

Clinical Communications

Shellfish allergy is a risk factor for cricket anaphylaxis

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Clinical Implications

- The risk of life-threatening anaphylaxis after ingestion of crickets in individuals with preexisting crustacean shellfish allergy is not widely recognized. As insects are increasingly promoted as a source of protein worldwide, physicians need to educate patients about this risk.

Conventional animal- and plant-based foods are key sources of high-quality food protein; however, more than 500 million people worldwide lack sufficient food, and as the population grows, alternative sources of protein must be identified to meet increasing demands.¹

The Food and Agriculture Organization of the United Nations has promoted edible insects as a source of sustainable dietary protein.¹ The extent of insect consumption globally is not well documented; however, a significant portion of the population residing in Africa, Asia, and South America consumes insects as part of a traditional diet.²

Insects such as crickets are an abundant source of protein, fat, vitamins, and minerals and emit fewer greenhouse gases than most livestock.¹ Given the high nutritional value and straightforward harvesting, there has been increasing interest in insects as an environmentally and economically conscientious source of food. With the introduction of new dietary proteins comes the potential to introduce food allergies.

We describe a man with known crustacean allergy who experienced an anaphylactic reaction after ingestion of crickets.

Data were collected by retrospective chart review. Informed consent was obtained. The patient's sensitization profile was measured with the ALEX allergen array (Allergy Explorer, Macro Array Diagnostics, Vienna, Austria), which consisted of 156 allergen extracts, 126 components, and 3 insect extracts spotted onto a nitrocellulose membrane.³ A positive result indicating sensitization was defined as greater than or equal to 0.30 kUA/L.

Competitive inhibition studies were performed by incubating patient serum with allergen extract before measurement with the ALEX array. The allergen extracts tested were cricket at 1000 ng/mL (Macro Array Diagnostics), European house-dust mite at 100 ng/mL (BÜHLMANN Laboratories AG, Schönenbuch, Switzerland), and lobster at 1:10 dilution (Omega Laboratories, Montreal, Quebec, Canada). The observed inhibition to a given allergen was then calculated as $1 - (\text{specific IgE [sIgE] in presence of competing allergen}) / (\text{specific IgE baseline})$.

A 35-year-old man presented with anaphylaxis after ingestion of roasted crickets. One hour after consuming dry roasted crickets for the first time, he developed generalized urticaria with no angioedema or shortness of breath. He took diphenhydramine and fell asleep. Three hours later, he woke up with

generalized burning and itching, abdominal pain with diarrhea, palpitations, and lightheadedness. He collapsed, with loss of consciousness lasting about 1 minute. He was taken to an emergency department where he was monitored with resolution of symptoms. He had 2 bottles of beer and onion rings when eating the roasted crickets, with no prior exercise or ingestion of other medications or recreational drugs.

He had a history of generalized urticaria 1 to 2 hours after eating sea urchin roe (5 years earlier) and crayfish (4-5 years earlier). Since then he avoided both sea urchin roe and crayfish. He had never eaten lobster but had tolerated other crustaceans and molluscs (shrimp, crab, oyster, mussel, clam, scallop, squid, octopus). Sea urchin roe and crayfish allergies were not confirmed by oral food challenge. He did not have clinical symptoms of dust mite allergy.

Skin testing with commercial extracts showed mild reactivity to dust mite, cockroach, shrimp, lobster, and crab. Skin testing to roasted cricket in 0.9% saline gave a strongly positive reaction (Figure 1). Serologic testing was undertaken for sIgE by ImmunoCAP testing, with positive result defined as more than 0.35 kUA/L (Thermo Fisher Scientific, Mississauga, Ontario, Canada). Results demonstrated the following values: shrimp, 5.77 kUA/L; crab 5.49, kUA/L; lobster, 2.85 kUA/L; scallop, 0.19 kUA/L; snail, less than 0.1 kUA/L; octopus, 0.23 kUA/L; oyster, less than 0.1 kUA/L; and cockroach, 4.48 kUA/L. ImmunoCAP testing for cricket sIgE was unavailable. Results were consistent with cricket and crustacean allergy.

Multiplex serological testing (ALEX array) confirmed sensitization to cricket, grasshopper, mealworm, dust mite, and crab (Figure 2). Crayfish was not available for testing. Potential cross-reactivity was investigated by performing *in vitro* inhibition assays between members of the *Arthropoda* phylum. Preincubation of the patient's serum with cricket extract resulted in a 98% reduction in sIgE binding to cricket allergen. A 95% inhibition of sIgE against cricket in the presence of house-dust mite extract and a 91% inhibition in the presence of lobster extract were observed (see Table E1 in this article's Online Repository at www.jaci-inpractice.org). A similar pattern of inhibition was observed for sIgE binding to grasshopper and mealworm with these extracts. In addition, an 85% inhibition of binding to crab in the presence of cricket extract was demonstrated. Cross-reactivity between cricket and shrimp could not be performed because there was no detectable sIgE to shrimp or shrimp tropomyosin (Pen m 1) using the ALEX array. These data suggest the presence of cross-reactivity between crustacean and insect allergens independent of tropomyosin reactivity.

Crustacean shellfish and insects, including crickets, belong to the phylum *Arthropoda*. Cross-reactivity and cosensitization between insects including crickets, cockroach, fruit fly, and crustacean shellfish has been reported.^{4,5} In addition, cricket anaphylaxis has been reported in a patient with sensitization to house-dust mite and cockroach.⁶ Although the patient described was also allergic to sea urchin roe, sea urchins are part of the phylum *Echinodermata* belonging to the class *Echinoidea*.⁷ Cross-reactivity between *Arthropods* and *Echinoidea* has not been reported.

Shrimp-allergic patients have been shown to have cross-reactive sIgE with insects including cricket, giant/lesser



FIGURE 1. Skin prick testing results. On the left side: from top to bottom demonstrate small positive skin test results to shrimp (1), lobster (2), crab (3) and negative skin test results to oyster (4) and scallop (5). The test result for saline control (6) was negative and that for histamine control (7) was positive. On the right side: 2 strongly positive reactions to cricket extract (8).

mealworm, grasshopper, wax moth, and black soldier fly, the major allergenic proteins being tropomyosin and arginine kinase.⁸ In one study, tropomyosin from the cricket *Gryllus bimaculatus* was identified as the major cross-reactive allergen.⁵ Another study also identified tropomyosin as the cross-reactive allergen in crustaceans, house-dust mite, and cockroach.⁹ Interestingly, our patient did not have evidence for sensitization to tropomyosin. *In vitro* competitive inhibition studies suggest that the presence of cross-reactivity between crustacean and insect allergens is independent of tropomyosin reactivity. This may be explained by proteins such as arginine kinase, hexamerin 1B, and the myosin light and heavy chains, or another undescribed protein.⁴ Further investigations including immunoblotting will help to determine the cross-reactive allergen in our patient.

The risk of anaphylaxis after ingestion of crickets in individuals with preexisting crustacean shellfish allergy is not widely recognized, nor are patients with shellfish allergy aware of the need to avoid ingestion of insects in the phylum *Arthropoda*. As insects are increasingly promoted as a source of protein

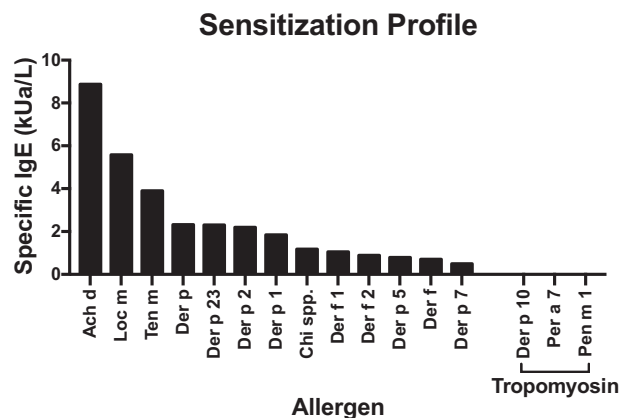


FIGURE 2. Sensitization profile to insect, dust mite, shellfish allergen extracts, and component proteins. Strong positive results are demonstrated to cricket (Ach d), grasshopper (Loc m), mealworm (Ten m), crab (Chi spp.), and house-dust mite (Der p, Der f) respectively, consistent with clinical history. No evidence of sensitization to tropomyosin from house-dust mite, cockroach (Per a), or shrimp (Pen m).

worldwide, physicians will need to educate patients about this risk and regulatory agencies will need to consider the requirement for relevant precautionary labeling.

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ONLINE REPOSITORY

TABLE E1. Inhibition of sIgE binding by cross-reactive allergens

Patient serum sIgE	% Inhibition of IgE binding in the presence of:		
	Cricket (<i>Acheta domesticus</i>)	European house-dust mite (<i>Dermatophagoides pteronyssinus</i>)	Lobster (<i>Homarus gammarus</i>)
Cricket (<i>Acheta domesticus</i>)	98%	95%	91%
Grasshopper (<i>Locusta migratoria</i>)	97%	94%	90%
Mealworm (<i>Tenebrio molitor</i>)	88%	84%	86%
Crab (<i>Chionoecetes spp.</i>)	85%	NA	NA

NA, Not available.

Crab was tested with the standard Allergen Explorer chip separately from cricket/grasshopper/mealworm. House-dust mite and lobster allergen extracts were unavailable during assessment of crab and added to subsequent experiments.