Zekić, Ž.D., Ademović, E., Hadžiabulić, A., Temim, E., Aliman, J., Čolak, A. (2026). Comparison of distribution of pine processionary Thaumetopoea pityocampa (Denis & Schiffermüller, 1775) in the areas of Mostar, Livno and Tomislavgrad municipalities in Bosnia and Herzegovina. Agriculture and Forestry, 72 (1): 287-294. https://doi:10.17707/AgricultForest.72.1.17

DOI: 10.17707/AgricultForest.72.1.17

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COMPARISON OF DISTRIBUTION OF PINE PROCESSIONARY *THAUMETOPOEA PITYOCAMPA* (DENIS & SCHIFFERMÜLLER, 1775) IN THE AREAS OF MOSTAR, LIVNO AND TOMISLAVGRAD MUNICIPALITIES IN BOSNIA AND HERZEGOVINA

SUMMARY

The pine processionary, *Thaumetopoea pityocampa* (Denis and Schiffermüller, 1775), is described in the scientific literature as a major pest of forest ecosystems in the Mediterranean region (Androić, 1957). It was first recorded in Bosnia and Herzegovina during the 1960s and 1970s in the area of Trebinje and the Neretva River canyon (Konjic and Prozor). Its harmful impact is emphasized by its geographical expansion and high adaptability, influenced by both internal and external factors such as climate change and the expansion of areas under coniferous forests.

The aim of this study was to determine and compare the distribution of this pest at three locations-Mostar, Livno, and Tomislavgrad. Field investigations were conducted during 2023 and 2024 at ten microlocations, including five in Mostar, two in Livno, and three in Tomislavgrad. The study included pest identification, determination of the number of nests, and assessment of their position and exposure within the tree canopy. The highest number of nests was recorded in the upper third of the canopy, on southern exposures, and within the 30-50 cm diameter class. Statistical analysis revealed significant differences among canopy sections only at Location 3 (Privala, Tomislavgrad), while the remaining locations showed a more uniform nest distribution. Urbanized sites in Mostar had a minimal number of nests (five in total), and at the University Campus (Location 9) a decrease in nest numbers was observed compared to

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Notes: The authors declare that they have no conflicts of interest. Authorship Form signed online.
Recieved:18/09/2025 *Accepted:03/03/2026*

previous studies. Successful recovery of previously infested trees was recorded, manifested through the emergence of new green shoots and regeneration of damaged branches. The attack of the pine processionary is localized and currently does not threaten forest stands; however, it poses a health risk to visitors and domestic animals. Regular removal of nests remains a key management measure, while climate change and milder winters may increase the intensity of attacks, particularly on weakened and older trees.

Keywords: *Thaumetopoea pityocampa*, distribution, pine trees, defoliator pest-caterpillar, health risk

INTRODUCTION

The pine processionary, *Thaumetopoea pityocampa* (Denis and Schiffermüller, 1775) (order Lepidoptera), is one of the most destructive pests causing defoliation of pine forests in the Mediterranean region, while simultaneously representing a serious allergen hazardous to human and animal health. Its harmful impact is largely determined by its geographical expansion and population increase over recent decades (Čolak *et al.*, 2024). The biological characteristics of the pest-including phenotypic plasticity, high adaptability, preference for warmer and sunnier exposures, and considerable reproductive potential-are key drivers of its spread (Mirchev *et al.*, 2021). Favorable factors such as mild winters and the expansion of coniferous forests (particularly pine stands) significantly influence the distribution, abundance, and population dynamics of *T. pityocampa* (Mirchev *et al.*, 2000; Battisti *et al*., 2005, Hrašovec *et al*., 2011). From all the above mentioned reasons, larvae of the pine processionary are considered to be the main pest of pine trees in the entire Mediterranean region (Hodar *et al*., 2003).

The pine processionary is characteristic of the Mediterranean region with mild winters, and its northward expansion and spread to higher altitudes in recent decades have been closely associated with climate change. In Bosnia and Herzegovina, the pest was first recorded in the early 1960s in the Trebinje area and later, in the late 1970s, in the Neretva River canyon (Androić, 1978), while its occurrence in the northern part of the country was first documented in 2007 (Canton 10) (Mirchev *et al*., 2000). In the sub-Mediterranean zone of Bosnia and Herzegovina, the pine processionary represents a significant pest of black pine (*Pinus nigra*), and it has also been recorded on *P. sylvestris, P. halepensis, P. mugo,* and *P. heldreichii* (Dautbašić *et al.*, 2018).

The aim of this study was to determine and compare the distribution of the pest at three locations-Mostar (Canton 7), Livno, and Tomislavgrad (Canton 10)-in order to assess the level of infestation in two climatically distinct areas within a limited range of pine forests. Particular emphasis was placed on identifying the canopy sections where infestation was most pronounced, considering both attack intensity and the risk posed by the pest to humans and animals. Contact with pine processionary larvae may cause severe allergic reactions affecting the skin and mucous membranes of humans and animals (Kaszak *et al*., 2015).

MATERIAL AND METHODS

The aim of this study was to determine and compare the distribution of the pine processionary at three different locations-the municipalities of Mostar, Livno, and Tomislavgrad in Bosnia and Herzegovina-which are situated within two distinct climatic zones. Field research was conducted during 2023 and 2024. A total of ten microlocations were selected: five in Mostar, two in Livno, and three in Tomislavgrad. Microlocations were chosen based on the presence of pine forests, their representativeness of the forest ecosystems of the respective municipalities, terrain accessibility, and differences in altitude. Transects with a width of 10 m (5 m to the left and 5 m to the right of the transect centerline) were established at the selected microlocations. The total number of trees assessed per transect varied depending on stand density at each microlocation. For each tree, the number of nests, the position of nests within the canopy (upper, middle, and lower third), and tree exposure (north, south, east, west) were recorded. The "degree of infestation" was determined through a visual assessment based on the number of nests per tree and the intensity of defoliation, with each canopy third evaluated separately. All pine species present at the microlocations were treated equally in the study, including *Pinus nigra*, *P. sylvestris*, *P. halepensis*, *P. mugo*, and *P. heldreichii*.

Overall, data were collected on pest identification, the number of nests, and their position and exposure. For statistical analysis, the chi-square test was applied to determine differences in nest numbers among canopy sections and diameter classes of trees.

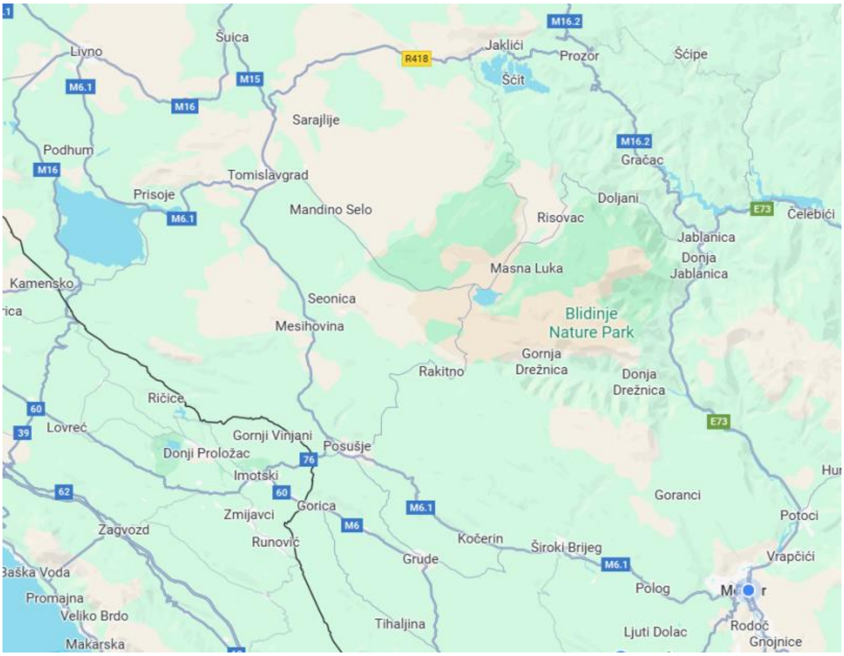

Fig 1. Area of the investigated locations (Google maps)

Microlocations were selected at different altitudes as follows:
Livno
Location 1 43.72669719037238, 17.022689132245436 altitude of 880 m
Location 2 43.725534207884365, 17.022517470868483 altitude of 870 m
Tomislavgrad
Location 3 43.70344876282711, 17.127548736534667 altitude 950 m
Location 4 43.70261109279604, 17.12274221797998 altitude 970 m
Location 5 43.700470327318165, 17.11694864650781 altitude 980 m
Mostar
Location 6 43.45865094194867, 17.956777826766483 altitude 980 m
Location 7 43.356114728635234, 17.809698350611146 altitude 65 m
Location 8 43.340972778007824, 17.794024054164765 altitude 74 m
Location 9 43.300990094022644, 17.843153539724884 altitude 120 m
Location 10 43.34966770010976, 17.830673755524916 altitude 435 m

RESULTS AND DISCUSSION

The Table 1. is presenting overview of all the locations and number of pine processionary nests spotted on pine trees in the locations and altitidu of the sites.

Table 1. Number of nests per location and altitude

Microlocation	Number of nests	Altitude
Location 1 – Livno Batinića brdo area	39	880m
Location 2 - Livno Batinića brdo area	60	870m
Location 3 – Tomislavgrad Privala area	101	950m
Location 4 - Tomislavgrad Privala area	34	970m
Location 5 - Tomislavgrad Privala area	42	980m
Location 6 – Mostar Rujište (Humi)	20	980m
Location 7 - Mostar Trimuša	5	65m
Location 8 – Mostar Carski vinogradi	5	74m
Location 9 – MostarUniversity campus	29	120m
Location 10 – Mostar Fortica	45	435m
TOTAL:	**381**	-

Location 3, situated above the reservoir (Buško Lake), recorded the highest number of nests (101 nests) compared to the other two locations in the same region. This can be explained by highly favorable microclimatic conditions, including a combination of sunny exposure, warm air currents originating from the water surface, and protection from strong winds, all of which promote the development of larvae and the pest on edge and individual trees. At this location, damage to older branches resulting from previous pine processionary attacks was also observed, along with clear signs of recovery of affected pine branches, manifested by the emergence of new green needles. The lowest number of nests was recorded in the Mostar area (Locations 7 and 8-University Campus and Carski Vinogradi), which are urban environments with individual trees at lower altitudes.

In a regional comparison, Livno and Tomislavgrad (characterized by higher altitudes, cooler conditions, and less sunny exposures) exhibited a lower number of nests per tree than Mostar, indicating that microclimatic factors-such as temperature, solar radiation, and air humidity-play a significant role in determining attack intensity. At higher-altitude locations, nests were predominantly concentrated in the upper third of the canopy, whereas at lower elevations the infestation was more dispersed, which may be attributed to differences in solar exposure and temperature fluctuations.

Table 2. Analyses of statistical significance of number of nests in the upper, middle and bottom part of the tree by diameter class

	Tree diameter (cm)					**Total**
	0-10	**10-20**	**20-30**	**30-50**	***>50***	
	Number of nests					
Upper third of the canopy	**8**	**22**	**49**	**75**	**21**	**175**
Middle third of the canopy	**1**	6	32	45	28	**112**
Botom third of the canopy	**1**	17	38	18	20	**94**
Total	10	45	119	138	69	**381**
	Tree diameter (cm)					**Total**
	0-10	**10-20**	**20-30**	**30-50**	***>50***	
	Number of nests					
Upper third of the canopy	4.60	20.66	54.7	63.4	31.7	**175**
Middle third of the canopy	2.94	13.22	35.0	40.6	20.3	**112**
Botom third of the canopy	2.47	11.10	29.4	34.0	17.0	**94**
Total	**10**	**45**	**119.0**	**138.0**	**69.0**	**381**
DATA				***RESULTS***		
Level of significance		0.05		*Critical value*		15.51
Degree of freedom		8		*Chi square*		**32.47**

It can be seen in the Table 2., in the upper third of the tree, the largest number of nests was in the thickness class 30-50 cm (75 nests), followed by the thickness class 20-30 cm (49 nests). Regarding the middle third of the tree canopy, the largest number of nests was found in the thickness class 30-50 cm (45 nests), followed by the thickness class 20-30 cm (32 nests), similar results were reported by Dautbasic *et al.* 2018. In the lower third of the tree canopy, the largest number of nests was in the thickness class 20-30 cm (38 nests), followed by the thickness class over 50 cm (20 nests). Observing the number of nests by tree parts, the largest number of nests was located in the upper third of the tree (175 nests or 45%), followed by the middle third (112 nests or 30%), while the lowest number of nests was located in the lower third (94 nests or 25%).

Statistical analysis (Chi-square test) has shown that there are statistically significant differences between the number of pine conifer nests in the upper, middle and bottom parts of the tree by thickness classes.

Table 3. Analyses of statistical significance of number of nests in the upper, middle and bottom part of the tree by diameter classe Location 3

	Tree diameter (cm)					***Total***
	0-10	**10-20**	**20-30**	**30-50**	**>50**	
	Number of nests					
Upper third of the canopy	0	0.39	5.50	16.89	10.21	**33**
Middle third of the canopy	0	0.46	6.50	19.96	12.07	**39**
Botom third of the canopy	0	5.32	4.35	5.32	14.02	**29**
Total	**0**	**6**	**16**	**43**	36	**101**
DATA				***RESULTS***		
Level of significance	0.05			*Critical value*	*15.51*	
Degree of freedom	8			*Chi-square*	***19.37***	

Statistical analysis for all the locations showed no statistically significant differences for all examined locations, except the Location 3, where there was statistically significant differences between the number of nests in the upper, middle and bottom parts of the tree by thickness classes (Table 3). Statistical analyses for Mostar locations 7 and 8, at Trimusa and Carski vinogradi were not performed due to the lack of valuable data, since only 5 nests were spotted in total. Location 9 – University campus, which was previously subject of research by Čolak *et al*. 2024 showed a decrease in a number of spotted nests, from 42 to 29.

Table 4. Number of nests of the pine processionary by tree part and exposure

	Diameter class (cm)				***Total***
	north	**east**	**west**	**south**	
	Number of nests				
Upper third of the canopy	0	0	31	154	**185**
Middle third of the canopy	0	14	23	82	**119**
Botom third of the canopy	0	3	9	65	**77**
Total	0	17	63	301	**381**

Microclimatic factors significantly influence the distribution of nests. At higher altitudes (Livno and Tomislavgrad), nests were predominantly concentrated in the upper third of the canopy, whereas at lower altitudes (Mostar) nests were more dispersed (Table 4). Sunny exposure, temperature, air humidity, and the local influence of water bodies or urban surfaces act as key drivers of attack intensity. Comparison with similar studies conducted in the Mediterranean region shows that the observed patterns of nest distribution are consistent with the findings of Dautbašić *et al*. (2018) and Battisti *et al.* (2006), who reported a dominant concentration of nests in the upper third of the canopy and a preference for warmer exposures. Localized but numerous infestations in urban and peripheral areas represent an increased risk of contact between humans, domestic animals, and larvae, while in high-altitude forests the intensity of infestation may affect the future structure of forest stands. These findings enable more targeted control measures and timely nest removal, taking into account microclimatic conditions and regional differences, thereby contributing to risk reduction and improved forest management planning.

In Canton 10, the pine processionary currently does not pose a serious threat to forest stands; infestations are localized and do not occur within the interior of the canopy. Compared with lower-altitude and more urbanized areas (Mostar, Canton 7), the number of nests per tree is lower and infestations are more dispersed, further indicating the influence of microclimatic factors. Nevertheless, regular monitoring and control of this pest are necessary, as climate change is becoming increasingly pronounced, creating more favorable conditions for its spread.

The current intensity of infestation has not caused significant damage, as needle-feeding caterpillars-typically forming one to two nests per tree-do not yet interfere with normal tree development. At sites where nests were present in the past, the emergence of young green needles indicates regeneration of previously damaged canopy sections.

CONCLUSIONS

The highest number of pine processionary nests was recorded on warmer exposures, particularly southern aspects, in the upper part of tree canopies and within the 30–50 cm diameter class.

Successful recovery of previously infested trees was also observed, indicating that the current intensity of infestation is not at a critical level. Given the overall vitality of the trees, the pine processionary represents a greater risk to nature visitors and domestic animals within the study area. It is necessary to continue the timely removal of nests, as this method is environmentally friendly; the removal and destruction of nests contribute to environmental protection and enable safe use of natural areas.

Based on evaluation, identification, and analysis of the numerical status of the pine processionary population, it is evident that infestation intensity has increased in peripheral zones of pine forests and on individual trees, particularly on southern aspects, which receive greater solar radiation and thus favor pest development. Mild winter conditions have further contributed to increased attack intensity, although they have not resulted in a significant expansion of the pest’s range.

Ongoing climate change further facilitates the spread of the pine processionary and causes negative impacts on pine forest ecosystems. Consequently, an increase in infestation intensity is expected in the future, particularly on weakened and older trees with reduced physiological activity and, therefore, lower resistance.

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