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Elia Ramírez Arriaga, Enrique Martínez Hernández. Resources foraged by *Euglossa atroveneta* (Apidae: Euglossinae) at Union Juárez, Chiapas, Mexico. A palynological study of larval feeding. *Apidologie*, 1998, 29 (4), pp.347-359. hal-00891500

**HAL Id: hal-00891500**

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## Original article

# Resources foraged by *Euglossa atroveneta* (Apidae: Euglossinae) at Unión Juárez, Chiapas, Mexico. A palynological study of larval feeding

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(Received 25 August 1997; accepted 5 March 1998)

**Abstract** – Weekly larval feeding samples belonging to 51 nests of *Euglossa atroveneta* were analyzed palynologically at Unión Juárez, Chiapas, Mexico. It was determined that *E. atroveneta* foraged 74 plant species throughout 1 year, from 31 May 1990 to 29 May 1991. The most important resources of larval feeding were classified as: a) polliniferous: *Antirhea* sp., *Cassia* sp., *Combretum* sp., *Comelina* sp., *Cordylone terminalis*, *Dendropanax* sp., Leguminosae type 4, *Lycianthes* sp., *Saurauia* sp., *Solanum* aff. *torvum*, *Solanum* aff. *tuerckheimii*, *Tibouchinia longifolia*; and b) nectaropolliniferous: *Drymonia* aff. *strigosa*, *Kohleria elegans*, *Lonchocarpus* sp. and *Nautilocalyx* aff. *panamensis*. Through the year *E. atroveneta* displayed a heterogeneous foraging behavior with a diversity index average of 0.83, and little overlap for resources between the solitary and parasocial nests studied.  
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*Euglossa atroveneta* / larval feeding / palynology / Neotropics / orchid bees / trophic resources

## 1. INTRODUCTION

The Euglossinae are neotropical bees. They are solitary, communal and parasocial bee species, and they comprise five genera: *Eulaema*, *Eufriesea*, *Euglossa*, *Exaerete* and *Aglae*. The *Euglossa* genus is the most abundant and diverse in the neotropics [17].

This group of bees is well known because the male bees collect fragrances from orchid flowers and at the same time they carry out the pollination, often with specific pollinizers for each orchid species. These relationships are considered to constitute examples of coevolution [2, 5, 6, 16, 29, 32].

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The Euglossinae have a broad flight pattern and sometimes fly as far as 23 km [8]. Due to this capacity to travel for collecting pollen and nectar, they are one of the main agents for cross pollination in tropical rain forest.

These bees visit plants with wide distribution and long flowering periods [1, 8], plants that offer abundant food reward (nectar or pollen), or that provide resin that is used in nest construction. Records related to plant species of feeding importance in Euglossinae have been based exclusively on direct field observations [1, 8, 15, 31]. However, many flowering plants visited by Euglossine bees are unknown to science. It is important to increase knowledge of how the Euglossinae exploit the angiosperms and to find out what taxa are most relevant in their life cycle. In this way, it will be possible to better understand the role of female euglossine bees in tropical ecosystems.

The utilization of floral resources may be assessed by direct observation or by palynological analysis of larval feeding and measuring ecological parameters such as pollen diversity, evenness and overlapping of feeding resources [4, 9, 12–14, 20–22, 28].

For this research, a nesting area was established for *Euglossa atrovirens* in a disturbed zone on the hillside of Tacaná volcano, in Chiapas State. It was possible to assess the annual foraging behavior of female bees through palynological analysis of larval feeding and to complement these data by means of field observations. Finally, the results were compared with those cited for stingless bees (Apidae; Meliponinae) studied in the same area, where the overlap in resource utilization was also determined.

## 2. MATERIALS AND METHODS

The studied nests of *E. atrovirens* are located at Unión Juárez in Chiapas (15°5'N, 92°3'W), at an altitude of 1 400 m. In this region, secondary vegetation of tropical rain forest is found in

patches and the landscape is dominated by crops of various coffee varieties (*Coffea arabica*).

The larval feeding samples were collected from open cells in 51 nests of *E. atrovirens* maintained in wooden boxes [23], to know which resources were currently being exploited. During 1 year, from 31 May 1990 to 27 May 1991, a total of 143 weekly samples were collected: in solitary nests, one sample per nest and in parasocial nests, from 1 to 5 weekly samples per nest. To remove the larval food a wooden stick was used and each sample was put in individual tubes, sealed carefully and labeled with date, nest and cell number.

All larval feeding samples were acetolyzed, following Erdtman's [7] method, and the slides obtained deposited in the palynological collection of the Institute of Geology, at the National University of Mexico (IGLUNAM).

The pollen grains of each sample were described and identified, consulting palynological reference collections (IGLUNAM) from Chiapas and Los Tuxtlas, Veracruz, and by means of Mexican catalogues of tropical pollen [10, 11, 18, 24] and following floristic lists [3]. For each sample, the frequencies of the plant taxa were based on 1 200 pollen grains counted randomly [30].

The important species were those present in 10 % or higher percentages [21]. The flower morphology of important taxa was reviewed. Some field observations of plants visited by the bees were made also.

Based on palynological results, three ecological parameters were calculated monthly: the Shannon-Weaver index [26] ( $H'$ ), Pielou's formula [19] ( $J'$ ) and the Schöener index [25] ( $PS'$ ).

The Shannon-Weaver Index ( $H'$ ) expresses the palynological diversity of the samples, considering the total number of plant species and the relative frequency of each taxa in the sample

$$H' = - \sum_{i=1}^n p_i \ln p_i$$

where  $H'$  is the diversity index,  $p_i$  is the proportion of each pollen type found in samples of nest in question during the month considered, and in the natural logarithm.

Pielou's formula ( $J'$ ) was used to determine the uniformity of pollen species at each sample. The  $J'$  value can vary from 0 to 1, and is a measure of whether a sample is heterogeneous or homogeneous

$$J' = \frac{H'}{H' \max}$$

where  $J'$  is the evenness,  $H'$  is the diversity index, and  $H' \max$  is the natural logarithm of the total number of pollen types present in the samples.

Schöener (PS) index was calculated to determine the overlapping of resources among the *E. atrovoneta* nests. This index can vary from 0 to 1, when two samples are different or similar, respectively. The overlap in feeding sources was calculated monthly

$$PS = 1 - \frac{1}{2n} \sum_{h=1}^n |ph_i - ph_j|$$

where PS is the resource overlap,  $ph_i$  the proportion of pollen from species  $h$  collected by *E. atrovoneta* at nest  $i$ , and  $ph_j$  is the respective value for the nest  $j$ .

The palynological analysis of larval feeding, the study of the flower morphology and the field observation were used to show the collecting strategies of *E. atrovoneta* at Unión Juárez. The ecological parameters employed (pollinic diversity, the evenness and overlapping of feeding resources), are also important tools to evaluate foraging behavior in the Apidae [12–14, 20–22, 27].

### 3. RESULTS

During the year of this research, 51 nests of *E. atrovoneta* were studied. Through palynological analysis, 67 plant species belonging to 42 families and seven undetermined taxa were registered. Of the total taxa observed, only 22 were of importance ( $\geq 10\%$ ) in the *E. atrovoneta* diet at the Unión Juárez area (table I).

The total number of plant species found for each nest varied from 4 to 25. The major number of taxa (from 20 to 25) was registered only in five parasocial nests.

Generally, only a few species were exploited with high intensity in solitary and parasocial nests. The species with low frequencies could be considered as alternative resources (table I).

In the case of solitary nests, i.e. nests constructed by only one female ( $n = 42$ ), from one to six species of importance were

registered, with an average of three important taxa per sample. In parasocial nests ( $n = 9$ ), three to nine important taxa were observed, with an average of five important species per sample.

In this species, some female bees were polylectic (figure 1), while some others had an oligolectic behavior (figure 2).

The important resources ( $\geq 10\%$ ) for *E. atrovoneta* were exploited during short time periods from 1 to 3 months and consisted of *Dendropanax* sp., *Commelina* sp., *Kohleria elegans*, *Cordyline terminalis*, *Antirhea* sp., *Rondeletia* sp., *Solanum* aff. *torvum*, *Solanum* aff. *tuerckheimii*, *Cassia* sp. and four undetermined species. Other resources registered during medium time periods, from 4 to 6 months were *Saurauia* sp., *Begonia biserrata*, *Combretum* sp., *Drymonia* aff. *strigosa*, *Nautilocalyx* aff. *panamensis* and Leguminosae type 4. The species, visited during long flowering periods from 7 to 11 months, were *Lonchocarpus* sp., *Tibouchinia longifolia* and *Lycianthes* sp.

The monthly analyses showed from nine to 39 plant species, but only from two to ten important species per month were recorded. The major number of taxa was registered in June, July, September, October, January and February (table I).

The flower morphology of these taxa was reviewed and nectaropolliniferous species with tubular flowers were detected (*Drymonia* aff. *strigosa*, *Kohleria elegans*, *Nautilocalyx* aff. *panamensis*, *Rondeletia* sp.) and a Fabaceae (*Lonchocarpus* sp.) (figure 3). Also, two genera had been associated with buzz pollination for Euglossinae bees: *Cassia* and *Solanum* [15, 31].

The important polliniferous species were *Saurauia* sp., *Dendropanax* sp., *Begonia biserrata*, *Combretum* sp., *Commelina* sp., *Cassia* sp., Leguminosae type 4, *Cordyline terminalis*, *Tibouchinia longifolia*, *Antirhea* sp., *Lycianthes* sp., *Solanum* aff. *torvum*, *S. aff. tuerckheimii* and four undetermined taxa.



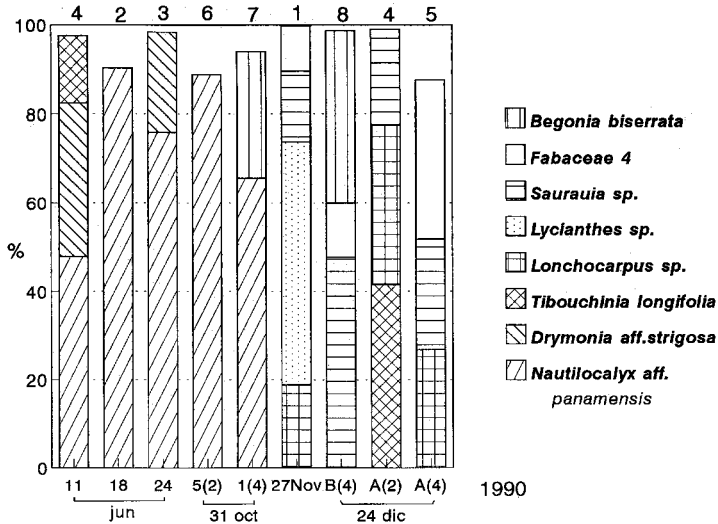
[illegible]

Taxa	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	May
<b>RUBIACEAE</b>												
<i>Antirhea</i> sp.	-	+	-	-	-	-	-	-	-	-	-	-
<i>Coffea arabica</i>	-	-	-	-	-	-	-	-	×	×	×	-
<i>Rondeletia</i> sp.	-	-	-	-	-	+	+	×	+	×	-	-
<b>RUTACEAE</b>												
<i>Citrus</i> sp.	×	-	-	-	-	×	×	×	×	×	×	×
<b>SOLANACEAE</b>												
<i>Capsicum</i> sp.	-	-	-	-	-	×	-	-	-	×	×	-
<i>Lycianthes</i> sp.	×	+	+	+	+	+	+	×	+	+	-	+
<i>Solanum</i> aff. <i>torvum</i>	-	-	-	-	+	-	-	-	+	-	-	+
<i>Solanum</i> aff. <i>tuerckheimii</i>	-	-	+	-	-	-	-	-	-	-	-	-
<b>TILIACEAE</b>												
<i>Heliocarpus</i> sp.	×	×	×	-	-	×	×	×	-	×	-	-
<b>ULMACEAE</b>												
<i>Celtis</i> sp.	-	-	-	-	-	×	-	-	-	-	-	-
<i>Trema micrantha</i>	×	×	×	-	×	×	-	-	-	-	-	×
<i>Chaetoptelea mexicana</i>	-	-	-	-	×	×	-	-	-	-	-	-
Type I	-	×	-	-	-	-	-	-	-	-	-	-
<b>ZINGIBERACEAE</b>												
<i>Costus</i> sp.	×	×	×	-	-	×	-	-	-	-	-	×
<i>Elettaria cardamomum</i>	-	×	-	-	×	×	-	-	-	-	-	-
<b>Undetermined Taxa</b>												
Type a	×	-	-	-	-	-	-	-	-	-	-	-
Type b	-	-	×	-	×	-	-	-	-	-	-	-
Type c	-	+	-	-	×	-	-	-	-	-	-	-
Type d	-	-	×	-	-	-	-	-	×	×	-	+
Type e	-	-	-	-	×	×	-	-	-	×	-	×
Type f	-	-	×	-	-	×	-	-	+	-	-	-
Type g	-	×	-	-	-	×	-	-	-	-	-	+
Total and (important)	16	28	24	9	27	39	16	17	27	23	15	18
taxa registered per month	(2)	(9)	(8)	(4)	(7)	(10)	(7)	(5)	(9)	(6)	(3)	(9)

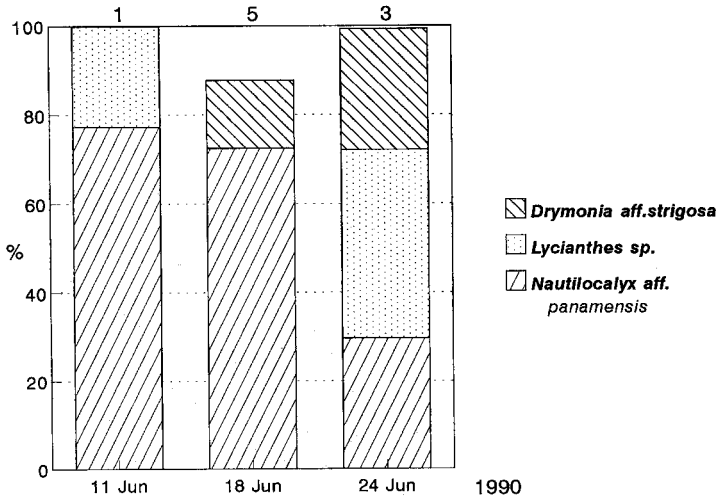
The resources of feeding importance were from the secondary vegetation of this area, most of them constituted the arboreal and bushy strata, and few plant species belong to the herbaceous stratum.

Some important plants, such as *Begonia biserrata*, *Commelina* sp., *Cordylone termi-*

*nalis*, *Saurauia* sp. and *Solanum torvum* were within a few meters around *E. atrovirens* nests. Other taxa visited exclusively to collect nectar and which were near the nesting area included *Elettaria cardamomum* (cultivated species) and *Salvia purpurea*.



**Figure 1.** Important plant species registered in a parasocial nest. The numbers that are at the top of each bar refer to taxa represented by less than 10 %.



**Figure 2.** Important plant species registered in a social nest. The numbers that are at the top of each bar refer to taxa represented by less than 10 %.

### 3.1. Foraging behavior

#### 3.1.1. Pollinic diversity ( $H'$ )

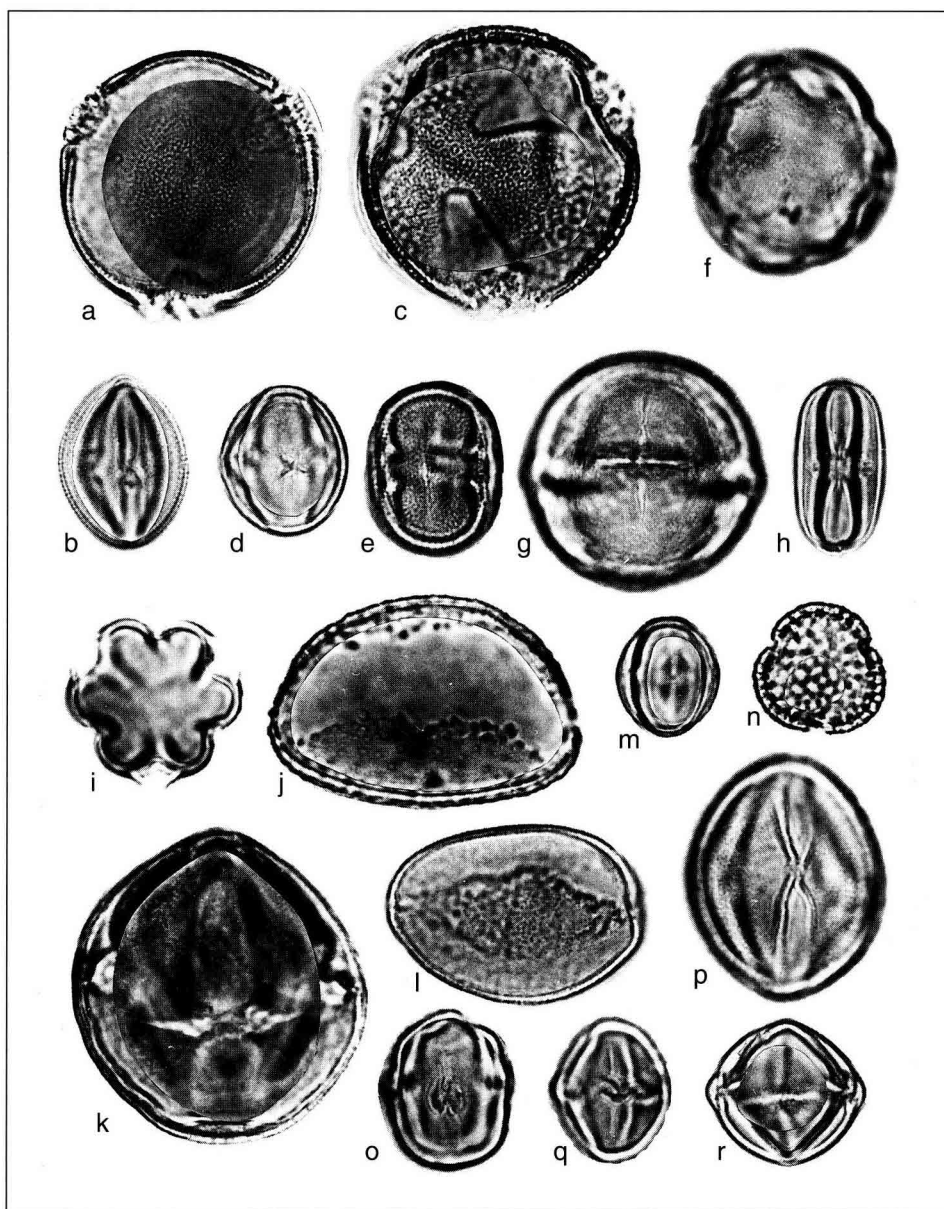
In the population studied, the diversity index by nest ( $n = 51$ ), varied from 0.12 to 2.04, with a population average of  $1.12 \pm$

0.19. However, most of the data were between 0.83 and 1.3 (figure 4).

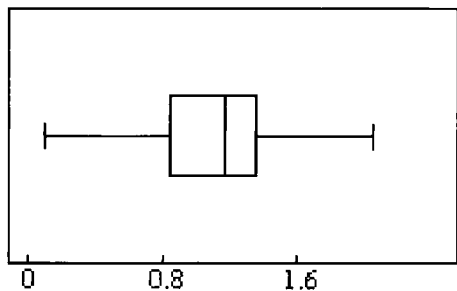
#### 3.1.2. Evenness ( $J'$ )

Regarding the evenness ( $n = 51$ ), the values varied from 0.07 to 0.75, with an ave-

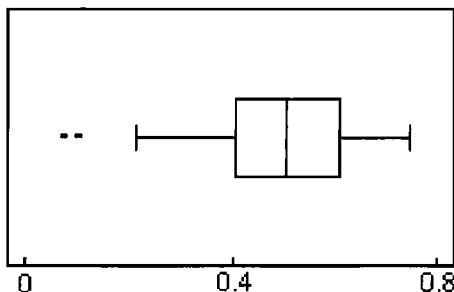




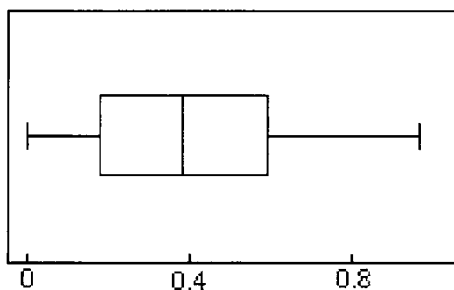
**Figure 3.** Nectaropolliniferous plant species. Gesneriaceae (a–c): a) *Drymonia* aff. *strigosa*, b) *Kohleria elegans*, c) *Nautilocalyx* aff. *panamensis*; Leguminosae: d) *Lonchocarpus* sp.; Rubiaceae: e) *Rondeletia* sp. Polliniferous plant species: Actinadiaceae: f) *Saurauia* sp.; Araliaceae: g) *Dendropanax* sp.; Begoniaceae: h) *Begonia biserrata*; Combretaceae: i) *Combretum* sp.; Commelinaceae: j) *Commelina* sp.; Leguminosae: k) type 4; Liliaceae: l) *Cordyline terminalis*; Melastomataceae: m) *Tibouchinia longifolia*; Rubiaceae: n) *Anthirhea* sp.; Solanaceae: o) *Lycianthes* sp. Polliniferous plant species with buzz pollination: Leguminosae: p) *Cassia* sp.; Solanaceae (q–r): q) *Solanum* aff. *tuerckheimii*, r) *Solanum* aff. *torvum*.



**Figure 4.** Box diagram showing the distribution of the diversity indexes ( $H'$ ) calculated per nest.



**Figure 5.** Box diagram showing the distribution of the evenness indexes ( $J'$ ) calculated per nest.



**Figure 6.** Box diagram showing the the resources overlapping (PS) during the studied year

range of  $0.48 \pm 0.02$ , which means that *E. atrovoneta* had heterogeneous collecting sources (figure 5). The major record numbers obtained were registered from 0.4 to 0.6.

### 3.1.3. Overlapping of feeding resources (PS)

The overlapping values ( $n = 300$ ) varied from 0.002 to 0.95 with a mean of  $0.38 \pm 0.06$ . On the other hand, the main records were grouped in the 0.19–0.57 interval.

In general, when the *E. atrovoneta* population was increased, the major number of plants and the major number of high overlapping indexes were registered. These occurred during June, July, September, October, January, February and May (figure 6).

The overlapping behavior occurred when *E. atrovoneta* females foraged over *Saurauia* sp., *Dendropanax* sp., *Chamaedorea* sp., *Impatiens wallerana*, *Begonia biserrata*, *Alnus* sp., Betulaceae type 1, Chenopodiaceae–Amaranthaceae, *Combretum* sp., *Evolvulus* sp., *Dioscorea* sp., *Drimonia* aff. *strigosa*, *Kohleria elegans*, *Nautilocalyx* aff. *panamensis*.

*rata*, *Alnus* sp., Betulaceae type 1, Chenopodiaceae–Amaranthaceae, *Combretum* sp., *Evolvulus* sp., *Dioscorea* sp., *Drimonia* aff. *strigosa*, *Kohleria elegans*, *Nautilocalyx* aff. *panamensis*.

## 4. DISCUSSION

The present study is the first palynological research of larval feeding carried out in solitary and parasocial *E. atrovoneta* nests.

The *E. atrovoneta* population studied was polylectic. All the plant species with values of importance for *E. atrovoneta* were exclusively polliniferous and nectaropolliniferous from the arboreal and herbaceous strata belonging to secondary vegetation. Despite the abundance of *Coffea arabica* in the surroundings, this species was not an important feeding resource.

Some important genera for *E. atrovoneta*, such as *Solanum*, *Cassia*, *Drymonia* and *Tibouchinia* had been previously cited for other Euglossinae through field observations.

With respect to resource availability, the important species *Begonia biserrata*, *Comelina* sp., *Cordyline terminalis*, *Saurauia* sp. and *Solanum torvum* were near the nests although, these plants were not in abundance. This forage behavior differs from that cited by Janzen [8], who mentioned that Euglossinae moves long distances in the

Costa Rican tropical forest, to obtain resources and it can take up to 2 h even for a single trip. It is possible that *Euglossa* at Unión Juárez visited nearby plants that were attractive because their exploitation involved less energy expenditure. It is possible that they do travel long distances during periods of scarcity. This is indicated by pollen collecting times that vary from 5 min to 2 h [23].

The differences in the foraging behavior observed between the Costa Rica *Euglossinae* and that of *E. atrovoneta* at Unión Juárez, Chiapas, could be related to differences in the types of vegetation. Hence, Janzen carried out his observations in an undisturbed tropical rain forest, while the present study was made in a perturbed tropical community. Janzen [8] cited that the important food plants for 'orchid bees' produce a small number of flowers over long periods of time. However, *E. atrovoneta* visited not only species with long flowering periods, but also foraged plants that flowered for medium and short time periods.

Female bees that constructed their nests at the same time had similar forage behavior and visited the same taxa, although the intensity of exploitation could change. This was reflected in the frequencies registered in larval feeding samples. There were also differences in female behavior, possibly related to the individual preferences for some flowers. This indicates a level of plasticity in the diet of these bees.

Differences were also observed in foraging behavior between solitary and parasocial nests (i.e. figures 1 and 2). The differences in the higher number of taxa of importance may reflect that parasocial nests existed for a longer period of time and it is possible that during this interval, the plants registered at the beginning finished flowering and then other plant species started to bloom and were visited by *Euglossa* females. The previous statement could be tested with the following regression analysis with the equation:

$$Y = 7.64 + 0.076 (X)$$

where Y is the number of plant species (dependent variable), and X the time of nest construction (independent variable).

The result gave a value for R-squared of 35.4, which means that 35.4 % of plant species variation depends on the time of nest construction.

Also, differences between solitary and parasocial nests may be due to the particular preferences of each female bee. In parasocial nests two or more bees cohabited, but there was no communication among them on the location of the important resources, as in social bees. Then, it is possible that each female had different preferences at the same time and thus increased the species richness. This could be proved with a regression where 26.7 % of sample richness is due to the variation of number of female bees in the same nest. The regression equation was:

$$Y = 8.82 + 1.44 (X)$$

where Y is the number of plant species (dependent variable), and X the number of female bees by nest (independent variable).

Comparing the results obtained in the present study with those from other studies for stingless bees (eusocial bees) in the same area, it was observed that *E. atrovoneta* visited more plant species than stingless bees. This may be due to *E. atrovoneta* displacement ability that permits it to forage over more polliniferous and nectariferous resources in a given time.

In addition, the *E. atrovoneta* larval feeding analysis showed that the important trophic species are polliniferous and polliniferous-nectariferous. Similar results were obtained for *Melipona* and *Trigonini* [12, 14, 22, 27], indicating that both bee groups follow the same patterns for foraging to optimize their resources.

It is worth noting that there were important common taxa visited by *Melipona*, *Trigonini* and *E. atrovoneta* in Unión Juárez which were: *Saurauia* sp., *Commelina* sp.,

*Lonchocarpus* sp., *Cordyline terminalis*, *Tibouchinia longifolia*, *Rondeletia* sp. and *Solanum* sp. [12, 14, 22, 27]. Particular floral preferences were registered in the *E. atrovæneta* population, where female bees exploited the following plant species: *Dendropanax* sp., *Begonia biserrata*, *Combretum* sp., *Drimonia* aff. *strigosa*, *Kohleria elegans*, *Nautilocalyx* aff. *panamensis*, *Cassia* sp., Leguminosae type 4, *Antirhea* sp., *Lycianthes* sp., *Solanum* aff. *torvum* and *Solanum* aff. *tuerckheimii*.

So far, it is evident that a resource partition exists among the different Apidae members that had been studied at the same zone. Although there is overlapping in feeding resources, there are differences in interspecific and intraspecific forage strategies.

#### 4.1. Ecological aspects

According to the palynological diversity registered in the samples, the  $H'$  values were high throughout the year of study. These results indicated that *E. atrovæneta* collected its resources heterogeneously. The heterogeneous foraging in space and time determined that euglossas have different preferences to collect their resources. Nevertheless, they exploited more intensely only a few plants, and even *E. atrovæneta* had very specific foraging.

In general, the values of PS show a low amount of overlapping, proving that although *Euglossa* females visited the same blooming resources, these were exploited in a different way. Higher levels of overlapping occurred only during the rainy season and at the beginning of the year, coinciding with an increase in the *E. atrovæneta* population [23].

If the  $H'$  values of *E. atrovæneta* are compared with those cited for maximum and minimum  $H'$  and  $J'$  values for *Tetragonisca angustula* [27] in the same area, the major diversity in larval feeding samples had been registered in both *Tetragonisca* and *E. atro-*

*væneta*.

With respect to the evenness ( $J'$ ), the highest index was registered in *T. Angustula* [27], meaning that this bee forages homogeneously for its resources, and *E. atrovæneta* follows in importance. In contrast, the lowest evenness data were registered in *E. atrovæneta*, indicating that this bee can collect its resources heterogeneously, when it has specific floral preferences.

#### ACKNOWLEDGMENTS

This research was supported by CONACyT (reg. 55888). The authors are grateful to Dr Michener and Dr Dressler for their important taxonomical contributions as well as Magdalena Alcayde for reviewing the English version and to M. en C. Lourdes Flores Delgadillo for her statistical advice.

**Résumé – Plantes butinées par *Euglossa atrovæneta* (Apidae : Euglossinae) à Unión Juárez, Chiapas, Mexique. Une étude palynologique de la nourriture larvaire.** Des échantillons de nourriture larvaire ont été prélevés chaque semaine durant une année, du 31 mai 1990 au 29 mai 1991, dans 51 nids d'*Euglossa atrovæneta* à Unión Juárez, dans le Chiapas (Mexique). Leur analyse palynologique a montré que *E. atrovæneta* butinait 74 espèces de plantes (tableau I). On a observé des différences dans le comportement de butinage entre nids solitaires et nids parasociaux (figures 1 et 2), différences qui sont liés à la période de nidification et aux préférences de chaque femelle. Au cours de l'année *E. atrovæneta* a présenté un indice moyen de diversité de 0,83 (figure 3) et un comportement de butinage hétérogène ( $J' = 0,45$ ) (figure 4) avec un faible recouvrement des ressources (PS moyen = 0,38) entre les nids solitaires et les nids parasociaux étudiés (figure 5). On a enregistré le plus grand nombre d'espèces butinées et le plus grand indice de recouvrement pour les populations les plus nombreuses. Les res-

sources les plus importantes pour la nourriture larvaire sont au nombre de 22 et ont été classées en : a) espèces pollinifères : quatre taxons indéterminés, *Anthirhea* sp., *Begonia biserrata*, *Cassia* sp., *Combretum* sp., *Commelina* sp., *Cordylina terminalis*, *Dendropanax* sp., Légumineuses type 4, *Lycianthes* sp., *Rondeletia* sp., *Saurauia* sp., *Solanum* aff. *torvum*, *Solanum* aff. *tuerckheimii*, *Tibouchinia longifolia* et b) nectaropollinifères : *Drymonia* aff. *strigosa*, *Kohleria elegans*, *Lonchocarpus* sp. et *Nautilocalyx* aff. *panamensis* et toutes les Gesneriaceae à fleurs tubulaires. Certaines de ces espèces sont associées à la pollinisation vibratile (*Cassia* et *Solanum*). © Inra/DIB/AGIB/Elsevier, Paris

***Euglossa atroveneta* / ressource alimentaire / nourriture larvaire / analyse pollinique**

**Zusammenfassung – Nahrungsressourcen von *Euglossa atroveneta* (Apidae: Euglossinae) in Unión Juárez, Chiapas, Mexiko. Eine palynologische Untersuchung der Larvenernährung.** Bei 51 Nestern von *Euglossa atroveneta* wurden wöchentlich Proben von der Larvennahrung entnommen und palynologisch untersucht. Es zeigte sich, daß *E. atroveneta* im Verlauf eines Jahres, vom 31 Mai (1990) bis zum 29 Mai (1991) 74 Pflanzenarten besammelte, von denen 22 Arten vermehrt befliegen wurden. Dabei wurden Unterschiede im Sammelverhalten zwischen Einzel- und parasozialen Nestern beobachtet (Abb. 1 und 2), die mit der Zeit des Nestbaus und besonders mit individuellen Bevorzugungen einzelner Weibchen zusammenhingen. Während des Jahres zeigte *E. atroveneta* einen durchschnittlichen Diversitätsindex von 0,83 (Abb. 3) und ein heterogenes ( $J' = 0,45$ ) Sammelverhalten (Abb. 4). Zwischen den einzelnen und den parasozialen Nestern ergab sich eine durchschnittliche Überschneidung der Nahrungsressourcen von  $PS = 0,38$  (Abb. 5). Bei zunehmender Populationsdichte von *E. atroveneta* war die

Anzahl der besammelten Arten am größten und der Wert des Überlappungsindex am höchsten. Als für die Larven wichtigste Nahrungsressourcen wurden folgende Arten bestimmt: a) die Pollenerzeuger: *Antirhea* sp., *Begonia biserrata*, *Cassia* sp., *Combretum* sp., *Commelina* sp., *Cordylina terminalis*, *Dendropanax* sp., der Leguminosen Typ 4, *Lycianthes* sp., *Sauria* sp., *Solanum* aff. *torvum*, *Solanum* aff. *tuerckheimii*, *Tibouchinia longifolia*, und b) die Nektar- und Pollenerzeuger: *Drymonia* aff. *strigosa*, *Kohleria elegans*, *Lonchocarpus* sp. und *Nautilocalyx* aff. *panamensis*. Alle Gesneriaceae hatten Röhrenblüten. © Inra/DIB/AGIB/Elsevier, Paris

***Euglossa atroveneta* / Larvennahrung / Palynologie / neotropisch / Orchideenbienen / Nahrungsressourcen**

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