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Seasonal Abundance and Species Composition of Flower-Visiting Flies

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Composição, Abundância e Sazonalidade de Dípteros Visitantes Florais

RESUMO - Foram registradas, na Estação Ecológica da Universidade Federal de Minas Gerais (UFMG), espécies de moscas que visitam flores para se alimentar. Asteraceae, Rhamnaceae, e Boraginaceae foram as famílias mais visitadas. Asteraceae foi a mais rica em espécies floridas, sendo também a mais visitada por famílias e espécie de moscas. A diversidade mais elevada de visitantes ocorreu em *Baccharis trinervis* (Lam.) (H'=1.86). As famílias de moscas mais diversas foram Syrphidae (H' = 2,07) e Bombyliidae (H' = 1,52). Os sirfídeos *Ornidia obesa* (L.) e *Palpada furcata* (Wied.) foram as espécies mais abundantes entre as visitantes. A abundância total de visitantes foi significativamente maior na estação chuvosa, quando um número maior de plantas estavam florescendo. Entretanto, um maior número de famílias visitou plantas durante a estação seca. O número de fêmeas em quatro famílias de moscas foi ligeiramente mais elevado do que o número de machos. Calliphoridae e Sarcophagidae mostraram padrões similares com relação ao número de espécie de plantas visitadas. Syrphidae foi mais generalista mas, Bombyliidae e Stratiomyidae foram relativamente mais especializadas. Muita espécies de moscas visitam flores, por isso a abundância e frequência de visitas podem indicar sua importância como polinizadores, bem como a importância das flores em sua dieta.

PALAVRAS-CHAVE: Insecta, Diptera, visitantes florais, riqueza de insetos, sazonalidade.

ABSTRACT - The species of flies that visit flowers to feed were recorded, at the Ecological Station of the Federal University of Minas Gerais (UFMG). Asteraceae, Rhamnaceae, and Boraginaceae were the most visited families. Asteraceae was the richest family and the most visited by flies families and species. The highest diversity of visiting flies was on *Baccharis trinervis* (Lam.) (H'=1.86). The most diverse families of Diptera were Syrphidae (H'= 2.07) and Bombyliidae (H'= 1.52). The syrphids *Ornidia obesa* (L.) and *Palpada furcata* (Wied.) were the most abundant species amongst visitors. Despite the total abundance of Diptera was significantly higher in the rainy season, when a higher number of plants were blooming, there were more families of visitors during the dry season. The number of females in four families of flies was typically slightly higher than the number of males. Calliphoridae and Sarcophagidae showed similar patterns regarding the number of plant species visited, while Syrphidae were the most generalized, and Bombyliidae and Stratiomyidae visited few plant species. Many species of Diptera visit flowers, and their abundance on plants could indicate their importance as pollinators as well the importance of flowers for their diet.

KEY WORDS: Insecta, Diptera, flower visitors insect, richness, seasonality.

Many species of Diptera, Brachycera and Cyclorrhapha feed on nectar and pollen (Kevan & Baker 1984). While members of Syrphidae are very common plant visitors, Stratiomyidae, Tachinidae, Conopidae, Calliphoridae and Bombyliidae also visit flowers (Arruda & Sazima 1996, Kevan & Baker 1984, Kearns & Inouye 1993, Fontenelle 1998).

The importance of nectar and pollen for adult diet varies among species in a given family (Toft 1983). The frequency of flower visits varies among the seasons and is due to flower abundance (Barret & Helenurm 1987, Inouye & Kearns 1993). Populational peaks of some species are positively correlated with wet and hot periods (Carvalho *et al.* 1991), though, in the tropics, many factors other than climate can influence the diversity of existing seasonal patterns, such as food abundance (Wolda 1988a).

In plants pollinated by flies (myophily), the flowers have well-exposed anthers and stigmas, light colored petals and

sepals, and usually a perceptible aroma. In such flowers, nectar and pollen are accessible to many insect species, especially short-tongued dipterous (Pombal 1995, Arruda & Sazima 1996).

The detection of patterns of plant use can indicate their importance as resources at a given time or place and also suggests which are the preferred resources for each taxa. Basic data on visitation can help to clarify aspects of floral biology as well.

The present study was intended to determine: the families and species of plants visited by Diptera in the UFMG Ecological Station; the abundance and distribution of Diptera at flowers throughout the year, and the contrast between the dry and rainy seasons; the similarity of resource use among different families of Diptera and the comparison of female and male visitation habits in the abundant families (Syrphidae, Calliphoridae, Bombyliidae and Stratiomyidae).

Material and Methods

This work was conducted at the Ecological Station of the Federal University of Minas Gerais (UFMG), Belo Horizonte (19º 52' **S**, 43º 58' **W**), Minas Gerais state, Brazil, from November 1996 to November 1997. The dry and rainy seasons are well defined, the dry (and cold) season receiving less than 50 mm mean monthly rainfall (May through August), with temperatures ranging from 19ºC to 21ºC, and the rainy (and hot) season receiving 300 mm mean monthly rainfall (November through January), with mean temperature of 23.9ºC (Moreira 1990).

The Ecological Station is a restricted area within the UFMG campus, covering an area of 150 ha, limited externally by major urban avenues (Borges 1997). It is covered by second growth vegetation, where herbs and bushes predominate, and a few second growth semideciduous forest areas where trees are median to large sized, reaching less than 25 m. Additionally there are field areas with shrubs, lianas, various grasses (*Mellinis minutiflora* P. Beauv., *Pennisetum purpureum* Schum.), swamps, and small streams (Macedo & Martins 1999).

Samples were taken along three 900 m long trails, 2-5 m wide, roughly in the center of the Station. Samples were made along the edges of these trails that border the field, forest and grassy areas. Weekly samples were conducted on sunny days between 9h and 12h, when Syrphidae (Diptera) visits are more frequent (Arruda *et al.* 1998). The trails were slowly and completely traversed, for observation and sampling of plants and their visiting flies. At each plant observed with visiting flies, a single 10 min. sampling was made each day, with a sweep net. These plants were marked with tape and continually sampled while they were flowering or until the end of the study.

Plant samples were preserved, identified to family, and to species (whenever possible, or grouped in morpho-species) in each family. All the flies were identified to family, and those from the families Syrphidae, Calliphoridae, Bombyliidae, and Stratiomyidae were identified whenever possible to species, or also grouped in morpho-species, to produce a more precise picture to be analyzed.

Voucher specimens of the flies are deposited in the Laboratory of Ecology and Behavior of Insects, Department of General Biology, and the plants in the Department of Botany, both within the Institute of Biological Sciences (ICB), at the Federal University of Minas Gerais (UFMG).

Meteorological data was supplied by the meteorological department of INFRAERO, at the Pampulha Airport, located approximately 2.5 km from the study site. (Fig. 1).

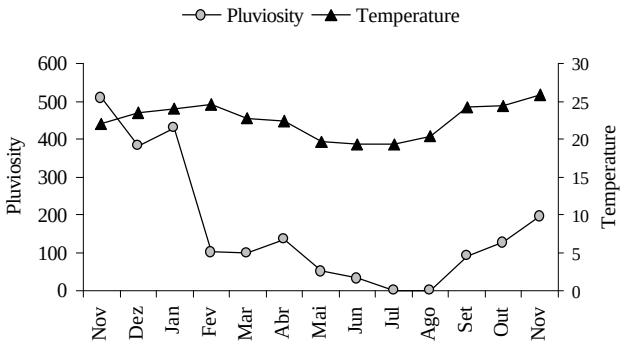

Figure 1. Monthly mean rainfall (mm) and temperature (ºC) in the region of the UFMG campus, from November 1996 to November 1997.

Differences among plant families or species, and between the rainy and dry seasons regarding visitor family and species abundance were looked for using a standard analysis of variance ANOVA (Zar 1984). A cluster analysis was used to show which Diptera families were using the same plant species with a higher frequency; that is, what the probability of finding similar abundances for different Diptera families at the same plant is. The linkage distance represents the similarity level for abundances at the plants used: the smaller the distances, the larger the similarity, and vice versa (Zar 1984). Finally, the Shannon-Wiener (Magurran 1988) diversity index was calculated for the families Syrphidae, Calliphoridae, Bombyliidae, and Stratiomyidae, and the visitors of 14 plant species that showed the highest visitor abundances.

Results

Plants Visited by Diptera. The flies visited 40 plant species in 18 families. These plants included small trees (three species), lianas (seven species), herbs (five species), and especially shrubs (25 species). The flowering period of many species varied, with much overlap. The largest number of flowering plants was verified in October and November (Fig. 2, App. 1).

The abundance of flies differed significantly among the 18 plant families ($F=3.9$; $P<0.00$). Only two among 16 families of Diptera did not visit at least one Asteraceae. Other important families were Rhamnaceae and Boraginaceae, which were most important for Syrphidae, Stratiomyidae and Tachinidae (Fig. 3, Table 1). Boraginaceae and Rhamnaceae showed abundant, aromatic flowers. Rhamnaceae flowers have a feces scent and the Boraginaceae ones have an strong undefined but not unpleasant scent. The remaining plant fami-

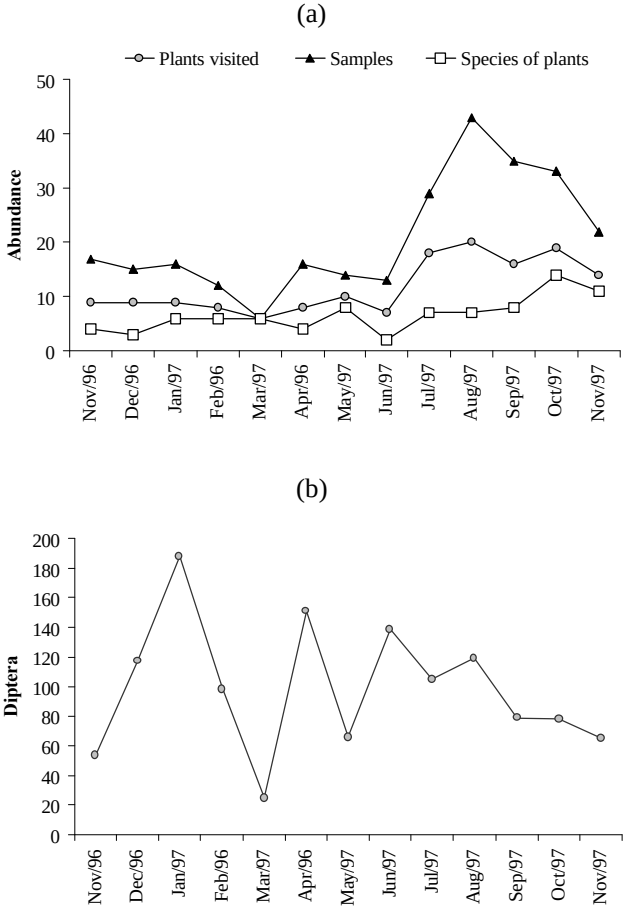

Figure 2. a) Individual monthly abundance, number of sample and number of the species of florid plants in the UFMG ecological station from November 1996 to November 1997; b) Diptera abundance.

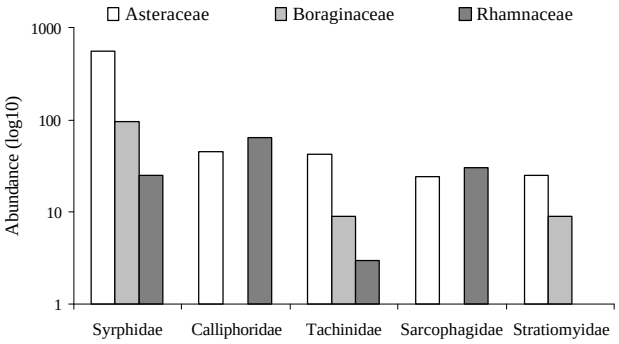

Figure 3. The five family of the Diptera more abundant in the three family of the plants more visited, from November 1996 to November 1997 in the UFMG ecological station.

lies had a lower number of visitors. Among them, Amaranthaceae, Rubiaceae, and Sapindaceae showed a total of individual visitors only slightly above 40 (App. 1).

The total visitor abundance differed significantly among different plant species (F = 4.12; P <0.00), 35% out of Asteraceae (N= 14) (App. 1). Furthermore, of the most-visited 14 species, 50% belong to this family (Table 2). *Baccharis intermixta* (Gardn.), Asteraceae sp7, and Asteraceae sp6 were visited by the greatest number of families. Mean while, *Baccharis trinervis* (Lam.) had a higher visitor diversity. The second highest visitor diversity occurred in *Gouania* sp. (Rhamnaceae; Table 2). *B. trinervis* flowered just in the first rainy season period, while *B. intermixta* and *Gouania* sp. flowered in the dry season (App. 1).

Some more specialized relationships were evident. *Sepsisoma* sp. (Richardiidae) visited *Ricinus communis* (L.) (Euphorbiaceae). Flies from this species fed in glands located in the inferior base of the limbs. *Lantana camara* ((L.) (Verbenaceae) and *Waltheria americana,* (L.) (Sterculiaceae), both with narrow and deep corollas, were visited only by *Stylogaster* sp. (Conopidae) and *Ligyra morio* (F) (Bombyliidae) respectively. In Asteraceae sp6, individuals of Acroceridae (Panopinae), visited many flowers in a sequence, always in a hovering flight.

Diptera Families. From 16 Diptera families, 1281 individuals were collected visiting flowers (Fig. 4). Syrphidae were the most abundant (70% of all collected individuals) at all plants except for Malvaceae.

The abundances of Calliphoridae, Sarcophagidae, and Tachinidae were also high (Fig. 4), with *Gouania* sp. (Rhamnaceae) as the species most visited by the first two Diptera families. Tachinidae and Muscidae were abundant in Asteraceae and the Sterculiaceae were more visited by Bombyliidae and Stratiomyidae, the latter more frequent in Asteraceae.

Other Diptera contributed few individuals when compared with the preceding families. Four of the 16 families were represented by only a single individual (Fig. 4).

The Diptera that showed similarity visitation profiles were Calliphoridae and Sarcophagidae; Muscidae and Tachinidae, and Syrphidae and Stratiomyidae, while Bombyliidae showed low similarity with these families (Fig. 5).

Diversity in Species of Syrphidae, Calliphoridae, Stratiomyidae and Bombyliidae. Syrphidae was the most species-rich and most diverse family (R= 30; H'= 2.07 ± 0.04; varH'= 0.001), followed by Bombyliidae (R= 7; H'= 1.52 ± 0.07; varH'= 0.005), Calliphoridae (R= 9; H'= 1.23 ± 0.20; varH'= 0.043) and Stratiomyidae (R= 3; H'= 0.37 ± 0.97; varH'= 0.944).

Ornidia obesa (F.), *Palpada furcata* (Wied.), *Palpada obsoleta* (Wied.), and *Palpada spectabilis* (Hull) were the most abundant species among the Syrphidae (Table 1). *O. obesa* was the only visitor at *Coccoloba* sp. (Polygonaceae), which flowered in February. *Pseudodorus clavatus* (F.) (Syrphidae) was the only species visiting at *Helicteris brevispira* (Ast. Juss) (Sterculiaceae), feeding by introducing the glossa into the openings chewed by stingless bees (*Trigona* sp.) in the base of the corollas. *Palpada* and *Allograpta* showed the largest number of plant species visited, *Palpada* being more frequent at Asteraceae and Boraginaceae. *P. furcata* and *Palpada uritaenia* (Curran)

Table 1. Species and abundance of males and females in four families, of Diptera of these, in florid plants of November of 1996 until November of 1997 and species of plants more visited.

Family	Species	Males	Females	Total	Plants more visited
Syrphidae	**-**	**422**	**488**	**910**	**-**
	Allograpta neotropica (Curran)	2	2	4	Anacardiaceae sp. 1
	Allograpta sp. 1	1	0	1	*Baccharis trinervis* (Lam.)
	Allograpta sp. 2	0	1	1	N I
	Allograpta sp. 3	1	0	1	Apiaceae sp. 1
	Allograpta sp. 4	1	0	1	Apiaceae sp. 1
	Allograpta sp. 5	3	10	13	N I
	Allograpta sp. 6	1	0	1	Amaranthaceae sp. 1
	Allograpta sp. 7	8	3	11	Apiaceae sp. 1
	Copestylum pallens (Wiedmann)	4	9	13	*Baccharis trinervis*
	Copestylum sp.1	2	0	2	Asteraceae sp. 6
	Ocyptamus sp 1	3	0	3	*Baccharis intermixta* (Gardn.)
	Ocyptamus sp. 2	0	1	1	Asteraceae sp. 6
	Ocyptamus sp. 3	0	1	1	*Baccharis intermixta*
	Ornidia obesa (Fabricius)	145	143	288	Asteraceae sp.4
	Palpada conicus (Fabricius)	0	1	1	Amaranthaceae sp. 1
	Palpada furcata (Wiedmann)	85	153	238	*Baccharis trinervis*
	Palpada melanaspis (Wiedmann)	2	1	3	*Baccharis trinervis*
	Palpada obsoleta (Wiedmann)	27	76	103	Asteraceae sp. 6
	Palpada pygolampa (wiedmann*)*	0	3	3	Asteraceae sp. 3
	Palpada sp. 1	16	9	25	Asteraceae sp. 4
	Palpada sp. 2	1	0	1	*Cordia verbenacea* (D.C.)
	Palpada spectabilis (Hull*)*	38	40	78	*Baccharis intermixta*
	Palpada uritaenia (Curran)	20	12	32	*Baccharis trinervis*
	Palpada vinetorum (Fabricius)	4	4	8	*Baccharis trinervis*
	Pseudodoros clavatus (Fabricius)	23	6	29	Apiaceae sp. 1
	Salpingogaster punctifrons (Curran)	2	0	2	*Baccharis intermixta*
	Syritta flaviventris (Macquart*)*	15	1	16	Lamiaceae sp. 1
	Toxomerus sp. 1	7	5	12	Asteraceae sp. 1
	Toxomerus sp. 2	1	2	3	Anacardiaceae sp. 1
	Toxomerus sp. 4	7	7	14	*Baccharis intermixta*
Bombyliidae	**-**	**15**	**4**	**19**	**-**
	Ligyra morio (Fabricius)	6	2	8	*Waltheria americana* (L.)
	Phthiria sp. 1	3	2	5	N. I.
	Phthiria sp. 2	1	0	1	*Stachytarpheta cajenensis* (C. Ham)
	Phthiria sp. 3	1	0	1	*Sida* sp. 1
	Toxophora sp. 1	1	0	1	N. I.
	Villa sp. 1	2	0	2	*Baccharis trinervis*
	Villa sp. 2	1	0	1	*Mikania salviaefolia* (Gardn.)
Calliphoridae	**-**	**76**	**38**	**114**	**-**
	Chrysomya albiceps (Wiedmann)	19	8	27	*Gouania* sp. 1
	Chrysomya megacephala (Fabricius)	15	6	21	*Gouania* sp. 1
	Chrysomya putoria (Wiedmann)	0	1	1	Asteraceae sp. 7
	Chrysomya sp. 1	0	2	2	Asteraceae sp. 4
	Cochliomyia sp. 1	1	0	1	*Baccharis trinervis*
	Lucilia eximia (Wiedmann)	23	15	38	*Gouania* sp. 1
	Phormia sp. 1	2	0	2	*Baccharis intermixta*
	Phormia sp. 2	16	5	21	*Baccharis intermixta*
	Phormia sp. 3	0	1	1	Asteraceae sp. 7
Stratiomyidae	**-**	**9**	**26**	**35**	**-**
	Hedriodiscus pulcher (Wiedmann)	2	0	2	*Baccharis trinervis*
	Hoplitimyia mutabilis (Fabricius)	6	25	31	*Baccharis trinervis*
	Labostigmina fenestrata (Thomson)	1	1	2	*Baccharis trinervis*

Remarks: N.I. = Not identified

Table 2. Diversity (Shannon) of the visitors and the family more abundant of fourtheen species plants, more visited by Diptera in to Ecological Station UFMG, during one year.

Species of plants	Diversity of the visitors (H `)	Diptera family more abundant
Amaranthaceae sp1	1.37	Syrphidae
Apiaceae sp1	1.24	Syrphidae
Asteraceae sp 7	1.61	Syrphidae
Asteraceae sp1	0.66	Syrphidae
Asteraceae sp12	1.16	Syrphidae
Asteraceae sp3	1.63	Syrphidae
Asteraceae sp6	1.57	Syrphidae
Baccharis intermixta (Gardn.)	1.75	Syrphidae
Baccharis trinervis (Lam.)	1.86	Syrphidae
Cordia verbenacea (D.C.)	1.48	Syrphidae
Gouania sp1	1.80	Calliphoridae Sarcophagidae
Rubiaceae sp2	0.92	Syrphidae
Serjania lethalis (St. Hill)	1.42	Syrphidae
Struthantus sp1	1.09	Syrphidae

(Syrphidae) were similar regarding plants visited. *Palpada* sp1, *P. spectabilis*, and Calliphoridae also had similar visitation habits. *O. obesa* and *P. clavatus* showed low similarity to each other and to the other species regarding their plant choices.

Of the seven Bombyliidae, *Ligyra morio* (F.) was the most abundant, especially at *Waltheria americana* (Sterculiaceae). *L. morio* was also observed feeding at flowers of C*ordia verbenacea* (D.C.) (Boraginaceae). These plants occurred in a site where fossorial solitary bees and wasps usually dig their nests, and *L. morio* is a parasite of their larval stages (Hull 1973, Martins *et. al.* 1998). *Phthiria* (Bombyliidae) visited plants from the families Asteraceae, Malvaceae (S*ida* sp.), and Verbenaceae, *Stachytarpheta cajenensis* (C. Ham) (Table 1).

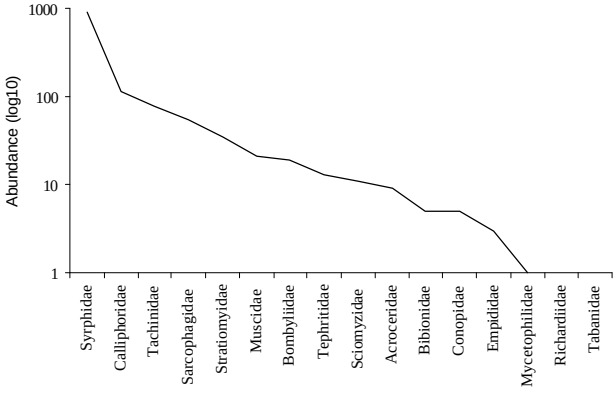

Figure 4. Abundance of the sixteen Diptera family sample in flower from November 1996 to November of 1997 in the UFMG ecological station.

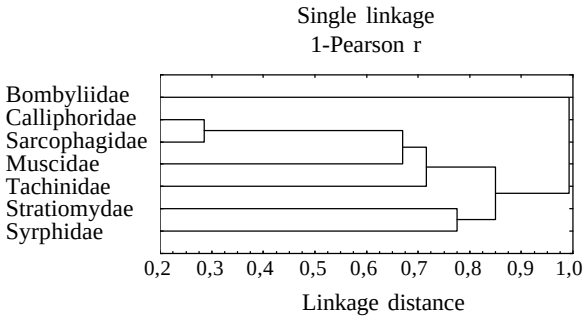

Figure 5. Analysis of grouping (cluster) of the abundance of the families of Diptera in florid plants in the UFMG ecological station, from November 1996 to November 1997.

Among the Calliphoridae, *Chrysomya albiceps* (Wied.), *Chrysomya megacephala* (F.), *Lucilia eximia* (Wied.), and *Phormia* sp2 were the most abundant species, especially at Rhamnaceae and Asteraceae (Table 1). In Calliphoridae, *C. albiceps* and *L. eximia* were the most similar in patterns of visitation.

Stratiomyidae showed the lowest richness in visitation. The species visited Boraginaceae, Asteraceae, and Sapindaceae, with all three species visiting Asteraceae (Table 1). *Hoplitimyia mutabilis* (F.) was the most abundant species, visiting primarily Asteraceae and also Boraginaceae.

Males and Females of Syrphidae, Bombyliidae, Calliphoridae and Stratiomyidae. In total counts of Syrphidae sampled, females were more abundant than males. However, in 16 of the 30 species of this family males were more abundant than females, though the differences in numbers were small. The total number of females was almost two times in *P. furcata,* and three times in *P. obsoleta* the number of males. The total number of males in *P. clavatus* was almost four times and fifteen in *Syritta flaviventris* (Mcquart) the number of females (Table 1). For all plant families visited by *P. obsoleta* there were more females than males, the same occurring in *P. furcata*, except at Boraginaceae.

In all the species of Bombyliidae, the total abundance of males was higher than the total abundance of females (especially in April and July, but not in August). In April, the same was observed for *C. albiceps, C. megacephala, L. eximia,* and *Phormia* sp2. Despite this overall pattern, *Gouania* sp. (Rhamnaceae) was visited by a larger number of females from the species cited above, except from *Phormia* sp2. In Stratiomyidae, the total number of females was greater than of males, *H. mutabilis* contributing 90% of the total females (Table 1). More than 80% of the collected individuals in this species were females. *Baccharis trinervis* received the largest number of visits from males and females of Stratiomyidae. In this family, females showed their highest abundance in January and February, while males did so in February.

Variation in the Abundance of Diptera. Although Diptera were more abundant in the rainy season (60% of the total), in the dry season family richness was higher. The months with

the highest abundances were January, June, and April, respectively. Monthly variation in abundance was more dramatic in the dry than in the rainy season.

Only moisture was significantly correlated to abundance, as showed for b value of the linear regression (b= 0.01 P<0.00). In the first rainy season, from November 1996 through May 1997, the abundances were significantly different from the dry season (May to September 1997), and from the abundances seen in the second rainy season (September through November 1997; F=17.7; P < 0.00).

Syrphidae were most abundant in January and August (>100 individuals), when the remaining families were rare or absent. Calliphoridae and Sarcophagidae were most abundant in April, and Tachinidae in June. Muscidae were most abundant in June, Bombyliidae in April and July, and Stratiomyidae in February.

Discussion

Diptera at the study site visited many plant species, overall, as happens in other sites (Gilbert 1995, Arruda & Sazima 1996, Proctor & Lack 1996). In this study, plant families and species with higher abundance of visits were not exclusively those with higher abundance in individuals or species; accordingly they may not necessarily have been presented more available resources, though obviously abundance is at best only a rough indicator of resource quantity. Resource quality and accessibility may influence the attraction of flies, while resource quantity may be important in maintaining a high number of visitors (plant species that receive frequent visits from Diptera have usually many flowers; Arruda & Sazima 1996). These differing features can determine the importance of resources.

In Asteraceae and Rhamnaceae, such features may have influenced the abundance and diversity of the visitors. Both families showed high insect visitor abundance and richness. These two families differed in flowering time and number of flowering species or individuals (App. 1). They show abundant flowers, and nectar and pollen are easily accessed (Arruda & Sazima 1996).

Conversely, plant species with some specific visitors often have their resources much less accessible. The morphology of flowers can promote or inhibit visits. For example, Diptera with short mouthparts usually feed in flowers with open, low corollas (Tybirk 1993, Pombal & Morrelato 1995) while tubular flowers are visited by species with longer mouthparts (Toft 1983, Kevan & Baker 1984). Resource use in the narrow flowers of *L. camara* (Verbenaceae) by long-tongued *Stylogaster* sp. (Conopidae) is presumably due to such morphological restrictions.

Baccharis trinervis, B. intermixta, Gouania sp., Asteraceae sp3, *C. verbenacea*, Asteraceae sp6, and Asteraceae sp7 may have easily accessible nectar and pollen, considering the diversity and the abundance of their visitors (Tables 1 and 2). In the campus of the UFMG, species of Asteraceae and Boraginaceae attracted the highest abundances of flies (Fontenelle 1998). The visitation of Boraginaceae by flies is in contrast to North America, where this plant family is often visited by bees and wasps with mouthparts specialized for retrieving pollen from the hidden anthers (Doug Yanega, pers. comm.).

The Bombyliidae include species highly specialized as flower visitors. The frequency of visits in this group can vary with the quantity and/or morphology of flowers (Toft 1993, Proctor & Lack 1996, Arruda & Sazima 1996). *Phthiria* sp. and *L. morio* visited flowers with tubular corollas frequently and both flies used few plant species, some of them little visited by other Diptera.

Syrphidae were more generalized, seen both by their predominance in the habitat and frequency of visits to flowers along the year. Visits of Syrphidae to different plant species can be related to ease of access to nectar and pollen, kind and quantity of the available resource (Schemske *et al*. 1978, Arruda & Sazima 1996). This group uses flower resources frequently (Schemske *et al.* 1978, Morse 1981, Lindsey 1984, Jarlan *et al.* 1997). Syrphidae have hovering flight, an energetically costly behavior that demands the ingestion of energy-rich resources, especially nectar. This behavior leads to a longer permanence at the flowers (Gilbert 1981). When visiting *Styrax camporum* (Pohl) and *S. ferrugineus* (Nees et Mart.), *O. obesa* tends to remain for a long time at the same plant (Saraiva, *et al.* 1988). This species is commonly found hovering along trails of the Ecological Station (Fontenelle 1998).

The similarity of visitation between Stratiomyidae and Syrphidae at certain plants may be due to the fact that both families visit flowers with easy access to pollen and nectar (Fig. 5, Table 1). The width and depth of the corolla can inhibit Stratiomyidae from feeding (Proctor & Lack 1996). Calliphoridae and Sarcophagidae, very frequent in flowers, are also associated (Fig. 5). The magnitude of the relationship can be quite variable, depending on the kind of resource available and on how these families use them (Fontenelle 1998).

In *Gouania* sp1 (Rhamnaceae), the characteristic feces scent possibly influenced the higher frequency of visits of Calliphoridae and Sarcophagidae, which show preference for garbage and similar resources (Paraluppi & Castellon 1994, Lomônaco & Almeida 1995b, Fontenelle 1998) and attraction to flowers and fungi with similar odors (sapromyophily syndrome; Van Der Pijl & Dodson 1966). Species of Calliphoridae and Sarcophagidae can lay eggs in feces, animal wounds and garbage, where they are frequently observed, and the presence of these resources along trails could have influenced abundance of these flies in the samples. The dominance of males at the flowers might not necessarily reflect feeding, but rather searching for females to mate (e.g., Maier 1982, Downes 1994), as females visit flowers searching for more proteinic foods, related to a better gonadotrophic development (Mendes 1991).

Variations in the abundance of males and females in Syrphidae and Stratiomyidae may also reflect the reproductive condition of the individuals. During ovogenesis in females, many species are attracted by different kinds of food, especially those that satisfy proteinic necessities (Gilbert 1981, Lomônaco & Almeida 1995a). Females are more frequently observed feeding on pollen than males, and for some species the pollen, by being proteinic, is very important for egg maturation (Gilbert 1981, Arruda 1997). According to flower gender, the relative frequency of visits by Syrphidae

may vary, due to differential search for flower resources (nectar vs. pollen; Agren *et al.* 1986).

However, during reproductive periods, females of Bombyliidae remain in the vicinity of host nesting sites, searching for places to deposit their eggs (Pimenta & Martins 1999). The low abundance of females visiting flowers in this group might reflect this tendency, that could possibly limit feeding time.

The seasonal variation in flower visits is almost certainly related to resource availability. Higher species richness is correlated to a higher resource diversity (Fontenelle 1998). Moister periods may be needed by many plants to flower, consequently the augmentation of available flower resources can lead to an increase of phenological synchrony of insects that depend on them (Wolda 1988b). Less frequent visitors are possibly related to specific plants or have a short activity period as adults, visiting flowers only in certain periods during the year (Wolda 1988a, Inouye & Kearns 1993).

Many species of Diptera visit flowers to feed, and their abundance on plants may not only indicate the importance of the flowers in their diet, but also their importance of the species as potential pollinators, and thus play a crucial role in ecosystem function. These facts suggest the importance of deeper study of insect /plant interactions in this habitat, especially regarding the efficiency of pollination by the various insect groups, essential for the production of seeds and for the maintenance of natural or agricultural plant communities. It is unfortunate that detailed studies on pollination by Diptera are rare, especially in Brazil, but hopefully the present work can serve as groundwork for such studies.

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Appendix 1. Individual's monthly abundance and (number of sample), of the species of florid plants from November 1996 to November 1997 in the UFMG ecological station.

Family / Morfospecie	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Flies abund.
Asteraceae														-
Asteraceae sp1			3(6)											51
Asteraceae sp2			1(1)											1
Asteraceae sp3							1 (1)		1(2)	3(9)				34
Asteraceae sp4	1(1)	4(6)			1(1)	4(5)								125
Asteraceae sp5 *						2(1)						1(1)	1(1)	4
Asteraceae sp6 *				1(1)			1(1)		8(14)	7(13)	1(2)			84
Asteraceae sp7							1(2)	1(2)						61
Asteraceae sp8	3(3)													4
Baccharis intermixta *(Gardn).*							1 (1)	6(14)	5(7)					149
Baccharis trinervis *(Lam.) Pers.*			2(9)	3(6)										173
Mikania hirsutissima (D.C.)										1(2)				7
Mikania salviaefolia *(Gardn.)*										2(3)	3(10)			26
Trixis antimenorrhoea (Mart. Ex. baker)											1(1)	2(3)		12
Wulfia baccata *(Kutnze)*			1(1)											6
Boraginaceae														-
Cordia verbenacea *(D.C.)*	4(10)	4(8)			1(2)		1(2)					1(2)	3(9)	114
Amaranthaceae														-
Amaranthaceae sp1	1(3)	1(1)	1(1)		1(1)							1(1)	1(3)	41
Sterculiaceae														-
Helicteres brevespira (Ast. Juss)											1(1)			4
Waltheria americana *(L.)*					1(1)	1(4)	1(2)							7
Rhamnaceae														-
Guoania *sp1*						1(6)	1(1)							126
Myrsinaceae														-
Myrsine *sp1*				1(1)										5
Malvaceae														-
Sida sp1												1(1)		1
Lamiaceae														-
Lamiaceae sp1												2(2)	3(3)	8
Coleus babatus (Benth)											1(1)			1
Euphorbiaceae														-
Euphorbia sp1													1(1)	3
Ricinus communnis (L.)													1(1)	1
Sapindaceae														-
Serjania sp1												2(2)		3
Serjania lethalis (Ast. Hill)										4(6)	4(11)		1(1)	49
Rubiaceae														-
Borreria *sp1*				1(1)										10
Rubiaceae sp1					1(1)		3(4)							11
Rubiaceae sp2			1(1)	1(2)	2(2)				1(1)	1(1)				31
Rubiaceae sp3												1(1)		1
Styracaceae														-
Styrax sp1													1(1)	1
Verbenaceae														-
Lantana camara (L.)												1(1)		2
Stachytarpheta cajanensis (c. Ham)													1(1)	1
Polygonaceae														-
Coccoloba *sp1*				1(1)										15
Loranthaceae														-
Strutanthus *sp1*									1(1)		4(5)	3(6)		28
Anacardiaceae														-
Anacardiaceae sp1										2(8)				24
Leguminosae														-
Mimosa sp1												1(1)		1
Apiaceae														-
Apiaceae sp1											1(3)	1(5)	1(1)	28
-														-
N.I. 1									1(1)					4
N.I. 2									1(1)					12
N.I. 3												1(1)		2
N.I. 4												1(2)		10
Total monthly	9(17)	9(15)	9(16)	8(12)	6(6)	8(16)	10(14)	7(13)	18(29)	20(43)	16(35)	19(33)	14(22)	

*Remarks: Asteraceae sp6 = *Vernonanthura membranacea* (Gardn.) H. Rob., *Vernonanthura brasiliana* (L.) H. Rob e *Vernonanthura phosphorica* (Vell) H. Rob. Asteraceae sp5 = *Mikania cordifolia* (L. f.) Wild. e *Eclipta prostata* (L.) L.

N.I.= Plant not identified