FIELD DIET OF THE GRASSHOPPER *ABRACRIS DILECTA* WALKER (ORTHOPTERA, ACRIDIDAE)

Carlos Frankl Sperber [1]

ABSTRACT. *Abracris dilecta* Walker, 1870 (Orthoptera, Acrididae, Ommatolampinae) ate leafs of at least 14 plant species, in the families Asteraceae, Lamiaceae, Malvales (Sterculiaceae, Tiliaceae or Malvaceae), Poaceae, Fabaceae, Verbenaceae, Aristolochiaceae, Rubiaceae and Melastomataceae. *Elephantopus mollis* H.B.K. (Asteraceae) and *Hyptis suaveolens* Poit. (Lamiaceae) comprised 50% of the diet. The diet breadth of *A. dilecta* was compared to that of other 11 grasshopper species of the same sub-family, with rarefaction curves. The number of plant species eaten by *A. dilecta* was greater than that of nine other grasshopper species of the same sub-family (*Rhachicreagra* spp.) but was lower then two others (*Microptylopteryx hebardi* Rehn, 1905 and *Rhachicreagra astytophallus* Jago & Rowell, 1981). This results are discussed in view of the broad geographical range and possession of developed wings by *A. dilecta*, which contrasts with most Ommatolampinae grasshoppers.

KEY WORDS. herbivory, diet breadth, tropical dry forest edge, Neotropical region, Brazil

Abracris dilecta Walker, 1870 belongs to the Ommatolampinae (Tribe Abracrini), a Neotropical sub-family of the Acrididae. *A. dilecta* is found in dry, shrubby habitats (ROBERTS & CARBONELL 1981), while most Ommatolampinae are associated with secondary growth vegetation and dry forest areas (AMÉDÉGNATO & DESCAMPS 1980; ROWELL 1987), or light-gaps in moist tropical forests (BRAKER 1991; JAGO & ROWELL 1981). *A. dilecta* differs from most Ommatolampinae for having a broad geographical distribution, from northern Mexico to Argentina, and for the presence of developed wings. These characteristics could lead to a broader diet in *A. dilecta* than in the species with more restricted distribution and mobility. The aim of this study was to analyse the diet composition (taxonomic range, proportion of host plant species and families in the diet), and breadth (number of plant species ingested) in the field, comparing them with data on other Ommatolampinae grasshoppers.

METHODS

The field data were collected in an area of 360x30m (20°47'S, 49°20'W), at a border of a semi-deciduous tropical forest, including the pasture beside it, in São José do Rio Preto, State of São Paulo, Brazil. Grasshoppers were captured with translucent plastics vials and kept with moist cotton, fasting for 24 hours, to collect their faeces.

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[1] Departamento de Biologia Geral, Setor de Ecologia, Universidade Federal de Viçosa. 36570-000 Viçosa, Minas Gerais, Brasil.

The field diet composition and breadth were determined comparing the faeces of 69 grasshoppers to reference material. To obtain reference faeces material, 51 grasshoppers were kept in the laboratory individually separated, feeding on one of 55 plant species collected in the field (Tab. I). Epithelial reference material was done of the plant species not accepted by these grasshoppers.

The faeces were fixed in a solution of FAA (formalin, acetic acid, and alcohol), macerated over microscope glass plates with glycerine and drawn through optic microscope observations. Every new plant species found in each individual's faeces was recorded as one observation, giving a total of 104 observations. Plant fragment identification was made when possible. When in doubt, plant species in the faeces were lumped, instead of split. The frequency of ingestion was calculated using the number of individuals that presented at least that plant fragment. As several individuals ingested more than one plant species the frequencies did overlap.

The field diet was compared to literature data, with rarefaction curves (KREBS 1989), using the estimates of 95% confidence intervals. Number of observations were considered as abundance estimates of the plant species ingested in the diet of the grasshoppers. With the rarefaction curves, the estimate of expected number of plant species present in smaller samples than the actual one is possible. This permits comparisons of samples with different size. Only published data on Ommatolampinae diets with details on the frequency of each host plant in the diet could be analysed. The frequency of the host plants in *Rhachicreagra* spp.'s diet (ROWELL 1983a) was estimated multiplying the number of analysed individuals by the minimum estimate of the proportion of the host plant in the diet. In most cases minimum and maximum estimates of host plant frequencies in *Rachicreagra*'s diet did not result in different rarefaction curves. When they did differ, minimum estimates generated rarefaction curves more similar to the rarefaction curve of *A. dilecta* and *Microptylopteryx hebardi* Rehn, 1905, for which the actual frequencies were known. The diet frequencies of *Rhachicreagra* spp. overlap, resulting in greater number of observations than individual grasshoppers analysed. *M. hebardi* data (BRAKER 1991) referred to number of individual grasshoppers observed eating in the field. No distinction was done of these frequencies with faeces data.

RESULTS

Within the plant families eaten, *A. dilecta* ate some but not all of the species present in the field (Tab. I). For example, *Orthopappus angustifolius* Gleason and *Pterocaulon lanatum* Kuntze were two common Asteraceae in the field that were not present in the grasshoppers' faeces. Both were ingested by *A. dilecta* in the laboratory (Tab. I).

A. dilecta presented a diet that included both weeds and forest border species, and among herbs both forbs and Poaceae (Tab. II). *A. dilecta* ate at least 14 plant species, of at least nine different families. Six plant families ingested by *A. dilecta* are also eaten by other grasshopper species of the same sub-family (GANGWERE & RONDEROS 1975; ROWELL 1978, 1983a,b, 1985; MARQUIS & BRAKER 1987; BRAKER 1991): Asteraceae (four species ingested), Lamiaceae, Rubiaceae, Verbenaceae, Poaceae, and Melastomataceae (Tab. II). There were no prior reports on Ommatolampinae feeding on other three plant taxa: Malvales (Sterculiaceae, Tiliaceae or Malvaceae, not distinguishable through faeces fragments), Fabaceae and Aristolochiaceae.

Table I. Plant species offered to *Abracris dilecta* grasshoppers to obtain reference faeces material for the identification of the field diet, and abundance of them in the field (+abundant, - rare). Plants not accepted (*) were analysed with epithelium glass slides.

Plant species	Field abundance
Agonandra englerii Hoehne (Opiliaceae) *	-
Alibertia cf. sessilis K. Schum. (Rubiaceae)*	+
Apocynaceae sp. 1 *	-
Aristolochia esperanze Kuntze (Aristolochiaceae)	+
Asclepiadaceae sp. 2	+
Aspidosperma sp. (Apocynaceae)*	-
Baccharis dracunculifolia DC.(Asteraceae)	-
Bauhinia bongardi Steud. (Caesalpiniaceae)	-
Blainvillea cf. biaristata DC.(Asteraceae)	-
Byrsonima intermedia A. Juss. (Malpighiaceae) *	-
Casearia sylvestris Sw. (Flacourtiaceae)	-
Celtis spinosa Ruiz ex. Miq. (Ulmaceae)	+
Chaptalia integerrima (Vell.) Burkart (Asteraceae)	-
Chomelia sp. (Rubiaceae)	-
Cupania cf. oblongifolia Mart. (Sapindaceae)	-
Dalechampia tryphylla Lam. (Euphorbiaceae)	+
Desmodium adscendens DC. (Fabaceae)	-
Desmodium sp. (Fabaceae)	+
Diodia teres Walt. (Rubiaceae)	-
Elephantopus mollis H.B.K. (Asteraceae)	+
Erythroxylum campestre A. St.-Hil. (Erythroxylaceae) *	-
Eupatorium sp. (Asteraceae)*	-
Fridericia speciosa Mart. (Bignoniaceae)*	-
Guapira sp. (Nyctaginaceae)	-
Guettarda cf. uruquensis Cham. & Schltdl. (Rubiaceae)	-
Helicteres ovata Lam. (Sterculiaceae)	+
Hyptis suaveolens Poit. (Lamiaceae)	+
Lantana camara L. (Verbenaceae)	-
Lantana lilacina Desf. (Verbenaceae)	-
Lantana sp. (Verbenaceae)*	-
Luehea paniculata Mart. & Zucc. (Tiliaceae)*	-
Malpighiaceae sp. 3	-
Matayba elaeagnoides Radlk. (Sapindaceae)*	-
Miconia albicans Steud. (Melastomataceae)*	-
Nectandra cf. rigida Nees (Lauraceae)	-

(cont.)

Table I. Continued.

Plant species	Field abundance
Orthopappus angustifolius Gleason (Asteraceae)	+
Paspalum sp. (Poaceae)*	+
Peritassa sp. (Celastraceae)	-
Pterocaulon lanatum Kuntze (Asteraceae)	+
Rhamnidium elaeocarpum Reissek (Rhamnaceae)	+
Sebastiania sp. (Euphorbiaceae)	-
Serjania communis Cambess. (Sapindaceae)	+
Sida cf. glaziovii K. Schum. (Malvaceae)*	+
Smilax sp. (Liliaceae)	-
Solanum paniculatum L. (Solanaceae)*	-
Terminalia brasiliensis Spreng. (Combretaceae)	-
Tournefortia sp. (Boraginaceae)	-
Trichilia casaretti C. DC. (Meliaceae)	+
Trichilia clausseni C. DC. (Meliaceae)*	+
Vernonia brasiliana Druce (Asteraceae)	-
Vernonia ferruginea Less. (Asteraceae)	+
Vernonia ruficoma Schtdl. (Asteraceae)*	-
Waltheria indica L. (Sterculiaceae)*	-
Wissadula cf. subpeltata R.E.Fr. (Malvaceae)	-
Xylopia aromatica Baill. (Annonaceae)	-

Elephantopus mollis H.B.K. (Asteraceae) and *Hyptis suaveolens* Poit. (Lamiaceae) were the most frequently ingested plants, followed by one or more of four Malvales species, which could not be separated with the faeces fragments, Poaceae, *Baccharis dracunculifolia* DC. (Asteraceae), *Desmodium* sp. (Fabaceae), *Vernonia ruficoma* Schltdl. (Asteraceae), *Lantana camara* L. (Verbenaceae), *Aristolochia esperanzae* Kuntze (Aristolochiaceae), *Vernonia ferruginea* Less (Asteraceae), *Chomelia* sp. (Rubiaceae), and *Miconia albicans* Steud. (Melastomataceae) (Tab. II). Two plant species could not be identified at the family level.

In table III the diet breadth of 19 Ommatolampinae grasshoppers is presented. Of these, 12 could be compared using rarefaction curves (Fig. 1). *Microtylopterix hebardi* Rehn, 1905 has a more then two fold broader diet then *A. dilecta*, confirmed by the rarefaction curves. *Rhachicreagra astytophallus* Jago & Rowell, 1981 and *Rhachicreagra brachysphagicerca* Jago & Rowell, 1981 presented a proximate diet breadth with *A. dilecta*, but analysis of the confidence intervals reveals that only *R. astytophallus* has a greater diet breadth then *A. dilecta*, whereas *R. brachysphagicerca* has a narrower diet breadth. The remaining *Rhachicreagra* species have all narrower diets than *A. dilecta*. The diet breadth of *Abracris flavolineata* (De Geer, 1773) and *Leptomerithoprora brevipennis* Rehn, 1905 are very similar with *A. dilecta*, but no conclusive analysis was possible because of lack of detailed data on this and other six Ommatolampinae species.

Table II. Plant species found in the faeces of *Abracris dilecta* (Orthoptera: Acrididae), number of individual grasshoppers that presented the plant, and plant life form (H: herb, B: bush, A: arboreal, V: vine, W: weed). Number of grasshoppers analysed = 69. Weed classification based on Bacchi *et al.* (1984) and Lorenzi (1982).

Plant species	Individuals	Life form
Elephantopus mollis H.B.K. (Asteraceae)	31	H, W
Hyptis suaveolens (Lamiaceae)	21	H, W
Helicteres ovata Lam. (Sterculiaceae)		A
Luehea paniculata Mart. & Zucc. (Tiliaceae)		A
Waltheria indica L. (Sterculiaceae)		H, W
Wissadula cf. subpeltata R.E.Fries (Malvaceae)	18	H, W
Poaceae	9	H, W
Baccharis dracunculifolia DC. (Asteraceae)	6	B, W
Desmodium sp. (Fabaceae)	6	H, W
Vernonia ruficoma Schltdl.(Asteraceae)	3	B
Lantana camara L. (Verbenaceae)	2	B, W
Aristolochia esperanze Kuntze (Aristolochiaceae)	1	V
Vernonia ferruginea Less. (Asteraceae)	1	B, W
Chomelia sp. (Rubiaceae)	1	A
Miconia albicans Steud. (Melastomataceae)	1	B
Not identified species (sp. 1)	1	
Not identified species (sp. 2)	3	

Table III. Number of plant species and families eaten by Neotropical grasshoppers of the sub-family Ommatolampinae (Orthoptera, Acrididae) in the field, number of grasshopper individuals analysed (N), and reference. (≥) At least; (≤) not more then; (**ns**) not specified; (**1**) Rowell 1983b; (**2**) Rowell 1978; (**3**) Braker 1991; (**4**) Rowell 1983a; (**5**) Rowell 1985.

Grasshopper species	Plant species	Plant families	N	Reference
Abracris flavolineata (De Geer, 1773)	≥ 10	≥ 10	ns	1
Abracris dilecta Walker, 1870	≥ 14	≥ 6	69	This work
Ateliacris annulicornis (Bruner, 1908)	1	1	ns	2
Microtylopteryx hebardi Rehn, 1905	52	16	438	3
Microtylopteryx fusiformis Rehn, 1905	2	2	ns	2
Microtylopteryx talamancae Rehn, 1929	≥ 4	3	ns	2
Leptomerinthoprora brevipennis Rehn, 1905	≥ 9	≥ 6	ns	4
Rhachicreagra anchidiphalara Jago & Rowell, 1981	9	6	39	5
Rhachicreagra astytophallus Jago & Rowell, 1981	8 - 9	6	16	5
Rhachicreagra brachysphagicerca Jago & Rowell, 1981	7	5	17	5
Rhachicreagra drymocnensis Jago & Rowell, 1981	4	4	15	5
Rhachicreagra gracilis Bruner, 1908	3	2	11	5
Rhachicreagra haematodes Jago & Rowell, 1981	ns	1	ns	5
Rhachicreagra khayachrosa Jago & Rowell, 1981	≤ 8	1	13	5
Rhachicreagra melanota Jago & Rowell, 1981	5	4	15	4
Rhachicreagra nothra Rehn, 1905	8 - 10	6 - 7	46	4
Rhachicreagra obisidian Jago & Rowell, 1981	4	5	16	4
Rhachicreagra sp. 215	5	4	15	4
Rhachicreagra sp. 243	3	2	12	4

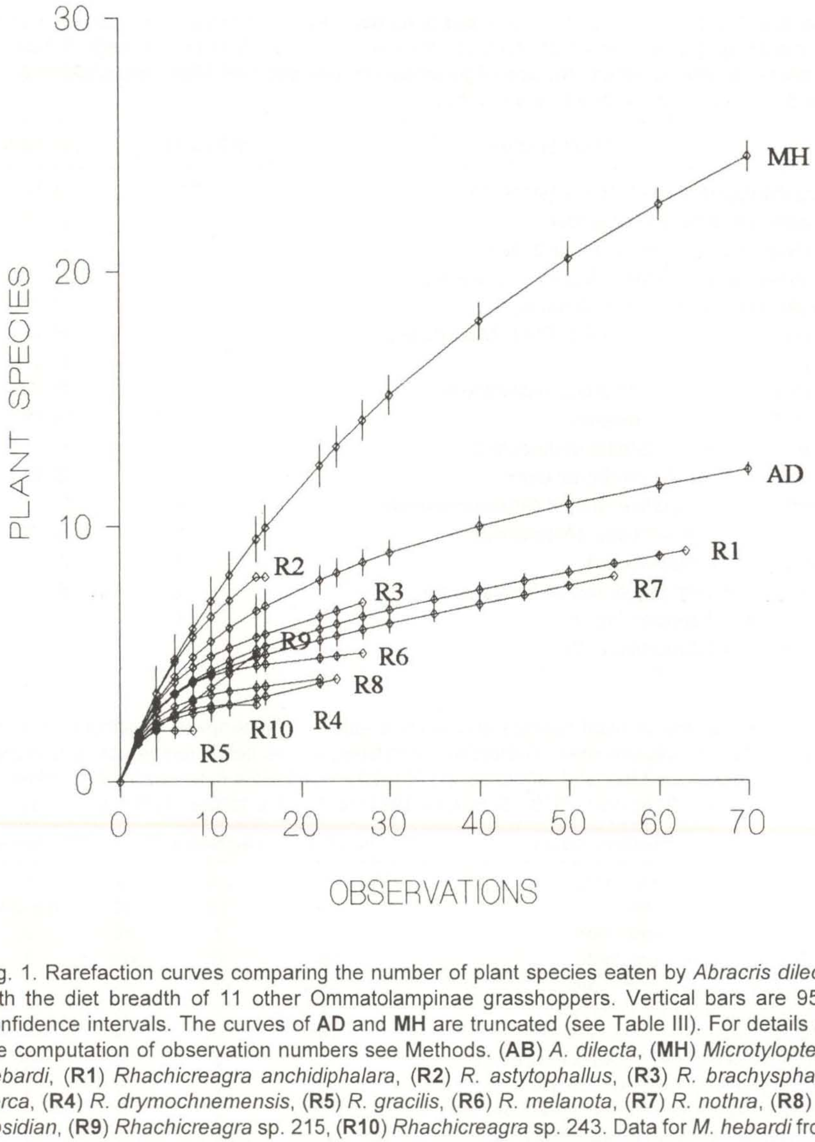

Fig. 1. Rarefaction curves comparing the number of plant species eaten by *Abracris dilecta* with the diet breadth of 11 other Ommatolampinae grasshoppers. Vertical bars are 95% confidence intervals. The curves of **AD** and **MH** are truncated (see Table III). For details on the computation of observation numbers see Methods. (**AB**) *A. dilecta*, (**MH**) *Microtylopterix hebardi*, (**R1**) *Rhachicreagra anchidiphalara*, (**R2**) *R. astytophallus*, (**R3**) *R. brachysphagicerca*, (**R4**) *R. drymochnemensis*, (**R5**) *R. gracilis*, (**R6**) *R. melanota*, (**R7**) *R. nothra*, (**R8**) *R. obsidian*, (**R9**) *Rhachicreagra* sp. 215, (**R10**) *Rhachicreagra* sp. 243. Data for *M. hebardi* from BAKER (1991) and for *Rhachicreagra* spp. from ROWELL (1985).

Each individual *A. dilecta* had one to four plant species fragments in its faeces (Mean=1.6, Standard Deviation=0.8). This individual diet breadth is the same as that found for *Dociostaurus maroccanus* (Thunberg, 1815) (Orthoptera: Acrididae: Gomphocerinae) (BEN HALIMA *et al.* 1985), but much less than the number of plant species eaten by *Taeniopoda eques* (Burmeister, 1839) (Orthoptera: Romaleidae: Romaleinae) in a 12-hour period (RAUBENMEIER & BERNAYS 1993).

DISCUSSION

There was no obvious chemical pattern in the diet of *A. dilecta*. The grasshoppers ingested plant species with different alelochemical compositions (*e.g.*, lactone sesquiterpenes in *Elephantopus* mollis, *O. angustifolius* and *Baccharis dracunculifolia* (JAKUPOVIC *et al.* 1987); alcohol sesquiterpenes in *B. dracunculifolia* (ZDERO *et al.* 1989); tripterpenoids in *Hyptis suaveolens* and *Lantana camara* (PEREDA-MIRANDA *et al.* 1990; QUEIROZ *et al.* 1990; RAO *et al.* 1990; SHARMA *et al.* 1990); coumarins in *B. dracunculifolia* (ZDERO *et al.* 1989). In addition, *A. dilecta* did not eat all plants with similar alelochemicals, even if they were abundant in the field. These results agree with observations on other grasshopper species, that also do not present chemical fidelity (BERNAYS & CHAPMAN 1978; CHAPMAN 1990). This work reinforces, therefore, the thesis that there was no chemical coevolution of grasshoppers and their host plants (BERNAYS & GRAHAM 1988).

A. dilecta has biological characteristics of generalist species: a broad geographic range, great mobility, and association with secondary vegetation - a possible opportunistic strategy. However it has a narrower diet breadth than two geographically restricted, wingless, grasshoppers: *Microtylopterix hebardi* Rehn, 1905 (Orthoptera, Acrididae) and *Rhachicreagra astytophallus* Jago & Rowell, 1981 (Orthoptera, Acrididae), of the same sub-family. This paradox may have the following reason: wingless grasshoppers must use rare plant species, in unpredictable and ephemeral habitats (forest clearings), favouring diet broadening. Moreover, *A. dilecta* may use more predictable resources than the forest light-gap inhabitants, not due to the vegetation dynamics *per se*, but due to the ubiquity of certain well-adapted weed species, and the great mobility of *A. dilecta*, which permits searching for specific host plants.

CONCLUSIONS

The results of this work reinforced the proposal that alelochemicals are of little importance in the determination of grasshoppers diet composition and breadth. The comparison of the diet breadth of *A. dilecta* with other Ommatolampinae grasshoppers showed an apparent paradox: though *A. dilecta* has biological characteristics of generalist species, it presented a narrower diet breadth than some micropterous, forest light-gap inhabiting grasshoppers. It is proposed that the host plants of *A. dilecta* may be more predictable than light-gap plants, and that the ability of *A. dilecta* to fly may diminish the costs of host plant searching.

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