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## SPECIES COMPOSITION AND ABUNDANCE OF SANDFLIES AT NATURAL DESERT AND MODIFIED AGRICULTURAL LANDS AT NEKHEL, SINAI, EGYPT

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Running head: Sandfly composition and abundance at different habitats

Key words: Sandflies, habitat diversity, species composition, abundance, Egypt.

### ABSTRACT

The impact of landscape modification on the sandfly community and abundance was assessed at Nekhel, northern Sinai, Egypt. Two *Phlebotomus* and two *Sergentomyia* species were collected from the natural habitat, while four *Phlebotomus* and only one *Sergentomyia* species were collected from the agriculturally modified site. Significantly more sandflies ( $T= 4.6, P< 0.005$ ) were consistently captured, using oiled paper traps, at the natural habitat during the study period. Densities of *P. papatasi*, the vector of cutaneous leishmaniasis in Sinai, varied between 3 fly / trap to 29 fly / trap and between 2 fly / trap to 6 fly / trap at the natural and modified habitats respectively. The highest densities were observed during September. Sex ratios of sandflies were male biased in both habitats. Landscape modification for agricultural development was believed to have affected sandfly species composition and densities. Irrigation and new diverse agricultural crops may support a greater diversity of sandfly species, particularly those with anthropophilic / anthropophagic tendencies.

### INTRODUCTION

Eight different anthrophagic sand fly species are reported from Sinai Peninsula, Egypt (Lane, 1986; El Sawaf *et al.*, 1987). Six of those species are either proven or suspected vectors of leishmaniasis (WHO, 1990). Entomological studies carried out in Egypt proved that *Phlebotomus papatasi* is the vector of zoonotic cutaneous leishmaniasis (ZCL) in Sinai (Fryauff *et al.*, 1993).

Distribution of ZCL in Sinai appears to be focal and disease prevalence varies from one area to another (Faris *et al.*, 1988; Fryauff *et al.*, 1993). Geographic proximity to sandfly habitats usually determines levels of human exposure. The risk of ZCL infections is mostly higher at the peripheries of villages or at sparsely inhabited areas (Faris *et al.*, 1988). Land use and modification of natural

habitats are among the most important factors contributing to alteration in sand fly population densities and disease risk (Yuval, 1991; Fryauff *et al.*, 1993; Mbarki *et al.*, 1994).

The government of Egypt is systematically carrying out a land reclamation program to develop desert areas mostly on the eastern and western fringes of the Nile Delta and along the valley, for expansion of agricultural lands. Currently, work is also underway to reclaim some 400,000 acres in the northern and eastern parts of Sinai. Water from the Nile mixed with agricultural drainage water, will be used for irrigation of these areas in north and central Sinai. Large scale construction work is in progress to provide irrigation/drainage networks and other required infrastructure to these areas.

Modification in existing land use represents the beginning of a dynamic process of ecological change associated with demographic variation and alteration in vector species composition and abundance (PEEM, 1988). In fact, physical disturbance specifically alter the availability of vector breeding sites and the opportunities for human-vector contact. This seems particularly apparent at the margin between development and an established environment. Procedures for survey of margins, and for monitoring changes in relation to vector population dynamics would provide baseline information on potential impacts of such physical disturbance. This information could be delivered to health authorities to be incorporated into development planning. The aim of the present study is to investigate the effect of landscape modification induced by agricultural development in northern Sinai on sandfly species composition, and

abundance.

## MATERIAL AND METHODS

### Study sites

The present study was carried out at a site (N 29° 54' E 33° 42') located some 4 Km to the west of Nekhel, northern Sinai Governorate, along the road leading to Cairo. The Cairo road forms a corridor through the matrix representing the undisturbed desert habitat of the study area. To the south of that corridor lies an area of 1.5 hectare which has been modified by intensive agriculture of almond trees, melons (cantaloupe), watermelon and grapes. Currently, irrigation is provided mainly by water pumped out from deep wells and occasional rainfall. Natural vegetation of the desert habitat is dominated by *Corchorus* sp., *Atriplex* sp., *Schonginia* sp. and *Tamarix* sp. (shrubby sp.). No physical structures exist in this area except for a small primitive hut built from hay and trunks of palm trees, in which four farmers live. No domestic animals were kept / raised at the site. The study area is characterized by an annual mean of daily air temperature of 20 °C, relative humidity of 50 % and an annual mean of precipitation of 50 mm (Egyptian Meteorological Authority, 1996).

Nekhel has a population of about 1500; mostly bedouins working in government offices, small businesses and agriculture. No information exists on CL in the study site. However, during initial surveys in Nekhel itself, four human cases were observed among people working for the government agricultural authority, having many skin lesions indicating infection with CL.

### Sandfly collection

Sandflies were collected for 1-2 nights each month during the period

July-September 1997 which falls within the peak period of sandfly density (Merdan *et al.*, 1992; Fryauff *et al.*, 1993). Sandflies were collected using sticky paper traps (21.5 x 16.5 cm) well coated with castor oil from both sides. Oil coated papers were held by 30 cm long wooden sticks and placed 15-20 cm above the soil. Fifty traps were placed at fixed locations in the vicinity of rodent burrows each trapping night to provide monthly measures of species composition, density, and sex ratio.

#### Rodent collection

Rodents were trapped, each sampling night, using wire box traps with spring doors. The traps were thoroughly cleaned with soap and water before each use. Traps were baited with tomatoes and placed adjacent to burrow entrances. Ten rodent traps per site/sampling night were set prior to sunset and checked shortly after sunrise. Collected rodents were identified using the key adapted by Osborn and Helmy (1981).

#### Statistical analysis

A student T-test was used to assess the differences in sandfly abundance and sex ratio among habitats.

## RESULTS

#### Sandfly collection

Sandflies were captured at both the natural and modified habitats with consistently greater numbers being captured at the former habitat. The total number of flies captured at the natural habitat (N = 2483) was over four-fold greater than that collected at the modified (N = 558) (T = 4.604, P < 0.005). Sandfly activity was evident during the whole study period, with fly numbers increasing continuously from July to September in both habitats. The increase in fly numbers observed during September coincided with

relatively lower maximum temperature (31 °C), minimum temperature (17.5 °C) and higher relative humidity 50 %.

Six sandfly species were captured during the present study. At the natural habitat, two *Phlebotomus* sp. and two *Sergentomyia* sp. were captured while at the modified habitat, four *Phlebotomus* sp. and only one *Sergentomyia* sp. were collected (Fig 1 a & b). *Phlebotomus papatasi* was captured during July to September and constituted 97% and 99 % of the collected flies at the modified and natural habitats respectively. At the natural habitat, both *P. kazeruni* (0.3%) and *S. antennata* (0.6%) were captured throughout the study period whereas *S. fallax* (0.1%) was captured during August and September only. At the modified habitat, *P. kazeruni* accounting to 1.4% of total flies was captured during July and September while *P. sergenti*, *P. alexandri* and *S. antennata*; collectively constituting 1.7% of total collection; were captured only during September. Thus, the greatest sandfly species diversity appears to be evident during August and September at the natural habitat and during September for the modified habitat.

A gradual increase in sandfly densities (number of sandflies / paper trap) was observed from July to September (Fig 1), and such increase was more pronounced at the natural habitat. Sandfly densities did not vary greatly between the two habitats during July, however, densities at the natural habitats were almost 7-fold and 5-fold greater than at the modified habitat during August and September, (Fig 1).

Densities of *P. papatasi*, followed the same trend. During July, densities of *P. papatasi* in both habitats were similarly low ( 2-3 fly / paper trap). Density continued to increase at the natural habitat during August to reach

ca. 17 flies / trap, while it remained the same at the modified habitat. A sharp increase in *P. papatasi* densities was observed in September where it reached almost 30 fly / trap and 6 fly / trap at the natural and modified habitats respectively.

#### Sex ratio

Sex ratio of sandfly populations was male biased, and more so in the modified habitat (1.5-fold higher). However, the number of males collected from the natural (N= 1378) was significantly higher than those collected from the modified habitat (N= 394) (T = 6.04, P<0.005). The sex ratio of *P. papatasi* was also uneven; males usually outnumbered females by 2-3 folds in both habitats. Only during September that males and females had almost equal numbers (male : female ratio = 0.97) at the natural habitats. The low numbers of other fly species did not allow solid sex ratio calculations.

#### Rodent collection

Observations made during field surveys indicated that rodent burrows were more abundant and homogeneously distributed all over the natural habitat, while in the modified habitat, burrows were few and spatially restricted beneath trees. During the study period, only three rodents were collected; one from the natural habitat (*Dipodellus* sp.) and two (*Meriones sacramenti* and *Gerbillus andersoni*) from the modified habitat.

### DISCUSSION

Sandfly composition and abundance show great variability relevant to land use/landscape change. Such changes were spatially confined to the modified patch although it shares the edge with the natural habitat.

The presence of more

*Phlebotomus* species at the modified site may be influenced by the presence of extensive vegetation cover, moistened soil due to irrigation, and human host. This indicates that these species are ecologically more resilient and adapted to landscape change or that they prefer more moist soils (irrigation). This finding supports earlier observations suggesting that the presence of some sandfly vectors is not adversely affected by changes in the original landscape (WHO, 1990). The presence of more *Sergentomyia* species with high frequency of collection at the natural habitat generally corroborates El Sawaf *et al.* (1987) results that this species preferred wild habitats. During the present study, *P. alexandri*, *P. kazeruni* and *P. sergenti* were collected for the first time above latitude N 28°41', and thus represent a northward extension of their geographic range from southern Sinai. These results draw the attention to the potential importance of *P. kazeruni* and *P. sergenti* as vectors of CL in that area since they appear to tolerate land use change, and were reported as suspected vectors of leishmaniasis elsewhere (WHO, 1990).

The sharp reduction in sandfly densities induced by landscape modification confirms earlier reports of WHO (1990). At the modified site, routine agricultural activities following the original landscape modification induce dynamic impact on sandflies by the continuous disturbance of their breeding habitats, probably reducing their numbers. In fact, rodent burrows which represent the main breeding sites of sandflies were found to be few and spatially restricted around and beneath shrubs and trees. In contrast, rodent burrows are distributed all over the area of the natural site and their numbers are far greater than those at

the modified site providing larger areas for sandfly breeding with expected increase in the population densities. Whether the presence of undisturbed and more breeding area at the natural site is the sole cause in sandfly numbers is uncertain. The few rodents collected during this study do not allow detailed discussion of this matter. Of the rodents collected, only *Meriones sacramenti* was reported to be naturally infected (Morsy *et al.*, 1993; El Hossary, 1998). *Gerbillus andersoni* was collected from a ZCL endemic focus in north Sinai, but was not incriminated as a reservoir (Fryauff *et al.*, 1993). The status of *Dipodellus* sp. is not yet known.

Sex ratios of sandfly populations observed during the present study were highly male biased, and significantly more so in the modified habitat. Similar findings were reported previously in certain habitats of the Jordan Valley (Yuval, 1991). The author suggested that the larval environment may be responsible, as it may differentially prejudice survival of either sex. For example, Hard *et al.* (1989) reported that in some mosquitoes larval competition for food biased the sex ratio in favour of males. The lower number of breeding sites encountered in the modified habitat during this investigation may well induce such a competition with subsequent alteration in original sex ratios. Also, females may be determining the sex ratio of their offspring according to environmental cues and stresses (e.g. landscape modification) perceived at some crucial period before fertilization (e.g. Austad and Sunquist, 1986).

The observed monthly pattern of sandfly densities is similar to that reported earlier in Sinai (Fryauff *et al.*, 1993) and Jordan (Janini *et al.*, 1995). The recorded densities of *P. papatasi*

at the natural habitat is comparable to those of a highly endemic site reported by Fryauff *et al.* (1993) in northern Sinai. Such densities (> 15 flies/trap), far exceed any levels that have been reported from endemic foci in Israel (Schlein *et al.*, 1982). This may shed the light on the potential risk of CL around the peripheries of modified habitats, since a temporal association between *P. papatasi* abundance and prevalence of CL was reported (Janini *et al.*, 1995). A similar relationship was also reported earlier by Dye (1988). However, the risk level is further dependent on the role of the peridomestic rodent population as reservoirs. As *Meriones sacramenti*, collected during this study, was previously incriminated as CL reservoir in the area (Morsy *et al.*, 1993; El Hossary, 1998), ZCL might be established at the peripheries of such habitats. In fact, in many villages and cities of various countries including Egypt, the infection rate has been reported to be highest among people living at the edge of natural foci (e.g. desert), close to the sylvatic cycle. The transmission rate decreased rapidly as the distance from the focus increased, because of the limited dispersal of sand flies (WHO, 1990). Consequently, based on the results of the present investigation and those reported earlier (Faris *et al.*, 1988; WHO, 1990), it appears that the risk of ZCL is greater at the edge of modified patches. Sandflies dispersal potential may also play a role in determining ultimate risk as it would influence flies' movement between natural and modified habitats.

Accordingly, it is recommended to plan for a buffer zone around the peripheries of land plots to be developed within a natural habitat to protect people against the risk of ZCL in Sinai. The extent of such buffer

zones should be spatially determined based on accurate estimates of sandflies dispersal range measured at target areas.

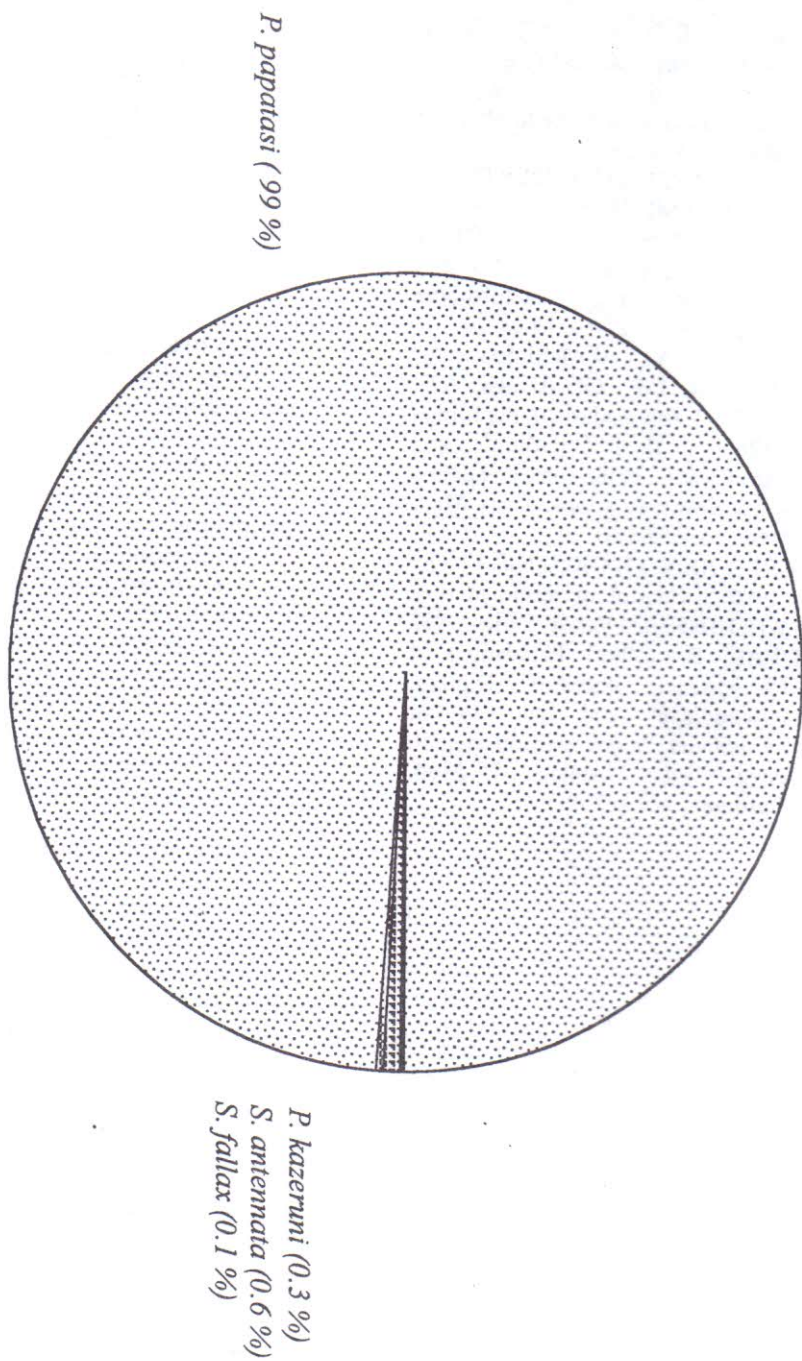
### ACKNOWLEDGEMENTS

This work was supported by the Research and Training Center on Vectors of Diseases (RTC), Ain Shams University, Cairo, Egypt. The authors thank the RTC field team for their effort during this study.

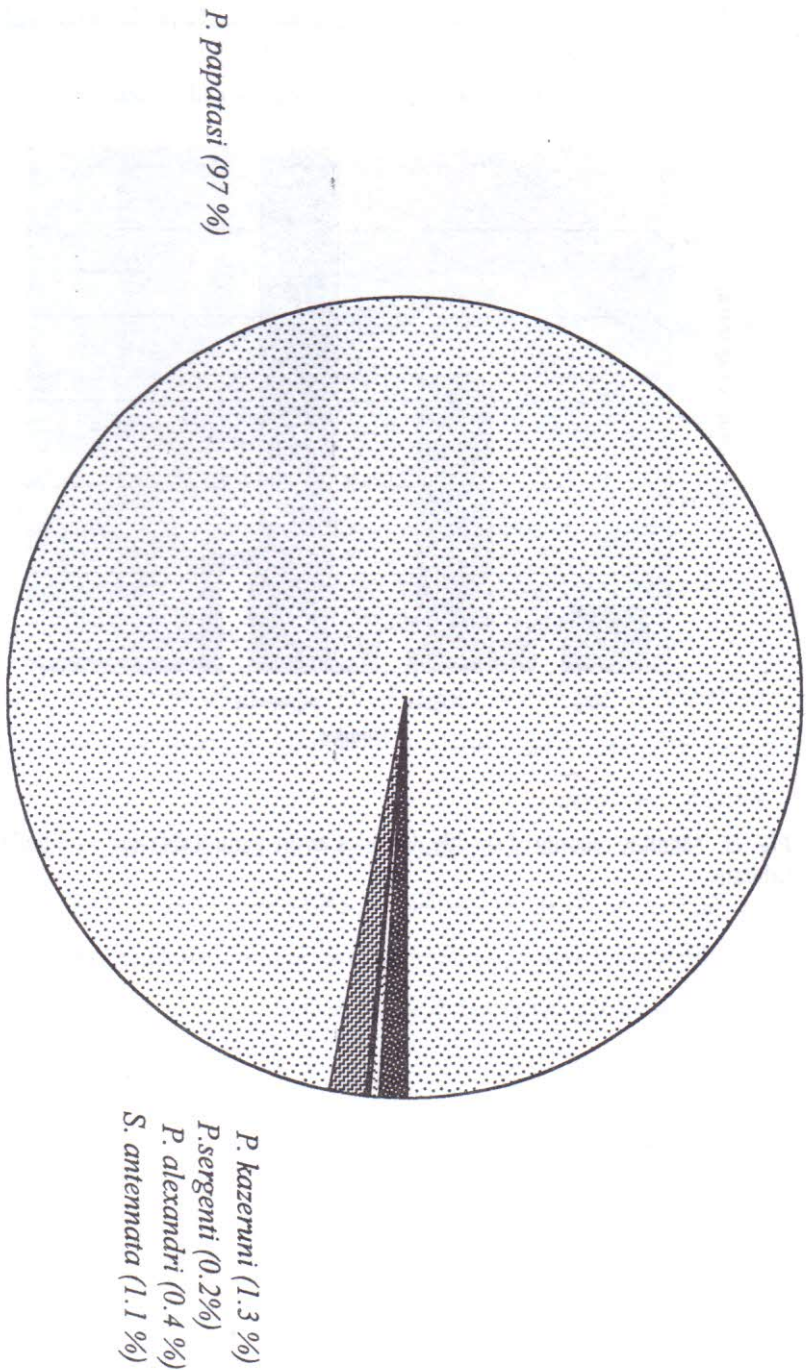
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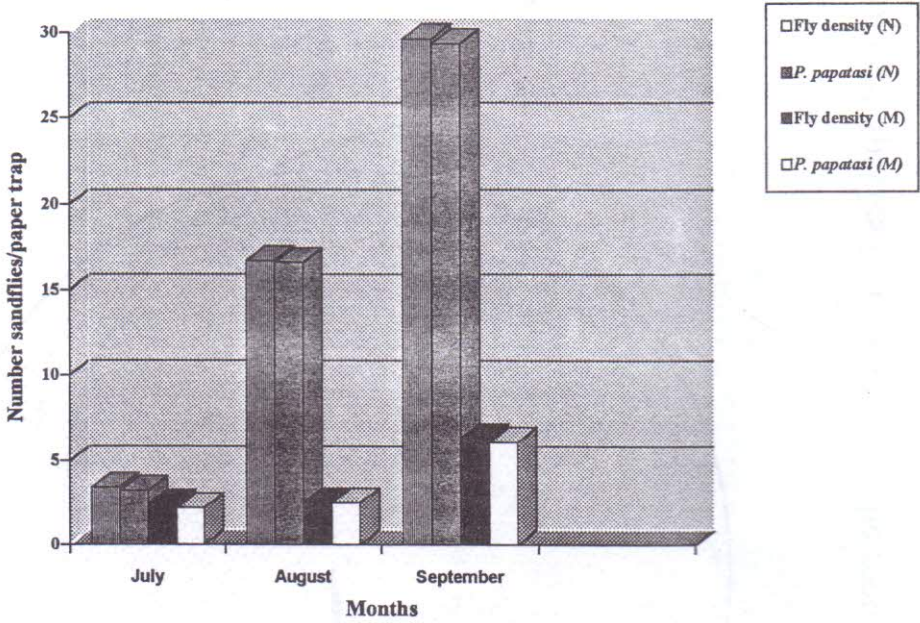
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**Fig. 1. a.** Sandfly species composition at the natural habitat



**Fig 1. b.** Sandfly Species Composition at the modified habitat



**Fig. II.** Monthly records of sandfly densities at the natural (N) and modified (M) habitats.