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Attraction of Chloropidae (Diptera) to pyrrolizidine alkaloids

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Both sexes of several species of Chloropidae in 4 genera (*Melanochaeta*, *Chlorops*, *Eutropha*, *Oscinella*) and 2 subfamilies (Chloropinae, Oscinellinae) have been found visiting pyrrolizidine alkaloid (PA)[1] baits and ingesting these secondary plant chemicals. Some of the same species have also been observed visiting decaying plants and flowers containing PAs.

Key words: *Melanochaeta*, *Chlorops*, *Eutropha*, *Oscinella*, Chloropinae, Oscinellinae, Chloropidae, Diptera, pharmacophagy, pyrrolizidine alkaloids.

Beide Geschlechter verschiedener Arten von Chloropidae aus 4 Gattungen (*Melanochaeta*, *Chlorops*, *Eutropha*, *Oscinella*) und 2 Unterfamilien (Chloropinae, Oscinellinae) wurden an Pyrrolizidin-Alkaloid Ködern gefunden; sie nehmen diese sekundären Pflanzenstoffe auf. Einige dieser Arten wurden auch an verwelkenden Teilen und Blüten PA-haltiger Pflanzen beobachtet.

[1] Pyrrolizidine alkaloids; in further text PAs

1 Introduction

Insects of numerous species belonging to several families of the Lepidoptera, Coleoptera, and Orthoptera have been observed visiting decaying and/or withered parts of plants containing pyrrolizidine alkaloids (PAs)[1] as well as pure PAs, which they take up (review and refs. in Boppré 1986; *cf.* Discussion). We here report on field studies, undertaken in Kenya, demonstrating that PAs are powerful attractants for flies of several species belonging to four genera of the Chloropidae.

2 Material and methods

Flat plastic dishes (95 x 70 x 12 mm) containing 50-200 mg of pyrrolizidine alkaloids extracted and purified from dry seeds of *Crotalaria scassellatii* Chiov. (Fabaceae) (major PA: axillaridine; Wiedenfeld *et al.* 1985; *cf.* Boppré in prep.) were displayed on the ground or on appropriate stands (up to a height of 100 cm). Observations and collection were made at these baits as well as at damaged withering parts of *Heliotropium pectinatum* Vaupel (Boraginaceae) and at flowers of *Gynura scandens* O. Hoffm. (Asteraceae). The baits were primarily displayed to collect Lepidoptera; the chloropids were thus studied opportunistically.

The baits were used in a variety of Kenyan habitats, mainly Coastal Forest (Shimba Hill area; Coast Province), savanna (sourroundings of Mtito Andei; Central Province), primary forest interspersed with cultivation (Kakamega; Western Province), and in the city of Nairobi. In these areas, baiting was done for several days in the months of August, September, and December 1984 and 1985.

In addition, PA-baits were put out by colleagues for a few days on sand dunes on the Mediterranean island of Corsica (France) in May 1985 and near La Grille, Grande Comoro, Comoro Archipelago, in September 1985.

Reference material of the flies collected is deposited at the National Museum, Nairobi/Kenya, at the British Museum (Natural History), London, and in M. B.'s collection.

3 Results

In the course of baiting for Lepidoptera with PA-containing dishes, individual flies were occasionally noted. We did not pay much attention to these because of the paucity of their appearance until we recognized, one late afternoon, large numbers of flies aggregated at leaves of *Heliotropium pectinatum*, which during previous hours had been damaged by danaine butterflies. (Danainae damage *Heliotropium* leaves by scratching with their legs at holes made previously by flea beetles (*Longitarsus gossypii* Bryant - Coleoptera: Alticinae) and thus gain access to PAs, Boppré 1983.) The flies collected on this occasion (Shimba Hills area; v/83) turned out to be *Melanochaeta atricornis* (Adams 1905) (Oscinellinae) (35 ♂♂, 33 ♀♀). Subsequently, checks during the last two hours of daylight often revealed large numbers of Chloropidae at PA-baits (Fig. 1A). Near Mtito Andei a bait once lured more than 200 specimens within 1 hour. During the day, individual flies of the same species visited the baits.

The flies approached the baits from upwind, and they seemed properly orienting even if there was quite strong wind. They landed on the dishes and extended their probosces (Fig. 1B). Uptake of PAs was observed using close-up video recordings in the laboratory. The flies were extremely shy. Even careful movements in their vicinity caused them to fly up, although, usually, they then hovered around the dishes and settled again after a while.

Having observed Chloropidae visiting pure PAs, we checked living plants of *Heliotropium pectinatum* as well as flowers of *Gynura scandens* in the Shimba Hills and found several species of flies known from baiting in this area visiting the seeds and flowers, respectively, of those plants; the dominant species was *Chlorops* sp. 1 with a sex-ratio of almost 1:1 (221 ♂♂ vs. 184 ♀♀), except in a sample collected at flowers of *Gynura scandens* in vii/86 where males outnumbered the females (428 ♂♂ vs 270 ♀♀).

Samples comprising a total of 3,374 Chloropidae from Kenya were analysed. These belong to the genera *Melanochaeta* (Oscinellinae), *Chlorops* (Chloropinae) and *Oscinella* (Oscinellinae). The actual number of flies observed was much higher, but they were not collected quantitatively.

Table 1 lists the material (species, sex, dates and sites of baiting) obtained from PA-baits. The sex ratio of these 2,271 Chloropidae was practically 1:1 (1,142 ♂♂ vs 1,129 ♀♀).

Flies confined in clear plastic containers (80 x 80 x 60 mm) lived longer than a fortnight if they had been supplied with a mash made of maize and bean flower, sugar and jam as nutrient sources. We observed flies chasing each other (apparently aggressively) on numerous occasions, but we never saw courtship, mating, or egg-laying behaviour.

The above observations were confirmed and supplemented by O. Fischer and D. Sichelschmidt in Corsica, where *Eutropha fulvifrons* (Haliday 1833) (Chloropinae) visited PA-baits (69 ♂♂, 63 ♀♀) and by P. M. Brakefield on the Comoros, where he baited *Melanochaeta scapularis* (Adams) (3 ♂♂, 6 ♀♀) and M. sp. 1 (1 ♂).

4 Discussion

The finding of chloropid flies attracted to sources of pyrrolizidine alkaloids adds members of another order to the list of insects associated with these secondary plant metabolites. Previously, Pliske (1975) mentioned that he had seen Chloropidae at dead parts of *Heliotropium indicum* and *H. angiospermum* in Venezuela, but he did not give further details.

As a phenomenon, the PA-gathering behaviour by the species of Diptera reported here resembles that observed for a variety of Lepidoptera (Danainae, several genera of Ithomiinae, Arctiidae and Ctenuchiidae), *Gabonia* beetles (Chrysomelidae) and *Zonocerus* grasshoppers (Pyrgomorphidae) (refs. in Boppré 1986)

PAs are presumably not volatile and the insects seem to perceive a degradation product. This aspect is under investigation and involves the Chloropidae (Boppré *et al*. in prep.); therefore, we do not comment on the specificity of the flies' attraction. Catches of flies at damaged *Heliotropium* or at its flowers and seeds, respectively, indicate that decaying material of PA-plants provides a natural source of PAs. The nectar of certain PA-plants also contains PAs. Finding chloropids at flowers of *Gynura scandens* (a recognized PA-plant; Wiedenfeld 1982) indicates that these flies can utilize the rich PA-sources in nectar and are thus potentially able to take advantage of a great number of plants (particularly of the Eupatoriae) as PA-sources.

It appears that all Lepidoptera associated with PAs store the secondary plant products for their defence against predators. In addition the males of various butterflies and moths require PAs for their courtship success, since they utilize PAs as precursors for the biosynthesis of pheromones (for review see Boppré 1986). The apparent similarity in the behaviour of these insects and of chloropids does not permit us, however, to draw any conclusion as to the function(s) PAs might have for these flies. Because of the diversity of insects attracted to PAs and the variety of ways in which PAs are utilized it is assumed that the relationships between insects and PA-plants evolved independently in different insect groups.

Both sexes of all chloropid species found in numbers visited sources of PAs as with *Zonocerus* and some Lepidoptera (*e.g. Rhodogastria*, Arctiidae). In contrast, in *Gabonia* and other Lepidoptera (*e.g.* Danainae), this behaviour is strongly male-biased. Sex-biased PA-gathering suggests that plant metabolites are utilized in a sexual context. In the Chloropidae no explanation for PA-gathering behaviour exists. Since the flies are so tiny, a defensive use of PAs by them is difficult to imagine although some of the species involved appear aposematic.

Gathering secondary plant substances independent of feeding behaviour to increase fitness has been termed „pharmacophagy" (Boppré 1984) in order to stress the peculiarity of this kind of insect-plant relationship. At present, however, we cannot call the chloropids pharmacophagous because we entirely lack information on what they do with PAs. As with *Gabonia* (Scherer & Boppré 1987), hardly anything is known about the biology of the chloropid flies attracted to PAs discussed here. This makes an experimental approach on functional aspects very difficult, unless the species can be reared under laboratory conditions and subsequent experimental work is carried out. The (larval and adult) hosts of most species of Chloropidae („grass flies") are unknown or not precisely determined, larvae of many are saprophagous, of others phytophagous, the latter feeding especially on grasses (Poaceae). We are trying to breed one or the other species as a basis for studying the role(s) of PAs experimentally. Nevertheless, the phenomenon as such is extremely interesting, and the few tests conducted with PA baits demonstrate that a variety of species in very different habitats are associated with PAs. Also as it is likely that more species of Chloropidae may exhibit similar behaviour, baiting in other habitats or during other seasons should be carried out. Since Chloropidae include many cereal pest species, PAs, perhaps, might conceivably prove useful in integrated control.

Due to the opportunistic study of chloropids at sources of PAs the information available is not suited for evaluation with respect to abundance, seasonality, habitat requirements, etc., of the flies; at present we also lack any functional information. We did not therefore investigate the species in detail from a taxonomic point of view. Presently, 24 species of *Melanochaeta*, including 12 Afrotropical ones, are described; we found 3 of these. (*Melanochaeta* sp. 1 might be a colour-form of *M. scapularis* as might be *M.* spp. 2 a-g). For the 25 Afrotropical species of *Oscinella* and the 13 Afrotropical species of *Chlorops*, no recent, complete keys for their identification exist.

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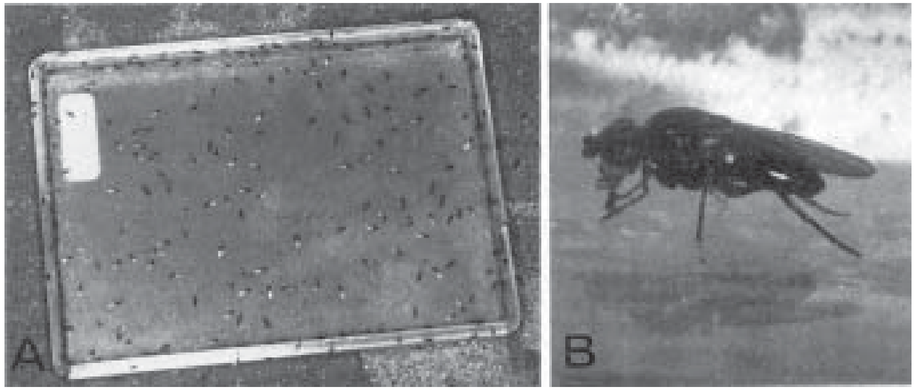
Fig 1: A) Chloropidae attracted to a dish containing PAs from *Crotalaria scassellatii* in Kenya. **B**) *Eutropha fulvifrons* (Haliday) gathering PAs with its proboscis from a bait dish; courtesy of D. Sichelschmidt.



	♂♂	♀♀		
M. atricornis	5	6	Shimba H.	xi/84, viii/85
(Adams 1905)	32	37	Nakuru	xi/84
	500	496	Mtito Andei	xi-xii/84, viii/85
	143	142	Kakamega	xi/84, ix/85
	106	101	Nairobi	viii/85, ix/85
	17	14	Aberdares	ix/85
		803	796	
M. scapularis	11	5	Mtito Andei	xi/84, viii/85
(Adams 1905)	13	20	Nairobi	viii/85, ix/85
	18	26	Kakamega	ix/85
		42	51	
M. dubia (Lamb 1918)	17	19	Mtito Andei	xi/84
M. sp. 1	49	47	Mtito Andei	xi/84
M. spp. 2 (a-g)	61	89	various areas	
Oscinella sp. 1	48	31	Kakamega	ix/85
Chlorops sp. 1	14	9	Mtito Andei	xi/84
	103	83	Shimba H.	xi/84
		4	Kakamega	ix/85
		117	96	
Chlorops spp. 2-7	5	11	various areas	

Table 1: Species of Chloropidae of the genera *Melanochaeta*, *Oscinella* and *Chlorops* collected in Kenya at pyrrolizidine alkaloid baits, their numbers, dates and localities of collection.