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Egg parasitoids of the pine processionary moth and their occurrence in Venosta/Vinschgau

Daniel Zovi[1], Andrea Battisti[1], Klaus Hellrigl[2], Stefano Minerbi[3]

[1] Department of Environmental Agronomy – Entomology, University of Padova, Legnaro, Italy
[2] Wolkensteinstraße 83, Bressanone/Brixen, Italy. [3] Forest Service of Bolzano/Bozen Province, Italy

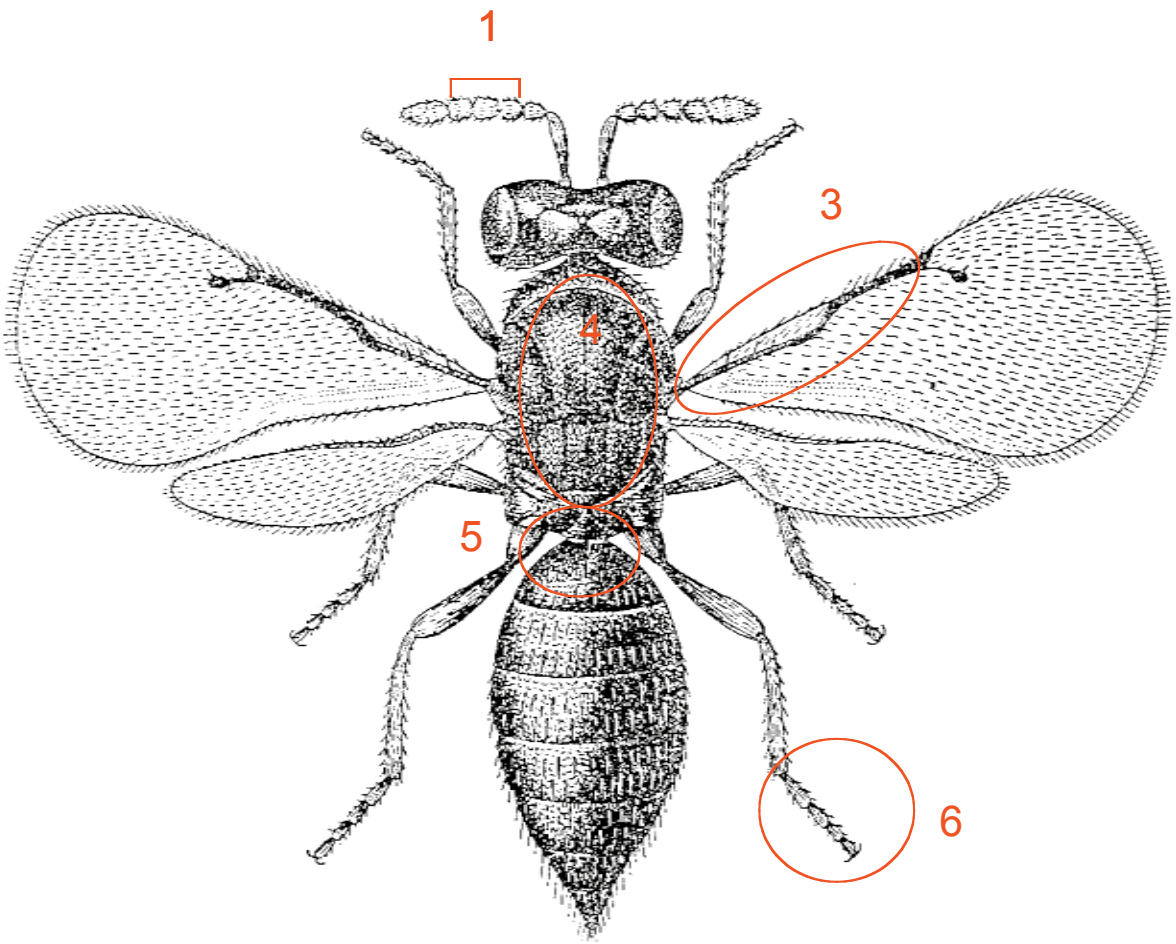
Abstract

The egg parasitoids of the pine processionary moth *Thaumetopoea pityocampa* are briefly presented, together with a simplified guide to their morphological identification. Three major, two minor, and three rare species are listed. A few of them occur in the outbreak area of the moth in Venosta/Vinschgau, South Tyrol, Italy, that represents a recent expansion territory for the moth. At the beginning of the outbreak (1999) the parasitoids were not abundant and were manly represented by the generalist species. A sudden increase of egg mortality due to the major specialist *Baryscapus servadeii* was observed in 2003 and contributed substantially to the natural limitation of the moth populations in the following years. A further increase of parasitism is predicted as long as the host density will remain high, as other potential competitors for the eggs are absent or at very low density.

Introduction

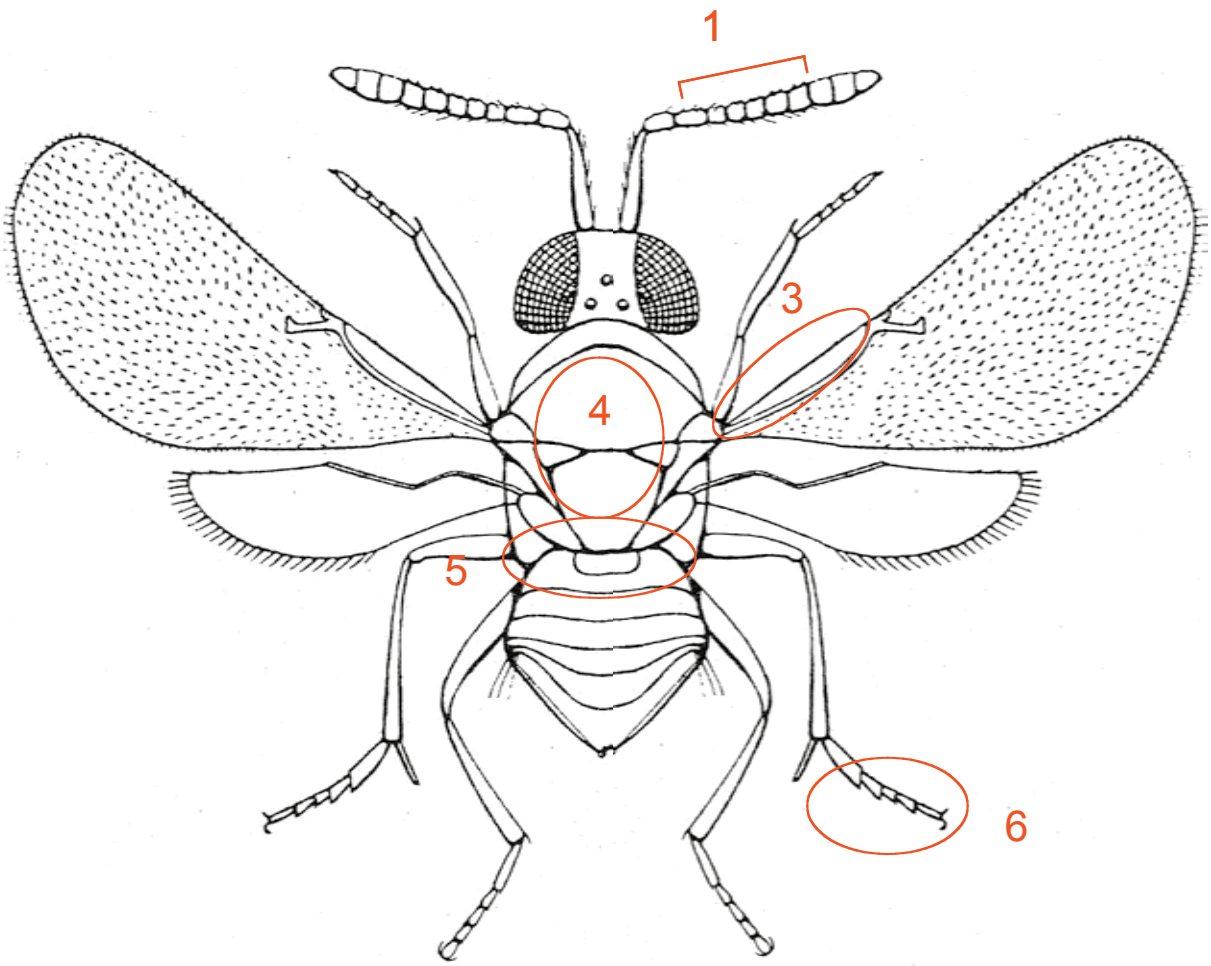
The pine processionary moth *Thaumetopoea pityocampa* (Denis & Schiffermüller) (Lepidoptera Notodontidae) has numerous natural enemies, with key species among parasitoids of eggs, larvae, and pupae, but competition may limit the overall mortality (Masutti & Battisti 1990, Battisti *et al.* 2000). In some cases diseases caused by viruses and fungi may induce great mortality, especially when the population density is high and the climate is not favourable to the larval development. Very few species of natural enemies have been found in expansion areas, where mortality levels are generally low (Aimi *et al*., this volume). For example, the specialist larval parasitoid *Phryxe caudata* Rondani (Diptera Tachinidae) is known for South Tyrol from only one individual collected more than 100 years ago at Ponte Gardena/Waidbruck, in spite of a discrete abundance of host (Hellrigl 2004). Also generalist larval parasitoids, such as *Compsilura concinnata* (Meigen) are known from the area (Hellrigl 2004), but do not cause any significant mortality in the population of Venosta/Vinschgau.

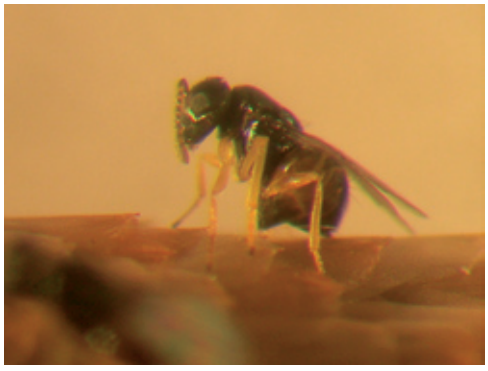
Three major species of egg parasitoids (Hymenoptera) attack the egg batches of the pine processionary moths: *Baryscapus servadeii* Graham (Eulophidae), *Ooencyrtus pityocampae* Mercet (Encyrtidae), and *Trichogramma* sp. (Trichogrammatidae). Two minor species and three rare species are also known. All these species spend the winter in diapause inside the eggs of *T. pityocampa*. Many of them have mainly parthenogenetic reproduction, with occasional presence of males, that are generally smaller than females. The suggested guide aims at assisting the non-taxonomy persons in morphological identification of adults. Six morphological characteristics are suggested to distinguish the three major parasitoid species: (1) the antennae, (2) the shape of the head, (3) the forewings, (4) the thorax, (5) the fore segments of the gaster, and (6) the tarsus. The information is taken from several sources (Mercet 1921, Biliotti 1958, Masutti 1964, Tiberi 1978 and 1980, Schmidt 1988, LaSalle & Graham 1990, Graham 1991, Tsankov *et al.* 1996).



Baryscapus servadeii (Domenichini) (Eulophidae) (Fig. 1)

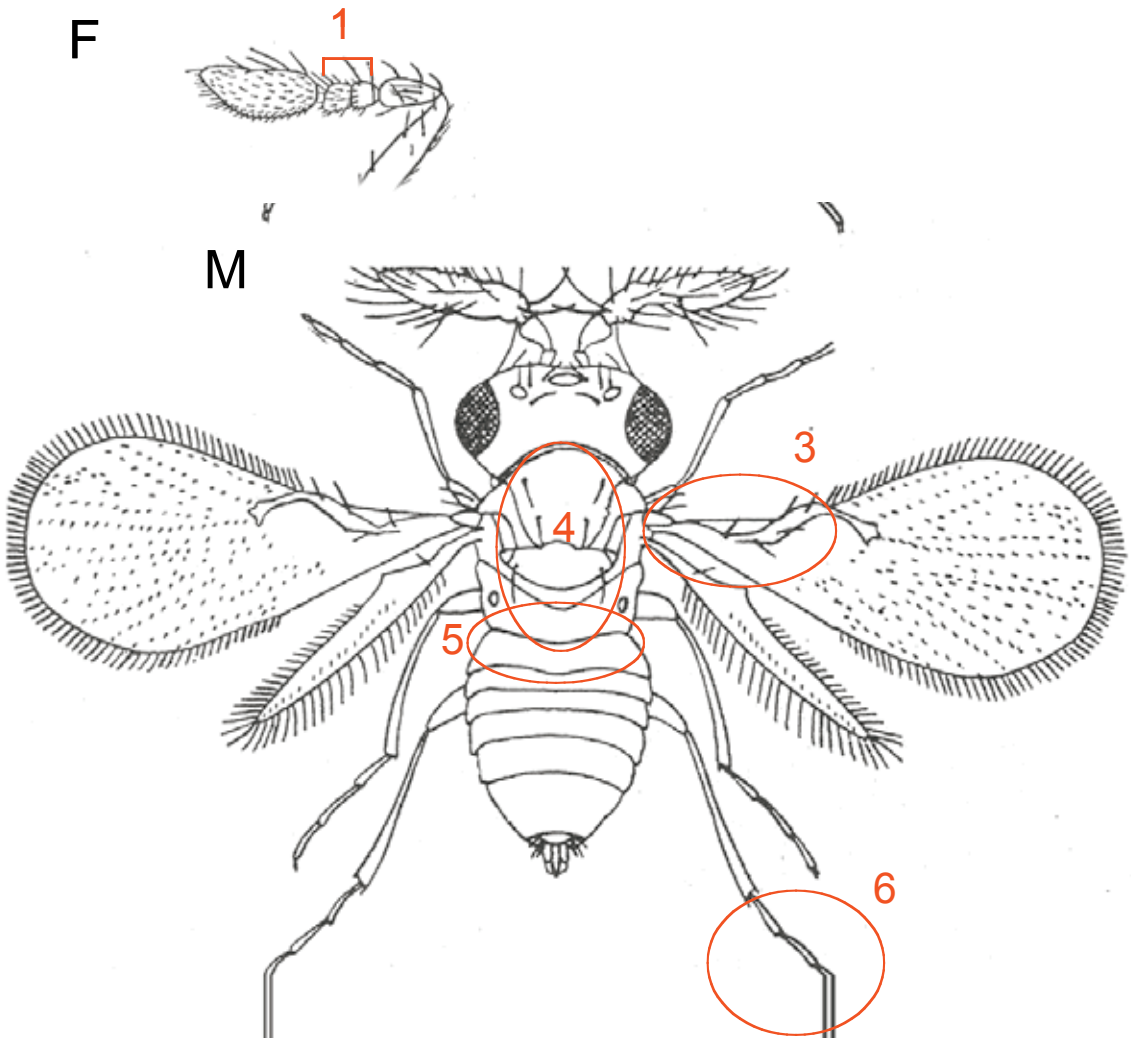
Body length: 1.7-2.1 mm.
Colour: dark, metallic.
Male: rare.
Host: eggs of *Thaumetopoea* sp. feeding on conifers.
Biology: solitary parasitoid with one or two generations per year in the eggs of the processionary moth. Its occurrence may vary from very low levels to a parasitism as high as 70% of the eggs. It may behave as a hyperparasitoid of other egg parasitoids, in particular of *O. pityocampae*.





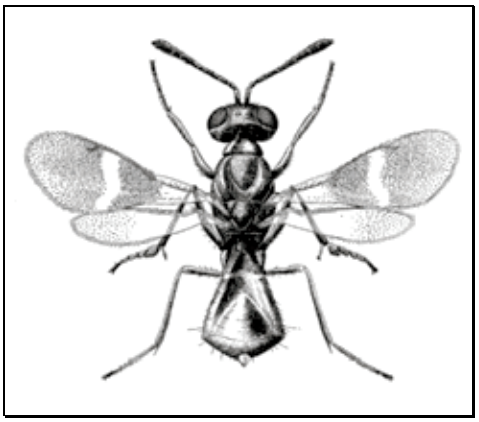
Ooencyrtus pityocampae (Mercet) (Encyrtidae) (Fig. 2)

Body length: 1.1 - 1.5 mm.
Colour: dark.
Male: rare.
Host: eggs of Lepidoptera and Hemiptera.
Biology: solitary parasitoid with two or more generations in the eggs of various hosts, such as Lepidoptera and Heteroptera (Battisti *et al.* 1988). It may cause important mortality in pine processionary moth populations. It may behave as a hyperparasitoid of other egg parasitoids, in particular of *B. servadeii.*



Trichogramma sp. (Trichogrammatidae) (Fig. 3)

Body length: 0.3 - 0.4 mm.
Colour: yellow.
Male: common.
Host: eggs of insects.
Biology: gregarious species, several adults emerge from an egg of *T. pityocampa*. Common species all over the host's range, however at low density.



Anastatus bifasciatus (Fonscolombe) (Eupelmidae) (Fig. 4)

Body length: 1.8 - 3 mm.
Colour: dark.
Male: common.
Host: eggs of Lepidoptera and Hemiptera.
Biology: solitary species exploiting eggs of a large number of insects, producing mainly males from *T. pityocampa* likely because the small size of the eggs. It occurs everywhere within the host's range, at low density.

Baryscapus transversalis (Graham) (Eulophidae)

Body length: <2 mm.
Colour: dark.
Male: common.
Host: hyperparasitoid of primary parasitoids of *T. pityocampa.*
Biology: mostly unknown, present in less than 1% of eggs (Bellin, 1995).

Eupelmus sp. (Eupelmidae)
Macroneura sp. (Eupelmidae)
Pediobius sp. (Eulophidae)

These three species are only occasionally obtained from the eggs of *T. pityocampa*.

Materials and methods

Egg batches were collected in the period 2002-2006 in the area of Silandro/Schlanders. Usually, around hundred egg batches were selected from different trees growing at an elevation varying from 800 to 1300 m. The egg batches were put individually in vials and kept under observation until the parasitoid emergence. Adults of parasitoids were identified and counted, then preserved into alcohol for further analysis. At the end of the emergence, each batch was analysed as far as the number of hatched/unhatched eggs and the egg size. A comparison with 1999 data was possible based on a data set of 63 egg batches collected by Dr. Klaus Hellrigl.

Results and Discussion

The mean fecundity varied around 200 eggs/batch and did not vary significantly among the years (ANOVA, $F_{(5,88)} = 1.58$, $p < 0.17$) (Fig. 5). In 1999, only 3 females of *B. servadeii* and 3 females of *O. pityocampae* were obtained from the eggs, whereas generalist species were responsible for a total egg mortality of 0.9% out of 7.75% of unhatched eggs (Fig. 6). The most frequent species was *Trichogramma* sp. (71.5% of all parasitoids) and *A. bifasciatus* (23.6%). In 2002 and 2003 there was a slight increase in parasitism, however the egg mortality did not exceed 10%. Surprisingly, *B. servadeii* reappeared in a greater number in 2003, becoming immediately the dominant parasitoid species (84% of all parasitoids).

A strong increase in parasitism was observed in 2004, with 19.9% of eggs parasitised over a total of 38.6% of unhatched eggs (ANOVA, $F(5,88) = 30.46$, $p < 0.01$). This increase was due to *B. servadeii*, amounting to nearly 100% of emerged parasitoids. The trend was confirmed in 2005 and 2006, when *B. servadeii* parasitised the 40% of the eggs and the number of unhatched eggs amounted to 50%.

The reason why it took years to observe an increase of *B. servadeii* population, in spite of high host density, is unknown. We hypothesise that the parasitoid arrived in the area following its host in an undefined time, likely because of very suitable climatic conditions. The parasitoid was found in a survey conducted in the near area of Isarco/Eisack valley (thesis work of Ronald Amort, reported in Hellrigl 1995). It is possible that the population remained at low density because of a synchronization problem between the host and the parasitoid, as the moth population of Venosta/Vinschgau is characterized by a very early emergence of adults (Aimi *et al.* this volume). The record warm summer of 2003 (Luterbacher *et al.* 2004), together with other unknown factors, may have started the process through which the parasitoid has become synchronized with the host and significantly increased the population density. To test these hypotheses, a survey of the Venosta/Vinschgau parasitoids (early vs. late emerging individuals) compared to nearby populations should be carried out, using ecological and molecular methods. The analysis should reveal how good is the adaptation of local *B. servadeii* populations, allowing predictions about the natural biocontrol of *T. pityocampa* in the expansion area.

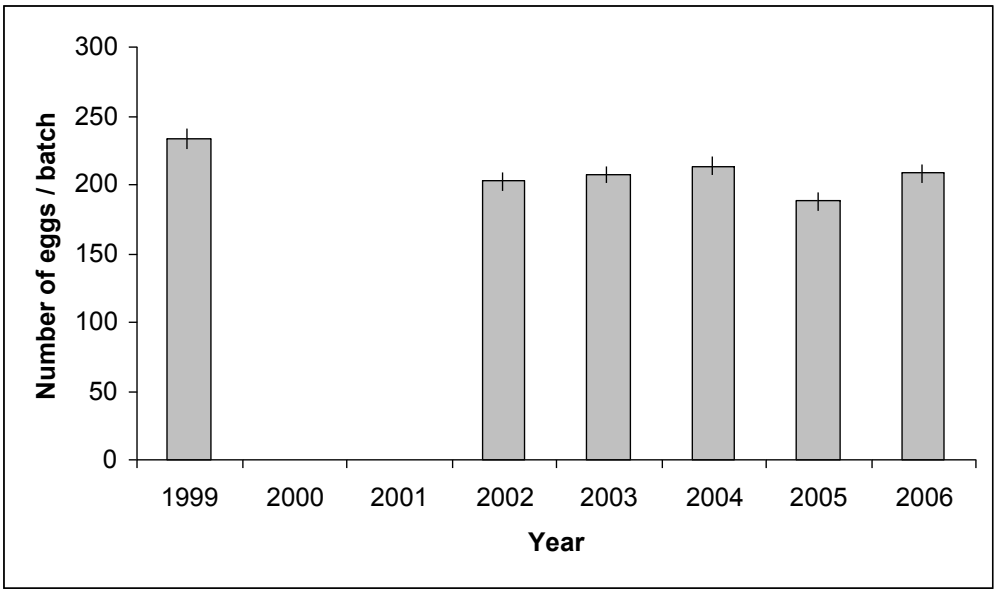


Figure 5: Mean fecundity (± standard error) of egg batches of *Thaumetopoea pityocampa* at Silandro/Schlanders between 1999 and 2006.

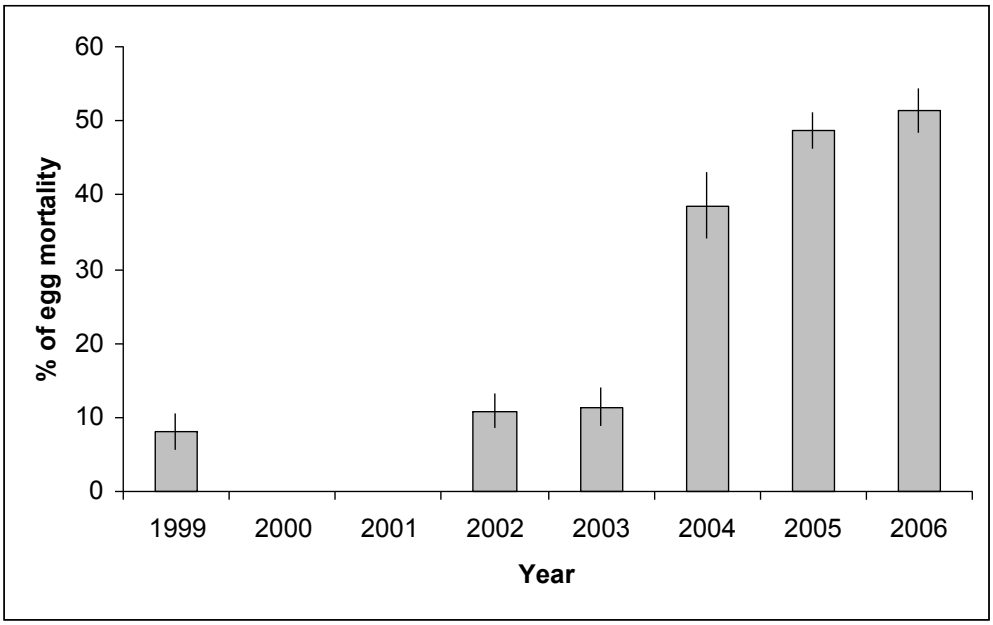


Figure 6: Percentage of egg mortality in the period 1999-2006. Egg mortality was mainly due to parasitism by *Baryscapus servadeii*, that was firstly found in 2003.

Conclusion

In spite of the repeated applications of biocontrol in Venosta/Vinschgau (Aimi *et al*. this volume), the population density of *T. pityocampa* has not reached yet a level allowing safety to visitors and an efficient role of the forest in protection the mountain slope from erosion. The unexpected increase of *B. servadeii* density since 2003, however, has lead to an increase of egg mortality up to 50%, a level considered very promising for the achievement of a natural limitation of the moth populations in the valley (Masutti & Battisti 1990). In the future we may expect a further increase of mortality, also because the reduction of the initial colony size may have some negative drawbacks on the colony survival during the winter, as smaller colonies suffer higher mortality from weather and natural enemies (Pérez-Contreras *et al.* 2003). Thus, we may expect an increase in the natural mortality and consequently a limitation of the applications of biocontrol by Btk to the most infested areas.

Acknowledgements

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Zusammenfassung

Die Ei-Parasitoiden des Kiefernprozessionsspinners *Thaumetopoea pityocampa* werden kurz vorgestellt, zusammen mit vereinfachten Angaben zu ihrer morphologischen Identifizierung. Aufgelistet werden drei mehr, zwei weniger häufige und drei seltene Arten. Einige davon kommen im Gradationsgebiet des Kiefernprozessionsspinners im Vinschgau (Südtirol, Italien) vor, das ein rezentes Ausbreitungsgebiet des Schädlings darstellt.
Zu Beginn der Massenvermehrung (1999) waren die Parasitoiden nicht zahlreich und zudem hauptsächlich vertreten durch weniger spezialisierte Arten. Eine plötzliche Zunahme der Eimortalität, zurückzuführen auf den wichtigsten Spezialisten *Baryscapus servadeii*, wurde ab 2003 festgestellt und trug wesentlich bei zur natürlichen Begrenzung der Schmetterlingspopulation in den folgenden Jahren. Eine weitere Zunahme der (Ei-)Parasitierung läßt sich vorhersagen so lange die Wirtsdichte hoch bleiben wird, da andere potentielle Konkurrenten für den Befall der Eier fehlen oder nur in sehr geringer Dichte vorhanden sind.

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