Ecology and distribution of *Thanasimus formicarius* (Linnaeus, 1758) and the newly discovered *Thanasimus femoralis* (Zetterstedt, 1828) in Belgium (Coleoptera: Cleridae)

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Abstract

In this article, we report the first observations of *Thanasimus femoralis* (Zetterstedt, 1828) in Belgium. This species seems to be widespread in the Campine ecoregion but has also been observed at five locations outside this region. We present distribution maps, the phenology as well as identification characteristics of this species and the morphological similar but very common *Thanasimus formicarius* (Linnaeus, 1758). We discuss the origin of *T. femoralis* in Belgium which could be rather recent.

Keywords: *Monochamus,* saproxylic, *Thanasimus femoralis*, phenology, distribution

Samenvatting

In dit artikel melden we de eerste waarnemingen van *Thanasimus femoralis* (Zetterstedt, 1828) in België. Deze soort blijkt wijd verspreid in de ecoregio van de Kempen maar is ook gezien op vijf locaties buiten de Kempen. We tonen de verspredingskaart, de fenologie en de deterministische kenmerken van deze soort en de vrij gelijkaardige maar zeer algemene *Thanasimus formicarius* (Linnaeus, 1758). We bespreken de oorsprong van *T. femoralis* in België die mogelijks vrij recent is.

Résumé

Dans cet article, nous rapportons les premières observations de *Thanasimus femoralis* (Zetterstedt, 1828) en Belgique. Cette espèce semble être répandue dans l'écorégion de Campine, mais elle a aussi été observée à cinq endroits à l'extérieur de cette région. Nous présentons des cartes de distribution, la phénologie ainsi que les critères de détermination de cette espèce et de l'espèce *Thanasimus formicarius* (Linnaeus, 1758), assez similaire et très commune. Nous discutons également le fait que l'origine de *T. femoralis* en Belgique puisse être assez récente.

Introduction

Since long, only *Thanasimus formicarius* (Linnaeus, 1758) was known to be present in Belgium, which is a very common species that can be found present all over Belgium (LAMEERE, 1900; DELEDICQUE, 1996). *Thanasimus femoralis* (Zetterstedt, 1828) (syn. *Thanasimus rufipes* (Brahm, 1797)) has been discovered recently and seems to be present in the entire Campine ecoregion and also in some other places (Stekene, Bertrix, Eupen, Yvoir and Gedinne). In the Campine ecoregion it is not a very rare species but it seems very hard to find it by hand collecting.

Thanasimus formicarius is 7 to 11 mm long; its has a typical and well known pattern. It has a black head, antenna and legs and a black central to apical band on the elytra. The abdomen and upper part of the elytra is reddish brown. Two white bands are present on the elytra, the upper white band is at least partly but often completely bordered by a black band at the upper edge (Figs 1-2). *Thanasimus femoralis* is the smaller nephew of the *T. formicarius* and measures 5,5 to 9,5 mm. The coloration of this species strongly resembles that of *T. formicarius* but the upper white band directly borders the brownish upper part of the elytra. The brown part on the elytra is also larger than with *T. formicarius*. Also the legs are brown instead of black. Furthermore, the ventral side clearly differs (Figs 1-2), with *T. formicarius* being orange with strongly contrasting black legs while *T. femoralis* has a brown red underside (meta- and mesosternum darker to black) and non-contrasting brown legs and antenna (PORTEVIN, 1931; FREUDE *et al.,* 1979; GERSTMEIER, 1988, DOYCHEV & OVCHAROV, 2008).

Fig. 1. Dorsal and ventral view of *T. formicarius*. Specimen originating from the 'Monochamus' project, collected in Pijnven Rijksbos (Overpelt), 5-23.VI.2014 (Photos: Florence Trus).

Fig. 2. Dorsal and ventral view of *T. femoralis*. Specimen originating from the 'Monochamus' project, collected in Pijnven Rijksbos (Overpelt), 5-23.VI.2014 (Photos: Florence Trus).

Thanasimus spp. are saproxylic predators of Scolytinae (bark beetles), both as adults and as larvae. It has been observed that adults of *T. formicarius* even kill more bark beetles than they are able to eat. This makes them excellent natural enemies in the control of bark beetles which often form a pest for forestry (e.g. KENIS *et al.,* 2004; HILSZCZAJSKI *et al.,* 2007). For example, in a transect of traps for the scolytid beetle *Ips typographus* (Linnaeus, 1758) set-up in a spruce stand comprising patches of pines, *T. formicarius* was in a predator / prey ratio of 1/650 (WARZÉE, 2000). *Thanasimus formicarius* differs from the other bark-beetle predators by its wide flight period (more than four months), which begins at the same time as that of the earliest bark-beetles *Tomicus piniperda* (Linnaeus, 1758), *Trypodendron lineatum* (Olivier, 1795) and *Hylurgops palliatus* (Gyllenhal, 1813) and continues to the end of the summer when many scolytid species infest conifers and broad-leaves trees (WARZÉE, 2005). Because they have such a long life span, they depend on a wide range of bark beetles. *Thanasimus* spp. (and some other Cleridae) have a typical coloration of black and reddish brown with white bands. This coloration mimics that of the antwasp (*Mutilla* spp. (Hymenoptera: Mutillidae)), which are known to have a painful stinging. *Thanasimus formicarius* is usually a common species in pine forests but rare in spruce. In Belgium, it was trapped in high numbers in a pine stand (VIATOUR, 1997), close to spruce stands where *T. formicarius* had not been found during earlier studies (GRÉGOIRE *et al*., 1995). In an other study in Belgium, it was also abundant in mixed stands comprising pines whilst it was rarely trapped in spruce and broad-leave stands (WARZÉE, 2005). WARZEE *et al*. (2006) showed that *T. formicarius* larvae are present under the bark of *Picea abies* as well but fail to pupate there.

The Central European range shown by GERSTMEIER (1988) for *T. femoralis* is more reduced compared to the large number of European countries listed by LÖBL & SMETANA (2007). In Germany, *T. femoralis* is widely distributed and only absent in the northwest (bordering The Netherlands). Several records are relatively close to Belgium and Luxembourg (www.colkat.de). The species is present all over France but more common in the mountainous areas in the south (NEID, 2000; TRONQUET, 2014). In the Netherlands, only a few records are available. In BRAKMAN (1966) only the province of Overijsel was mentioned. KOOMEN (1996) mentions a specimen caught in Hulshorst (Nunspeet, Gelderland) and VORST (2010) mentions Overijsel, Noord-Brabant and Gelderland for the period 1967-2007.

The goal of this article is to present the current data on the distribution and phenology of both *Thanasimus* spp. in Belgium. Finally, we try to unravel the reasons why *T. femoralis* has not been discovered before and try to interpret its distribution and habitat.

Material and methods

The main data for this paper come from the 'Monochamus' project. This project was funded by the Federal Public Service (FPS) Health, food chain safety and environment and carried out by the Université Libre de Bruxelles (ULB), Institute for Agricultural and Fisheries Research (ILVO) and Département de l'Etude du Milieu Naturel et Agricole (DEMNA) from 2013 to 2015. The main objective of this project was to study the presence of *Monochamus* spp. (Cerambycidae) in Belgium. This genus of longhorn beetles lives in pine and spruce trees and is the vector of the pinewood nematode *Bursaphelenchus xylophilus*. This nematode has established in Portugal and Spain and causes severe damage to pine forests. For this project, 89, 90 and 92 baited traps were deployed in 2013, 2014 and 2015, respectively, throughout Belgium. Ten traps were set up each year in pine trees in the vicinity of import risk locations and the remaining traps were established in pine forest stands, evenly distributed according to the distribution of pine forests throughout Belgium. No clear evidence was found for a persistent *Monochamus* population in Belgium as only 7 individuals were caught at different locations and never in the same site in successive years (BOONE *et al.,* 2015). The traps used in this project were cross vane flight interception traps baited with Galloprotect Pack® lures (SEDQ: Barcelona, Spain) containing the *Monochamus* aggregation pheromone (monochamol) and kairomones (*Ips* spp. pheromones: ipsenol and 2-methyl-3-buten-1-ol, and a conifer volatile, α-pinene). These attractants not only attract *Monochamus* spp. but also many other pine-associated species, predominantly saproxylic beetles. Due to the fact that the trapping was quite systematic over entire Belgium and for three years, the catches resulting from this project were analyzed in order to learn more about our pine associated beetles, including the *Thanasimus* spp. Due to the large number of

samples, only the rest fractions of the first two years were checked and excluding samples from the import risk locations. These results are included in this paper.

To compile all the literature data, the Belgian entomological database was used (http://www.srbe-kbve.be/speciesIndex/) and all retrievable records of these species mentioned in the Bulletin SRBE/KBVE, Lambillionea, Phegea, Entomo-Info and Atalanta were entered in a database. The articles retrieved that included data of *T. formicarius* are DEPRÉ *et al.* (1930), MARÉCHAL & LECLERCQ (1938), LELEUP (1977), HANSEN (1981), BOSSELAERS (1984), COULON (1985), JANSSENS (1991), VISKENS & BRUERS (1993), TROUKENS (1999), VERSTEIRT *et al.* (2000), HEIRBAUT *et al.* (2001), LODEWYCKX (2002), LODEWYCKX *et al.* (2004) and VAN MALDEREN (2007).

We also included the data of the saproxylic data base (DRUMONT *et al*., 2011, http://projects.biodiversity.be/beetles/) as well as data from the "Objective 1000" network project coordinated by the Royal Belgian Institute of Natural Sciences (RBINS) that aims at making an inventory of the insect fauna of the botanical garden Jean Massart in Auderghem (Brussels). Here, also Galloprotect Pack® baited traps were used from 2015-2017.

Another research included here are results from baited traps used for scolytids and *Thanasimus* in 2002-2003 in Luxembourg province by Nathalie Warzée for her PHD thesis. She used small 30x15 cm bottle–traps baited with Pheroprax®, a commercial lure for *Ips typographus*, racemic ipsdienol and exo-brevicomin, and inspected every three weeks from February-March to September-October. The attractants have been recognized to collect *T. femoralis* in experiments set-up by N. Warzée in France (Vosges region in 2001-2004 and Landes region in 2003) (WARZÉE, 2005). These traps were set-up in Wellin forest (2002) in a wide variety of stands and in Libin forest (2003) comprising 267 ha of spruces and 7 ha of pines. In Libin, traps were distributed by pairs along 6 transects which all started in the central pine stand and extended to the large neighboring spruce stands.

Finally, data from Waarnemingen.be/Observations.be (Natuurpunt Stichting Natuurinformatie and Natagora) that included a picture, were checked and requested, and data from Likona were requested as well. We are aware that more data is available for *T. formicarius* but as it is a very common species this was not further included.

For the distribution, all available data is used. As the Galloprotect Pack® was clearly attractive for the *Thanasimus* spp., we can consider a species to be absent at sites where the traps were placed for at least one full season and did not catch the species.

For the phenology, the data of the 'Monochamus' project was split into 'Flanders' (where traps samples were collected monthly) and 'Wallonia and Brussels' (where traps were visited every two weeks). For every period, the mean and standard deviation of the number of specimens per trap was calculated. For *T. femoralis*, only the traps where the species was found were included in the calculation.

Results

An overview of the compiled data can be found in Table 1. Distribution maps of *T. formicarius* and *T. femoralis* are given in Figs 3-4. *Thanasimus formicarius* clearly covers the entire Belgium while *T. femoralis* was mainly found in the samples of the 'Monochamus' project from the Campine ecoregion (Appendix A). Outside this region, the species was found in five locations including three with a single individual:

- Stropersbos (Stekene, East-Flanders), 17.VI-8.VII.2014: 1 ex.
- La Haye (Bertrix, Luxembourg), 15.VII-1.VIII.2013: 1 ex.
- Stehling (Eupen, Liège), 15.VII-1.VIII.2013: 2 ex., 15.V-1.VI.2014: 1 ex., 1.VII-15.VII.2014: 2 ex.
- Durnal (Yvoir, Namur), 1.VIII-15.VIII.2013: 1 ex.
- Tienne du Long Pré (Gedinne, Namur), 15.VII-1.VIII.2013: 1 ex., 1.VIII-15.VIII.2014: 1 ex.

Furthermore, specimens were found by Eugène Stassen and Luc Crèvecoeur (all records form Limburg):

- Sahara (FS5980, Lommel), 22.IV-11.V.2010: 1 ex., pitfall trap, Leg. Eugène Stassen & Toon Janssen (werkgroep Levend Zand)
- Pijnven (FS6370, Hechtel-Eksel), 8.VII.2013: 1 ex., light trap, Leg. Luc Crèvecoeur
- Pijnven (FS6370, Hechtel-Eksel), 12.VII.2014: 1 ex., light trap, Leg. Luc Crèvecoeur

The phenology of both species is given in Figs 5-6. *Thanasimus formicarius* was mainly caught in the spring (mainly May and June) and its activity strongly decreased from August onwards, although some specimens were found up to 16-31.X. From the phenology (Fig. 5), one could think that more specimens are present in the Flemish traps but as the collecting period is twice as long (monthly instead of every two weeks), we can conclude that the results are fairly comparable between Flanders and Wallonia + Brussels. The collection data, the literature, and the Likona and Waarnemingen.be/Observations.be data, furthermore, reveal that specimen have been found in all months, but 31% of the records comes from May, 18% from April and 17% from June. *Thanasimus femoralis* was captured in much lower numbers than *T. formicarius* (in Flanders, respectively 3,5 ± 7,2 and 50,6 ± 77,4 per trap sample of the 'Monochamus' project). The phenology of *T. femoralis* is also less clear with captures ranging from April to August and a few specimens up to October. This can either be interpreted by the fact that too little specimens were captured to see a clear peak in the phenology or by the species having a very broad activity period. The phenology of this species in Wallonia is not given as only a small number of individual specimens were found.

Concerning the baited bottle-traps in Luxembourg province, only three *T. formicarius* were caught in Libin forest in contrast to 518 in Wellin forest. *T. femoralis* was not collected in Belgium, despite the same setup in France successfully captured *T. femoralis*.

Table 1. Overview of the data compiled for *T. formicarius* and *T. femoralis* giving the number of observations or records with the number of specimen between brackets. For the 'Monochamus' project, the number of records representing absences are added with '+'.

Origin	***T. formicarius***	***T. femoralis***
'Monochamus' project	586 (17.115) + 199	64 (408) + 721
Literature	48	0
Waarnemingen.be/Observations.be	145 (183)	0
Likona	94 (156)	3 (3)
RBINS (DRUMONT *et al.,* 2011), "Objective 1000" network project 2015-2016	289 (548)	0

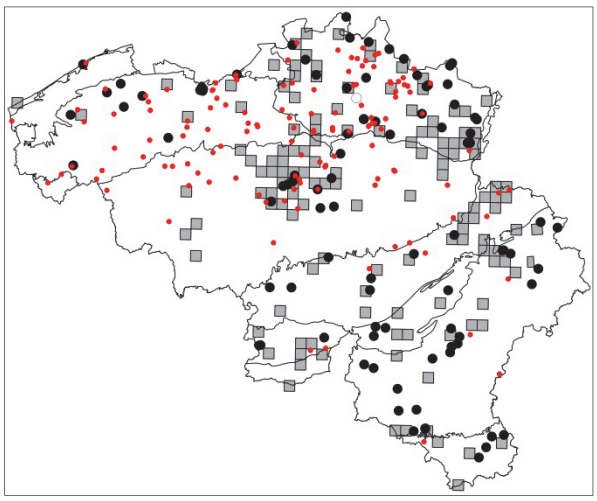

Fig. 3. Distribution of *T. formicarius* in Belgium with large black dots representing presences based on the 'Monochamus' project; the hollow circle represents an absence; small red dots represent recent data (≥2000) from waarnemingen.be/Observations.be and grey 5*5km UTM squares represent literature or collection material (mainly <2000).

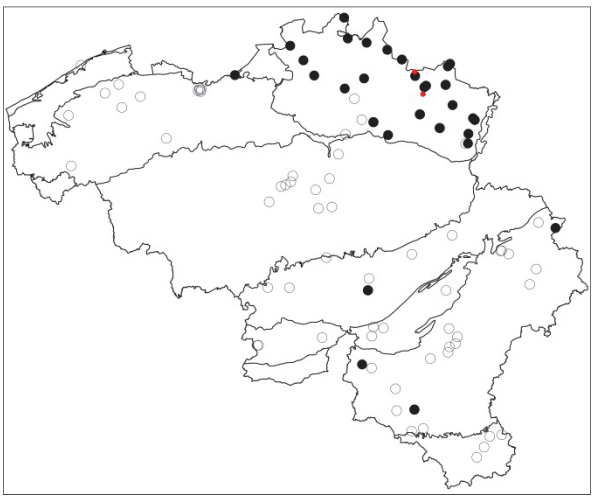

Fig. 4. Distribution of *T. femoralis* in Belgium with large black dots representing presences based on the 'Monochamus' project; hollow circles are absences; small red dots represent recent data (≥2000) from Luc Crèvecoeur and Eugène Stassen.

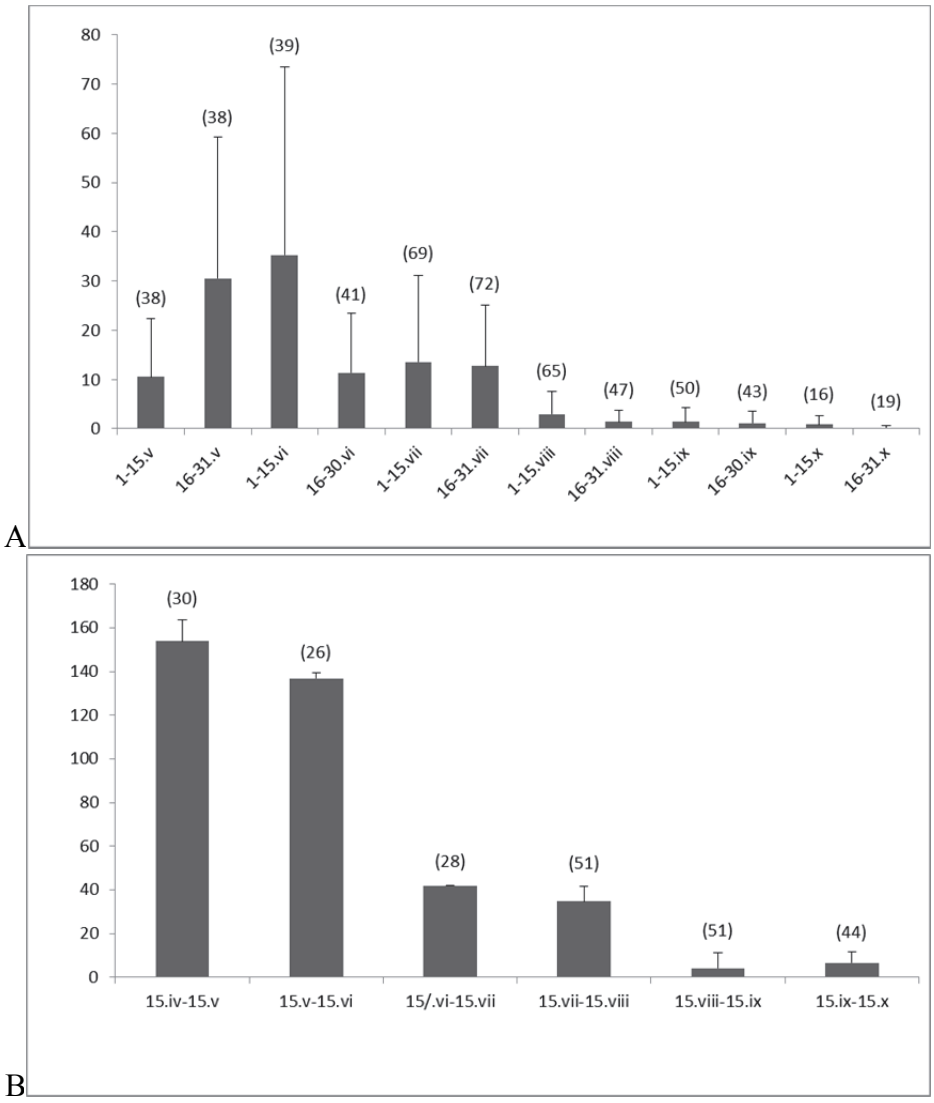

Fig. 5. Phenology of *T. formicarius* in Wallonia and Brussels (A) and Flanders (B) given the number of specimens (mean ± st. dev.) per trap for a given period based on the samples of the 'Monochamus' project. The number of traps with successfully collected samples during the given period is mentioned between brackets.

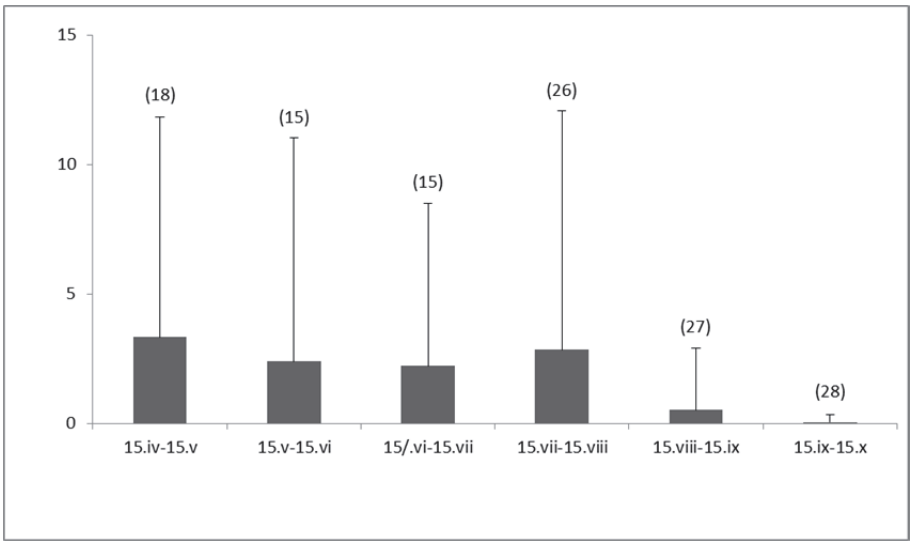

Fig. 6. Phenology of *T. femoralis* in Flanders given the number of specimens (mean ± st. dev.) per trap for a given period based on the samples of the 'Monochamus' project. The number of traps with successfully collected samples during the given period and *T. femoralis* present at the site is mentioned between brackets.

Discussion

Based on our results, we can firmly conclude that *T. femoralis* is present in Belgium with established populations. More precisely it seems to be present all over the Campine ecoregion and very locally outside this region. Three out of the five locations outside the Campine ecoregion are represented by only one single specimen, so it is possible that these individuals were transported with e.g. fire wood. However, in Gedinne and Eupen, where specimens have been found in successive years, the existence of an established population is quite sure.

Thanasimus femoralis has been reported as a new species to the local fauna in many countries only recently (FERENCA, 2004: Lithuania; TSINKEVICH *et al.,* 2005: Bialowieza, Poland; DOYCHEV & OVCHAROV, 2008: Bulgaria; KOVÁCS *et al.,* 2014: Albania). These new observations are in most cases not related to the use of pheromones or other innovative techniques. Also the records in the Netherlands show an increasing number of provinces (see introduction). Based on this, we can assume that the species has been expanding its range. This range expansion is also expressed by a comparison of the number of European countries listed in LÖBL & SMETANA (2007) and http://www.faunaeur.org/ which is respectively, 31 and 8. Also GERSTMEIER (1988) only mentions 'North and central Europe, Alps, Bavarian Forest, Hungary, Czechoslovakia'. Another argument in favor of this, is that Nathalie Warzée has not found *T. femoralis* in Wellin and Libin forest in 2002-2003, which is near to the current location in Bertrix, despite the use of attractive pheromones for *T. femoralis*.

Due to the fact that *T. femoralis* is difficult to detect as it lives predominantly in the crowns of trees, the possible range expansion has likely remained unnoticed. Based on our observations, we can wonder whether the current distribution is stable or whether the population is still expanding. In the latter case the Campine ecoregion might have been colonized quickly as it is an ideal habitat with a warm microclimate and large pine forests while the few records outside this region would represent the first colonization outside this optimal habitat. Alternatively, the current distribution could show a stable situation which could be explained by habitat limitations such as climate and availability of host trees (e.g. large pine forests).

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Appendix A. Overview of the localities with *Thanasimus femoralis* in the Campine ecoregion found in the samples of the 'Monochamus' project ordered by province and town. Number of specimens mentioned is based on the trap samples from 2013 and 2014 unless the year in the name indicates that the trap was placed at this locality for only one year.

Antwerpen: Hoge-vijverbos 2014 (Arendonk): 30 ex., Mik Dom (Brasschaat): 12 ex., Peertsbos (Herentals): 1 ex., Elsakker (Hoogstraten): 3 ex., Eindepoel (Hoogstraten-Merkplas): 3 ex., Withoefse heide 2014 (Kalmthout): 8 ex., Koningsbos (Kasterlee): 10 ex., Achter Grootbosheide 2014 (Mol): 28 ex., Drijhoekbos (Schilde): 1 ex., Paardsdrank (Turnhout): 57 ex., **Limburg:** Grote Kiewitsweide 2014 (As): 1 ex., Koerselseheide (Beringen): 4 ex., Hees (Diest): 11 ex., Wouterbos 2013 (Dilsen-Stokkem): 1 ex., Wouterbos 2014 (Dilsen-Stokkem): 8 ex., Rozendaalbos 2013 (Hamont-Achel): 37 ex., Rozendaalbos 2014 (Hamont-Achel): 23 ex., Hengelhoef (Houthalen-Helchteren): 1 ex., Blekerheide (Lommel): 27 ex., Mechelse Bos 2013 (Maasmechelen): 37 ex., Bos bij Ellikom (Meeuwen-Gruitrode): 5 ex., Kolisbos (Neerpelt): 10 ex., Pijnven Rijksbos 2013 (Overpelt): 30 ex., Pijnven Rijksbos 2014 (Overpelt): 46 ex., Averbodebos (Tessenderlo): 2 ex.