Floristic Features, Distribution, and Ethnobotany of Plants Gathered and Used by Local People from the Mediterranean Forest in Northern Jordan

Oraib Saleh Nawash, Amani Al-Assaf, Ahmad El-Oqlah, and Mohammad Omari

Research

Abstract

خلفية : فهم توزيع والخصائص النباتية لنباتات الغابات المحلية والأسباب التي ندفع السكان المحليين لجمعها ذو أهمية كبيرة لتخطيط وتنفيذ مشاريع الحفاظ و إعادة تأهيل الغابات في الغابات البحر المتوسطية مع إشراك المجتمعات المحلية في هذه العمليات .

الأهداف (1) دراسة نمط توزيع (2) تحليل المميزات النباتية (3) التحقيق في الاستخدامات الرئيسية للنباتات التي تم جمعها من ثلاث النظم الإيكولوجية للغابات البحر الأبيض المتوسط في شمال الأردن.

طرق البحث : تم اختيار 14 قرية وفقا لموقعها على حافة و داخل أنواع الغابات المتوسطية الثلاث في الجزء الشمالي من الأردن ، و 300 من السكان المحليين وأجريت مقابلات وجها لوجه باستخدام استبيان شبه منظم . وشملت البيانات التي تم الحصول عليها وما هي النباتات التي تم جمعها وماذا عن الاستفادة منها. وأجري تحليل Detrended Correspondence Analysis (DCA) من أجل التحقيق في توزيع الأنواع النباتية التي تم جمعها من ثلاثة أنواع الغابات وتم حساب مؤشرات مهمة في علم المعرفة المحلية ، ومستوى (ICF)للنباتات بما في ذلك اختبار اجماع الناس على استخدام معين (FL%.)الدقة في اشتغلال نبات معين لاشتخدام معين

النتائج: أظهرت نتائج DCA أن هناك نوعا من النباتات الشائعة التي تم جمعها من نوع ثلاثة الغابات بشكل مكثف على سبيل المثال الزعتر البري *Origanum syriacum* L. الخبيزة، *Malva parviflora* L. و اللوف *Arum palaestinum* Boiss. وأن هنالك بعض الأنواع النباتية تم جمعها من نوع معين من الغابات. كما وتم الأجماع من قبل العينه من السكان المحلين بأن الاستخدام الرئيسي للنباتات المحلية هو الغذاء ومن ثم الغذاء والدواء.

الاستنتاج : بناء على نتائج الدراسة ، يقترح أن تأخذ في الاعتبار سلوك جمع الناس للنباتات الحرجية المحلية االموجودة في نظام الغابات البيئي الهش قي برامج الحفاظ على النظام الإيكولوجي على أساس اشراك السكان المحليون من أجل تحقيق الاستدامة البيئية و منع انجراف التنوع البيولوجي.

Abstract

Understanding the distribution and floristic features of native forest plants, as well as the reasons that lead local people to collect them, is of great value for planning and implementing forest conservation and rehabilitation projects in the Mediterranean forest involving local communities. The aims of this study were to (1) investigate the distribution pattern, (2) analyze the floristic features, and (3) investigate the main uses of plants gathered from three Mediterranean forest ecosystems in Northern Jordan. We sampled 14 villages that were selected according to their location on the edge and within the three Mediterranean forest types in Northern Jordan. Three hundred informants were interviewed face to face using a semi-structured questionnaire. The data obtained included a list of plants collected and their uses. A Detrended Correspondence Analysis (DCA) was carried out to investigate the distribution of plant species collected from the three forest types. Also, important indices were calculated including Informant Consensus Factor (ICF), Fidelity Level (FL%), and uses totaled. The DCA showed that there are common plant species gathered intensively from all three for-

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est types, namely *Origanum syriacum* L., *Malva parviflora* L., and *Arum palaestinum* Boiss., and that some plant species are collected from a particular forest type. The main uses of the collected plants are food and medicine. The study results suggest value in taking into account the behavior of people who collect native forest plants when designing fragile forest ecosystem restoration programs. These programs should be community-based in order to achieve ecosystem sustainability and prevent biodiversity erosion.

Introduction

The Mediterranean region has provided examples of human interactions with plants (ethnobotany *sensu* Jones (1941)) over the past decades through studies of collecting native plants for food and medicine (Aburjai *et al*. 2007, Ali-Shtayeh *et al*. 2008, El-Darier & El-Mogaspi 2009, Faker *et al*. 2009, Rigat *et al*. 2007). Previous ethnobotanical research in the Mediterranean region has identified about 2,300 different plant and fungi taxa which are gathered and consumed (Rivera *et al*. 2006). Ethnobotanical data contribute to ecosystem restoration and forest sustainability management programs that involve all stakeholders including communities surrounding forests. This involvement is crucial to achieve the indispensable target "sustainability," both through rewarding people and ecosystems. Choudhary *et al*. (2008) indicated that today's ethnobotanical studies, including applied projects, have potential to reduce poverty levels. Thus, it is important to define the relationship between people and forest as recommended by Michon *et al*. (2007), who called for a new concept of land management in which production and conservation are compatible and in which there is no choice to be made between people and nature. Accordingly, this study focused on investigating such a relationship in order to help stakeholders implement effective conservation management plans while also reducing the poverty of the local people.

The northern area of Jordan contains three types of forests: pine forest, deciduous oak forest, and evergreen oak forest (Al-Eisawi 1996, El-oqlah *et al*. 1985, Kaspligil 1956, Lahham *et al*. 1987, Long 1957, Zohary 1962).

(1) Pine forest dominated by *Pinus halepensis* Mill. and associated with *Arbutus andrachne* L., *Calicotome villosa* (Poir.) Link, and *Cistus creticus* L. This forest is located in the Jerash district and surrounds the villages of Raymoon, Burma, Nahleh, and Ketah. This is the only natural pine forest in Jordan; the other pine forests are man-made. The altitude of this forest is the highest at about 850 m above sea level.

(2) Deciduous oak forest dominated by *Quercus ithaburensis* Decne. (the national tree of Jordan) and associated with *Pistacia atlantica* Desf., *Rhamnus palaestina* Boiss., *Ceratonia siliqua* L., *Prunus dulcis* (Mill.) D.A.Webb, *Retama raetam* (Forssk.) Webb, and occasionally with *Quercus infectoria* G.Olivier. This forest type occurs at a lower elevation of 300 m above sea level.

(3) Evergreen oak forest dominated by *Quercus coccifera* L. and associated with *P. halepensis*, *Olea europaea* L., *Pyrus syriaca* Boiss., and *Crataegus azarolus* L. and less commonly with *Pistacia palaestina* Boiss. and *Q. ithaburensis*. This forest is located in Ajlune district at 700 m above sea level and includes the villages of Anjara, Wahdneh, Hashemieh, Rasoon, Shafa, and Zobia.

These forest areas receive the highest precipitation levels in Jordan, with annual rainfall amounts ranging from 400 to 600 mm. The area is bordered by the Irano-Turanian and Sudanian vegetation territories from the west and the Irano-Turanian and Saharo-Arabian vegetation from the east (Al-Eisawi 1996).

Jordan's forest area is less than 1% of the total country. This area is declining both in regard to quality and quantity due to urbanization, shifting olive cropping at the expense of forests, grazing, and climate change, including the reduction and fluctuations of the annual rainfall amounts (Alrababah *et al*. 2007). Nevertheless, forest ecosystems in Jordan are still providing local people living in the forest periphery with many valuable ecosystem services such as wood, food (e.g., wild mushrooms, wild plants, honey), medicinal plants, forage, and other services that support their living. There are five forest types in Jordan: pine, evergreen oak, deciduous oak, juniper, and mixed forests (Kasapligil 1956, Long 1957). The current study investigated the first three forest types located in the northern part of Jordan.

Recently, Jordanian researchers have started to study the ethnobotany of indigenous people in Jordanian ecosystems (Aburajai *et al*. 2007, Afifi & Abu-Irmaileh 2000, Alzweiri *et al*. 2011, Hudaib *et al*. 2008, Nawash & Al-Horani 2011, Nawash *et al*. 2013, Takruri *et al*. 2008). Most prior studies have focused on traditional medicinal uses (ethnopharmacology) or targeted certain known edible plants used in the Jordanian diet (Tukan *et al*. 1998). Thus, these studies ignored other uses of plants, collection behaviors in general, and the potential of this knowledge to improve livelihoods. Therefore, a great part of knowledge, including general use patterns, is still undocumented. The aims of this study in particular were to investigate: (1) the most utilized species using Informant Consensus Factors, Fidelity Levels, and Uses Totaled and (2) distributions of species collected in the three forest ecosystems using Detrended Correspondence Analysis. The current study is a part of a comprehensive survey investigating the ecosystem services of three forest ecosystems in Jordan.

Methods

Study area and data collection

This study targeted 14 villages that were selected according to their location on the edge and within the three Mediterranean forest types in Northern Jordan (Figure 1).
A stratified random sampling was used in which the sampled villages were randomly selected from all villages surrounding the forests. A total of 300 interviewees (100 for each of the three forest ecosystems) were interviewed as a part of a larger study concerning the ecosystem services of the area. The study utilized a semi-structured questionnaire with "face to face" information collection. The interviews followed the national law for protecting and preserving personal information of the informants, and this was announced clearly at the beginning of each interview. Interviewees were asked questions about the local names of plants, parts of plants used, collection months, and main uses of plants. Voucher specimens were collected in cooperation with the local people, then identified and deposited at the Royal Botanic Gardens of Jordan (RBG) and at the herbarium of the Yarmouk University Biology

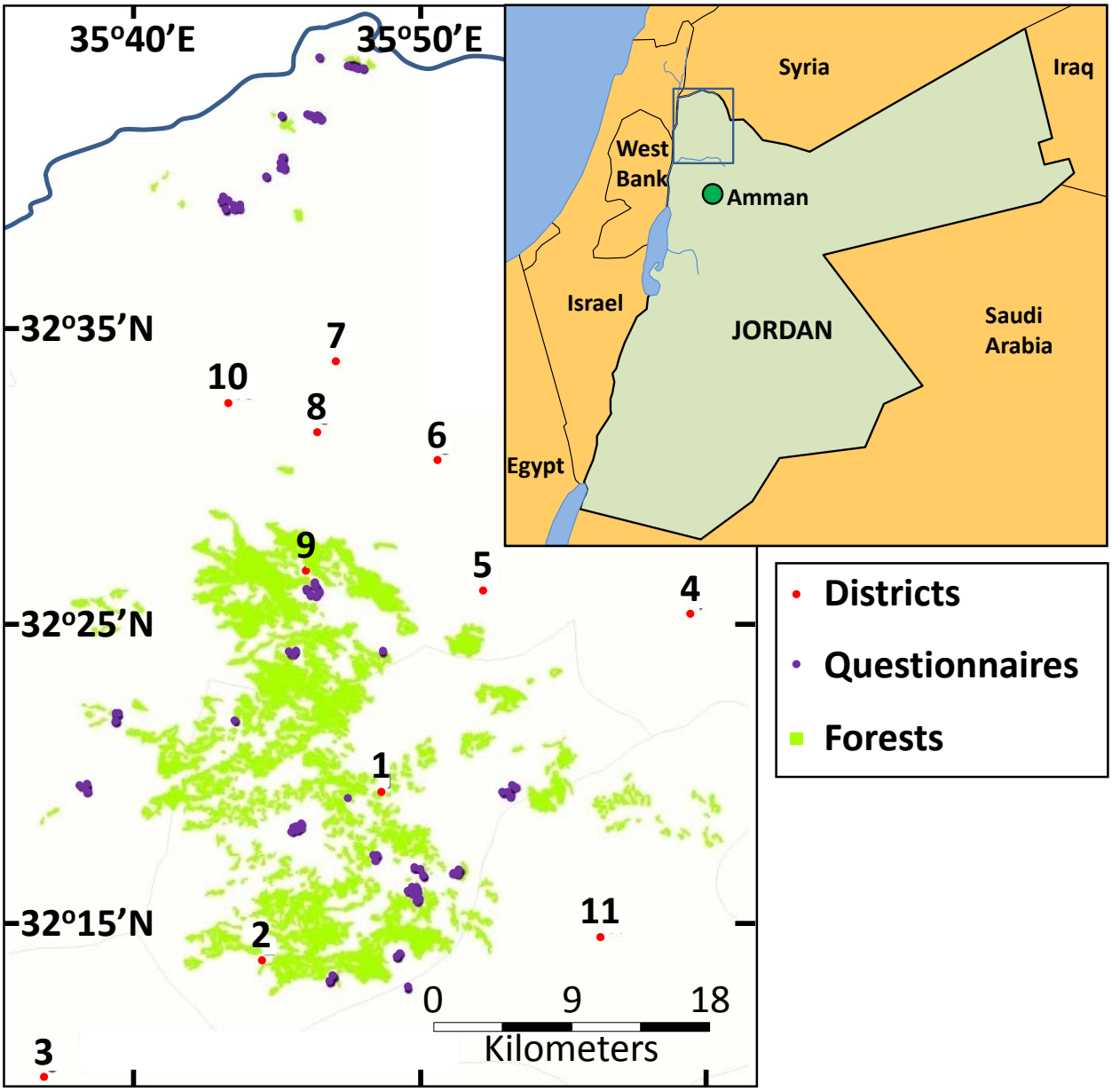

Figure 1. Jordan and the study area districts: 1. Aljoun, 2. Kofranjah, 3. Dair Alla, 4. Aghwar Shamaliyyeh, 5. Bagi Kenanah, 6. Hariema, 7. Irbid, 8. Kora, 9. Mazar Shamali, 10. Tayybeh, and 11. Jarash.

Department. The plants were identified by Prof. Dr. Ahmad Al-Ogla, a visiting researcher at the Royal Botanic Gardens and Botany professor at Yarmouk University in the north of Jordan. Zohary and Feinbrun-Dothan (1977) was used for identification and names were updated following the APG-3 (Steens 2012) and the online database Tropicos (www.TROPICOS.org). The RBG, during the review of this paper published the first IUCN Redbook of native plants of Jordan (Taifour *et al.* 2014) thus, information about the conservation status of the collected plants has been included.

Data analysis

Three categories of plant uses mentioned by the informants were sorted with the following observations:

1. Medicine: the informants collect the plant for addressing health problems in their family
2. Food: the informants collect the plants as food for their family
3. Food-Medicine: the informants collect the same plant species as a food source and as medicine

Importance indices were applied to categorize main uses and species importance. First, in order to test the homogeneity of the information collected and the degree of overall agreement between interviewees on specific use categories for plants in the study area, an Informant Consensus Factor (ICF) was calculated according to Gazzaneo *et al*. (2005):

$ICF = n_{ur} - n_t / n_{ur} - 1$

where n_{ur} is the number of use citations in each category and n_t is the number of species used.

The second indicator calculated was the Fidelity Level (FL%) for each use of each plant. This index was calculated to rank the recorded plant species based on their claimed relative effectiveness following Friedman *et al*. (1986) as follows:

$FL = (I_p / I_u) \times 100$

where I_p is the number of informants who mentioned the use of a particular species for a particular purpose and I_u is the total number of informants who mentioned the plant for any use.

Species that were mentioned by only one informant were not included in the FL% calculations.

The third indicator calculated was Uses Totaled, in which the uses of each species are summed and ranked (Hoffman & Gallaher 2007).

Detrended Correspondence Analysis (DCA) was chosen as a multivariate method for ordination. DCA was performed using CANOCO for Windows 4.5 (ter Braak & Smilauer 2002). The test was executed to identify species distribution in reference to plants collected from three forest types. The results were interpreted according to ter Braak (1995) and Lepš and Šmilauer (2003).

Results

Interviews and informants

The interviews were conducted from September 2012 to March 2013. About 80% of interviewees were female because interviews were conducted during work hours when most male heads of households were not at home. Respondents' ages ranged between 37 and 45 with an average of 41 years. The most frequent family monthly income bracket was JD 200–300 (39.3%); 23.7% were in the JD 301–400 bracket, 6.7 % were in the JD 401–500 bracket, 3.3% were in the JD 501–600 bracket, and only 6.3% of families had incomes above JD 600. The rest of interviewees (20.7%) indicated they were in the lowest income bracket (less than JD 200). With respect to education level, 53.7% of the interviewees indicated that they finished primary school, 22% had obtained a high school certificate, and 10.3% had acquired a diploma degree in colleges. In addition, 11.7% and 1.7% had attended university and acquired a post-graduate degree, respectively.

General floristic characteristics

A total of 47 plant species belonging to 18 families were recorded as used by the local people (Table 1). All species are native to Jordan except *Rosmarinus officinalis* L. which apparently is now grown in the forest by local people and nurseries. The family Asteraceae was most common, comprising about 23% of the total species (Figure 2). The most commonly used Asteraceae species were *Cichorium pumilum* Jacq. and *Gundelia tournefortii* L. ,

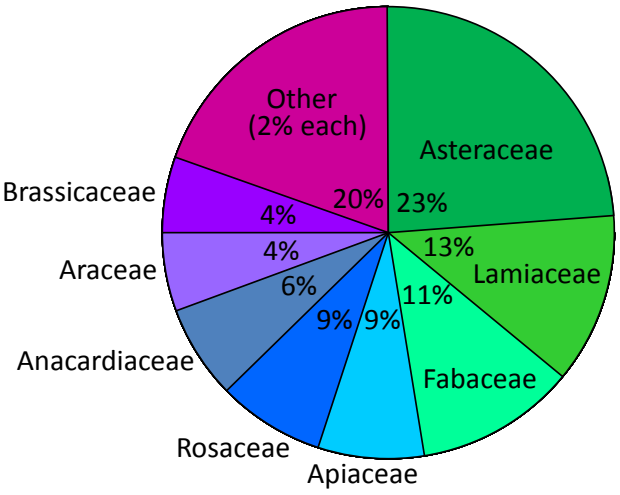

Figure 2. Percentages of plant species by family collected from the forest in the study areas of Northern Jordan. Other families (2% each) are: Amaranthaceae, Caryophyllaceae, Crassulaceae, Fagaceae, Malvaceae, Pinaceae, Polygonaceae, Primulaceae, Rutaceae, and Urticaceae.

Table 1. Floristic characterisitcs of plant species collected from three forest ecosystems in Northern Jordan. Life forms: (**A**) annual, (**C**) chamaephyte, (**G**) geophyte, (**H**) hemicryptophyte, (**S**) phanerophyte shrub, and (**T**) phanerophyte tree. Origin chorotypes: (**1**) Euro-Siberian-Med, (**2**) Irano-Turanian, (**3**) Irano-Turanian-Saharo-Arabian, (**4**) Mediterranean, (**5**) Med-Irano-Turanian, and (**6**) Plurireginalbor-trop. Main uses: (**F**) food, (**M**) medicine, and (**S**) for sale. Conservation status: (**CR**) critical endangered, (**DD**) data deficiency, (**EN**) endangered, (**NA**) not applicable (not native to Jordan), (**NE**) not evaluated yet, (**NT**) near threatened, (**RE**) regional extent (region: Jordan), and (**VU**) vulnerable.

Plant names		Life form	Origin	#. of main use informants	Uses		FL%	Status
Scientific	Arabic				Main	Totaled		
Achillea fragrantissima (Forssk.) Sch.Bip. Asteraceae	**Qaisoum**	H	3	-	M	1	-	LC
Apium nodiflorum (L.) Lag. Apiaceae	**Qurra**	H	5	3	FM	5	60	NT
Arum palaestinum Boiss. Araceae	**Loaf**	G	4	78	FMS	81	96	EN
Beta vulgaris L. Amaranthaceae	**Salaq**	A	1,5	-	F	2	-	NT
Calicotome villosa (Poir.) Link Fabaceae	**Qandoul**	S	4	4	FM	5	80	LC
Carlina libanotica Boiss. Asteraceae	**Saq Elaroos**	H	4	-	F	1	-	NE
Centaurea iberica Trevir. ex Spreng. Asteraceae	**Morrar**	A	5	11	F	11	100	LC
Ceratonia siliqua L. Fabaceae	**Kharoub**	T	4	4	F	4	100	LC
Cichorium pumilum Jacq. Asteraceae	**Alet**	A	5	21	F	21	100	NE
Coriandrum sativum L. Apiaceae	**Quzbara**	A	5	25	FMS	27	93	LC
Crataegus azarolus var. *aronia* L. Rosaceae	**Zarour**	T	5	6	F	6	100	NE
Crataegus azarolus L. Rosaceae	**Nabaq**	T	4	-	F	2	-	DD
Cyclamen persicum Mill. Primulaceae	**Zamatout**	G	4	2	FS	3	67	EN
Eminium spiculatum (Blume) Schott Araceae	**Jaadah**	G	4	12	FM	15	80	VU
Ferula communis L. Apiaceae	**Shwemra**	H	4	-	F	1	-	LC
Foeniculum vulgare Mill. Apiaceae	**Shomar**	H	5	10	FS	11	91	NT
Geropogon hybridus (L.) Sch.Bip. Asteraceae	**Lehiet Eteas**	A	5	-	FM	2	-	LC
Glebionis coronaria (L.) Cass. ex Spach Asteraceae	**Besbas**	A	4	-	F	2	-	LC
Gundelia tournefortii L. Asteraceae	**Akkoub**	H	2	15	F	15	100	VU
Malva parviflora L. Malvaceae	**Khobeza**	A	5	56	FS	58	97	LC
Matricaria aurea (Loefl.) Sch. Bip. Asteraceae	**Babonj**	A	5	8	FM	9	89	LC
Medicago orbicularis (L.) Bartal. Fabaceae	**Smeena**	A	5	-	F	1	-	LC
Melilotus indicus (L.) All. Fabaceae	**Handaqouq**	A	4	17	F	17	100	LC
Mentha longifolia (L.) L. Lamiaceae	**Nana Wadi**	H	1,5	4	FM	5	80	LC
Nasturtium officinale R.Br. Brassicaceae	**Ehwara**	H	6	8	FM	10	80	NE
Notobasis syriaca (L.) Cass. Asteraceae	**Khorfeesh**	A	4	8	FM	9	89	LC
Origanum syriacum L. Lamiaceae	**Zater**	C	4	43	FMS	66	65	VU
Paronychia argentea Lam. Caryophyllaceae	**Reglet Asfora**	H	4	-	M	2	-	LC

Plant names		Life form	Origin	#. of main use informants	Uses		FL%	Status
Scientific	Arabic				Main	Totaled		
Phlomis brachyodon (Boiss.) Zohary ex Rech.f. Lamiaceae	**Athena**	C	2	-	F	1	-	LC
Pinus halepensis Mill. Pinaceae	**Lezab**	T	4	-	F	1	-	VU
Pistacia lentiscus L. Anacardiaceae	**Elesfar** Tree	S	4	-	M	2	-	CR
Pistacia palaestina Boiss. Anacardiaceae	**Botom**	T	4	-	F	2	-	LC
Prunus dulcis (Mill.) D.A.Webb Rosaceae	**Looz Bary**	T	5	-	F	1	-	NE
Pyrus syriaca Boiss. Rosaceae	**Nowar Enjas**	T	5	-	F	1	-	LC
Quercus ithaburensis Decne. Fagaceae	**Malol**	T	4	-	F	2	-	VU
Rhagadiolus stellatus (L.) Gaertn. Asteraceae	**Akefah**	A	5	-	F	1	-	LC
Rhus coriaria L. Anacardiaceae	**Sumaq**	S	2	-	F	2	-	LC
Rosmarinus officinalis L. Lamiaceae	**Hasalban**	S	4	-	M	2	-	NA
Rumex tuberosus L. Polygonaceae	**Homad**	G	5	14	FS	15	93	NE
Ruta chalepensis L. Rutaceae	**Fajen**	C	4	-	FM	3	-	LC
Salvia fruticosa Mill. Lamiaceae	**Merameia**	C	4	3	FM	5	60	RE
Salvia hierosolymitana Boiss. Lamiaceae	**Elsaina**	H	4	29	FS	30	97	LC
Sedum palaestinum Boiss. Crassulaceae	**Orf Edeek**	A	4	4	F	4	100	NE
Silybum marianum (L.) Gaertn. Asteraceae	**Shaloh**	A	5	-	M	1	-	LC
Sinapis alba L. Brassicaceae	**Khardala**	A	1,5	10	F	10	100	LC
Trigonella foenum-graecum L. Fabaceae	**Helba**	A	4	3	FM	5	60	LC
Urtica pilulifera L. Urticaceae	**Quras**	A	1,5	5	FMS	8	63	LC
Wild mushrooms				25	FS	26	96	

both of which are used for food. Other families showed low species presentation, yet their species showed high use values. For example, among the most gathered food species in the study were *Arum palaestinum* Boiss. (Araceae) and *Malva parviflora* L. (Malvaceae), each the only species recorded in its family, yet each with high use values.

Table 2 reports the number of informants indicating that a particular species is collected during a particular month. The distribution across time is an indicator of periods when people are interacting for these purposes with the forest ecosystems.

Table 2. Numbers of informants reporting collection months of plant species from three forest ecosystems in Northern Jordan.

Plant names		No. of informants reporting collection months											
Scientific	Arabic	January	February	March	April	May	June	July	August	September	October	November	December
Achillea fragrantissima (Forssk.) Sch.Bip.	**Qaisoum**				1								

Plant names		No. of informants reporting collection months											
Scientific	**Arabic**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Apium nodiflorum (L.) Lag.	**Qurra**		2		3								
Arum palaestinum Boiss.	**Loaf**	1	6	22	47	4							1
Beta vulgaris L.	**Salaq**		1		1								
Calicotome villosa (Poir.) Link	**Qandoul**			1	3								1
Carlina libanotica Boiss.	**Saq Elaroos**				1								
Centaurea iberica Trevir. ex Spreng.	**Morrar**			4	6					1			
Ceratonia siliqua L.	**Kharoub**					2			1	1			
Cichorium pumilum Jacq.	**Alet**		3	5	11	2							
Coriandrum sativum L.	**Quzbara**	1		5	18	1	1						1
Crataegus azarolus var. *aronia* L.	**Zarour**			1	2				1	2			
Crataegus azarolus L.	**Nabaq**				1		1						
Cyclamen persicum Mill.	**Zamatout**				3								
Eminium spiculatum (Blume) Schott	**Jaadah**		1	1	11				1				1
Ferula communis L.	**Shwemra**			1									
Foeniculum vulgare Mill.	**Shomar**		1	4	5								1
Geropogon hybridus (L.) Sch.Bip.	**Lehiet Eteas**			1	1								
Glebionis coronaria (L.) Cass. ex Spach	**Besbas**			1	1								
Gundelia tournefortii L.	**Akkoub**			5	10								
Malva parviflora L.	**Khobeza**	2	9	9	33	4						1	
Matricaria aurea (Loefl.) Sch. Bip.	**Babonj**			4	4								1
Medicago orbicularis (L.) Bartal.	**Smeena**				1								
Melilotus indicus (L.) All.	**Handaqouq**			5	9	2							1
Mentha longifolia (L.) L.	**Nana Wadi**			1	1								
Nasturtium officinale R.Br.	**Ehwara**		1		8		1						
Notobasis syriaca (L.) Cass.	**Khorfeesh**		2	2	5								
Origanum syriacum L.	**Zater**	1	4	20	36	5							
Paronychia argentea Lam.	**Reglet Asfora**			1	1								
Phlomis brachyodon (Boiss.) Zohary ex Rech.f.	**Athena**			1									
Pinus halepensis Mill.	**Lezab**							1					
Pistacia lentiscus L.	**Elesfar** Tree								2				
Pistacia palaestina Boiss.	**Botom**				2								
Prunus dulcis (Mill.) D.A.Webb	**Looz bary**				1								
Pyrus syriaca Boiss.	**Nowar Enjas**			1									
Quercus ithaburensis Decne.	**Malol**				4					1			
Rhagadiolus stellatus (L.) Gaertn.	**Akefah**			1									
Rhus coriaria L.	**Sumaq**								2				
Rosmarinus officinalis L.	**Hasalban**				2								
Rumex tuberosus L.	**Homad**	1	2	4	8								

Plant names		No. of informants reporting collection months											
Scientific	**Arabic**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Ruta chalepensis L.	**Fajen**				3								
Salvia fruticosa Mill.	**Merameia**				5								
Salvia hierosolymitana Boiss.	**Elsaina**	1	2	6	19								1
Sedum palaestinum Boiss.	**Orf Edeek**			1	1	2							
Silybum marianum (L.) Gaertn.	**Shaloh**					1							
Sinapis alba L.	**Khardala**		2	2	5	1							
Trigonella foenum-graecum L.	**Helba**				5								
Urtica pilulifera L.	**Quras**		2	2	4								
Wild mushrooms		7	5	12	1								1

Table 3. Geographical origin distribution (using chorotype percentage) for species collected from the study areas of Northern Jordan.

Chorotype	Species	
	Number	Percent
Euro-Siberian - Med	4	9
Irano-Turanian	3	6
Irano-Turanian-Saharo-Arabian	1	2
Med-Irano-Turanian	16	34
Mediterranean	21	45
Plurireginalbor-trop	2	4

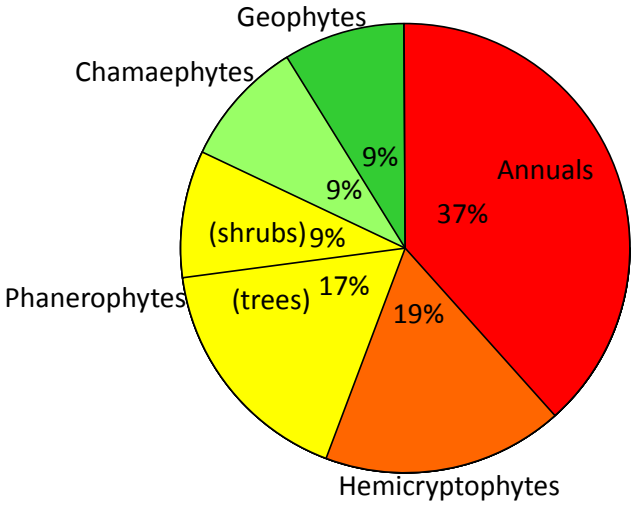

Figure 3. Percentages of plant species by life form collected from the forest in the study areas of Northern Jordan.

For the geographical distribution (Table 3), about 90% of the plants belong totally or partially to the Mediterranean regions. The next largest group of plants comes from the Irano-Turanian regions. This may be explained by the fact that the Irano-Turanean bioregion in Jordan borders the Mediterranean bioregion.

Parts gathered of the plants

Regarding the life form, 1/3 (37%) of the used plants were annuals (Figure 3). The survey showed that the most common plant parts used were the stems (30%), followed by fruit (26%), leaves and stems (20%), whole plants (14%), flowers (6%), and roots (4%). The stems and leaves were mainly used as food, whereas flowers and roots are mainly used for medicinal purposes. The months with the highest collection activity were April and March (Table 2).

Species distribution (ordination)

Plant distribution according to habitat (Figure 4) shows that many species are common in both deciduous and evergreen oak forest while some are present in the pine forest. Three species showed utilization in all forest types: *O. syriacum*, *M. parviflora*, and *A. palaestinum*. These also showed the highest total uses values as seen in Table 4. *Origanum syriacum* is a well-known main component of the Jordanian diet that has disappeared from forests and has been relocated to the house gardens of the forest periphery. Its seedlings are produced in many nurseries and sold all over the country. *Malva parviflora*, whose leaves are the main component of a desirable spring dish, is widely spread by grazing animals. According to interviewees, some species were mainly collected from the pine forest (e.g., *Melilotus indicus* (L.) All. and *Coriandrum sa-*

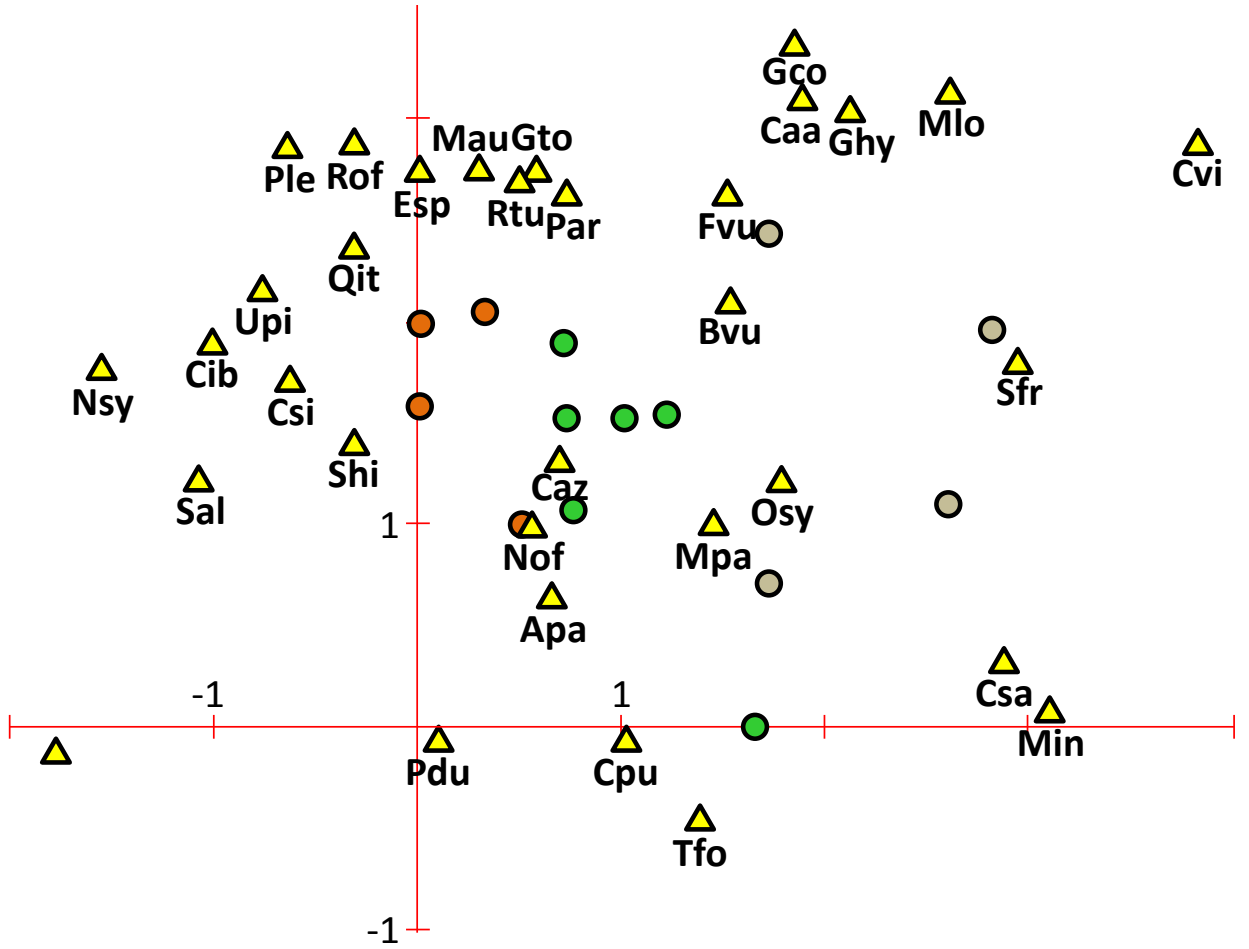

Figure 4. Detrended Correspondence Analysis bi-plot of useful species and forest ecosystem samples to show plant by habitat from the study areas of Northern Jordan. Forest ecosystem samples: (orange) deciduous oak forests, (green) evergreen oak forests, and (gray) pine forests. Species displayed are limited to those with weights ranging from 5 to 100. Species: *Arum palaestinum* Boiss. (**Apa**), *Beta vulgaris* L. (**Bvu**), *Crataegus azarolus* var. *aronia* L. (**Caa**), *Crataegus azarolus* L. (**Caz**), *Centaurea iberica* Trevir. ex Spreng. (**Cib**), *Cichorium pumilum* Jacq. (**Cpu**), *Coriandrum sativum* L. (**Csa**), *Ceratonia siliqua* L. (**Csi**), *Calicotome villosa* (Poir.) Link (**Cvi**), *Eminium spiculatum* (Blume) Schott (**Esp**), *Foeniculum vulgare* Mill. (**Fvu**), *Glebionis coronaria* (L.) Cass. ex Spach (**Gco**), *Geropogon hybridus* (L.) Sch. Bip. (**Ghy**), *Gundelia tournefortii* L. (**Gto**), *Matricaria aurea* (Loefl.) Sch. Bip. (**Mau**), *Melilotus indicus* (L.) All. (**Min**), *Mentha longifolia* (L.) L. (**Mlo**), *Malva parviflora* L. (**Mpa**), *Nasturtium officinale* R.Br. (**Nof**), *Notobasis syriaca* (L.) Cass. (**Nsy**), *Origanum syriacum* L. (**Osy**), *Paronychia argentea* Lam. (**Par**), *Prunus dulcis* (Mill.) D.A.Webb (**Pdu**), *Pistacia lentiscus* L. (**Ple**), *Quercus ithaburensis* Decne. (**Qit**), *Rosmarinus officinalis* L. (**Rof**), *Rumex tuberosus* L. (**Rtu**), *Sinapis alba* L. (**Sal**), *Salvia fruticosa* Mill. (**Sfr**), *Salvia hierosolymitana* Boiss. (**Shi**), *Trigonella foenum-graecum* L. (**Tfo**), and *Urtica pilulifera* L. (**Upi**).

Table 4. Informant Consensus Factor (ICF) for plant use categories from the study areas of Northern Jordan.

Use category	Citations		Species		ICF
	Use citations	% of use	No. used	% of all	
Food	448	87	43	91	0.90
Medicine	41	8	15	32	0.65
Food & medicine	25	5	9	19	0.67

tivum L.), whereas *Sinapis alba* L. was collected from the deciduous oak forest.

Plant uses and ICF

Table 4 shows that there is high agreement among interviewees. The ICF value was highest for plants collected as a food SOURCE (0.90), followed by plants used as both food and medicine (0.67), and plants used solely for medicinal purposes (0.65). Moreover, some interviewees mentioned that parts of 13 plant species were also sold in the local market as alternative income sources. In previous investigations when people were asked directly about the medicinal use of plants, they listed many uses. However, interview responses in this study indicated that food was the main use of plants. This may imply that in such low income territories food collection is a priority and a main reason why locals visit the forest.

Fidelity level

Table 1 shows the FL% for the effectiveness of a certain plant to be designated for a main use. Most plants have high fidelity levels as a food, although many of them are also considered medicinal (see Table 4). The food category here not only includes species used directly as food but also species considered as food additives such as spices or herbs (e.g., *M. indicus*, which adds flavor to the Jordanian traditional dish **mansaf** and gives color and smell for **ghee**). *Cichorium pumilum* Jacq. is prepared in salads after adding a good amount of salt and squeezing the leaves to reduce bitterness. *Gundelia tournefortii* L. is prepared in yogurt or tomato sauce after removing the spines.

Wild mushrooms

Wild mushrooms are also collected from the forest areas. One of the main mushroom species was mentioned as associated with *Ferula communis* L. and *P. halpensis*.

Discussion

General floristic characteristics

Asteraceae, Lamiaceae, and Fabaceae were most important in this study and also the most frequent families represented in other ethnobotanical studies in the Mediterranean region (Ali-Shtayeh *et al*. 2008, El-Darier & El-Mogaspi 2009, Rigat *et al*. 2007). Similar percentages of Asteraceae and Lamiaceae were found in an ethnopharmacological study of a Jordanian desert ecosystem (Nawash *et al*. 2013).

Life form results are consistent with the results of Lahham and El-oqlah (1987). Tables 1 and 2 show that the main trees (e.g., *Q. coccifera*) were rarely utilized according to the local people, whereas the understory shrubs and herbs species wer used more often. However, in an ethnopharmacological study in the evergreen oak forest of Jordan, the dominant tree *Q. coccifera* was recognized to have important medicinal value (Aburajai *et al*. 2007). This indicates that when not targeting a specific use category such as medicinal, local people mostly are concerned with collecting these plants for food.

Parts gathered of the plants

Although stems were most common in this study, fruit and young leaves were the most used plant parts in Mediterranean food plants (Rivera *et al*. 2005).

Fidelity level

For medicinal uses, *Matricaria aurea* (Loefl.) Sch. Bip. showed the highest fidelity level (89%) followed by *Eminium spiculatum* (Blume) Schott (80%) and *Salvia fruticosa* Mill. (60%). When including these data in any alternative income programs, economics, agricultural practices, and packaging methods should be further investigated. Many women in the study area collect these plants and sell them to the public, yet the quality of plant processing, packaging, and other marketing parameters need to be improved.

Wild mushrooms

Wild and native mushrooms of Jordan have been ignored in Jordanian field surveys and in the research on production protocols. However, recently, the Royal Botanic Garden of Jordan established the National Mushroom Project, headed by Prof. Dr. Ahmad Al-Momany from the University of Jordan to fill in the gap.

Conservation

Twenty-six out of 47 plant species (Table 1) are of least concern in terms of conservation status. However, some species should receive special conservation attention since they are collected from the wild and potentially under threat of losing genetic variability. For example, *A. palaestinum*, *Cyclamen persicum* Mill., and *E. spiculatum* are either endangered or vulnerable of being lost. *Salvia fruticosa*, a main component of daily Jordanian diet, is being exterminated from the wild yet translocated to the gardens in the forest surroundings and in plant nurseries.

In Jordan, attempts to use native plants as sources of food and medicine in order to improve the income of local communities, preserve biodiversity, and enhance the national economy are in their infancy. By contrast, success in neighboring countries such as Turkey and Lebanon, which harbor many common native plant species with Jordan, illustrate potential for similar success in Jor-

dan. Distributions of plants based on geographical orign as ecological information might be useful when utilizing the species in life improvement projects in the different bioregions in Jordan.

Conclusions

The results obtained about the collection behavior, ethnobotany indices, and conservation status should be used together to produce a model for forest sustainable management. This will provide paths for native plant production and commercialization that may improve the livelihood of the local community.

The analyzed data obtained from interviewees indicated that the degraded Mediterranean forest ecosystem in northwest Jordan is still visited by local people to collect plants which improve their lives. There was a consensus among interviewees that collected plants are used as sources of food. The people surrounding the three forests collect some common important species that are sold in local markets. Wild mushrooms are also widely collected. Linking these data to the conservation plans of the forest in community-based activities is important to keep the forest sustainable, reward local people, and improve the ecosystem. There is an urgent need for more detailed analysis about the economic value and cultural practices associated with the collected species. This information can be used to improve local income through programs associated with the forest restoration programs by taking into consideration the conservation status of each species.

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