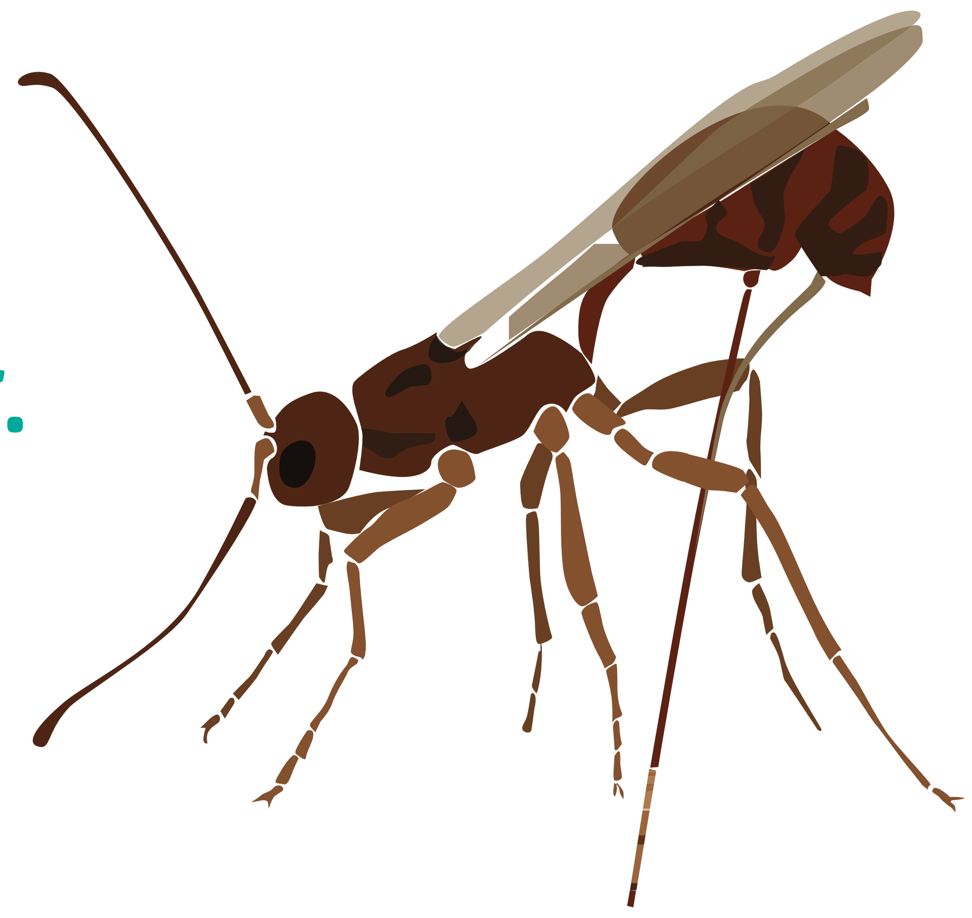
# A new biological control method for the common furniture beetle with *Spathius exarator*.



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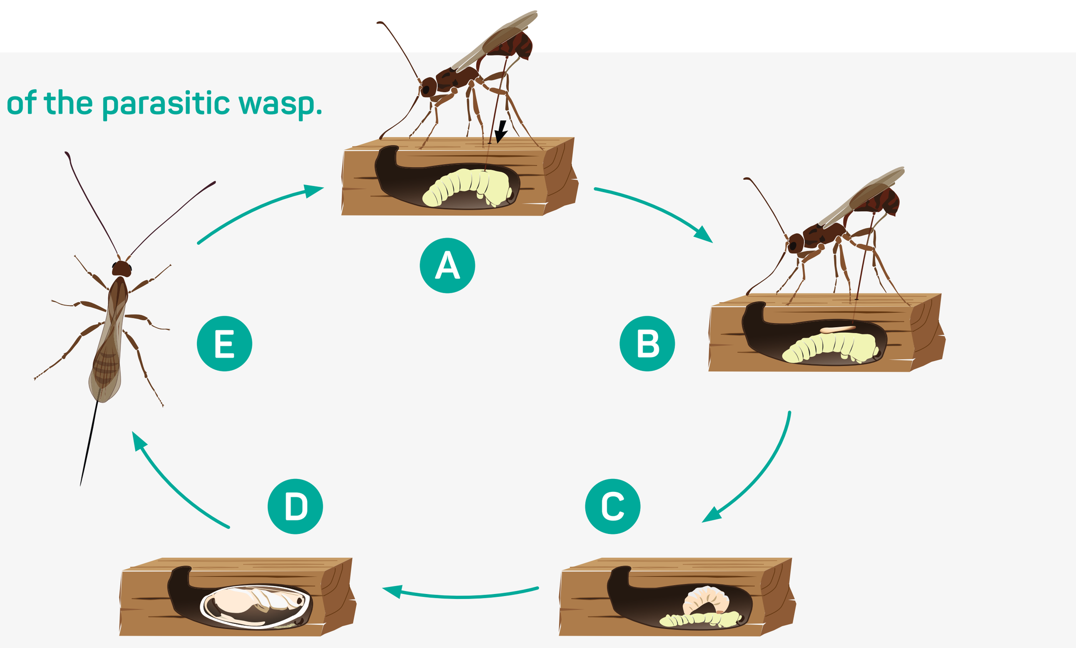
**Life cycle of the parasitic wasp.**
(Figure 1)




- A Female parasitic wasp detects furniture beetle larva, pierces its ovipositor into the timber and paralyzes it.
- B Oviposition onto paralyzed furniture beetle larva.
- C Eclosion of a parasitic wasp larva, which feeds on furniture beetle larva.
- D Death of furniture beetle larva, pupation of the wasp larva, eclosion and flying out.
- E Adult parasitic wasp.



## Efficient by Nature: Spathius exarator versus Anobiidae.

The common furniture beetle *Anobium punctatum* (Coleoptera, Anobiidae) is the most frequent wood pest in historical buildings in middle, north and eastern Europe, causing devastating damage disintegrating the wooden interior. We present here a new biological control method of *A. punctatum* using its most frequently found antagonist, the braconid wasp *Spathius exarator* (Hymenoptera, Braconidae).

The 5 to 9 mm large female tracks down the pest species within the galleries by perceiving the movements of the furniture beetle larva. It pierces its ovipositor through the timber and initially paralyzes the larva. Then it presses the flexible egg through the ovipositor and places it onto the larva. Within a few days, a larva of the parasitic wasp hatches and feeds on the paralyzed furniture beetle larva.

At that time, the destruction of the timber by feeding activities of the furniture beetle larva has already stopped. *S. exarator* larvae pupate and adult wasps hatch through a 0.5 mm wide exit hole which can be easily distinguished from the 2 mm wide holes caused by *A. punctatum*.

## Commercial use and monitoring procedure

Since summer 2012 more than 50 *A. punctatum* infested objects were or are currently treated with *S. exarator*. Between May and October six treatments at intervals of about one month were conducted. Concomitant to the treatments a monitoring of success, based on the intensity of infestation and the effectiveness of the parasitoids, was performed. Already existing exit holes of *A. punctatum* and *S. exarator* were counted on exactly defined areas before the first treatment started and a basic parasitization rate was calculated as the proportion of parasitized *A. punctatum*:

$$\frac{\text{no. of } \textit{S. exarator} \text{ exit holes}}{(\text{no. of } \textit{S. exarator} \text{ exit holes}) + (\text{no. of } \textit{A. punctatum} \text{ exit holes})}$$

During each treatment, the number of newly appeared exit holes of *A. punctatum*, representing a surviving beetle, and *S. exarator*, representing a killed beetle, were documented at the monitoring area. Parasitization rates were recalculated for each treatment year. After a two to three years period of intensive treatment, monitoring was continued and, if necessary, further single treatments were conducted.

We present here the results of the monitoring of 29 buildings treated with *S. exarator* for two to three years by comparing the pooled basic parasitization rate before the first treatment with the pooled parasitization rate found during the last monitoring (Figure 2). Moreover, we show the mean cumulative increase of newly appeared exit holes of *S. exarator* (Figure 3) and the decline of newly appeared *A. punctatum* exit holes (Figure 4) in objects treated over a period of two or more years.

## Results from five years of practical application

The monitoring of success in *S. exarator* treated objects reveals *S. exarator* as an efficient and sustainable biological control method against the furniture beetle. Parasitization rates in treated objects are significantly higher compared to untreated objects. Concurrently with the increase in the parasitization rates and the corresponding number of newly *S. exarator* exit holes, the number of annually newly appeared exit holes of *A. punctatum* decreased. After three years, an average of 92,61 % less furniture beetles emerged.

However, in the fourth and fifth year with no or only single treatments, the number of new *A. punctatum* exit holes slightly increased. This slight increase demonstrates the requirement of an elaborated application program adapted to the respective conditions in the treated objects, since the type of wood, the strength of infestation, paintings or prior insecticide treatments might influence the parasitization success of *S. exarator*.

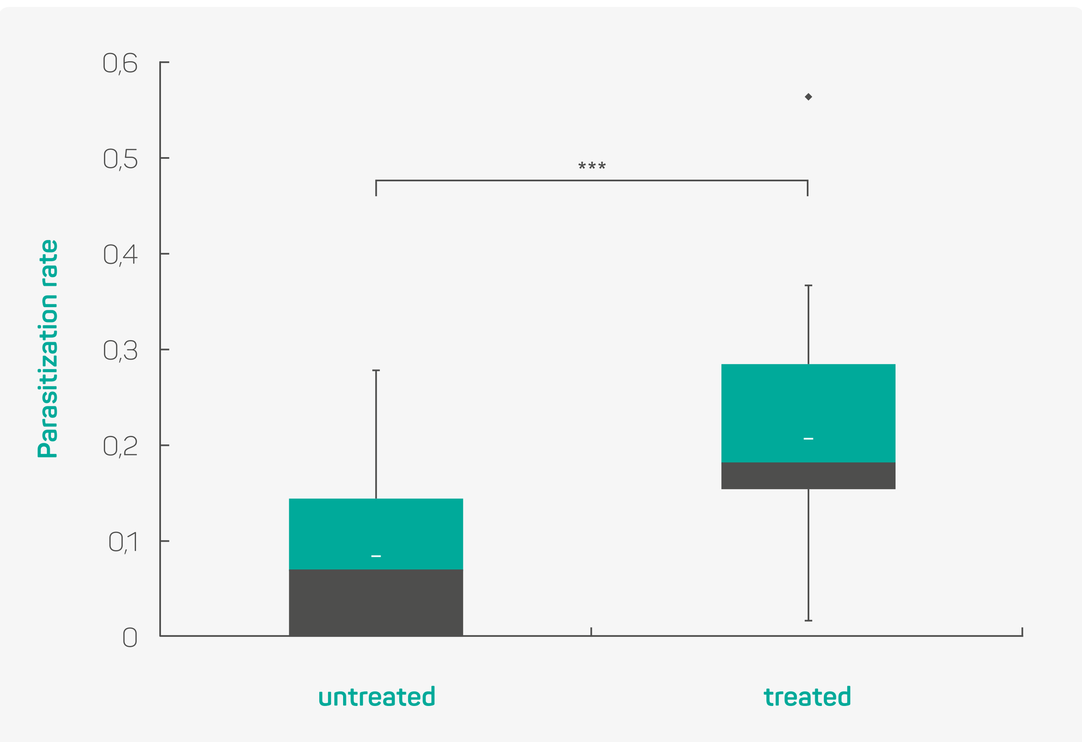



Figure 2: Parasitization rates of 29 churches before the first treatment (untreated) and during the last monitoring (treated). Rhombus: outlier; asterisks indicate significant differences between the parasitization rates (p≤0.001; Mann-Whitney U test).

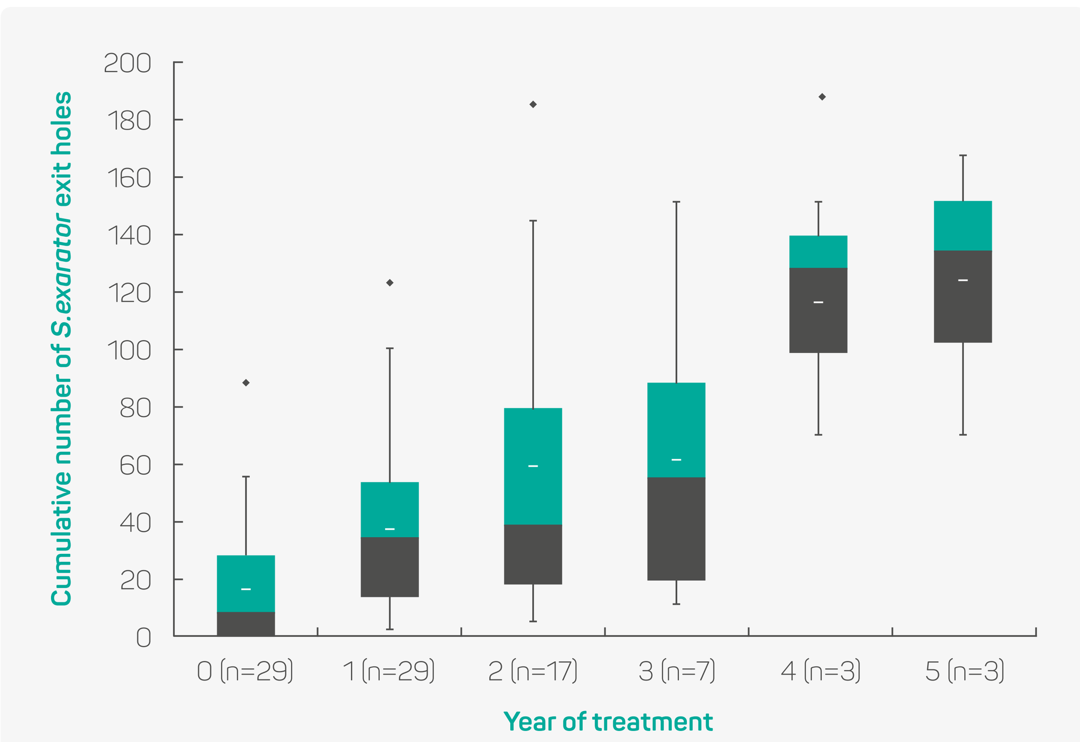



Figure 3: Cumulative number of newly appeared S. exarator exit holes per treatment year in the monitored areas in S. exarator treated churches. Rhombus: outlier. Numbers in brackets represent the number of objects.

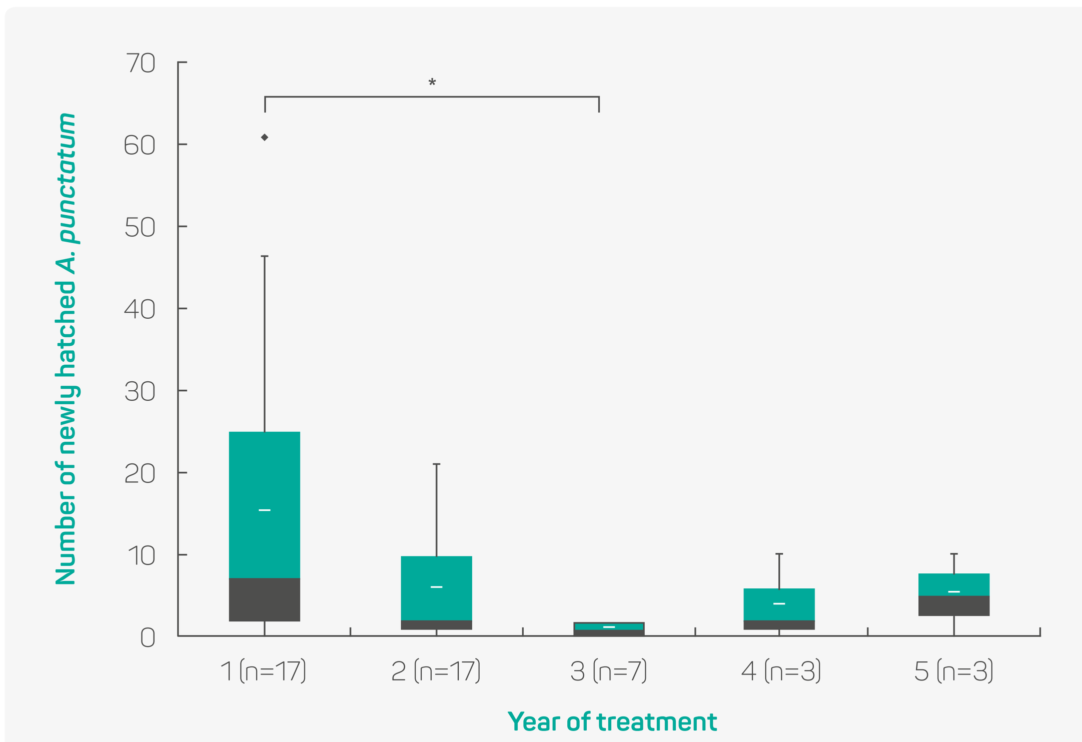



Figure 4: Number of newly appeared A. punctatum exit holes per treatment year and their percent decline compared to the first treatment year in the monitored areas in S. exarator treated churches. The mean numbers of treatments per year were 5.8, 5.4, 3.7, 0.7 and 1.7 for treatment years 1, 2, 3, 4 and 5 respectively. Numbers in brackets represent the number of objects. Rhombus: outlier; Asterisks indicate significant differences between the parasitization rates (*: p≤0.05; Mann-Whitney U test).

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