

SANDFLIES IN THE GREATER ATHENS REGION, GREECE

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Summary :

During the period from May to October 1992, a survey of phlebotomine sandflies was conducted in the Greater Athens region where cases of human and canine leishmaniasis occur. Using castor-oil paper traps, a total of 3015 sandflies were caught. Of the identified specimens, 1002 (34.1%) were *Phlebotomus neglectus*, 541 (18.4%) were *P. papatasi*, 182 (6.2%) were *P. tobbi*, 50 (1.7%) were *P. simici*, 30 (1.0%) were *P. alexandri*, 13 (0.4%) were *P. sergenti* and 1122 (38.2%) were *Sergentomyia minuta*. The seasonal activity of most *Phlebotomus* species was bimodal, while that of *S. minuta* was unimodal. The population density of sandflies varied significantly in different localities; it was low in most of the stations and high in some stations in the outskirts. Among the potential vectors of *Leishmania* spp., *P. neglectus* and *P. papatasi* were the most widespread species. The former species showed high density in 12 of the 70 sampled stations, while the latter in only 4. Hence, the risk of transmission of sandfly-borne diseases is still present in the Greater Athens region.

KEY WORDS sandflies, distribution, seasonal activity, Greece.
MOTS CLÉS : Phlébotomes, distribution, activité saisonnière Grèce.

INTRODUCTION

The Greater Athens region is one of the endemic areas of visceral leishmaniasis (VL) in Greece (Orphanidis, 1979; Tselentis *et al.*, 1979; Tzamouranis, 1979). Human and canine cases of Kala-azar were reported in this region early in this century (Cardamatis, 1911, 1912; Aravandinos, 1916; Caminopetros, 1934), as well as an epidemic of papatasi fever (Cardamatis, 1931). Statistics of the Greek Ministry of Health for the period 1966-1991, showed that 57.9% of all human VL cases in Greece originated in Athens, Piraeus and their suburbs. A retrospective study conducted in the same region in the 70's recorded an increase of the clinical VL cases since the decade of 1960 and pointed out that 75% of the infected persons were living on or near the slopes of the mountains surrounding the Athens Basin and the hills situated in it (Orphanidis, 1979; Tselentis *et al.*, 1979). It was also observed that many of the cases

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Résumé

LES PHLÉBOTOMES DE L'AGGLOMÉRATION D'ATHÈNES, GRÈCE.
Pendant la période de mai à octobre 1992, une étude sur les phlébotomes a été entreprise dans l'agglomération d'Athènes où existent des cas de leishmaniose humaine et canine. Au total, 3015 phlébotomes ont été capturés par la méthode des pièges adhésifs. Ont été identifiés : *Phlebotomus neglectus* : 1002 (34,1%), *P. papatasi* : 541 (18,4%), *P. tobbi* : 182 (6,2%), *P. simici* : 50 (1,7%), *P. alexandri* : 30 (1,0%), *P. sergenti* : 13 (0,4%) et *Sergentomyia minuta* : 1122 (38,2%).

L'activité saisonnière de la plupart des espèces du genre *Phlebotomus* montre une évolution diphasique, tandis que celle de *S. minuta* est monophasique. La densité des populations de phlébotomes varie largement dans les différentes localités prospectées; elle est basse dans la majorité des stations et élevée dans certaines stations périphériques. Parmi les vecteurs potentiels de *Leishmania* spp., *P. neglectus* et *P. papatasi* sont les espèces les plus répandues. Le premier présente une haute densité dans 12 des 70 stations prospectées, le second seulement dans 4 d'entre elles. Ainsi, le risque de la transmission de maladies par les phlébotomes reste présent dans l'agglomération d'Athènes.

occurred in the vicinity of quarries. According to Veterinarian Services leishmania infections in dogs are common in the region. Tzamouranis *et al.* (1984), succeeded in isolating the parasites causing human and canine VL, and identified them as *Leishmania infantum*.

According to Rioux *et al.* (1977), the principal determinant of the focus of leishmaniasis in the Mediterranean region is the vector. Therefore, the presence and abundance of certain sandfly species in an area could indicate the occurrence of this parasitic infection. Twelve sandfly species, in 2 genera and 5 subgenera, are known to be present in Greece (Léger *et al.*, 1986). The sandflies in the region of Athens were studied in the 30's by Cardamatis (1931), Caminopetros (1934; 1935) and Adler and Theodor (1935). After World War II two additional studies were undertaken to evaluate sandfly density after the extensive spraying with residual insecticides to control anopheline mosquitoes (Hertig, 1949; Hadjinicolaou, 1958). All these studies were limited to a few localities in the Greater Athens area and were of short duration, mainly conducted in July and



Fig. 1. – Stations in which the survey was carried out in the Greater Athens region.

August. In addition, the extensive construction and expansion of the city to the foothills of the surrounding mountains and the hills inside it, due to the rapidly increasing population, resulted in a highly modified landscape in the last 35 years, which undoubtedly changed the distribution of sandflies.

In this paper the results of an extensive survey on the sandfly population carried out in Athens, Piraeus and their suburbs, during the period May-October 1992, are presented.

STUDY AREA

The Greater Athens region, consisting of the cities of Athens, Piraeus and their suburbs, is part of the prefecture of Attica. The study area is situated between 37°47'-38°05' N and 23°36'-23°50'E. It belongs to the pronounced mesomediterranean bioclimatic zone (Mavrommatis, 1980). It is delimited on the east by Mount Ymittos (1026 m), on the northeast by Mount Penteli (1108 m), on the north-west by Mount Parnis (1413 m), on the west by Mount Aegaleo (452 m) and on the south by the Saronic Gulf. It is a highly built-up area with a large population. About one-third of the total Greek population of 10 millions resides here. During the last years, due to an intense urbanization, the suburbs have been expanded on the slopes of the mountains surrounding the city.

Seventy (70) stations, situated at between 20 m and 300 m altitude and distributed in the following 4 transects, were selected to sample sandflies. The transects were selected in such a way as to reach the foothills where most of the cases of VL have occurred (Fig. 1).

East transect (27 stations): On the southeast slopes of Mount Ymittos.

West transect (31 stations) : On the southwest slopes of Mount Aegaleo.

Center 1 transect (6 stations) : On and around the hill of Tourkovounia (337 m).

Center 2 transect (6 stations) : On and around the hill of Philopappou (160 m) and the rock of Acropolis.

The distance between two neighbouring stations varied from 300 m to 3 Km.

MATERIAL AND METHODS

The survey was carried out from May to October 1992. The preparatory steps for this study were conducted during the month of May. In this month, the study was limited to the east and center 1 transects. In June, it was expanded to

include the rest. The stations were visited once per month.

Sandflies were caught by the use of castor-oil treated paper sheets (21×29.7 cm). A total of 6050 castor-oiled treated paper sheets were set and 5830 of them were recovered (losses 3.6%). The sticky traps (10 to 20 traps/station) were placed into any potential sandfly breeding or resting site (holes or cracks in dry walls, buttresses or rocks; spaces in stone walls; pipes of buildings, gardens or park walls). This sampling method is considered to be the most suitable for ecological studies on sandflies in a wide area (Rioux *et al.*, 1982). The papers were left in place for 3 days. In the laboratory, the specimens were picked up with a fine paint-brush, washed in 90% ethanol, cleared in Marc-André solution and mounted in Fauré's Gum Chloral for identification.

The identification of male sandflies was based on the morphology of their external genitalia, while the identification of the females was based on the morphology of spermathecae, pharynges and cibaria, according to the descriptions of Léger *et al.* (1986).

To compare the capture results in the different sites, the number of collected sandflies per papertrap (sf/pt) per month and station was calculated. The mean of these monthly values represents the number of sf/pt for the station during the entire period (mean monthly density). We prefer to express the sandfly density as sf/pt rather than as sf/m², a method used by other authors (Rioux *et al.*, 1967; Croset *et al.*, 1977), because the sheets of paper were often put in place folded, twisted or rolled up in the holes and cracks. So, the total available surface of the paper was not always the same in all situations.

RESULTS

A total of 3015 sandflies was collected during the entire period of study. Of these, 75 were so damaged that it was impossible to identify them with certainty. Table 1 shows the identified species, their number and percent of total, percent of females for each species and the number of localities they were found, while Figures 2 to 4 show their distribution and maximum monthly density (number of sf/pt observed in the month of the highest density).

All but 6 stations were positive, at least once, for sandflies. *Phlebotomus neglectus* was the most widespread species (Fig. 3). *P. papatasi* and *S. minuta*, present in more than 50% of all the stations, as well as *P. tobbi*, present in about 40% of them, had a rather even distribution (Figs. 2, 3 and 4). *P. simici* and *P. alexandri* were totally absent from the stations

MOUNT
PENTELI



Fig. 2. - Distribution and maximum monthly density of *Phlebotomus (Phlebotomus) papatasi* (\triangle), *P. (Paraphlebotomus) alexandri* (\square) and *P. (Paraphlebotomus) sergenti* (\circ).
 Legend : max monthly density (\triangle \square \circ) < 0.25 sf/pt. (\triangle \square \circ) 0.25-1 sf/pt. (\blacktriangle) > 1 sf/pt.

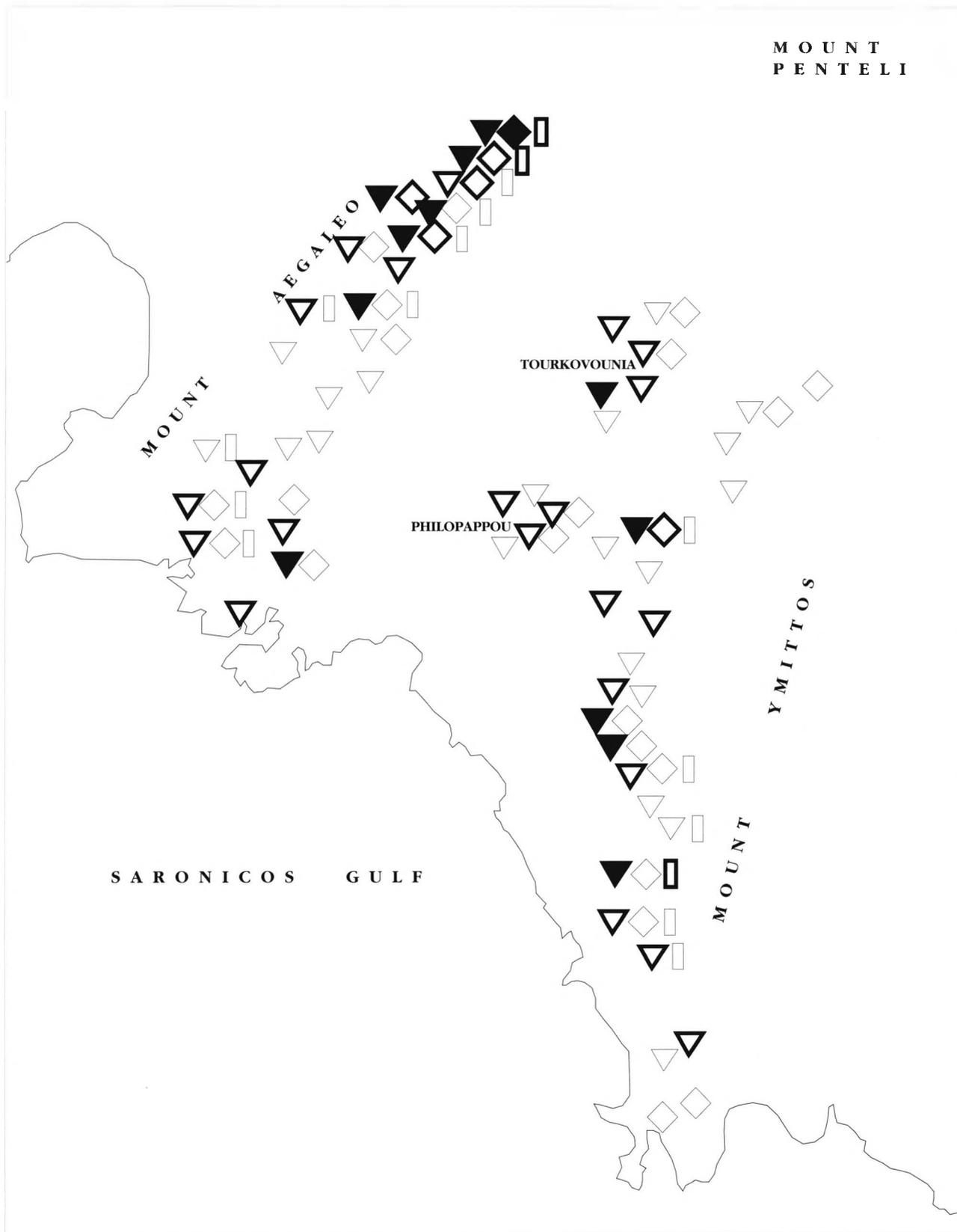


Fig. 3. – Distribution and maximum monthly density of *Phlebotomus (Larroussius) neglectus* (▽), *P. (Larroussius) tobbi* (◇) and *P. (Alderius) simici* (□).
 Legend : max monthly density (▽◇□) < 0.25 sf/pt, (▽◇□) 0.25-1 sf/pt, (▼◆) > 1 sf/pt.

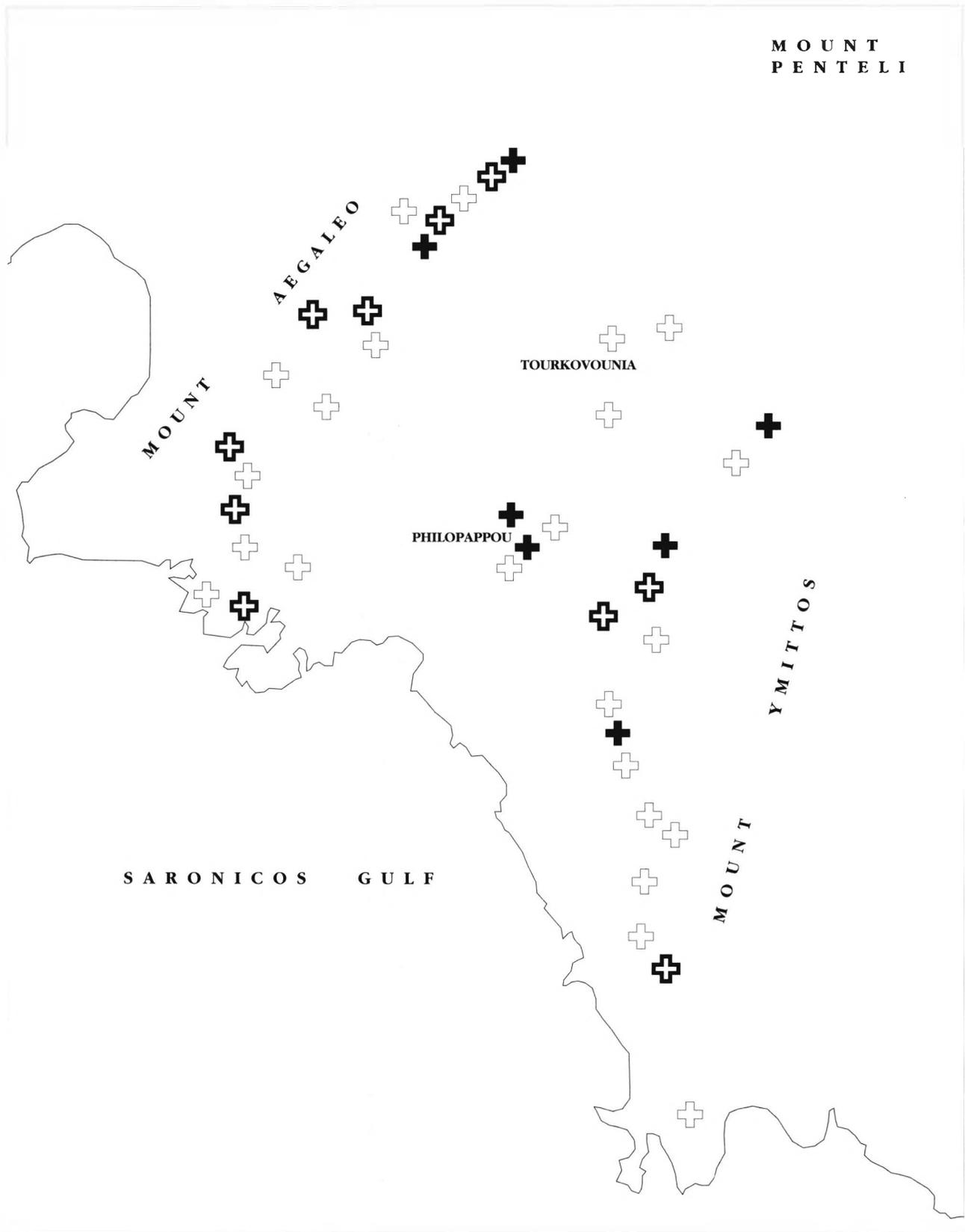


Fig. 4. – Distribution and maximum monthly density of *Sergentomyia (Sergentomyia) minuta*.
 Legend : max monthly density (☐) < 0.25 sf/pt, (◐) 0.25-1 sf/pt, (●) > 1 sf/pt.

of the center transects and generally had an uneven distribution (Figs. 2 and 3). *P. sergenti* was found only in 3 stations. The sex ratio of the captured specimens was strongly in favour of males, especially for *Phlebotomus* spp. (Table I).

A high variability was observed concerning the number of sf/pt in the various stations. The mean number of sf/pt was similar for the east and west transects. However, the mean number of *Phlebotomus* spp./pt was higher in the west transect and that of *Sergentomyia* sp./pt in the east transect (Table II). The former is due to the relative abundance of *Phlebotomus* spp. in the stations in the north part of the west transect (2.2-6.4 sf/pt), while the latter is attributed to the abundance of *Sergentomyia minuta* in the station Y20 (14.8 sf/pt).

The seasonal activity of *Phlebotomus* spp. was bimodal and reflected in some way the seasonal activities of the three most numerous members of the genus in this region, i.e. *P. neglectus*, *P. tobbi* and *P. papatasi* (Fig. 5). The two peaks of activity for *P. neglectus* were in June and in October, while the peaks for *P. papatasi* were in July and in September. The bimodal activity of *P. tobbi* was not pronounced; and for this species too, a significant drop was observed in August. *P. simici* showed a rather unimodal activity with a maximum in June. The number of captured *P. alexandri* and *P. sergenti* was not large enough to draw conclusions. *S. minuta*, the only representative of the genus *Sergentomyia*, had its maximum activity in September.

DISCUSSION

This is the first extensive and full-season study on sandflies that has ever been carried out in an urban and peri-urban environment in Greece.

P. papatasi represented about 1/5 of the collected specimens and was found in more than 50% of the sampled localities. This species appeared to be much more common in this study than in previous ones conducted by the same method in different parts of Greece, except eastern Crete and Karpathos (Léger *et al.*, 1979; Pesson *et al.*, 1984; Léger *et al.*, 1992; Pesson *et al.*, 1993). This scarcity may be due to the low number of domestic sites explored by these researchers. It is noteworthy that in studies done in Athens before and after the anti-malaria residual insecticide campaign, *P. papatasi* was the only or the main species present in Athens (Caminopetros, 1934, 1935; Hertig, 1949; Hadjinicolaou, 1958). The extreme abundance of this anthropophilic species in these

early studies is probably due to the limited number of localities explored and to the different procedures of collection used (mainly manual capture, often done on the internal walls of houses). The anthropophilic and domestic behaviour of this species was noted in Yugoslavia where *P. papatasi* represents 80-90% of the captures in houses but only 20% of the captures in stables and chicken-coops (Simic, 1951).

P. papatasi is considered to be the main vector of *Leishmania major* and sandfly fever. However, *L. major* has never been isolated from sandflies, dogs or man in Greece. *P. sergenti*, which had been incriminated as the main vector of *L. tropica* in Crete (Adler *et al.*, 1938), was very rare in our study. The scarcity of this species could explain the absence or very low frequency of cases of cutaneous leishmaniasis in the Athens Basin.

The absence of *P. alexandri* and *P. simici* from the highly urbanized center transect is interesting. In Southern Morocco this species is chiefly present outside the concrete settlements in wild areas (Rioux *et al.*, 1984), in agreement with our results.

P. neglectus, the most common species in our study, was suspected as a vector of visceral leishmaniasis in Athens because of its abundance in the vicinity of the Pasteur Institute, where several cases of infantile kala-azar occurred (Adler and Theodor, 1935). It is also the only sandfly species from which a *Leishmania infantum* has been isolated in Greece (Léger *et al.*, 1988; Garifallou *et al.*, 1989). Thus, it appears to be the best candidate for the transmission of VL in the metropolitan area. The other member of the subgenus *Larroussi* in Athens, *P. tobbi*, was less abundant than *P. neglectus* and is probably less important in the transmission of VL in the region. *P. tobbi* was experimentally infected with *L. infantum* and was considered as the probable vector of this parasite in Cyprus (Adler, 1945).

S. minuta is the only species of the genus *Sergentomyia* present in Athens. *S. dentata*, often more abundant than *S. minuta* in other parts of Greece (Léger *et al.*, 1979; Pesson *et al.*, 1984), has never been collected in the region of Athens.

The unimodal seasonal activity of *S. minuta* with its peak in late summer was also observed in Tunisia, while the bimodal activity with two peaks in spring and autumn of *P. neglectus* and *P. tobbi* is similar to the activity of two other species of the subgenus *Larroussi*, *P. perniciosus* and *P. perfiliewi*, present in that country (Croset *et al.*, 1978).

The results of our study indicate that there exist significant foci of sandfly breeding in the Greater Athens area. The vectors of VL (*P. neglectus*, *P. tobbi*) and sandfly fever (*P. papatasi*) are distributed widely and

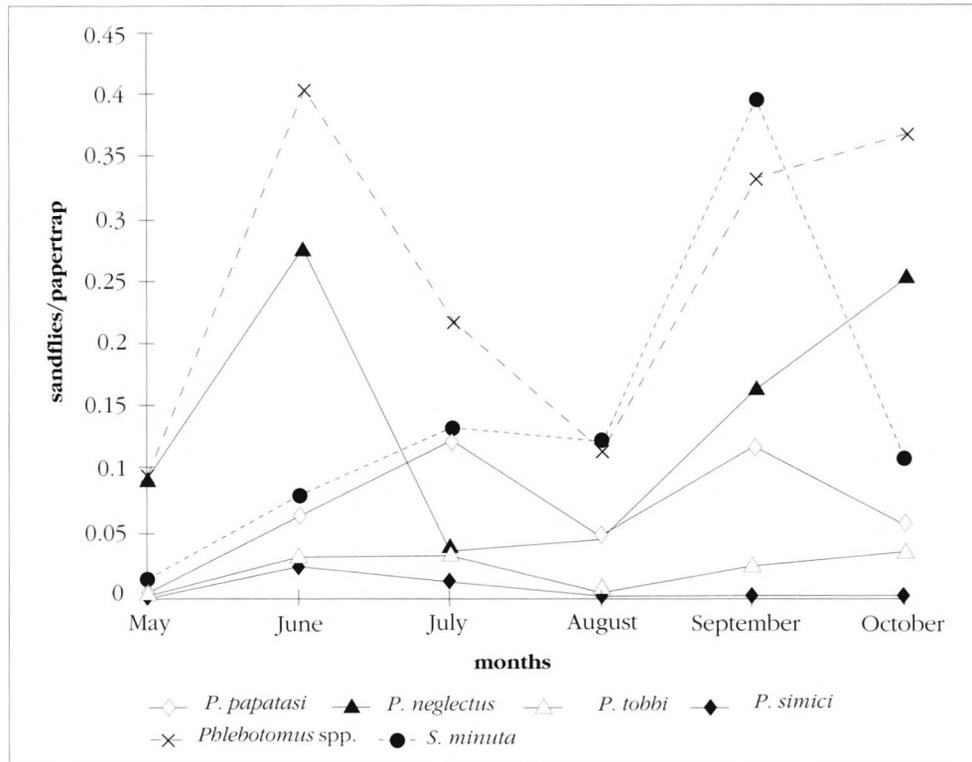


Fig. 5 – Fluctuations in seasonal density of sandflies in the Greater region of Athens.

SANDFLY SPECIES	Nbr sf	%	♂♂	♀♀	♀/ (♂+♀)	Nbr local.
<i>Phlebotomus (Phlebotomus) papatasi</i>	541	34.1	414	127	0.23	40
<i>Phlebotomus (Paraphlebotomus) alexandri</i>	30	18.4	28	2	0.07	9
<i>Phlebotomus (Paraphlebotomus) sergenti</i>	13	6.2	10	3	0.23	3
<i>Phlebotomus (Larrousius) neglectus</i>	1002	1.7	915	87	0.09	55
<i>Phlebotomus (Larrousius) tobbi</i>	182	1.0	163	19	0.10	27
<i>Phlebotomus (Adlerius) simici</i>	50	0.4	46	4	0.08	16
<i>Sergentomyia (Sergentomyia) minuta</i>	1122	38.2	747	375	0.33	40
Total	2940	100.0	2323	617	0.21	64

Table I. – Sandfly species of the Greater Athens region

Legend : Nbr sf, number of sandflies; %, percentage on the total number of collected specimens; ♂, number of males; ♀, number of females; ♀/(♂+♀), proportion of females; Nbr local., number of localities they were found

SANDFLY SPECIES	MEAN MONTHLY DENSITY				Athens Total
	West transect	East transect	Center 1 transect	Center 2 transect	
<i>Phlebotomus (Phlebotomus) papatasi</i>	0.072	0.136	0.006	0.015	0.090
<i>Phlebotomus (Paraphlebotomus) alexandri</i>	0.011	0.001	0.000	0.000	0.005
<i>Phlebotomus (Paraphlebotomus) sergenti</i>	0.005	0.000	0.002	0.000	0.002
<i>Phlebotomus (Larrousius) neglectus</i>	0.129	0.208	0.169	0.131	0.168
<i>Phlebotomus (Larrousius) tobbi</i>	0.018	0.052	0.007	0.004	0.031
<i>Phlebotomus (Adlerius) simici</i>	0.007	0.015	0.000	0.000	0.009
Total <i>Phlebotomus spp.</i>	0.241	0.413	0.183	0.150	0.304
<i>Sergentomyia (Sergentomyia) minuta</i>	0.264	0.112	0.018	0.252	0.175
Unknown	0.009	0.017	0.005	0.014	0.013
Total	0.514	0.542	0.207	0.416	0.492

Table II. – Mean monthly density of the collected sandflies, per transect and total, for the period June-October 1992.

thus the potential exists for transmission of these diseases under some circumstances. We believe that the risk is greater on the outskirts of the city and less in the central part where urbanisation and pollution have created unfavourable conditions for the survival of sandflies.

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