

# Variation of *Thaumetopoea processionea* (Notodontidae: Thaumetopoeinae) in Europe and the Middle East

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## KEY WORDS

Appearance, distribution, taxonomy

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In 1998 *Thaumetopoea processionea* (Linnaeus, 1758) was reported as new for Lebanon by Demolin and Nemer (1998). The authors noticed that this could be a separate species. Halperin and Sauter (1999) provisionally identified specimens from Israel as the subspecies *T. processionea pseudosolitaria* Daniel, 1951. In the current article the variation of *T. processionea* is described. Specimens from all over Europe and the Middle East were examined and genitalia dissected. After studying all material, *T. processionea* appears to be only one species with a large variation in external and genital characters. In the Middle East the forewings of *T. processionea* are, in general, brighter coloured than those from specimens in Western Europe. The hind wings are clear white in the Middle East and creamy, with an ashgrey transfer fascia, in Western Europe. In the male genitalia the species shows a large variation in the shape of the valvae. This variation is even found among specimens from the same breed. The female genitalia are rather constant in shape. It is concluded that all populations from Europe and the Middle East belong to *T. processionea*.

## Introduction

*Thaumetopoea processionea* (Linnaeus, 1758) is a well known pest species on oak throughout Europe, but used to be rare in Western Europe. In 1970 the species was rediscovered in Belgium, after being absent for 65 years. This population developed into a plague and spread to The Netherlands and Germany. In the last decades of the 20<sup>th</sup> century the species has become a very common moth in large parts of Western Europe. At the end of the 20<sup>th</sup> century a population of *T. processionea* was discovered in Israel and Lebanon. In 2001 and 2002 specimens were collected in Jordan. It appears that *T. processionea* is not only spreading in Northwest Europe but also in the Middle East.

Because the caterpillars entered the soil for pupation and the adults resembled *T. solitaria* (Freyer, 1838), Halperin & Sauter (1999) provisionally identified the Israelian specimens as the subspecies *T. processionea pseudosolitaria* Daniel, 1951. Based on a superficial study of the genitalia and differences with European specimens in external characters of caterpillars and adults, Demolin & Nemer (1998) noted that Lebanese specimens of *T. processionea* could be a new form, or even a new closely related species. In Southeast Europe the subspecies *T. processionea pseudosolitaria* is known to occur and Agenjo (1941) noticed that the form *luctifica* Staudinger, 1901 is the most common form in Spain. After examining a few specimens, the genitalia of the Northwest European specimens displayed small but constant differences relative to the material from Spain and Southeastern Europe.

The sudden return of the species to Belgium and The Netherlands, the differences between populations and the

suggestion by Demolin & Nemer (1998) that the Lebanese specimens could be a separate species, stimulated the current study of the taxonomy of *T. processionea*. For this article the external characters and genitalia of the various populations from the Middle East to Northwest Europe were examined and compared to find out whether *T. processionea* consists of more than one species. A second article about the historical distribution will be published elsewhere.

## Abbreviations

EIAZ, Experimental Institute of Agricultural Zoology, Firenze, Italy; GNL, collection F. Groenen, Luyksgestel, The Netherlands; KBIN, Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussels, Belgium; MNCN, Museo Nacional de Ciencias Naturales, Madrid, Spain; MWM, Museum Witt München, Germany; MZLU, Moravski Museum, Brno, Czech Republic; NMNH, National Museum of Natural History, Sofia, Bulgaria; RMNH, Nationaal Natuurhistorisch Museum, Leiden, The Netherlands; SMNK, Staatliches Museum für Naturkunde Karlsruhe Karlsruhe, Germany; ZMAN, Zoological Museum of Amsterdam, The Netherlands

## Material and methods

Recent and historic specimens and data were collected from most European countries and the Middle East. The data consist of more than 2000 records from Spain, Italy, Sicily, France,

Switzerland, Austria, Czech Republic, Slovenia, Montenegro, Macedonia, Poland, Germany, Belgium, The Netherlands, Denmark, Sweden, Bulgaria, Hungary, Turkey, Israel, Jordan and Lebanon. Genitalia of males and females of *T. processionea* from many European countries were dissected and compared. A list of the studied material will be sent on request.

Material was examined from the following collections: EIAZ, KBIN, MNCN (Collection Agenjo), MWM, MZLU, NMNH, RMNH, SMNK (only data), ZMAN, G. Demolin (Malaucène, France), L.J. van Deventer (Drunen, The Netherlands), GNL, S. Gomboc (Ljubljana, Slovenia), G. De Prins (Antwerp, Belgium), J.B. Wolschrijn (Twello, The Netherlands) and C.J. Zwakhals (Arkel, The Netherlands).

## Taxonomy

*Thaumetopoea* Hübner, 1820 - *Verz. Bekannt. Schmett.*: 185. Type species: *Phalaena processionea* (Linnaeus, 1758)  
*Cnethocampa* Stephens, 1828 - *Illust. Br. Ent. Haustellata II*: 46  
*Thaumetocampa* Staudinger, 1894 - *Staudinger, 1894*: 269-271  
*Thaumetopoea* Agassiz, 1847 - *Nomencl. zool. Index. univ.*: 367

*Thaumetopoea processionea* (Linnaeus, 1758)  
*Phalaena processionea* Linnaeus, 1758 - *Systema Naturae* (editio 10) 1: 500  
subspecies *pseudosolitaria* Daniel, 1951 - *Veröff. Zool. Staatssamml. (Münch.)* 2: 278  
subspecies *pseudosolitaria* de Freina, 1999 - *Atalanta* 30 (1/4): 221  
forma *luctifica* Staudinger & Rebel, 1901 - *Catalog der Lepidopteren des Palaearktischen Faunengebietes, vol. I*: 113 (*luctifica* Staudinger, 1901: in Agenjo, 1941 misspelling)  
forma *seifersi* Closs, 1917 - *Int. Ent. Zeitschr.*, vol. X: 147

## Variation in *Thaumetopoea processionea*

In Europe the subfamily of Thaumetopoeinae (Notodontidae) consists of three genera: *Thaumetopoea* Hübner, 1820, *Traumatocampa* Wallengren, 1871 and *Helianthocampa* De Freina & Witt, 1985. The genus *Thaumetopoea* can easily be separated from other genera by the different form of the canthus. The canthus is a convex or jagged structure on the forehead. This structure is used by the moths to emerge from the nest. In the genus *Thaumetopoea* the canthus is convex, in the other two genera the canthus is conical and jagged. From the genus *Thaumetopoea* two species are known: *processionea* (Linnaeus, 1758) and *solitaria* (Freyer, 1838).

Externally, specimens from *T. processionea* from the Middle East are very similar to *T. solitaria* and difficult to separate. *Thaumetopoea solitaria* has clear white hind wings, lacks the grey-black fascia, with a small grey-black dot at the anal angle. The forewing is generally more brightly coloured than in *T. processionea*. In *T. processionea* the fascia of the forewing are converging dorsally, in *T. solitaria* they are more or less parallel. For positive identification dissection of the male genitalia is necessary.

*Thaumetopoea processionea* was described by Linnaeus (1758). The type locality is unknown. More recent descriptions of the nominate forms (figures 1-2, 11) are given by Stephens (1828) and De Freina & Witt (1987).

Staudinger (1901) described *T. processionea* f. *luctifica* (figures 3, 12) from Germany and Southern Hungary as much darker and usually smaller with blackish grey forewings and dirty grey hind wings (especially in the male) ('multo obscura (plerumque minor) al. ant. nigrescente griseus, al. post. (etiam in ♂) sordide griseis').

In *T. processionea* f. *seifersi*, described by Closs (1917) (figure 5)

from Zossen, Brandenburg, Germany, the males have similar colours as the females of the nominate form.

Daniel *et al.* (1951) described the subspecies *T. processionea* ssp. *pseudosolitaria* from Macedonia (figures 6-9, 13, 15), with the forewings very bright and more expressed maculation. The hind wings of the males are clear white, dark bordered, fascia weakly perceptible and cilia weakly checkered. The fascia at the hind wings of the subspecies ranges from a few scales to an indistinct scattered band.

Demolin and Nemer (1998) described differences between the external characters of the caterpillars found in Lebanon and Europe, and the pupation in the soil rather than on the tree. After a rapid analysis of the genitalia they concluded that the specimens collected in Lebanon could be a new variation or even a new species.

Halperin & Sauter (1999) published records of *T. processionea* ssp. *pseudosolitaria* from Mont Hermon (figure 9). Because the nearest population was found at a distance of 1000 km in Anatolia, Turkey, the differences in biology and the external similarity to *T. solitaria* Freyer, 1838, the moths were provisionally regarded as belonging to ssp. *pseudosolitaria*.

In the collection Witt (MWM) several specimens from Jordan (figure 8) were found, collected in 2001 by Müller. Externally these specimens are similar to the Israelian specimens. Here the species is recorded as new to Jordan.

In Southeastern Europe the ssp. *pseudosolitaria* is known from Macedonia, Greece, Turkey and locally from Bulgaria (Kresna Gorge, Haskovo, Assenovgrad and Plovdiv). In the material examined it is sometimes difficult to spot differences between ssp. *pseudosolitaria* and other forms (figure 6-7). Generally, specimens from Southeast Europe and the Middle East are lighter and brighter coloured than specimens from Western Europe.

In Spanish males (figure 3) the hind wing-fascia is moderately broader than in the Northwest- and Central European specimens (figure 1-2). According to Agenjo (1941), both the nominate form and f. *luctifica* Staudinger, 1901 occur in Spain, with *luctifica* as the most common form. Among the examined specimens from Spain no differences were found in external and genital characters and they were identified as f. *luctifica*. Adults bred from nests, collected in The Netherlands and Italy, are externally very close or similar to f. *luctifica*. In the MWM collection, a male of the form *seifersi* Closs, 1917 collected in the Czech Republic (figure 5) and a specimen with equally ash-grey hind wings were found (figure 4).

According to De Freina & Witt (1987) the distribution area of *T. processionea* ssp. *pseudosolitaria* is Macedonia, Greece and Turkey. Also in Italy specimens with clear white hind wings occur (figures 7, 15). These specimens differ from ssp. *pseudosolitaria* in the lesser brightness of the fore wings.

*Thaumetopoea processionea* shows, even in the same population, a large variation in size and colouring. The range of the fore wing length in males is 24-30 mm, in females 27-38 mm. The colouring of the fore wings varies from yellow-brownish, with bright fascia, until almost unicoloured ashgrey, in the hind wings from unicoloured white, with or without a dark fascia, to unicoloured dull ashgrey. Different coloured specimens can be found in the same population.

In the male genitalia *T. processionea* can be distinguished from *T. solitaria* by the shape of the valvae and aedeagus. In *T. solitaria* the cucullus has a clear pointed process and the aedeagus is basally semi circular (Agenjo 1941, De Freina & Witt 1987). The cucullus of *T. processionea* lacks this pointed process and the aedeagus is amphora shaped.

In the genitalia of *T. processionea* variable characters can be found. Male genitalia (figures 16-31) have the uncus rounded, its top with two thorns. The socii are kidney shaped, connected



1-15. *Thaumetopoea processionea*. Males: **1** The Netherlands, nominate form. **2** Italy, idem. **3** Spain, f. *luctifica*. **4** Czech Republic. **5** Czech Republic, f. *seifersi*. **6** Macedonia, ssp. *pseudosolitaria*. **7** Italy, idem. **8** Jordan, idem. **9** Israel, idem. **10** Lebanon, ssp. *pseudosolitaria*. Females: **11** Belgium, nominate form. **12** Spain, f. *luctifica*. **13** Macedonia, ssp. *pseudosolitaria*. **15** Italy. Female genitalia: **14a,b,c** slide FG1327, 9th sternite, **a** dorsal part: ostium bursae, **b** papillae analis, **c** ventral part. Photos: F. Groenen (1-13 & 15) and C. Gielis (14)

1-15. *Thaumetopoea processionea*. Mannetjes: **1** Nederland, nominaat vorm. **2** Italië, idem. **3** Spanje, f. *luctifica*. **4** Tsjechië. **5** Tsjechië, f. *seifersi*. **6** Macedonië, ssp. *pseudosolitaria*. **7** Italië, idem. **8** Jordanië, idem. **9** Israël, idem. **10** Libanon, ssp. *pseudosolitaria*. Vrouwelijke genitaliën: **14a,b,c** preparaat FG1327, 9de sterniet, **(a)** dorsaal gedeelte: ostium bursae, **(b)** papillae analis en **(c)** ventraal gedeelte.



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**16-31.** *Thaumetopoea processionea*, male genitalia: **16-18** Spain, slides FG1112, FG1101, FG1225. **19-21** The Netherlands, slides FG1362, FG1430, FG1259. **22-23** Italy, slides FG1229, RV1172.

**24** Sicily, slide RV1170. **25-26** Bulgaria, slides FG1429, FG1427. **27-28** France, slides FG1318, RV1174. **29** Jordan, slide FG/TW11748. **30** Israel, slide FG/TW11752. **31** Lebanon, slide FG1800. Photos: F. Groenen (16-18, 21, 22) and C. Gielis (19, 20, 23-31)

**16-31.** *Thaumetopoea processionea*, mannelijke genitaliën: **16-18** Spanje, preparaten FG1112, FG1101, FG1225. **19-21** Nederland, preparaten FG1362, FG1430, FG1259. **22-23** Italië, preparaten FG1229, RV1172. **24** Sicilië, preparaat RV1170. **25-26** Bulgarije, preparaten FG1429, FG1427. **27-28** Frankrijk, preparaten FG1318, RV1174. **29** Jordanië, preparaat FG/TW11748. **30** Israël, preparaat FG/TW11752. **31** Libanon, preparaat FG1800.

to the uncus with a triangle process. The valva triangle with costa s-shaped, straight or convex, cucullus triangle-shaped, sometimes costa and dorsum of valva parallel. Depending on the form of the costa, the valva looks more slender (costa s-shaped) or broader (costa convex). De Freina & Witt (1987) picture the broader form, with the convex costa of the valva, of the male genitalia (figure 22). In Spanish and Dutch specimens the costa of the valva is often s-shaped (figures 16, 19). From Sicily one specimen was found with a specific square valva (figure 24). Sometimes the valva are disformed. The aedeagus is amphora-shaped.

In the male genitalia the specimens from Jordan (figure 29) are very similar to those from The Netherlands, Italy and Bulgaria (figures 21, 23, 25), with a straight costa and a tapering cucullus. The male genitalia of the Israelian and Lebanese specimens (figure 30, 31) are similar to those from The Netherlands, Italy, Bulgaria and France (figures 20, 22, 26, 27).

Female genitalia (figures 14a,b,c): 9<sup>th</sup> sternite, dorsal two triangle lobes connected through a rectangular band (a), ventral a semi circular band, on both sides with a hook (c). Robust and more slender forms of the triangle lobes exist in specimens from one breed.

## Conclusions

From the Middle East to Northwest Europe *T. processionea* changes, in general, in colouration of the hind wings from clear white, without a dark fascia, to more or less creamy with a broad ash-grey fascia. The fore wings vary from brownish, with bright fascia, to yellowish and unicoloured ash-grey. Sometimes in one population this variation is shown. After dissecting a high number of genitalia of specimens from many sources, in all populations a large variation was found, especially in the shape of the valva in the male genitalia. The costa of the valva is variably convex, straight or s-shaped. The dorsum basally often straight, sometimes parallel with the costa, between 1/3 and 2/3 bent and converging to the costa. In all populations, specimens with disformed small valvae occur. The cause of this disformed valvae is unknown. Variability of the female genitalia is less

expressed. Only in the form of the triangle lobes of the 9<sup>th</sup> sternite small differences in size were found.

*Thaumetopoea processionea*'s high variability in external characters and male genitalia is found all over Europe and the Middle East. An exception is the clear white hind wings of ssp. *pseudosolitaria* that occurs in the Middle East and, often mixed with darker specimens, in Southern Europe. The variation of the specimens collected by Demolin and Nemer in Lebanon and Halperin and Sauter in Israel, falls within the variability found in European populations of *T. processionea*. It is therefore concluded that all populations of *T. processionea* belong to a single species.

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## Samenvatting

### Variatie van *Thaumetopoea processionea* (Notodontidae: Thaumetopoeinae) in Europa en het Midden-Oosten

In 1998 is *Thaumetopoea processionea* Linneaus, 1758 als nieuw gemeld voor Libanon door Demolin en Nemer (1998). Zij merken op dat, na onderzoek van adulten en de eerste analyse van de genitaliën, het mogelijk een nieuwe soort betreft. In dit artikel wordt de morfologische variatie van *T. processionea* beschreven. Hiervoor is materiaal uit nagenoeg geheel Europa en het Midden-Oosten onderzocht op externe en genitaalkenmerken. Uit onderzoek blijkt dat al het materiaal slechts één soort betrof, maar dat *T. processionea* een zeer variabele soort is in externe en mannelijke genitaalkenmerken. In het Midden-Oosten en Zuid-Europa zijn de voorvleugels over het algemeen scherper getekend en de achtervleugels helder wit. In Noordwest-Europa zijn de voorvleugels minder helder van tekening en de achtervleugels hebben een zwarte dwarsband en variëren van vaalwit, met een donkere dwarsband, tot egaal grijsbruin zonder dwarsband. In de mannelijke genitaliën is de vorm van de valva zeer variabel. Deze variabiliteit kan, zelfs binnen exemplaren gekweekt uit een nest, over het gehele verspreidingsgebied gevonden worden. Over de oorzaak van deze variatie is niets bekend. In de vrouwelijke genitaliën is slechts een geringe variatie gevonden.



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