Reacções Cutâneas, Oculares e Respiratórias pela Processionária *(Thaumetopoea Pityocampa)*

Rita Aguiar[1], Teresa Estanislau Correia[2]
[1]Resident of Immunoallergology, Immunoallergology Department – Hospital Santa Maria, Centro Hospital Lisboa Norte, Lisbon, Portugal
[2]Graduated Consultant, Dermatology and Venereology Department – Hospital Santa Maria, Centro Hospitalar Lisboa Norte, Lisbon, Portugal

RESUMO – A lagarta do pinheiro, *Thaumetopoea pityocampa*, é um inseto desfolhador responsável pelo atraso do crescimento ou a morte de vários tipos de pinheiros. Além de danos ambientais a lagarta pode provocar reações cutâneas em humanos pelo contato com os pelos irritantes das larvas. Embora a dermatite ocorra entre grupos de profissionais de ar livre, afecta principalmente grupos não-ocupacionais. Os meios de transmissão compreendem o contato directo com o ninho e/ou processionária e o contato indireto com os pelos dispersos no ar. A dermatite é geralmente observada no final da Primavera, particularmente, de Março a Junho, entre os ultilizadores de parques de campismo. A erupção cutânea tem início 1-12 horas após o contato com os pêlos e apresenta-se com prurido intenso e persistente. Para além da pele, a *T. pityocampa* pode envolver a olhos e a via aérea, mas de forma menos frequente. Apesar dos danos consideráveis para os seres humanos e para natureza, a infestação é um problema subestimado; a literatura médica é escassa e, muitas vezes, a informação relevante é a que se refere aos meios de comunicação locais e à sabedoria popular.
PALAVRAS-CHAVE – Dermatite Alérgica de Contacto; Dermatite Ocupacional; Hipersensibilidade Imediata; Larva; Lepidópteros; Lesões Oculares; Pinheiro; Testes Cutâneos; Urticária.

Cutaneous and Other Reactions to the Processionary Caterpillar (Thaumetopoea Pityocampa)

ABSTRACT – *Pine caterpillar, Thaumetopoea pityocampa, is a phyto-lepidopteran, responsible for the delay in the growth or the death of various types of pine trees. Besides nature damage, pine caterpillar causes dermatological reactions in humans by contact with the irritating hairs of the larvae. Although dermatitis occurs among outdoor professionals, it is primarily non-professional. Means of contamination comprise direct contact with the nest or the processional caterpillar and indirect contact with air dispersed hairs. Dermatitis is generally observed in late spring and particularly from March to June, among campers and tourers. The eruption has its onset 1-12 hours after contact with the hairs and presents with intense and continuous itching. Apart from the skin, T. pityocampa can involve the eyes and rarely the airways. Despite the considerable damages to humans and nature, pine caterpillar infestation is an underestimated problem; medical literature lists few studies and, often, relevant information is referred to local media and popular wisdom.*
KEY-WORDS – *Dermatitis, Allergic Contact; Eye Injuries; Hypersensitivity, Immediate; Larva; Lepidoptera; Pinus; Skin Tests; Urticaria.*

1. INTRODUCTION

Lepidoptera are among the most common insects, with around 175000 described species worldwide.[1]

In Portugal as in Mediterranean countries pines on coastal regions are assaulted each year by an apparently inoffensive insect: the pine caterpillar *Thaumetopoea pityocampa* Schiff.

Caterpillars - the larval form of these insects - are responsible for most of the adverse reactions in humans, although such reactions have also been reported after contact with the adult insect (moths or butterflies). Caterpillars have defense mechanisms as urticating hairs, sharp spines and a range of toxic substances.[2,3] Pine processionary larvae have an urticating apparatus, which may release up to 1 million setae to the air in order to protect the larvae from their predators. The setae are very sharp in the distal part, and have backward spikes in the proximal part, in order to facilitate the penetration

Correspondência: Rita Aguiar
Hospital de Santa Maria - Centro Hospitalar Lisboa Norte - Serviço de Imunoalergologia - Piso 7
Av. Prof. Egas Moniz - 1649-035 Lisboa, Portugal
E-mail: aguiar2016@gmail.com

Recebido/*Received*
28 Março/*28 March* 2016
Aceite/*Accepted*
15 Maio/*15 May* 2016

Artigo de Revisão

of the setae into the skin or mucosa of the attacking animal.[3]

The first clinical reports on pine caterpillar were given by entomologists.[4,5]

In Portugal, all forest zones are burdened by such environmental threat causing also a medical problem, which is referred by the social communication as a nightmare.

Recent studies point out the expanding pine processionary northwards as a result of global warming, which permits better survival of its larvae in areas where previously it was impossible to survive.[6-8]

This article will focus on the main diseases caused by the pine processionary caterpillar (*Thaumetopoea pityocampa*), a major economic pest of pine forests in southern Europe,[6] and a common cause of adverse reactions due to lepidopteras in Portugal.

2. BIOLOGY

The terminology used to describe reactions to lepidopteras is confusing and contradictory. The term erucism (from the Latin *eruca*: caterpillar) should be used in any disease caused by caterpillars or the larval phase of these insects. The word lepidopterism (from the Greek *lepís*: scale and *ptèron*: wing) is referred to reactions caused exclusively by lepidopteras in the adult reproductive phase, butterflies and moths.

The pine processionary moth (*T. pityocampa*) is a nocturnal lepidoptera of the *Thaumetopoeidae* (*Notodontidae*) family. It is found in several parts of Europe, Northern Africa and the Middle East. In Europe, there are different species of *Thaumetopoea*: *T. pityocampa* Schiff, pine caterpillar, in Mediterranean regions; *T. pinivora* predominates in the north Europe and *T. processionea*, oak caterpillar, in central regions.[9]

The biological cycle encompasses 2 phases: an aerial as well as a ground one.[4,5] The former begins with the moth formation and includes the evolution from eggs to larvae. Female moths, once fecundated, lay eggs (70-300) only once at the extremities of pine branches. Larvae hatch from eggs within 5-6-weeks, and during this larval phase they show a gregarious behavior with caterpillars staying together and attached to pine needles. While being fed on pine needles, larvae weave a net creating "tent" nests, typically placed on tree-tops. Caterpillars move among branches an also among trees in order to feed, typically in a procession fashion (nose to tail columns), usually at night.

The caterpillars themselves go through 5 larval stages (L1-L5). From the start, they are social and have a characteristic way of moving in single file, as if in a procession, hence their common name. From the third larval stage (L3), which takes place between September and November according to the climate, the colony forms readily visible nests in the tops of the pine trees.

From their third to fifth larval instars, larvae are armed with urticating hair-like material called setae for protection against predators. These microscopic elements are between 150 and 200 μm long and 5 μm in diameter. Unlike true hairs, they are not innervated and readily detach from the skin with the slightest mechanical shock or stimulus.[10] New hairs are produced while the old ones remain in the larval remnants.

The larvae then transform into chrysalis and further to moth during one month. Pine processionary cycle is therefore annual. Based on climatic conditions, it can span among years.[2-5] Even the above 2 biological phases can vary in duration.

Setae from larvae can lodge in the skin or the ocular and respiratory mucosa where they produce clinical symptoms.[11,12] Setae can also be present in the air, as shown by techniques used to detect pollen or airborne microorganisms. The abundance of these hairs in the air depends on the distance from areas with contaminated pines, weather conditions and stage in the biological cycle.

The hairs can attach to objects (wood, pine cones, clothes) or to animals (pets) and cause symptoms outside the forest. They can persist for a long time in the environment and so patients may show reactions during the whole year.[11]

3. EPIDEMIOLOGY

Pine processionary affects all species of pines and cedrus trees, with a marked preference for black pines. Climatic conditions, warm weather in particular, are essential for larvae development. Pine caterpillar does not tolerate temperatures above 25°C or below 5°C, the optimal range being 20-25°C. Aerial larval phase ends between March and June. At this time caterpillars look for a feasible ground to infiltrate, in a warm and well-lighted area, beginning the ground phase.

Workers in forest areas are therefore the group most at risk of *T. pityocampa*-related disease (the risk is 5 times higher). The occupations at greater risk are pine cone collectors and lumberjacks, followed at some distance by resin collectors, farmers, forest wardens, gardeners, bricklayers, and haulage contractors who work in regions of pine forest.[11-14]

Children are another risk group, most likely because their natural curiosity leads them to touch the caterpillars or play with sand or vegetation that has these larvae.[15,16]

Symptoms may occur with the start of the pruning season and pine cone collection in the fall, or wood and sand collection in summer months.

4. PATHOGENIC EFFECTS AND CLINICAL PRESENTATION

The pathogenic effects of pine processionary are not limited to the skin but extend to the eyes and, more rarely, to the respiratory system. The dual pathogenic mechanism is as follows:

1 - Direct contact with nests or caterpillars is the cause of the processionary dermatitis;
2 - Airborne contact due to air dispersed urticarial hairs is the cause of the skin lesions as well as ocular and the respiratory manifestations.

Skin and mucosal reactions to *T. pityocampa* result mostly from mechanical irritation arising when the hairs of the caterpillar lodge in the skin and from the release of toxic or irritant substances, but the hairs of *T. pityocampa* also contain several allergens that promote an IgE response in man and animals.[17]

Penetration of the skin by urticating hairs leads to mast

cell degranulation, with the subsequent histamine release. Specifically to *T. pityocampa*, this IgE-independent degranulation has been associated with a protein known as thaumetopoein present in the hairs of the caterpillar. Nevertheless, another study has shown the slow onset of skin lesions after intracutaneous exposure to hairs of another irritating species of *Thaumetopoea*, thereby casting doubt on the part played by fast mediators such as histamine.[9]

In some cases, cutaneous and systemic reactions depend on IgE anti-Thaumetopoein (Tha p1), the protein also responsible for non-specific mast cell degranulation, IgE against related allergens (Tha p2) or IgE that recognizes other still uncharacterized antigens.[17]

Pretreating the hairs with different chemical products or heating them does not alter their pro-inflammatory and allergenic capacity.[14]

4.1. Cutaneous Involvement

Skin involvement is the most common clinical manifestation after exposure to *T. pityocampa*. Face, neck, limbs and in particular the wrists, forearms, ankles are mainly affected, although covered areas of the body may also be involved. The palms and the interdigital spaces/folds are more affected in children due to the direct contact with caterpillars.[15] Based on contact modality, lesions can be confined (direct contact) or rather multiple and extended (airborne contact), given that irritant hairs can pass through clothes. The eruption begins 1-12 hours after contact, or rarely, a few days thereafter.

The most frequent skin patterns are **papular dermatitis** and **contact urticaria**. The first one is characterized by the appearance of a papular, erythematous rash, with severe pruritus, numerous lesions caused by scratching, and eczematous areas. The lesions appear within hours and they can persist for several days. In contact urticaria, there are evanescent itchy papules, often in association with angioedema, particularly on the eyelids[14] and mucosae.[18]

Linear and figurated papulo-urticarial lesions are seen in children who let caterpillar stroll on their skin. Less frequently, papulo-vesicular and even pustular lesions have been reported, mainly on the palms of small children.[17] Itching is intense and continuous, with intermitting worsening and tends to disappear in a few days. Cutaneous lesions leave a brownish macule that resolves within 1-2 weeks.

In allergic patients, the characteristic skin manifestations are contact urticaria accompanied by angioedema in half of the cases. As with other cases of allergic contact urticaria, after contact, which can be minimal, lesions appear quickly, usually during the first hour, and often spread to covered areas of the body and may even become generalized, including the possibility of angioedema and anaphylaxis particularly in cases where the mucosa is the first area of contact /penetration of the hairs.

4.2. Ocular Manifestations

Early ocular lesions are represented by immediate burning sensation, almost invariably unilateral, with hyperemia and edema of conjunctiva and eyelids.

The inflammatory reaction worsens over the following days, with photophobia, profuse tearing and formation of conjunctival yellowish nodules, known as ophthalmia nodosa.

Ocular toxicity due to processionary hairs, whose movement occurs preferentially towards the posterior pole, includes early signs (conjunctivitis, keratitis, and uveitis) and late signs (cataract, pars planitis, vitritis and retinitis).

However, inactive setae can also be visible in the corneal stroma. Intraocular migration, which can occur years after the initial episode, is possible and might be severe, thus requiring a life-long surveillance.

4.3. Respiratory Manifestations

They are not frequent and, when present are associated with the inhalation of pine processionary hairs.

5. DIAGNOSIS

There are no specific clinical signs of reactions to *T. pityocampa*. Diagnostic suspicion of a cutaneous reaction to *T. pityocampa* is based on:

1. History of exposure in the previous 24 hours in forest areas with pine and cedrus trees infested with *T. pityocampa* in any period of the year, but particularly between February and April. Depending on the period of the year, there are different types of workers affected. For example, pine cone collectors have a peak in the incidence between October and December; workers who remove sand from the pine forests can have reactions in the middle of summer, when there are no irritating caterpillars but the remains of larvae or chrysalises may be present in the sand;
2. Presence of itchy wheals, with or without angioedema, or pruritic papular dermatitis. In children, the palms and interdigital spaces should be checked for lesions;
3. Identification of urticating hairs on the skin or clothes of the patient with an adhesive tape strip or a dermatoscope (entodermoscopy);
4. Exclusion of other differential diagnosis, namely insect bites, nodular or atopic prurigo and contact eczema.

5.1. In vivo method: Skin Prick Tests (SPT)

SPT with grinded hair filtrate turn positive with a variably marked urticarial reaction. These tests support the histaminergic urticarial activity of the substances, the necessity of skin scarification for the reaction to take place, as well as the need for hairs crushing in order to release the pathogenic substances.[20] SPT can be performed with a whole body extract and a setae extract, both from L5 larvae (Bial-Aristegui Laboratory, Bilbao, Spain).[17]

5.2. In vitro methods:

5.2.1. **Specific IgE**: IgE-immunoblotting can be performed in patients with a positive prick test to confirm the allergic nature of the cutaneous reaction.[17]

Artigo de Revisão

5.2.2. **Recombinant Tha p 2**: It was produced and used in an ELISA diagnostic test validated with 15 allergic patients but currently this test is not commercially available. In the near future, ELISA can be a very useful for the diagnosis of *T. pityocampa* allergy and for epidemiologic testing.[12]

5.2.3. **SDS-PAGE Immunoblotting** can be used to detect the corresponding sIgE-binding bands according to the molecular mass of the antigen. The IgE-immunoblot will detect several reactive bands in the caterpillar extract.[17]

5.3. Differences between allergic and non-allergic reactions to T. pityocampa

In allergic reactions: A prior contact with the caterpillar is necessary; contact urticaria is more frequent, latency period <1 hour, more severe clinical manifestations, positive skin prick test (SPT) and specific IgE (sIgE);

In non-allergic reactions: A prior contact with the caterpillar is not necessary, dermatitis presents mostly as a papular dermatitis, latency period >1hour, severity of the clinical manifestations lower except for extensive exposure; Negative SPT and sIgE.

6. TREATMENT

Treatment is mainly supportive, with oral antihistamines to control pruritus, contact urticaria and angioedema; topical corticosteroids can be used for eczematous lesions and papular dermatitis.

In patients with extensive or refractory lesions, oral corticosteroids can be used.

It is important to avoid scratching as this will exacerbate symptoms when the caterpillar hairs are rubbed against the skin or become lodged in the skin or mucosae.

In allergic cases if there are manifestations of anaphylaxis, immediate treatment with adrenaline will be necessary.

In the majority of cases of ocular manifestations, irrigation and removal of the hairs together with topical steroids and symptomatic surveillance leads to a good outcome. Steroid eye drops accelerate the resorption of these infiltrates.

Dyspnea, thoracic pain and asphyxia rarely occur and require urgent treatment.[12,14,15]

7. CONCLUSIONS

Pine processionary cutaneous reactions are common in the human population of South Europe where pine processionary moth is endemic.

Therefore, the aeromediated contact papulo-urticarial eruption due to setae of pine caterpillar should be considered, as well as respiratory and mucosal symptoms from these seasonal inhalant allergens. In areas where these caterpillar proteins are present they should be taken into account in this diagnosis of urticarial dermatitis and other allergic pathologies in children. Larval allergens are delivered to the skin by penetration of the setae, which have minute amounts of protein contained in a chitinaceous structure, and this method of administration seems to be the second relevant fact that could polarize the immune system to a Thelper 2 (Th2) response.[17]

It is noteworthy that specific IgG was not found in the majority of our patients, suggesting that processionary caterpillars induce a predominantly IgE-mediated immune response in humans.[17]

The disease caused by *T. pityocampa* should be taken into consideration by dermatologists, as skin manifestations are without doubt the most common symptoms.

Correct diagnosis and appropriate information that emphasizes preventive measures will reduce the incidence and severity of these reactions.

Conflitos de interesse: Os autores declaram não possuir conflitos de interesse. **Suporte financeiro**: O presente trabalho não foi suportado por nenhum subsídio ou bolsa.

Conflicts of interest: *The authors have no conflicts of interest to declare.* ***Financing Support:*** *This work has not received any contribution, grant or scholarship.*

REFERENCES

1. Mallet J. The Lepidoptera Taxome Project Draft Proposals and Information, 2007. [accessed March 2015] Available at: http://www.ucl.ac.uk/taxome/lepnos.html.
2. Hossler EW. Caterpillars and moths. Part II. Dermatologic manifestations of encounters with Lepidoptera. J Am Acad Dermatol. 2010; 62:13-28.
3. Hossler EW. Caterpillars and moths. Dermatol Ther. 2009; 22:353-66.
4. R.A.F. De Reaumur, Mémoire pour servir à l'histoire des insects. Paris: Imprimerie Royale; 1736.
5. J. H. Fabre, Un virus des insectes, Masson, 1898.
6. Hódar JA, Castro J, Zamora R. Pine processionary caterpillar *Thaumetopoea pityocampa* as a new threat for relict Mediterranean Scots pine forests under climatic warming. Biol Conserv.2003; 110:123-9.
7. Solt I, Mendel Z. The pine processionary caterpillar *Thaumetopoea pityocampa*. Harefuah.2002; 141: 810-57.
8. Battisti A, Stastny M, Netherer S, Robinet C, Schopf A, Roques A, at al. Expansion of geographic range in the pine processionary moth caused by increased winter temperatures. Ecological Applications. 2005; 15:2084-96.
9. Fagrell B, Jorneskog G, Salomonnson AC, Larsson S, Holm C. Skin reactions induced by experimental exposure to setae from larvae of the northern pine processionary moth *(Thaumetopoea pinivora)*. Contact Dermatitis.2008; 59:290-5.
10. Battisti A, Holm G, Fagrell B, Larsson S. Urticating hairs in arthropods: their nature and medical significance. Annu Rev Entomol.2011; 56:203-20.
11. Vega JM, Moneo I, Armentia A, Fernández A, Vega J, de la Fuente R, et al. Allergy to the pine processionary caterpillar *(Thaumetopoea pityocampa)*. Clin Exp Allergy. 1999; 29:1418-23.
12. Vega JM, Moneo I, Garcia Ortiz JC, Sánchez Palla P,

Sanchís ME, Vega J, et al. Prevalence of cutaneous reactions to pine processionary moth *(Thaumetopoea pityocampa)* in an adult population. Contact Dermatitis.2011; 64:220-8.

13. Vega JM, Moneo I, Armentia A. Anaphylaxis to a pine caterpillar. Allergy. 1997; 52:1244-5.
14. Vega JM, Moneo I, Armentia A, Vega J, de la Fuente R, Fernández A. Pine processionary caterpillar as a new cause of immunologic contact urticaria. Contact Dermatitis.2000; 43:129-32.
15. Vega ML, Vega J, Vega JM, Moneo I, Sanchéz E, Miranda A. Cutaneous reactions to pine processionary caterpillar *(Thaumetopoea pityocampa)* in pediatric population. Pediatr Allergy Immunol.2003; 14:1-5.
16. Lamy M, Pastureaud MH, Novak F, Ducombs G, Vincendeau P, Maleville J, et al. Thaumetopoein: an urticating protein from the hairs and integument of the pine processionary caterpillar *(Thaumetopoea pitycampa Schiff., Lepidoptera, Thaumetopoeidae)*. Toxicon.1986; 24:347-56.
17. Rodriguez-Mahillo AI, Gonzalez-Muñoz M, Vega JM, López JA, Yart A, Kerdelhué C, et al. Setae from the pine processionary moth *(Thaumetopoea pityocampa)* contain several relevant allergens. Contact Dermatitis. 2012; 67:367-74.
18. Vega JM, Vega J, Vega ML, Moneo I, Armentia A, Sánchez B. Skin reactions to pine processionary caterpillar. Allergy.2003; 58:87-8.
19. Inal A, Altintaş DU, Güvenmez HK, Yilmaz M, Kendirli SG. Life-threatening facial edema due to pine caterpillar mimicking an allergic event. Allergol Immunopathol. 2006; 34:171-3.
20. Bonamonte D, Foti C, Vestita M, Angelini G. Skin reactions to pine processionary caterpillar *Thaumetopoea pityocampa* schiff. ScientificWorldJournal. 2013; 2013:867431.