

# Report and comments on introduced *Carabus* species of the subgenus *Chrysocarabus* (Coleoptera: Carabidae) in Belgium

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**Abstract.** The authors report on the occurrence of introduced populations of non-native taxa belonging to the subgenus *Chrysocarabus* Thomson, 1875 in Belgium. More information is provided regarding the species and habitats.

**Samenvatting.** De auteurs maken melding van het voorkomen van geïntroduceerde populaties van niet-inheemse soorten behorende tot het subgenus *Chrysocarabus* Thomson, 1875 in België. Er wordt meer informatie verschaft betreffende de specifieke soorten en de biotopen.

**Résumé.** Les auteurs signalent la présence en Belgique d'espèces introduites appartenant au sous-genre *Chrysocarabus* Thomson, 1875. De l'information est fournie concernant les espèces mentionnées et sur les habitats.

**Key words:** *Carabus* — *auronitens* — *festivus* — *subfestivus* — *rutilans* — *Chrysocarabus* — individual form — Belgium.

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## Introduction

An introduced non-native species (or subspecies) can generally be defined as an organism which does not naturally occur in the area, but is considered to be introduced, either accidentally or deliberately, by human activity. When it proliferates and persists in the new geographic region, it may become invasive (Ricciardi 2013). The term *invasive* is also used (often by policy makers) to describe colonizing species that have an undesirable ecological or economic impact (Ricciardi 2013). As the case may be, the most common reason for introducing a species into a new habitat or area is for economic gain (Johnson 2003). A recent study by Blackburn *et al.* (2019) states that alien species are considered to be a contributing cause of no less than 25% of plant extinctions and 33% of animal extinctions. In addition to competition for food and habitat, introduced species are also able to eradicate native species by hybridisation, and is considered a distinctly strong threat when the native species is less common than the introduced one (Simberloff 2001). Plants as well as animals are under the threat by such introgression, a problem much more common in regions inhabited by closely related species (Simberloff 2001).

On the other hand, when it comes to active and sustainable forms of nature conservation, it seems reasonable to re-establish populations by releasing specimens into isolated and vacant habitats, or restoring populations by artificial dispersion and introduction (Turin *et al.* 2003; Schultz *et al.* 2008).

In this paper, the authors not only focus on 'newly' observed and aberrant populations of the Belgian indigenous *Carabus* (*Chrysocarabus*) *auronitens* ssp. *auronitens* (Fabricius, 1792), but also report on three other introduced taxa of the subgenus *Chrysocarabus*: *C. (Chrysocarabus) auronitens* ssp. *subfestivus* (Oberthür, 1884), *C. (Chrysocarabus) auronitens* ssp. *festivus* (Dejean, 1826) and *C. (Chrysocarabus) rutilans* (Dejean, 1826), all of which belong to the Carabinae, a subfamily of Carabidae.

## Material and methods

For this research, beetles were photographed *in situ*, and a small number of specimens were collected for the purpose of study and documentation. Most specimens were released after identification. Some specimens are now included in the entomological collection of the Royal Belgian Institute of Natural Sciences. The nomenclature used is according to the reference work 'Le sous-genre *Chrysocarabus* Thomson, 1875 (Coleoptera, Carabidae)' by Maguerre (2009).

### *Carabus (Chrysocarabus) auronitens* ssp. *auronitens*

*Carabus (Chrysocarabus) auronitens* ssp. *auronitens* is a widespread European species, ranging from the French Pyrenees and Atlantic coast to Poland, Romania and Ukraine in the East, and from the Alpine chain in the south to the northern parts of Germany (Turin *et al.* 2003).

According to the Flemish Red List (Desender *et al.* 2008a), the species is endangered. *C. auronitens* is also protected by law (Soortenbesluit 2009). In the Walloon region (the southern half of Belgium), the species is currently not considered to be endangered, and rather abundant in the proper habitat. The greater part of its natural distribution area is, under natural circumstances, confined to the south and southeast of the country (Fig. 1, blue areas). Nonetheless, during the past 20 years the species has been recorded in an increasing number of locations in the northern part of the country (Fig. 1, red areas). Especially in the regions surrounding Mol, Dessel, Kasterlee, Lichtaart, Retie (Province of Antwerpen) and Sint-Truiden (Province of Limburg), new populations have emerged and several seem to be expanding. In addition, a single verified observation in 2018, from the region of Knesselare (Province of Oost-Vlaanderen), was made.

Desender *et al.* (2008b) mention no records of *C. auronitens* between 1950 and 1980 for the Provinces of Antwerp, Limburg and East Flanders. However, for the period between 1830 and 1950, Desender *et al.* (2008b)

mention two records for the Province of Antwerp (Kalmthout and Berchem), three records for Limburg (Genk, Heusden en Beverlo) and one record for East Flanders (Heusden, near Gent). According to W. Dekoninck (pers. comm., 15.i.2021), these older observations all predate 1900. The catalogue by Muilwijk, Felix, Dekoninck & Bleich (2015) also mentions the presence of *C. auronitens* in Antwerp before 1950. The single record for East Flanders is omitted in Muilwijk *et al.* (2015). These older records are well worth a separate and extended investigation since they generate an array of questions, e. g. are these observations correct and are the specimens part of an existing collection?

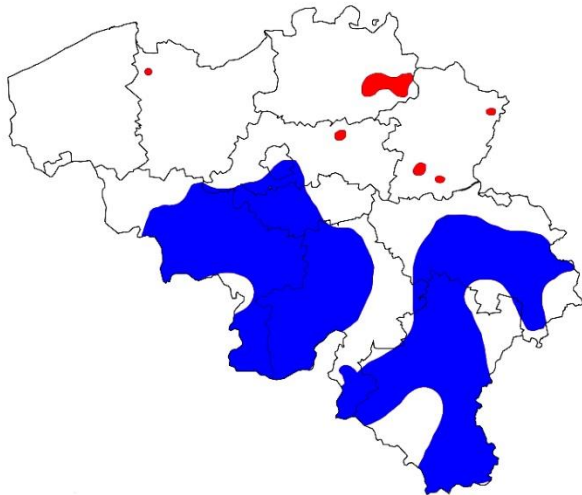


Fig. 1. Current (1980–2021) geographical distribution of *Carabus auronitens* ssp. *auronitens* in Belgium. Native populations indicated in blue, non-native, introduced populations indicated in red. © Ief Peeters.

As a result of forest defragmentation, loss of natural corridors and absence of sightings between the red areas, it is very plausible to assume the red area-populations are not natural and have been established as a result of human interference. This hypothesis is further strengthened by the presence of specific individual colour forms in the red areas, of which the origin is known: var. *putzeysi* (Fig. 7j) from the Sonian forest near Brussels), and var. *aureopurpureus*, var. *atronitens* (Fig. 7i) and *noviprati* (Fig. 7k) from the region of Neupré, near Liège.

### ***Carabus (Chrysocarabus) auronitens* ssp. *subfestivus***

*Carabus (Chrysocarabus) auronitens* ssp. *subfestivus* (Figs. 2, 7g) is a subspecies endemic to the French region of Bretagne (Côtes d'Armor, forêts de Lorges, Coat'loch, Coat-an-Noz, etc.) (Maguerre 2009). In general, this subspecies is slightly smaller in comparison to the ssp. *auronitens*. The most distinctive feature is the black tibiae. In France, *C. auronitens* ssp. *subfestivus* is protected by law (Legifrance.gouv.fr).

This particular subspecies was only recently detected in the vicinity of Retie (Province of Antwerp). Its presence has been confirmed by both authors in February and May 2020. Please note that the population in Retie of *C.*

*auronitens* consists of both *C. auronitens* ssp. *auronitens* and *C. auronitens* ssp. *subfestivus*. The habitat at the sites in which these subspecies occur is rather atypical for either species, with a dominance of pine trees (*Pinus* sp.). In their native range, both taxa have a distinct preference for shady forests in which beech (*Fagus sylvatica*) is the dominant species. In Dessel, *C. auronitens* ssp. *auronitens* cohabits with *C. nemoralis* (Müller, 1764) (rare) and *C. granulatus* (Linnaeus, 1758) (abundant). In the Retie-habitat, the species occurs together with *C. problematicus* (Herbst, 1786).



Fig. 2. *Carabus (Chrysocarabus) auronitens* ssp. *subfestivus* in situ, Retie, Belgium, 16.ii.2020. © Ief Peeters.

### ***Carabus (Chrysocarabus) auronitens* ssp. *festivus***

The natural range of this subspecies is situated in the French Departments of Aude, Tarn and Aveyron; Forêt de la Loubatière, Pic de Nore, Barrage des Cammazes, Montagne Noire, etc. (Maguerre 2009).

*Carabus auronitens* ssp. *festivus* (Fig. 7a) is the most southern subspecies of the *auronitens*-group. It differs morphologically from ssp. *auronitens* in the smaller size, black tibiae and reduced primary intervals on the elytra (or even lacking in some individuals).



Fig. 3. Habitat of *Carabus (Chrysocarabus) auronitens* ssp. *festivus* in the Visé region, Belgium, 26.i.2020. © Ief Peeters.



The first report of its presence in Belgium emerged in May 2019, and was confirmed by both authors in January 2020. The habitat in the region of Visé, in the Province of Liège, is very atypical for this species. The natural habitat in the Loubatière forest (Montagne Noire, France) has a dominance of beech trees (*Fagus* sp.) with relatively little irradiation from the sun (pers. obs. first author). The habitat at Visé (Fig. 3) consists mainly of hazel (*Corylus* sp.) and maple (*Acer* sp.), indicating a sufficiently moist, calcareous and loamy soil (Fig. 3).

Based on recent surveys by the authors, *ssp. festivus* is abundant in this habitat; in January 2020, 64 specimens were found by the first author and 42 specimens by the second. In addition, seven specimens of *C. (Megodontus) violaceus ssp. purpurascens* (Fabricius, 1787) were found by the first author.

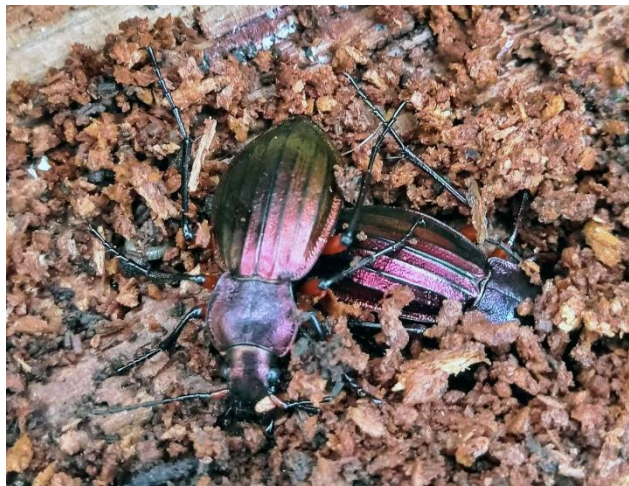


Fig. 4a. *Carabus (Chrysocarabus) auronitens ssp. festivus, var. violaceopurpureus* in situ in the hibernation chambers in the Visé region, Belgium, 26.i.2020. © Ief Peeters.



Fig. 4b. *Carabus (Chrysocarabus) auronitens ssp. festivus, var. violaceopurpureus* and *var. purpureorutilans* in situ in the hibernation chambers in the Visé region, Belgium, 28.xii.2020. © Ief Peeters.

*Carabus (Chrysocarabus) auronitens ssp. festivus* shows a very high tendency towards hyperchromatism (Figs. 4a, 4b, 7), and also other individual forms (Maguerre 2009). Undermentioned forms were found during a

sampling conducted by the authors in January, May and December 2020.

- ❖ *var. purpureorutilans* Barthe, 1908 (Fig. 7c)
- ❖ *var. holochrysus* Barthe, 1908 (Fig. 7d–e)
- ❖ *var. violaceopurpureus* Barthe, 1908 (Fig. 7f)
- ❖ *var. pumicatus* Lapouge, 1910 (Fig. 7b)
- ❖ *var. ceroglossoides* Barthe, 1923

According to information obtained by the second author, *C. auronitens ssp. festivus* was introduced in the Visé-habitat by an amateur entomologist in 2013, under the guise of an ‘attempt to reintroduce a rare Belgian species’. Of course, this explanation is gratuitous to the fullest extent for several reasons. First of all, the subspecies is not native to Belgium and second, the habitat to which the population was introduced has never been occupied by *C. auronitens* s. l. (Desender *et al.* 2008b), let alone the French endemic *C. (Chrysocarabus) auronitens ssp. festivus*.

### *Carabus (Chrysocarabus) rutilans*

*Carabus (Chrysocarabus) rutilans* (Figs 6, 7h), one of Europe’s most spectacular ground beetle species, can measure up to 40 mm. The distribution range of this ground beetle is located in the South-Eastern Pyrenees; France, Spain (including some locations in Catalunya) and Andorra. *C. rutilans* is a rather eurytopic species, showing a preference for relatively humid *Fagus* or *Castanea* forests at middle altitudes with a northern exposure. Sometimes it can be found in dry cork oak forests, or even subalpine prairies up to 1800 m (Turin *et al.* 2003).



Fig. 5. Hibernation spot of *Carabus (Chrysocarabus) rutilans* in the Belgian habitat, 13.ii.2020. © Ief Peeters



The first observations of *C. rutilans* in Belgium occurred in 2013 and 2014 in the region of Liège. Its presence was confirmed by the first author, when seven specimens were found during a focused winter sampling in February 2020 (Fig. 6). This indicates a stable population for over at least seven years. The habitat consists of shale slopes with a northeastern exposure (Fig. 5). It has a dense cover of *Robinia pseudacacia*, *Quercus rubra*, *Salix nigra*, *Sorbus* sp. and an undergrowth of predominantly *Rubus* spp. and *Hedera* sp. As a whole, the habitat seems to hold enough moisture to constitute a suitable habitat for this species.



Fig. 6. *Carabus (Chrysocarabus) rutilans* in situ in the hibernation chamber in Belgium, 13.ii.2020. © Ief Peeters.

## Hypothesis

The abundance, species richness and attractive coloration of many species have made carabids popular objects of study by both professional and amateur entomologists (Lövei & Sunderland 1996). Especially the latter is the case for the subgenus *Chrysocarabus*; the polychromatic variety (hyperchromatism, melanisation, cupreousness and hypochromatism) made sure these insects are considered to be amongst the most beautiful beetles of the European fauna. Some individual forms are very rare and difficult to find, consequently making them very sought after by commercial collectors.

The number of polychromatic individuals within a population of *Chrysocarabus* can be influenced by inbreeding as a result of introgression. This is especially the case for the introduced *C. rutilans* and *C. auronitens* ssp. *festivus*, since the habitat patches for both species are very limited. No less than 56.6% of all individuals of *C. auronitens* ssp. *festivus* found during the sampling in February 2020 were subject to some stage of a hyperchromatic aberration. Individual forms of *C. auronitens*

ssp. *auronitens* in Retie and Dessel were much less abundant, yet present; the melanic and hyperchromatic forms indicate that the parental beetles most probably originate from the Sonian forest near Brussels and the region of Neupré, near Liège.

## Conclusion

It remains unclear when the populations *C. auronitens* ssp. *auronitens* and ssp. *subfestivus* were introduced in the north of Belgium, although for some populations an estimate can be made. A distribution map by Henderickx (1998) indicates one population in the southern part of the Province of Limburg, while the populations in Dessel and Retie are not present. In 2009, the population in Dessel came to the attention of the first author, and after a sampling in December 2009 approximately 50 specimens of *C. auronitens* ssp. *auronitens* were found. Consequently, it is acceptable to assume the introduction occurred in the period between 1998 and 2009. In 2016 and 2017, *C. auronitens* ssp. *auronitens* was found near Aarschot (Flemish Brabant). It is very likely that this population was also introduced, since the habitat is isolated, thus eliminating chances on natural colonization. The population of *C. auronitens* ssp. *festivus* near Visé was introduced in 2013 and is currently well established. *C. rutilans* was probably introduced near Liège shortly before 2013, when the first specimen was encountered.

The future dynamics of these introduced populations are unknown, but verified records show that some populations of *C. auronitens* ssp. *auronitens* in the Province of Antwerp are clearly expanding to neighbouring and interconnected forests. Future monitoring will reveal whether this process will be ongoing. *C. auronitens* ssp. *auronitens* and ssp. *subfestivus* are found together in at least two sites, and interbreeding is very likely to occur. If descendants of these populations are able to reach the Sonian-population, the latter will be subject to genetic pollution through the process of hybridization. Consequently, the replacement of local genotypes will result in irreversible and perpetual genetic alteration to the Sonian population.

The population of *C. auronitens* ssp. *festivus* is currently still very localized but the forest it inhabits are part of a larger corridor and, based on the high densities the species have at the known site, further expansion is not unlikely. The population of *C. rutilans* near Liège is quite different, being a completely isolated site from which further distribution is highly unlikely.

Even though competition between *Carabus* species is known to exist, among both larvae and adults, evidence for interspecific competition as a regulatory force in populations remains inconclusive, because of methodological limitations, unrealistic densities, noncomparable habitats and a general lack of experimental tests (Lövei & Sunderland, 1996). However, despite not a single *Carabus* species being considered to be invasive in Europe, one species could outrank the other. Moreover, no known research exists on the competition of introduced, non-native populations of *Carabus* species with native ones.

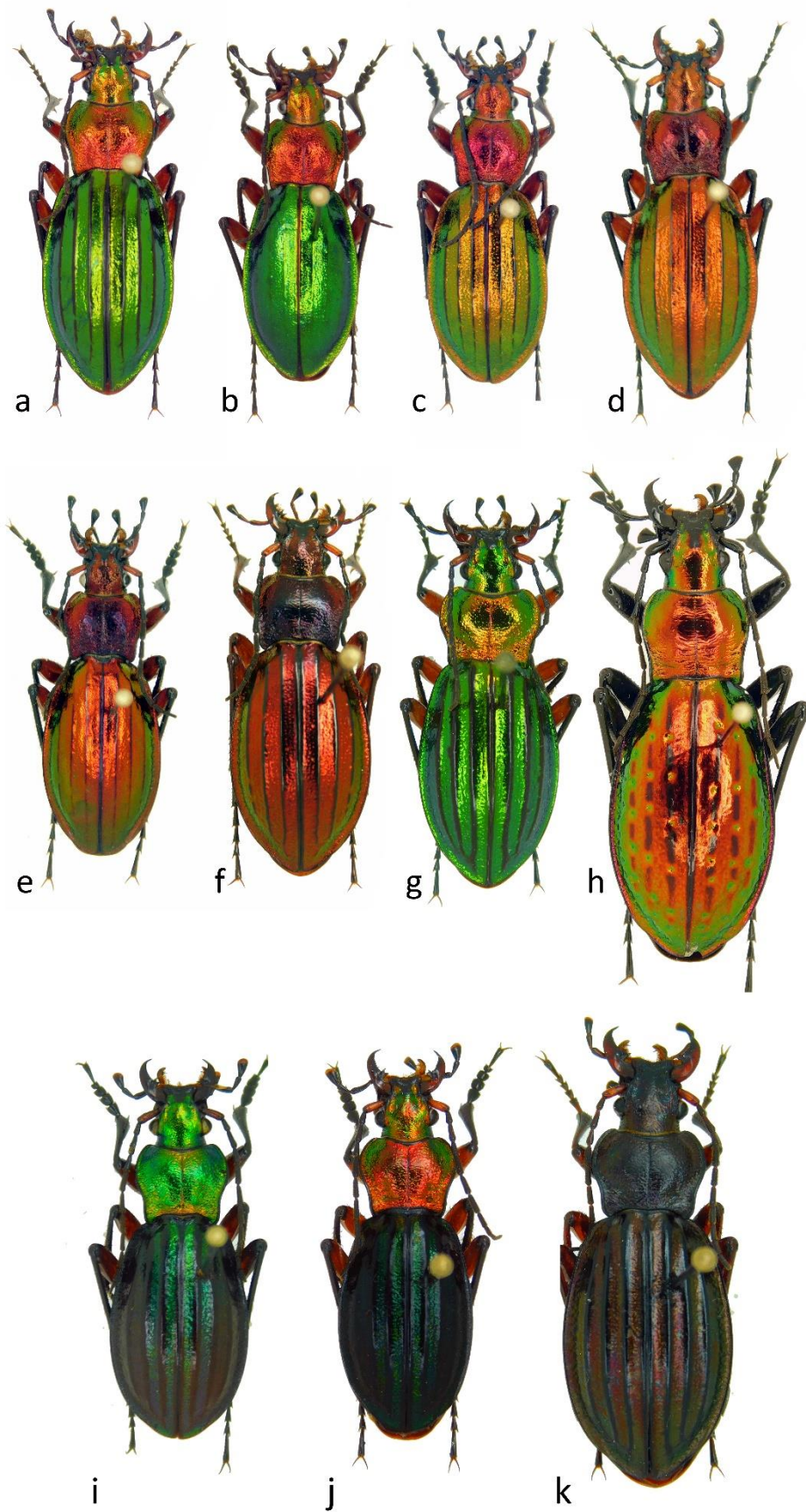


Fig. 7. A colour plate of introduced *Carabus* species and individual forms of the subgenus *Chrysocarabus* in Belgium. a. ssp. *festivus*; b. var. *pumicatus*; c. var. *purpureorutilans*; d. var. *holochrysus*; e. var. *holochrysus*; f. var. *violaceopurpureus*; g. ssp. *subfestivus*; h. *C. rutilans*; i. var. *atronitens*; j. var. *putzeysi*; k. var. *novi-prati*. © Ief Peeters.



Furthermore, hybridization is possible where native and non-native subspecies occur together and could be considered a real threat if the non-native subspecies expand their range. At this point it is impossible to predict to what extent the introduced species will have an impact on the existing indigenous *Carabus* species.

Smulders *et al.* (2006) state as main motivation for a reintroduction, *inter alia*, the combination of (1) the conservation of both species and (2) natural distribution area, (3) the ecosystem restoration in itself, (4) the restoration of stenotopic species in a specific habitat and (5) nature restoration in general. Since none of these motivations apply to the taxa mentioned in this paper, we can conclude the only reason for the illegal introduction is

the one of economic gain ('harvest', sale and or exchange of rare individual forms), and therefore reprehensible.

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