

Case report

Occupational IgE-mediated allergy to *Tribolium confusum* (confused flour beetle)

Background: We report on IgE-mediated allergy in a worker caused by *Tribolium confusum* (confused flour beetle). These beetles lived in the “old” flour to which he was exposed in his work.

Case report: A 35-year-old, nonatopic mechanic in a rye crispbread factory developed rhinitis, conjunctivitis, and asthmatic symptoms, as well as urticaria on his wrists, lower arms, hands, neck, and face, during the maintenance and repair of machines contaminated by flour. This flour had been in and on the machines for a long time, and it contained small beetles. The patient did not suffer any symptoms when handling fresh, clean flour.

Results: Skin prick tests with standard environmental allergens, storage mites, enzymes, flours, and molds were negative. A prick test with flour from the machines gave a 10-mm reaction. An open application of the same flour caused urticarial whealing on the exposed skin. Prick tests with fresh flour from the factory were negative. A prick test with minced *T. confusum* from the flour in the machines gave a 7-mm reaction. Histamine hydrochloride 10 mg/ml gave a 7-mm reaction. Specific serum IgE antibodies to *T. confusum* were elevated at 17.2 kU/l. Prick tests with the flour from the machines were negative in five control patients.

Conclusions: The patient had occupational contact urticaria, rhinitis, conjunctivitis, and asthmatic symptoms from exposure to flour. His symptoms were caused by immediate allergy to the beetle *T. confusum*. Immediate allergy to this beetle has rarely been reported in connection with respiratory symptoms, but it may be more common. Contact urticaria from this source has not been reported before.

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Tribolium confusum (confused flour beetle, rice flour beetle) is a common pest in stored flour and in other organic remnants, such as cereals, nuts, spices, and plant seeds. It is one of four flour beetles of the genus *Tribolium*, belonging to the family Tenebrionidae (“black beetles”) (Figs. 1 and 2) (1).

Respiratory allergy, positive skin prick tests, and specific IgE antibodies to *T. confusum*, indicating IgE-mediated, immediate-type allergy, have rarely been demonstrated (1–4). Rudolph et al. (1) administered prick tests and intradermal tests with whole-body extracts of *T. confusum* to patients suffering from perennial asthma and/or rhinitis and with proven sensitization to indoor allergens. Positive skin prick tests were seen in 16.5% ($n=1040$) and positive intradermal tests in 30.7%. In 10 of 33 patients with positive skin reactions to *T. confusum*, a nasal provocation test was also positive. Using a crude *T. confusum* extract, Schultze-Werninghaus et al. (2) recorded positive skin prick tests in 8.3% of 133 bakers.

Immediate-type or dual reactions were seen after bronchial provocation tests with these extracts in subjects positive in the skin prick test. Later, Schultze-Werninghaus et al. (3) detected specific IgE to proteins of *T. confusum* in 9/125 sera of subjects exposed to rye and wheat flour. Immunoblot experiments showed specific binding to three proteins of *T. confusum* not present in rye or wheat flour. Kersten & von Wahl (4) analyzed retrospectively 90 cases of occupational allergy in bakers. In 89%, sensitization to flour was diagnosed. Allergy to two storage pests, *T. confusum* and *Sitophilus granarius*, was studied by intracutaneous testing and by specific serum IgE antibodies. Allergy was found in 5.4%. To our knowledge, contact urticaria from flour beetles has not been previously reported.

We report on occupational IgE-mediated allergy caused by *T. confusum* and manifesting as contact urticaria, conjunctivitis, rhinitis, and asthmatic symptoms. These beetles were living in “old” flour to which the patient was exposed in his work at a crispbread factory.



Figure 1. Photomicrograph of *T. confusum* ($\times 27$); length of beetle is 3 mm. Photo: Reima Kämppi.

Case report

A 35-year-old, nonatopic man had worked as a mechanic in a rye crispbread factory for 15 years. Rye flour and, to a lesser extent, wheat flour were used. Deposits of "old" flour were common on the surfaces of some of the dough machines. After 4 years of work, he began to notice work-related rhinitis, i.e., nasal congestion with itching, sneezing, and watery rhinorrhea, in dusty places. Seven years later, in the maintenance and repair of dough machines contaminated by flour, he developed mucosal, respiratory, and skin symptoms. He suffered from severe rhinitis, as well as conjunctival itching and redness, dyspnea, cough, and nighttime respiratory wheezing. On his uncovered skin areas, i.e., wrists, lower arms, hands, neck, and face, he had itching and redness. On his lower arms he had also pruritic wheals. The skin symptoms began to disappear in 2 h and were gone the next morning. A pulmonologist diagnosed pulmonary asthma, and regular asthma medication was commenced. During a 2-month sick leave, the asthmatic symptoms lessened. Later, the patient no longer suffered from cough or respiratory wheezing, but he still had dyspnea in dusty working conditions. The rhinitis, skin, and eye symptoms also continued to recur in dusty work. He connected his symptoms to exposure to "old" flour. This flour had been in and on the machines for a long time, and it contained small beetles. The patient suspected that the beetles caused his symptoms. He was without symptoms when handling fresh, clean flour.

Three years later, as the patient's symptoms continued, the company physician observed severe nasal congestion and conjunctival erythema and irritation, as well as urticarial wheals on his arms. He suspected occupational conjunctivitis and contact urticaria, and referred the patient for further examinations at the local central hospital. At the department of dermatology, studies for immediate allergy were carried out. In skin prick testing, histamine gave a 5-mm reaction, the other flours were negative, but the patient's own, "old" flour gave an



Figure 2. Scanning electron micrograph of *T. confusum*. Photo: Reima Kämppi.

8-mm reaction. The patient's flour was tested on five control subjects with negative results. The total serum IgE antibody content was 309 IU/l (normal adult value < 110 IU/l), specific IgE antibodies to flour and storage mites were negative. To *S. granarius* (grain weevil) the content was 2.1 IU/l (Pharmacia CAP System). At the department of pulmonology of the central hospital, an inhalation challenge test with "old" flour from the machines was carried out. An immediate 13% reduction in FEV₁ was measured. During and immediately after the challenge, the patient showed severe rhinitis, conjunctival symptoms, and redness of the skin. A placebo challenge with lactose powder was negative, with a reduction of only 1% in FEV₁. The insurance company referred the patient for further investigation at the Finnish Institute of Occupational Health.

Material and methods

Skin prick tests

Skin prick tests were performed by a previously described method (5). Histamine hydrochloride 10 mg/ml was used as a positive control.

Skin challenge (open application test)

The flour, slightly moistened in water, was applied to intact skin of the volar side of the lower arm on a rectangular area 5×5 cm. The follow-up time was 20 min.

Specific IgE determinations

IgE antibodies to *T. confusum* were measured by a tailor-made method as follows. Beetles were minced in acetone and stirred at room temperature for 3 h. After filtration, the defatted precipitate was dried at room temperature overnight. The proteins from the dried preparation were extracted in 0.1 mol/l potassium phosphate buffer, pH 7.4. A volume of 100 µl of the supernatant was coupled to a cyanogen-bromide activated paper disk by the method of Ceska et al. (6). Patient serum, 50 µl, was added to the paper disks and incubated for 3 h, washed, and incubated overnight with J-125-labeled anti-IgE (Pharmacia & Upjohn, Sweden). The activity was measured by a Rackgamma II-counter (LKB Wallac). IgE antibodies to other, commercially available, allergens were detected by the CAP FEIA technique (Pharmacia & Upjohn, Sweden).

Results

The beetle was identified by a biologist as *T. confusum* (confused flour beetle). Skin prick tests with standard environmental allergens, flours (rye, wheat, barley, and oats), storage mites, industrial enzymes, and molds were negative. Prick tests with fresh rye and wheat from the factory were also negative. A prick test with "old" flour from the machines gave a 10-mm reaction. A prick test with minced *T. confusum* from the factory gave a 7-mm reaction. Histamine hydrochloride 10 mg/ml gave a 7-mm reaction. An open application of the flour caused urticarial whealing on the exposed skin. During this skin exposure, the patient also developed rhinitis. Prick tests with the "old" flour from the machines were negative in five control patients. The patient's total serum IgE was 223 kU/l (normal adult value <110 IU/l). Specific serum IgE antibodies to the beetle *T. confusum* were strongly elevated, 17.2 kU/l, indicating specific, IgE-mediated allergy. IgE antibodies were detected also to *Blattella germanica* (cockroach, 2.42 kU/l), *S. granarius* (grain weevil, 1.52 kU/l), and *Trogoderma angustum solier* (Berlin beetle, 1.03 kU/l). They were negative to *Ephestia kuehniella* (Mediterranean flour moth), *Chironomus thummi* (bloodworm), rye, wheat, and storage mites. Inhalation or nasal challenge tests were not performed, because a challenge with the patient's "old" flour had been adequately performed at the central hospital. It was concluded that the patient had occupational contact urticaria, occupational rhinitis, and asthmatic symptoms caused by *T. confusum* in "old" flours at the factory.

Discussion

Flour can also contain allergens other than the proper flour proteins. Endogenous enzymes, such as α -amylase,

exogenous enzymes (dough improvers of bacterial or fungal origin), other additives (e.g., spices, flavorings, egg, and milk), fungi, storage mites, or other storage pests (e.g., *T. confusum*, *S. granarius*) can be the source of "flour allergy" (4, 7). Occupational flour exposure occurs mainly in bakeries and mills, but flour is also used in several other industries, such as confectionery, agriculture, animal-feed manufacture, and malt making (7).

Our patient was exposed to flour dust when working as a mechanic in a rye crispbread factory. He developed occupational immediate allergy to the beetle *T. confusum* by mucosal and skin exposure to flour containing the beetles. The clinical manifestations were contact urticaria, conjunctivitis, rhinitis, and asthmatic symptoms. His immediate, IgE-mediated allergy was confirmed by skin prick tests and specific serum IgE antibodies, and the clinical manifestations by specific skin challenge and inhalation challenge. Specific IgE antibodies to other insects may be considered cross-allergic reactions to *T. confusum*. Our patient did not react to storage mites or house-dust mites. A similar lack of cross-reactivity has been reported previously (4, 8).

Respiratory IgE-mediated allergy has previously been reported only rarely (1–4), but it may be more common. To our knowledge, contact urticaria from flour beetles has not been reported previously. A case of dermatitis related to *T. confusum*, most probably protein contact dermatitis, has occurred in The Netherlands (D. P. Bruynzeel, unpublished). A 33-year-old male baker had eczema on his feet, later spreading to his lower legs, hands, and arms. It improved when he was not working, but relapsed at work. His work shoes proved to be inhabited by *T. confusum*. Patch tests with the European standard series, shoe allergens, an extra series for bakers, and his own flour were negative. Skin prick tests showed positive reactions to rye and timothy-grass pollens; extract of wheat, barley, and maize; and house-dust mite and the storage mite *Acarus siro*. Patch or prick tests were not performed with the beetle. The patient did not have dermatitis after he kept his shoes free of beetles.

Allergy to *T. confusum* has to be kept in mind when a worker from a bakery or other flour-exposed work presents with work-related skin or respiratory symptoms, and the conventional allergy test panels have proven negative. Occupational allergy to *T. confusum* may be prevented by industrial hygiene measures to minimize the exposure. These include regular and thorough cleaning of the work environment and the storage areas to prevent colonization by the beetle.

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