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ORIGINAL ARTICLE / ÖZGÜN ARAŞTIRMA MAKALESİ

Pine Processionary Caterpillar (Thaumetopoea pityocampa) Envenomations and Global Climate Change: A Retrospective Analysis

Çam Kese Tırtılı (Thaumetopoea pityocampa) Envenomasyonları ve Küresel İklim Değişikliği: Retrospektif Analiz

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ABSTRACT

Aim: Pine Processionary Caterpillar (Thaumetopoea pityocampa) envenomations have become increasingly relevant due to the species' expanding habitat, influenced by global climate change. These envenomations present unique challenges, particularly in regions previously unexposed to this species. This study aims to retrospectively analyze envenomations caused by the Pine Processionary Caterpillar over a ten-year period, evaluating the frequency, clinical manifestations, and the impact of climate change on these cases.

Material and Methods: We reviewed patient records from four different hospitals between January 2014 and May 2024, focusing on cases with confirmed contact or exposure to the caterpillar. Data on demographics, clinical findings, treatment approaches, and seasonal trends were collected and analyzed.

Results: A total of 53 patients were included, with a nearly equal distribution between male and female patients. The most affected areas were the neck and face, primarily due to outdoor activities in pine forests. The peak incidence of envenomations was observed in May and June. Antihistamines, particularly intramuscular administration, were the most common treatment, with racemic epinephrine used in cases of severe reactions. Notably, the northward expansion of the caterpillar's habitat has been linked to increasing cases of envenomation.

Conclusion: The findings highlight the need for heightened awareness and preventive measures, especially during the caterpillar's peak activity season. As climate change continues to alter the distribution of Thaumetopoea pityocampa, regions unaccustomed to such exposures must prepare for the associated health risks.

Keywords: Allergic reactions, ecological shifts, public health impact, climate-driven expansion

ÖZ

Amaç: Küresel iklim değişikliğinin etkisiyle yaşam alanı genişleyen Çam Kese Tırtılı (Thaumetopoea pityocampa) zehirlenmeleri, giderek daha fazla önem kazanmaktadır. Bu zehirlenmeler, özellikle bu tür ile karşılaşmamış bölgelerde benzersiz zorluklar oluşturmaktadır. Bu çalışma, Çam Kese Tırtılı ile temas sonrası oluşan zehirlenmeleri on yıllık bir dönem boyunca retrospektif olarak analiz ederek, vakaların sıklığını, klinik belirtilerini ve iklim değişikliğinin bu vakalar üzerindeki etkisini değerlendirmeyi amaçlamaktadır.

Gereç ve Yöntemler: Ocak 2014 ile Mayıs 2024 arasında dört farklı hastaneden alınan hasta kayıtları incelendi ve tırtıl ile temas veya maruziyetin doğrulandığı vakalar tespit edildi. Demografik veriler, klinik bulgular, tedavi yaklaşımları ve mevsimsel değişimler tespit edildi ve analiz edildi.

Bulgular: Toplamda 53 hasta çalışmaya dahil edildi ve cinsiyet dağılımı neredeyse eşit bulundu. En çok etkilenen vücut bölgeleri boyun ve yüz olup, bu durum çoğunlukla çam ormanlarında yapılan açık hava aktivitelerine bağlandı. Zehirlenmelerin en yoğun olduğu dönem Mayıs ve Haziran aylarıydı. Tedavide en sık kullanılan ilaç antihistaminikler olup, özellikle kas içi uygulama tercih edildi; ciddi reaksiyonlar için ise rasemik epinefrin kullanıldı. Tırtılın yaşam alanının kuzeye doğru genişlemesi, artan zehirlenme vakalarıyla ilişkilendirildi.

Sonuç: Bulgular, özellikle böceğin en aktif olduğu mevsimde farkındalık ve önleyici tedbirlerin artırılması gerektiğini vurgulamaktadır. İklim değişikliği Thaumetopoea pityocampa'nın dağılımını değiştirmeye devam ettikçe, bu tür maruziyetlere alışık olmayan bölgeler ilgili sağlık risklerine hazırlıklı olmalıdır.

Anahtar Kelimeler: Alerjik reaksiyonlar, ekolojik değişimler, halk sağlığı etkisi, iklim kaynaklı yayılım

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Introduction

The Pine Processionary Caterpillar (Thaumetopoea pityocampa) is a species of caterpillar that predominantly inhabits pine trees and is widespread in the Mediterranean region (1,2). This species prefers hot and dry climates and typically resides in large colonies within pine forests. The geographic distribution of Thaumetopoea pityocampa spans Central and Southern Europe, the northern regions of the Middle East, North Africa (particularly Algeria), and the Marmara, Aegean, Mediterranean, and Black Sea regions of Türkiye (3). In addition to pine species such as Pinus (P.) pinaster, P. silvestris, P. halepensis, P. nigra, P. pinea, and P. radiata, this caterpillar also affects cedar trees (4).

Humans are frequently exposed to the pine processionary caterpillar through occupational exposure, outdoor activities, picnics, or forest walks. Envenomation occurs from caterpillar hairs, which can cause clinical conditions such as urticarial rash, angioedema and anaphylaxis after these hairs contact with the skin or mucosa. The potential for envenomation increases during the caterpillar's larval stage. The caterpillar's urticant hairs, which begin to appear in the third stage of its development (L3) around September, increase progressively until the last stage (L5), which can extend from January to May, depending on the climatic conditions of the area (5). These urticating hairs are highly specialized structures, each caterpillar possessing up to 1 million of these hairs (6). These hairs are typically around 100-250 micrometers in length and are designed to easily detach and become airborne, acting as a defense mechanism when the caterpillar feels threatened (Figure 1). The hairs are also notable for their "mirror-like" morphology, being densely packed and arranged on the caterpillar's dorsal and medial segments (6). These airborne hairs can be detected using techniques designed for airborne microorganisms and pollen research (7).

Figure 1. Pine processionary caterpillar

The parts of the body most often affected by this caterpillar hairs are the neck, arms, and legs, with the abdomen, face, and hands being less frequently involved. This clinical condition was first described by Reaumur in 1736 and later by Fabre in 1900 (8). Lamy and colleagues in 1986, and Werno and colleagues in 1993, identified a 28 kDa IgE-binding band from these hairs, which they named thaumetopoein, composed of two polypeptides (9,10). Skin reactions are primarily triggered by contact with these highly allergenic hairs during this stage. People who encounter these hairs often report itchy rashes at contact area, dermatitis, and sometimes angioedema. Depending on the contact area, these hairs can cause contact dermatitis on the neck, allergic conjunctivitis in the eyes, or severe anaphylactic reactions (6,11). The term "contact urticaria" describes the rapid onset of these reactions, typically within 30–60 minutes after exposure, with symptoms usually resolving within a few hours to 24 hours. Treatment typically involves local and systemic antihistamines; and in severe cases, corticosteroids are used (12). Precautions and treatment methods for the caterpillar's hairs are important for protecting and effectively treating patients.

Global climate change, which affects many ecosystems and species, also impacts the habitats of Thaumetopoea pityocampa. Rising temperatures and changing climate conditions have caused this species to spread northward, from the Mediterranean region to the Marmara and Black Sea regions (3,13). Because of climate change, the habitat of the pine processionary caterpillar has expanded, and populations have begun to form in areas where they were not previously observed. This expansion has allowed the caterpillar to establish itself in regions that were previously too cold for its survival, increasing the likelihood of human contact and leading to a rise in envenomation cases (3,13). Understanding these ecological shifts is crucial for predicting and managing future risks associated with this species as it continues to adapt to changing environmental conditions.

This study examines the 10-year retrospective data of patients who presented to the emergency departments of four different hospitals. The aim of the study is to evaluate the frequency, clinical findings, and the impact of global climate change on pine processionary caterpillar envenomations. We emphasize that health services and the public should be made aware of these types of envenomations and necessary precautions should be taken. It is important to clarify the terminology used throughout this study to avoid confusion. 'Envenomation' specifically refers to the process where urticating hairs from the caterpillar cause systemic toxic reactions. In contrast, 'reactions' can refer to both localized and systemic responses, 'dermatitis' denotes an inflammation of the skin, and 'urticaria' is characterized by transient, itchy welts on the skin. 'Exposure' simply denotes contact with the caterpillar's hairs, regardless of symptom presence.

Material and Methods

Our study is designed as a multi-center, retrospective analysis. Cases presenting to the emergency departments of Trabzon Kanuni Training and Research Hospital, Karadeniz Technical University Faculty of Medicine Farabi Hospital, Yeditepe Koşuyolu Hospital, and Yeditepe Kozyatağı Hospital between January 1, 2014, and May 31, 2024, and identified as having Pine Processionary Caterpillar (Thaumetopoea pityocampa) envenomations were included in the study. During the diagnosis stage, direct history of contact with and encounter with the Pine Processionary Caterpillar (Thaumetopoea pityocampa), the presence of patients in areas with pine trees, and subsequent skin reactions were considered. Ethical approval for the study was obtained from the Scientific Research Ethics Committee of the Faculty of

Medicine, University of Health Sciences Trabzon, with approval number 2024/120.

A comprehensive list of all patients who presented to the emergency department and were assigned ICD codes related to allergy, urticaria, and anaphylaxis between January 1, 2014, and May 31, 2024, was requested from the hospital information systems unit. The ICD codes examined included T78.4, L50, L50.0, L50.1, L50.2, L50.3, L50.4, L50.5, L50.6, L50.8, L50.9, T78.0, W57, and T78.2. Following this, the medical records of the identified patients were thoroughly reviewed using the hospital information system. After this review, patients who provided a history of direct contact with the caterpillar in pine forests, presence in areas with pine trees 1-24 hours before the onset of contact urticaria symptoms, and subsequent skin reactions were included in the study. Demographic data, clinical findings, treatment applied in the emergency department, and outcome information for each identified patient were meticulously recorded.

All relevant data for all patients were processed using Microsoft Excel. Statistical calculations were performed using SPSS 23.0 (IBM USA). Frequency data were presented as numbers and percentages. Ordinal and nominal data were presented as mean ± standard deviation.

Results

Between January 1, 2014, and May 31, 2024, a total of 53 patients identified from hospital records were included in the study. These patients had a history of direct contact or encounter with the pine processionary caterpillar in pine forests, or they were present in areas with pine trees 1-24 hours before the onset of contact urticaria symptoms, leading to subsequent skin reactions. The average age of the patients was 30.75 ± 22.9 years, with a range from 1 to 80 years. Of these, 25 (47.2%) were male, and 28 (52.8%) were female. A significant proportion of the patients, 37.7% (20), were younger than 18 years old (Table 1).

The most frequently affected body regions were the neck with 35 cases (66%), the face with 34 cases (64.2%), and the hands with 18 cases (34%), highlighting the vulnerability of exposed areas during outdoor activities. Among the treatment modalities, intramuscular antihistamines were the most commonly used, administered to 27 patients (50.9%), followed by oral antihistamines for 19 patients (35.8%) and intravenous steroids for 12 patients (22.6%). Racemic epinephrine was administered to 16 patients (30.2%), showcasing its importance in managing severe allergic reactions. The majority of envenomations were recorded during the peak activity season of the caterpillar, with 27 cases (50.9%) occurring in May and 17 cases (32.1%) in June (Table 1).

Parameter	*n*	*%*
Gender		
Male	25	47,2
Female	28	52,8
Child (0-18)	20	37,7
Adult(>18)	33	62,3
Environment		
Island	18	34
City	13	24,5
Rural	22	41,5
Contact Area		
Neck	35	66
Face	34	64,2
Hands	18	34
Forearms	16	30,2
Mouth	11	20,8
Back	2	3,8
Arms	1	1,9
Trunk	2	3,8
Legs	1	1,9
Treatment		
Antihistaminic Oral	19	35,8
Antihistaminic Intramuscular	27	50,9
Antihistaminic Topical	2	3,8
Antihistaminic Ocular	1	1,8
Epinephrine Racemic	16	30,2
Epinephrine Inhaler	3	5,7
Steroids Intravenous	12	22,6
Months		
February	1	1,9
March	2	3,8
April	5	9,4
May	27	50,9
June	17	32,1
July	1	1,9
Other Clinical Findings		
Anaphylaxis	10	18,9
Angioedema	14	26,4
Dyspnea	2	3,8
Conjunctivitis	27	50,9
Rhinitis	16	30,2
Skin Lesions Types		
Urticaria	42	79,2
Papules	13	24,5
Pustule	3	5,7
Reason for Exposure		
Lumberjack	8	15,1
Farmer	3	5,7
Touristic Trip, Picnic	42	79,2
Other Affected Persons(a)		
1	23	43,4
2	10	18,9
3	1	1,9

Table 1. Demographic data of Pine Processionary Caterpillar exposure
a.The patient evaluated in the emergency department and the other accompanying patients

Discussion

This study retrospectively analyzes envenomations caused by the pine processionary caterpillar (Thaumetopoea pityocampa) over a ten-year period, from January 1, 2014, to May 31, 2024, in four different hospitals. A total of 53 patients with various complaints following contact with this caterpillar were identified. This study represents the largest case series in the literature to date, with a notable inclusion of the highest number of pediatric cases, providing a comprehensive overview of the clinical implications of pine processionary caterpillar envenomations. The average age of the patients was 30.75±22.9 years, with a range from 1 to 80 years. The majority of the cases were female (52.8%). The data collected provided insights into the demographics, exposure characteristics, clinical findings, and treatment outcomes of these cases. This study also examines the impact of global warming on the spread of Thaumetopoea

pityocampa, particularly in regions where the habitat of this species has expanded, leading to an increase in envenomation cases. Literature suggests that the rise in global temperatures has facilitated the northward expansion of this caterpillar, contributing to a higher incidence of human contact and subsequent envenomations (4,11).

The most commonly affected areas during pine processionary caterpillar envenomations are the neck, face, forearms, and hands. These exposed body parts are particularly vulnerable during outdoor activities, as the caterpillar's urticating hairs can easily penetrate the epidermis and cause significant allergic reactions, including contact urticaria. Studies consistently highlight that the neck and face are the most frequently impacted regions, given the high sensitivity of the skin in these areas and their regular exposure (1,11,14,15). The frequent contact with the neck and face areas may be due to the caterpillar falling onto patients while they are walking in pine forests (Figure 2). Additionally, children are especially susceptible to these reactions, often experiencing papular dermatitis and vesiculopustular rashes on the wrists, forearms and mouth after contact with the caterpillar's hairs (1,14). Particularly in young children, handling the caterpillar with their hands and then putting it in their mouth could lead to an increased occurrence of angioedema-like reactions around the mouth and surrounding areas (Figure 3). Interestingly, while exposed areas are most commonly affected, covered regions can also be impacted due to airborne dispersal of the hairs, particularly in cases of high infestation or strong winds (4–6). These findings underscore the need for protective clothing and preventive measures, particularly during periods of high caterpillar activity, to reduce the risk of envenomation and subsequent allergic reactions.

Figure 2. Contact urticarial lesions that have developed on the neck of a patient following contact with the pine processionary caterpillar.

Figure 3. Angioedema and contact urticarial rash around the mouth in a child who had placed the caterpillar in his mouth.

The majority of envenomations occurred between May and June, coinciding with the larval stage of the pine processionary caterpillar. During this period, the larvae are highly allergenic due to their urticating hairs. Literature indicates that the larval stage is the most hazardous time for human contact, as the caterpillar's defense mechanism is most active. Some of the cases were observed in February and March, which might indicate occupational exposures. Additionally, the larval stages of the caterpillars could vary depending on regional temperature differences due to changing seasons (7,16). Public awareness campaigns and preventive measures should be intensified during these months to reduce the risk of envenomations.

Pine processionary caterpillar envenomations have been treated with various approaches in the literature. In our study, antihistamines were administered intramuscularly, orally, topically, and ocularly, while corticosteroids were given intravenously. Racemic epinephrine and nebulized epinephrine were also used effectively found in our study. For instance, Cuevas et al. utilized topical potassium dobesilate cream for dermatitis, achieving rapid symptom resolution without side effects (12). Similarly, Galip et al. emphasized the success of systemic steroids and antihistamines in severe cases involving bullous reactions (15). On the other hand, Vega et al. primarily used oral and intramuscular antihistamines alongside corticosteroids for treatment (11).

In our study anaphylaxis developed in 10 cases. According to patient records, in addition to the standard treatment protocols for anaphylaxis, racemic epinephrine was administered to patients with severe airway edema. All patients showed clinical improvement following the treatments. Racemic epinephrine provided a rapid effect in reducing airway edema when used alongside standard anaphylaxis treatment. Racemic epinephrine was administered to 16 patients (30.2%), playing a supportive role in managing angioedema associated with severe allergic reactions. It is crucial to clarify that systemic epinephrine remains the primary treatment for anaphylaxis. Racemic

epinephrine, due to its balanced adrenergic effects, is particularly effective in managing airway edema in emergency settings. This intervention, when used alongside standard anaphylaxis treatments, contributes to rapid bronchodilation and reduction of mucosal edema, thus preventing progression to more severe outcomes. The use of racemic epinephrine as an adjunct treatment highlights its value in the comprehensive management of severe allergic reactions, especially when immediate intervention is critical to prevent life-threatening outcomes.

Global warming has significantly influenced the geographic distribution of the pine processionary caterpillar. Rising temperatures have allowed this species to expand northward, from the Mediterranean region to the Marmara and Black Sea regions. This northward spread increases the likelihood of human encounters and subsequent envenomations in areas previously unaffected. Understanding these ecological shifts is vital for predicting and managing future risks associated with this species. Netherer et al. conducted a study using climate modeling and field observations to investigate how global warming influences the habitat of this species. The study found that the warming of winter temperatures has enabled the caterpillar to thrive in areas like the Marmara and Black Sea regions, where it had not been able to establish colonies before (13). Similarly, Kriticos et al. used ecological niche modeling to predict future distribution shifts, indicating that if global warming continues, the caterpillar's habitat could expand even further, underscoring the need for proactive management strategies to mitigate potential risks (3). Bonamonte et al. emphasized that this expansion is not just a regional issue but part of a broader pattern driven by climate change, highlighting the necessity for comprehensive monitoring and management strategies to anticipate and address future ecological shifts (14).

Limitations

This study is subject to several limitations, including its retrospective design and reliance on hospital records, which may not capture all cases of envenomation. Clinical presentations in some patients exposed to the Pine Processionary Caterpillar may have been interpreted as anaphylaxis and treated accordingly. However, due to the retrospective nature of our study and the reliance on existing medical records, a secondary validation of these diagnoses was not feasible. Additionally, the data was collected from a limited geographic area, which may not be representative of broader trends. Further research is needed to validate these findings and explore envenomations in other regions and contexts.

Conclusion

In conclusion, the pine processionary caterpillar poses a significant envenomation risk, particularly during its larval stage. Effective treatment protocols, including the use of racemic epinephrine for angioedema, are crucial for managing these cases. The northward expansion of this species due to global warming necessitates increased awareness and preventive measures in newly affected regions. Future studies should aim to expand the geographic scope and investigate long-term trends to better understand and mitigate the impact of this environmental and health concern.

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Ethical Approval: This retrospective study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Local Ethics Committee approved this study. The study received approval from the Scientific Research Ethics Committee of the Faculty of Medicine, University of Health Sciences Trabzon (approval number: 2024/120). Informed consent was obtained from all patients for the capturing and publication of their images. The patients were informed about the purpose of the study and the potential use of their images in academic publications.

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