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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 heteromeran 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 Hymenopterenfamilie 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 & HAVELKA 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 heteromeran 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 *Perilitus plumicornis* which is a parasite of the anthicid *Notoxus monoceros* (GÖRNITZ 1937).

List of insects attracted to cantharidin

Coleoptera

Anthicidae
Anthicinae

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| <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 albitarsis</i> (LAFERTÉ) 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 |

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| <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 flavitaris</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 maccheryi</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 |

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

- Microhoria ghilianii* (LAFERTÉ)
Microhoria insignis (LUCAS)²²
Microhoria insignis (LUCAS) var. *panousei* (PIC)²³
Microhoria obscuripes (PIC)²⁴
Microhoria plagifer (KREKICH)
Microhoria syrensis (PIC)
Microhoria terminata (SCHMIDT)

Microhoria tortiscelis (MARSEUL)²⁷
Microhoria venusta (VILLA)

Notoxus allansoni VAN HILLE
Notoxus alluaudi PIC
Notoxus amaculatus VAN HILLE
Notoxus anchora HENTZ
Notoxus bifasciatus (LECONTE)
Notoxus brutoni VAN HILLE
Notoxus buraensis UHMANN
Notoxus calcaratus HORN
Notoxus candatus FALL
Notoxus cavicornis LECONTE
Notoxus celatus CHANDLER
Notoxus conformis LECONTE
Notoxus constrictus CASEY
Notoxus cornutus THUNBERG
Notoxus cucullatus LAFERTÉ
Notoxus cumanensis LAFERTÉ
Notoxus daressalaamensis UHMANN
Notoxus decorus VAN HILLE
Notoxus denudatus HORN
Notoxus desertus CASEY
Notoxus filicornis CASEY
Notoxus fraternus CHAMPION
Notoxus guttulatus BUCK
Notoxus hageni CHANDLER
Notoxus hiltoni VAN HILLE
Notoxus hirsutus CHAMPION
Notoxus hirsutus PIC
Notoxus hirtus LAFERTÉ
Notoxus holmi UHMANN
Notoxus intermedius FALL
Notoxus lateralis CHANDLER
Notoxus lesnei PIC
Notoxus lunulifer PIC
Notoxus marginatus LECONTE
Notoxus mauritanicus LAFERTÉ
Notoxus mexicanus CHAMPION
Notoxus mkuziensis VAN HILLE
- BOLOGNA & HAVELKA 1984
GÖRNITZ 1937, YOUNG 1984a
YOUNG 1984a
ABDULLAH, 1964, YOUNG 1984a
pers. observ.²⁵
pers. comm.²⁶
SCHÜTZ & DETTNER 1992, HEMP &
DETTNER 1997
YOUNG 1984a
BOLOGNA & HAVELKA 1984

VAN HILLE 1971
HEMP et al. 1999a
VAN HILLE 1971
CHANDLER 1977a, 1982
YOUNG 1984b
VAN HILLE 1985
HEMP et al. 1999a
CHANDLER 1976, 1982, YOUNG 1984a
CHANDLER 1982
CHANDLER 1982
CHANDLER 1977a
CHANDLER 1977a, 1982
CHANDLER 1977a, YOUNG 1984a
ABDULLAH 1964
VAN HILLE 1971
CHANDLER 1977a
HEMP et al. 1999a
SCHÜTZ & DETTNER 1992, HEMP et al. 1999a
CHANDLER 1982
CHANDLER 1977a, 1982, YOUNG 1984a
YOUNG 1984b
CHANDLER 1977a
ABDULLAH 1964, pers. comm.²⁸
CHANDLER 1982
VAN HILLE 1971
CHANDLER 1977a, 1982
pers. observ.⁵²
BOLOGNA & HAVELKA 1984
VAN HILLE 1985
CHANDLER 1982
CHANDLER 1977a
pers. comm.²⁹
VAN HILLE 1971, HEMP et al. 1999a
CHANDLER 1976, 1977a, 1982
ABDULLAH 1964, YOUNG 1984a
CHANDLER 1976, 1977a
VAN HILLE 1971

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| <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>haustrus</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 roebri</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 |

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| <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>Trichananca 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 |

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| <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 lenisi</i> (HORN) | YOUNG 1981 |
| <i>Pedilus longilobus</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</i> (<i>Hylemyia</i>) <i>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 levis</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 setosipennis</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>Bradysia 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)

MAFRA-NETO & JOLIVET 1994

Cryptocapsus sp.

DETTNER 1997

Cyrtocapsus caliginus (STAL)

HEMP & DETTNER, 2000

Eurychilella sp. near *pallida* REUTER

YOUNG 1984b

Hadronema bispinosa KNIGHT

PINTO 1978

Hadronema breviata KNIGHT

YOUNG 1984b

Hadronema militaris UHLER

FOX 1943

Hadronema princeps UHLER

YOUNG 1984b

Hadronema sp.

PINTO 1978

Hadronema uhleri VANDUZEE

PINTO 1978, YOUNG 1984b

Hadronema uniformis KNIGHT

YOUNG 1984b

Halticotoma nicholi KNIGHT

PINTO 1978

Halticotoma sp.

YOUNG 1984b

Halticotoma valida TOWNSEND

YOUNG 1984b

Neuleucon 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

Thentecoris sp.

DETTNER 1997

Tingidae
sp. MAFRA-NETO & JOLIVET 1994, DETTNER 1997

Hymenoptera

Braconidae
Blacus ruficornis (NEES) YOUNG 1984b

Perilitus plumicornis RUTHE GÖRNITZ 1937

Streblocera near *pubvilicornis* WALLEY & MACKAY YOUNG 1984b

Syrphizus agilis (CRESSON) YOUNG 1984b

Microtonus sp. DETTNER 1997

Melittobia sp. BOLOGNA 1991

Diapriidae
Gen. sp. (Diapriinae) DETTNER 1997

¹ *Anthicus albitarsis* 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 bianriculatus* 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 cinctatus* in GÖRNITZ 1937, ABDULLAH 1964, BOLOGNA & HAVELKA 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 tortiselis* 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 brunripes* 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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