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# The beetle (Coleoptera) fauna of an abandoned exercise field in south Sweden

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## ABSTRACT

Species diversity and composition of the Coleoptera (beetle) fauna in a recently abandoned military exercise field in south Sweden was studied during sixteen years. The sixteen square km large area contained deciduous wood (mainly *Fagus* and *Carpinus*), shrubland, open ground, and pastures. Beetles were captured using three different methods: pitfall trapping, striking of foliage, and sweep bag collection, giving clearly different results. Most species caught in pitfall trapping belonged to the Carabidae, but many species of Staphylinidae, and Silphidae were found as well. Foliage striking of individual trees and shrubs not only gave many species of the Curculionidae, but also of Cantharidae and Elateridae. The highest species diversity was found in *Salix aurita*. Sweep bag collection resulted in a great variety of beetles, belonging to many families, especially to Chrysomelidae, Curculionidae and Apionidae. This mode of collection was often carried out in such a way that affinity for individual plant species could be decided. It is concluded that land use is a decisive factor for the structure of the Coleoptera fauna, definitely more important than, e.g. climate change.

**KEYWORDS:** beetle, biodiversity, deciduous wood, decline, land use, open land, pasture, species diversity.

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## INTRODUCTION

Biodiversity changes, especially widespread extinction of a considerable share of the indigenous fauna and flora in large parts of the world, are one of the greatest environmental problems of our time. It is most often discussed in connection with climate change, but the main causes of biodiversity decline are changes in land use, such as destruction of virgin forest in the tropics. In a review of carabid beetle decline in northwestern Europe [1] authors concluded that populations of large-sized Carabidae had declined more than populations of the smaller-sized ones. Explanations were possibly a lower productivity and a lower power of dispersal in large carabids. Habitat-specific populations had also decreased more than non-habitat specialists. A recent study by Kunin in Nature [2] concluded that there is a clear evidence of a substantial decline in abundance and biodiversity during recent decades; especially in grassland, the number of individuals had decreased by almost 80 percent. The decline in insect biomass in grasslands was about two thirds. The decrease in species richness was smaller, about one third in both grassland and forest. In central and northern Europe, however, modern forestry involving removal of waste wood, dead trees and shrubland, the replacement of partly non-forested semi-natural pasture land with dense stands, often of non-native trees, fertilisation of remaining pastures, etc. is the main problem. For species of small insects, less easy to observe and with small populations, it may often be difficult to decide, if they are close to extinction or already

extinct. They might only be reported with long intervals. A method to conclude the extinction of a species based on sight records was proposed by Jaric and Ebenhard [3]. Conservation measures are undertaken in many countries in order to compensate for large-scale damages on species diversity by establishing nature reserves. These are certainly of great importance, but such reserves are inevitably non-continuous (too much land in between) and often too small to secure permanent stability of populations.

Documentation of species diversity is thus essential in understanding and certifying its degree of stability and long-term changes. In the present study, the beetle (Coleoptera) fauna in a recently abandoned military exercise field containing both forest and open land was investigated during a period of sixteen years. Since about 75 years it was not inhabited by people. The purpose of this work was primarily to establish a document for current and future studies of this and other related areas.

## METHODS

### The study area

The study area was a recently abandoned military exercise field situated 8-12 km southwest of the town of Hässleholm (ca 20 000 inhabitants in the town itself) in the north-central part of the province of Skane (Scania) in south Sweden (see Figure 1, where names of former farms and other buildings are included, as well as the two lakes of the area). The elevation above sea-level varies between 43 and ca 110 m and the nearest distance to the sea is westwards ca 60 km (Kattegatt of the


**Figure 1.** Survey of the study area.

North Sea) and eastwards ca 55 km (Baltic Sea). The climate of the area is temperate, with monthly mean temperatures ranging from ca 17 °C in July to ca minus 1 °C in January. However, during the last few decades most winters have been on average somewhat warmer than "normal", with few exceptions between 0 and 3 degrees above the freezing point. A few exceptions do have occurred, however, with winter mean temperatures well below freezing point and 10-30 cm snow depth for some weeks or even a couple of months.

The area studied has been inhabited for thousands of years. It was mainly some kind or farmland, most suited for cattle grazing, until it was almost completely evacuated and abandoned in the 1940s. In the years around 1945 it was transformed to a military exercise field covering 16 square km. All buildings were gradually removed, except for a few houses close to the dominating castle of Hovala slott. Since the 16th century this castle is located in the central part of the area and is nowadays a tourist attraction. The landed property as such dates back to the Middle Ages [4]. A detailed study covering the cultivation history and way of living, especially in the 19th and early 20th centuries, was published by Claesson *et al*. [5], unfortunately only in Swedish. The authors of this work calculated that up to 350 people would have been living here during this period, having ca 300 cattle, a similar number of sheep, 80 horses, and in addition several hundreds of swine. The swine were often feeding in the forest in years when there were plenty of beechnuts. The infields of each farm were quite small and most often owned by the castle, so such use of the outlying area was certainly necessary. The farmers were often obliged to make work by the day, to be able to pay for their house and land to the castle owners. This land-use has certainly influenced the present-day insect fauna, as well as the military land use during the latter half of the 20th century.

All types of ground and vegetation within the 16 square km large study area are included in this study. An exception, however, is planted spruce (*Picea abies*) forest, found in the most western and most southern parts of the area. The woodland is usually otherwise dominated by beech (*Fagus sylvatica*) or hornbeam (*Carpinus betulus*), partly as single-species stands or these two species mixed. Such woodland is characteristic of the northwest (the Dallerod and Saljalt forest and several kilometers along the eastern edge of Aspehojden (see Figure 1)). Other trees, especially birch (*Betula pendula*, *B. pubescens*), oak (*Quercus robur*), hazel (*Colylus avellana*), cherry (*Prunus avium*), bird-cherry (*Prunus padus*), and alder (*Alnus glutinosa*) occur in small patches or as mixed decidous woodland. Some scattered pines (*Pinus sylvestris*) are also found. Shrubland is becoming more widespread than before, especially in those parts of the study area which had been kept completely open by exercise activities. It is mainly willow (*Salix aurita*), a species with a high biodiversity of beetles, and birch (*Betula* spp.) which tend to colonize such ground.

The open non-forested ground is mainly found in the northern half of the former exercise field. But a shooting-range was located in the southwest, which proved to be very rich in beetle species, especially many carabids. Due to lack of management, shrub land is spreading nowadays, especially in its southern parts, which might favour the *Salix* fauna, but disfavour many carabids, some of them otherwise quite rare in Sweden (see Results and discussion section). North of the former farm village Lorup, in the long slopes down to Lake Finjasjon and Guldkusten ("Gold Coast"), Figure 1, there is much open ground, nowadays mainly grazed by cattle or sheep.

Most of the area east of the castle (Hovdala slott) is an extensive grassland (Aspehojden), partly grazed by sheep nowadays. The castle itself lies on the bottom of a valley formed between Lorup and Aspehojden. During the 19th century Lake Finjasjon was lowered twice to produce more arable land, and part of the area between the castle and the lake, formerly a bay, is now cultivated land, where only the margins of the small fields have been possible to include in the study.

Important for a large number of beetles are roadsides along the many small gravel roads built by the militaries. Their roadsides are inhabited by numerous herbaceous plants and grasses and consequently ideal sites for herbivorous beetles.

A great many species (see the section 'List of species found') were caught by sweep bag collection, especially when these herbs were flowering, but also in springtime and early autumn, when many other beetles were found in the plant litter and in the maturing vegetation. These roadsides have been quite carefully considered for the collections.

**Methods of collection**

The area was visited 20-40 times annually during the summer half of the 16 years 2004-2019, usually between 15 April and 15 September. Three different methods were used for collection: (a) pitfall traps, open continuously, (b) striking foliage of shrubs or trees, and (c) using a sweep bag for ground vegetation.

**Pitfall traps:** were cylindrical, open at top but not at bottom, made of plastic, diameter 75 or 87 mm, length ca 100 mm. They were inserted vertically in the soil with their top margin at or slightly below the soil surface. In most cases 20 such traps were located at each 'site' during one to three summer seasons and emptied every three to five days [6, 7, 8]. Three such 'sites' were located in the open (or gradually to some extent shrub-colonized) former shooting range in the southwest of the total area (Figure 1). Three 'sites' were located in the northwest (between the former farms Dallerod and Saljalt, Figure 1) in beech, hornbeam and mixed deciduous forest. Two other 'sites' were placed in former lakeland, nowadays on open herbaceous dry grassland above the shore of Lake Finjasjon (Figure 1). Another two 'sites' were localised in a large, non-wooded grassland, on Aspehojden in the eastern part of the area (Figure 1). It is nowadays mainly used for less intensive sheep grazing.

**Striking:** The foliage of woody species (*Carpinus betulus*, *Fagus sylvatica*, *Corylus avellana*, *Betula pendula* and *pubescens*, *Salix aurita*, *Quercus robur*, *Alnus glutinosa*, *Prunus padus*, *Prunus avium*) were stroken, often vigorously, with a 2.5 m long cane, falling material collected in a 10 litre bucket, circular top diam. 30 cm, and as rapidly as possible transferred through a funnel into a small ampoule with a piece of soft paper moistened with some ethyl acetate. Selective striking of these woody species were utilized wherever possible throughout the area.

**Sweep bag collection:** A sweep bag ('slaghav') was used almost everywhere, provided dense shrubland or lack of ground vegetation did not prevent this. The sweep bag was mounted on an iron frame, diam. 30 cm, with a bag of textile, ca 40 cm deep. Every ca 5 min the bag was emptied in a bucket and transferred to an ampoule, as with striking (above).

The three collection methods gave rise to quite different results concerning the composition of the beetle fauna. Species of the soil surface or flying beetles attracted by some smell were primarily captured in the filfall traps, such as species of the families Carabidae, Staphylinidae, Siphidae, and the numerous *Geotrupes stecorosus*. In striking the foliage of shrubs and trees, woodland species of Curculionidae were primarily caught, but in the early summer e.g. many Elateridae and Cantharidae, as well. The sweep bag collections resulted chiefly in plant-feeding beetles, such as species of the families Apionidae, Curculionidae, Chrysomelidae including Halticinae, and also many individuals of other families.

**Methods of determination**

Beetles were determined to species level using several published sources, mainly seventeen volumes of Danmarks Fauna and seven volumes of Die Käfer Mitteleuropas [9, 10]. Moreover, data from the Internet was utilised in many cases for a more detailed confirmation of the determinations. With few exceptions, scientific names used by the Swedish 'artdatabanken.se' in 2004 are identical to those given in the present study. Instruments utilized for the determinations were preparation microscopes, with 20 and 40 times magnification. Both obliquely incidental and direct light from above was used. In a few cases, people from the Swedish "Artdatabanken" at the SLU (The Swedish University of Agriculture and Forestry) in Uppsala were helpful in critical determinations.

## RESULTS AND DISCUSSION

During the 1950s and in the early 1960s a large-scale inventory of the beetle fauna of a region surrounding the town of Hässleholm was carried out by G. Israelson [11]. The area was as large as ca 300 square km, but the present study area of 16 square km was also included in his study.

Many more species were reported from his area as a whole than those reported in the author's study of the Hovdala field 60-70 years later. The much larger and even more diversified area studied by Israelson, but also differences in capturing methods, might be an explanation for the difference in number of species. However, this is far from certain. A real decline in species diversity is not possible to exclude, though a trial to apply some kind of statistical method to explain the difference is beyond the scope of the present study.

About 550 species of beetles were captured and determined using the three different methods of collection discussed above. They are reported in the section 'List of species found' given below. Most rich in species were the families Curculionidae (n = 108), Apionidae (n = 33), Chrysomelidae (n = 85), Carabidae (n = 64) and Staphylinidae (n = 40). Species of the three first-mentioned families are herbivorous. Those of the two latter families mainly feed on small animals, are cadaverivorous or more exceptionally feed on fungal mycelia. Altogether these five families contained 60% of all species found in the study, and two thirds of them (n = 226) were feeding on plants. These families were followed by Cantharidae (n = 21), Elateridae (n = 21), and Coccinellidae (n = 18) when considering the number of species.

It might be somewhat remarkable that only 11 species of the Cerambycidae were captured. This fact may have several explanations. The methods of capturing might have been less suitable in finding these species. Modern forestry in the surrounding areas using clear-cutting of tree-stands, removal of dying or dead trees, and sometimes applying toxic chemicals on the surface of the tree stumps to prevent colonization of insects considered harmful to forest productivity may have been of importance to a possible decline of such species.

In the herbivorous families, presence of the main feeding plant is certainly of great importance. Therefore, wherever possible, the name of this or these plant(s) are reported in the list of species below, after the name of the beetle. In order to understand possible long-term changes in the beetle fauna it is essential to know changes in the floristic diversity and composition. No comprehensive inventory of this has been carried out in the present study area, but for the entire province of Scania such a recent study exists [12]. Much attention is nowadays paid to climate warming and its consequences. But even more important to the biodiversity than climate change are changes in land use in most regions of the world. Man-induced elimination or deterioration of habitats by altered land use is of major importance.

In the following text, some more attention will be paid to selected beetles among the 550 species found in the study. Species of *Carabus* s.l. (Carabidae) were almost exclusively captured by pitfall trapping. Out of the thirteen species reported from Scandinavia, nine were found in this study. Two of them are quite rare in Sweden. *Carabus convexus* is close to extinction in this country and only two individuals were found. Of the usually rare and very local *C. nitens*, however, at least 50 individuals were found. Both species seemed to be restricted to the former shooting range ('skjutfaltet', Figure 1) in the southwest. The very large beetle *C. coriaceus* (body length 35-40 mm) was rather common and widespread on forested ground, whereas the usually scarce *C. cancellatus* occurred on open land, sometimes in abundance. The remaining five species of this genus were all widespread in the forested parts of the area. Other major carabid genera, *Amara*, *Harpalus* and *Poecilus*, were mainly found on treeless ground, whereas *Pterosticus niger* and *P. melanarius* were abundant in all forest. Using the caption method it was possible to find only two species of the genus *Bembidion*.

Among the Chrysomelidae, nine species of the form-rich genus *Longitarsus* were captured, mainly by sweep bag collection of stands containing, e.g. the herbs *Plantago lanceolata* or *Achillea millefolium*. In a few cases determining them to the species level was not possible and these catches are, therefore, not included in the species list. Two *Crepidodera* species were commonly found by striking the foliage of *Salix aurita*, as were *Gonioctena viminalis*, *Lochmaea capreae*, *Phratora vulgatissima*, and *Plagiodera versicolora*. The four *Donacia* species reported under Chrysomelidae were captured from the belt of large sedges (Carex) along the shore of Lake Finjasjon using sweep-

bag collection. *Lythraria salicariae* and *Psylliodes picinus* were found on *Lysimachia vulgaris*, often in this site.

Another herb, *Achillea millefolium*, growing on dry open ground and very widespread, was apparently food-plant for, e.g., *Cassida denticollis*, *C. sanguinolenta*, *C. sanguinosa*, *Galeruca tanaceti* and *Longitarsus succineus*. Food plant for *Chrysolina geminata*, *Ch. hyperici and Ch. varians* was *Hypericum spp*., a widespread herb in any type of open land. Seven species of *Phyllotreta* were captured by sweep bag, but to which plant species they were attached was not clarified.

Among the 108 species of Curculionidae reported below, deciduous trees, legumes (Papilionaceae), and *Rumex* spp. were the most common food-species. The preference of Curculionidae and Apionidae species for different legumes was reported elsewhere [13] and this is therefore not much commented in the present study. Typical legume-preferring species were found in the genera *Hypera* and *Sitona*; to a great extent in the Apionidae, as well. Several species among these two families had an affinity to *Rumex* spp., such as *Apion curtirostre*, *A. frumentarium*, *A. marchicum*, *A. miniatum*, and *A. violaceum*, as well as *Hypera rumicis*, *Rhinoncus castor*, *and Rh. pericarpius*. Other species preferred the abundant herb *Plantago lanceolata*, such as *Gymnetron labile*, *Mecinus pascuorum*, *M. pyraster*, and *Trichosirocalus troglodytes*. Feeding on the nettle *Urtica dioica* were *Ceutorhynchus pollinarius*, *Nedyus quadrimaculatus* and *Phyllobius urticae*, as well as two common beetles of the family Kateridae: *Brachypterus glaber* and *B. urticae*.

Among the Curculionidae of deciduous woody plants, *Salix aurita* had the highest biodiversity with at least ten species preferring or bound to this plant. The beetles most often obtained by striking the foliage were several species of *Phyllobius* while *Polydrusus* was obtained to a lesser extent. However, any clear preference for only one tree species was generally not observed in any of these genera. Birch (*Betula* spp.) was clearly preferred by *Coeliodes rubicundus*, by *Deporaus betulae* in the related family Attelabidae, and by *Apion simile*. A preference for oak (*Quercus robur*) was apparent in *Neocoenorrhinus germanicus (*Attelabidae), *Coeliodes quercus*, *Curculio venosus*, and *Rhynchaenus quercus*.

In Scandinavia as a whole the Staphylinidae is the beetle family richest in species. However, in the list of the present area only 40 species were found and determined. Another 10-15 small individuals, mainly belonging to the subfamily Aleocharinae, could not be determined with certainty using the 40 X magnification. They are hence not listed. Species of the subfamily Staphylininae were mainly caught by pitfall trapping, whereas those of the genera *Stenus*, *Tachinus*, and *Tachyporus* were captured by sweep bag collection. Many of the staphylinids recorded are considered scarce or rare in Sweden and Denmark [10], but this may be due to insufficient knowledge about their frequencies. The rather low number of species found in this study is mainly due to insufficient capturing methods for this family.

Species of the family Coccinellidae (n = 18) were frequently found using sweep bag collection of open land. Most common species were *Propylea 14-punctata*, *Coccinella 7-punctata*, *C. 5-punctata*, *Tytthaspis 16-punctata* and *Psyllobora 22-punctata*. Species of Cantharidae (n = 21) and Elateridae (n = 21) were frequently found using both sweep bag collection and by foliage striking in late spring and early autumn. Among the Catharidae, three species of *Cantharis* and three of *Rhagonycha* were characterized as common in most years. The Elateridae was mainly dominated by three species of *Athous* and by *Dolopius marginatus*. Most of the remaining species of elaterids were less common or just found one to three times during the 16 years.

The remaining 34 families in the list contain fewer, sometimes only one or two species. It ought to be emphasized, however, that some of the most abundant beetles of the area are found here. *Geotrupes stercorosus* was seen everywhere in forest. It was usually feeding on fungal sporophores and was often the most abundant species found in the pitfall traps. In sweep bag collection of grasslands, considerable numbers of *Oedemera* (Oedemeridae), *Meligethes* (Nitidulidae), and *Olibrus* (Phalacridae) individuals became apparent. Very frequent were also *Dolichosoma lineare* and species of *Dasytes* (both genera

Dasytidae) as well as *Cortinicara gibbosa* (Lathridiidae).

A more detailed study of the data gathered concerning differences among years in the amount of beetles captured has not been performed. It would have to include statistical analyses in which a close consideration of especially meteorological conditions should be considered. The fact that the hot and extremely dry summer of 2018 gradually reduced both species numbers and amounts of beetles captured, at least by striking and by sweep bag collection, is quite apparent in comparison with all the other years. It also seems that this tended to prevail to some extent during 2019, the last year of the study.

Much attention has been paid in recent years to invasive or foreign species of plants and animals. This topic has usually been discussed in connection with climate change, though the possibility of direct importation of garden or ornamental plants has also been discussed by the media [3]. A difference is sometimes made between just ‘foreign’ and ‘invasive’ species. The latter ones are those which constitute a risk of ecosystem disturbance, as they are difficult to control and may outcompete species of the native flora and fauna. An example in animals is the introduction of the field hare in Sweden, which most probably resulted in the disappearance of the forest hare from the southern parts of this country. But in Scandinavia the risks of invasive plants are rather limited by the fact that soils are very acidic or have become acidified by atmospheric deposition during the last century [14, 15].

But in the vicinity of gardens and on roadsides there could be some problems. Some insects have certainly been ‘naturalized’ in new areas. However, this is quite natural, if the climate gets warmer. For foreign herbivorous beetles, however, lacking suitable food-plants, the risk of uncontrolled spreading is usually limited. Important, but rarely paid any attention to, is that changes in land use or cultivation practices also may favour some native species. Hence they become a dangerous competition to other plants (and insects). The grass *Arrhenatherum elatior* and the herb *Anthriscus sylvestris* seem to be such examples in Sweden.

In the area of this study, the introduction of foreign or invasive species has been quite limited. The only apparent example from this study that has enabled recent colonization of a foreign beetle (*Sitona gressorius*) is the legume lupin (*Lupinus polyphyllus*). Some small stands occur within the area and this large *Sitona* weevil was found in at least three of these stands. It is also possible that the small population of the rare species *Longitarsus curtus* (Chrysomelidae) originated from the cultivation of *Symphytum* spp. during World War I and II. This plant is still rather common around the Hovdala castle.

**List of species found**

About 550 species of beetles were found and determined during the years using the collection methods mentioned above. Some tenths of individuals, mainly small forms of the families Staphylinidae and Nididulidae, of the genus *Altica* and in a few cases of *Longitarsus*, were not determined with enough certainty to be included below. As to the general frequencies of the species found, it is estimated that 10 to 15 per cent of all species in the list constitute quite scarce or definitely rare species in south Sweden and/or in our closely situated country Denmark. This can be evidenced from the information in the official lists of beetle species in these countries.

In the primary field data there are always notes concerning where in the Hovdala field every beetle was found. Number of individuals, plant species etc. were also notated on each occasion. Unfortunately it has not been possible to include these data in this publication. That would have been too space consuming, as it is a question of totally almost one hundred thousand of individuals. However, material has usually been collected from pure stands or single individuals of vascular plant species. Dependence on a plant is given after the name of many beetle species, wherever possible, mainly for trees and legume plants. Scientific plant names are never given in italics in the list, whereas scientific names of beetle species are always given in italics, to increase the lucidity of the text.

Important for possible future studies of the area is not only the species list as such, but also estimations of the average frequency and abundance

of the different species during these 16 years. How common or little common they were in the early part of the 21st century would be of documentary value for repeated studies of the same area or other parts of south Sweden with a related mix of habitats. Therefore, beetle species found were arranged into four levels of frequency according to this scale, and this information is positioned in brackets after the species name. Reservations are made considering that the three capturing methods employed might not be optimal to all included species, as commented in the section Results and discussion.

The four levels of frequency are indicated in the following way:

(*c*) = common, widespread and often abundant in appropriate habitats.

(*rc*) = rather common, but usually not abundant and less widespread.

(*lc*) = less common, usually rather few individuals found.

*No frequency* determination given after species name: only 1-3 individuals found altogether during the 16 years.

This does not necessarily always mean that the species was rare, as capturing failure might have been caused by the mode of collection.

Species found are recorded below, arranged according to family names in alphabetical order. Authors of scientific names of Coleoptera are given in the works used for species determination [9, 10].

**ANTHICIDAE:** *Notoxus monoceros* (*rc*).

**ANTHRIBIDAE:** *Anthribus nebulosus* (*lc*), *Dissoleucas niveirostris*, *Platystomus albinus*.

**APIONIDAE:** *Apion s.l. A. aethiops*, *A. affine* (*lc*), *A. apricans* (*rc*), Trifolium pratense, *A. assimile* (*rc*), Trifolium pratense, *A. cerdo* (*rc*), Vicia cracca, *A. craccae* (*lc*), *A. curtirostre* (*c*), Rumex spp., *A. dispar*, *A. dissimile* (*rc*), Trifolium arvense, *A. ervi* (*rc*), Lathyrus pratensis, *A. frumentarium* (*c*), Rumex spp., *A. fulvipes* (*flavipes*) (*c*), Trifolium repens, T. hybridum, *A. gracilipes* (*rc*), Trifolium medium, *A. gyllenhali*, *A. hookeri*, *A. loti* (*c*) Lotus spp., *A. marchicum* (*c*), Rumex spp., *A. miniatum* (*lc*), Rumex spp., *A. nigritarse* (*lc*), Trifolium spp., *A. onopordi*, *A. pallipes* (*rc*), Mercurialis perennis, *A. pomonae*, *A. pubescens* (*lc*), *A. seniculus* (*rc*), Trifolium hybridum, *A. simile* (*rc*), Betula, *A. spencii* (*rc*), Vicia cracca, *A. tenue* (*rc*), *A. trifolii* (*rc*), Trifolium pratense, *A. varipes* (*rc*), Trifolium arvense, *A. viciae* (*c*), Vicia cracca, *A. vicinum* (*lc*), Mentha spp., *A. violaceum* (*c*), Rumex spp., *A. virens* (*lc*), Trifolium repens.

**ATTELABIDAE:** *Apoderus coryli* (*lc*), *Corylus avellana*, *Deporaus betulae* (*c*), Betula, *Neocoenorrhinus germanicus* (*lc*), Quercus robur, *N. nanus* (*lc*), *N. tomentosus* (*lc*).

**BRUCHIDAE:** *Bruchus loti* (*lc*), Lathyrus pratensis, *B. atomarius* (*lc*), legumes.

**BUPRESTIDAE:** *Trachys minuta* (*rc*).

**BYRRHIDAE:** *Byrrhus fasciatus*, *B. pilula* (*lc*), *B. pustulatus*, *Morychus aeneus*.

**BYTURIDAE:** *Byturus ochraceus* (*aestivus*) (*rc*), Rubus idaeus, *B. tomentosus* (*rc*), Rubus idaeus.

**CANTHARIDAE:** *Cantharis bicolor*, *C. figurata* (*lc*), *C. flavipes ab. flavilabris*, *C. fusca* (*rc*), *C. livida rufipes*, *C. nigricans* (*c*), *C. obscura* (*c*), *C. paludosa*, *C. pellucida* (*c*), *C. rufa* (*rc*), *C. rustica* (*lc*), *Malthinus biguttulus* (*lc*), *M. facialis*, *Malthodes marginatus*, *M. spathifer*. *Podabrus alpinus* (*rc*), *Rhagonycha atra*, *R. fulva* (*c*), *R. lignosa* (*c*), *R. limbata* (*c*), *R. testacea* (*lc*).

**CARABIDAE:** *Agonum sexpunctatum*, *Amara aenea* (*rc*), *A. aulica*, *A. brunnea*, *A. communis* (*c*), *A. convexior* (*lc*), *A. equestris* (*lc*), *A. familiaris*, *A. lunicollis* (*rc*), *A. ovata* (*lc*), *A. similata*, *A. tibialis*, *Badister bullatus* (*lc*), *B. dilatatus*, *Bembidion lampros* (*lc*), *B. quadrimaculatum*, *Calathus fuscipes* (*rc*), *C. melanocephalus* (*rc*), *C. rotundicollis* (*lc*), *Carabus* (*s.lat.*) *C. cancellatus* (*rc*), *C. convexus*, *C. coriaceus* (*rc*), *C. glabratus* (*c*), *C. granulatus* (*rc*), *C. hortensis* (*c*), *C. nemoralis* (*c*), *C. nitens* (*rc, shooting range*), *C. violaceus* (*c*), *Cicindela campestris* (*lc*), *Clivina fossor* (*lc*), *Cychrus caraboides* (*rc*), *Dromius quadrimaculatus*, *Dyschirius globosus*, *Harpalus affinis* (*lc*), *H. griseus*, *H. laevipes*, *H. latus* (*c*), *H. rubripes* (*lc*), *H. rufipes* (*rc*), *H. smaragdinus* (*lc*), *H. tardus* (*lc*), *Leistus ferrugineus* (*lc*), *L. rufescens*,

*L. terminatus*, *Lonicera pilicornis* (*rc*), *Nebria brevicollis* (*c*), *Notiophilus aquaticus*, *Olisthopus rotundatus*, *Ophonus rufibarbis*, *Oxypselaphus obscurus*, *Patrobus atrorufus* (*lc*), *Philorhizus sigma* (*lc*), *Platynus assimilis*, *P. livens*, *Poecilus cupreus* (*lc*), *P. lepidus* (*rc*), *P. versicolor* (*c*), *Pterostichus crenatus*, *P. diligens*, *P. melanarius* (*c*), *P. niger* (*c*), *P. nigrita* (*lc*), *P. oblongopunctatus* (*rc*), *P. strenuus.*

**CERAMBYCIDAE:** *Agapanthia villosoviridescens*, *Alosterna tabacicolor* (*rc*), *Anastrangalia sanguinolenta*, *Dinoptera collaris*, *Oplosia cinerea*, *Oxymiros cursor*, *Phytoecia cylindrica*, *Stenostola dubia*, *Stenurella melanura* (*c*), *Stictoleptura maculicornis* (*rc*), *S. rubra* (*lc*).

**CHRYSOMELIDAE:** *Agelastica alni* (*c*), Alnus glutinosa, *Altica lythri*, *A. oleracea* (*rc*), *A. palustris*, *Aphthona cyanella*, *A. lutescens* (*lc*), *A. nonstriata*, *Batophila rubi*, *Bromius obscurus* (*lc*), *Cassida denticollis* (*rc*), *C. flaveola* (*lc*), *C. prasina*, *C. rubiginosa*, *sanguinolenta* (*rc*), Achillea millefolium, *C. sanguinosa* (*rc*), Achillea millefolium, Tanacetum vulgare, *Chaetocnema aridula* (*c*), *Ch. concinna* (*c*), *Ch. hortensis* (*c*), *Chrysolina fastuosa*, *Ch. geminata* (*rc*), Hypericum spp., *Ch. hyperici*, *Ch. oricalcea*, *Ch. staphylaea* (*lc*), *Ch. varians* (*c*) Hypericum spp., *Chrysomela populi*, *Crepidodera aurata* (*c*) Salix aurita, *C fulvicornis* (*c*), Salix aurita, *Cryptocephalus fulvus* (*c*), *C. labiatus*, *C. moraei* (*rc*), *C. pusillus*, *C. punctiger*, *Donacia aquatica*, *D. clavipes*, *D. impressa*, *D. thalassina*, *Galeruca tanaceti (rc*), Tanacetum vulgare, *Galerucella calmariensis*, *G. lineola*, *G. sagittariae*, *G. tenella*, *Gastrophysa polygoni* (*rc*), Polygonum spp., Rumex spp., *G. viridula* (*rc*), Rumex obtusifolius, *Gonioctena 5-punctata* (*rc*), *G. viminalis* (*c*), Salix aurita, *Hermaeophaga mercurialis*, Mercurialis perennis, *Labidostomis longimana* (*lc*), *Lema cyanella* (*lc*), *L. erichsoni*, *Lilioceris merdigera* Convallaria, Polygonatum, *Lochmaea capreae* (*c)*, Salix aurita, *Longitarsus anchusae*, *L. curtus*, *L. exsoletus* (*lc*), Anchusa officinalis, *L luridus* (*rc*), Ranunculus spp., *L. melanocephalus* (*rc*), Plantago lanceolata, *L. nasturtii*, *L. pratensis* (*c*) Plantago lanceolata, *L. rubiginosus*, *L. succineus* (*c*), Achillea millefolium, *L. suturellus* (*lc*), *Luperus flavipes* (*lc*), *Lythraria salicariae* (*lc*), Lysimachia vulgaris, *Mantura chrysanthemi*, *Neocrepidodera ferruginea* (*rc*), *N. transversa* (*lc*), *Oulema melanopus/duftschmidi* (*lc*), *Phratora* (*Phyllodecta*) *laticollis*, *Ph. vulgatissima* (*c*) Salix aurita, *Phyllotreta atra*, *Ph. nemorum* (*rc*), *Ph. striolata*, *Ph. tetrastigma*, *Ph. undulata* (*rc*), *Ph. vittata*, *Ph. vittula*, *Plagiodera versicolora* (*rc*), Salix aurita, *Plateumaris discolor*, *Psylliodes chrysocephalus*, *P. cucullata*, *P. luteola*, *P. napi* (*lc*), *P. picinus* (*lc*), Lysimachia vulgaris, *Sermylassa halensis* (*rc*), Galium verum, *Sphaeroderma testaceum*.

**CIDIDAE:** *Orthosis alni*.

**CLERIDAE:** *Korynetes caeruleus.*

**COCCINELLIDAE:** *Adalia 10-punctata* (*lc*), *A. bipunctata*, *Anatis ocellata*, *Anosticta 19-punctata*, *Aphidecta obliterata* (*lc*), *Calvia 14-guttata* (*lc*), *Coccidula scutellata*, *Coccinella 5-punctata* (*c*), *C. 7-punctata* (*c*), *C. 11-punctata*, *Coccinula 14-pustulata* (*c*), *Cynegetis impunctata*, *Halyzia 16-guttata* (*rc*), *Platynaspis luteorubra*, *Propylea 14-punctata* (*c*), *Psyllobora 22-punctata* (*rc*), *Scymnus nigrinus*, *Tytthaspis 16-punctata* (*c*).

**CRYPTOPHAGIDAE:** *Cryptophagus pilosus*.

**CURCULIONIDAE:** *Acalyptus carpini* (*lc*) Salix aurita, *Anthonomus pedicularius*, *A. rectirostris* (*lc*), Prunus padus, P. avium, *A. rubi* (*lc*), *Archarius salicivorus* (*rc*) Salix aurita, *Barypithes pellucidus* (*lc*), *Ceutorhynchus asperifoliarum* (*lc*), Anchusa officinalis, *C. fennicus*, *C. litura* (*lc*), Circium spp., *C. obstrictus* (*assimilis*) (*c*), *C. pallidactylus* (*rc*), *C. pollinarius* (*lc*), Urtica spp., *C. quadridens* (*rc*), *C. sulcicollis*, *C. typhae* (*floralis*) (*c*), *Cionus tuberculosus* (*lc*), Scrophularia nodosa, *Cleopomiarius* (*Miarus*) *graminis*, *Coeliodes cinctus* (*lc*), *C. quercus* (*lc*), *C. rubicundus* (*lc*), Betula spp., *Curculio salicivorus* (*rc*) Salix, *C. venosus* (*lc*) Quercus, *Dorytomus rufatus* (*lc*) Salix aurita, *D. taeniatus* (*rc*), Salix aurita, *Eleschus bipunctatus* (*lc*), Salix aurita, *Grypus equiseti* (*lc*), *Gymnetron labile* (*rc*), Plantago lanceolata, *Gymnetron melanarium* Veronica sp., *G. rostellatum* (*lc*), *Hylobius abietis*, *H. transversovittatus*, *Hypera arator* (*lc*), *H. nigrirostris* (*rc*), legumes, *H. punctata* (*lc*), legumes, *H. rumicis* (*rc*) Rumex, Polygonum spp., *H. variabilis* (*lc*), legumes, *H. zoilus*, *Limobius borealis*, *Liophloeus tesselatus*, *Lixus iridis*, *Magdalis armigera*, *Mecinus pascuorum* (*c*), and

*M. pyraster* (*rc*), both Plantago lanceolata, *Miarus campanulae* (*rc*), Jasione montana, Campanula rotundifolia, *Micrelus ericae* (*rc*), Calluna vulgaris, *Nanophyes marmoratus* (*lc*), Lythrum salicaria, *Nedyus quadrimaculatus* (*c*), Urtica spp., *Neocoenorhinus aeneovirens*, *N. germanicus*, *Otiorrhynchus ligneus*, *O. ligustici* (*rc*), *O. raucus* (*rc*), *O. scaber* (*rc*), *O. singularis* (*rc*), *O. sulcatus* (*lc*), *Pissodes pini*, *Polydrusus flavipes*, *P. mollis* (*rc*), *P. cervinus* (*c*), *P. undatus* (*c*), *Phyllobius argentatus* (*c*), *Ph. betulae*, *Ph. glaucus* (*c*), *Ph. maculicornis* (*c*), *Ph. oblongus* (*rc*), *Ph. pyri* (*c*), *Ph. urticae* (*lc*) Urtica dioica, *Ph. virideaeris* (*c*), *viridicollis* (*c*), (most spp. of this genus on woody plants), *Rhamphus pulicarius* (*rc*), Salix spp., Betula spp., *Rhinoncus bruchoides* (*lc*), Polygonum spp., *R. castor* (*c*), Rumex spp., *R. pericarpius* (*c*), Rumex spp., *Rhinusa linariae*, *Rhynchaenus fagi* (*c*), Fagus sylvatica, *R. quercus* (*lc*), Quercus robur, *R. rusci*, *R. salicis* (*rc*), Salix aurita, *R. signifer*, *R. stigma* (*lc*), *Rhynchites nanus* (*lc*), *Rytidosoma globulus*, *Sciaphilus asperatus* (*lc*), *Scolytes intricatus*, *Simo hirticornis* (*lc*), *Sitona* (nearly all species on legumes), *S. ambiguus* (*rc*), *S. cylindricollis* (*lc*), *flavescens* (*lc*), *gressorius* (*lc*), *hispidulus* (*rc*), *humeralis* (*c*), *lepidus* (*c*), *lineatus* (*c*), *lineellus* (*rc*), *puncticollis* (*lc*), *sulcifrons* (*c*), *suturalis* (*c*), *Stereonychus fraxini*, *Strophosoma capitatum* (*rc*), *S. melanogrammum* (*c*), *Tapinotus sellatus* (*lc*), *Trachyphloeus bifoveolatus* (*lc*), *Trichosirocalus troglodytes* (*c*) Plantago lanceolata, *T. barnevillei* (*lc*), Achillea millefolium, *Trachodes hispidus*, *Tropiphorus elevatus*, *Tychius picirostris* (*c*), *T. polylineatus*.

**DASYTIDAE:** *Dasytes cyaneus* (*coeruleus*) (*c*), *D. niger* (*rc*), *D. plumbeus* (*c*), *Dolichsoma lineare* (*c*).

**DERMESTIDAE:** *Anthrenus museorum* (*lc*).

**ELATERIDAE:** *Adrastus nitidulus*, *A. pallens* (*rc*), *Agriotes lineatus* (*lc*), *A. obscurus* (*c*), *Agrypnus murinus* (*lc*), *A. nigrinus*, *Athous haemorrhoidalis* (*c*), *A. subfuscus* (*c*), *A. vittatus* (*rc*), *Cidnopus aeruginosus*, *C. minutus* (*rc*), *Dalopius marginatus* (*c*), *Denticollis linearis* (*lc*), *Ectinus aterrimus*, *Hemicrepidius niger* (*lc*), *Limonius aeneoniger* (*rc*), *Oedostethus quadrimaculatus* (*lc*), *Prosternon tesselatum* (*rc*), *Selatosomus aeneus* (*lc*), *S. cruciatus* (*lc*), *S. impressus*.

**EROTYLIDAE:** *Tritoma bipustulata*.

**EUCNEMIDAE:** *Dirrhagus pygmaeus*.

**GEOTRUPIDAE:** *Geotrupes stercorarius*, *G. stercorosus* (*c*).

**HALIPLIDAE:** *Haloplus ruficollis*.

**HISTERIDAE:** *Hister unicolor*.

**HYDROPHILIDAE:** *Sphaeridium bipustulatum*.

**KATERETIDAE:** *Brachypterus glaber* (*c*), Urtica dioica, *B. urticae* (*c*), Urtica dioica.

**LATHRIDIIDAE:** *Cortinicara fuscula*, *C. gibbosa* (*c*), *C. impressa*, *Enicmus testaceus*, *E. transversus* (*lc*), *Lathridius* (*Conithassa*) *minutus*, *L. nodifer*.

**LEIODIDAE:** Sporadically found in pitfall traps. *Catops fumatus*, *C. nigricans*, *C. picipes*, *C. tristis*, *C. westi*.

**LUCANIDAE:** *Platycerus caprea*, *P. caraboides*.

**LYCIDAE:** *Dictyophorus minuta*, *Platycis cosnardi*.

**MALACHIIDAE:** *Charopus graminicola*, *Malachius bipustulatus* (*rc*).

**MELOIDAE:** *Meloe violaceus*.

**MORDELLIDAE:** *Mordella aculeata* (*rc*), *Mordellistenula perrisi* (*rc*), *M. variegata*.

**NITIDULIDAE:** *Cychramus luteus* (*rc*), *C. variegatus*, *Meligethes aeneus* (*c*).

**OEDEMERIDAE:** *Chrysanthia viridissima* (*viridis*) (*lc*), *Oedemera femorata* (*c*), *O. lurida* (*c*), *O. virescens* (*c*).

**ORSODACNIDAE:** *Orsodacne cerasi* (*lc*).

**PHALACRIDAE:** *Margarinotus brunneus* (*lc*), *M. cadaverinus*, *M. obscurus* (*lc*), *M. striola* (*lc*), *M. terricola*, *Saprinus semistriatus* (*rc*), *Olibrus aeneus* (*c*), *O. affinis* (*c*), *O. bicolor* (*rc*), *O. flavicornis*, *O. millefolii* (*rc*).

**PYROCHROIDAE:** *Pyrochroa coccinea* (*lc*), *Schizotus pectinicornis* (*lc*).

**SALPINGIDAE:** *Rhinosimus ruficollis*.

**SCRAPTIDAE (ANASPIDAE):** *Anaspis frontalis* (*lc*), *A. rufilabris* (*rc*), *A. thoracica*.

**SCARABAEIDAE:** *Aphodius contaminatus*, *A. rufipes*, *Melolontha melolontha* (*lc*), *Phyllopertha horticola* (*c*), *Protaetia cuprea*, *Serica brunnea* (*rc*), *Trichius fasciatus* (*lc*).

**SCIRTIDAE:** *Cyphon coarctatus* (*rc*), *C. laevipennis* (*lc*), *C. padi* (*c*), *C. phragmiteticola*, *C. variabilis*, *Microcara testacea*.

**SILPHIDAE:** Most often found in pitfall traps left non-emptied for more than three days. *Dendroxena quadrimaculata*, *Nicrophorus humator* (*lc*), *N. investigator* (*c*), *N. vespillo* (*c*), *N. vespilloides* (*c*), *Oeceoptoma thoracicum* (*c*), *Phosphuga atrata* (*c*), *Silpha carinata* (*rc*), *S. tristis* (*lc*), *Thanatophilus rugosus* (*lc*), *T. sinuatus*.

**STAPHYLINIDAE:** Only individuals exceeding 2 mm body length have usually been determined to species level and are included in the list. *Bolitobius castaneus*, *Gabrius splendidulus*, *Gyrohypnus angustatus*, *Ilyobates nigricollis*, *Ischnosoma splendidum* (*lc*), *Lathrobium fulvipenne*, *Neobismus villosus*, *Ocalea picata*, *Ocypus aeneocephalus*, *O. nitens* (*lc*), *Othius angustus*, *O. punctatulus*, *Philonthus carbonarius* (*lc*), *Ph. decorus* (*rc*), *Ph. intermedius*, *Ph. marginatus*, *Ph. micans*, *Ph. politus* (*rc*), *Pseudocypus* (*Staphylinus*) *brunipes*, *Staphylinus caesareus*, *S. erythropterus* (*lc*), *Stenus* (*Tesnus*) *brunnipes*, *S.* (*Nestus*) *carbonarius*, *S.* (*Cryptostenus*) *cicindeloides*, *S.* (*Hemistenus*) *flavipes*, *S. juno*, *S. picipes*, *Tachinus laticollis*, *T. marginellus*, *T. signatus*, *Tachyporus chrysomelinus* (*rc*), *T. hypnorum* (*lc*), *T. nitidulus*, *T. obtusus* (*lc*), *T. pusillus*, *T. solutus* (*lc*), *Xantholinus linearis*, *X. longiventris*, *Xylodromus affinis*, *Zyras limbatus*.

**TENEBRIONIDAE:** *Lagria hirta* (*rc*).

**TROSCIDAE:** *Throscus dermestoides* (*rc*).

## CONCLUSION

Coleoptera (beetle) species diversity and composition of an abandoned exercise field in south Sweden was studied during sixteen years. It is concluded that land use is a very decisive factor for the structure of the Coleoptera fauna, more important than, e.g. climate change. The most species-rich families were the Chrysomelidae, Curculionidae, and Carabidae. As a total, about 550 species were found, many of them certainly scarce or rare in northern Europe. The limitations of the three capturing methods are also discussed.

## CONFLICT OF INTEREST STATEMENT

To my knowledge, there are no conflicts of interest with regard to this paper.

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