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Discovery of a new inland population of *Amara strenua* Zimmerman, 1832 at Heverlee, central Belgium (Coleoptera: Carabidae)

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Abstract

A new inland population of the rare ground beetle *Amara strenua* Zimmerman, 1832 is reported for Belgium. This species was encountered during a survey using pitfall traps at Abdij van Park near Heverlee. This observation marks the first record in Flemish Brabant, as well as the most inland known population of *A. strenua* in Flanders. Details on the habitat and the phenology of the newly discovered population are provided. Furthermore, an overview of the known records and an updated distribution map are given and discussed.

Keywords: Ground beetles, Flanders, rare species, pitfall traps, distribution

Samenvatting

We rapporteren de vondst van een nieuwe Belgische binnenlandse populatie van de zeldzame loopkever *Amara strenua* Zimmerman, 1832. Deze soort werd waargenomen tijdens een onderzoek met bodemvallen in Abdij van Park in Heverlee. Deze opmerkelijke vondst telt zowel als de eerste observatie voor Vlaams-Brabant, als de meest binnenlands gekende populatie in Vlaanderen. Gegevens over de habitat en fenologie van deze ontdekte populatie worden gegeven. Verder wordt een overzicht van de gekende records gemaakt en besproken, samen met een aangepaste verspreidingskaart.

Résumé

Une nouvelle population du rare carabe *Amara strenua* Zimmerman, 1832 est mentionnée en Belgique. L'espèce a été observée lors d'un inventaire à Abdij van Park (Heverlee). Cette observation constitue le premier signalement de l'espèce dans le Brabant flamand et sa localisation la plus à l'intérieur des terres en Flandre. Des informations détaillées sur l'habitat et la phenologie sont fournis. En outre, une carte de distribution actualisée et un compte rendu des observations sont donnés et discutés.

Introduction

Amara strenua is an 8-10 mm long ground beetle (Carabidae) (Fig. 1). It is characterized by a metallic green or bronze dorsal coloration and trifurcate protibial spur. It can be identified reliably by the unique shape of the male genitalia. *A. strenua* most closely resembles *A. tricuspidate*, but can be differentiated by a deeper groove-shaped basal impression on the



Fig. 1 - *Amara strenua* Zimmerman, 1832 collected in a pitfall trap at Abdij van Park (Heverlee, Belgium), habitus.
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pronotum and a narrower pronotum posteriorly in *A. tricuspidata*. The male genitalia of *A. strenua* are distinctive, missing lateral indentations on the aedeagus (MUILWIJK *et al.*, 2015). *Amara strenua* is sparsely distributed in the northern parts of Central- and North-West Europe (GBIF, 2021). While it has a relatively wide overall distribution, the species occurs patchily and is known only from scattered records. In Belgium, *A. strenua* is listed as an eurytopic species with a clear preference for moist grasslands (DESENDER *et al.*, 2008). In other studies *A. strenua* typically occurs in salt marshes, where they are mainly found under vegetation and stones (LINDROTH, 1974, 1986; LUFF, 1998). They are also recorded inland on floodplain grasslands of large rivers in plant litter, between the roots of plants and on grasses (HIEKE, 1970; TURIN, 2000). Until recently, in the Netherlands this species was only known from a few old observations around major rivers (TURIN, 2000). In 1999, *A. strenua* was found in Yerseke (BOEKEN *et al.*, 2002). More recently the presence of this species could be confirmed in Maarn (2021), Oosterhout (2021) and Oostvoorne (2021) (waarneming.nl, 2021). A link with the polders is only present in the latter two records, the former observation was done at a sand pit surrounded by heathland and forest on dry sandy soil.

On the first Red list of carabid beetles in Flanders, this species was considered regionally extinct (DESENDER *et al.*, 1995). Only four historic captures are known between 1874 and 1942, all around major rivers or near the coast. In 2002, *A. strenua* was rediscovered in the Uitkerkse Polder in Flanders (VERSTEIRT *et al.*, 2002). This led to its updated status "susceptible" in the updated list of ground and tiger beetles in Flanders (DESENDER *et al.*, 2008). More recently several new records were provided by DEKONINCK *et al.* (2019).

During a year round biodiversity monitoring survey at Abdij van Park (Heverlee, Belgium) in 2020, a population of *A. strenua* was observed (GEERAERT *et al.*, 2021). This finding was unexpected due to the more inland locality, regarding its current known distribution and habitat.

Material and Methods

In 2020 a survey was carried out by BINCO at Abdij van Park (Heverlee). Ground beetles were monitored with sets of three pitfall traps at four sites. These four sites consisted of different habitats (forest with seepage water, orchard, park forest, riparian reed beds) and samples were collected every two weeks from 2020-06-20 to 2020-11-07 (GEERAERT *et al.*, 2021).

Each pitfall trap consisted of a transparent container (1000 ml) with a circular opening (115 mm diameter). To prevent unwanted bycatch of small mammals and amphibians, a small grill was placed in the container (10 mm deep, mesh size 10 mm). This trap was placed in a PVC tube, to facilitate emptying. The traps were filled 1/3 with a solution of formaldehyde (4%) and a drop of detergent was added to eliminate the effects of surface tension. A transparent PVC board, positioned above the opening of the trap, served as a cover for rain and leaf litter. Additionally ground beetles were also collected with skinner light traps and hand collecting on site.

All specimens were identified in unmounted condition (70% ethanol). Study of the male genitalia confirmed the identification. Literature used for identification was MUILWIJK *et al.* (2015). Specimens are stored in the collections of CARARE.

A distribution map (Fig. 4) of the known distribution of *Amara strenua* in Belgium was made with ArcGIS 10.4.1 and is based on all records in cited literature and in the Database of Belgian Carabidae CARABEL.

Results

During this study, 18 specimens of *A. strenua* were found. All collected specimens originated from pitfall traps in an orchard meadow grazed by sheep. The first individuals were collected in the third week of June (Fig. 2). Peak activity was reached in the first week of July. During this study, the last two individuals were caught in the second week of September.

The collection site (Fig. 3) comprises historic grassland and a low-stem orchard. It is categorized as species-poor permanent cultivated grassland (DE SAEGER *et al.*, 2016). The most abundant plant species present were *Agrostis capillaris*, *Anisantha sterilis*, *Cirsium arvense*, *Dactylis glomerata* and *Ranunculus repens*. The soil consists of sandy loam. Ellenberg indicator values point towards high soil humidity and high nutrient availability (GEERAERT *et al.*, 2021).

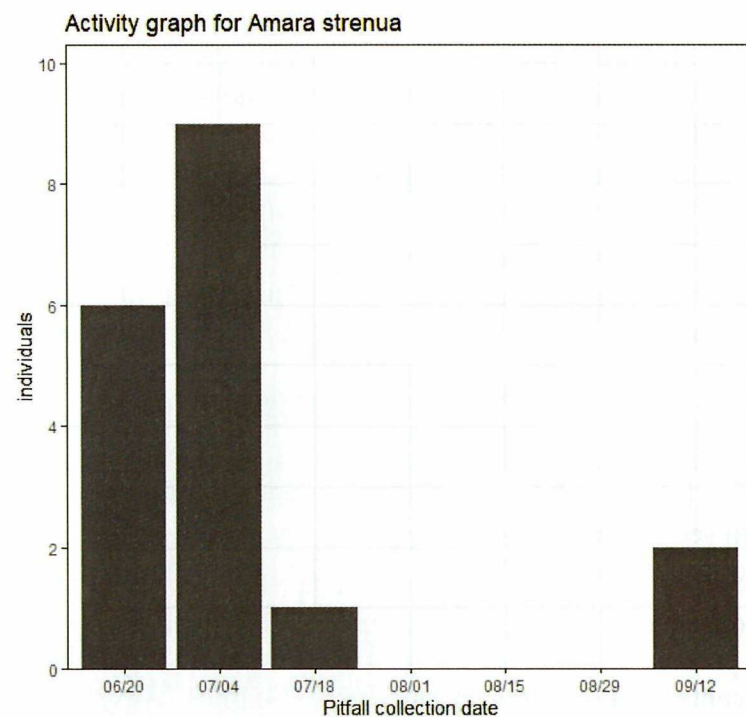
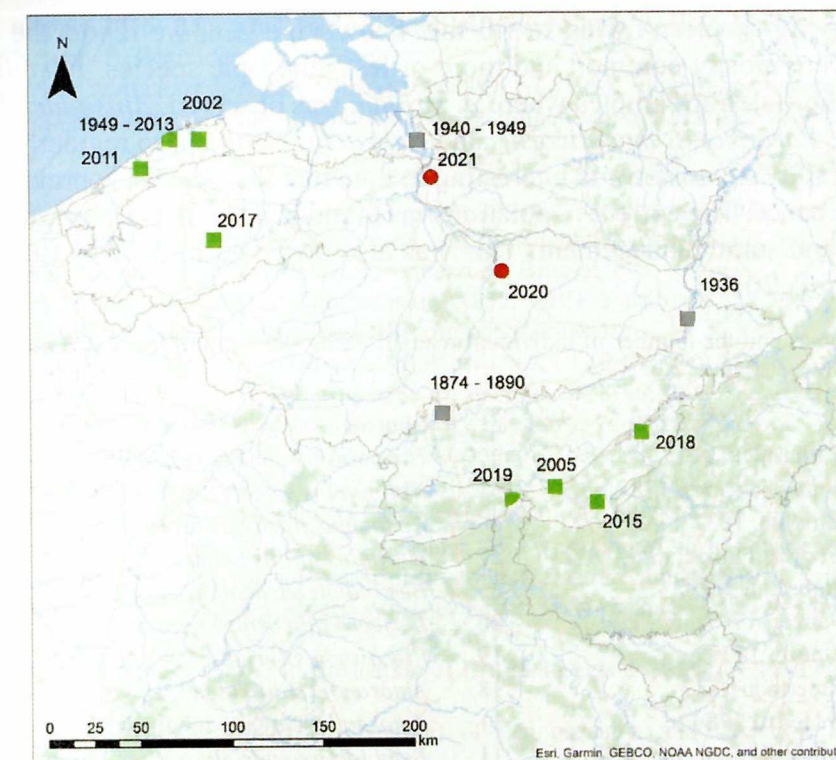


Fig. 2 - Phenology of individuals collected during the survey at Park Abbey



Fig. 3 - Collection site of the low-stem orchard in Abdij van Park (Heverlee) © Lore Geeraert.

Fig. 4 - Distribution of *Amara strenua* in Belgium with first and last year of recording.

During the pitfall trapping at the site at Abdij van Park, 34 species were collected together with *A. strenua* at the same location (Table 1). The most abundant and most commonly co-caught species were *Poecilus versicolor*, *Anisodactylus binotatus*, *Amara lunicollis*, *Paraphonus maculicornis* and *Nebria brevicollis*.

Discussion

A total of 18 individuals of *A. strenua* were collected during this study, indicating the presence of a population and not just dispersing individuals. This new population is the first observation of this species in Flemish Brabant, and the most inland known population of *A. strenua* in Flanders.

Our study site is located both central of all Belgian records and about 100 km away from the nearest known population (Fig.4.) LAMBRECHTS *et al.* (2016) noted its presence in exclusively grazed saline vegetation at the east coast of Belgium, while almost none were found in pioneer vegetation. We also report a recent record of *A. strenua* from 2021 in Wilrijk that was found in a pitfall trap on a roof terrace. This further supports the hypothesis from VERSTEIRT *et al.* (2002) that at least part of the population is able to fly and colonize new habitats.

Amara strenua follows a fluvial distribution in Europe, and occurs in wet or humid grasslands or marshes. As this study location is in proximity to the river Dyle, this may suggest such a distribution for Flanders too. Moreover, this suggests more populations are expected to be found around major rivers, when monitoring effort is increased. The soil is a heavy sandy loam with a rather high humidity as confirmed by the Ellenberg indicator values (GEERAERT *et al.*, 202). This also conforms to the habitat requirements as depicted in literature (TURIN, 2000).

Our results suggest an activity peak in the beginning of July and a second peak in the beginning of September. However, more pitfall data is needed to make a more conclusive evaluation of the species' activity peak since the traps were only active from June 20th until November 7th and the number of collected specimens was low. TURIN (2000) did not provide enough data to

report accompanying species. Trying to fill this knowledge gap, we report the co-occurring species. These were mostly common and more or less eurytopic species. *Poecilus versicolor* was present in all pitfall trap samples where *A. strenua* was observed. *Anisodactylus binotatus*, *Amara lunicollis*, *Paraphonus maculicornis* and *Nebria brevicollis* also regularly accompanied *A. strenua* at this site. Moreover, it is interesting to note that this species is probably not highly sensitive to disturbance. The current population was found in a small sheep grazed orchard with regular mowing and some management. This was also observed in another study in Belgium (LAMBRECHTS *et al.*, 2016).

Table 1 - List of species and the number of individuals caught in the same pitfall traps as *Amara strenua* during the survey in Park Abbey 2020.

Species	ex.	Species	ex.
<i>Poecilus versicolor</i> Sturm, 1824	377	<i>Harpalus tardus</i> Panzer, 1796	4
<i>Anisodactylus binotatus</i> Fabricus, 1787	51	<i>Notiophilus substriatus</i> Waterhouse, 1833	4
<i>Amara lunicollis</i> Schiodte, 1837	44	<i>Acupalpus flavicollis</i> Sturm, 1825	3
<i>Paraphonus maculicornis</i> Duftschmid, 1812	27	<i>Harpalus affinis</i> Schrank, 1781	3
<i>Nebria brevicollis</i> Fabricius, 1792	25	<i>Bembidion tetracolum</i> Say 1823	2
<i>Amara communis</i> Panzer, 1797	20	<i>Loricera pilicornis</i> Fabricius, 1775	2
<i>Calathus fuscipes</i> Goeze, 1777	19	<i>Pterostichus vernalis</i> Panzer, 1796	2
<i>Amara strenua</i> Zimmerman 1832	18	<i>Amara cfr. kulti</i> Fassati, 1947	1
<i>Bembidion lampros</i> Herbst 1784	11	<i>Amara plebeja</i> Gyllenhal, 1810	1
<i>Calathus melanocephalus</i> Linnaeus, 1758	11	<i>Bembidion quadrimaculatum</i> Linnaeus, 1760	1
<i>Amara familiaris</i> Duftschmid, 1812	9	<i>Harpalus latus</i> Linnaeus, 1758	1
<i>Clivina collaris</i> Herbst, 1784	8	<i>Harpalus rubripes</i> Duftschmid, 1812	1
<i>Harpalus griseus</i> Panzer, 1796	7	<i>Ophonus puncticeps</i> Stephens, 1828	1
<i>Harpalus rufipes</i> De Geer, 1774	7	<i>Pterostichus anthracinus</i> Panzer, 1795	1
<i>Agonum muelleri</i> Herbst, 1784	5	<i>Pterostichus strenuous</i> Panzer, 1796	1
<i>Badister bullatus</i> Schrank, 1798	5	<i>Syntomus foveatus</i> Geoffroy, 1785	1
<i>Trechus obtusus</i> Erichson, 1837	5	<i>Trechus quadristriatus</i> Schrank, 1781	1

The discovery of a population of this species in this location is remarkable and it would be interesting to have more long term surveys in neighboring ecologically similar sites to see if more populations of *Amara strenua* are present in the region. For the conservation of this population it would be valuable to keep the current management and water conditions (no draining) of the orchard and its grasslands consistent.

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