

A COMPREHENSIVE ACCOUNT OF SPECIES COMPOSITION, DISTRIBUTION AND ECOLOGY OF PHLEBOTOMINE SANDFLIES IN JORDAN.

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Summary :

Extensive sampling of 18 localities representing the distinct ecological zones of Jordan was carried out during the sandfly seasons of 1986 to 1988. This resulted in the collection of 21 sandfly species, 8 of which are reported for the first time from Jordan. The newly reported species include *Phlebotomus jacusieli*, *P. tobbi*, *P. perfiliewi galilaeus*, *P. mascitti*, *P. arabicus*, *P. halepensis*, *Sergentomyia palestinensis* and *S. taizi*. The distribution, relative abundance in domestic and rural sites for all species and the epidemiological significance of *Phlebotomus* species as vectors of leishmaniasis are discussed.

KEY WORDS : *Phlebotomus*. *Sergentomyia*. climatic zones. Jordan. leishmaniasis.

MOTS CLES : *Phlebotomus*. *Sergentomyia*. zones climatiques. Jordanie. leishmanioses.

Résumé : COMPOSITION, DISTRIBUTION ET ÉCOLOGIE DES ESPÈCES DE PHLEBOTOMES EN JORDANIE

Des récoltes intensives de Phlébotomes ont été réalisées dans 18 localités réparties dans les différentes zones écologiques de Jordanie, pendant les saisons d'activité des Phlébotomes de 1986 à 1988. Une collection de 21 espèces de Phlébotomes a été obtenue, dont huit rapportées pour la première fois de Jordanie. Les nouvelles espèces récoltées comprennent *Phlebotomus jacusieli*, *P. tobbi*, *P. perfiliewi galilaeus*, *P. mascitti*, *P. arabicus*, *P. halepensis*, *Sergentomyia palestinensis* et *S. taizi*. La répartition, l'abondance relative des espèces dans les sites domestiques et ruraux et la signification épidémiologique des données concernant les *Phlebotomus* sont discutées, en relation avec leur rôle de vecteur des leishmanioses.

INTRODUCTION

Up to date, 13 identified sandfly species were reported from Jordan through preliminary and focal studies (Oumeish *et al.*, 1982; Saliba *et al.*, 1985; Kamhawi *et al.*, 1988; Lane *et al.*, 1988). These included five of the genus *Phlebotomus* and eight of the genus *Sergentomyia*. Moreover, specimens belonging to the subgenus *Adlerius* were reported by Lane *et al.* (1988). Taking into consideration that zoonotic cutaneous leishmaniasis (ZCL) caused by *Leishmania major* is endemic in the country (Oumeish *et al.*, 1982; Saliba *et al.*, 1985; Arbagi *et al.*, 1993), and the recent identification of a *L. tropica* focus from the centre (Saliba *et al.*, 1993) and north of Jordan (Kamhawi *et al.*, in press), a more detailed investigation of the species composition, distribution and ecological requirement of sandflies was undertaken through a comprehensive survey of localities representing all the climatic zones of Jordan.

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MATERIALS AND METHODS

Jordan is a small country situated at the tip of one of the Red Sea horns. It falls within the Palaearctic region but is also influenced by the Afrotropical region along the Rift Valley system to the extreme west of Jordan. Furthermore, there is the intrusion of Mediterranean elements on the relatively wet northern part of Jordan which decreases further south to be replaced by a dry desert climate.

The Koppen classification model (Anonymous, 1984) divides Jordan into six climatic zones from which 18 localities were chosen to provide a comprehensive survey of all the ecologically distinct regions in the country (Fig. 1).

Sampling of the diverse regions was carried out around the peak of three sandfly seasons (1986 to 1988) and included rural and domestic sites selected from each locality. Rural sites included rocky boulder ranges, open desert, caves and ruins of ancient sites such as amphitheatres and tombs. The domestic sites included mud huts, cement or stone houses, barns for keeping domestic animals (cows, sheep, goats, donkeys and chicken) and rooms used for storage of food. Table I describes the nature of the rural and domestic sites sampled from each of the 18 localities.

Climatic zone ¹ and sampling sites	Physical parameters ²			Site description	
	Alt m	MST (°C)	MSRH %	Rural	Domestic
CMC					
Ajlun	+ 1023	24	50	Evergreen <i>Quercus</i> forests, limestones, terra rosa soil	Inhabited mud huts, food stores, animal barns
Shaubak	+ 1475	20	40	Evergreen <i>Quercus</i> forests, open scrub land	Inhabited mudhuts, food stores, animal barns
WMC					
Irbid	+ 300	26	50	Deciduous <i>Quercus</i> forests, open grassland	Stone houses
Jarash	+ 640	24	50	<i>Pinus</i> & <i>Quercus</i> forests, caves & ruins	Inhabited mud huts
Salt	+ 796	24	50	Brush steppes, grassland, terra rosa soil, ruins	Inhabited mudhuts, animal barns
CSC					
Amman suburbs	+ 830	24	48	Desert scrub land, chenopods, rodent burrows, caves	Inhabited mud huts & cement houses, chicken farms
Petra	+ 1000	24	38	Limestone & basalt wadis, steppe vegetation, caves	Not sampled
WSC					
Hemmah	- 75	30	50	Savannah, rendzina soil, banana & date plantations	Inhabited mud huts & cement houses, food stores, animal barns
Um-Quais	+ 100	28	50	Deciduous <i>Quercus</i> forests, pastures ruins, caves	Not sampled
Tabakat Fahl	+ 400	30	50	Agricultural area, caves	Food stores, animal barns
CDC					
Mafraq	+ 580	24	45	Basalt desert, chenopods, rodent burrows	Inhabited mud huts, animal barns
Ras el Naqb	+ 1570	25	35	Sandy desert, scanty scrub land, caves	Not sampled
WDC					
Swainma, Dead Sea	- 390	30	48	Sandy desert, chenopods, rodent burrows	Inhabited mud huts, food stores, animal barns
South Shuna	- 200	30	49	Not sampled	Inhabited mud huts
Ghor el Safi	- 380	30	40	Cultivated scrub land	Inhabited mud huts & cement houses, food stores, chicken farm houses, citrus farm
Azraq	+ 533	28	40	Basalt desert oasis, halophytes & chenopods, rodent burrows	
Wadi Rum	+ 500	27	30	Steep sandy mountains, chenopods, wild trees & grasses	Not sampled
Aqaba	+ 51	30	30	Sandstone & granite desert, chenopods	Inhabited mud huts & cement houses, animal barns

Table I. – Physical parameters and site description of the various localities selected from Jordan

1 Key to climatic zones following Koppen's classification (see Fig. 1).

2 Alt : Altitude ; MST : Mean Seasonal Temperature ; MSRH : Mean Seasonal Relative Humidity. The temperature and relative humidity were calculated as means during the sandfly season, July to September (Anonymous, 1984).

COLLECTION OF SANDFLIES

Sticky paper traps made of A4 sheets of paper and coated with castor oil were the principal method used for the collection of sandflies. The number of sticky traps placed in each site depended on its nature, the diversity of its habitats, and the number of times it was sampled. Aspiration and CDC miniature light traps were occasionally used in houses and caves.

IDENTIFICATION OF SANDFLIES

Sandflies were identified according to the keys of Theodor (1958), Perfil'ev (1968), Lewis (1973, 1982), Lewis and Buttiker (1982), Lane and Al-Taqi (1983) and Lane (1986).

The dissection of the base of the spermatheca is required to distinguish between females of *P. tobbi* and *P. perfiliewi galilaleus* (Léger *et al.*, 1983). As the males are easily distinguishable, the females were grouped together and the number of males were relied upon to reflect the abundance of each species in a locality. Furthermore, due to the difficulty of distinguishing males of some *Sergentomyia* species, *S. antennata*, *S. theodori* and *S. fallax* were grouped together as *S. antennata* complex (Lane *et al.*, 1988) and those of *S. clydei* and *S. adleri* as ad/cl.

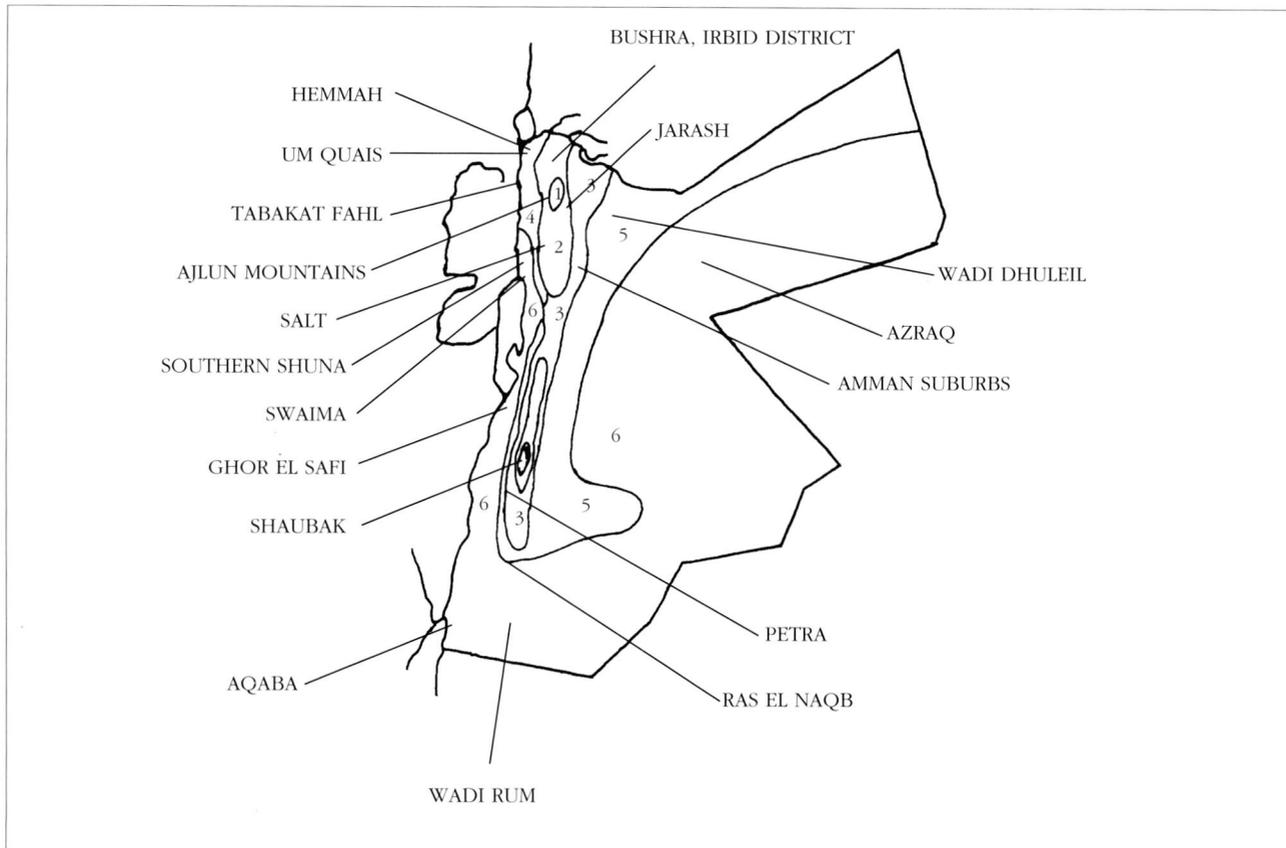


Fig.1. – Distribution of the eighteen sampled sites within the six climatic zones of Jordan (Koppen's classification model, for information on the climatic zones see Lane *et al*, 1988). Key to climatic zones : 1 Cool Mediterranean Climate 2 Warm Mediterranean Climate 3 Cool Steppe Climate 4 Warm Steppe Climate 5 Cool Desert Climate 6 Warm Desert Climate

RESULTS

Some 26 582 sandflies were collected throughout this study from domestic and rural sites of 18 localities distributed throughout Jordan. A total of 21 species were identified, 11 *Phlebotomus* spp. and 10 *Sergentomyia* spp. Of these, 8 species are recorded for the first time from Jordan : *Phlebotomus jacusieli*, *P. tobbi*, *P. perfiliewi galilaeus*, *P. mascitti*, *P. arabicus*, *P. halepensis*, *Sergentomyia palestinienis* and *S. taizi*.

The *Phlebotomus* and *Sergentomyia* species composition differed from one locality to another reflecting changes in the environment from north to south and from west to east. Overall, *P. papatasi* and *P. sergenti* and the *S. antennata* complex were collected from all zones (tables II and III). Members of the subgenus *Larrousius* were predominant in the Mediterranean influenced sites in the north while Afrotropical species such as *S. africana* were present only along the narrow strip of the Rift Valley system along the western border of the country. Jarash, Salt, Petra, Tabakat Fahl and Ras el Naqb are considered transitional localities as they are influenced by two zones (Fig. 1).

The sandfly fauna in these localities is rich and often included species known from dry desert areas such as *P. kazeruni* as well as Mediterranean species such as *P. major syriacus*.

Males of the *Phlebotomus* species were collected in significantly larger numbers than females from most of the sites sampled (table IV). The overall male to female ratio was highest for *P. major syriacus* and lowest for *P. tobbi/perfiliewi galilaeus*. This observation was not applicable to *Sergentomyia* species where the male to female ratio was variable (table V). For example, more males than females were collected for *S. christophersi* and the reverse was noted for *S. africana*. Moreover, there was no consistency observed in the male to female ratio for the same species when collected from different localities (table V).

COMMENTARY ON THE DISTRIBUTION AND ECOLOGY OF COLLECTED SPECIES

Figs. 2, 3 and 4 show the relative abundance of the predominant species collected from domestic and rural habitats within productive sites.

P. papatasi was most predominant in the Jordan Valley, in sites such as Hemmah, Swaima and

Climatic zone ¹ and sampling sites	Sandfly species ²									
	pa	se	al	ja	ka	ma	to	pe	ms	Adl
CMC										
1. Ajlun	+	-	-	+	-	*	-	-	+	+
2. Shaubak	-	+	-	+	*	-	-	-	-	-
WMC										
3. Irbid	+	+	-	+	+	+	+	*	-	-
4. Jarash	+	*	+	+	+	+	-	-	-	-
5. Salt	-	+	-	-	-	*	-	-	-	-
CSC										
6. Amman Suburbs	+	*	+	+	+	-	-	-	-	-
7. Petra	-	+	+	+	*	+	-	-	+	+
WSC										
8. Hemmah	*	+	+	+	-	+	+	+	+	+
9. Um-Quais	-	-	-	-	-	+	+	-	-	-
10. Tabakat Fahl	+	+	+	-	-	-	-	-	-	-
CDC										
11. Wadi Dhulail	+	+	+	-	*	-	-	-	-	-
12. Ras el Naqb	+	+	+	+	*	+	+	-	-	+
WDC										
13. Swaima	*	+	+	-	-	+	-	-	+	-
14. South Shuna	*	-	+	-	-	-	-	-	-	-
15. Ghor el Safi	+	-	-	-	-	-	-	-	-	-
16. Azraq	*	+	-	-	+	-	-	-	-	-
17. Wadi Rum	-	-	-	-	*	-	-	-	-	-
18. Aqaba	+	+	*	-	+	-	-	-	-	-

Table II. – Distribution of *Phlebotomus* species collected from 18 sampling sites in Jordan. (* indicates the most abundant species).

1 Key to climatic zones following Koppen's classification (see Fig. 1).

2 Key of sandfly species: pa, *Phlebotomus papatasi*; se, *P. sergenti*; al, *P. alexandri*; ja, *P. jacusieli*; ka, *P. kazeruni*; ma, *P. major syriacus*; to, *P. tobbi*; pe, *P. perfiliewi galilaeus*; ms, *P. mascitti*; Adl, *P. arabicus* and *P. halepensis*.

Southern Shuna. It was also abundant in some localities endemic for ZCL such as the suburbs of Amman but rare from the very arid sites such as Ras el Naqb which is distant from human habitation and supports only scanty vegetation. Although *P. papatasi* was collected from both domestic and rural habitats (Figs. 2, 3 and 4), it was more abundant in domestic habitats from the sites where it was dominant, such as Hemmah and Swaima.

P. sergenti represented a small proportion of the total catch in 11 out of 13 sites (table II, Figs. 2 and 4). It was the dominant *Phlebotomus* species in the suburbs of Amman and was abundant in Jarash. The low density of this species has been observed by many workers (Buttiker and Lewis, 1979, 1983; Dedet *et al.*, 1984). Although *P. sergenti* is known to be highly anthropophilic, it was collected from both domestic and rural sites from the suburbs of Amman (Fig. 4) and only from rural habitats in Jarash (Fig. 2). This exophilic behaviour was also observed in collections from Algeria (Dedet *et al.*, 1984).

P. alexandri has a fairly wide distribution in Jordan. It was collected from both domestic and rural habitats

of all zones apart from the CMC (table II). It was relatively abundant in Swaima and Aqaba where it was the dominant *Phlebotomus* species (Fig. 3). Its abundance appeared to correspond to areas where the African *Acacia* trees are present supporting the reports of Lewis and Buttiker (1980, 1986).

P. jacusieli, reported for the first time from Jordan, showed a wide distribution range. It was well represented in the suburbs of Amman, rare in Ras el Naqb and absent from the rest of the eastern and western desert sites (table II and Fig. 4). This species was reported from hilly mountainous areas in Iran and Israel (Theodor and Meshgali, 1964; Warburg, 1986; Lane *et al.*, 1988).

P. kazeruni is common in Jordan and was collected from 10 sites. It was abundant from the dry desert sites in the east and south particularly in Ras el Naqb. Furthermore, it was the dominant *Phlebotomus* species in Petra and Wadi Dhuleil and the only *Phlebotomus* species collected from Wadi Rum (table II and Fig. 4).

Typical Eastern Mediterranean fauna such as *Phlebotomus major syriacus*, *P. tobbi* and *P. perfiliewi*

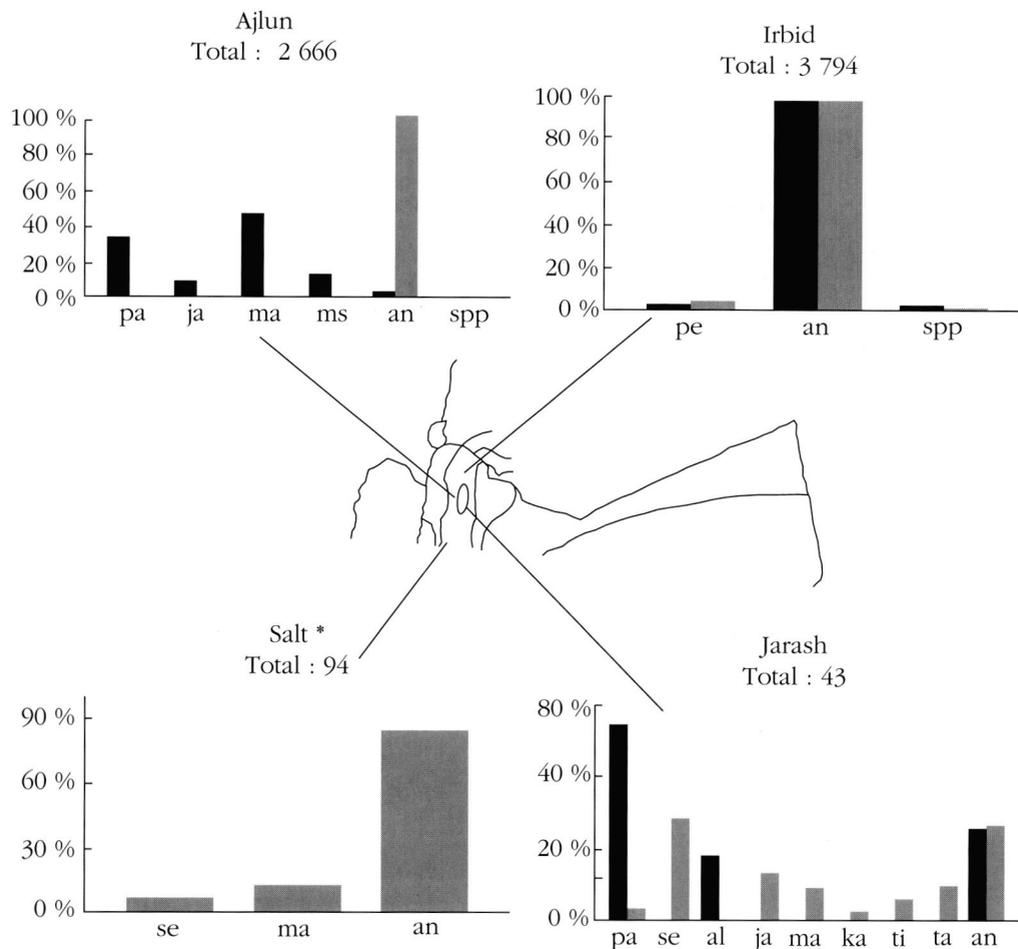


Fig. 2. – The relative abundance of the dominant species collected from productive sites situated within the Mediterranean influenced northern part of Jordan. (■) domestic habitats, (▒) rural habitats; spp, other species; (*) domestic habitats not sampled. Key to species code is given in Tables II and III.

galilaeus of the subgenus *Larroussi* as well as *P. arabicus* and *P. halepensis* of the subgenus *Adlerius*, were well represented from the north of Jordan and were rare or absent from the desert zones (table II).

Phlebotomus major syriacus was the dominant *Phlebotomus* species in Ajlun Mountains and Salt (Fig. 2) where it was collected from both domestic and rural habitats. This species is usually found in rocky areas of high altitude and water table (Buttiker and Lewis, 1983; Lane *et al.*, 1988). In Jordan, it was abundant in lowlands such as Hemmah (75m below sea level) as well as highlands such as Ajlun Mountains (1023m above sea level) indicating that altitude is of little importance in restricting the spatial distribution of this species.

P. tobbi and *P. perfiliewi galilaeus*, reported for the first time from Jordan, were mostly restricted to sites situated in the WMC and WSC such as Irbid, Hemmah and Um-Quais (table II). They were rare in most of the collections apart from Irbid where *P. perfiliewi galilaeus* was the dominant *Phlebotomus* species and

was collected in relatively large numbers indoors (Fig. 2). *P. mascitti*, *P. halepensis* and *P. arabicus* also reported for the first time from Jordan, were collected in very small numbers from rural and domestic habitats in five sites belonging to different zones (table II). The *Sergentomyia antennata* complex, which consists of *S. antennata*, *S. theodori* and *S. fallax*, was the predominant *Sergentomyia* spp. present in Jordan. These species were collected in large numbers from both rural and domestic habitats of all the localities sampled apart from Shaubak and Um-Quais (table III, Figs. 2, 3 and 4).

S. africana is an afrotropical species and was restricted in its distribution to the western strip of the Rift Valley system in Jordan (table III). It was most abundant in rural and domestic habitats in Swaima, a dry arid desert which supports some *Chenopods* and sparse *Acacia* trees (Fig. 3). It was also common in El-Hemmah, which represents a different biotope from Swaima and is a humid area with dense agricultural vegetation.

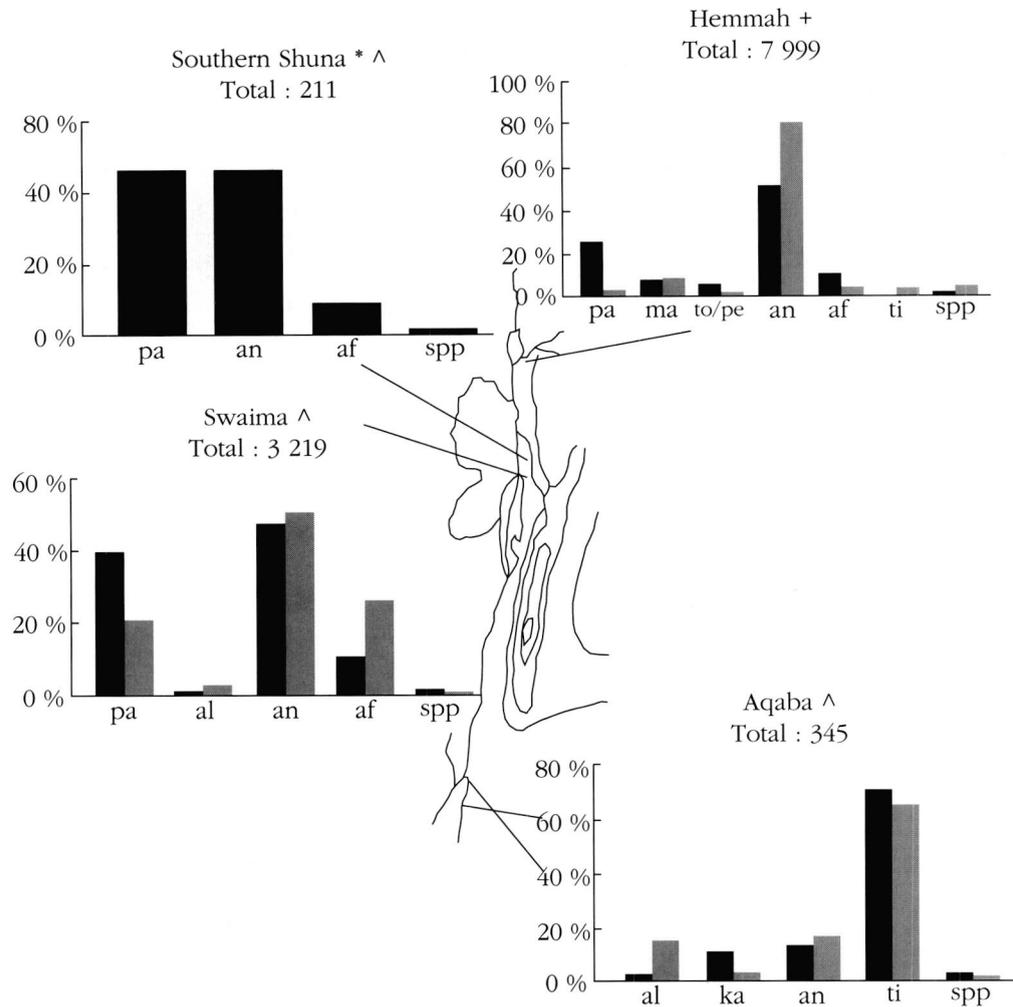


Fig. 3. – The relative abundance of the dominant species collected from productive sites located along the African Rift Valley Strip in the west of Jordan. (■) domestic habitats, (▒) rural habitats; spp, other species; (*) rural habitats not sampled; (+) site influenced by the Mediterranean climate; (^) site influenced by the desert climate. Key to species code is given in tables II and III.

S. tiberiadis was collected from both Mediterranean zones such as Jarash and Hemmah and desert zones such as Aqaba and Wadi Rum (Figs. 2, 3 and 4). It was more abundant in desert zones and was the most dominant species in Aqaba.

S. christophersi was collected from five sites, most of which were dry and arid (table III). It was rare in most of the collections except Wadi Rum where it was the most dominant sandfly species (Fig. 4).

S. adleri and *S. clydei* were collected in small numbers from Hemmah and Ghor el Safi situated along the Rift Valley and Ras el Naqb in the eastern desert (table III). Both are considered as afrotropical species (Theodor and Meshgali, 1964; Buttiker and Lewis,

1983; Lane and Al-Taqi, 1983). These species were reported earlier from Aqaba (Kamhawi *et al.*, 1988).

S. taizi was collected in low numbers from both desert and Mediterranean zones and although it is known as a typically high altitude species (Buttiker and Lewis, 1983), it was collected from Hemmah and Swaima at altitudes of 75m and 390m below sea level respectively (table III).

S. palestiniensis was collected in very small numbers from Hemmah, Swaima and Petra (table III). It has been reported from Israel, Iraq, Iran, Saudi Arabia and Egypt (Lane, 1986) and was therefore expected to be present in Jordan (Lane *et al.*, 1988).

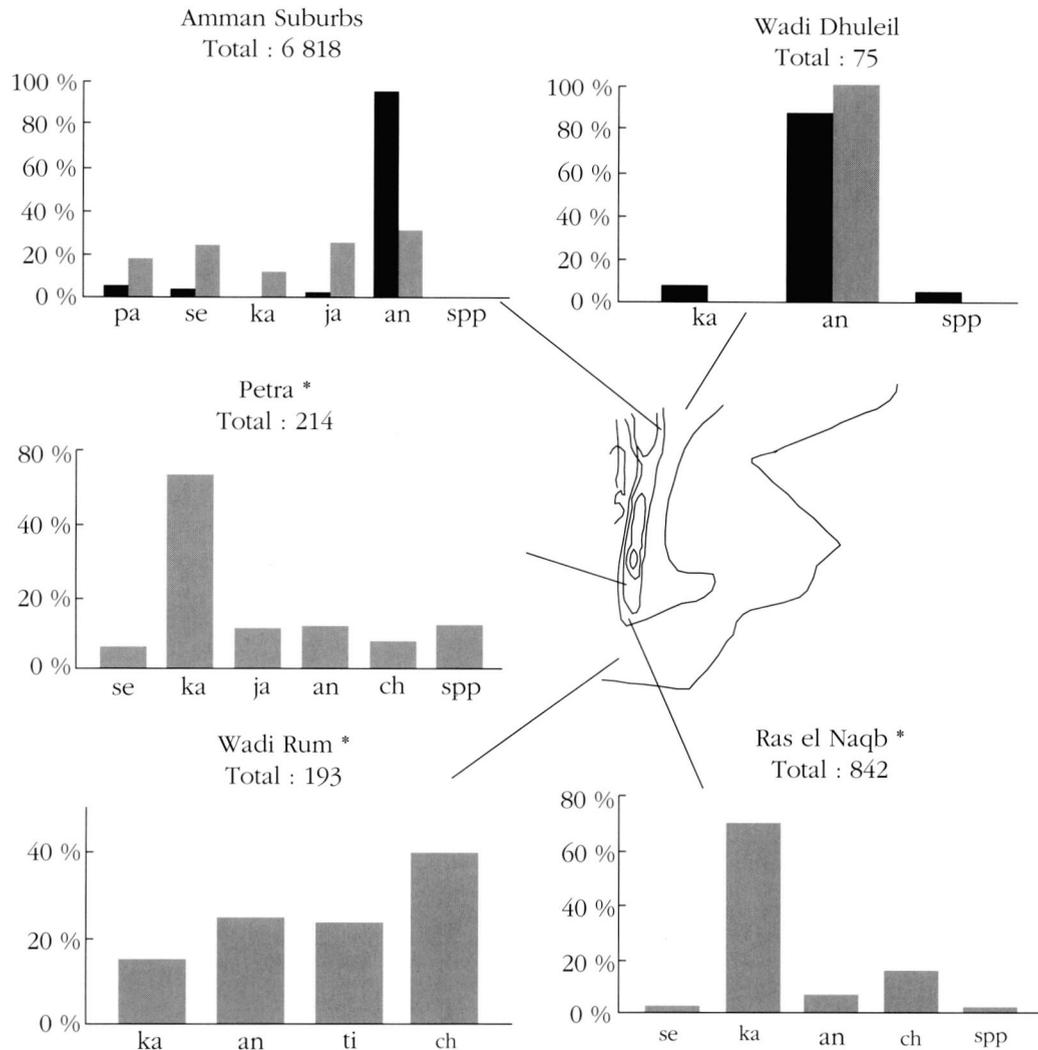


Fig. 4. – The relative abundance of the dominant species collected from productive sites situated in the eastern highlands and desert of Jordan. (■) domestic habitats, (▒) rural habitats; spp, other species; (*) domestic habitats not sampled. Key to species code is given in tables II and III.

DISCUSSION

ECOLOGICAL CONSIDERATIONS

Jordan, although a small country, supports a rich sandfly fauna. Some 16 out of the 21 species collected from Jordan were present in Hemmah making it the most versatile of all the sites sampled (table II). Despite being a low altitude locality (ca 75m below sea level) it has produced typically high altitude species such as *P. major syriacus* which was the most abundant *Phlebotomus* species present apart from *P. papatasi* (Fig 3). This diversity may be a reflection of the rocky nature and the warm and humid climatic conditions of this area combined with the influence of both the Mediterranean and

Afrotropical Rift Valley elements. Jarash, Petra and Ras el Naqb also exhibited a rich sandfly fauna (table II). All of these are transitional sites which are influenced by two zones. This is reflected in their sandfly fauna whereby typical desert species such as *P. kazeruni* and typical Mediterranean species such as *P. major syriacus* were collected from the same site. Ajlun Mountains represented an interesting site in terms of the discrete division observed in the distribution of its sandfly species in domestic and rural habitats (Fig. 2). There, *Phlebotomus* species were almost restricted to domestic habitats and *Sergentomyia antennata* to rural ones.

Jordan seems to represent the extreme of the distribution range for some species such as *P. perfiliewi gali-*

Climatic zone ¹ and sampling sites	Sandfly species ²						
	an	af	ti	ch	ad/cl	ta	pl
CMC							
1. Ajlun	*	-	-	-	-	-	-
2. Shaubak	-	-	-	-	-	-	-
WMC							
3. Irbid	*	-	-	-	-	-	-
4. Jarash	*	-	+	-	-	+	-
5. Salt	*	-	-	-	-	-	-
CSC							
6. Amman Suburbs	*	-	-	-	-	-	-
7. Petra	*	-	+	+	-	+	+
WSC							
8. Hemmah	*	+	+	+	+	+	+
9. Um-Quais	-	-	-	-	-	-	-
10. Tabakat Fahl	*	+	-	-	-	-	-
CDC							
11. Wadi Dhuleil	*	-	-	-	-	-	-
12. Ras el Naqb	+	-	+	*	+	+	-
WDC							
13. Swaima	*	+	+	+	-	+	+
14. South Shuna	*	+	-	-	-	-	-
15. Ghor el Safi	+	-	-	-	+	-	-
16. Azraq	*	-	-	-	-	+	-
17. Wadi Rum	+	-	+	*	-	-	-
18. Aqaba	+	-	*	-	-	-	-

Table III. – Distribution of *Sergentomyia* species collected from 18 sampling localities in Jordan. (* indicates the most abundant species).

1 Key to climatic zones following Koppen's classification (see Fig. 1).

2 Key of sandfly species: an, *Sergentomyia antennata* complex including *S. antennata*, *S. theodori* and *S. fallax*; af, *S. africana*; ti, *S. tiberiadis*; ch, *S. christophersi*; ad/cl, *S. adleri* and *S. clydei*; ta, *S. taizi*; pl, *S. palestiniensis*.

Sampling sites	Sandfly species						
	pa	se	al	ka	ja	ma	to/pe
Ajlun						13:0	
Shaubak		4:0		5:1			
Jarash	6:1	8:1					
Salt		2:1				11:0	
Amman Suburbs	8:1	1:2		1:2	10:0		
Petra		2:1		10:1	1:1	7:1	
Hemmah	4.6:1	1.6:1	18:1			3:1	2:1
Ras el Naqb		18:1		7.5:1			
South Shuna	3:1						
Swaima	2:1		2.6:1				
Wadi Rum				27:1			
Aqaba			5:0	8:1	20:1		
Overall	4.7:1	5.9:1	9.5:1	10.7:1	11:1	17:1	2:1

Table IV. – The male : female ratio for the dominant *Plebotomus* species collected from productive sites in Jordan. (Code of sandfly species as in Table II).

Sampling sites	Sandfly species					
	an	af	ti	ch	ad/cl	ta
Ajlun	1:1					
Irbid	1:3.8					
Jarash	3:1					
Salt	1:1.6					
Amman Suburbs	1:2					
Petra	1.4:1			7.5:1		1:3
Hemmah	1:3.4	1:1.3	1:1		2.6:1	
Tabakat Fahl	1:1					
Wadi Dhuleil	1:8.6					
Ras el Naqb	6:1			1:1		
Azraq	1:1					4:1
South Shuna	1:2	1:8				
Swaima	2.6:1	1:1	4:1			
Wadi Rum	5:1		1:1	1.8:1		
Aqaba	2.8:1		2.8:1			
Overall	1:1	1:3.4	2.2:1	3.4:1	2.6:1	1.3:1

Table V. – The male : female ratio for the dominant *Sergentomyia* species collected from productive sites in Jordan. (Code of sandfly species as in Table III).

laeus and *P. jacusieli* whose present record from Jordan represents the eastern limit of their distribution range.

As for the sex ratio of sandflies throughout the collections, *Phlebotomus* species showed a greater male to female ratio (table IV). This ratio was variable for *Sergentomyia* species being biased towards the reverse (table V). This may be a reflection of the attraction of *Phlebotomus* males to sticky traps which were the main method of sampling used in this investigation.

EPIDEMIOLOGICAL CONSIDERATIONS

P. papatasi was recently incriminated as the vector of *L. major* in the Jordan Valley (Janini *et al.*, in press). In the present study, it was found to be the dominant *Phlebotomus* species in sites such as Swaima and Southern Shuna in the Jordan Valley which is known for its hyperendemicity to ZCL (Arbagi *et al.*, 1993). It was also abundant in the suburbs of Amman from an area where a ZCL outbreak caused by *L. major* occurred in 1982-1983 (Saliba *et al.*, 1985). Therefore, this species is suspected of being the vector of *L. major* throughout the country. This is supported by the fact that it is a proven vector of this parasite in surrounding countries such as Israel (Schlein *et al.*, 1982) and Saudi Arabia (Killick-Kendrick *et al.*, 1985).

P. sergenti is the principal vector of *L. tropica* in the Old World (Killick-Kendrick, 1990). *L. tropica* has been recently identified from foci in the centre (Saliba *et al.*, 1993) and north of Jordan (Kamhawi *et al.*, in

press). The collection of *P. sergenti* from several sites sampled during this study including Salt, the area from where *L. tropica* was identified (Saliba *et al.*, 1993), is indicative of the epidemiological importance of this species which is thought to be the vector of *L. tropica* in Jordan.

P. major neglectus, a closely related species to *P. major syriacus*, is a proven vector of visceral leishmaniasis in the Mediterranean Basin (Killick-Kendrick, 1990). Recently, canine visceral leishmaniasis has been reported from Israel with *P. major syriacus* as its proven vector (Jaffe *et al.*, 1988). Information available on the true situation in Jordan with respect to the presence and incidence of visceral leishmaniasis is lacking. The abundance of *P. major syriacus* in several sites from Jordan; its tendency towards endophilic behaviour in some; the availability of resting and breeding sites in domestic habitats and the presence of possible reservoirs such as dogs make Jordan vulnerable to the introduction of visceral leishmaniasis.

P. perfiliewi was incriminated as the vector of a dermatotropic strain of *L. infantum* which causes cutaneous leishmaniasis in the Mediterranean Basin (Maroli *et al.*, 1987). Therefore, *P. perfiliewi galilaeus*, which was found to be the dominant *Phlebotomus* species in Irbid and which seems to be endophilic in its behaviour, can be of epidemiological importance in Jordan.

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