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Biogeographical observations on four scolytids (Coleoptera, Scolytidae) and one lymexylonid (Coleoptera, Lymexylonidae) in Wallonia (Southern Belgium)

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ABSTRACT. Following a very sudden, early and deep frost at the end of autumn 1998, the availability of weakened trees (mainly beech trees) reached very high levels in Southern Belgium in the spring of 1999. Consequently, the ambrosia beetles *Trypodendron domesticum* L. and *T. signatum* (Fabricius) (Coleoptera, Scolytidae) initiated outbreaks and, in 2000 and 2001, they heavily contributed to the depreciation of nearly 1,600,000 m^3 of stem volume (to upper limit girth of 22 cm) in the natural regions of “Ardenne” and “Belgian Lorraine”. Because of the lack of biogeographical data on both insects, of their conspicuous aggressiveness towards apparently healthy trees and of the economic importance of the beech wood chain in Belgium, a large-scale survey was undertaken in 2001, in order to outline the range of both ambrosia beetles in Wallonia. To this effect, a network of 172 traps baited with ethanol was set up, attempting to cover the Walloon beech forest as representatively as possible. Two other scolytids and one lymexylonid were also frequently caught, which made it possible to outline their regional distribution too. Although the damage was limited to the Ardenne and Belgian Lorraine, *T. domesticum* and *T. signatum* are widespread throughout Wallonia. We discuss these results, their long-term validity, the secondary pest status of these insects and the need for a permanent monitoring of the major forest pest species and diseases.

KEY WORDS : Scolytidae, *Trypodendron domesticum*, *T. signatum*, *Xyleborus dispar*, *Taphrorychus bicolor*, Lymexylonidae, *Hylecoetus dermestoides*, range, Wallonia, beech disease, monitoring.

INTRODUCTION

The beech forests of Southern Belgium have been undergoing severe entomological and fungal attacks in 2000 and 2001. Many factors, such as repeated droughts, destabilisation of the root systems as a consequence of the storms of 1990, air pollution and soil impoverishment, for instance, may potentially be involved in and have encouraged this situation. However, the factor that most likely set off the crisis seems to be a very early, sudden and severe frost that happened during the autumn of 1998, after a period of mild temperatures (Huart & Rondeux, 2001). This climatic event induced cortical and subcortical lesions. Produced by anaerobic fermentation, the subsequent ethanol emissions triggered off the response of wood-boring insects, mainly scolytids.

Two ambrosia beetles[1] were responsible for the entomological damage : *Trypodendron domesticum* L. 1758 and *T. signatum* (Fabricius, 1787). Although apparently not as problematic as both *Trypodendron* species, the population levels of a third ambrosia beetle, *Xyleborus dispar* (Fabricius, 1792), were very high too. Their role in the past crisis still remains unclear (Grégoire & De Proft, 2002, unpubl. report).

Almost the totality of the beetle attacks occurred on beech trees, *Fagus sylvatica* L.. However, very sporadic attacks occurred on another thin-barked tree species : the sycamore, *Acer pseudoplatanus* L.. Rondeux et al. (2002) showed that the occurrence of the damage was restricted to the natural regions of “Ardenne” and “Belgian Lorraine”, almost exclusively at elevations higher than 350 m a.s.l. (Fig. 1). According to this study, more than 11 % of the beech trees (girth at breast height > 39 cm) situated in those regions were damaged (by scolytids and/or fungi); in some plots, however, the scolytid attack rates reached 100%. The damage amounted to nearly 1,600,000 m^3 stem volume [2] (18 % of the total standing volume) with huge financial losses as a result of the depreciation of the wood and premature tree felling. Although not easily quantifiable, the financial losses for private and public forest owners undoubtedly exceeded 50 million m^3.

While in 2000 the entomological attacks were restricted to very weakened trees, both *Trypodendron* spp. begun in the spring of 2001 to attack healthy-looking beech trees. This conspicuous aggressiveness bewildered the Walloon forest managers since :

1. the financial incomes associated with the beech wood chain are of major importance in Belgium;
2. *T. domesticum* and *T. signatum* are polyphagous and able to breed on several tree species producing highly

[1] Wood-boring Scolytoidae (Coleoptera) feeding upon symbiotic fungi.

[2] To upper limit girth of 22 cm.

valuable timber such as oaks, maples, ash, etc. (Balachowsky, 1949; Lekander et al., 1977);

3. although the most important part of the Belgian beech forest is situated in the Ardennes, a significant part of it is also scattered throughout Wallonia : it was thus feared that the attack range could extend to the rest of this Region.

Very little biogeographical information on scolytids is available for Wallonia. The most valuable is undoubtedly the maps drawn by Dourojeanni in 1971. Unfortunately, besides being relatively ancient, those maps are based on few, randomly and non-synchronously collected observations (since he drew them up from museum specimens) : some regions of Wallonia may thus have been under-sampled and some data could be out-of-date.

In this context, a survey aimed at outlining the present range of *T. domesticum* and *T. signatum* in Wallonia was undertaken. According to Lekander et al. (1977), accurate data on the distribution of scolytids are always needed since "many of them are of direct concern to the forest manager". This was undoubtedly the case of *T. domesticum* and *T. signatum* in Wallonia. In particular, up-to-date biogeographical information on those scolytids were, to some extent, of interest for improving the understanding of the "Walloon beech crisis" and the subsequent set up of a pest control program.

X. dispar, *Taphrorychus bicolor* (Herbst, 1793) (Coleoptera, Scolytidae), and another prejudicial and very polyphagous wood borer, *Hylecoetus dermestoides* (L., 1761) (Coleoptera, Lymexylonidae), were also regularly caught, which made it possible to outline their distribution too.

MATERIAL AND METHODS

Window traps of transparent plastic (10 x 23 cm high) with funnel and collector vial were hooked on beech trees at 1.7 m height above ground level. The trees belonged to different categories of diameter. Ethanol, which is known to attract many bark and ambrosia beetles such as e.g. *Trypodendron* spp. (e.g. Moek, 1970; Kerk, 1972; Bauer & Vité, 1975; Nijholt & Schönherr, 1976; Klimetzek et al., 1986; Schroeder & Lindelöw, 1989; Byers, 1992; Markalas & Kalapanida, 1997), was released from a plastic-vial dispenser (ca. 250 mg.day^{-1}). These were made of polyethylene (2 cm diam. x 8 cm high). A total of 172 traps were set up from the beginning of April to the end of October 2001.

The chosen location of most of the traps was among the Walloon Permanent Forest Inventory (W.P.F.I.) plots. The W.P.F.I. is a network of 11,000 permanent plots located on a 500 x 1,000 m systematic grid covering Wallonia. It aims at assessing the wood resources of the Region and monitoring the sustainability of the forest management (see e.g. Lecomte & Rondeux, 1994). Globally, 222 plots were extracted from the W.P.F.I. data base : they concern "public beech stands (with beech relative basal area (G_{beech}) > 66 %) of at least 1 ha". One trap was set up in each of 129 of those plots ("W.P.F.I. traps"). These were selected in order to cover Wallonia as homogeneously as possible. However, the number of plots (and consequently of the traps) is much greater in the Ardennes and Belgian Lorraine, where the forestation rate is much higher than in the other natural regions of Wallonia (Lecomte & Rondeux, 1995). Thus, in order to get a better picture of the beetles' range, 43 additional traps were set up in the less-forested natural regions ("non-W.P.F.I. traps"). Fig. 2 shows the trap network and the W.P.F.I. plots located in beech stands (relative G_{beech} > 50 %).

Catches were checked every 8th week. Because of the small size of the traps and the number of traps per site (one), only the presence of a species at a given site was recorded (i.e. at least one individual caught), instead of the number of individuals. The survey methodology doesn't permit assessment of the local population levels of the insects (see Henin et al., 2003). For the same reasons, the absence of a species in the collections at a site may not be considered as evidence of the absence of this species at this site. Therefore, the equality of observed presence rates (number of sites where a given species was caught, vs. number of trapping sites in a particular natural region or altitude category) was not tested statistically (either within a species or between species).

The insects were identified using Balachowsky's identification key (1949) and the reference collection of the entomological museum of the Zoology Department (Faculté universitaire des Sciences agronomiques, Gembloux).

RESULTS

Fig. 3 and Fig. 4 show our observations of *T. domesticum* and *T. signatum* in Wallonia. Both species occur all over this Region, whatever the altitude or the natural region. *T. domesticum* was caught in 144 traps : it was thus present in at least 84 % of the sites. *T. signatum* was caught in 90 traps (presence rate of min. 52 %).

As shown on Fig. 5, *X. dispar* is also widely distributed in Wallonia. It was caught in 119 traps, which means it was present in at least 69 % of the sites. As for both *Trypodendron* spp., altitude and natural region do not influence the presence of the insect.

Based on our survey, the distribution of *T. bicolor* appears relatively wide (Fig. 6). This bark beetle was caught in 65 traps (presence rate of min. 38 %) and its presence was not influenced either by the natural region or by the altitude.

H. dermestoides was caught in 28 traps (presence rate of min. 16 %). Even if not as common as the bark and ambrosia beetles caught, it is present in a large part of Wallonia (Fig. 7). It should be noticed that no *H. dermestoides* were captured in the "Loess" and "Sandy loam" regions : however, the low number of traps in those regions is the reason for this apparent absence. Indeed, in 2002, we observed in the "forêt de Soignes" (a 4,000 ha beech stand located in the sandy loam region) several adults and many typical larval galleries on beech logs and snags.

DISCUSSION AND CONCLUSION

The omnipresence of *T. domesticum*, *T. signatum* and *X. dispar* in Wallonia was to be expected, considering the characteristics (particularly climate and breeding substrate requirements, as well as European distribution) of

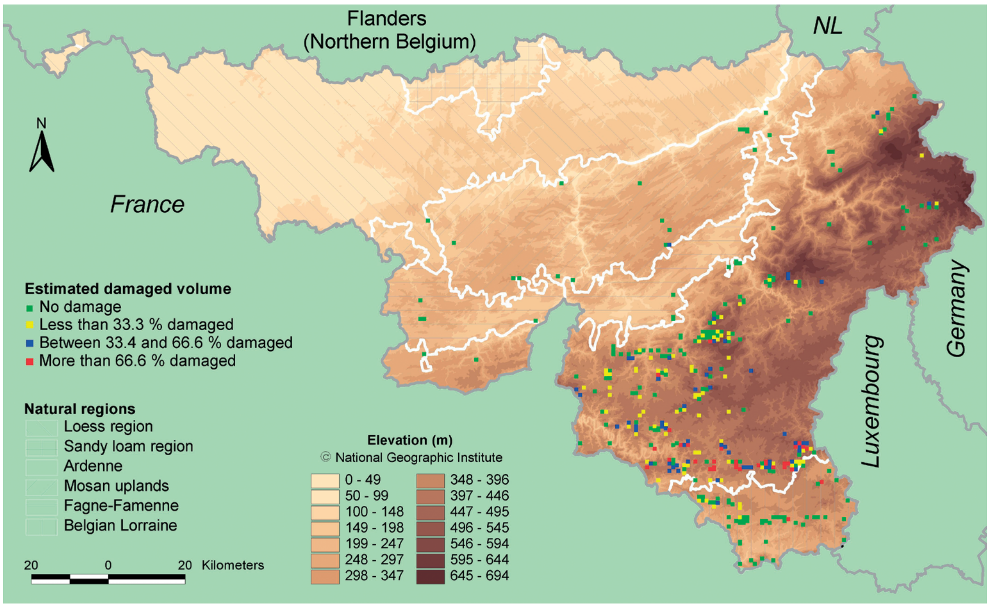

Fig. 1. – Distribution of damaged beech stands in Wallonia, according to a specific survey carried out i 2001 (381 sampling plots), in the context of an unusual beech disease (RONDEUX et al., 2002).

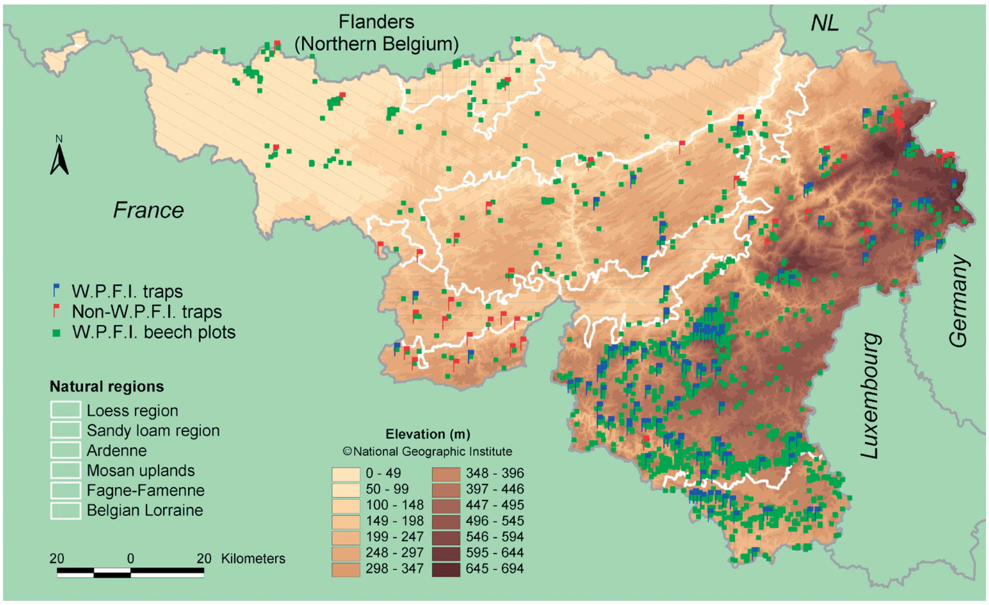

Fig. 2. – Trap network and beech plots (relative G_{beech} > 50%) belonging to the Walloon Permanent Forest Inventory (W.P.F.I.) plot network

those indigenous species (see e.g. BALACHOWSKY, 1949). According to DECELLE (1995), *T. domesticum* and *T. signatum* are also quite common in the forêt de Soignes : personal observations made in 2002 confirmed this fact. DOUROJEANNI (1971) also reported a wide distribution of these three ambrosia beetle species in Wallonia. Taking into account the variability of the number of traps in the natural regions, the observed presence rates of the three species do not seem to vary between the six Walloon natural regions (HENIN et al., 2003). Concerning *T. bicolor*, DOUROJEANNI (1971) reported only two observations for Wallonia. In 1995, DECELLE mentions a third observation in the forêt de Soignes. The much wider distribution we found seems however logical, considering the omnipresence of beech stands in Wallonia and the ecological niche[3] occupied by *T. bicolor* (see e.g. BALACHOWSKY, 1949; NICOLAI, 1997; DAJOZ, 1998). Up-to-date data on this species are important as it seems to be involved in beech decline (KOHNLE et al., 1987; NAGELEISEN, 1994) and able to cause damage on living trees (SCHÖNHERR & KRAUTWURST, 1979). Finally, *H. dermestoides* has long been considered as extremely rare in our Region (COLLART, 1952). Our survey evidenced that, as expected by

[3] As defined by HUTCHINSON (1957, in BEGON et al., 1996).

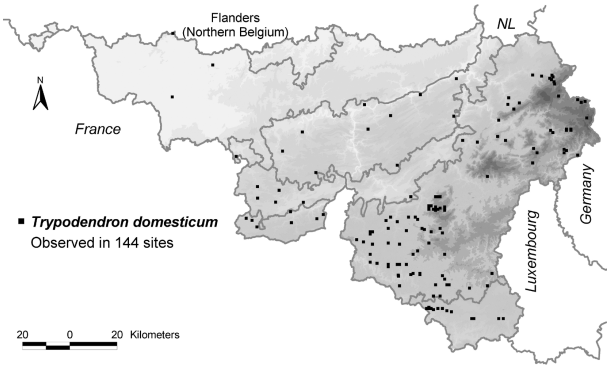

Fig. 3

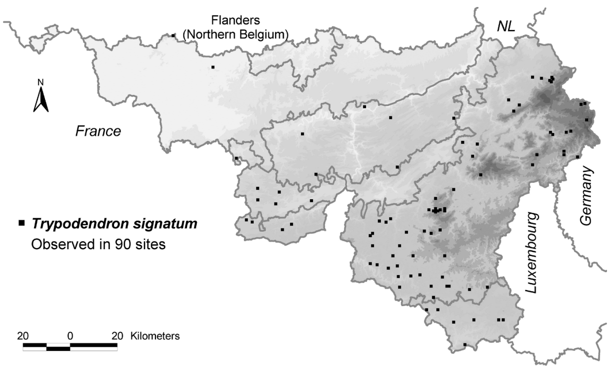

Fig. 4

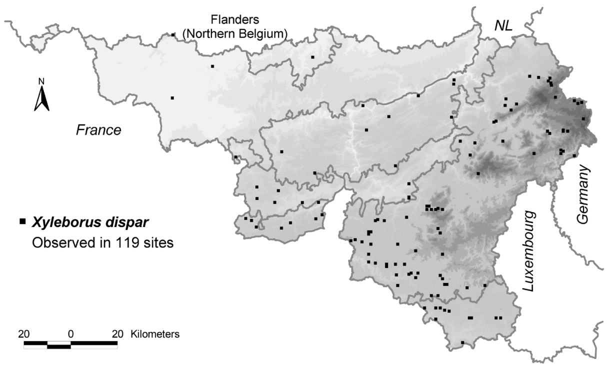

Fig. 5

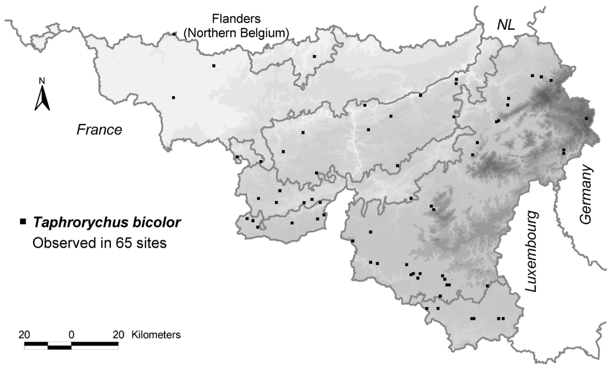

Fig. 6

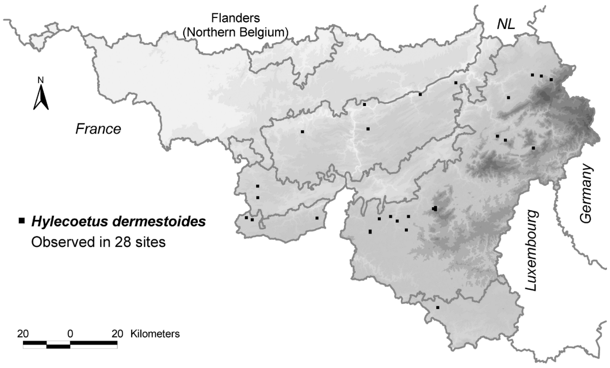

Fig. 7

Figs 3-7. – Distribution of five beech damaging Coleoptera in Wallonia, based on a 172 traps survey network set up in 2001.

the same author, this opinion is biased : in Wallonia, this coleopteran is widespread and may be locally extremely abundant (pers. obs.). Like Collart (1952), we think that the short flight period and climatic requirements for flight explain the scarcity of this species in Belgian entomological collections. Because of its abundance and of the damage it may cause on many tree species (e.g. beech, oak and spruce trees), Vrijdagh (1952) considers that *H. dermestoides* may locally have a pest status. Besides, in 2001 it also caused considerable damage in many beech stands (both on logs and weakened trees).

The observations here presented were made during a period of high and widespread availability of weakened beech trees. The five studied insects are favoured by those conditions : besides, the populations of *T. domesticum* and *T. signatum* reached epidemic levels over a wide area. It could be argued that this abnormal abundance of suitable hosts could have influenced our observations and the resulting maps. However, we think it reasonable to assume that these maps also reflect the beetles' distribution in non-epidemic conditions. Bark and ambrosia beetles (as well as *H. dermestoides*) are indeed dependent on ephemeral and generally scattered breeding substrate (Eidmann, 1985; Forsse & Solbreck, 1985; Schiegg & Suter, 2000). Well adapted to seek out this resource, most of the scolytids are strong flyers, often able to spread over several, sometimes tens of kilometres (Atkins, 1961; Nuorteva & Nuorteva, 1968; Botterweg, 1982; Nilssen, 1984; Forsse & Solbreck, 1985; Jactel & Gaillard, 1991; Byers, 2000). More specifically, Dyer (1961) and Chapman (1958, in Dyer, 1961) report "considerable flight potential" in the genus *Trypodendron*. The first author suggests that *Trypodendron lineatum* (Olivier, 1795) "may, in some circumstances fly several miles to attack logs". Thus, it is likely that Wallonia is permanently inhabited with variable local population levels of the studied Coleoptera. Once the availability of weakened trees increases locally, pre-existing populations grow and may reach epidemic levels : it is assumed that a part of the population behaves rather sedentarily, while another part spreads to neighbouring or relatively remote areas, possibly anemochorously (migration being an important process in the dynamics of most bark beetle populations, according to Forsse & Solbreck, 1985; Duelli et al., 1997). Hence, the major part, if not the totality of the small region that is Wallonia is very likely permanently submitted to the action of these indigenous insects. We agree with BEAVER & LÖYTTYNIEMI (1991) who, although working on Zambian bark and ambrosia beetles, suggest a stable distribution over time on a regional scale, "even though the species involved are opportunistic colonists of temporary habitats which, in natural conditions, are likely to show a strongly heterogeneous distribution in space and time on a local scale".

The omnipresence of both studied *Trypodendron* spp. in Wallonia on the one hand, and the occurrence of damage only in the Ardennes and Belgian Lorraine on the other, is evidence of the lower population levels in the other Walloon natural regions (assuming that, in stands under similar sanitary conditions, the higher the population the heavier the damage), and/or of the strict location of the trigger factor in both natural areas. These facts confirm, to some extent, the secondary pest status[4] of both involved ambrosia beetles. Furthermore, careful observations and experiments realised during the summer of 2001 proved that *T. domesticum* and *T. signatum*, unlike what was feared in the spring of the same year, are definitely secondary pests (GRÉGOIRE & DE PROFT, unpubl.). Indeed, although looking healthy, the trees attacked in 2001 exhibited cortical micro-necrosis and/or were covered with dying mosses : although not yet understood, the relationship between those elements and the entomological attacks appeared strong (HUART et al., 2003). Consequently, the pest management program (that was based upon phytosanitary cuttings, the set up of trap trees and the use of 20,000 flight barrier traps baited with ethanol and lineatin) has been set up only in the Ardennes and Belgian Lorraine. The other natural regions of Wallonia, although inhabited by *T. domesticum* and *T. signatum*, do not seem, in the context of the persistence of the 2000-2001 crisis, to be in danger of unusual large-scale beech attacks by those secondary pests.

From a wider point of view, these results highlighted the lack of "basic knowledge" about the tiny, unattractive insects we have studied. However, although more common in resinous stands, large-scale scolytid outbreaks of economic importance have already occurred in Belgian deciduous forests, notably in beech stands. Sixty years ago, for several years after the hard winter of 1942, *T. domesticum* caused extensive damage to beech trees in the Ardennes (PRIEELS, 1954; PONCELET, 1965). It is likely that *T. signatum* was also involved in this damage, but owing to its relatively lower abundance in central Europe compared with *T. domesticum* (e.g. PAIVA, 1982; PAYNE et al., 1983; pers. obs.), and close resemblance to the latter, the former was not detected. Besides, although indigenous, *T. signatum* was first recorded in Belgium by Debatisse only in 1945 (DOUROJEANNI, 1971). Nevertheless, and despite the known pest-status of both species, the Walloon Nature and Forest Division (W.N.F.D.) lacked up-to-date biogeographical data concerning these disregarded insects. The forest managers and phytopathologists had little information (based on randomly collected data), scattered in different organisations and not always easily accessible. This unfortunate situation could be improved, to some extent, by permanent monitoring of the most important forest pest species and tree pathologies. From this viewpoint, a part of the W.P.F.I. plot network could be devoted to the collection of entomological and phytosanitary data. Each plot of this network being accurately characterised in terms of forest structure, productivity, edaphic conditions, topography, phytosociology, etc., it would also be an efficient tool to assess and understand the relationships between those factors and pest population dynamics or phytosanitary problems.

[4] A pest is secondary when its development is dependent on physiological deficiency of its host. Oppositely, the insects able to develop in healthy, not physiologically weakened trees are called primary pests (RUDINSKY, 1962).

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