



Insects and arachnids as elicitors of toxic and allergic reactions in Germany

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Abstract

Background Bees and wasps are the main culprits in terms of severe allergic reactions to insects in Germany; venoms from both insects are available for specific immunotherapy (SIT). Therefore, it is important to differentiate reactions to venom from other animals. It is also necessary for the sake of targeted prevention to assign sting reactions of any kind to their causal agents.

Methods By searching Medline, it was possible to identify relevant elicitors of sting and bite reactions particularly in Germany and Europe.

Results Not only Hymenoptera stings, but also bites and stings from other insects, as well as skin contact with insect components, can cause allergic and/or toxic skin reactions. Mosquitoes, horseflies, and thrips cause local reactions. Contact with some beetles may lead to blister formation and skin inflammation. Bed bugs are becoming an increasing problem in Germany too, and introduction into the domestic environment via luggage is possible. Although spider bites can also cause reactions in humans in Germany, reactions to lice and flea bites are more common. Some caterpillars have hair and bristles that act as a defense mechanism and cause not only skin reactions, but also respiratory reactions, including asthma attacks. Ants, particularly in the US and Australia, are relevant triggers of anaphylactic reactions.

Conclusion Hymenoptera stings are the most common cause of systemic allergic reactions, while ants also need to be borne in mind in tropical and subtrop-

ical countries. Other insects rarely cause anaphylactic reactions. In this part of the world, numerous other insects may be the cause of local sting reactions.

Keywords Allergy · Insects · Insect stings · Insect bites · Oak processionary caterpillar · Paederus dermatitis

Abbreviations

α -Gal	Galactose- α -1,3-galactose
DEET	N,N-diethyl-meta-toluamide
HIV	Human immunodeficiency virus
IgE	Immunoglobulin E
SIT	Specific immunotherapy
TBE	Tick-borne encephalitis

Introduction

Hymenoptera (bee and wasp, more rarely hornet and bumblebee) stings are undoubtedly the most important triggers of systemic allergic reactions through insect bites; bites and stings from numerous other insects are generally only local and nothing more than bothersome. Whereas aculeates by and large only sting humans as a mode of self defense, whereby they inject venom into the skin, blood-sucking insects seek humans as a source of food. Some of the latter in the skin-injected substances that have an anesthetizing or blood-thinning effect may cause local or, more rarely, systemic allergic reactions. Even skin contact with or inhalation of insect components can cause irritant or allergic skin reactions. Insect sting reactions may be clinically reminiscent of not only spontaneous urticaria but also dermatitis; the localization and distribution of the principal lesions are often key to diagnosis [1].

Environmental and “host” factors can represent predisposing factors for insect stings from blood-sucking insects. A tendency to perspire, skin flora,

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Table 1 A list of insects relevant in allergology. (Modified from [2])

Order Diptera (true flies)
Suborder Nematocera (flies)
Family Culicidae (mosquitos)
Family Simuliidae
<i>Simulium damnosum complex</i> (black flies)
Family Ceratopogonidae (biting midges)
Family Psychodidae (moth fly)
Subfamily Phlebotominae (sand flies)
Suborder Brachycera (flies)
Family Muscidae (true flies)
<i>Stomoxys calcitrans</i> (stable fly)
Family Tabanidae (horsefly)
Genus Tabanus (bot fly)
Genus Chrysops (deer flies)
Genus Haematopota (clegs)
Order Siphonaptera (fleas)
Order Hymenoptera (e. g., bees, wasps, ants)
Order Phthiraptera (lice)
Order Hemiptera (true bugs)
Order Thysanoptera (thrips/thunderflies)
Order Coleoptera (beetles)
Order Dictyoptera (cockroaches)
Order Lepidoptera (butterflies, moths)

and personal body odor are responsible for the fact that some people are stung by mosquitoes more often than others. In addition to these factors, children, male adults, and pregnant females are popular prey. Alcohol consumption also appears to increase an individual's risk for stings [2]. Insects have olfactory antennae that enable them to sense carbon dioxide (CO₂), odorants (e. g., 1-octen-3-ol, lactic acid), and heat [3]. Repellents block olfactory neurons and deprive the insect of its ability to localize its target. The duration of action depends on evaporation; high molecular weight substances are effective for longer [4].

It is important to note that stings from blood-sucking insects play an important role as vectors for bacterial and viral diseases worldwide [5]. Table 1 provides a list of insects relevant in allergology (corresponding images can be found in Fig. 1). Table 2 gives characteristics of some insects and arachnids with special regard to transmitted pathogenic organisms.

Diptera (two-winged or true flies)

Numerous insects belong to the Diptera order; they are subdivided into mosquitoes (Nematocera) and flies (Brachycera). Plants are their main source of food. Generally only the females bite, since they need protein from blood to lay their eggs. Mosquitoes

(Culicidae, Fig. 1a), black flies (Simuliidae, Fig. 1b), biting midges (Ceratopogonidae), as well as the stablefly (*Stomoxys calcitrans*, Fig. 1c) and the horsefly (Tabanidae, Fig. 1d) belonging to the true flies, seek warm blood – and hence also humans – to feed on. Local sting reactions described as taking the form of reddish, itchy, and sometimes also painful wheals and papules are normal, if undesirable. Local reactions that are pronounced and last several days are frequently seen in children. This type of reaction often abates in adulthood. Pronounced local reactions, sometimes involving blister formation, may be associated with fever, in which case they are referred to as Skeeter syndrome [2]; reactions of this kind are often erroneously diagnosed as erysipelas and treated with antibiotics.

Mosquito species in particular are carriers of a variety of viral diseases, e. g., malaria, yellow fever, and Dengue fever. Black flies can cause purulent infections via toxic substances, while species indigenous to Africa, Central and South America transmit the pathogen that causes onchocerciasis. South American biting midges transmit certain filariae and are otherwise known as vectors of animal diseases (blue tongue disease, African horse sickness). Horseflies and biting houseflies can transmit viruses that have a pathogenic effect on animals (lentiviruses); the tsetse fly, a member of the biting houseflies, is a known vector of sleeping sickness. The possibility of *Borrelia* transmission is under discussion.

In the case of unusual local reactions, one should also consider underlying diseases. Particularly in Japan and Korea, pronounced local reactions to insect stings, involving necrosis and possibly associated with fever and hallucinations, have been described in chronic Epstein–Barr virus infection and lymphoproliferative disorders [6]. Pruritic papular eruptions as a reaction to insect bites have been described in HIV-infected patients in tropical countries [7, 8].

Anaphylactic reactions to Diptera stings are rare; isolated cases of urticaria and angioedema due to mosquito and horsefly bites have been reported in the literature [9–11]. Anaphylactic reactions to mosquitoes and horseflies should always prompt consideration of underlying mastocytosis [12].

In terms of treatment, cooling compresses, topical glucocorticosteroids, and systemic antihistamine therapy are helpful. Specific immunotherapy (SIT) using mosquito extracts has been investigated in small studies on patients that developed local reactions and/or rhinitis due to mosquito bites. These reactions no longer occurred following treatment [13]. There are no commercially available preparations, either for skin tests or for SIT, to treat Diptera allergy. The use of repellents is recommended for the prevention of insect stings.

Fig. 1 Members of the insect world whose sting or bite can cause allergic and/or toxic skin reactions or bothersome local reactions: **a** mosquitoes (Culicidae), **b** black flies (Simuliidae), **c** biting midges (Ceratopogonidae), **d** stablefly (*Stomoxys calcitrans*), **e** horse-fly (Tabanidae), **f** thrips/thunderflies, **g** bed bugs (*Cimex lectularius*), **h** carpet beetle larvae, **i** Paederus (*Paederus littoralis*), and **j** moth fly (Psychodidae). (Photo sources: **a** © abet/stock.adobe.com, **b** © Henrik Larsson/stock.adobe.com, **c** © Sinclair Stammers/Science Photo, **d** © Pavel Krok/wikipedia.de, **e** © Marco Uliana/stock.adobe.com, **f** © Nigel Cattlin/SCIENCE PHOTO, **g** © smuay/stock.adobe.com, **h** © lunaundmo/stock.adobe.com, **i** © entomart/wikipedia.de, **j** © gordzam/stock.adobe.com)



Table 2 Stinging/biting insects and arachnids, as well as some of the pathogens they transmit

Insect	Particular features	Disease transmission
Mosquitoes	Only females feed on blood. The stinger is so thin that pain receptors are only rarely stimulated. Analgesic and anticoagulatory substances in salivary secretions	A number of species in Germany are able to transmit <i>Borrelia</i> Mosquitoes in the tropics and subtropics transmit, e. g., the Sindbis, West Nile, and Rift Valley viruses. Filariæ (nematodes) Aedes species: dengue, yellow fever, Zika virus Aedes aegypti: e. g., yellow fever, dengue, chikungunya, Rift Valley, Zika viruses Asian tiger mosquito: West Nile, yellow fever, St. Louis encephalitis, dengue, chikungunya viruses Anopheles: Plasmodia (malaria)
Black flies	Painful bites, feed on emitted blood. Females must feed on blood (humans, birds, mammals). Bruising possible due to local anticoagulation	Purulent inflammation, lymphangitis In Africa, filarial nematodes (onchocerciasis)
Biting midges	Only females bite. Bites often inflicted in the evening/at night	Transmission of animal diseases (blue tongue and African horse plague viruses)
Stable fly	Only active during the day. Bites are painful. Males and females feed on blood (humans, horses, cattle, dogs) every 2–3 days. Feeding lasts 8–9 min	Mechanical transmission of various bacteria West Nile, Rift Valley; EIA virus (equine infectious anemia), African swine fever virus. Possibly also Rickettsia, Anaplasma, Coxiella, Trypanosoma; helminths and roundworms
Horseflies	Particularly around horse and cattle pastures. Painful bites/stings from which blood is drawn; stings occur between June and August	Mechanical transmission of: <i>Bacillus anthracis</i> (anthrax), <i>Francisella tularensis</i> (tularemia), <i>Borrelia</i> Filaria (Loa Loa), Trypanosoma (sleeping sickness), EIA virus (equine infectious anemia), (possibly also HIV?)
Thrips	Only rarely sting. Multiple stings trigger Thysanoptera dermatitis	Plant viruses
Moth flies	Only a few species feed on blood	Important subfamily of the sand flies <i>Leishmania</i> , sand fly fever virus
<i>Cimex lectularius</i>	Found in domestic environments and chicken coops. Stings in a row are clinically typical. Nighttime stings; saliva contains anesthetizing substances, since stings go unnoticed. They cause allergic reactions including possible anaphylaxis. Preferred sources of blood: humans (also birds and small mammals)	Although in principle bed bugs can transmit a wide range of pathogens, there is no reliable evidence of disease caused in this way Assassin bugs (Reduviidae) transmit <i>Trypanosoma cruzi</i> (Chagas disease) in Central America
Ticks	Stings go unnoticed due to locally anesthetizing substances in saliva Local allergic reactions and possibly also induction of allergy to alpha-Gal Pigeon tick (<i>Argas reflexus</i>) can survive for many years in bird nests. Allergic reaction involving nighttime anaphylaxis has been described	<i>Borrelia burgdorferi</i> , FSME viruses Rickettsia (typhus, Mediterranean spotted fever, Rocky Mountain spotted fever) Babesia, Ehrlichia canis, Coxiella burnetii [Q fever] <i>Francisella tularensis</i> (Tularemia)
Fleas	Feed daily on blood Host is sought by nest fleas for feeding only. Bites are generally in a row formation	Superinfection often caused by Staphylococci, Streptococci, and other bacteria that cause disease in humans Oriental rat flea <i>Yersinia pestis</i> Dog/cat fleas are intermediate hosts for <i>Dipylidium caninum</i> (tapeworm) Tularemia (<i>Francisella tularensis</i>), Rickettsia (typhus)
Lice	Pronounced local reactions due to type IV reactions to saliva components. Superinfection caused by scratching	<i>Salmonella typhi</i> , Rickettsia <i>proWazekii</i> (typhus), <i>Bartonella quintana</i> (five-day fever), <i>Borrelia recurrentis</i> (louse-borne relapsing fever)
Ants	Ant species living in Germany cause reactions that itch locally due to sprayed venom. Species not indigenous to this part of the world are equipped with a defensive stinger that can penetrate the skin; anaphylactic reactions are possible	Are able to transmit bacteria mechanically

Thrips/thunderflies

Thrips form the order Thysanoptera, 5000 different species of which are found worldwide. These insects measuring 1–3 mm in length feed primarily on plants, are able to transmit certain plant viruses, and are not actually blood-sucking insects. However, they do occasionally bite during warm weather periods [2, 14, 15]. There is speculation that they respond to perspiration from the skin or try to take up water. As they bite, they release saliva into the skin, which goes on to cause itchy papules. Thysanoptera dermatitis in-

volving multiple sting reactions has been described in the context of dense concentrations of thrips.

Ants

Ants belong to the Formicidae family (order Hymenoptera). There are more than 13,000 species known worldwide. The females of some of these species are equipped with a stinger that is used for defense and is similar in structure to those of other aculeates. Numerous ant species, while they no longer have a stinger, do have a venom gland from which

they are able to spray venom. Ants have powerful jaws as a tool of defense, with which they are able to crush food as well as inflict painful bites on humans.

Only some species, e. g., *Solenopsis* spp., *Myrmecia* spp., or *Pachycondyla* spp., regularly cause immediate-type allergic reactions. These species of ant are particularly indigenous to the US, Australia, South-east Asia, and the Middle East [16]. At present, there are no anaphylaxis-triggering ant species in Europe. As with other Hymenoptera, toxic systemic reactions involving rhabdomyolysis and kidney failure are possible alongside anaphylactic reactions in the event of multiple stings [16]. In some countries, venoms from individual ant species are available for skin testing, and specific IgE antibodies in serum can be investigated. Studies on SIT using venom from individual ant species have been published [17–19].

The fire ant (*Solenopsis invicta*), which originated in South America, was first inadvertently introduced into the southern states of the US in about 1930 [20]. Ants are estimated to cause costs (in medical treatment, monitoring, and damage) of around six billion dollars in the US [21]. They have since spread as a result of the movement of goods from the US to Taiwan, China, Hong Kong, Australia, and New Zealand; thanks to genetic analysis, it has been possible to identify their pathways of spread with considerable accuracy.

While fire ants are relevant only in certain areas of Australia, bulldog ants – green-head ants (*Rhytidoponera metallica*) and hopper or jack jumper ants (*Myrmecia pilosula*) – have always been endemic to Australia. Hopper ants derive their name from their characteristic locomotion by jumping; they are particularly aggressive in that they jump towards intruders and bite immediately. Reactions to *Myrmecia* are most common in Australia; cross-reactivity between various ant venoms is highly variable [22].

True bugs

The approximately 40,000 species of true bugs (Hemiptera) are found worldwide; in addition to herbivores, ectoparasites like the bed bug (*Cimex lectularius*, Fig. 1e) also belong to this order. The bed bugs found worldwide are, inevitably, blood-sucking ectoparasites that are able to survive for up to 1 year without food. In Germany, one also encounters bat bugs (*Cimex dissimilis*, *Cimex pipistrelli*), the pigeon bug (*Cimex columbarius*), and the swallow bug (*Oeciacus hirundinis*); humans can serve as a temporary host once birds have left their nests in autumn [23]. The generally painless stings are typically arranged in a linear configuration (“breakfast – lunch – dinner”). The stings do not initially cause itch and reactions often occur in a delayed manner after around 7–10 days. Pronounced local as well as systemic reactions involving generalized urticaria, asthma, and anaphylaxis are possible following sensitization [23, 24]. Although bed bugs are also carriers of numerous infectious agents,

there is no evidence to date they actually transmit infectious diseases [2, 23].

A single fertilized female that can lay up to 150 eggs and be inadvertently transported in luggage is all it takes for domestic infestation. In Germany too, bed bugs represent a growing problem. In 2007, 210 cases were reported to the Berlin regional branch of the German Association for Pest Control (*Schädlingsbekämpfungsverband*), whereas 761 cases were reported in 2012. Bed bugs can be found in hotels, accommodations of all types, healthcare facilities, the second-hand furniture trade, as well as in transport [23]. Particularly in the case of strong infestation, bed bugs emit a characteristic odor described as sickly sweet or coriander-like.

Repellents containing N,N-diethyl-meta-toluamide (DEET) are able to protect against bed bug stings [25]. DEET is especially used in repellents that are suitable for the tropics.

Cockroaches

Of the more than 4000 known cockroach species (Blattodea), the most relevant species worldwide from a medical perspective are the *Blattella germanica* and the American cockroach (*Periplaneta americana*). Since cockroaches have a predilection for warm environments, human habitations represent ideal living conditions. They transmit disease and are a source of allergens in inhalant allergies. It has also been shown that cockroaches bite, and sleeping children in particular are affected; bites can cause ulceration, crusts, pain, and itching [26].

Fleas

Fleas (Siphonaptera), which belong to the subclass of winged insects in the class Insecta, are wingless, jumping insects that, as ectoparasites (birds and mammals), feed on blood. Around 1600 species have been described worldwide, of which 80 are found in Central Europe. Fleas seek a host only for the purposes of feeding.

Humans are infested not only by the human flea (*Pulex irritans*), but other fleas can also be the culprits in flea bites, e. g., the cat flea (*Ctenocephalides felis*), the dog flea (*Ctenocephalides canis*), and the oriental rat flea (*Xenopsylla cheopis*). Bites are often located in the ankle region and several bites in the form of highly itchy, red papules with central points of bleeding are typical, arranged either adjacent to one another or in a line. The highly itchy bites are often scratched open, whereupon the risk of local infection due to bacteria transmitted by fleas increases. It is important to note that fleas transmit various diseases [27], the best known among these being plague.

A number of insecticides are used to combat flea infestation; the key to combating infestation is to distinguish between nest fleas and fur fleas. Nest fleas

are found only temporarily on the host, preferring as they do their host's sleeping place.

Repellents, in particular plant extracts, appear to also be effective against fleas [28].

Lice

Human lice (Pediculidae) – the head louse (*Pediculus humanus capitis*) and the pubic louse (*Phthirus pubis*) – are wingless insects belonging to the order Phthiraptera. They are transmitted from human to human. Lice also transmit various diseases. A number of cases of louse-borne relapsing fever (*Borrelia recurrentis*) were recently reported in Germany among refugees from Africa [29]. Infection is caused when crushed lice come into contact with injured skin.

For the diagnosis and treatment of head lice infestation, the reader is referred to the advice pamphlets issued by the Robert Koch Institute (www.rki.de/DE/Content/Infekt/EpidBull/Merkblaetter/Ratgeber_Kopflausbefall.html, <https://www.fda.gov/ForConsumers/sumerUpdates/ucm171730.htm>).

Plant-based repellents can be used to protect against infestation. Vitex agnus castus (monk pepper) and eucalyptus have been shown to contain substances that have a preventive action against head lice [30].

Ticks

Ticks (Ixodida) belong to the arachnids and, together with mites, form the subclass Acari. Over 900 different species of these blood-sucking parasites are known. Using their chelicerae, they create a wound in the skin from which they suck blood via a proboscis. The tick releases a salivary secretion that contains locally anesthetizing and anticoagulatory substances into the wound. Therefore, the sting itself often goes unnoticed – only the blood-filled insect is found. Viruses, bacteria, and parasites taken up in blood can then be transmitted via saliva to the next sting victim. Thus, the tick acts as both host and intermediate host for pathogens. The castor bean tick (*Ixodes ricinus*) is the species most commonly found in Central Europe and transmits numerous pathogens that cause disease in humans and animals. The transmission of borrelia (*Borrelia burgdorferi*) and tick-borne encephalitis (TBE) is of particular relevance. The duration of sucking correlates with the risk of pathogen transmission. Therefore, ticks should be removed as rapidly as possible, ideally without crushing the parasite.

Pronounced and persistent tick sting reactions may be due to hypersensitivity. Sensitization to galactose- α -1,3-galactose (α -Gal) has increased in importance in recent years. Evidently, sensitization can be caused by tick bites [31] and goes on to manifest later as food anaphylaxis. Delayed allergic reactions following the consumption of α -Gal-containing red meat (e. g., beef, pork, lamb, game) are typical [32]. Immediate-type re-

actions ranging from urticaria to anaphylactic shock generally occur between 4 and 8 h following consumption. Sensitization is confirmed by detecting specific IgE antibodies to α -Gal. Meat allergy is generally not suspected due to the interval between meat consumption and allergic reaction. Excessive local reactions to tick bites are considered a predictive marker of meat allergy [33].

In addition to checking the skin and clothing for ticks after being outdoors, repellents that are sprayed on the skin and clothes can also be used to protect against bites.

Spiders

When biting, spiders inject poison to paralyze or kill their prey. Of the approximately 41,000 different species worldwide, only a handful are medically relevant [34]. There are also a number of spider species indigenous to Europe that are capable of biting humans and causing reactions with their venom [35, 36]. As a result of climate change, poisonous spiders are expanding their habitat to also include Germany [37].

The diagnosis of a spider bite on the basis of patient history is usually incorrect; other insects are usually the culprit, but dermatosis of a quite different kind may also be responsible, in particular infections [36].

During the period between June 2011 and May 2013, 14 symptom-causing spider bites were reported in Switzerland: the spider was seen to inflict the bite in eight cases; furthermore, six spiders were submitted for identification following bites. Stings from all five spider species identified were relatively harmless and primarily caused local symptoms involving pain, swelling, and redness [36].

A bite from *Loxosceles rufescens* can cause skin necrosis, as well as systemic reactions including fever, nausea, and rashes (petechial, scarlatiniform, or morbilliform) [38, 39]. A case of intoxication by a spider bite with a fatal outcome due to hemolysis, kidney failure, intravascular coagulopathy, and shock has been reported in Italy [40]. Bites from nocturnal spiders may be mistaken for skin infections; the case reports published in Europe to date come predominantly from the Mediterranean region.

The widow spider species belonging to the genus *Latrodectus* are also endemic in the Mediterranean region. Priapism, muscle cramps, hypertension, and tachycardia have been described following bites from the Mediterranean black widow (*Latrodectus tredecimguttatus*) [41]; a case report from Greece documents transient, reversible takotsubo cardiomyopathy [42].

At a maximum body length of 1.5 cm, the yellow sac spider (*Cheiracanthium puncturium*) is a relatively large spider that is also found in Germany. Its bite can be very painful (comparable with a bee/wasp sting) and may also cause headache, nausea, vomiting, and occasionally necrosis at the site of the bite [43].

Spider bites are treated symptomatically; analgesics and antipyretics are additionally used in the case of fever.

Caterpillars and beetle larvae

Some caterpillars and beetle larvae are equipped with hairs and bristles that cause mechanical irritation or carry venom. Urticaria, dermatitis, vasculitis, lymphadenopathy, and rhinoconjunctivitis have been described in sensitized individuals. Carpet beetle larvae (Fig. 1f) are covered with bristle-like tufts of barbed hair that can cause carpet beetle dermatitis [44, 45]. Skin reactions are treated with topical corticosteroids. It is essential in the fight against these pests to thoroughly clean the home, a task that can prove extremely difficult given that beetles and larvae concealed in, e. g., drawers or on soft toys may evade treatment with pyrethroid pesticides.

The hairs of more than 150 caterpillar species are able to cause skin reactions; the oak processionary caterpillar is particularly well known in Germany, while the pine processionary caterpillar, for instance, is relevant in the US. IgE-mediated reactions to caterpillar protein have been described in the US as triggering urticaria, asthma, rhinitis, and rashes [46]. Caterpillar hairs can cause skin reactions via direct contact, as well as respiratory reactions via airborne exposure [47].

Severe poisoning by the *Lonomia obliqua* caterpillar, which has reached epidemic levels in southern Brazil, is particularly problematic. Reactions start as localized pain, burning, and redness; followed by malaise, vomiting, respiratory distress, hemorrhage, hypotension, headache, arthralgia, myalgia, weakness, and fever; and culminating in kidney failure as well as pulmonary and intracerebral hemorrhage [48].

Beetles (blister beetles)

Beetles belonging to the genus *Paederus* and to the oil beetles (family Meloidae) warrant a brief mention here, since contact with components of these beetles can cause skin reactions [49].

Paederus, from the family of rove beetles in the order beetles (Coleoptera), is found worldwide. In all, 10 species are indigenous to Central Europe. These slim beetles are usually relatively brightly colored; the Central European species have blue elytra and a red pronotum. Epidemic contact dermatitis caused by contact with these beetles is known particularly in various parts of Africa, as well as in India, Malaysia, and China. There are also case reports from Italy [50]. The beetle is nocturnal and attracted by light. Endosymbiotic bacteria synthesize highly toxic alkaloids (mainly pederin), which can be isolated in the hemolymph of the beetle and which cause blister formation upon skin contact – *Paederus* dermatitis. Contact with intact beetles is unproblematic; reactions only occur if

the beetle is crushed against the skin. After approximately 12–24 h, progressive, itchy, or burning rashes develop, followed by the formation of blisters that grow in intensity over a period of days. Skin reactions may be reminiscent of burns. Linear dermatitis is the result of the swiping movements with which the insect is removed from the skin. Although the blisters dry out after 5–8 days, postinflammatory hyperpigmentation can persist for longer periods [51, 52].

Cantharidin is the toxin contained in the hemolymph of oil beetles. Contact with this substance – again, as a result of the beetle being crushed against the skin – also causes blister formation. In addition to being employed as an aphrodisiac under the name Spanish fly, cantharidin is also used to treat molluscum contagiosum [53].

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