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Compilation of canthariphilous insects

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Summary

A list of insects attracted to cantharidin is given. Most canthariphilous insects are found within the heteropteran beetle family Anthicidae with 190 species in the three subfamilies Anthicinae (184), Lemodiinae (1) and Tomoderinae (5). Further cantharidin baited species are known from the beetle families Endomychidae (5), Cleridae (4), Chrysomelidae (3), and Staphylinidae (1). In the beetle family Pyrochroidae 23 species from the subfamily Pedilinae and 6 species of the Pyrochroinae are canthariphilous. The insect order Diptera is represented by the families Anthomyiidae (3), Cecidomyiidae (2), Ceratopogonidae (22) Chloropidae (1), Platystomatidae (1) and Sciaridae (5). Many species from the heteropteran family Miridae (29) are known to be attracted by cantharidin, also one species from the families Lygaeidae and Tingidae respectively. Parasites of the hymenopteran family Braconidae (6) show a positive reaction to cantharidin as well as species from the subfamily Diapriinae of the family Diapriidae. Chemical analyses of a fulgorid and a cicadid species revealed that also species of Homoptera may contain cantharidin.

Keywords

cantharidin; canthariphilous insects; Coleoptera; Diptera; Heteroptera; Homoptera

Zusammenfassung

Die durch Cantharidin angezogenen Insekten werden aufgelistet. Die meisten Cantharidin-abhängigen Insekten sind in der Käferfamilie Anthicidae mit 190 Arten in den drei Unterfamilien Anthicinae (184), Lemodiinae (1) und Tomoderinae (5) gefunden worden. Weitere Cantharidin-abhängige Arten sind bekannt aus den Käferfamilien Endomychidae (5), Cleridae (4), Chrysomelidae (3) und Staphylinidae (1). In der Familie Pyrochroidae sind 23 Arten aus der Unterfamilie Pedilinae und 6 Arten aus den Pyrochroinae Cantharidin-beeinflußt. Bei den Dipteren sind dies in den Familien Anthomyiidae (3), Cecidomyiidae (2), Ceratopogonidae (22), Chloropidae (1), Platystomatidae (1) und Sciaridae (5). Manche Arten der Heteropterenfamilie Miridae (29) sind bekannt wegen des Einflusses von Cantharidin ebenso jeweils eine Art aus den Familien Lygaeidae und Tingidae. Parasiten der Hymenopterengattung Braconidae (6) zeigen eine positive Reaktion auf Cantharidin, ebenso wie Arten der Unterfamilie Diapriinae der Familie Diapriidae. Chemische Analysen von Arten der Fulgoridae und Cicadidae zeigen, dass auch Arten der Homoptera Cantharidin-abhängig scheinen.

Introduction

Cantharidin, a formal monoterpene anhydride, is known to humans for its toxic properties for over 2000 years. Applied on the human skin it induces serum filled blisters, which gave blister beetles (Coleoptera: Meloidae) their common name, beside Oedemeridae the only known natural sources of this chemical. Used internally cantharidin acts as diuretic and abortifacient. It may induce priapism, which made cantharidin one of the most well known aphrodisiacs.

In meloid and oedemerid beetles cantharidin is used as an effective haemolymph poison (CAVILL & CLARK 1971, CAPINERA et al. 1985, CARREL et al. 1986, BLODGETT et al. 1991, NICHOLLS et al. 1990, HOLZ et al. 1994), which protects the adults as well as larval stages and eggs.

Another interesting phenomenon in connection with cantharidin is its attractancy on other insects, which perceive this insecticide partly over great distances (GÖRNITZ 1937, WIRTH 1980, YOUNG 1984 a, b). Many of these so-called canthariphilous insects ingest cantharidin without any obvious damage.

This paper gives a compilation of insects attracted to cantharidin on species level. Canthariphilous species are known from following orders and families: Coleoptera (Anthicidae, Cleridae, Chrysomelidae, Endomychidae, Pyrochroidae, Staphylinidae), Diptera (Anthomyiidae, Cecidomyiidae, Ceratopogonidae, Chloropidae, Platystomatidae, Sciaridae), Heteroptera (Miridae, Lygaeidae, Tingidae), and Hymenoptera (Braconidae, Diapriidae). Analysis of Homoptera species proved, that cantharidin containing species can also be found in these order of insects.

Possible function of cantharidin in the life cycles of canthariphilous insects

Coleoptera

Most canthariphilous species are found in the beetle family Anthicidae with 190 recorded species. Mostly *Notoxus* and *Aulacoderus* species are attracted. Conspicuous in many anthicid genera associated with cantharidin are notches at the tips of the elytra in males which function as test organs. Females bite into these structures and choose their sexual partner by the amount of cantharidin a male has taken up (SCHÜTZ & DETTNER 1992). Ingested cantharidin is stored in the reproductive organs of the males and transmitted to females during copulation. The nuptial gift is secreted into eggs and thus provides protection for the offspring.

From the family Cleridae *Pallenothriocera rufimembris* is attracted to the terpenoid cantharidin (HEMP et al. 1999b). Also single specimens of other clerid species were collected in cantharidin traps put out in southern Europe. Further clerids were suggested to be canthariphilous (CHANDLER 1976, BOLOGNA & HAVELK 1984) or reported to contain cantharidin (JUANJIE et al. 1995, DETTNER, in prep.). Gland-like structures on the elytra of male *Pallenothriocera rufimembris* suggests an analogous cycle as found in anthicids. Specimens of a up to now unidentified clerid species attracted to cantharidin baits near Nairobi, Kenya were observed to remain several hours in the open traps, attacking there other arriving canthariphilous species (mostly *Notoxus* sp.), killing and feeding on them. Remaining elytra of the preys showed that one clerid often fed more than 10 *Notoxus* during the day hours.

Canthariphilous pyrochroid beetles show a similar cycle for cantharidin as discussed above for anthicids (HOLZ et al. 1994, EISNER et al. 1996b). Test organs for cantharidin titres are present on the head of the male in form of grooves (EISNER et al. 1996a). As in anthicid beetles the females bite into these structures to inform themselves about the amount of cantharidin the would-be partner has taken up.

For all other beetles families (Chrysomelidae, Endomychidae, Staphylinidae) with canthariphilous species only the phenomenon that members are attracted to the natural product cantharidin is known. No investigations have been undertaken up to now to illuminate life cycles and function of cantharidin for these insects.

Diptera and Heteroptera

Ceratopogonids are an ever present group as soon as cantharidin is put out. Studies on the function of cantharidin in the biology of canthariphilous ceratopogonids have been made by FRENZEL & DETTNER (1994). Both sexes of the investigated canthariphilous gnats are attracted to cantharidin, ingesting the terpenoid readily. Maximal concentrations in tissues of ceratopogonids analysed are similar to those detected in the cantharidin producing species of the heteromeren beetle families Meloidae and Oedemeridae. High concentrations of cantharidin in the haemolymph of European ceratopogonids proved to deter Empididae, which prey on these gnats.

As for most beetle families only the phenomenon that dipterans and heteropterans from families like Anthomyiidae, Cecidomyiidae, Chloropidae, Platystomatidae, Sciaridae (Diptera) and Miridae, Lygaeidae and Tingidae (Heteroptera) are attracted, is noted.

Hymenoptera

Braconids are parasitoids of other insects. Females are capable of sensing their host for egg-deposition via kairomones. This may also be the case in canthariphilous species that are attracted by the cantharidin smell of their hosts as suggested for *Perilissus plumicornis* which is a parasite of the anthicid *Notoxus monoceros* (GÖRNITZ 1937).

List of insects attracted to cantharidin

Coleoptera

Anthicidae
Anthicinae

<i>Acanthinus scitulus</i> (LECONTE)	CHANDLER 1976, YOUNG 1984a, b
<i>Anthicus lutulentus</i> CASEY	CHANDLER 1976, YOUNG 1984a
<i>Anthicus nanus</i> LECONTE	CHANDLER 1976, YOUNG 1984a
<i>Anthicus punctulatus</i> LECONTE	YOUNG 1984b
<i>Anthicus sonoranus</i> WERNER	YOUNG 1984b
<i>Aulacoderus albitalis</i> (LA FERTÉ) ¹	VAN HILLE 1954
<i>Aulacoderus apterus</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus asymmetricus</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus bicoloritarsis</i> (PIC) ²	VAN HILLE 1954

<i>Aulacoderus bilineatus</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus bonadonai</i> (VAN HILLE)	FORCHHAMMER 1985
<i>Aulacoderus bradfordi</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus brevicornis</i> (VAN HILLE)	VAN HILLE 1984b
<i>Aulacoderus bryanti</i> (PIC)	pers. comm. ³
<i>Aulacoderus canariensis</i> (WOLLASTON)	SCHÜTZ & DETTNER 1992
<i>Aulacoderus canthariphilus</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus cecileae</i> (VAN HILLE)	VAN HILLE 1985
<i>Aulacoderus chappuisi</i> (PIC)	HEMP et al. 1999a
<i>Aulacoderus citernii</i> (PIC)	VAN HILLE 1984a
<i>Aulacoderus colletti</i> (VAN HILLE)	pers. observ., 49
<i>Aulacoderus dorsalis</i> (LAFERTÉ)	VAN HILLE 1984a
<i>Aulacoderus flavitarsis</i> (FAHRAEUS) ⁴	VAN HILLE 1984a
<i>Aulacoderus flavopictus</i> (LAFERTÉ)	VAN HILLE 1954, 1984a
<i>Aulacoderus forchhammeri</i> (VAN HILLE)	VAN HILLE 1985
<i>Aulacoderus formicomisternus</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus forsythi</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus fragilis</i> (FAHRAEUS)	VAN HILLE 1984a, pers. observ. ⁵
<i>Aulacoderus govenderi</i> (VAN HILLE)	VAN HILLE 1984b
<i>Aulacoderus halleyi</i> (VAN HILLE)	VAN HILLE 1988
<i>Aulacoderus inopinans</i> (KREKICH)	HEMP et al. 1999a
<i>Aulacoderus kochi</i> (VAN HILLE)	VAN HILLE 1985
<i>Aulacoderus macbleryi</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus martini</i> (PIC)	VAN HILLE 1984a
<i>Aulacoderus mediofasciatus</i> (PIC)	VAN HILLE 1984a
<i>Aulacoderus milleri</i> (VAN HILLE)	VAN HILLE 1984b
<i>Aulacoderus mogotoensis</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus multidenticulatus</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus munroi</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus mutatus</i> (GEMMINGER)	VAN HILLE 1984a
<i>Aulacoderus orangensis</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus pedester</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus perlucidus</i> (VAN HILLE)	VAN HILLE 1971, 1984a
<i>Aulacoderus poweri</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus ranchbodi</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus recognitus</i> (PIC)	VAN HILLE 1984a
<i>Aulacoderus reverendus</i> (PIC)	VAN HILLE 1984a
<i>Aulacoderus rotundipennis</i> (PIC)	VAN HILLE 1971
<i>Aulacoderus scydmaenoides</i> (WOLLASTON)	HEMP 1994 ⁶
<i>Aulacoderus serowensis</i> (VAN HILLE)	VAN HILLE 1985
<i>Aulacoderus sibayensis</i> (VAN HILLE)	VAN HILLE 1971, 1984a
<i>Aulacoderus simoni</i> (PIC) ⁷	VAN HILLE 1954, 1984a
<i>Aulacoderus smithersi</i> (VAN HILLE)	VAN HILLE 1984a
<i>Aulacoderus techowi</i> (PIC)	VAN HILLE 1985, pers. observ. ⁸
<i>Cordicomus instabilis</i> (SCHMIDT)	pers. comm. ⁹
<i>Cyclodinus basilewskyi</i> BUCK	pers. comm. ¹⁰

<i>Endomia tenuicollis</i> (ROSSI)	BOLOGNA & HAVELKA 1984
<i>Formicilla munda</i> (LECONTE)	YOUNG 1984b
<i>Formicomus caeruleus</i> (THUNBERG)	VAN HILLE 1954, 1985
<i>Formicomus canaliculatus</i> LAFERTÉ	VAN HILLE 1971, HEMP et al. 1999a
<i>Formicomus chappuisi</i> PIC	pers. observ. ¹¹
<i>Formicomus consul</i> LAFERTÉ	YOUNG 1984b
<i>Formicomus gestroi</i> PIC	SCHÜTZ & DETTNER 1992, HEMP et al. 1997, HEMP & DETTNER 1997, HEMP et al. 1999a
<i>Formicomus lacustris</i> KREK.	VAN HILLE 1971, HEMP et al. 1999a
<i>Formicomus linnavouri</i> VAN HILLE	pers. observ. ⁵⁰
<i>Formicomus millerianus</i> PIC	HEMP et al. 1999a
<i>Formicomus opaculus</i> KOLBE	HEMP et al. 1999a
<i>Formicomus pedestris</i> (ROSSI)	GÖRNITZ 1937, BOLOGNA & HAVELKA 1984, HEMP & DETTNER 1997 SCHÜTZ & DETTNER 1992, HEMP et al. 1997, HEMP & DETTNER 1997, HEMP et al. 1999a
<i>Formicomus rubricollis</i> LAFERTÉ	YOUNG 1984b
<i>Formicomus sp. (lewisi</i> MARSEUL?)	HEMP et al. 1999a
<i>Formicomus spatulatus</i> VAN HILLE	VAN HILLE 1971
<i>Formicomus tropicalis</i> KREK.	
<i>Hirticomus biplagiatus</i> (LAFERTÉ)	pers. observ. ⁵¹
<i>Hirticomus hispidus</i> (ROSSI)	pers. observ. ¹²
<i>Hirticomus quadriguttatus</i> (ROSSI)	BOLOGNA & HAVELKA 1984, pers. observ. ¹³
<i>Mecynotarsus balsensis</i> WERNER	CHANDLER 1976, 1977b
<i>Mecynotarsus casperi</i> PIC	pers. comm. ¹⁴
<i>Mecynotarsus falcatus</i> CHANDLER	YOUNG 1984b
<i>Mecynotarsus lacustris</i> VAN HILLE	VAN HILLE 1971
<i>Mecynotarsus nevermanni</i> WERNER	HEMP et al. 1999a
<i>Mecynotarsus nigronotatus</i> PIC	HEMP et al. 1999a
<i>Mecynotarsus obliquemaculatus</i> MARSEUL	YOUNG 1984b
<i>Mecynotarsus oblitteratus</i> PIC	HEMP et al. 1999a
<i>Mecynotarsus serricornis</i> (PANZER)	BOLOGNA & HAVELKA 1984
<i>Mecynotarsus vagipictus</i> FAIRMAIRE	YOUNG 1984b
<i>Microhoria aspelia</i> (TRUQUI)	pers. comm. ¹⁵
<i>Microhoria aubei</i> (LAFERTÉ) ¹⁶	GÖRNITZ 1937, ABDULLAH 1964, YOUNG 1984a
<i>Microhoria biauriculatus</i> (PIC) ¹⁷	GÖRNITZ 1937, ABDULLAH 1964, YOUNG 1984a
<i>Microhoria calliger</i> (MARSEUL)	pers. comm. ¹⁸
<i>Microhoria chobauti</i> (PIC) ¹⁹	GÖRNITZ 1937, ABDULLAH 1964, YOUNG 1984a
<i>Microhoria cinctuta</i> (MARSEUL) ²⁰	GÖRNITZ 1937, ABDULLAH 1964, BOLOGNA & HAVELKA 1984, YOUNG 1984a
<i>Microhoria fairmairei</i> (BRISOUT) ²¹	GÖRNITZ 1937, ABDULLAH 1964, YOUNG 1984a
<i>Microhoria fasciata</i> (CHEVROLAT)	BOLOGNA & HAVELKA 1984
<i>Microhoria fasciata</i> (CHEVROLAT) <i>codinai</i> PIC	BOLOGNA & HAVELKA 1984

<i>Microboria ghilianii</i> (LAFERTÉ)	BOLOGNA & HAVELKA 1984
<i>Microboria insignis</i> (LUCAS) ²²	GÖRNITZ 1937, YOUNG 1984a
<i>Microboria insignis</i> (LUCAS) var. <i>panousei</i> (PIC) ²³	YOUNG 1984a
<i>Microboria obscuripes</i> (PIC) ²⁴	ABDULLAH, 1964, YOUNG 1984a
<i>Microboria plagifer</i> (KREKICH)	pers. observ. ²⁵
<i>Microboria syrensis</i> (PIC)	pers. comm. ²⁶
<i>Microboria terminata</i> (SCHMIDT)	SCHÜTZ & DETTNER 1992, HEMP & DETTNER 1997
<i>Microboria tortiscelis</i> (MARSEUL) ²⁷	YOUNG 1984a
<i>Microboria venusta</i> (VILLA)	BOLOGNA & HAVELKA 1984
<i>Notoxus allansonii</i> VAN HILLE	VAN HILLE 1971
<i>Notoxus alluaudi</i> PIC	HEMP et al. 1999a
<i>Notoxus amaculatus</i> VAN HILLE	VAN HILLE 1971
<i>Notoxus anchora</i> HENTZ	CHANDLER 1977a, 1982
<i>Notoxus bifasciatus</i> (LECONTE)	YOUNG 1984b
<i>Notoxus brutoni</i> VAN HILLE	VAN HILLE 1985
<i>Notoxus buraensis</i> UHMANN	HEMP et al. 1999a
<i>Notoxus calcaratus</i> HORN	CHANDLER 1976, 1982, YOUNG 1984a
<i>Notoxus candatus</i> FALL	CHANDLER 1982
<i>Notoxus cavicornis</i> LECONTE	CHANDLER 1982
<i>Notoxus celatus</i> CHANDLER	CHANDLER 1977a
<i>Notoxus conformis</i> LECONTE	CHANDLER 1977a, 1982
<i>Notoxus constrictus</i> CASEY	CHANDLER 1977a, YOUNG 1984a
<i>Notoxus cornutus</i> THUNBERG	ABDULLAH 1964
<i>Notoxus cucullatus</i> LAFERTÉ	VAN HILLE 1971
<i>Notoxus cumanensis</i> LAFERTÉ	CHANDLER 1977a
<i>Notoxus daressalaamensis</i> UHMANN	HEMP et al. 1999a
<i>Notoxus decorus</i> VAN HILLE	SCHÜTZ & DETTNER 1992, HEMP et al. 1999a
<i>Notoxus denudatus</i> HORN	CHANDLER 1982
<i>Notoxus desertus</i> CASEY	CHANDLER 1977a, 1982, YOUNG 1984a
<i>Notoxus filicornis</i> CASEY	YOUNG 1984b
<i>Notoxus fraternus</i> CHAMPION	CHANDLER 1977a
<i>Notoxus guttulatus</i> BUCK	ABDULLAH 1964, pers. comm. ²⁸
<i>Notoxus hageni</i> CHANDLER	CHANDLER 1982
<i>Notoxus hiltoni</i> VAN HILLE	VAN HILLE 1971
<i>Notoxus hirsutus</i> CHAMPION	CHANDLER 1977a, 1982
<i>Notoxus hirsutus</i> PIC	pers. observ. ⁵²
<i>Notoxus hirtus</i> LAFERTÉ	BOLOGNA & HAVELKA 1984
<i>Notoxus holmi</i> UHMANN	VAN HILLE 1985
<i>Notoxus intermedius</i> FALL	CHANDLER 1982
<i>Notoxus lateralis</i> CHANDLER	CHANDLER 1977a
<i>Notoxus lesnei</i> PIC	pers. comm. ²⁹
<i>Notoxus lunulifer</i> PIC	VAN HILLE 1971, HEMP et al. 1999a
<i>Notoxus marginatus</i> LECONTE	CHANDLER 1976, 1977a, 1982
<i>Notoxus mauritanicus</i> LAFERTÉ	ABDULLAH 1964, YOUNG 1984a
<i>Notoxus mexicanus</i> CHAMPION	CHANDLER 1976, 1977a
<i>Notoxus mkuziensis</i> VAN HILLE	VAN HILLE 1971

<i>Notoxus monoceros</i> (LINNÉ)	GÖRNITZ 1937, ABDULLAH 1964, YOUNG 1984a, BOLOGNA & HAVELKA 1984
<i>Notoxus monodon</i> (FABRICIUS)	CHANDLER 1976, 1982
<i>Notoxus montanus</i> CASEY	CHANDLER 1982
<i>Notoxus murinipennis</i> (LECONTE)	CHANDLER 1976, 1977a, 1982
<i>Notoxus namibianus</i> UHMANN	pers. observ. ³⁰
<i>Notoxus nevadensis</i> CASEY	CHANDLER 1982
<i>Notoxus nuperus</i> HORN <i>bastrus</i> CHANDLER	CHANDLER 1982
<i>Notoxus nuperus</i> HORN	CHANDLER 1976
<i>Notoxus opacus</i> CHAMPION	CHANDLER 1977a
<i>Notoxus ornatus</i> VAN HILLE	VAN HILLE 1971
<i>Notoxus photus</i> CHANDLER	YOUNG 1984b
<i>Notoxus pictus</i> CASEY	CHANDLER 1982
<i>Notoxus planicornis</i> LAFERTÉ	pers. comm. ³¹
<i>Notoxus pretiosus</i> VAN HILLE	HEMP et al. 1999a
<i>Notoxus pygidialis</i> CHANDLER	CHANDLER 1977a
<i>Notoxus reavelli</i> VAN HILLE	VAN HILLE 1984b
<i>Notoxus recticornis</i> VAN HILLE	pers. comm. ³²
<i>Notoxus robustus</i> CASEY	CHANDLER 1982, YOUNG 1984a
<i>Notoxus roehri</i> UHMANN	VAN HILLE 1985, pers. comm. ³³
<i>Notoxus rothschildi</i> PIC	HEMP et al. 1999a
<i>Notoxus rufomaculatus</i> PIC	HEMP et al. 1999a
<i>Notoxus seminole</i> CHANDLER	YOUNG 1984a, b
<i>Notoxus serratus</i> (LECONTE)	CHANDLER 1977a, 1982
<i>Notoxus sparsus</i> LECONTE	CHANDLER 1977a, 1982, YOUNG 1984a
<i>Notoxus spatulifer</i> CASEY	CHANDLER 1982
<i>Notoxus talpa</i> LAFERTÉ	CHANDLER 1976, 1977a
<i>Notoxus tansanianus</i> UHMANN	HEMP et al. 1999a
<i>Notoxus toltecorum</i> CHANDLER	CHANDLER 1977a
<i>Notoxus vanhillei</i> UHMANN	HEMP et al. 1999a
<i>Notoxus whartoni</i> CHANDLER	CHANDLER 1982
<i>Notoxus walteri</i> VAN HILLE	pers. observ. ⁵³
<i>Notoxus youngi</i> CHANDLER	CHANDLER 1982
<i>Notoxus zapotecorum</i> CHANDLER	CHANDLER 1977a
<i>Omonadus bottegoi</i> PIC	pers. comm. ³⁴
<i>Pseudoleptaleus unifasciatus</i> (DESBR.)	FORCHHAMMER 1985, HEMP et al. 1999a
<i>Pseudonotoxus testaceus</i> (LAFERTÉ)	VAN HILLE 1985
<i>Sapintus javanus</i> (MARSEUL)	YOUNG 1984b, pers. comm. ³⁵
<i>Sapintus malayensis</i> (PIC) ³⁶	GÖRNITZ 1937
<i>Sapintus plectilis</i> (PIC)	YOUNG 1984b
<i>Sapintus pollocki</i> UHMANN	pers. comm. ³⁷
<i>Sapintus tavetanus</i> (PIC)	HEMP et al. 1999a
<i>Tenuicomus babaulti</i> (PIC)	HEMP et al. 1999a

<i>Tenuicomus barnevillei</i> (PIC)	BOLOGNA & HAVELKA 1984
<i>Tenuicomus pumilus</i> (BAUDI) ³⁸	GÖRNITZ 1937, ABDULLAH 1964, YOUNG 1984a
<i>Vacusus infernus</i> (LAFERTÉ)	CHANDLER 1976
 Lemodiinae	
<i>Trichanana aptera</i> LEA	pers. observ. ³⁹
 Tomoderinae	
<i>Tomoderus</i> sp.	CHANDLER 1976, YOUNG 1984b
<i>Tomoderus alluaudi</i> PIC	HEMP et al. 1999a
<i>Tomoderus brevicornis</i> CHAMPION	pers. observ. ⁴⁰
<i>Tomoderus congoanus</i> PIC	HEMP et al. 1999a
<i>Tomoderus kolbei</i> PIC	HEMP et al. 1999a
 Endomychidae	
<i>Aphorista laeta</i> (LECONTE)	YOUNG 1984b
<i>Aphorista vittata</i> (FABRICIUS)	YOUNG 1984b
 <i>Danae testacea</i> (ZIEGLER)	YOUNG 1984b
 <i>Lycoperdina ferruginea</i> LECONTE	YOUNG 1984b
 <i>Xenomycetes morrisoni</i> HORN	YOUNG 1989, DETTNER 1997
 Cleridae	
<i>Cymatodera</i> sp.	CHANDLER 1976
 <i>Pallenothriocera rufimembris</i> PIC	HEMP et al. 1999a, HEMP et al. 1999b
 Gen. sp.	BOLOGNA & HAVELKA 1984
 Cleridae sp.	pers. observ. ⁴¹
 Chrysomelidae	
<i>Aristobrotica angulicollis</i> (ERICHSON)	MAFRA-NETO & JOLIVET 1994
 <i>Barombiella</i> (Bonesioides) <i>vicina</i> LABOISSIERE	HEMP et al. 1999a
<i>Barombiella</i> (Bonesioides) ssp.	HEMP et al. 1999a
 Pyrochroidae	
 Pedilinae	
<i>Anisotria shooki</i> YOUNG	YOUNG 1984a
 <i>Pedilus abnormis</i> (HORN)	YOUNG 1981
<i>Pedilus bardi</i> (HORN)	YOUNG 1981
<i>Pedilus canaliculatus</i> (LECONTE)	YOUNG 1981

<i>Pedilus cavatus</i> FALL	YOUNG 1981
<i>Pedilus collaris</i> (SAY)	BUTLER 1984
<i>Pedilus crotchi</i> (HORN)	YOUNG 1981
<i>Pedilus elegans</i> (HENTZ)	YOUNG 1981, YOUNG 1984a
<i>Pedilus impressus</i> (SAY)	ABDULLAH 1964, YOUNG 1981, YOUNG 1984a
<i>Pedilus inconspicuus</i> (HORN)	YOUNG 1981
<i>Pedilus joanae</i> YOUNG	YOUNG 1981
<i>Pedilus johnsonorum</i> YOUNG	YOUNG 1981
<i>Pedilus labiatus</i> (SAY)	ABDULLAH 1964, YOUNG 1981
<i>Pedilus lewisi</i> (HORN)	YOUNG 1981
<i>Pedilus longlobus</i> FALL	YOUNG 1981
<i>Pedilus lugubris</i> (SAY)	YOUNG 1981, YOUNG 1984a
<i>Pedilus monticolus</i> (HORN)	YOUNG 1981
<i>Pedilus oregonus</i> FALL	YOUNG 1981
<i>Pedilus picipennis</i> FALL	YOUNG 1981
<i>Pedilus punctulatus</i> LECONTE	YOUNG 1981
<i>Pedilus serratus</i> FALL	YOUNG 1981
<i>Pedilus</i> sp. nov.	YOUNG 1984a
<i>Pedilus terminalis</i> (SAY)	YOUNG 1981, YOUNG 1984a
Pyrochroinae	
<i>Neopyrochroa femoralis</i> (LECONTE)	YOUNG 1984b
<i>Neopyrochroa flabellata</i> (FABRICIUS)	YOUNG 1984a
<i>Pyrochroa coccinea</i> LINNÉ	HOLZ et al. 1994
<i>Pyrochroa serraticornis</i> (SCOPOLI)	BOLOGNA & HAVELKA 1984
<i>Schizotus cervicalis</i> NEWMANN	YOUNG 1984b
<i>Schizotus pectinicornis</i> LINNÉ	HOLZ et al. 1994
Staphylinidae	
<i>Eusphalerum minutum</i> (F.)	DETTNER 1997
Diptera	
Anthomyiidae	
<i>Anthomyia benguellae</i> MALLOCH	HEMP et al. 1999a
<i>Anthomyia pluvialis</i> (LINNÉ)	GÖRNITZ 1937, BOLOGNA & HAVELKA 1984, FRENZEL & DETTNER 1994
<i>Delia (Hylemyia) trispinosa</i> KARL	GÖRNITZ 1937, DETTNER 1997
Cecidomyiidae	
Gen. sp. Cecidomyiinae	DETTNER 1997
Gen. sp. Lestremiinae	DETTNER 1997
Ceratopogonidae	
<i>Atrichopogon brunnipes</i> MEIGEN	GÖRNITZ 1937 ⁴² , FRENZEL et al. 1992
<i>Atrichopogon downesi</i> WIRTH	WIRTH 1980

<i>Atrichopogon epicautae</i> WIRTH	WIRTH 1980
<i>Atrichopogon favri</i> WIRTH	WIRTH 1980
<i>Atrichopogon geminus</i> BOESEL	YOUNG 1984b
<i>Atrichopogon illiesi</i> HAVELKA	BOLOGNA & HAVELKA 1984
<i>Atrichopogon levius</i> (COQUILLET)	YOUNG 1984b
<i>Atrichopogon lindneri</i> WIRTH	WIRTH 1980
<i>Atrichopogon lucorum</i> (MEIGEN)	BOLOGNA & HAVELKA 1984, FRENZEL et al. 1992
<i>Atrichopogon maculosus</i> EWEN	YOUNG 1984b
<i>Atrichopogon meloesugans</i> KIEFFER	WIRTH 1980, BOLOGNA & HAVELKA 1984
<i>Atrichopogon mittmanni</i> HAVELKA	pers. observ. ⁴³
<i>Atrichopogon oedemerarum</i> STORA	FRENZEL et al. 1992, FRENZEL & DETTNER 1994
<i>Atrichopogon rostratus</i> (WINNERTZ)	WIRTH 1956
<i>Atrichopogon ruediger</i> HAVELKA	pers. observ. ⁴⁴
<i>Atrichopogon setospennis</i> KIEFFER	BOLOGNA & HAVELKA 1984
<i>Atrichopogon</i> sp.	BOLOGNA & HAVELKA 1984
<i>Atrichopogon</i> sp. near <i>websteri</i> (COQUILLET)	YOUNG 1984b
<i>Atrichopogon trifasciatus</i> KIEFFER	BOLOGNA & HAVELKA 1984, FRENZEL et al. 1992, FRENZEL & DETTNER 1994
<i>Atrichopogon websteri</i> (COQUILLET)	YOUNG 1984b
<i>Culicoides obsoletus</i> MEIGEN	BOLOGNA & HAVELKA 1984
<i>Forcipomyia crinita</i> SAUNDERS	BOLOGNA & HAVELKA 1984
Chloropidae	
<i>Goniopsita</i> spec.	DETTNER 1997
Platystomatidae	
<i>Peltacanthina</i> near <i>mythodes</i> HENDEL	HEMP et al. 1999a
Sciaridae	
ssp.	YOUNG 1984b
Gen. sp.	DETTNER 1997 ⁴⁵
<i>Bradyzia optata</i>	RUDZINSKI, FRANK & DETTNER, 2001
<i>Heterosciara</i> sp.	pers. observ. ⁴⁶
<i>Schwenkfeldina</i> sp.	pers. observ. ⁴⁷
<i>Scythropochroa</i> sp.	pers. observ. ⁴⁸

Heteroptera**Lygaeidae***Dieuches* sp.HEMP & DETTNER, in press, HEMP et al.
1999a**Miridae***Caulotops* ssp.

YOUNG 1984b

Cryptocapsus paraensis (CARVALHO)*Cryptocapsus* sp.

MAFRA-NETO & JOLIVET 1994

DETTNER 1997

Cyrtocapsus caliginosus (STAL)

HEMP & DETTNER, 2000

Eurychilella sp. near *pallida* REUTER

YOUNG 1984b

Hadroneura bispinosa KNIGHT

PINTO 1978

Hadroneura brevirostrata KNIGHT

YOUNG 1984b

Hadroneura militaris UHLER

FOX 1943

Hadroneura princeps UHLER

YOUNG 1984b

Hadroneura sp.

PINTO 1978

Hadroneura ubleri VANDUZEE

PINTO 1978, YOUNG 1984b

Hadroneura uniformis KNIGHT

YOUNG 1984b

Halticotoma nicholi KNIGHT

PINTO 1978

Halticotoma sp.

YOUNG 1984b

Halticotoma valida TOWNSEND

YOUNG 1984b

Neoleucon sulinus (CARVALHO)

MAFRA-NETO & JOLIVET 1994

Pachymerocista pilosus (CARVALHO)

HEMP & DETTNER, 2000

Pycnoderes quadrimaculatus (GUERIN-MELNEVILLE)

YOUNG 1984b, HEMP & DETTNER, 2000

Pycnoderes sp.

YOUNG 1984b

Pycnoderes vanduzeei REUTER

HEMP & DETTNER, 2000

Sixeonotus brevirostris KNIGHT

YOUNG 1984b

Sixeonotus insignis REUTER

YOUNG 1984b

Sixeonotus sp.

PINTO 1978, YOUNG 1984b, HEMP &

DETTNER, 2000

Sixeonotus sp. near *brevirostris* KNIGHT

YOUNG 1984b

Sixeonotus tenebrosus (DISTANT)

YOUNG 1984b

Sysinas fulvicollis (FABRICIUS)

MAFRA-NETO & JOLIVET 1994

Sysinas linearis DISTANT

YOUNG 1984b

Sysinas signaticollis (REUTER)

MAFRA-NETO & JOLIVET 1994

Thbentecoris sp.

DETTNER 1997

Tingidae
sp.

MAFRÀ-NETO & JOLIVET 1994, DETTNER
1997

Hymenoptera

Braconidae

Blacus ruficornis (NEES)

YOUNG 1984b

Perilissus plumicornis RUTHE

GÖRNITZ 1937

Streblocera near *pulvillicornis* WALLEY &

MACKAY

YOUNG 1984b

Syrrhizus agilis (CRESSON)

YOUNG 1984b

Microtonus sp.

DETTNER 1997

Melittobia sp.

BOLOGNA 1991

Diapriidae

Gen. sp. (Diapriinae)

DETTNER 1997

¹ *Anthicus albitarvis* in VAN HILLE 1954

² *Anthicus bicoloritarsis* in VAN HILLE 1954

³ collected by Dr. POLLOCK at cantharidin in Australia (pers. comm UHMANN)

⁴ *Anthicus flavopictus* in VAN HILLE 1954 and 1984a

⁵ Expedition of the Museum Berlin to southern Africa (pers. comm UHMANN)

⁶ attracted to cantharidin on the canary island Tenerife

⁷ *Anthicus simoni* in VAN HILLE 1954 and 1984a

⁸ Expedition of the Museum Berlin to southern Africa (pers. comm UHMANN)

⁹ collected by Dr. SCHAWALLER in Nepal, feeding on meloids

¹⁰ collected by Dr. T. WAGNER at cantharidin in Uganda, East Africa

¹¹ attracted to cantharidin bait in March 1999 at the Tanzanian coast near Pangani

¹² attracted to cantharidin bait on the mediterranean island Mallorca 7.90

¹³ attracted to cantharidin at the mediterranean island Mallorca 7.90

¹⁴ Expedition of the Museum Berlin to southern Africa (pers. comm UHMANN)

¹⁵ collected at cantharidin by C. KOCH in Cyprus

¹⁶ *Anthicus aubei* in GÖRNITZ 1937, ABDULLAH 1964 and YOUNG 1984a

¹⁷ *Anthicus biauriculatus* in GÖRNITZ 1937, ABDULLAH 1964 and YOUNG 1984a

¹⁸ collected at cantharidin bait by Dr. W. ARENS in Greece, Olympia

¹⁹ *Anthicus chobauti* in GÖRNITZ 1937, ABDULLAH 1964 and YOUNG 1984a

²⁰ *Anthicus cinctutus* in GÖRNITZ 1937, ABDULLAH 1964, BOLOGNA & HAVELK 1984 and YOUNG 1984a

²¹ *Anthicus fairmairei* in GÖRNITZ 1937, ABDULLAH 1964 and YOUNG 1984a

²² *Anthicus insignis* in GÖRNITZ 1937 and YOUNG 1984a

²³ *Anthicus panousei* in YOUNG 1984a

²⁴ *Anthicus obscuripes* in ABDULLAH 1964 and YOUNG 1984a

²⁵ at cantharidin on the mediterranean island Mallorca, July 1990

²⁶ collected at cantharidin by C. KOCH in Cyprus

²⁷ *Anthicus tortiselsi* in YOUNG 1984a

²⁸ Expedition of the Museum Berlin to southern Africa (pers. comm UHMANN)

²⁹ Expedition of the Museum Berlin to southern Africa (pers. comm UHMANN)

- ³⁰ Expedition of the Museum Berlin to southern Africa (pers. comm UHMANN)
- ³¹ personal communication with Prof. CHANDLER, USA
- ³² around 150 specimens at cantharidin in December 1998 and April 1999 in the suburb Karen of Nairobi, Kenya
- ³³ Expedition of the Museum Berlin to southern Africa (pers. comm UHMANN)
- ³⁴ caught by Dr. T. WAGNER at cantharidin in Uganda, East Africa
- ³⁵ collected at cantharidin by Prof. CHANDLER on the Phillipines, Cebu, Inayagan and Naga
- ³⁶ *Anthicus malayensis* in GÖRNITZ 1937
- ³⁷ collected at cantharidin by Dr. POLLOCK, Australia (pers. comm UHMANN)
- ³⁸ *Anthicus pumilus* in GÖRNITZ 1937, ABDULLAH 1964 and YOUNG 1984a
- ³⁹ specimen labeled „at cantharidin“, coll. POLLOCK, Australia
- ⁴⁰ baited with cantharidin, southcoast, Dominican Republic, 1.95
- ⁴¹ in December 1998 about 50 specimens of a up to now not identified clerid species were attracted to cantharidin baits from a piece of indigenous *Olea*-forest at Karen near Nairobi, Kenya
- ⁴² *Kempia brunneipes* in GÖRNITZ 1937
- ⁴³ new species from Tanzania, Kilimanjaro, mentioned in FRENZEL et al. (1998), species description by HAVELKA, in prep.; listed in HEMP et al. 1999a under *Atrichopogon* spec. 1
- ⁴⁴ new species from Tanzania, Kilimanjaro, mentioned in FRENZEL et al. (1998), species description by HAVELKA, in prep.; listed in HEMP et al. 1999a, under *Atrichopogon* spec. 2
- ⁴⁵ 3 males were collected at Mistelbach/Bayreuth (August 90) at cantharidin
- ⁴⁶ 21 males and 2 females were collected at Bayreuth (June 1991) at cantharidin. According to MENZEL & MOHRIG (1997) *Heterosciara* is a synonym of *Scatopsiara*
- ⁴⁷ 1 male was collected at Bayreuth (June 1991) at cantharidin
- ⁴⁸ 4 males and 1 female were collected at Mistelbach/Bayreuth (August 1990) at cantharidin
- ⁴⁹ attracted to cantharidin in savannah grassland at 1400 m near Mt. Kitumbeine, Tanzania (11/99)
- ⁵⁰ attracted to cantharidin in coastal grassland near Pagani, Tanzania (1/00)
- ⁵¹ attracted to cantharidin in coastal grassland near Pagani, Tanzania (3/00)
- ⁵² attracted to cantharidin in savannah grassland near Mt. Kitumbeine, Tanzania (11/99)
- ⁵³ attracted to cantharidin in savannah grassland near Mt. Kitumbeine, Tanzania (11/99)

Homoptera

First results in analysing cantharidin contents in fulgorids suggest, that there are also members in the order Homoptera associated with cantharidin. The lantern fly *Lycorma delicatula* proved to contain cantharidin, which probably was taken up by host plants (FENG et al. 1988, DETTNER 1997). There was also suggested the Cicadidae species *Huechys sanguinea* (DE GEER) would contain cantharidin (JUANJIE et al. 1995).

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