Agrilus biguttatus (*Col.*: *Buprestidae*) in relation with oak decline

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INTRODUCTION

Oak decline is in general associated with a complex of biotic and abiotic stress factors, such as repeated insect defoliation, fungi, late winter frost and drought. Some of these primary stress factors are reversible and oaks may recover. However, oaks may become attacked by secondary pest insects such as the buprestid beetle, *Agrilus biguttatus* (F.) (syn. *A. pannonicus* (Pill. et Mit.)). This insect may kill the trees before they are able to recover. The larvae excavate galleries under the bark of weakened trees, which are killed through girdling. Recently, the populations of *A. biguttatus* in Europe have increased and the beetles' attacks have become a new component in oak dieback in several countries. Because of the difficult diagnosis it is necessary to draw more attention to the infestations.

GEOGRAPHICAL DISTRIBUTION AND HOST PLANTS

The buprestid beetle, *A. biguttatus* is a palearctic, euro-siberian species, present all over Europe, except Denmark and Finland (BILY, 1982). Outside Europe, the insect is occurring in the Middle-East, Northern-Africa and Siberia (HELLRIGL, 1978). Host plants are *Quercus* species and occasionally *Fagus sylvatica* and *Castanea sativa* (HELLRIGL, 1978). Infestations on *Q. rubra* are very rare (Hartmann, pers. comm.).

BIONOMICS

In May-July, the 8–13 mm long beetle deposits groups of 5–6 eggs, preferably on the south-side of the bark of living trees (WACHTENDORF, 1955). Beetles prefer big sized trees (average DBH 30–40 cm) over 80 years old, with thick bark (STARZYK, unpubl.data). The cream-coloured and legless larvae are relatively long and flat, with a pronotum that is a bit wider than the rest of the body. They have a unique tail segment that terminates in a pair of minute black-brown horns (Fig. 2). The larvae excavate, up to 155 cm long, zigzagging galleries under the bark (Fig. 3–4). The insect may have a one-year cycle, but a two-year cycle is more common. The mean length is about 10 mm for those from the current year and 25–43 mm for the $1^1/_2$-year-old larvae (HARTMANN, pers. comm.; KOLK & STARZYK, 1996). Hibernation of the

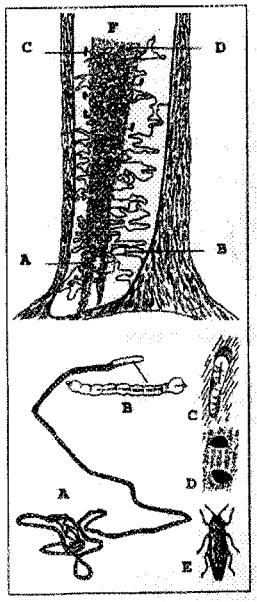

Fig. 1. Schematic development of *Agrilus biguttatus*.
Source: HARTMANN & KONTZOG 1994

A. Zigzagging larval galleries on the south-side of the tree,
B. Larva with two minute brown-black horns on the tail segment,
C. Hibernation of the larva takes place within the bark,
D. Characteristic, D-shaped, exit holes of the young beetles,
E. Adult beetle,
F. Bark necrosis.

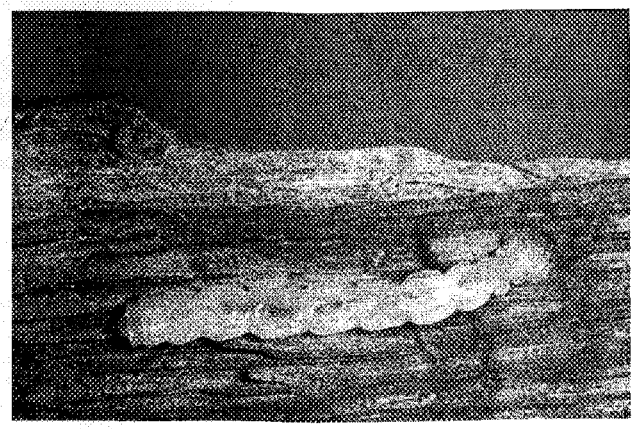

Fig. 2. The larva of *Agrilus biguttatus*; the last abdominal segment terminates in a pair of minute black-brown horns.
photo: Alterra/A. van Frankenhuyzen

larvae takes place inside the bark (HARTMANN & KONTZOG, 1994; WACHTENDORF, 1955), in the pupal chambers of the size 10.4–14.8 by 3.0–4.5mm. During its complete development, larvae have 5 instars. The young beetles leave the tree by gnawing characteristic, D-shaped exit holes of about 2.5–4 by 2–3 mm (KOLK & STARZYK, 1996) (Fig. 5). Very heavily infested trees have shown up to 38 exit holes per 0.5 m^2 bark (WACHTENDORF, 1955). In Poland from a 28 m long oak trunk (DBH 65 cm), infested as standing tree, more than 700 specimens of adults emerged (HILSZCZAŃSKI, unpubl. data).

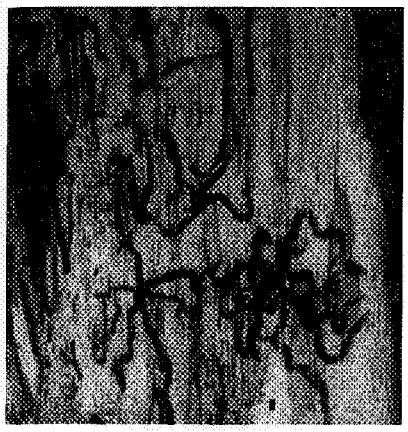

Fig. 3. Living tree with zigzagging galleries under the bark .
photo: Alterra/R. Venekamp

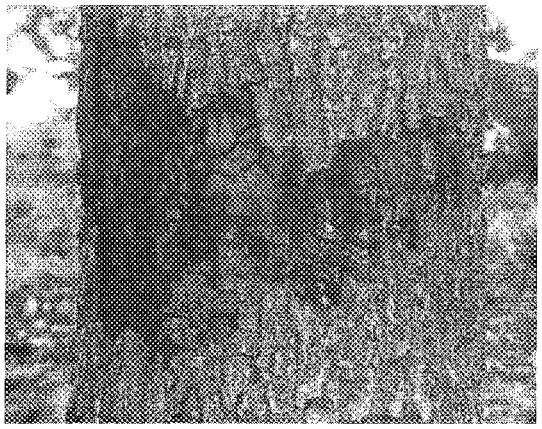

Fig. 4. Dead tree with old larval galleries.
photo: L.G. Moraal

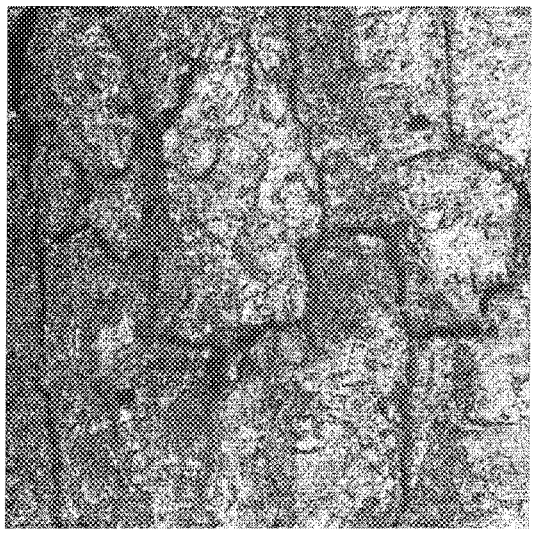

Fig. 5. The young beetles leave the tree by gawing small characteristic, D-shaped exit holes.
photo: L.G. Moraal

INFESTATIONS

Young larvae make their galleries in a longitudinal direction of the tree. Older larvae produce galleries in irregular twisting, transverse directions. This can lead to partial or complete girdling of the trees. As a result of larval activity, twigs and branches in the top of the tree will die. The tree may show a transparent crown with clusters of foliage on the surviving branches. Epicormic shoots are formed on the stem. In a later stage the tree may die.

Relatively vigorous trees can ward off early larval feeding by wound reactions, which show as dark cracks with slime flux (HARTMANN & BLANK, 1992, 1993). For the recognition of *Agrilus*-infestations can be referred to Hartmann et. al. (1995), see also figures 1–5.

OTHER *AGRILUS*-SPECIES IMPORTANT AS OAK PESTS

In Italy Agrilus graminis has been fund in declined *Q. cerris (Vamini et al. 1996)* in several countries, some other Agrilus-species play a role in oak decline. These species are *A. sulcicollis* Lacord. and *A. angustulus* (Ill.). There are many similarities in the biology among these species. However, In contradistinction to *A. biguttatus, A. sulcicollis* and *A. angustulus* prefer to infest upper parts of the stems, branches (diameter 3–20 cm) and smaller size host trees (KOLK & STARZYK, 1996; KÖNIG, 1996). These usual smaller species (3.5–8.5mm) are recorded to occur sometimes in high densities in oak stands weakened by different factors. However, the preferences of these buprestids to infest crown layers of distinctly weakened trees, place them rather among secondary factors within the oak decline.

PEST INCIDENCE OF AGRILUS BIGUTTATUS IN EUROPE

In Poland, *A. biguttatus* occurs in many oak stands all over the country except in mountains (BURAKOWSKI & al., 1985). The species is regarded as the first cambiophagous insect infesting weakened oaks, preferring trees over 80 years old, but recorded also on 20 years old hosts (Starzyk, unpubl. data). In oak stands of Niepolomice Forest District (near Krakow), weakened by industrial air pollution, the high incidence of *A. biguttatus* is also the effect of heavy defoliation caused by *Tortrix viridana* L. and other defoliators (STARZYK, unpubl. data). During 1997, flood in Lower Silesia created forest edges with many weakened oaks. *A. biguttatus* was the main insect infesting and killing these oaks in the following years (together with accompanying *Agrilus sulcicollis*, cerambycids such as *Plagionotus* spp. and the oak bark beetle, *Scolytus intricatus* Ratz.). As a result in 1998-1999, about 40 thousand m^3 of infested oaks were harvested from two Forest Districts in the Odra river valley.

In The Netherlands, insect pests on trees are monitored annually since 1946. Since then, infestations of *A. biguttatus*, have never been observed. However, in 1997, heavy attacks were noticed in several oak stands on several locations. Oaks with ages varying from 58–110 years old appeared to be attacked (MORAAL, 1997). In some stands more than 70% of the trees were killed. In these trees numerous larvae or exit holes have been found.

In Germany, attacks by *A. biguttatus* have become very common recently. At present they are considered as an important factor for tree mortality. The infestations mostly occurred in oak stands which have been previously defoliated by *Lymantria dispar* (L.), *Operophtera brumata* (L.) and *Erannis defoliaria* (Clerck). For several reports on the incidence of *A. biguttatus*, Wulf & Kehr (1996) mention several authors. Winterfrost injuries to trees weakened by repeated insect defoliation, and locally by water stress (drought or fluctuating groundwater levels) are assumed to predispose oaks to attack by secondary organisms. *A. biguttatus* is the earliest and most aggressive secondary organism involved. Mortality or survival of predisposed oaks depends largely on whether or not an *Agrilus*-attack occurs. Warm summers in combination with a large supply of weakened trees are assumed to favour this thermophilic insect (ALTENKIRCH & HARTMANN, 1995; HARTMANN & BLANK, 1993).

Also from France, England, Hungary, Russia, Ukraine and Belarus, severe infestations were reported recently (MORAAL & HILSZCZAŃSKI, 2000).

ARMILLARIA IN RELATION WITH *AGRILUS*

In the past, many authors have contributed an important status to honey fungus, *Armillaria* spp., in relation to oak decline, as this fungus was observed in the roots and stems of dead trees. However, there are several *Armillaria* species; some of them are pathogenic while others are saprophytic. On the richer soils, in The Netherlands and Northern-Germany, where most oaks are cultivated, pathogenic *Armillaria* species do not occur (De KAM et al., 1990; HARTMANN, 1996). Infections with *Armillaria* mostly occur, after the trees have been infested by *Agrilus* (HARTMANN, 1996; HARTMANN & BLANK, 1992; SEEMANN, 1996). In Ukraine, larvae *of A. biguttatus* were observed to develop abnormally on trees infested with *Armillaria* sp. The most numerous larvae were found above the fungus layer (MEZENCEV, 1993).

SYLVICULTURAL MEASURES

To reduce the population of the beetle, a feasible countermeasure might be the removal of those stems which are heavily infested with larvae. The branches may be left in the stand because *A. biguttatus* mainly breeds in the stems. Non-infested trees, which are already dead for more than one year, or dead trees with already the beetles' exit holes, may be left in the stands for their contribution in the development of dead wood fauna. Long-term measures includes increasing age structure, and developing the shrub and underwood layers providing shade on stems, decrease the susceptibility of the trees for infestation.

CONCLUSIONS

The buprestid beetle, *Agrilus biguttatus* is nearly present all over Europe. During last years, the populations of this secondary pest insect have increased remarkably. In several countries the beetles' attacks have become a new and significant component in oak dieback. The insect may kill trees, weakened by repeated insect defoliation, water stress and late winter frosts, before they are able to recover from temporary drawbacks for tree vitality. As the infestations of *A. biguttatus* so far have been underestimated in most monitoring programs, further insight in population dynamics is needed. For further and more detailed information we refer to Moraal & Hilszczański (2000).

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