

## A new risk of occupational disease: allergic asthma and rhinoconjunctivitis in persons working with beneficial arthropods

### Preliminary data

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**Summary.** For some years, biological pest control has been re-evaluated as an alternative to the indiscriminate use of pesticides. The number of "bio-factories" in Europe has been constantly increasing and today more than 100 technicians work in mass rearing of arthropods. Seven cases of asthma and allergic rhinitis are reported in 13 workers engaged in the production of beneficial arthropods. The subjects suffered from attacks of asthma and rhinitis when they came into contact with eggs and scales or waste of *Chrysoperla carnea*, *Leptinotarsa decemlineata*, *Ostrinia nubilalis* and *Ephestia kuehniella*. These attacks occurred after an average exposure period of 18 months. A RAST test, prepared by Lofarma, was carried out on subjects' serum against the above-mentioned allergens and was positive in all symptomatic subjects (7 of 13) and negative in the others. This demonstrates IgE direct sensitization mediated by complete antigens.

**Key words:** Allergies to arthropods – Biological pest control – Occupational asthma and rhinitis

### Introduction

Recently, the use of biological pest control has been re-evaluated as an alternative to the indiscriminate use of pesticides. Classical biological control and/or integrated pest management, both in greenhouse crops and open field crops, are increasing, mainly due to new market requirements for foods free of pesticides or with only low residues [11, 14].

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In recent years, the number of European "bio-factories", or commercial insectaries, has constantly increased. At present there are about 30 such establishments [5]. Also, arthropod rearing exclusively for research is well represented in both private industry laboratories and in universities and scientific institutes. Today approximately 100 people in Europe are working in contact with arthropods, not counting breeders of silkworms and bees.

Persons who are constantly in close contact with these arthropods the course of rearing and research may, through inhalation, develop sensitization either to the volatile components of the arthropod itself or to its biological wastes. Cases of allergic rhinoconjunctivitis and asthma occurred in a group of workers employed in the production of insects (*Chrysoperla carnea*, *Leptinotarsa decemlineata*, *Ephestia kuehniella* and *Ostrinia nubilalis*) used for pest control. These operators were in contact during their work with eggs and/or scales of these insects [4, 7, 8].

### Materials and methods

Thirteen subjects (five women and eight men) ranging from 22 to 42 years of age and employed for 1–5 years at an experimental center for the production and research of pest control were studied.

Seven of these subjects developed rhinoconjunctivitis and/or asthma when they came into contact with eggs and/or scales of *C. carnea* (green lacewing), *L. decemlineata* (Colorado potato beetle), *E. kuehniella* (Mediterranean flour moth) and *O. nubilalis* (European corn borer). The other six were asymptomatic, even though they were equally exposed. One of the asymptomatic subjects had a contact allergy to nickel sulfate, while once of the symptomatic subjects was undergoing specific immunotherapy for allergic rhinitis to grass pollen.

The subjects underwent the following examinations for the determination of atopy:

- Case history;
- Physical examination;
- Hemochrome and blood eosinophils count;
- Skin prick tests with the most common allergens made by Lofarma (Milan) in hydroglyceric solution (grass pollen, *Parietaria officinalis*, trees, mycetes, *Dermatophagoides farinae* and *Pteronyssinus* spp.); histamine hydrochloride 0.1% as positive control and hydroglyceric solution as negative control were tested. After 20 min the cutaneous reactions were classified as +, ++, +++ or ++++ according to wheal and erythema dimension, from 5 mm (+) to 20 mm and over (++++); responses of +++ and ++++ were regarded as significant. Care was taken to exclude patients who had taken antihistamines, cortisone,  $\beta_2$ -stimulants, sodium cromoglycate or any other drugs which could distort the results.

Then the patients underwent a specific serum IgE examination for protein components found in the causative agents with which they had been in contact. A RAST (radio-allergo-sorbent test) was also carried out in order to study specific serum IgE for those foods used in raising insects: wheat flour, wheat and natural acid yeast. For this test, serum samples withdrawn from the subjects being studied were sent to Lofarma (Milan), which carried out a specific IgE count with radio-immune methods, on cyanogen bromide-activated paper disks [6], against the following causative agents:

Miscellaneous: durum wheat flour, adults of *Ephesia kuehniella*, eggs of *Ephesia kuehniella*, scales residuals of *Ephesia kuehniella*, eggs of *Chrysoperla carnea*, adults of *Chrysoperla carnea*, larvae of *Leptinotarsa decemlineata*, adults of *Ostrinia nubilalis*, frozen eggs of *Ephesia kuehniella*

Food: wheat, natural acid yeast

RAST results were expressed in percent of specific linked radio-activity and classified according to specific IgE amount: negative, low (+), moderate (++) , high (+++), or very high (++++).

An environmental study showed that it was difficult to purify the air using recycling units and that use of masks, though advised, created technical problems.

## Results

Normal hemochrome and blood eosinophil count were found in all the subjects. Skin prick tests with the most common causative agents (grass pollen, *Parietaria officinalis*, trees, mycetes, *Dermatophagoides farinae* and *Pteronyssinus* spp.) were negative in all but one subject who presented a positive reaction to grass pollen (+++).

The results of the specific serum IgE (RAST) count were specifically positive for the causative agents to which the subjects had been exposed during work. In Table 1 we have listed, for each subject, the main allergens to which they were exposed. Nevertheless, it is important to realise that the subject could all have been exposed to different allergens in the different sections of the bio-factory in which they were employed. This may explain the other positive reactions resulting from the RAST.

Those subjects with positive results also presented clinical symptoms, except for one asymptomatic subject who had a slightly positive reaction to some of the above-mentioned antigens.

Results suggest that the duration of exposure does not influence the serological evidence of sensitization and that *L. decemlineata* and *E. kuehniella* are the most frequent causative allergens.

We believe that low specific IgE values for those foods used in raising insects in four symptomatic subjects and in one asymptomatic subject should be considered only an exposure index (that is contact with allergens, positive serological tests without symptoms).

## Discussion

Seven of the 13 subjects presented relevant clinical symptoms corresponding to a net positive reaction to the substances with which they had been in contact during working hours. A further five subjects, even though they carried out the same work, did not present symptoms and their RAST results were negative. In only one case did an asymptomatic subject present positive reactions: slightly positive (++) to adults of *E. kuehniella* and very slightly positive (+) to eggs and adults of *C. carnea*.

Only two subjects had a history of allergy. Furthermore, all but these two had negative results to skin prick tests with the most common allergens. Before they were hired none of them had suffered from asthmatic or rhinitic attacks. The case histories were negative for other allergies except in the two cases mentioned above (one subject with allergy to grass pollen and another with a positive patch test to nickel sulfate). Therefore, we discounted the possibility that these subjects had an atopy that might have led to cumulative clinical manifestations. These manifestations had a latency period of about 1-2 years and then appeared in a more serious form (asthmatic attacks on contact with *E. kuehniella* adults, scales and eggs and *L. decemlineata* larvae). This demonstrates that the sensitization occurred during the occupational exposure.

The proteinaceous nature of these substances must be taken into account, as they may be considered complete antigens and are able to evoke an IgE-mediated direct immune response. On the other hand, the dimensions of eggs, particles and scales allow them to be easily inhaled and they may therefore sensitize the subjects through bronchial and nose mucosa absorption.

Few studies about rhinoconjunctivitis and asthma caused by insects have been reported. Wirtz lists a series of arthropods that are probable sources of respiratory allergic diseases, without taking advantage of allergometric and serum (RAST) tests for the confirmation of the presence of specific IgE [18]. Other reports concern cases of allergic conjunctivitis to adult *Artemia* and larvae of *Chironomus thummi* [15]. A series of data concerning subjects allergic to the larvae of Chironomidae has been published [9, 10]. Furthermore, insect hemoglobins of the Chironomidae (order Diptera) are considered relevant environmental, occupational, and hobby-related allergens [3]. All the other data on non-occupational allergic manifestations to insects by subjects not taking part in arthropod rearing or commercial insect breeding concern lepidopterism (i.e. adverse medical effects of contact with adults or larvae of butterflies and moths) [17] or "pan-allergy" to insects [1].

Occupational cases of allergy in entomologists employed in a research centre and exposed to the sheep blowfly *Lucilia cuprina* [2, 12, 13] and asthma due to insects [16] have also been reported.

Table 1. Data on the 13 subjects

| Subject | Age at blood sampling (years) | Symptoms                                   | Duration of exposure (years)                                                                   | Reactions                                                                                                                                                                                                                                                                           |
|---------|-------------------------------|--------------------------------------------|------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| M.S.    | 42                            | Rhinitis                                   | <i>Ostrinia nubilalis</i> (2)<br><i>Leptinotarsa decemlineata</i> (5)                          | Adults <i>O. n.</i> (+++)<br>Frozen eggs <i>E. k.</i> (+)                                                                                                                                                                                                                           |
| T.M.G.  | 28                            | Conjunctivitis, contact erythema, rhinitis | <i>Chrysopa carnea</i> (3)<br><i>Leptinotarsa decemlineata</i> (5)                             | Larvae <i>L. d.</i> (++++)<br>Wheat (+)                                                                                                                                                                                                                                             |
| F.S.    | 22                            | Rhinitis                                   | <i>Leptinotarsa decemlineata</i> (2)                                                           | Durum wheat flour (+)<br>Eggs <i>C. c.</i> (+++)<br>Adults <i>C. c.</i> (+++)<br>Larvae <i>L. d.</i> (++++)<br>Wheat (++)                                                                                                                                                           |
| M.G.    | 34                            | Rhinitis, asthma                           | <i>Chrysopa carnea</i> (3)<br><i>Ephestia kuehniella</i> (3)<br>Flour (3)                      | Durum wheat flour (++)<br>Adults <i>E. k.</i> (++++)<br>Eggs <i>E. k.</i> (++++)<br>Scales/wastes <i>E. k.</i> (++)<br>Eggs <i>C. c.</i> (+)<br>Adults <i>C. c.</i> (++)<br>Larvae <i>L. d.</i> (++++)<br>Adults <i>O. n.</i> (++)<br>Frozen eggs <i>E. k.</i> (++++)<br>Wheat (++) |
| D.P.    | 32                            | Asthma                                     | <i>Chrysopa carnea</i> (1)<br><i>Ephestia kuehniella</i> (2)<br>Flour (2)                      | Adults <i>E. k.</i> (++++)<br>Eggs <i>E. k.</i> (++)<br>Scales/wastes <i>E. k.</i> (++)<br>Adults <i>C. c.</i> (+)<br>Adults <i>O. n.</i> (+)<br>Frozen eggs <i>E. k.</i> (++++)<br>Wheat (++)                                                                                      |
| F.B.    | 25                            | Rhinitis, asthma                           | <i>Chrysopa carnea</i> (3)<br><i>Ephestia kuehniella</i> (3)<br>Flour (3)                      | Adults <i>E. k.</i> (++++)<br>Scales/wastes <i>E. k.</i> (++)<br>Larvae <i>L. d.</i> (+)<br>Adults <i>O. n.</i> (+)<br>Frozen eggs <i>E. k.</i> (++++)<br>Wheat (+)                                                                                                                 |
| D.M.    | 27                            | Rhinoconjunctivitis                        | <i>Chrysopa carnea</i> (2)<br><i>Ephestia kuehniella</i> (2)<br>Flour (2)                      | Adults <i>E. k.</i> (++)<br>Eggs <i>E. k.</i> (+)<br>Scales/wastes <i>E. k.</i> (++)<br>Frozen eggs <i>E. k.</i> (++++)                                                                                                                                                             |
| B.G.    | 29                            | None                                       | <i>Ostrinia nubilalis</i> (4)                                                                  |                                                                                                                                                                                                                                                                                     |
| M.A.    | 23                            | None                                       | <i>Chrysopa carnea</i> (1)<br><i>Ephestia kuehniella</i> (1)<br>Flour (1)                      |                                                                                                                                                                                                                                                                                     |
| G.M.    | 22                            | None                                       | <i>Chrysopa carnea</i> (2 months)<br><i>Ephestia kuehniella</i> (2 months)<br>Flour (2 months) |                                                                                                                                                                                                                                                                                     |
| S.P.    | 26                            | None                                       | <i>Chrysopa carnea</i> (2)<br><i>Ephestia kuehniella</i> (1)<br>Flour (1)                      |                                                                                                                                                                                                                                                                                     |
| P.L.    | 33                            | None                                       | <i>Chrysopa carnea</i> (3)<br><i>Ephestia kuehniella</i> (3)<br>Flour (3)                      |                                                                                                                                                                                                                                                                                     |
| P.R.    | 23                            | None                                       | <i>Chrysopa carnea</i> (2)<br><i>Ephestia kuehniella</i> (2)<br>Flour (2)                      | Adults <i>E. k.</i> (++)<br>Eggs <i>C. c.</i> (+)<br>Adults <i>C. c.</i> (+)<br>Wheat (+)                                                                                                                                                                                           |

*C. c.*, *Chrysopa carnea*; *E. k.*, *Ephestia kuehniella*; *L. d.*, *Leptinotarsa decemlineata*; *O. n.*, *Ostrinia nubilalis*

This report is the first in the field of occupational exposure in bio-factories and the findings are documented with a specific RAST test for those antigens coming from allergens to which subjects had been exposed.

Biological pest control is useful with regard to the environmental impact and as an alternative to the indiscriminate use of chemical pesticides. However, one should take into account the fact that people employed in mass arthropods rearing may experience manifestations, allergic in this case, that can provoke severe clinical pathology if the subjects are not suitably protected. In our opinion these substances are highly allergenic due to their proteinaceous nature and the ease with which they are inhaled. The data are at present only preliminary, although the above-mentioned RAST has a wide rate of specificity.

In collaboration with the research laboratory of Lofarma (Milan) we will prepare solubilized and standardized allergens for performance of dermatological tests (skin prick tests) on the above-mentioned subjects. We will also assess asthmatic episodes before and after occupational exposure through a test of respiratory function.

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