

Systemic Immediate Allergic Reactions to Arthropod Stings and Bites

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Key Words

Anaphylaxis · Insect bites and stings · Arthropods

Abstract

Most of the encounters with biting and stinging insects result in more or less pronounced localized reactions. Typically, urticarial wheals and papular reactions are observed. Less often local bullous or hemorrhagic or disseminated papular reactions, particularly in children and immunologically naive adults, may be seen. With the exception of bee and wasp venom allergies, immediate-type allergic reactions to arthropod stings and bites are rare. Systemic IgE-mediated hypersensitivity has also been reported from additional hymenoptera species, e.g. hornets, bumble bees and ants. Rare are systemic reactions to mosquitoes, flies or kissing bugs and exceptional from ticks, bed bugs, moths, caterpillars and spiders. A major problem is the often lacking standardization of extracts for skin testing and for the determination of specific IgE. Some of the allergens have been characterized and few of them synthesized using recombinant techniques. Most investigations have been made with whole-body extracts or extracts from salivary glands, while desensitization has rarely been attempted. Currently, primary prevention by avoidance of stings and bites, and adequate instruction of sensitized individuals in the use of emergency drugs are mandatory.

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Introduction

Bites and stings from insects are a very common event and may lead to a variety of cutaneous reactions. Most are only local, and their morphology and evolution depend mainly on the immunity of the host. Although local reactions are rarely life-threatening, they may be severe or may have at least a considerable impact on life quality. Severe systemic hypersensitivity reactions occur e.g. as a consequence of bee and wasp stings. In medicine, for a long time these local reactions have not been of major interest. Therefore, it was a pioneer task when Theo Rufli and Kosta Y. Mumcuoglu started in the 1970s to study medically relevant mites and insects in Europe. The cooperation between an MD and a PhD proved to be very successful, and the mutual enthusiasm resulted in a book on dermatological entomology published in 1982 [1]. It was a great step forward in the recognition of the medical importance of a great number of arthropods and the plentiful reactions they may elicit in the human host, and after over 20 years it remains an important reference textbook. Theo Rufli had demonstrated his interest in insects already many years earlier with his thesis dealing with house dust mites as asthma allergens [2].

In this article, the rather rare systemic immediate hypersensitivity reactions from arthropod stings and bites are reviewed.

The term arthropod meaning ‘articulated feet’ was coined in the 19th century by Siebold and Stannius [3].

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Table 1. Classification of some medically important arthropods

Phylum: Arthropoda
Classes:
Crustacea (9 orders)
Decapoda, e.g. shrimps, prawns, crabs, lobsters
Myriapoda
Centipedes, millipedes
Arachnida (8 orders)
Araneae, spiders
Acarina, mites and ticks
Scorpionidea, scorpions
Hexapoda (Insecta, 29 orders)
Diptera, e.g., flies, mosquitoes, midges
Coleoptera, beetles
Hemiptera, true bugs
Anoplura, sucking lice
Siphonaptera, fleas
Orthoptera, e.g. crickets, grasshoppers, locusts
Dictyoptera, e.g. cockroaches, praying mantids
Hymenoptera, e.g. wasps, ants, bees
Lepidoptera, butterflies, moths

The phylum Arthropoda is by far the largest in the animal kingdom and includes approximately 1.5 million species which account for approximately 80% of all known animal species [4]. They encompass four principal classes, namely Crustacea e.g. shrimps and daphniae, Myriapoda e.g. millipedes, the eight-legged Arachnida including spiders, scorpions, ticks and mites, and Hexapoda including the six-legged winged and unwinged true insects such as wasps, mosquitoes, flies and beetles (table 1). Apart from having a major impact on the whole chain of food production and storage, particularly the two latter classes are also of major medical interest. On the other hand, many insects are also utile as a source of food and for pollination, and they play an outstanding role in the ecological system.

All mammals, even aquatic species, may suffer from infestation or the sequels of encounters with arthropods. All humans are exposed in one way or the other, and virtually everybody repeatedly experiences stings and bites mainly from Hexapoda species and is directly or indirectly exposed to excrements and body parts from arthropods.

Dependent on the type and mode of exposure, the medical consequences are manifold. Stinging and biting arthropods are important vectors, and, particularly in tropical and subtropical countries, they may transmit a multitude of infectious (viral, bacterial and protozoal) diseases. Some produce potent venoms and elicit local or

systemic toxicity, others cause irritation of skin and mucosa by hairs, spikes and secretion of irritant and toxic substances. However, also in temperate climatic zones e.g. ticks may transmit infectious diseases, and imported insects may be encountered. Currently it is difficult to estimate how climatic changes and global warming will affect the living spaces and distribution of some species. One of the best-documented examples on a large scale is the import of the fire ant into the southern part of the USA and recently also into Australia [5]. Finally, due to the increasing worldwide travel, tourism and migration, patients with illnesses caused by tropical insects may be encountered also in countries with moderate climate.

Hypersensitivity reactions from arthropods include the following symptoms and signs or illnesses [3, 4, 6, 7].

(1) Delayed reactions: (a) local papules; (b) local bullous/hemorrhagic reactions; (c) disseminated papules; (d) generalized papular urticaria (strophulus); (e) general systemic symptoms (fever, myalgia, lymphadenopathy). There is no extensive information on the pathology underlying delayed reactions, and the pathogenesis is often unclear. Infiltration of mononuclear cells has been found on days 2–3. In some studies also deposits of complement components and immunoglobulins have been found [4]. Local papular reactions from midge stings are very common, but also bullous and hemorrhagic lesions may be observed [6]. Rarely general symptoms with fever and general feeling of sickness may occur. Rarely other types of reactions such as e.g. pseudoangiomatous-like lesions (erythema punctatum Higuchi) have been reported [8].

(2) Immediate reactions: (a) local swelling or urticaria; (b) generalized urticaria; (c) anaphylaxis; (d) asthma, rhinitis (upon inhalation). The pathogenesis is in many cases most likely an IgE-mediated reaction resulting in immediate local swellings, urticaria, anaphylaxis and asthma [6]. Specific IgE have been demonstrated against several insect antigens including Hymenoptera venoms, mosquito proteins and others [4, 9]. In local swellings and contact urticaria direct effects of mediators such as histamine and histamine liberators such as thaumetopoein from caterpillars may often play a role. The way of exposure influences the type of symptoms. Upon stings and bites, local cutaneous reactions up to anaphylaxis, as e.g. in Hymenoptera venom allergy, are typical. Apart from allergic rhinitis and asthma from the mite species such as *Dermatophagoides pteronyssinus* and *Dermatophagoides farinae* and *Blattella* sp., respectively, respiratory symptoms to Hexapoda allergens often occur in occupational situations with extensive exposure to insects or insect parts [3, 10]. Emanations from insects have also been suspected as aeroallergens causing

rhinitis and asthma in nonoccupational settings, e.g to Chironomides in fish bait and feed, and to silk wastes containing insect particles used in bed duvets and pillows [3, 10]. Ingestion of representatives of the Crustacea family may elicit severe allergy in sensitized individuals, and rarely food contaminated with arthropods causes systemic allergy. Cross-reactivity based on common epitopes of tropomyosin, an allergen present in shrimps, house dust mites and cockroaches, has been demonstrated [11].

Symptoms and Signs

Grading systems for acute allergic systemic hypersensitivity reactions vary considerably and several classifications are in use, which lack a consistent definition of anaphylaxis [12]. The clinical symptoms of anaphylaxis affect various organs. Typically it starts with pruritus, followed by urticaria and/or angioedema. Also the respiratory tract may show early involvement with laryngeal edema, bronchospasm and rhinitis. Gastrointestinal involvement includes colics, nausea, vomiting and diarrhea. Headaches, weakness and faintness, collapse, loss of consciousness and a sense of impending doom may be present. In the severest cases, these signs may proceed to cardiovascular symptoms and finally to cardiac and/or respiratory arrest and death [13].

Here we focus on the rare severe immediate-type hypersensitivity reactions particularly to biting and stinging arthropods, which may elicit at least a generalized urticaria. The much more common respiratory allergies from insect allergens presenting with rhinoconjunctivitis and asthma are not further discussed.

Systemic Reactions to Arthropods

Insects (Hexapoda)

Diptera: Nematocera

Mosquitoes (Culicidae)

Typical skin reactions to mosquito bites (fig. 1) consist of local urticarial wheal and flare followed by pruritic papules [14]. Large local reactions include bullous, hemorrhagic and Arthus-like lesions. Skeeter syndrome represents a large local reaction sometimes with elevated body temperature. Individuals at risk for severer local or systemic reactions include children with not yet acquired immunity, tourists with no previous exposure to local insect species, persons with high levels of exposure partic-

ularly in occupational settings, patients with immunodeficiencies and EBV-associated lymphoproliferative disorders [15].

Severe anaphylactic reactions to mosquito stings are surprisingly rare with regard to the worldwide distribution of species such as *Aedes aegypti*, *A. vexans*, *A. albopictus*, *A. togoi*, *A. triseriatus*, *Culex quinquefasciatus*, *C. pipiens*, *C. tarsalis*, *Anopheles sinensis* and *Culiseta inornata* [16]. Possibly the naturally acquired immunity by repeated exposure is crucial [17], e.g. IgE and IgG antibodies to allergens of several mosquito species have been found [15, 18]. Typically the levels are highest in children and slowly decrease over time. In some cases with systemic symptoms [19], desensitization with whole-body extracts has been successfully applied [20–22]. Some of the salivary allergens, which may be cross-reactive or species-specific, have been identified [16]. Since gaining saliva from mosquitoes in larger amounts is impossible, the recombinant allergens rAed a 1, rAed a 2, rAed a 3 and rAed a 4 from *A. aegypti* have been produced. They show biological activity in skin and in vitro tests as well as in mouse models. There seems to exist considerable cross-reactivity with saliva allergens from other mosquito species. In the future, these recombinant allergens may facilitate diagnosis and desensitization [15, 23].

Diptera: Brachycera

Horseflies and Tsetse Flies (Tabanidae and Glossinidae)

Anaphylaxis to horsefly bites is rare. Approximately 30 case reports particularly from deerflies (*Chrysops* sp.) have been reported. Using the Western blot, a 69-kDa salivary gland protein has been identified in 1 patient [6, 24]. Due to the lack of well-characterized extracts in vivo and in vitro diagnosis is difficult. A patient with coexistent anaphylaxis to horsefly (*Tabanus americanus*) and Hymenoptera venoms has been described [25]. However, in 20 control patients with Hymenoptera allergy, the skin test and IgE to Tabanidae allergens were also positive. A wasp-horsefly syndrome has recently been postulated; however, this is so far only based on in vitro cross-reactivity [26]. One patient has been successfully desensitized with a whole-body extract from deerfly [27].

In a repeatedly exposed doctoral student studying tsetse flies (*Glossina morsitans*), the bite of this insect resulted in a severe allergic reaction. By a dot blot technique, specific IgE to a salivary gland extract was demonstrated; however, specific IgE were also present in 1 of 5 previously exposed workers in the same laboratory who had had no clinical symptoms [28].

Bugs (*Heteroptera*)

Bed Bugs (*Cimex lectularius*)

Bed bugs such as *Cimex lectularius* (fig. 2) cause very pruritic local reactions after repeated exposure [1], with a hemorrhagic or bullous aspect. Systemic allergic reactions seem to be very rare [29, 30]. They are medically more important by transmitting infectious disorders such as trypanosomiasis (Chagas disease).

Kissing Bugs (*Triatoma* sp.)

Triatomid bugs (fig. 3) are also known vectors of Chagas disease. They belong to the family of Reduviidae and to the subfamily Triatominae. They are also known under the term 'kissing bugs'. Anaphylaxis from their bites has been described already over 100 years ago, to date nearly 50 patients have been reported [31, 32]. Their nocturnal painless bite is found on uncovered skin and may result in local papules, bullae or urticaria. The prevalence of anaphylaxis to kissing bug bites is not known, there may be a considerable underrecognition of cases. The patients typically wake up from itching cough and dyspnea, and may later develop the typical signs of anaphylaxis. An IgE-mediated mechanism has been demonstrated by RAST inhibition [32]. A major triatomine allergen has been identified and cloned. Procalin, a 20-kDa antigen from salivary glands, has been expressed by recombinant techniques [33]. It may facilitate more accurate diagnosis and therapy. So far few patients have been desensitized with a salivary gland extract, most of them apparently with success [34].

Hymenoptera

Hymenoptera stings are among the most common causes of anaphylaxis besides foods and drugs. Among the many families [35], only the Vespidae, Formicidae and Apidae are medically relevant. In a recent review, the medical importance of Hymenoptera has been summarized [36].

Bees and Wasps (Apidae and Vespidae)

Among the Apidae, the honey bee (*Apis mellifica*) and the bumble bee (*Bombus* sp.) may cause allergic reactions. Among the Vespidae family, the hornet *Vespa crabro* as well as species from the *Vespula*, *Dolichovespula* and *Polistes* genera are common causes of allergic reactions. Due to their frequency, the epidemiology of sting reactions, the composition of venoms and the different schedules and the value of desensitization have been extensively studied [37], and the most important allergens were identified. Attempts to desensitize with recombinant allergens have

been made [38]. Many reviews and position papers on this topic have been published in the last few years [39–43].

Ants (Formicidae)

Ant allergy is increasingly recognized, particularly in Asia and Australia. In the southern states of the USA, the problem of *Solenopsis* is well known [44]. *Solenopsis* sp. have so far also been found in Saudi Arabia and in Australia where also allergic reactions have been described [45]. *Pachycondyla* sp. are found in Asia, whereas *Myrmecia* sp. are abundant in Australia.

Imported Fire Ant (*Solenopsis invicta* and *richteri*). The exact incidence of fire ant anaphylaxis is unknown, it is estimated however that 0.6–16% of individuals who are stung develop an anaphylactic reaction. Systemic reactions range from pruritus, erythema, generalized urticaria and angioedema to potentially life-threatening manifestations of bronchospasm, laryngeal edema or hypotension. More than 80 fatalities from anaphylaxis have been reported [46]. The venom contains more than 95% water-soluble alkaloids, which elicit the pathognomonic pustular sting reaction. The peptide fraction contains 4 known allergens, i.e. Sol i 1–4; however, immunological cross-reactivity to venoms of vespid species is only known for Sol i 1. Immunotherapy has not been extensively studied, as no commercial venoms are available. In one uncontrolled study, it appeared to be successful in the prevention of anaphylactic episodes [44]. Recently, the first cases of allergy to *Solenopsis* have been identified in Australia [5]. In recent years, it has been tried to control *Solenopsis* sp. by biological measures, i.e. by introducing natural enemies such as decapitating flies belonging to the genus *Pseudacteon* [47].

Pachycondyla chinensis and *P. sennaarensis*. In Asia, the ant *Pachycondyla chinensis* has been increasingly reported to elicit anaphylactic reactions [48]. The prevalence of systemic reactions in an infested area was 2.1% [49]. Specific IgE and IgG4 have been found in a high percentage of patients with anaphylaxis to *P. chinensis*. Several IgE-binding components were identified, and a 12-kDa allergen was present in 85% of the cases. Cross-reactivity with other Hymenoptera venoms was only observed in the group with clinical allergy to other Hymenoptera species [50]. The Samsum ant, another representative of the *Pachycondyla* sp., is responsible for allergic reactions in the Arabian peninsula. In 31 individuals with systemic reactions, positive skin tests and/or specific IgE have been identified [51].

Myrmecia sp. The jack jumper or bull ant (*Myrmecia pilosula*) is native to Australia and commonly found. In

Fig. 1. Mosquito (*Culex pipiens*). Courtesy K. Mumcuoglu.

Fig. 2. Female bed bug (*Cimex lectularis*). Bed bug bites result, dependent on the host's immunology, in grouped or linear papular, urticarial or hemorrhagic lesions. Courtesy K. Mumcuoglu, Department of Parasitology, Hebrew University, Hadassah Medical School, Jerusalem, Israel.



Fig. 3. Kissing bug (*Triatoma* sp.). Its painless bite may result in nocturnal anaphylaxis. Courtesy Dr. Richard A. Grantham, Entomology and Plant Pathology, Oklahoma State University, Oklahoma, USA.



Fig. 4. Oak processionary caterpillar. Nest of *Thaumetopoea processionea* on an oak tree.



Fig. 5. Irritant dermatitis from oak processionary caterpillar. Papular and urticarial lesions 12 h after contact with hairs (setae) of *Thaumetopoea processionea*.

an emergency department on Tasmania, bites from bull ants accounted for 21–25% of cases of anaphylaxis as compared to 13% from honey bee stings. Fatal anaphylaxis has been reported in patients with known hypersensitivity. Postmortem analysis revealed specific IgE with cross-reactivity to other *Myrmecia* sp. Three of them suffered from previous severe allergic reactions but did not carry

emergency medication with them. All had significant cardiac co-morbidities, while 2 took ACE inhibitors which may aggravate anaphylaxis. Desensitization with whole-body extracts has been attempted. Unfortunately, cross-reactivity between native extracts and the synthetic peptides Myr p 1 and Myr p 2 was low; therefore, the latter may not yet be used for immunotherapy [52].

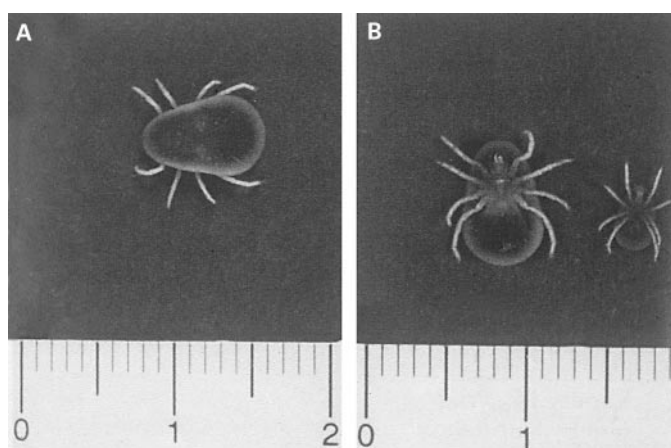


Fig. 6. Pigeon tick (*Argas reflexus*). Its primarily painless bite later becomes pruritic or painful. Urticaria and anaphylaxis have been reported. Reprinted with permission from Veraldi et al. [79] and from Blackwell Publishing.

Other Ant Species of Medical Importance. The winged ant *Brachyponera chinensis* is widely distributed in Japan. Local reactions to this ant are well known; however, anaphylaxis seems to be very rare. In this single case, no further diagnosis was attempted [53].

A young girl experienced severe urticaria after the sting of *Odontomachus bauri*, an ant species found in South America. A formal allergological workup was not done [54].

In temperate climates, systemic allergic reactions to ants seem to be extremely rare [55]. A case of a 12-year-old boy from Switzerland was described. After the bite of a red harvest ant (*Formica rufa*), he developed an immediate reaction. Skin test and specific IgE to a whole-body extract were positive but negative in controls. Specific IgE to *Solenopsis*, bee and wasp venom were also detected [56].

Butterflies and Moths (Lepidoptera)

Lepidopterism is the general term used for the ill effects of moths and butterflies to humans. It includes irritant and toxic reactions to hairs of caterpillars of moths and butterflies on skin, eyes and, if inhaled, the bronchi. Ingestion of such hairs may also cause irritant gastric symptoms. The case of a systemic reaction after contact with the cocoon of the Australian species *Chelepteryx collesi*, the white-stemmed gum moth, has been reported [57].

Caterpillars

Processionary caterpillars (*Thaumetopoea* sp.; fig. 4), particularly from pines and oaks, have hairs containing

proteins which cause contact urticaria and papular dermatitis (fig. 5) by mainly nonimmunological mechanisms [58, 59]. Systemic reactions are uncommon, and in a prospective study only local urticarial reactions to caterpillars have been reported [60]. Rarely, patients with IgE-mediated anaphylaxis have been observed; positive skin tests and IgE have been described [61, 62]. In occupationally exposed forest workers, reactive bands to thaumetopoein and other proteins have been detected by IgE blot techniques. In a recent study, a 15-kDa allergen was identified as the major caterpillar allergen [63]. Whether airborne hairs may also cause immunologically mediated urticaria in nonoccupationally exposed individuals is a matter of debate [64]. Recently, in some nonoccupationally exposed individuals, angioedema, urticaria and/or asthma was also observed after exposure to pine processionary caterpillars. Skin tests and specific IgE were positive. Western blots showed several IgE-binding antigens ranging from 18 to 107 kDa [65]. In susceptible individuals, not only an irritant, but also an IgE-mediated mechanism elicited also by airborne antigens is possible.

Arachnida

Acarina

Hard Ticks (Ixodidae)

Anaphylaxis from tick bites has been reported from several species, and it may also be underrecognized [66], since the sting itself is painless. In a study on 42 subjects stung by *Ixodes holocyclus*, 12 showed an immediate generalized reaction. A positive skin test reaction was observed in 83% and specific IgE in 100% of the examined individuals [67]. In 2 cases, specific IgE to extracts of *Ixodes pacificus* [68, 69] and of *Ixodes ricinus* [70] were observed. In a patient who had suffered a severe anaphylactic reaction, specific IgE were identified using a whole-body and a salivary-gland extract of *Rhiphicephalus* sp. Comparing the patterns of Western blots, cross-reactivity among extracts from *I. holocyclus*, *I. pacificus* and *Rhiphicephalus* was found [71]. However, in other cases often IgG and rarely IgE to tick allergens were found [72].

Soft Ticks (Argasidae)

Pigeon Tick (Argas reflexus) and *Ornithodoros capensis*. The pigeon tick (fig. 6) feeds preferentially on wild and domestic birds such as pigeons and chickens. Their stings are usually painless; however, the consecutive local reaction may be very pruritic or even painful [73]. Systemic allergic reactions have been reported to *Argas*

reflexus stings [74–78]. Urticaria and angioedema may be pronounced in the head and neck area and may evolve towards severe anaphylactic shock. In some patients, positive skin tests or more often specific IgE to salivary allergens or whole-body extracts have been identified [74, 79]. Since repeated exposure is rare and can be prevented after recognition of the problem, desensitization has not been attempted.

In an island population suffering from typical local reactions to the soft bird tick *Ornithodoros capensis*, skin prick tests and intradermal injections with whole-body homogenates were conducted, and cross-reactivity to some arthropods was observed [80].

Spiders (Araneae)

Only few spiders are harmful to humans. In general, either local or systemic toxic reactions are observed. In Europe and the USA, the black widow (*Latrodectus mactans*) causes local and systemic reactions known as latrodectism [1]. In the USA, the bite of *Loxosceles* causes local mild to severe ulcerative lesions (necrotic arachnidism or loxoscelism) [7]. Allergic reactions appear to be exceptional, and this has been postulated in only few cases [81, 82].

Food-Related Allergic Reactions from Insect Products

Allergic reactions due to ingestion of food from insect sources such as royal jelly, and mite-contaminated wheat flour were rarely reported.

Royal jelly is a secretion product from the glands of honey bee workers. It is used to feed larvae of worker bees, to raise bee queens [83, 84]. In humans it is used as a health supplement and has resulted in asthmatic and anaphylactic reactions. Skin prick tests and provocation tests with royal jelly were positive [83]. Specific IgE binding to the allergens in the protein fraction of royal jelly, particularly to 55- and 47-kDa components, has been demonstrated [84]. However, in sera of allergic controls with a history of hay fever and eczema but with no known reaction to royal jelly as well as in bee-venom-sensitized patients, a similar pattern was also observed. The 55-kDa band could correspond to an earlier described major royal jelly protein [84].

Mite-contaminated wheat flour is a food-related problem, which has been mainly observed in tropical and subtropical countries [85]. In patients with initially unexplained anaphylactic reactions after intake of wheat products, sensitization particularly to *D. farinae* was found.

Skin prick tests with mites and mite-contaminated heated and unheated flour were positive, indicating that heat-stable allergens were also involved. In flour, *D. farinae* and some other mite species were identified, and considerable allergen levels were measured. Mites were also found in 37% of unselected flour samples examined. These studies suggest that in rare instances upon ingestion such insect products may be responsible for severe allergic reactions.

In an individual known to be sensitized after inhalation of beetle larva particles, an anaphylactic reaction after intentional ingestion of mealworms was observed. The investigation included oral challenge, inhalation challenge, skin testing to *Tenebrio molitor*, *Zophobas morio* and *Blattella germanica* [86].

Discussion

Encounters of humans with the myriads of insects cause uncountable sting and bite reactions. Most of them are minor local reactions and are often more of a nuisance than a disease [87]. However, bacterial superinfection may result from scratching, and some tick species transmit infectious diseases such as *Borrelia burgdorferi*, the causative agent of Lyme disease in Europe. In tropical countries, on the other hand, transmission of infectious agents by arthropod vectors has a major impact on public health.

Localized hypersensitivity reactions appear to be a physiological response to the antigens present in saliva and other fluids, which are transferred during the stinging or biting act. In mosquito stings, during the first encounter, an immediate local urticarial wheal develops [17]. When the individual is re-infested, a delayed papular reaction can develop, followed in many cases by a state of anergy. This could explain why in young children often a severer local reaction than in adults can be seen. The reactions to insects such as Hymenoptera species depend mainly on the frequency by which the individual is stung or bitten.

With the exception of bee, wasp and ant venom hypersensitivity in some geographic regions, systemic hypersensitivity reactions to other insect groups are surprisingly rare. Anaphylactic reactions may be exceptionally observed for example to mosquitoes, flies, kissing bugs, bed bugs, ticks, moths and caterpillars. Some anecdotal reports describe food-related anaphylaxis due to insect products.

The main problem remains the standardization of extracts for skin testing and for determination of specific IgE antibodies. Although some of the allergens have been

characterized [16, 33, 44, 88], only few allergens have been synthesized with recombinant techniques [15]. Accordingly, most investigations have been made with whole-body extracts or extracts from salivary glands. For the same reasons, safe and efficient desensitization protocols are also lacking.

It is of major importance for the treatment and prevention that the exact cause of an anaphylactic reaction is identified. Some cases of so-called idiopathic anaphylaxis may be due to unrecognized arthropod encounters. Only if the eliciting insect is known can effective preventive measures be established, since habitat, behavior and exposure modes vary considerably among the arthropod classes. In

addition, patients with systemic allergic reactions to an arthropod should receive appropriate emergency drugs such as oral antihistamines and corticosteroids, and after severe events also injectable epinephrine. They should be thoroughly informed and repeatedly instructed about the appropriate steps to be taken in case of a reexposure.

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