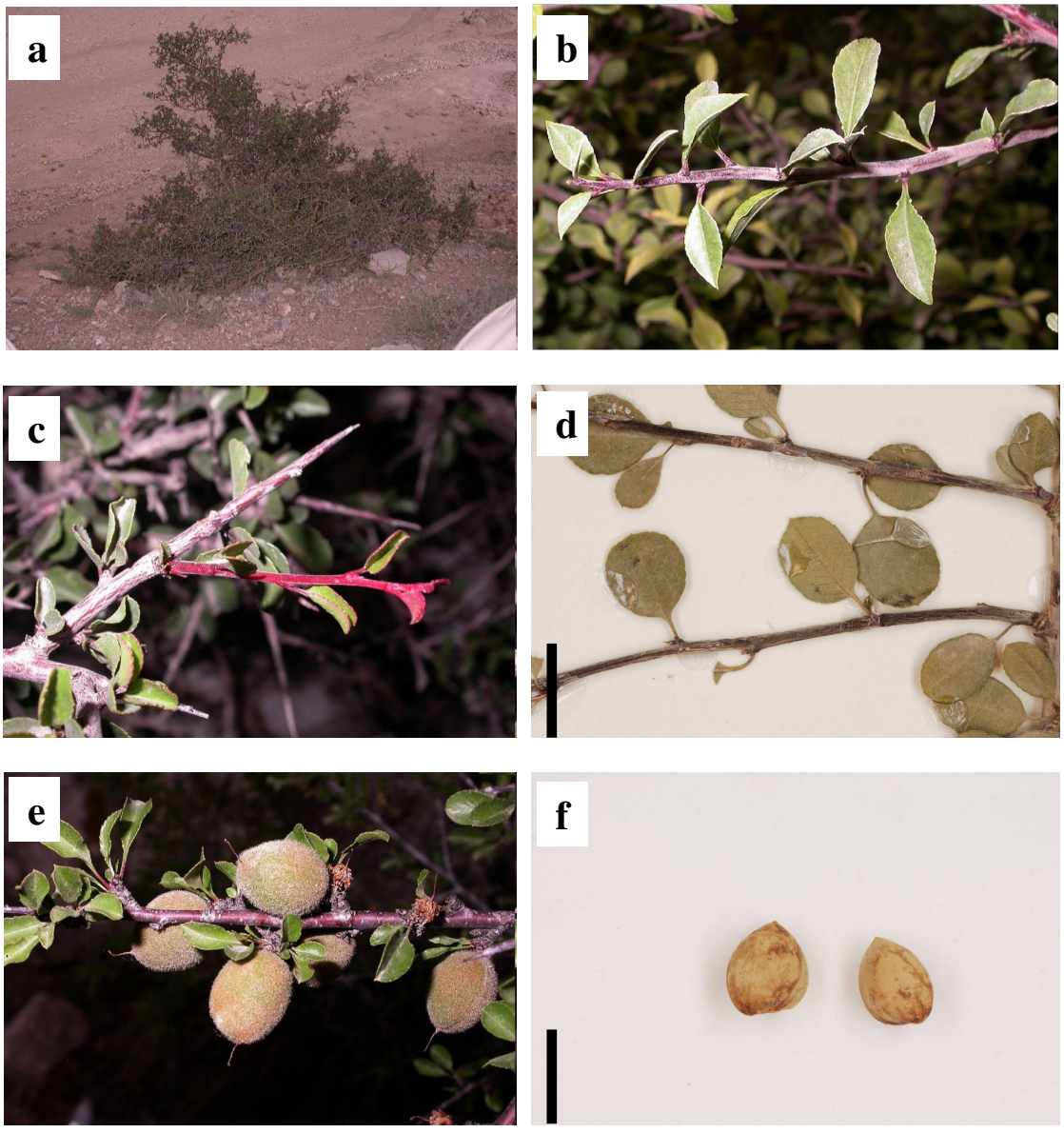

Figure 2.24.2. ***Prunus mongolica***. a. habit. b, c, d. shoots and leaves shape. e. drupe. f. endocarp.

LIST OF EXCLUDED AND DOUBTFUL NAMES

Persica nucipersica Borkh., Vers. Forstbot. Beschr.: 205. 1790. – *Amygdalus nucipersica* (Borkh.) Rchb., Fl. Germ. Excurs. 2(2): 647. 1832. – *Prunus persica* var. *nucipersica* (Borkh.) Dippel – *Persica vulgaris* Mill. convar. *nucipersica* (Borkh.) J.Holub in Folia Geobot. Phytotax. 28: 107. 1993. *Prunus persica* (L.) Batsch subsp. *nucipersica* (L.) D.Rivera , Obón , S.Ríos , Selma , F.Méndez , Verde & F.Cano in Varied. Trad. Frut. Cuenca Río Segura Cat. Etnobot. 1: 296 (1997). *Prunus persica* var. *nucipersica* (Borkh.) C. K. Schneid, Illustriertes Handb. Bot. 1905 Remarks: Publication not seen.

Persica laevis DC. in J.B.P.A. de Monet de Lamarck & A.P. de Candolle, Fl. Franc., ed. 3, 4: 487. 1805. – *Amygdalus laevis* (DC.) D. Dietr., Syn. Pl.: 3: 42. 1843.

Persica domestica Risso, Hist. Nat. Prod. Eur. Mérid. 2: 104. 1826. -- *Prunus persica* (L.) Batsch subsp. *domestica* (Risso) D. Rivera, Obón, S. Ríos, Selma, F. Méndez, Verde & F. Cano, Varied. Trad. Frut. Cuenca Río Segura Cat. Etnobot. 1: 293. 1997.

Persica violacea Risso, Hist. Nat. Prod. Eur. Mérid. 2: 119. 1826.

Persica atropurpurea Hort. ex Gard. Kew, i. Polypet. (1894) 131. *Persica vulgaris* Mill. subsp. *atropurpurea* (C.K.Schneid.) V.A.Zaiats Ukrayins'k. Bot. Zhurn. 57(1): 54. 2000. *Persica vulgaris* Mill. var. *atropurpurea* (C.K.Schneid.) Holub bis in Vedecke Prace Ovocnarske, 6(Bot.Klasif. Rodu Persica Mill.): 309 (1977).

Amygdalus chinensis Hort. ex K.Koch in Dendrol. i. 85. =Prunus persica.

Persica ispahamensis Thouin, Ann. Mus. Par. viii. (1806) 433.

Persica nucicarpa Steud. Nomencl. Bot., ed. 2 (Steudel) i. 81.

Persica pavia Delarbre Fl. Auvergne (Delarbre) ed. 2, 328. 1800.

Persica platycarpa Decne. Jard. Fruit. 7: 42 (1875).

Persica saligna Royle Ill. Bot. Himal. Mts. 204.

Persica vulgaris Mill. subsp. *erythrocarpa* V.A.Zaiats Ukrayins'k. Bot. Zhurn. 57(1): 55. 2000.

Persica vulgaris Mill. var. *alba* (Lindl.) Holub bis in Vedecke Prace Ovocnarske, 6(Bot. Klasif.Rodu Persica Mill.): 310. 1977.

Persica vulgaris Mill. var. alba-plena (C.K.Schneid.) Holub bis in Vedecke Prace Ovocnarske, 6(Bot. Klasif. Rodu Persica Mill.): 310. 1977.

Persica vulgaris Mill. var. *camelliiflora* (Dippel) Holub bis in Vedecke Prace Ovocnarske, 6(Bot. Klasif. Rodu Persica Mill.): 311. 1977.

Persica vulgaris Mill. var. *compressa* V.A.Zaiats see Loudon, Arbor. Frutic. Brit., 2: 680 (1838). 2000. *Persica vulgaris* Mill. var. *compressa* V.A.Zaiats Ukrayins'k. Bot. Zhurn. 57(1): 54, homonym. 2000.

Persica vulgaris Mill. var. *densa* (Makino) Holub bis in Vedecke Prace Ovocnarske, 6(Bot. Klasif. Rodu Persica Mill.): 308(1977). Notes: Prunus persica var. densa. Persica vulgaris Mill. var. densa (Makino) V.A.Zaiats Ukrayins'k. Bot. Zhurn. 57(1): 55, with incorrect basionym ref. 2000. Persica vulgaris Mill. var. densa V.A.Zaiats Ukrayins'k. Bot. Zhurn. 57(1): 54. 2000.

Persica vulgaris Mill. var. *dianthiflora* (Dippel) Holub bis in Vedecke Prace Ovocnarske, 6 (Bot. Klasif. Rodu Persica Mill.): 311. 1977.

Persica vulgaris Mill. var. duplex Holub bis in Vedecke Prace Ovocnarske, 6 (Bot. Klasif. Rodu Persica Mill.): 311. 1977.

Persica vulgaris Mill. var. *magnifica* (Bean) Holub bis in Vedecke Prace Ovocnarske, 6 (Bot. Klasif. Rodu Persica Mill.): 311. 1977.

Persica vulgaris Mill. var. magnifica (Bean) V.A.Zaiats see Holub in Vedecke Prace Ovocnarske, 6: 308 (1977):. 2000. Persica vulgaris Mill. var. magnifica (Bean) V.A.Zaiats Ukrayins'k. Bot. Zhurn. 57(1): 55. 2000.

Persica vulgaris Mill. var. *pendula* (Dippel) Holub bis in Vedecke Prace Ovocnarske, 6 (Bot. Klasif. Rodu Persica Mill.): 312 (1977). Notes: Prunus persica f. Pendula. Persica vulgaris Mill. var. pendula V.A.Zaiats Ukrayins'k. Bot. Zhurn. 57(1): 54. 2000.

Persica vulgaris Mill. var. *pyramidalis* (Dippel) Holub bis in Vedecke Prace Ovocnarske, 6 (Bot. Klasif. Rodu Persica Mill.): 312. 1977.

Prunus graeca Desf. ex Steud., Nomencl. Bot., 2: 403. 1841- nom. illeg. nom. superfl.

Prunus persica (L.) Batsch subsp. platycarpa (Decne.) D.Rivera, Obón, S.Ríos, Selma, F.Méndez, Verde & F.Cano Varied. Trad. Frut. Cuenca Río Segura Cat. Etnobot. 1: 298. 1997.

Prunus persica subsp. *floriplena* Burkart in Darwiniana 17: 447. 1972. Type: Unkown

Prunus persica var. *aposarca* Burkart in Darwiniana 17: 451. 1972.

Persica domestica Risso, Hist. Nat. Prod. Eur. Mérid. 2: 104. 1826. -- *Prunus persica* (L.) Batsch subsp. *domestica* (Risso) D. Rivera, Obón, S. Ríos, Selma, F. Méndez, Verde & F. Cano, Varied. Trad. Frut. Cuenca Río Segura Cat. Etnobot. 1: 293. 1997.

Persica violacea Risso, Hist. Nat. Prod. Eur. Mérid. 2: 119. 1826.

Persica nucicarpa Steud. Nomencl. Bot., ed. 2 (Steudel) i. 81.

Amygdalus chinensis Hort. ex K.Koch in Dendrol. i. 85.

Persica ispahamensis Thouin in Ann. Mus. Par. viii. 433. 1806.

Persica saligna Royle Ill. Bot. Himal. Mts. 204.

Persica pavia Delarbre Fl. Auvergne (Delarbre) ed. 2, 328. 1800.

Persica platycarpa Decne. Jard. Fruit. 7: 42. 1875.

Prunus persica (L.) Batsch subsp. *platycarpa* (Decne.) D.Rivera, Obón, S.Ríos, Selma, F.Méndez, Verde & F.Cano Varied. Trad. Frut. Cuenca Río Segura Cat. Etnobot. 1: 298. 1997.

Prunus persica subsp. *floriplena* Burkart, Darwiniana 17: 447. 1972.

Prunus persica var. *aposarca* Burkart, Darwiniana 17: 451. 1972.

Persica bauciana Poit. & Turp., Poit. Pomol. Franc. i. t. 314.= Prunus Persica

Persica albida Poit. & Turp., Poit. Pomol. Franc. i. t. 154. = Prunus Persica

Persica accensa Poit. & Turp., Poit. Pomol. Franc. i. t. 407. = Prunus Persica

Persica ambigua Poit. & Turp., Poit. Pomol. Franc. i. t. 228. = Prunus persica

Persica bullata Poit. & Turp., Poit. Pomol. Franc. i. t. 357. = Prunus persica

Persica cancellaria Poit. & Turp., Poit. Pomol. Franc. i. t. 409. = Prunus persica

Persica cerasiana Poit. & Turp. in Poit. Pomol. Franc. i. t. 315. Notes: = Prunus persica

Persica crispa Poit. & Turp., Poit. Pomol. Franc. i. t. 365. = Prunus Persica

Persica cunctabundia Poit. & Turp., Poit. Pomol. Franc. i. t. 238. = Prunus Persica

Persica cursonia Poit. & Turp., Poit. Pomol. Franc. i. t. 26. = Prunus Persica

Persica dubia Poit. & Turp., Poit. Pomol. Franc. i. t. 228 bis. = Prunus Persica

Persica duplex Poit. & Turp., Poit. Pomol. Franc. i. t. 276. = Prunus Persica

Persica flava Poit. & Turp., Poit. Pomol. Franc. i. t. 243. = Prunus Persica

Persica fromentina Poit. & Turp., Poit. Pomol. Franc. i. t. 369. = Prunus Persica

Persica heteroclita Poit. & Turp., Poit. Pomol. Franc. i. t. 225. = Prunus Persica

Persica ispahanensis Poit. & Turp., Poit. Pomol. Franc. i. t. 24. = Prunus Persica

Persica mammillata Poit. & Turp., Poit. Pomol. Franc. i. t. 381. = Prunus Persica

Persica mammosa Poit. & Turp., Poit. Pomol. Franc. i. t. 318. = Prunus Persica

Persica maxima Poit. & Turp., Poit. Pomol. Franc. i. t. 226. = Prunus Persica

Persica merleti Poit. & Turp., Poit. Pomol. Franc. i . = Prunus Persica

Persica militensis Poit. & Turp., Poit. Pomol. Franc. i. t. 309. = Prunus Persica

Persica mirabilis Poit. & Turp., Poit. Pomol. Franc. i. t. 227. = Prunus Persica

Persica mucronata Poit. & Turp., Poit. Pomol. Franc. i. t. 139. = Prunus Persica

Persica mucronata Poit. & Turp., Poit. Pomol. Franc. i. t. 413. = Prunus Persica

Persica nana Poit. & Turp., Poit. Pomol. Franc. i. t. 401. = Prunus

Persica narbonensis Poit. & Turp., Poit. Pomol. Franc. i. t. 147. = Prunus Persica

Persica newtonii Poit. & Turp., Poit. Pomol. Franc. i. t. 389. = Prunus Persica

Persica oblonga Poit. & Turp., Poit. Pomol. Franc. i. t. 356. = Prunus Persica

Persica praecox Poit. & Turp., Poit. Pomol. Franc. i. t. 367. = Prunus Persica

Persica prisca Poit. & Turp., Poit. Pomol. Franc. i. t. 311. = Prunus Persica

Persica reperta Poit. & Turp., Poit. Pomol. Franc. i . = Prunus Persica

Persica pulchella Poit. & Turp., Poit. Pomol. Franc. i. t. 135. = Prunus Persica

Persica sanguinea Poit. & Turp., Poit. Pomol. Franc. i. t. 237. = Prunus Persica

Persica serotina Poit. & Turp., Poit. Pomol. Franc. i. t. 390. = Prunus Persica

Persica subcursonia Poit. & Turp., Poit. Pomol. Franc. i. t. 229. = Prunus Persica

Persica succedanea Poit. & Turp., Poit. Pomol. Franc. i. t. 235. = Prunus Persica

Persica tenera Poit. & Turp., Poit. Pomol. Franc. i. t. 385. = Prunus Persica

Persica verrucosa Poit. & Turp., Poit. Pomol. Franc. i. t. 287. = Prunus Persica

Amygdalus variabilis *Bornm. ex C.K.Schneid. Ill. Handb. Laubholzk. i. 591. 1905. in obs. Type - Iraq: Arbil, In Mount Kuh-Sefin, above Schaklava, 10 May 1893, J.* Bornmuller 1040 *(WU!).nomen nudum*

Amygdalus variabilis *Bornm. ex C.K.Schneid. var.* latifolia . *– Type: Iraq. Arbil, in Mount Kuh-Sefin, above Schaklava, 11 May 1893,* J. Bornmuller 1039 *(WU!). nomen nudum.*

Amygdalus kermanensis var *velutina*. TYPE: Iran: Kerman. in monte Kuhe Dschupar [Jupar], 7 Jun 1892, *J. Bornmuller 3484* (WU! K!)

Amygdalus kermanensis Bornm. ex C.K.Schneid., Ill. Handb. Laubholzk. 1. 591. 1905. in obs.; *Amygdalus kermanensis* Bornm.- Beih. Bot. Centralbl. xix. II. 252. 1906.

Amygdalus kermanensis var *glabra.* Iran: Kerman. in mt Kuh-i Nasr, 24 May 1892, *J. Bornmuller 3486* (WU! K!).

Amygdalus glauca Browicz, Fl. Iranica, 66: 179. 1969.

Persica davidiana Carrière var. *potanini* (Batalin) Holub, Vedecke Prace Ovocnarske, 6, 314.1977.

Amygdalus jugata Browicz, Browicz in K. H. Rechinger, Fl. Iran., Lief. 181. 1969. TYPE: Afghanistan: SW: Ghorat: in N. slope of mountain Cheling Safed Daraq (Pirestan), 33°7' N 63°55'E, substr. Calc., 2600-2800m, 1 Aug 1962, Rechinger. 19081 (W!).

Amygdalus koelzii Browicz, Browicz in K. H. Rechinger, Fl. Iran., Lief. 182. 1969. TYPE: Afghanistan: E: Laghman: Ishpi, 2400m, 7 Jun 1937, Koelz 11754 (W!)

APPENDIX I

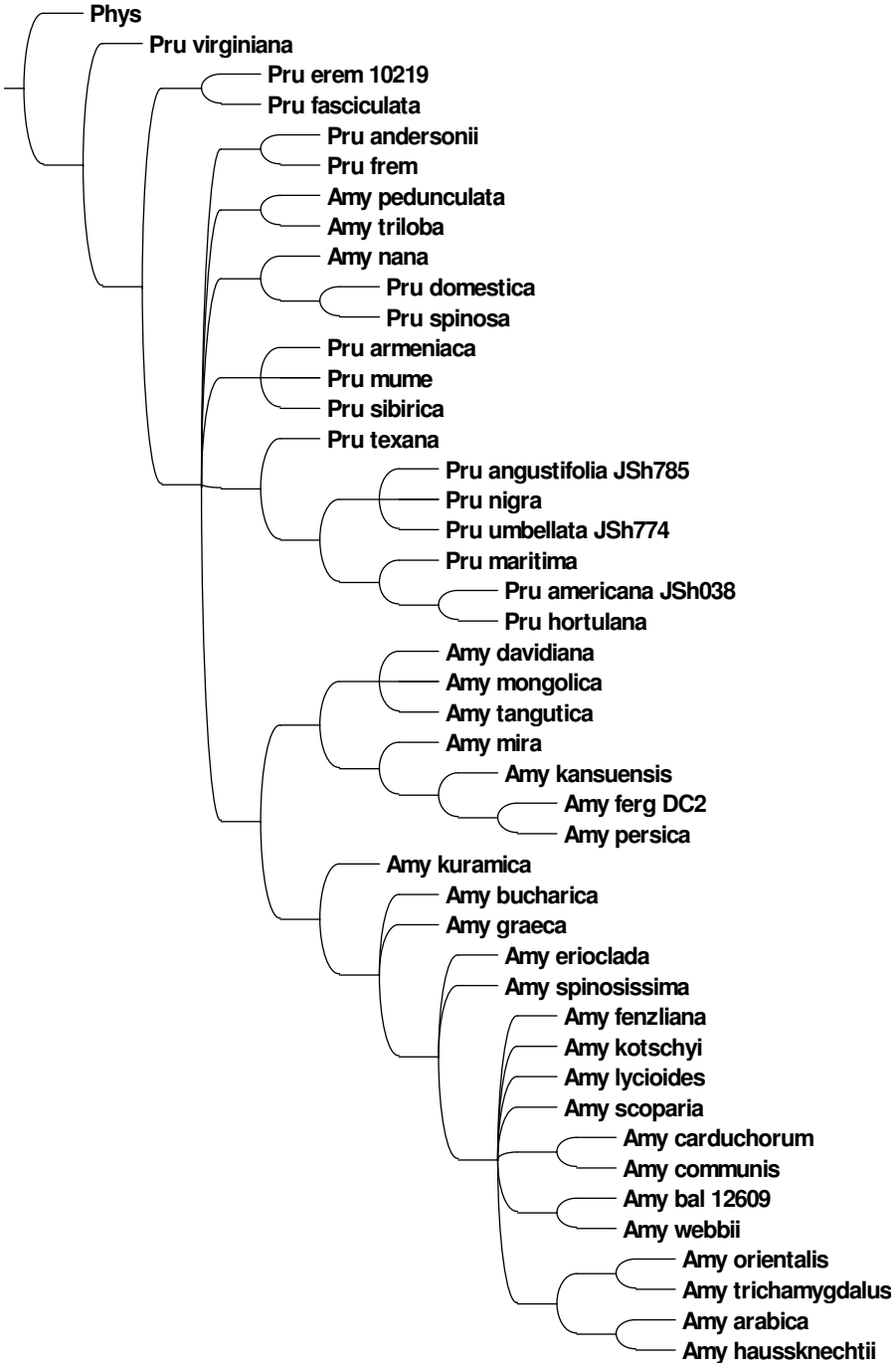

Figure 1. Strict consensus of 396 most parsimonious trees from the analysis of plastid sequence data (*ndhF-rpl3, rpL16, trnH-psbA, trnL-trnL-trnF, trnQ-5'rps16, trnS-trnG-trnG*) with indels. Tree statistics are given in Table (1.4).

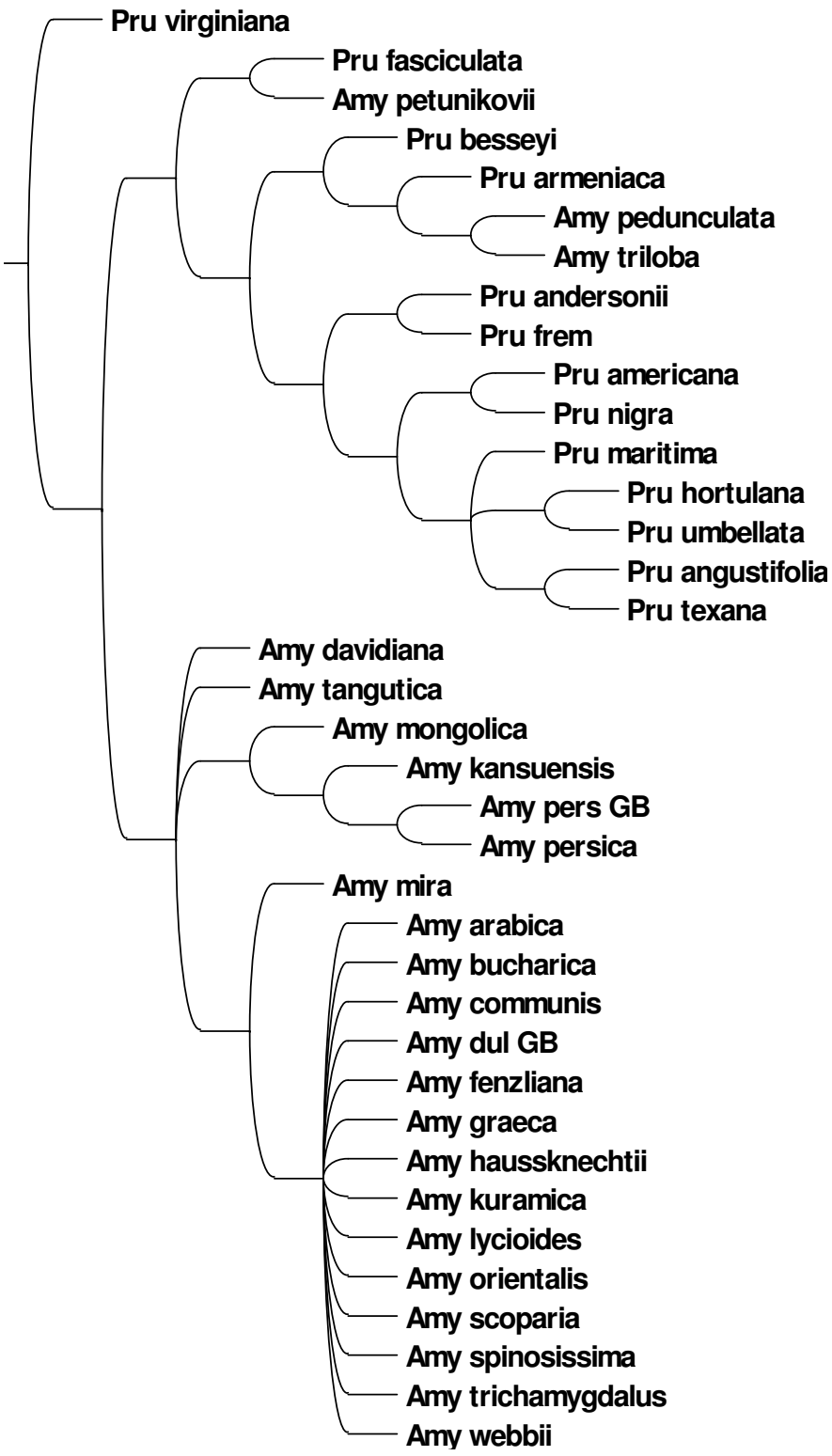

Figure 2. Strict consensus of 102 most parsimonious trees from the analysis of nuclear s6pdh (+ ms + indel) sequence data. Tree statistics are given in Table (1.4).

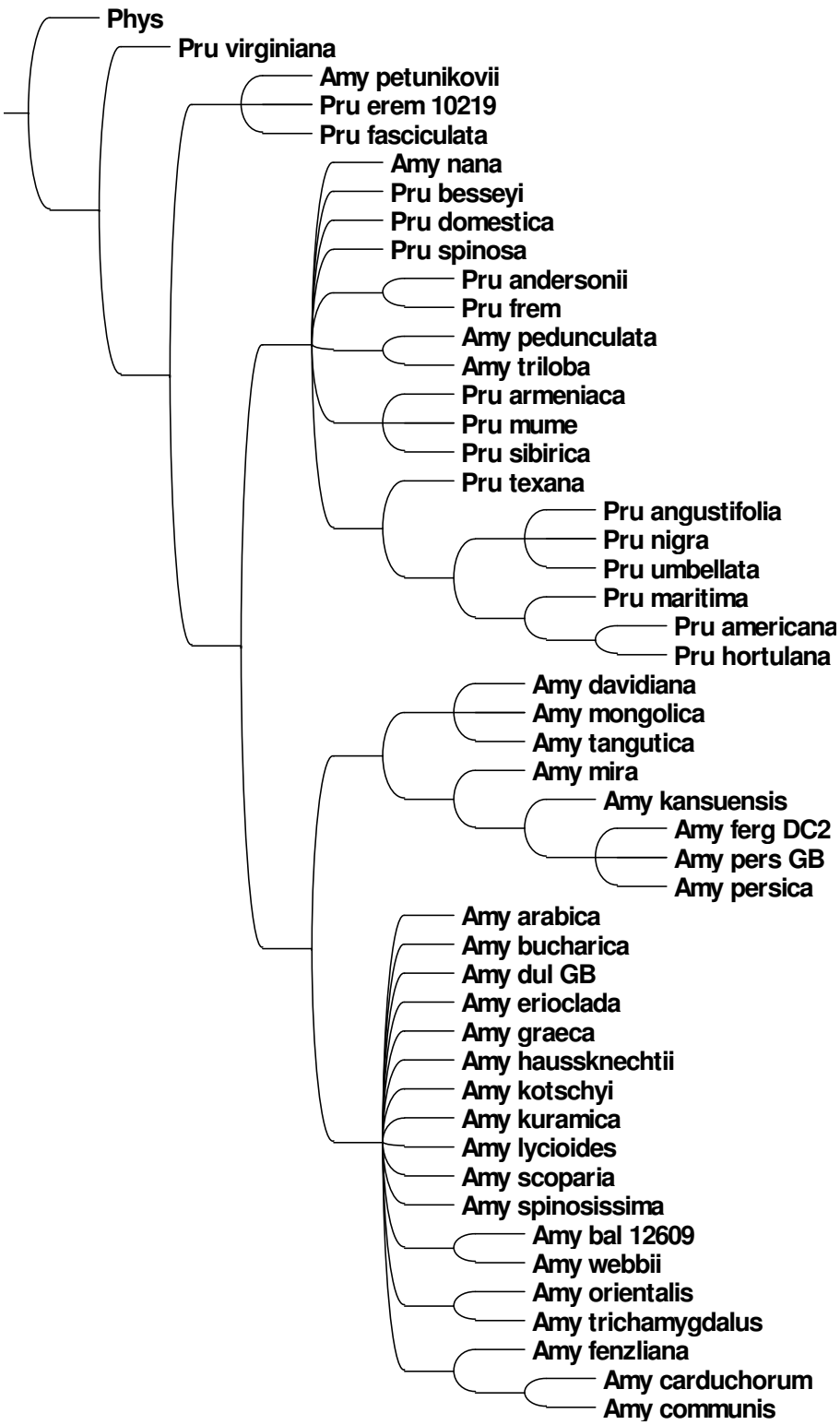

Figure 3. Strict consensus of 500 parsimonious trees from the analysis of molecular (combined plastid and nuclear) sequence data + indels. Tree statistics are given in Table (1.4).

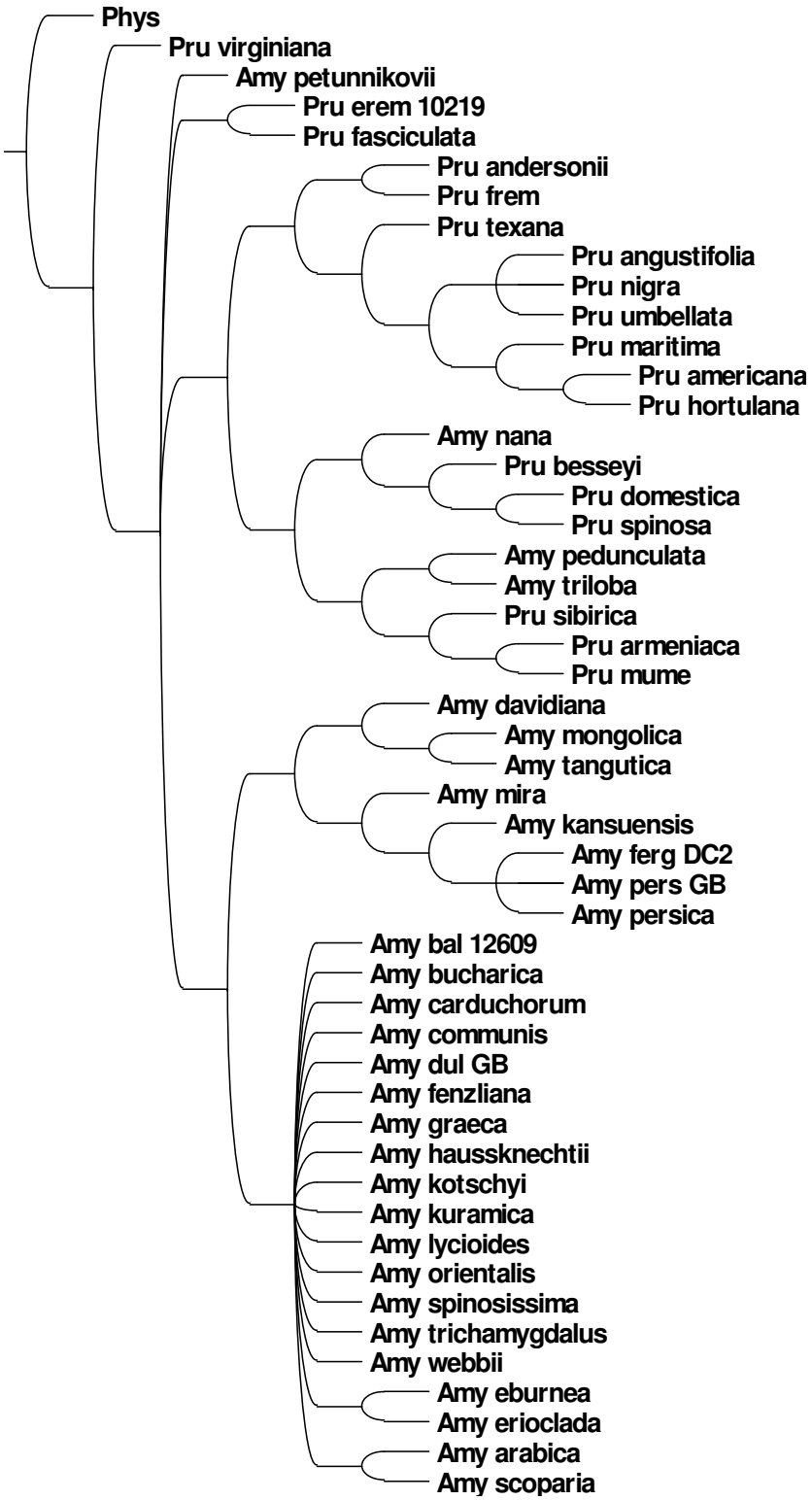

Figure 4. Strict consensus of 442 most parsimonious trees from the analysis of total available evidence (combined molecular (indels included) and morphological data). Tree statistics are given in Table (1.4).

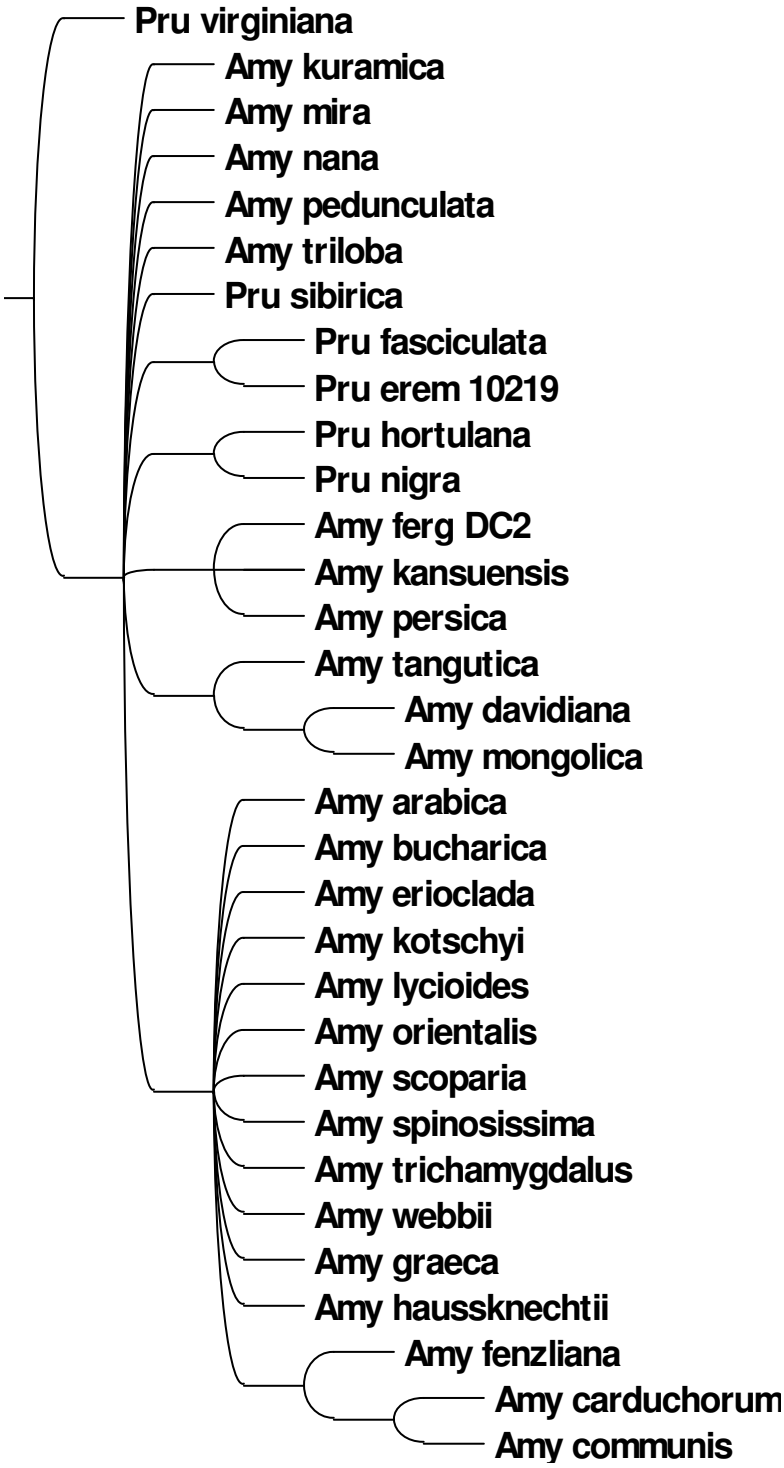

Figure 5. Strict consensus of 6882 most parsimonious trees from the analysis of *ndhF-rpl3* sequence data + indels.

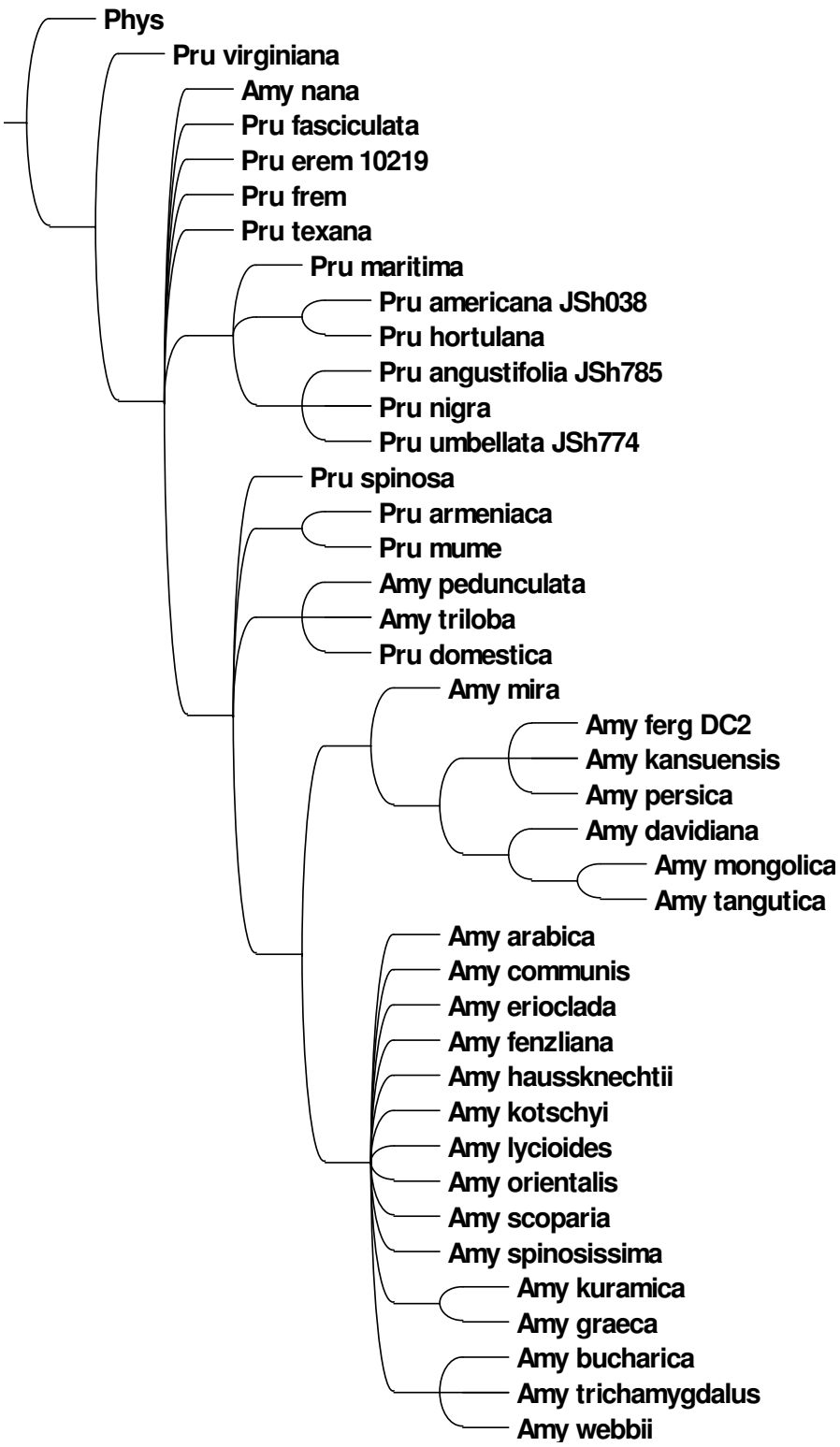

Figure 6. Strict consensus of 40 most parsimonious trees from the analysis of *rpL16* sequence data + indels.

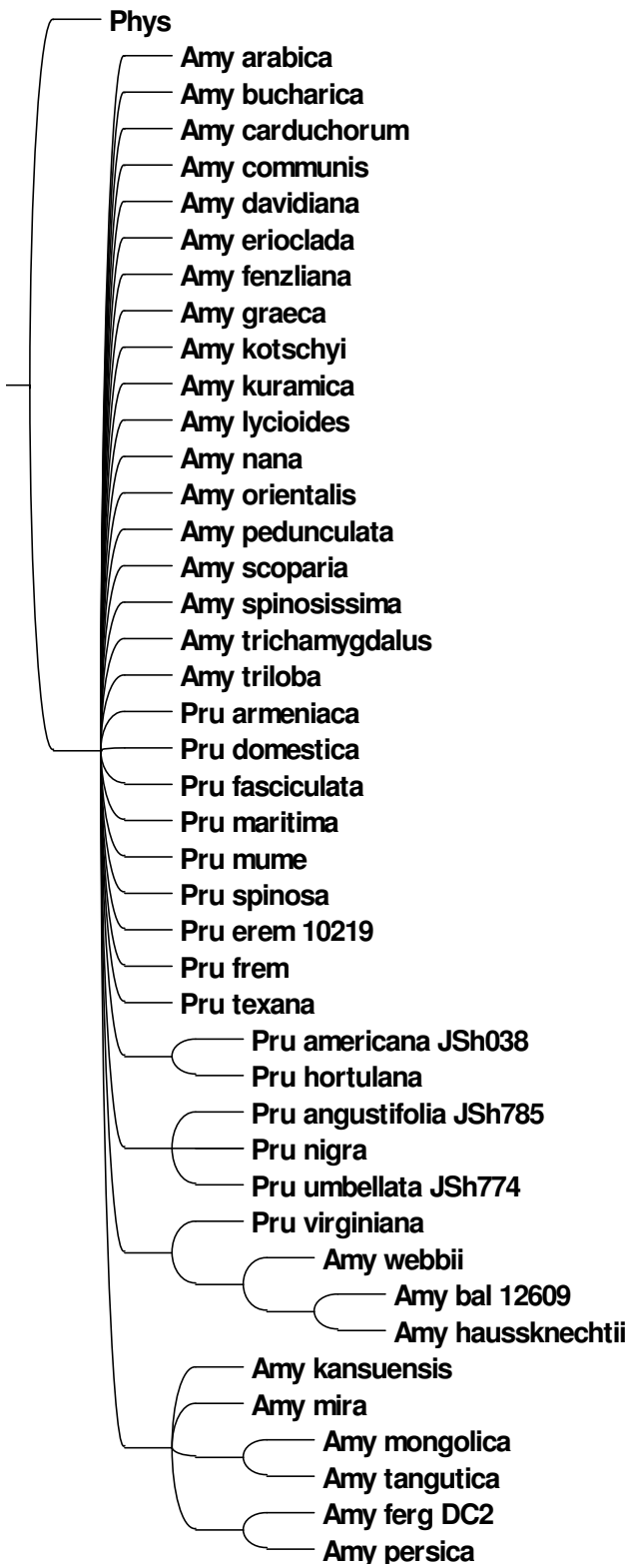

Figure 7. Strict consensus of 81 most parsimonious trees from the analysis of *trnH-psbA* sequence + indels.

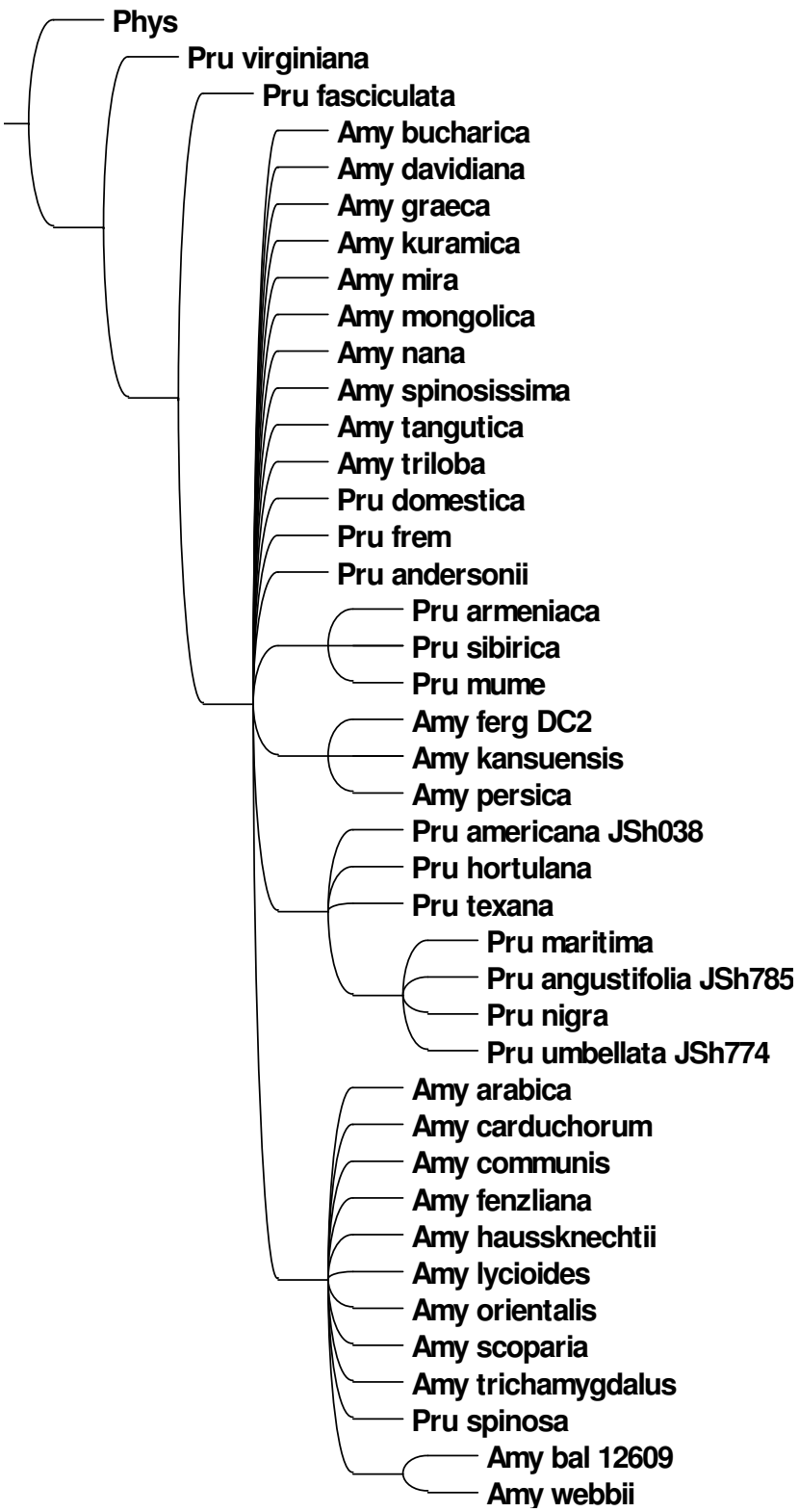

Figure 8. Strict consensus of 114 most parsimonious trees from the analysis of *trnL-trnL-trnF* sequence data + indels.

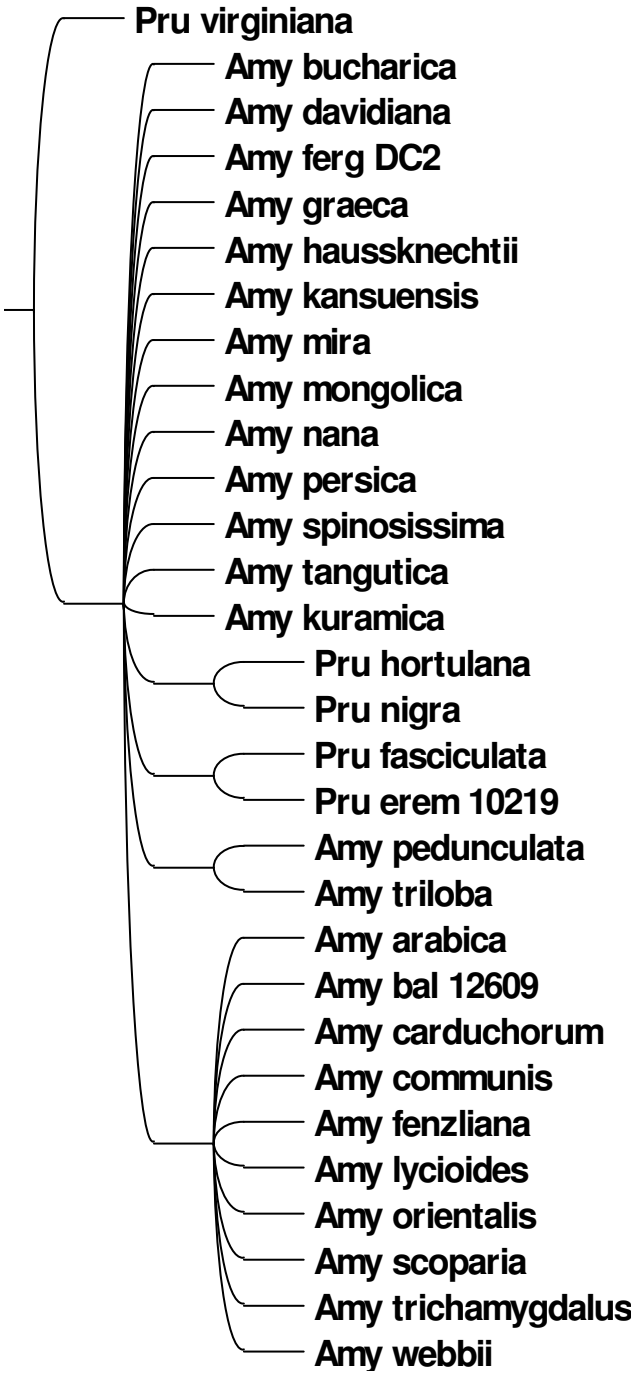

Figure 9. One most parsimonious tree from the analysis of *trnQ-5'rps16* sequence data + indels. (P.S. same as the tree recovered without indels since all indels in this region were uninformative.)

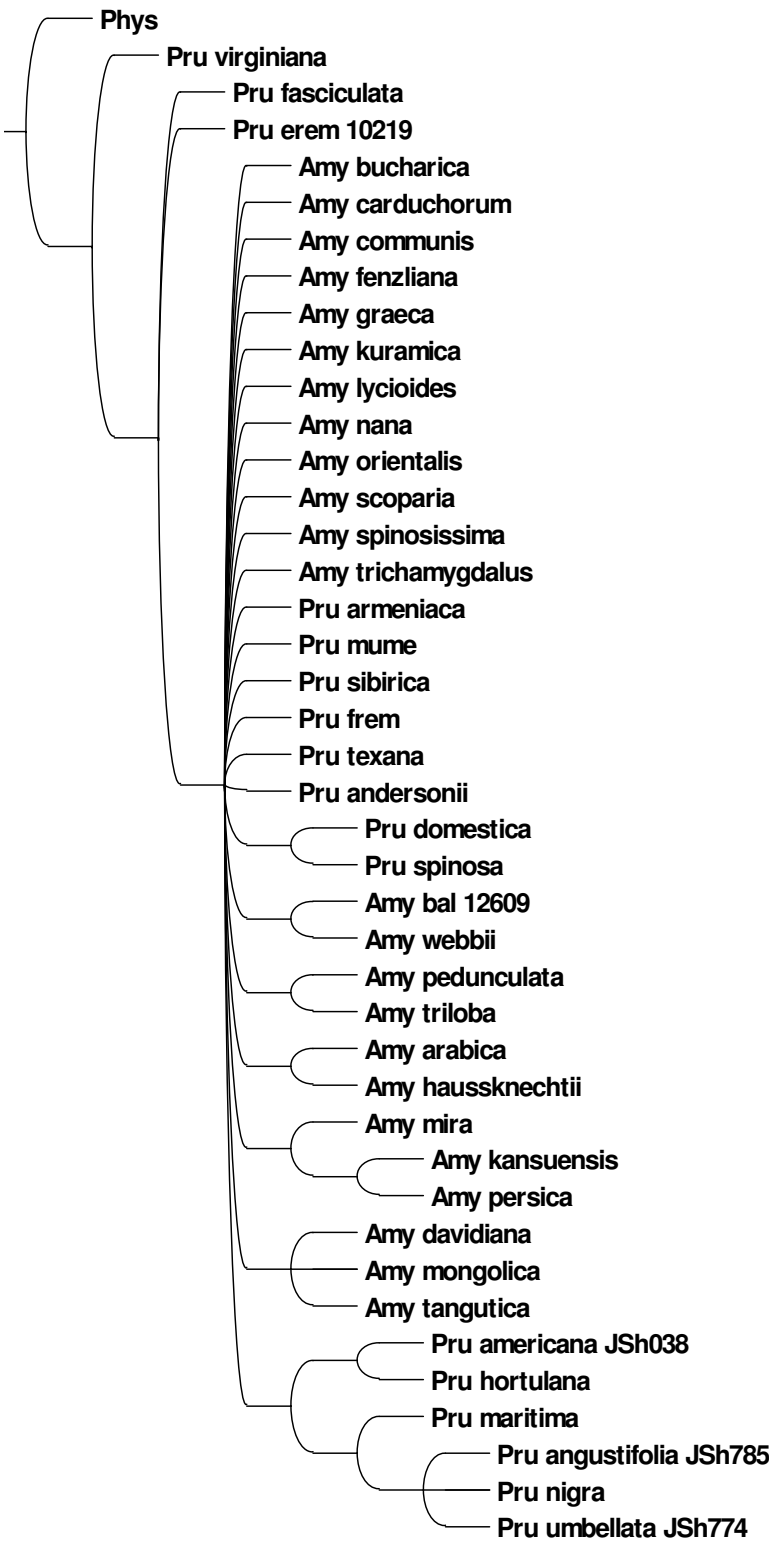

Figure 10. Strict consensus of 13430 most parsimonious trees from the analysis of , *trnS-trnG-trnG* sequence data + indels.

APPENDIX II

Table 1. Morphological characters matrix used in cladistic analysis.

Taxon	Habit	spinescence	leaves on short shoots	leaves in bud	Carpel number	hypanthium shape	Hypanthium pubescence	sepals margin	Fruit type	Fruit pubescence	mesocarp splitting	endocarp ornamentation presence	endocarp ornamentation type	Petiolar glands	terminal winter bud presence	axillary buds number	Pedicel pendulance
Amy arabica	0	0	1	1	0	0	1	0	2	1	1	0	?	0	-	-	0
Amy arabica var. scopa	0	0	1	1	0	0	1	0	2	1	1	0	?	0	-	-	0
Amy argentea	0	1	0	1	0	0	1	0	2	1	1	$	1	0	1	1	0
Amy bucharica	*	0	0	1	0	0	1	0	2	1	1	0	?	1	-	-	0
Amy carduchorum	0	1	0	1	0	0	1	0	2	1	1	1	2	0	-	-	0
Amy davidiana	*	0	0	1	0	0	1	0	2	1	*	1	2	*	1	1	0
Amy discolor	0	1	0	1	0	0	1	0	2	1	1	*	1	0	-	-	0
Amy dulcis	*	0	0	1	0	0	1	0	2	1	1	1	0	1	1	1	0
Amy eburnea	0	1	0	0	0	1	0	0	2	1	1	1	1	0	?	?	?
Amy erioclada	0	1	0	0	0	1	0	0	2	1	1	1	1	0	?	?	?
Amy fenzliana	*	1	0	1	0	0	0	0	2	1	1	1	2	1	-	-	0
Amy haussknechtii	*	1	0	1	0	0	1	0	2	1	1	1	0	0	-	-	0
Amy kansuensis	*	0	0	1	0	0	*	0	2	1	0	1	1	0	1	1	0
Amy kotschyi	0	1	0	1	0	0	1	0	2	1	1	*	0	0	-	?	0
Amy kuramica	*	0	0	1	0	0	1	0	2	1	1	1	2	1	-	-	0
Amy lycioides	0	1	0	0	0	1	1	0	2	1	1	1	1	0	?	?	?
Amy mira	1	0	0	1	0	0	1	0	2	1	0	$	1	*	1	1	0
Amy mongolica	0	1	0	1	0	0	1	0	2	1	1	$	1	0	-	-	0
Amy persica	1	0	0	1	0	0	*	0	2	1	0	1	1	*	1	1	0
Amy spinosissima	0	1	0	0	0	1	1	0	2	1	1	1	1	0	?	?	?
Amy tangutica	0	1	0	1	0	0	1	0	2	1	1	1	1	0	1	1	0
Amy trichamygdalus	0	0	0	1	0	0	1	0	2	1	1	1	0	1	-	-	0
Amy webbii	*	1	0	1	0	0	1	0	2	1	1	1	0	0	-	-	0
Pru americana	1	0	-	1	0	-	-	-	2	0	0	0	-	-	0	0	1
Pru andersonii	0	1	?	?	0	0	1	1	2	1	1	0	?	*	0	0	0
Pru angustifolia	1	0	-	1	0	-	-	-	2	0	0	0	-	-	0	0	1
Pru armeniaca	1	0	1	0	0	0	?	?	2	1	0	0	?	1	0	0	?
Pru besseyi	0	0	1	1	0	?	?	1	2	0	0	0	?	?	1	1	1
Pru domestica	1	0	1	0	1	-	0	0	2	0	0	0	-	0	-	0	1
Pru eremophila	0	1	0	-	0	-	-	-	2	1	-	-	-	-	-	-	0
Pru fasciculata	0	1	0	0	0	0	1	?	2	1	1	0	?	?	?	1	0
Pru fremontii	0	1	-	-	-	-	-	0	2	1	1	0	?	?	?	?	?
Pru hortulana	-	-	-	1	-	-	-	-	-	0	-	-	-	-	0	0	1
Pru maritima	0	1	-	1	-	-	-	-	2	0	0	0	-	-	0	0	1
Pru mume	1	0	-	0	0	0	0	-	2	1	0	-	-	1	0	0	0
Pru nigra	-	-	-	1	-	-	-	-	-	0	-	-	-	-	0	0	1
Pru pedunculata	0	0	0	1	0	0	1	1	2	1	1	$	3	0	-	-	0
Pru petunnikovii	0	0	0	1	0	3	1	1	2	1	1	1	-	0	?	-	0
Pru sibirica	*	0	?	0	0	0	?	?	2	1	1	0	?	*	1	0	?
Pru spinosa	*	1	0	0	0	?	1	1	2	0	0	-	2	0	-	0	1
Pru tenella	0	0	0	1	0	3	1	1	2	1	1	1	3	0	1	1	0
Pru texana	0	?	?	?	0	0	0	1	2	1	-	0	?	?	0	0	0
Pru triloba	0	0	0	1	?	0	1	1	2	1	1	$	3	0	1	1	0
Pru virginiana	0	0	-	1	0	-	-	-	2	0	0	0	-	-	1	-	1

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