

# Allergy to the pine processionary caterpillar (*Thaumetopoea pityocampa*)

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## Summary

**Background** The contact with the pine processionary caterpillar (*Thaumetopoea pityocampa*) induces dermatitis and ocular lesions by a mechanic and toxic mechanism. However, IgE-mediated hypersensitivity to this caterpillar has been demonstrated in two recent studies.

**Objective** To find if an IgE-mediated mechanism was operative among patients with suspected previous reactions to processionary caterpillars, particularly exposed workers.

**Methods** Fifty-five patients were studied by skin prick test (SPT), and specific IgE detection by immunoblotting.

**Results** A total of 58.18% patients had a positive SPT for caterpillar extract. Positive SPT patients had more generalized cutaneous reactions (47%) and oedema (50%) as well as a shorter latency period (mean, 36 min) and duration of cutaneous lesions (mean, 26 h) than the patients with negative SPT. A total of 60% of the positive SPT patients had occupational exposure to the processionary caterpillar. The occupationally exposed workers showed significant symptoms from October to December. The anaphylactic reactions only appeared in allergic patients with occupational exposure and were also more frequent from October to December. These patients with anaphylactic reactions had a major size of SPT and the exercise was found in them to be a variable that increased the symptoms. The IgE immunoblot detected in the caterpillar extract several reactive bands with apparent molecular weights from to 35–4 kDa in 72% of the cases with positive SPT.

**Conclusions** Allergic reactions to *T. pityocampa* urticating hairs have different clinical characteristics than those induced by a toxic-irritative mechanism and are more frequent than suspected. Allergic reactions to this caterpillar among occasional visitors to pine-wood areas, and particularly in pine-forest workers, should be taken into consideration by allergists.

**Keywords:** dermatitis, hypersensitivity, immunoglobulin E, immunoblotting, occupational, pine processionary caterpillars, *Thaumetopoea pityocampa*

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## Introduction

Approximately 150 species of Lepidoptera have been described as causing damage to human skin [1]. Several

species of caterpillars are equipped with poisonous hairs of chitinous spines that are capable of penetrating human epidermis causing dermatitis [1–6] known as erucism [7]. One of them is the pine processionary caterpillar (*Thaumetopoea pityocampa*), whose biological cycle is shown in Fig. 1. This caterpillar is the cause of considerable damage to forest and is also responsible for dermatitis, ocular

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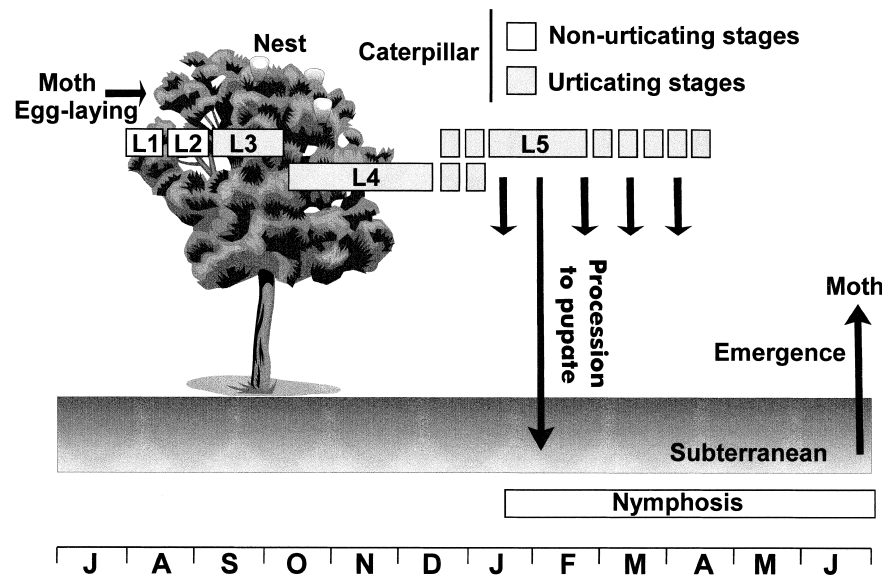


**Fig. 1.** Annual biological cycle of *Thaumetopoea pityocampa* Schiff (Lepidoptera)

lesions and, more rarely, respiratory signs and anaphylactic reactions in animals and humans [8,9].

The combination of a mechanical phenomenon (penetration of the hair) and a chemical phenomenon (discharge of toxic substance) seems to account for the pathological symptomatology induced by the processionary pine caterpillar [10]. *Thaumetopoea pityocampa* has a recently described hair protein: thaumetopoein [7]. This protein has a direct effect on mast cells leading to an IgE-independent degranulation [7]. This fact explains the urticating properties of these caterpillars.

Urticating hairs of pine processionary caterpillars are detectable in air using techniques designed for airborne micro-organism and pollen collection [11]. An IgE-mediated mechanism of hypersensitivity to this caterpillar has been demonstrated in a recent study [12] and an anaphylactic shock in a pine-forest worker was described

by our group [9]. We have seen some patients with cutaneous/ocular symptoms after walking in pine woods and without having clear contact with caterpillars. These symptoms do not appear in other equally exposed accompanying persons. We therefore suspected that an IgE-mediated allergic reaction to this caterpillar could be responsible for these symptoms and that this hypersensitivity could be more common than previously suspected.

## Materials and methods

Valladolid province was selected for this study. It has areas of extensive defoliation caused by processionary caterpillar infestation.

Fifty-five patients with cutaneous, ocular and/or respiratory symptoms after working or walking in a pine wood in the previous 24 h were included in this study. Thirty

**Table 1.** Clinical differences between patients with positive and negative SPTs for processionary caterpillar extract

|                                   | Positive SPT<br>(n = 32) | Negative SPT<br>(n = 23) | P-value |
|-----------------------------------|--------------------------|--------------------------|---------|
| Age (years)                       | 30.6                     | 30.29                    | NS      |
| Atopy (%)                         | 46.87 (15)*              | 26.8 (6)                 | NS      |
| Latency period (min)              | 35.78                    | 232.3                    | <0.0001 |
| Duration of cutaneous lesions (h) | 26                       | 77.65                    | <0.005  |
| Anaphylactic reaction (%)         | 12.5 (4)                 | 0 (0)                    | NS      |
| Dyspnea (%)**                     | 12.5 (4)                 | 4.34 (1)                 | NS      |
| Oedema (%)                        | 50 (16)                  | 17.39 (4)                | <0.05   |
| Generalized eruption (%)          | 46.9 (15)                | 17.4 (4)                 | <0.05   |
| Immunoblotting + (%)              | 72.22 (13/18)            | 0 (0/10)                 | <0.001  |

\*Absolute numbers of patients in brackets. \*\*Dyspnea was shown during anaphylaxis episodes.

unrelated subjects were used as a control (15 atopic and 15 nonatopic). A total of 28 of the 55 patients voluntarily agreed to go to hospital to give a serum sample.

#### *Skin testing*

Pine processionary caterpillars in the last larval stage (L5) were collected on pine trees from Valladolid (Spain). Extract of whole caterpillars was prepared by maceration in saline (1/10 w/v), centrifuged for 15 min at 15 000g, dialysed and sterilized by filtration. The extract was tested on 30 subjects (15 atopic and 15 nonatopic) as a control. A response diameter >3 mm was considered positive. Skin prick tests (SPTs) for pollens, moulds, animal epithelia and mites were also performed.

#### *SDS-PAGE and immunoblotting*

SDS-PAGE of the extract was performed in 16% acrylamide minigels. Specific IgE detection by immunoblotting was performed using a diffusion method as described [13].

#### *Statistical analysis*

The statistical analysis was carried out with the SPSS system. A descriptive analysis of the different variables was performed as well as a comparison of the means and ratios. Logistic regression analysis was performed. Probability (*P*) values below 0.05 were considered significant for all statistical analyses.

## **Results**

#### *Skin testing*

SPT for the caterpillar extract was positive in 32 of 55

patients (58.18%), and in only one of the 30 control subjects ( $P < 0.0001$ ). In all of these positive SPT subjects the symptoms appeared after walking in a pine wood and without having clear contact with caterpillars. This group ranged in age from 6 to 64 years, with a mean of 30.6 years. Twenty-nine (90.62%) subjects were male. Fifteen subjects (46.87%) had a history of atopy. We did not find significant differences between both positive and negative SPT patients in the sensitization to any kind of pollen, mould, animal epithelia or mite.

#### *Clinical symptoms*

Clinical differences between patients with positive and negative SPTs are shown in Table 1. The most frequent symptoms mentioned by the patients with positive SPT were urticarial papular eruption with itching (100%), and oedema (50%). Fifteen of these positive SPT patients (46.87%) experienced a generalized cutaneous reaction, and numbers were significantly higher than for those with negative SPTs ( $P < 0.05$ ).

Positive SPT patients showed a significantly higher proportion of oedema than the patients with negative SPT ( $P < 0.05$ ). The symptoms in positive SPT patients appeared from 15 to 60 min (mean, 35.78 min), significantly faster than among the subjects with negative SPT ( $P < 0.0001$ ) and they usually cleared up between 2 h and 7 days later (mean 37.6 h), but without significant differences with regard to negative SPT patients.

Nineteen positive SPT patients (59.37%) had occupational exposure to processionary caterpillars. Clinical differences between positive SPT patients with occupational and nonoccupational exposure to processionary caterpillar are shown in Table 2. The exposed workers showed presence of symptoms from October to December ( $P < 0.05$ ), when the caterpillar is in the urticating stages but not in the

|                                   | Occupational exposure<br>( <i>n</i> = 19) | Nonoccupational exposure<br>( <i>n</i> = 13) | <i>P</i> -value |
|-----------------------------------|-------------------------------------------|----------------------------------------------|-----------------|
| Atopy                             | 36.84 (7)*                                | 61.53 (8)                                    | NS              |
| <i>Distribution of symptoms</i>   |                                           |                                              |                 |
| Itching and urticarial dermatitis | 100% (19)                                 | 100% (13)                                    | NS              |
| Oedema                            | 54% (10)                                  | 30.76% (4)                                   | NS              |
| Conjunctivitis                    | 26.31% (5)                                | 0% (0)                                       | NS              |
| Dyspnea**                         | 21.05% (4)                                | 0% (0)                                       | NS              |
| Anaphylactic reaction             | 21.05% (4)                                | 0% (0)                                       | NS              |
| Symptoms: October–December        | 36.84% (7)                                | 0% (0)                                       | <0.05           |
| Size of prick test                | 69.77                                     | 66.45                                        | NS              |
| Immunoblotting +                  | 63.63% (7/11)                             | 85.71% (6/7)                                 | NS              |

**Table 2.** Clinical differences between positive SPT patients with occupational and non occupational exposure to processionary caterpillar

\*Absolute numbers of patients in brackets. \*\*Dyspnea was shown during anaphylaxis episodes.

**Table 3.** Clinical differences between positive SPT patients with anaphylactic and non anaphylactic reactions to processionary caterpillar.

|                             | Anaphylaxis<br>(n = 4) | Nonanaphylaxis<br>(n = 28) | P-value |
|-----------------------------|------------------------|----------------------------|---------|
| Symptoms October–December   | 4                      | 5                          | <0.001  |
| Occupational exposure       | 4                      | 16                         | NS      |
| Symptoms only with exercise | 2                      | 0                          | <0.001  |
| Size of prick test          | 110                    | 66                         | <0.05   |

processional stage. Duration of exposure to caterpillars in the exposed workers varied from 2 to 40 years (mean, 15.29 years). Clinical differences between positive SPT patients with anaphylactic and nonanaphylactic reactions to processionary caterpillar are shown in Table 3.

#### SDS-PAGE and immunoblotting

Specific IgE detection by ELISA using the crude processionary extract showed very low and inconsistent results, probably due to the low amount of allergens present in the crude extract (data not shown). SDS-PAGE of the whole caterpillar extract revealed the presence of multiple proteins with molecular weights from 10 to 200 kDa. A protein of around 80 kDa was present in high concentration but did not bind specific IgE (Fig. 2). The IgE-immunoblotting detected in caterpillar extract several reactive bands with apparent molecular weights between 35 and 4 kDa in 72.22% of the patients with positive SPTs. Twelve control sera show negative results.

#### Discussion

*Thaumetopoea pityocampa* is one of the most important causes of damage to forests in Mediterranean countries, Central Europe, the Middle East and North Africa [14–16].

The sting defenses of *T. pityocampa* have been studied by several authors [10,11]. Urticating hairs of pine processionary caterpillars are detectable in air using techniques designed for airborne micro-organisms and pollen research. Thus, these hairs may be able to penetrate the human respiratory system as far as the trachea and primary bronchi [11]. An abundance of hairs is correlated with the distance of production zone, local meteorological conditions, and the biological cycle [11].

Valladolid province has 79 282 ha of pine forest, of which 32 700 ha are of *Pinus pinea*, and is the major Spanish region in pine-nut production. In this province about 500 workers are directly employed in pine areas. Experts estimate that in Valladolid about 73 000 persons (including exposed workers, occasional visitors and residents in pine wood areas) could be exposed to this caterpillar during the months corresponding with the urticating stages. In addition, other workplaces must be also borne in mind because wood, pine cones and fomites infested with caterpillars may produce dermatitis for long periods [17].

An IgE-mediated mechanism of hypersensitivity to this caterpillar has only been demonstrated in two recent studies [9,12]. The first included 21 pine forest workers [12]. Specific IgE antibodies directed against pine processionary and oak processionary caterpillars assayed by ELISA were

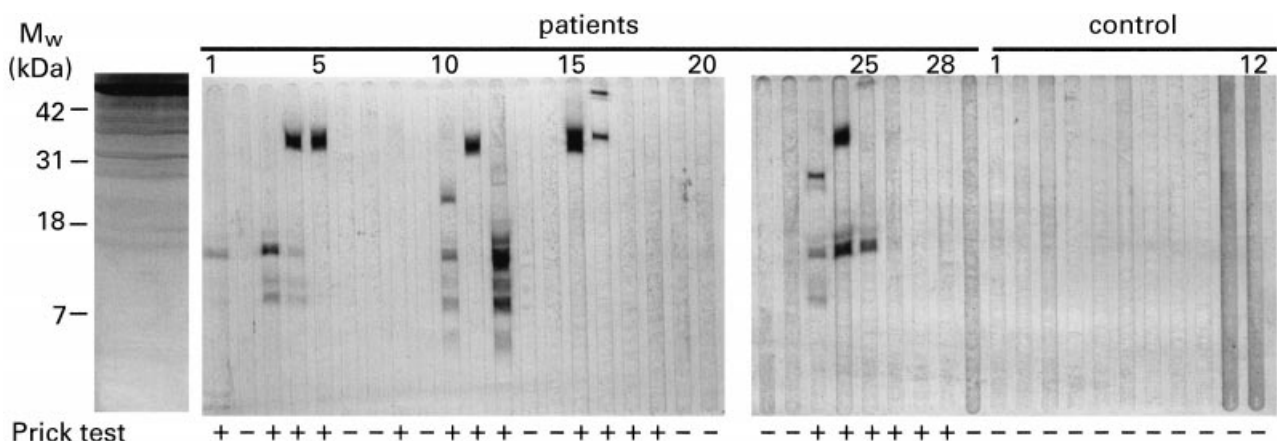


**Fig. 2.** IgE immunoblotting using whole processionary caterpillar extract. SDS-PAGE of the extract (Coomassie stained) is located at the left of the molecular weight standards.

detected in 4 of the 21 samples studied by these authors. More recently, we described the first IgE-mediated anaphylactic reaction to this caterpillar in a pine-forest worker [9]. The IgE-immunoblotting detected in caterpillar extract two reactive bands with apparent molecular weights close to 25 and 35 kDa. The present study demonstrated that the crude extract contained many IgE-binding proteins of several molecular weights and intense recognition of low molecular weight allergens were obtained in some patients. As it is frequently found with immunoblotting assays of other allergens, the patients showed different detection patterns, although some allergens were more frequently recognized than others.

The SPT was a helpful tool to distinguish between an IgE-mediated and a non-IgE-mediated mechanism. According to our results, 58.18% of patients with previously suspected reactions to *T. pityocampa* were sensitized to this caterpillar, as shown by SPTs. Although SPTs are highly sensitive, they usually have low specificity, but the results of the IgE-immunoblot clearly showed that at least 72.22% of the SPTs had specific IgE demonstrable by this method. Therefore, the sensitization to this insect was found to be at least as important as the toxic/irritant mechanism.

In allergic patients the skin lesions characteristically appeared after a few minutes, even in covered cutaneous areas, and frequently caused more serious symptoms than those which were non-IgE mediated. In our study the most common symptom was an urticarial dermatitis. Eye and respiratory symptoms were more rare, and appeared principally among 'pine cone-collectors'.

Clinical differences between allergic patients with occupational and nonoccupational exposure to processionary caterpillar could be made too. A repeated and higher exposure to caterpillars among workers could explain the more serious symptoms found in them, such as conjunctivitis, dyspnea and anaphylactic reactions, although without statistical significance. This higher bronchial exposure in the 'pine cone-collectors' could explain the presence of one case of dyspnea in the group of negative SPT where 11/23 subjects had an occupational exposure.

Although the symptoms appeared more frequently from January to April (corresponding to the L5 larval stage, in which the abundance of hairs in the air is high), some workers also had symptoms from October to December (corresponding with the L3–L4 larval stages), because they come into contact with the caterpillars' nests (for instance 'pine cone-collectors' often knock caterpillars' nests while collecting pine cones with a long stick).

The anaphylactic reactions were also more frequent during these months (anaphylaxis only appeared in allergic patients with occupational exposure). These patients had a major size of SPT and the exercise was found in them to be a variable that increased the symptoms.

Pine processionary caterpillars can remain in the chrysalis stage for several years if the environmental conditions are not favourable. Simultaneous emerging of the moths from several generations can occur and a whole community may suffer from a dermatitis epidemic due to these caterpillars [17]. In homes, caterpillars may crawl into clothes and bedding. Dead larvae, cocoons, nests, debris from an infested pine forest such as fomites infested with caterpillars, can cause dermatitis throughout the whole year [17]. This explains some cases of patients with symptoms when *T. pityocampa* is in the nonurticating larval stage.

This is the first clinical study of immediate hypersensitivity reactions caused by *T. pityocampa*, and it describes the first cases of IgE-mediated reactions in non occupational patients. *T. pityocampa* urticating hairs should be considered as an important airborne insect-allergen [12]. Although it has a seasonal importance, it can also cause symptoms throughout the whole year. Allergic reactions among occasional visitors and residents in pine wood areas, and particularly among pine-forest workers, should be taken into consideration by allergists. Further epidemiological studies with this new allergen are necessary to evaluate its medical relevance, but we firmly believe that it could become a relevant sensitizer in other countries.

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