

PUBLIC HEALTH

The Population Ecology of *Muscina stabulans* (Fallén) (Diptera: Muscidae), along an Urban-Rural Gradient of Buenos Aires, ArgentinaLUCIANO D PATITUCCI^{1,2}, PABLO R MULIERI^{1,2}, JUAN C MARILUIS^{1,2}, JUAN A SCHNACK^{1,3}¹Consejo Nacional de Investigaciones Científicas y Técnicas, Buenos Aires, Argentina²ANLIS "Dr C Malbrán", Depto Vectores, Av Vélez Sarsfield 563, CP 1281, Buenos Aires, Argentina; lpatitu@yahoo.com.ar; mulierii@yahoo.com; jcmartiluis@anlis.gov.ar; vectores@anlis.gov.ar³División Entomología, Facultad de Ciencias Naturales y Museo, Univ Nacional de La Plata, Paseo del bosque s/n, CP 1900 La Plata, Buenos Aires, Argentina; js@netverk.com.ar

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ABSTRACT - The false stable fly, *Muscina stabulans* (Fallén), was surveyed along an urban-rural gradient at Almirante Brown, Buenos Aires province, Argentina. Samples were taken at monthly intervals from May 2005 to April 2007. Hourly captures of adult flies (10:00 am – 04:00 pm) were taken at each sampling date with a hand net. The baits used were 250 g of rotten cow liver and 250 g of fresh dog faeces exposed in shaded and sunny areas. The entire sample accumulated 358 specimens. The number of specimens captured during the second year was higher than in the first year. *Muscina stabulans* was more abundant at urban-suburban sites. Females showed significant preferences for cow liver. We caught more specimens in shaded areas. The hourly activity increased toward the afternoon at the three sites. The present work was the first ecological study related to a muscid species in Argentina.

KEY WORDS: False stable fly, bait preference, heliophily, urbanization

The physical changes along the urban-rural gradient including increase in human density, urbanization, pollution, and other perturbations attributed to human intervention on environment produce natural habitat loss (McKinney 2002). These changes promote an increase in environmental aridity, air turbidity, and heat production, all of which make cities warmer than rural and wild environments (Gottschalk *et al* 2007). The disturbed habitat at the urban core provides new opportunities for non-native species because they can utilize new and different resources. These species well adapted to altered environments are frequently regarded as "urban exploiters" (McKinney 2002).

Muscina stabulans (Fallén), the false stable fly, is a cosmopolitan species, very common in the Neotropics (Carvalho & Couri 2002, Carvalho *et al* 2005). In Argentina, its geographical range includes Salta, Buenos Aires, Tucumán (Shannon & Del Ponte 1926) and Río Negro (Malloch 1934) provinces. This species often inhabits filthy habitats, including latrines, and household wastes, as well as with habitats created by agriculture (Queiroz & Carvalho 1987) and other human activities like live stock manure and wastewater treatment plants (Laos *et al* 2004). Some reports have determined the negative economic impact of this fly on dairy farms and on poultry industries (Perotti & Brasesco 1996, Avancini & Silveira 2000). In Argentina, the false stable fly has been found in poultry farms in southeast Buenos Aires province (Perotti & Brasesco 1996), and has been associated to composting of biosolids in Rio Negro province

(Laos *et al* 2004). Recent findings revealed its importance in the field of forensic entomology (Oliva 2007).

Flies contact with food incorporates additional risks by mechanical transport of food borne pathogens (Greenberg 1971). Each female may lay from ca. 140 to 200 eggs, over the food it spends. Larvae exploit temporarily irregular and ephemeral resources (James 1947) and their development time is directly correlated to ambient temperature (Mascarini & Prado 2002). Their role as producers of traumatic miasis in animals (James 1947) and gastrointestinal diseases have concerned regulatory agencies of sanitation and public health (Graczyk *et al* 2005). A few records of intestinal (DeFoliart & Pelton 1955) and cutaneous myiasis have been recorded for this species (James 1947).

Synanthropic studies of Muscidae in the Neotropical region have examined the relationship between *M. stabulans* and the urban environments (Linhares 1981, Carvalho *et al* 1984, Figueroa-Roa & Linhares 2004). In Argentina, comparative studies of calyptrate flies in several geographical locations have been undertaken only for calliphorids and sarcophagids (Schnack & Mariluis 2004, Mariluis *et al* 2007).

We expected to find higher number of false stable flies at urban site compared to suburban and rural site. The aim of this work was to analyze different attributes of *M. stabulans*, like sex ratio, synanthropy, seasonal and daily numerical changes, bait preference, and heliophily, comparing them along an urban-rural gradient at locations of Almirante

Brown, Buenos Aires province. Furthermore, we aspire that our study might be of value to assess the economical and sanitary potential impacts of this species within the area of influence of the study sites.

Material and Methods

Study areas. The study was carried out in Almirante Brown district, ca. 20 km south of Buenos Aires city and covered three sampling environments: a densely populated urban, a place housing isolate dwellings, and a rural. The urban site (34° 50' 15.02" S – 58° 23' 52.75" W) was placed in the commercial and residential building of the central area of the locality of Burzaco. The suburban site (34° 49' 36.9" S – 58° 24' 16.56" W) was placed in a sector that housed scattered country residences with widespread buildings surrounded by large grasslands, gardens, woodlands, and streets without pavement. The rural site (34° 51' 29.38" S – 58° 23' 17.75" W) was placed in the locality of Ministro

Rivadavia where native vegetation remained, adjacent to compounds dedicated to cattle rising; the place was not influenced by dwellings, roads and other constructions. Vegetation of the rural site included native species of grasslands, herbs, shrubs, and trees (e.g., *Eryngium* spp., *Baccharis* spp., *Celtis tala*, *Parkinsonia aculeata* and *Citrus trifoliata*).

The climate was temperate and humid, as it is expected for the plains in median latitude. We measured temperature and relative humidity in each site and sampling date along the two years surveyed (Fig 1).

Field samples. Muscids are small and very mobile organisms, difficult to sample randomly. Thus sampling methods are mostly based on estimates or counts on aggregation sites, such as fly attracting baits (Muirhead-Thomson 1968). Samples were taken from May 2005 to April 2007 once a month per site. Every sampling date, seven hourly captures of adult flies (10:00 am - 4:00 pm) were collected with a hand net. Two kinds of baits were used: 250 g of rotten cow liver (five days

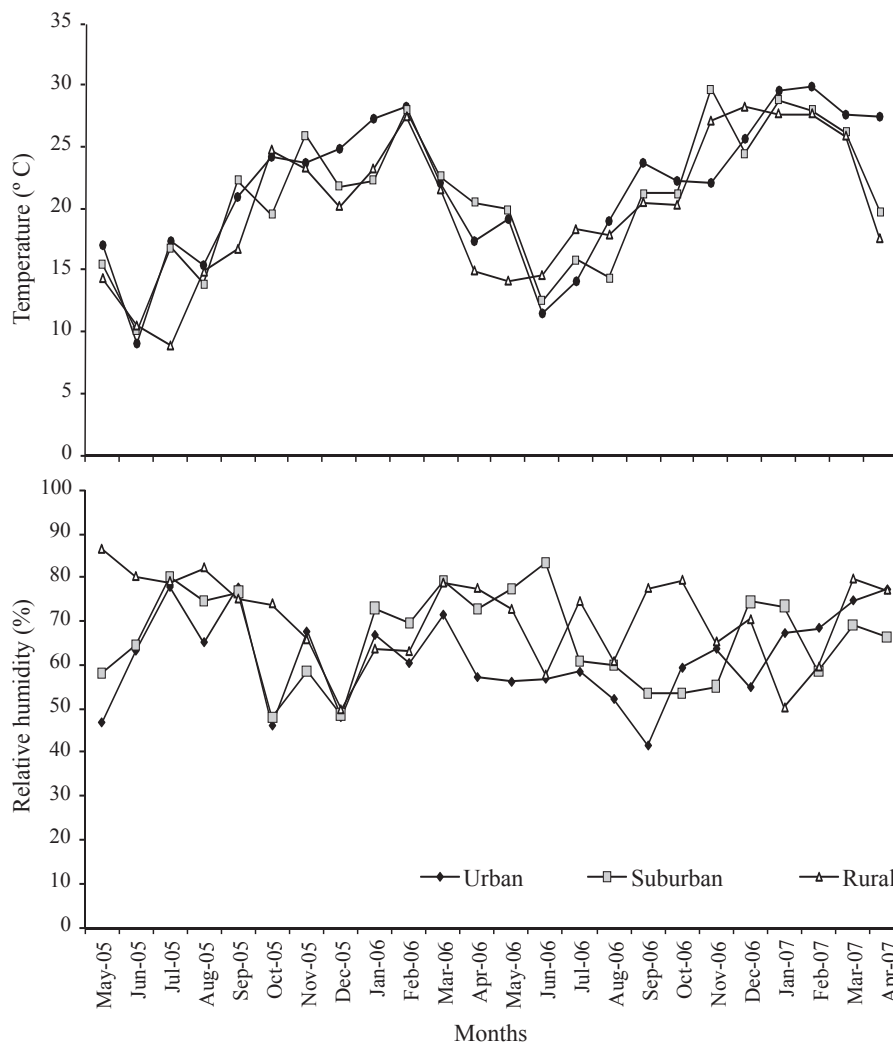


Fig 1 Monthly temperature and relative humidity of a rural, suburban and urban area during ecological study of *Muscina stabulans* (dots represent daily mean value) in Almirante Brown, Buenos Aires province.

aged) and 250 g of dog faeces. The baits were exposed in shaded and in sunny areas for 15 min at each hourly capture. The sampling effort was the same at each site and consisted of four baits per site, two in the shade and two in the sun (one of rotten cow liver and one of dog faeces, in the shade and in the sun, respectively).

Specimens were killed in glass vials with carbon tetrachloride and were stored in the field as described elsewhere (Schnack & Mariluis 2004); once in the laboratory, they were identified using the key of Carvalho & Couri (2002).

The Wilcoxon's test was used to compare the abundance between the two years. The association of the fly abundance with relative humidity and mean temperature at each site was correlated by means of the Spearman rank correlations (Zar 1996).

The degree of species synanthropy was measured by two different methods. We calculated total frequencies per site to obtain the synanthropic index (S.I.) (Nuorteva 1963). This index was compared with the Chi-square analysis. On the other hand, a Friedman's test of variance by ranks was applied to the number of flies per sample, by using the different sampling site (i.e., urban, suburban, and rural) as treatments and sampling dates as blocks. In the latter case, the Tukey procedure was performed for multiple comparisons (Zar 1996). We took into account the sex, baits and sunlight / shaded ratio in order to describe the response of the species. A non-parametric Chi-square test was used to estimate deviations of an expected ratio of 1:1 for each comparison (Zar 1996). We used a regression analysis to describe the hourly activity.

Results

During the two years sampled, a total of 358 specimens were collected at the three studied sites. *Muscina stabulans* occurred in all samples during both years. During the first year (May 2005-April 2006) this species showed the highest number in the summer and in early autumn, whereas during the second year (May 2006-April 2007) the highest abundance was observed in spring and in early summer (Fig 2). The number of specimens captured during the second year was higher than in the first year, but the difference was marginally significant (Wilcoxon test $T = 14$; $P = 0.049$). The correlations between abundance of flies captured and relative humidity and temperature were not significant at urban ($T^\circ: r = 0.097, P > 0.01$; RH: $r = -0.467, P > 0.01$), suburban ($T^\circ: r = 0.468, P > 0.01$; RH: $r = -0.176, P > 0.01$) and rural sites ($T^\circ: r = 0.386, P > 0.01$; RH: $r = -0.420, P > 0.01$).

According to Nuorteva index, *M. stabulans* behaved as a synanthropic species (S.I. = + 68.02). While differences were not remarkable between baits, overall number of flies captured showed significant differences among the studied sites ($\chi^2 = 131.91$ d.f. = 2; $P < 0.001$) (Table 1). Accordingly, mean number of flies per sample differed among the study sites ($\chi^2 = 27.54$ d.f. = 2; $P < 0.001$). While lower numbers per sample were obtained at rural site, urban and suburban sites showed higher numbers and did not show significant differences between them (Table 1). At rural site the number of flies per sample was lower, whereas at urban and suburban sites number was higher and did not show significant differences (Table 1).

The total captures of flies revealed a female biased trend

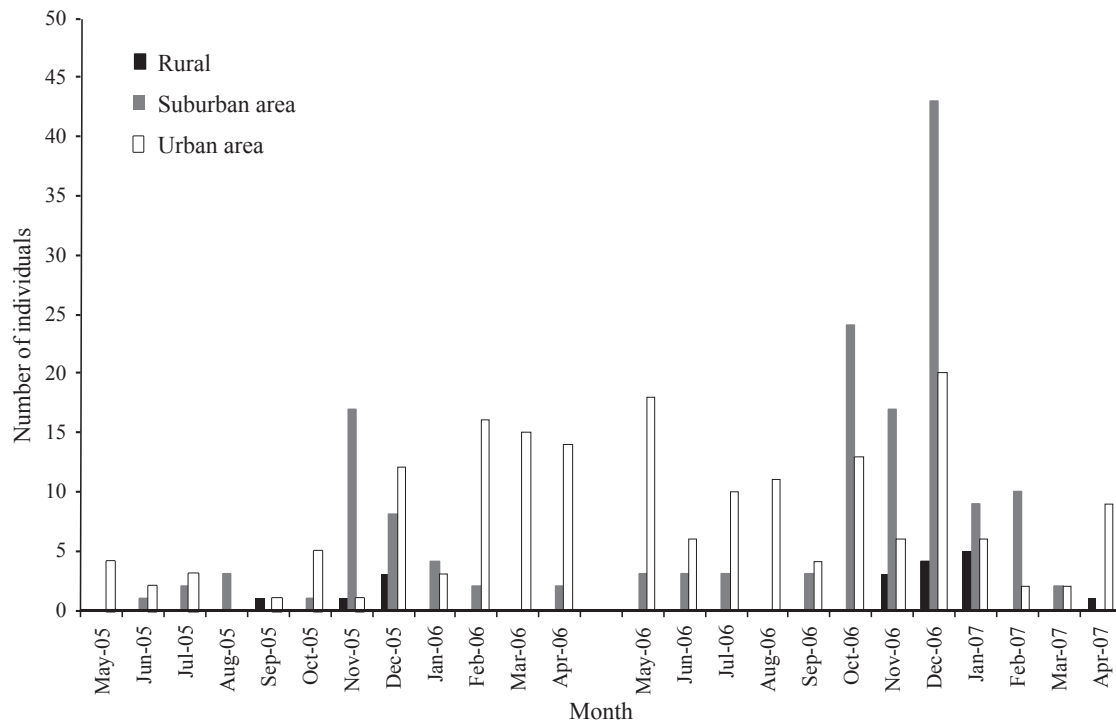


Fig 2 Biannual activity of *Muscina stabulans* at a rural, suburban and urban area (May 2005-April 2007) in Almirante Brown, Buenos Aires province.

Table 1 Frequency and mean number (\pm Std error) of *Muscina stabulans* at the three study sites in Almirante Brown, Buenos Aires province.

	Rural	Suburban	Urban
N°/total	18/358	157/358	183/358
Proportion (%)	5.03	43.85	51.12
Mean number per sample	0.75 \pm 0.29 a	6.54 \pm 2.04 b	7.29 \pm 1.15 b

Different letters indicate significant differences ($P \leq 0.010$).

($\chi^2 = 169.04$ d.f. = 1; $P < 0.001$). In addition, females showed significant preferences for cow liver bait ($\chi^2 = 12.73$, d.f. = 1; $P < 0.001$). Males did not show a preference for either bait.

Muscina stabulans was caught mostly on baits not exposed to the sunlight. This trend was significant in rural ($\chi^2 = 10.89$ d.f. = 1; $P = 0.001$) and suburban ($\chi^2 = 70.22$ d.f. = 1; $P < 0.001$) sites. On the other hand, the urban site did not exhibit significant differences ($\chi^2 = 0.14$ d.f. = 1; $P = 0.711$) (Fig 3).

Hourly activity of *M. stabulans* was quite similar in the three studied sites. While the number of flies captured was markedly lower in the rural site, all sites showed an increase to the afternoon (Fig 4). The overall number of specimens showed a trend to increase from the first (10.00 am) to the last daily sample (4:00 pm) ($F_{(1,5)} = 27.55$; $P < 0.033$) (Fig 5).

Discussion

The present study constitutes the first ecological research dealing with *M. stabulans*. This is also the first survey related to this taxon performed along an urban-rural gradient in Argentina.

The occurrence of *M. stabulans* all year long during the

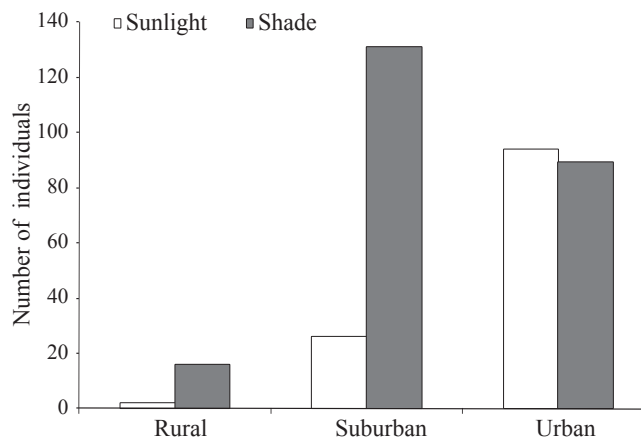


Fig 3 Number of *Muscina stabulans* specimens sampled at sunny and shaded sites of rural, suburban and urban areas the three study sites in Almirante Brown, Buenos Aires province.

two years sampled and its lowest representation during winter are in agreement with former observations (Carvalho *et al* 1984). It is worth pointing out that our samples contained higher number of specimens than those found in Brazil (Carvalho *et al* 1984, Linhares 1981, Mendes & Linhares 1993, 2002), and Chile (Figueroa-Roa & Linhares 2004). Our data agree with previous reported studies, and suggest that *M. stabulans* is mostly associated to the urban-suburban sites than to rural ones. However, the populations we surveyed in Greater Buenos Aires showed, according to Nuorteva Index, a higher degree of synanthropy than in the other South American locations of Brazil (e.g., Curitiba, Campinas) and Chile (e.g., Valdivia) (Carvalho *et al* 1984, Figueroa-Roa & Linhares 2004).

The female biased sex ratio found for this species was also observed in former studies (Mendes & Linhares 1993). This apparent sex ratio unbalance may be attributed to the fact that baits provided females with proteins they needed for ovary development. This sexual asymmetry was also recorded for

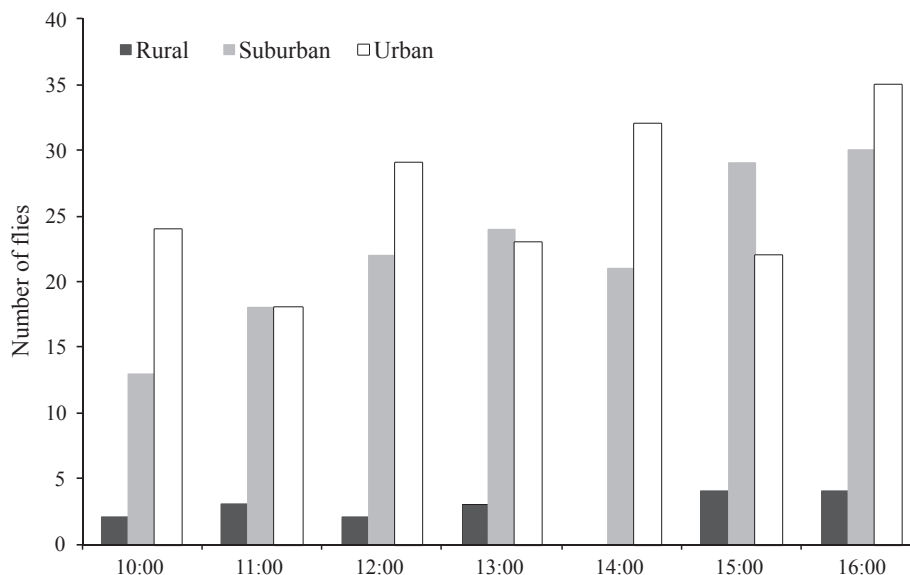


Fig 4 Hourly activity of *Muscina stabulans* at a rural, suburban and urban areas in Almirante Brown, Buenos Aires province.

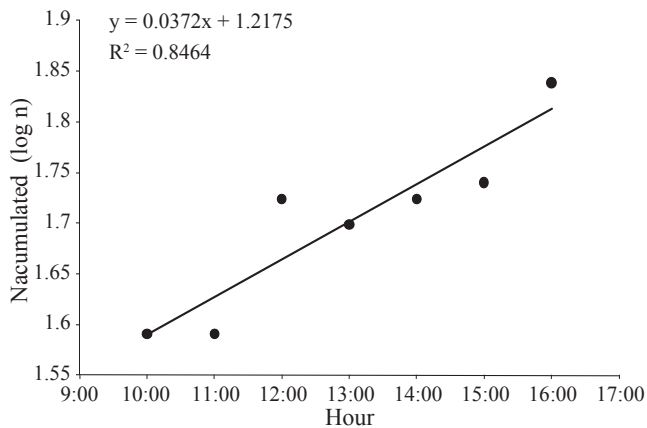


Fig 5 Relationship between abundance of *Muscina stabulans* and time of day in Almirante Brown, Buenos Aires province.

other Muscidae (Mendes & Linhares 1993) as well as for Calliphoridae (Mulieri *et al* 2006). It is interesting to note that other authors have found bait preference for baits different of those here offered to the flies, including the preference for human feces (Linhares 1981, Mendes & Linhares 1993) and rotten onion (Carvalho *et al* 1984).

So far, the only report where heliophily was analyzed showed preference to sunny areas (Linhares 1981). In contrast, our results showed the preference to shadowed areas in the suburban and rural sites and the lack of preference in the urban site. Furthermore, as it was previously observed in southeast Brazil (Avacini & Silveira 2000), we found that the number of flies increased during the afternoon. This temporal daily trend may suggest the preference of *M. stabulans* for shaded areas

The association of *M. stabulans* to shaded or sunny areas and the variability found on its baits preference suggest that different microhabitats placed in human-modified site are suitable for this fly. Therefore, urban sites may offer new niche conditions for this “urban exploiter” species.

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