

# SKIN REACTIONS TO ALLERGENS FROM PROCESSIONARY CATERPILLARS (GENUS THAUMETOPOEA)

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## ABSTRACT

**Background:** Moths of the genus *Thaumetopoea* are widespread pests in the coniferous and deciduous forests in Bulgaria. Contact with the caterpillars, larval form of different *Thaumetopoea* species, causes a series of complaints in humans: mainly contact dermatitis (erucism), but also IgE-mediated allergic reactions.

The aim of the present pilot study is to investigate the skin reaction after prick tests with allergens from different *Thaumetopoea* species in a group of people who have frequent contacts with the processionary caterpillars.

**Material and methods:** A group of 42 subjects was surveyed comprising 37 men and 5 women between the ages of 18 and 87. Specific sensitization to caterpillars of three *Thaumetopoea* species: *Thaumetopoea pityocampa* (pine processionary); *Thaumetopoea processionea* (oak processionary) and *Thaumetopoea solitaria* (pistachio processionary) was assessed by allergy skin prick tests (SPT) with specially designed caterpillar allergens.

**Results:** Positive allergy skin tests to one or more caterpillar's allergens were measured in 18 (43%) participants. A simultaneous test with the three allergens from the different *Thaumetopoea* species showed that in 6 (33%) of the cases, skin hypersensitivity only to *T. pityocampa* allergens was present. Monosensitization to *T. processionea* was observed in 2 (11%) cases. The rest 10 (56%) participants with positive skin test showed different profiles of polysensitization to the studied *Thaumetopoea* allergens.

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**Conclusions:** The SPT evaluation of skin reactivity to different caterpillar's allergens outlined the important role of processionary allergens, especially those from *T. pityocampa*, in the development of IgE-mediated allergic complaints in different groups of forestry professionals. In view of these results, it seems that IgE-mediated hypersensitivity allergic reactions to *Thaumetopoea* caterpillars are at least as important as those with no allergic mechanism.

**Keywords:** *Thaumetopoea pityocampa*, *Thaumetopoea processionea*, *Thaumetopoea solitaria*, IgE-mediated allergy, skin prick tests.

## INTRODUCTION

Moths of the genus *Thaumetopoea* are widespread pests in the coniferous and deciduous forests in Bulgaria. They are mainly represented by the following species: *Thaumetopoea pityocampa* (pine processionary); *Thaumetopoea processionea* (oak processionary) and *Thaumetopoea solitaria* (pistachio processionary) (1).

There is a plenty of literature and clinical evidences that contact with caterpillars, the larval form of different *Thaumetopoea* species, causes a series of complaints in humans dominated by contact dermatitis (erucism), and more rarely - conjunctivitis or keratitis, developed through a toxic-irritant mechanism (2,3). Toxic reactions are caused by the urticogenic hairs covering the caterpillar body. Upon contact with human skin the hairs break down and secrete toxic proteins causing irritation. One of the proteins, called thaumetopoein, has a histamine-releasing effect (4).

In recent years, in addition to the toxo-irritant reactions, IgE-mediated allergic reactions were also defined. These reactions are caused mostly by direct contact with caterpillars or inhalation of their airborne urticogenic hairs. Allergic reactions affect mainly forest workers in areas with excessive development of the caterpillars causing allergic rhinitis or asthmatic attacks and even anaphylactic shock (5,6). Therefore, the larval form of *Thaumetopoea* moths should be considered not only as a source of occupational contact allergy, but also as an aeroallergen causing inhalative and ocular allergic symptoms, which may affect a wide range of people found in such an environment (7). Due to the climate changes in recent years, different moths of the genus *Thaumetopoea* have expanded their habitat in Bulgaria and represent a serious health threat for the communities of people working and residing within the forests (8).

In this regard, the aim of the present pilot study was to investigate the skin reactions after prick tests

with allergens from different *Thaumetopoea* species in a group of people having frequent contacts with the processionary caterpillars in order to prove their sensitization.

**MATERIAL AND METHODS**

**Surveyed persons**

The skin sensitivity to most spread *Thaumetopoea* species in Bulgaria was studied in a group of people working daily in the forests and having frequent contact with processionary caterpillars. A total of 42 subjects were surveyed, 37 men and 5 women between the ages of 18 and 87.

After giving their informed consent, the project participants completed a specially designed questionnaire. Each participant was then subjected to a detailed examination to determine the presence of allergic complaints while working in the forest.

**Skin prick tests with allergens from different *Thaumetopoea* species**

Specific sensitization to caterpillars of three *Thaumetopoea* species: *Thaumetopoea pityocampa* (pine processionary); *Thaumetopoea processionea* (oak processionary) and *Thaumetopoea solitaria* (pistachio processionary) was assessed by allergy skin prick tests (SPT).

For this purpose in the Laboratory for Allergenic preparations at Bul Bio NCIPD, Sofia, Bulgaria, special diagnostic allergens from the above mentioned *Thaumetopoea* species were prepared.

As a raw material for the production of allergenic extracts, caterpillars in L4/L5 stage were collected and provided by scientists from the Forest Research Institute at Bulgarian Academy of Sciences. The allergens were prepared by an original methodology consistent with the procedures for production and standardization of allergens for SPT diagnostics and complying with the requirements of Good Manufacturing Practice (GMP).

To prove the specificity of the allergens from studied *Thaumetopoea* species a control group of 21 volunteers (11 healthy, non-allergic individuals; 5 patients, sensitized to grass pollen and 5 – sensitized to house dust mites), was tested with the above mentioned experimental extracts by SPT and showed no positive skin reactions.

The diagnostic allergy skin tests were performed simultaneously with the allergens from the three *Thaumetopoea* caterpillars in a volume of 0.05 ml on the volar side of the forearm of each participant. Negative (Coca I solution) and positive (histamine 1 mg/ml) controls were applied in parallel. The reactions obtained were read in 20 minutes according to size of wheal and flare. Wheal and flare with a mean diameter > 3mm were considered positive.

To determine |The degree of skin reaction to the allergen was determined using the following grading scale based on the size of the wheal (Table 1.)

**Table 1.** Degree of skin reaction to the allergens from caterpillars of three *Thaumetopoea* species

Wheal size (mm)	Interpretation of skin reaction
< 3	Negative
3-5	Slight positive
5-10	Moderate positive
10-15	Strong positive
>15	Very strong positive

**Statistics**

All analyses were performed using the software package GraphPad Prism 6.0 (GraphPad Software, Inc.). Descriptive analysis of the wheal areas in SPT as well as Comparisons of means and ratios were performed by Mann-Whitney test for unpaired data. Probability values of p < 0.05 were considered statistically significant.

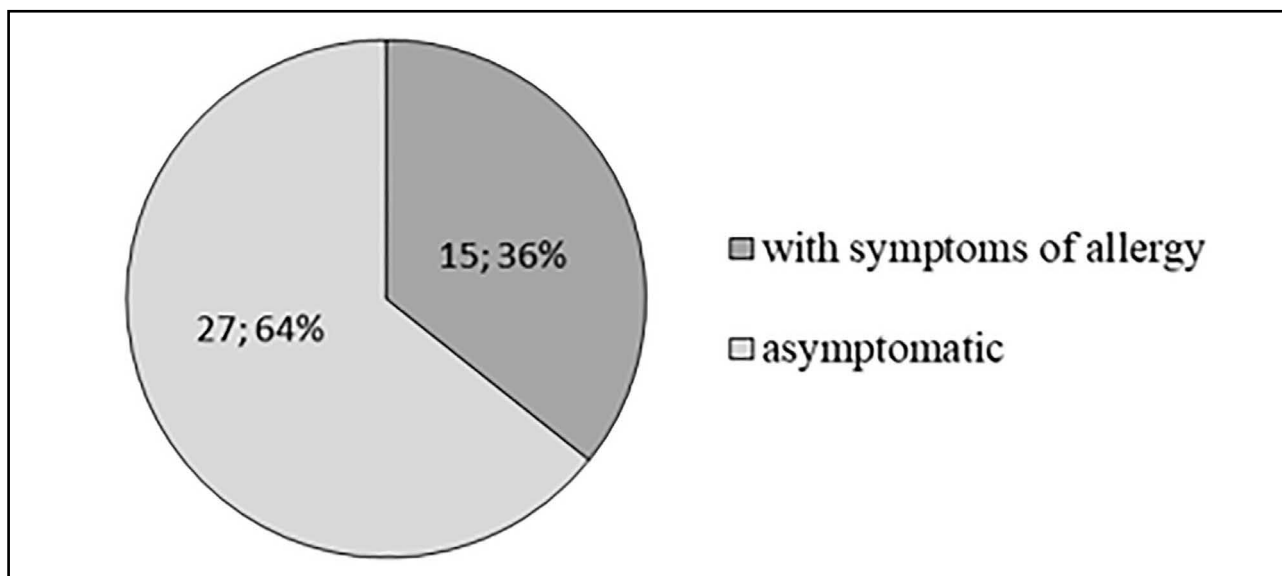
**Results**

During the examination for allergy complaints 27 (64%) participants declared no health problems. On the other hand, 15 (36%) persons reported allergic symptoms during their daily professional activities in the forest (**Fig.1.**).

The complaints were mainly from the skin: itching in 7 and rash - in 8 participants. In 4 forestry workers skin complaints were combined with symptoms from the upper respiratory tract (runny nose and sneezing).

Determination of the specific sensitization to different species of *Thaumetopoea* caterpillars was performed by SPT using specially designed diagnostic allergens.

Positive allergy skin tests to one or more caterpillar’s allergens were measured in 18 (43%) participants. According to the obtained data, 15 (36%) of the forest workers were with positive skin reactions

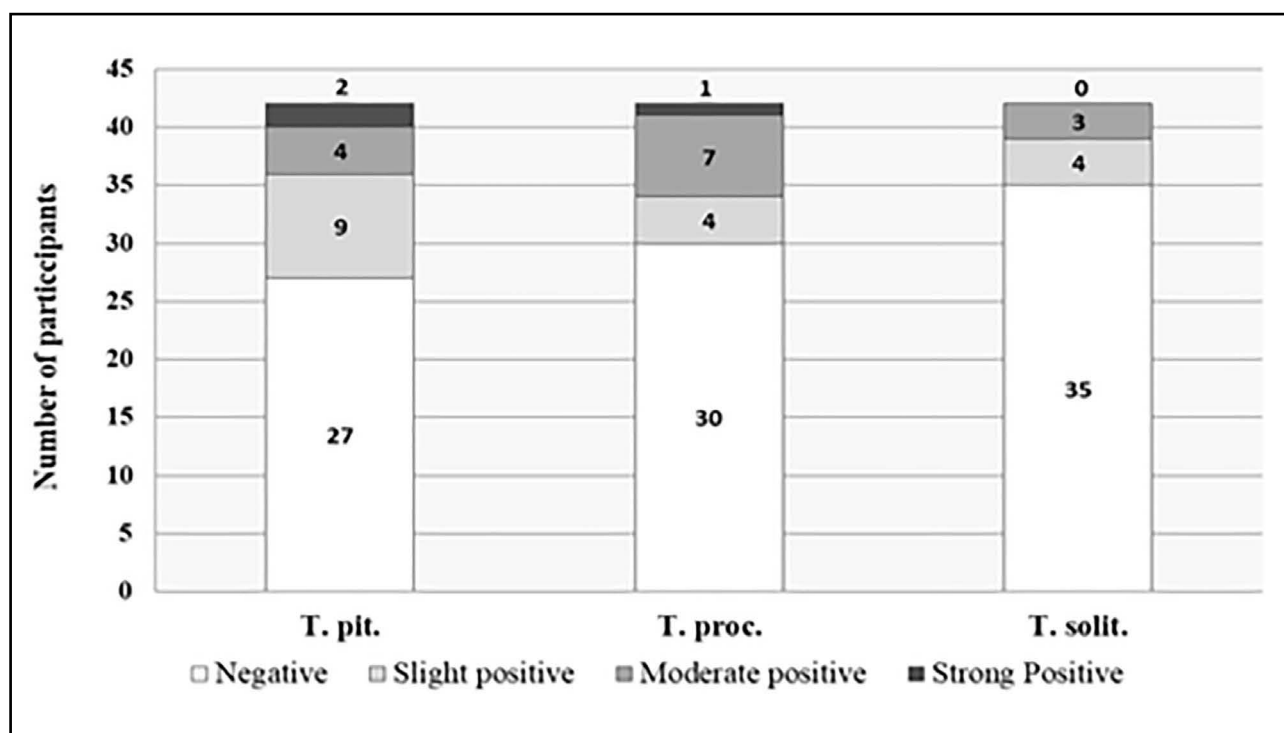


**Fig. 1. Distribution of participants after the examination for allergy**

to the allergen from *Thaumetopoea pityocampa* (*T. Pit.*); 12 (29%) - to allergen from *Thaumetopoea processionea* (*T. proc.*) and only 7 (17%) to the allergen from *Thaumetopoea solitaria* (*T. solit.*). There were no significant differences between the

three extracts regarding the wheal areas in SPT ( $p > 0,05$  for all comparisons).

The distribution of the degree of positive skin reactions after testing with the studied allergens from different *Thaumetopoea* species is shown in **Fig. 2**.



**Fig. 2. Degree of positive skin reactions from the studied allergens from different *Thaumetopoea* species**

After a SPT with *T. pit.* allergen 9 participants (60%) showed slight positive; 4 (27%) - moderate positive and 2 (13%) - strong positive skin reactions. The skin reactions to the allergen from *T. proc.* were as follows: - 4 (34%) slight positive; 7 (58%) moderate positive and 1 (8%) strong positive. In response to allergens from *T. solit.* No strong positive skin

reactions were observed, Slight positive reactions were observed in 4 (57%) and moderate positive reactions - in 3 (43%) of the tested.

A simultaneous test with the three allergens from the different *Thaumetopoea* species showed that in 6 (33%) of the cases, skin hypersensitivity only to allergens from *T. pit.* was present. Monosensitization

to *T. proc.* was observed in 2 (11%) participants. The rest 10 (56%) participants with positive skin test showed different profiles of polysensitization to *Thaumetopoea* allergens under study (Table 2).

**Table 2.** Profiles of sensitization to the different species of *Thaumetopoea* caterpillars among the participants with positive allergy skin pricks tests.

Positive SPT	Number	%
<i>T. pit.</i> +	6	33
<i>T. proc.</i> +	2	11
<i>T. pit.</i> + <i>T. proc.</i> +	3	17
<i>T. proc.</i> + <i>T. solit.</i> +	1	6
<i>T. pit.</i> + <i>T. proc.</i> + <i>T. solit.</i> +	6	33

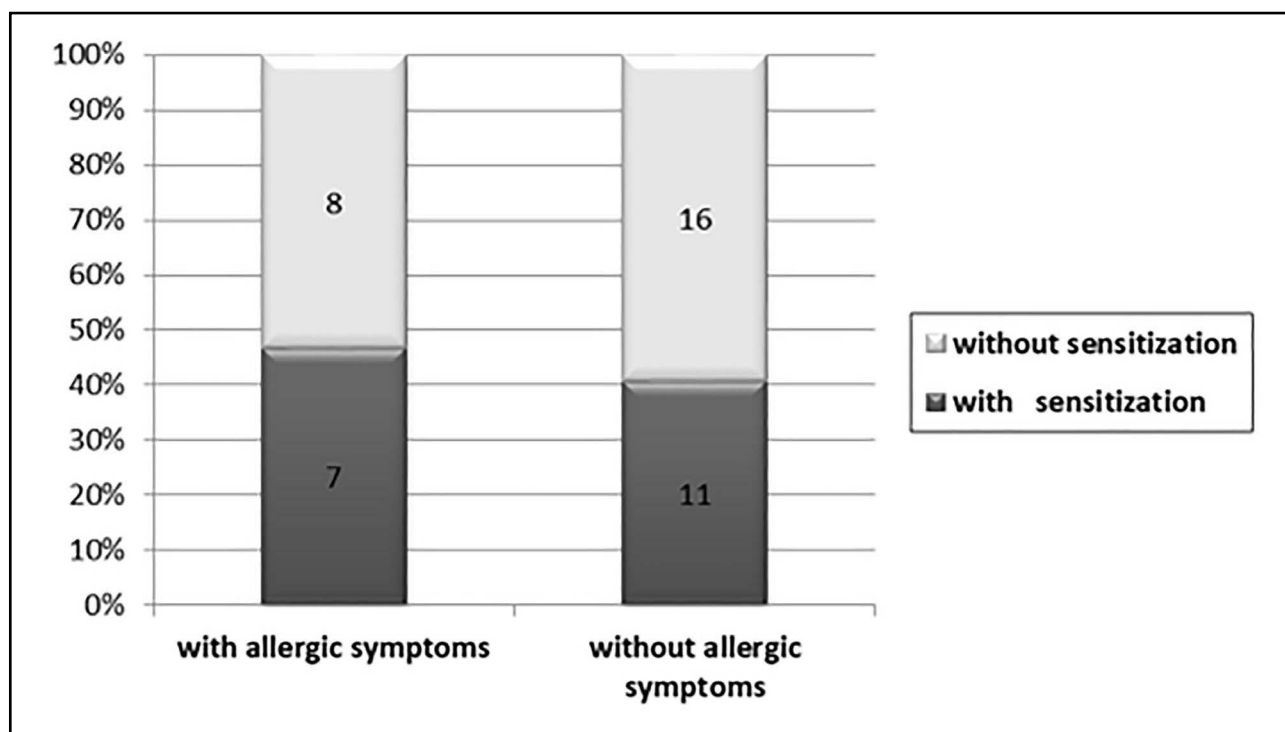
When comparing the data from the history and the SPT, it was found that in 8 (53%) of the surveyed 15 forest workers with complaints after contact with caterpillars, the symptoms developed without specific sensitization. In the remaining 7 (47%) the clinical history was supported by data for specific sensitization, while in 11 (41%) the detected sensitization to the caterpillars was asymptomatic (**Fig. 3**).

**DISCUSSION**

Our findings from a first of its kind pilot study unequivocally prove that representatives of the genus *Thaumetopoea* in Bulgaria cause health problems in people who have daily contact with their larvae, most often workers and scientists performing activities in the forests.

According to the results from a detailed allergic examination 15 (36%) persons reported allergic symptoms after a contact with *Thaumetopoea* caterpillars. Skin reactions were the most common clinical manifestation. 47% of the participants with symptoms reported severe itching, sometimes with no visible skin lesions. In 53% there was a rash, mainly of two different types: rapid hives (contact urticaria) or late-onset papular itchy rash, which persists for several days. In most of the studied participants, contact urticaria was IgE-mediated.

The pathogenic effects of the *Thaumetopoea* caterpillars are not limited to the skin. In 27% of participants with skin symptoms, upper respiratory tract involvement in the form of seasonal runny nose, coughing, swallowing disorders and difficulty breathing was also observed.



**Fig. 3.** Comparison between data from clinical history and presence of specific sensitization to processionary caterpillars

There are several possible explanations in the literature for the pathogenetic mechanism of the inflammatory response that develops after

contact with the urticogenic hairs of different *Thaumetopoea* species. Several studies have described a specific protein (thaumetopoein)

contained in hairs, which has a direct effect on the mast cells and leads to their degranulation and release of histamine (4, 9).

The fact that some individuals present with more intense, immediate reactions, while others show minimal or even no clinical manifestations after similar exposure has prompted that an IgE-mediated allergic mechanism might be involved. According to up-to-date studies of whole body allergenic extract from pine processionary it contains a mixture of at least 70 proteins, including 7 allergenic molecules, which penetrate the skin and mucous membranes after exposure to caterpillar hairs (9, 10).

For the purposes of our study, we have prepared whole body diagnostic allergens from different types of *Thaumetopoea* caterpillars. With their help, specific skin reactions to different caterpillar's allergens were studied for the first time.

The data obtained through the SPT revealed positive skin reactions to different caterpillar's allergens in 18 (43%) of the participants. test., were monosensitized to *Thaumetopoea pityocampa*. Monosensitization to *Thaumetopoea pityocampa* was observed in 6 (33%) of the positive cases and to *Thaumetopoea processionea* - in 2 (11%). The rest 10 (56%) participants showed different profiles of polysensitization to the studied *Thaumetopoea* allergens. A fact that needs to be examined in more detail in our future studies.

Our results clearly show that in the group of subjects having frequent professional contacts with different *Thaumetopoea* caterpillars, the positive skin reaction to *Thaumetopoea pityocampa* was most common and most pronounced.

Supplementation of SPT data with the initial allergic symptoms survey demonstrated that only 7 from the 18 participants with positive skin tests (39%) reported allergic symptoms on contact with processionary caterpillars. In the remaining 11 (61%) participants, the sensitization to caterpillar allergens was asymptomatic. Indeed, since the allergic immune response is genetically determined, not all sensitized individuals develop allergic symptoms after exposure to caterpillar's allergens.

The results from our pilot study are in line with data from other European studies, which found that in endemic areas, SPT with caterpillar whole body extract yielded positive results in 53% to 58% of individuals with suspected *T. pityocampa* reactions (11). Some epidemiological data in Spain have been published on reactions caused by *T. pityocampa* in a cross-sectional, randomized, age-, sex- and habitat-adjusted study of 1224

participants. The prevalence of skin reactions to *T. pityocampa* was 12% in rural areas, 9.6% - in semiurban areas with nearby pine forest, and 4.4% - in urban areas. It was found that the risk of skin reactions to *T. pityocampa* was directly related to the exposure to the caterpillar (12).

Summarizing these data, it can be argued that in significant number of cases the complaints following the contact with different processionary caterpillars have immunological pathogenesis and involve production of allergen-specific IgE. The demonstration of the IgE-mediated mechanism of reactions after contact with *Thaumetopoea* caterpillars should be performed as early as possible, in order to avoid new contacts with different caterpillar's allergens and progressive increase of sensitization.

## CONCLUSION

The present study provides important initial theoretical and practical information on the impact of different *Thaumetopoea* species in Bulgaria on human's health. Forestry workers are most at risk of *Thaumetopoea*-related disease. The evaluation of skin reactivity after SPT with different caterpillar's allergens outlined the important role of processionary allergens, especially this from *T. pityocampa*, in the development of IgE-mediated allergic complaints among forestry professionals. In view of these results, it seems that IgE-mediated hypersensitivity allergic reactions to *Thaumetopoea* caterpillars are at least as important as those with no allergic mechanism.

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## References:

1. Mirchev P, Tsankov G, Balov G. *Factors influencing on changes in the distribution and economic importance of the pine processionary moth (Thaumetopoea pityocampa Den & Schiff) in Bulgaria*. Forest science. 2000; No 2/3: 25-24.
2. Rodriguez-Mahillo AI, Gonzalez-Muoz M, Vega JM, et al. *Setae from the pine processionary moth (Thaumetopoea pityocampa)*. Contact dermatitis. 2012; 67 (6): 367-374.
3. Portero A, Carreño E, Galarreta D, Herreras JM. *Corneal inflammation from pine processionary caterpillar hairs*. Cornea. 2013; 32(2): 161-164.
4. Lamy M, Pastureaud MH, Novak F, et al.: *Thaumetopoein: an urticating protein from the hairs and integument of the pine processionary caterpillar (Thaumetopoea pityocampa Schiff)*. Toxicon. 1986; 24 (4): 347-356.
5. Aparicio VF, Remón LZ, Molero IM, Lebrero EL, Mazuecos JB, Bartolome B. *Allergy to pine processionary caterpillar (Thaumetopoea pityocampa) in children*. Allergol Immunopathol. 2006; 34(2): 59-63.
6. Vega JM, Moneo I, Armentia A, et al. *Anaphylaxis to a pine caterpillar*. Allergy. 1997; 52(12): 1244-1245.

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7. Aparicioa VF, Fernández M de B, Sotés MR, et al. *Non-occupational allergy caused by the pine processionary caterpillar (Thaumetopoea pityocampa)*. Allergol Immunopathol. 2004; 32(2): 69-75.
8. Mirchev P, Georgiev G, Matova M. *Prerequisites for expansion of pine processionary moth Thaumetopoea pityocampa (Den. & Schiff.) in Bulgaria*. Journal of Balkan Ecology. 2011; 14, (2): 117-130.
9. Werno J, Lamy M, Vincendau P. *Caterpillar hairs as allergens*. Lancet. 1993; 342: 936-937.
10. Moneo I, Vega JM, Caballero ML, Vega J, Alday E. *Isolation and characterization of Tha p1, a major allergen from the pine processionary caterpillar Thaumetopoea pityocampa*. Allergy. 2003; 58: 34-37.
11. Vega JM, Moneo I, Armentia A, et al. *Allergy to the pine processionary caterpillar (Thaumetopoea pityocampa)*. Clin Exp Allergy. 1999; 29: 1418-1423.
12. Vega JM, Moneo I, Ortiz JC, et al. *Prevalence of cutaneous reactions to pine processionary moth (Thaumetopoea pityocampa) in an adult population*. Contact Dermatitis. 2011; 64: 220-228.