Observations on the biology of *Hylochares cruentatus* (Gyllenhal) (Coleoptera: Eucnemidae)

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The biology of *Hylochares cruentatus* in Southern Finland is discussed. Contrary to previous observations in Russian Karelia, the species breeds in barkless willows along a regularly flooding small river in Southern Finland. The specialized biological requirements suggest this species might well survive in similar habitats in Eastern parts of Europe outside Russia. On the basis of existing information, this species is undoubtedly acutely threatened within the EU and potential breeding sites should be mapped, in Southern Finland as well as in other Baltic regions. The distribution of *Hylochares* spp. across the Holarctic in combination with their habitat choice suggests they are one of the few eucnemids adapted into a life in Northern latitudes.

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1. Previous records and distribution

Hylochares cruentatus (Gyllenhal) is one of the great rarities of the European insect fauna.

In the original description of *Elater cruentatus,* Gyllenhal (1808: 435–436) stated: "Habitat in Finlandia rarissime. Dom. Sahlberg." This referred to a Finnish entomologist, Carl Reinhold Sahlberg. Sahlberg was an eager young collector at the time, and had started exchanging material with prominent Swedish scientists as early as in 1803–1805 – Saalas (1956) mentions both Thunberg and Fallén, but not Gyllenhal. No direct link between Sahlberg and Gyllenhal is known before 1823, when Sahlberg in the company of Mannerheim visited him at his home (Saalas 1956). Possibly the type-material of *H. cruentatus* reached Gyllenhal *via* another Swedish collector, not directly from Sahlberg. The only specimen in the Gyllenhal collection bears a label in Gyllenhal's handwriting: "Finland/Salberg." (ditto). The Finnish Museum of Natural History collection contains one specimen of *H. cruentatus* labelled "Pemar", "Loppis", Pippingsköld", "Spec. Typ." and another one labelled "Pemar", "Pippingsköld". The "Spec. Typ." label is very old. Further specimens from the same locality exist, as we have seen one labelled "Pemar" in a French collection. It is unlikely that Gyllenhal saw the Helsinki collection material. These specimens cannot be regarded as being part of the type material and the Uppsala specimen is the only known syntype. In addition to the Gyllenhal label the specimen bears a printed red label "Uppsala Univ. Zool. Mus. Gyllenhals saml. TYP nr. 1511".

Mannerheim (1823) wrote in greater detail than Gyllenhal did:"Habitat in Fennia australi rarissime. In ligno putrido salicis ad Loppis prope Aboam a Dom. Pippingskioeld utriusque juris Candidato, amico mihi exoptatissimo, semel tantum lectus." Thus Mannerheim knew of one record only. His friend, the lawyer Pippingsköld

had collected this species from a rotten willow in the vicinity of the town Turku ("Abo") in SW Finland. The friend in question was Johan Josef Pippingsköld, born in 1792, who had a keen interest in entomology. It appears surprising that Sahlberg would have sent material collected by Pippingsköld unlabelled to Sweden before 1808, but this explanation seems to fit the data. Sahlberg (1824) gave the same information as Mannerheim did, although in a different, abridged form, "Pemar". Pemar was the Swedish name of the present-day town Paimio, and Loppis was the old name for the Spurila region, today within the limits of Paimio (Godenhjelm 1897).

All the early Finnish sources refer to one location only. The Helsinki University collection specimens as well as others labelled "Pemar" originate from this find and it seems clear that the type-specimen is from there as well, although its rout to Gyllenhal remains unknown.

The second Finnish find came to light from an old student collection, V: Mynämäki, 1920s, 60º41'N, 21º59'E, A. Cajander leg. This specimen was collected by the future professor of botany, A. Kalela, as a young man. No further details are available.

The only record from Estonia is from before 1870s, no new finds were known by 1937 (Horion 1953).

The only record from Lithuania is very old. Seidlitz (1891) reported *Hylochares* from "Livland" based on information provided by Eschscholtz, who died in 1831.

Two records have been reported from Poland. Several specimens in different collections came from Elblag, before 1860s, 54º10'N, 19º24'E (Horion 1953). *H. cruentatus* was reported from the Bialowieza National Park, 1959 as well (Burakowski & Sliwinski 1981), but this record is incorrect, (Burakowski 1989, 1991) and refers to *Dirrhagofarsus attenuatus* (Mäklin). *H. cruentatus* is known from several locations in Russia. With two exceptions these are from the Karelia region close to the Finnish border. The oldest records are obscure. The Turku University collection has a specimen labelled "Carelia Rossica, Günther leg." The location and date are unknown, but it was probably collected in the Petroskoi region around 1860–1890. The next find is from Gumbaritsa, 60º31'N, 32º56'E, A. Giorgiewsky leg. The date is unknown, but before 1898. Poppius (1899) and Sahlberg (1900: 147) point out that Günther got many young people interested in collecting in the region. Poppius lists Georgiewsky as one of them. Thus it is possible that Günther's and Georgiewsky's specimens came from the same place. Russian Karelia, with the exception of the Lake Onega region, was regarded as fairly well-known by Poppius (1899). Experienced collectors, among others J. Sahlberg, Poppius himself and R. Enwald had spent entire summers collecting there. None of them found *H. cruentatus*, however, and it is unlikely that the species was frequent in the region at the time. Kangas & Kangas (1944) reported two locations: Kuujärvi, 1943, 60º25'N, 33º06' E, *Populus tremula* and Pitkäjärvi, 1943, 60º34'N, 33º28'E, *P. tremula*. Fifty years later Siitonen & Martikainen (1994) and Siitonen *et al*. (1996) added four locations: Avdejevo, 1992, 61º55'N, 36º04'E and Kuganavolok, 1992, 62º08'N, 36º49'E, *P. tremula*; Vodlozersky, 1994, 62º27'N, 36º58'E, *P. tremula*; Kivatch, 1993, 62º33'N, 33º57'E, *P. tremula* and *Salix caprea*.

Two further Russian localities have been published. The species is known from the Moscow region (Horion 1953). In addition, *H. cruentatus* has been taken in the Altai Mts. in the 1840s. One specimen used to be known, collected by Gebler, given to count Mniszech and first detected from his unidentified material in Paris in the 1860s (Bonvouloir 1875). Several specimens from this find exist, however, as we have seen another one labelled "Siberia, leg. Gebler".

2. The new Finnish find

A single specimen of *H. cruentatus* was captured with a pit-fall trap in Vantaa, Southern Finland in 2004 (Rassi, Sundell, Nieminen, Nupponen). This unexpected find prompted JM to visit the location in VII.2005. The trap had been placed on forest floor in a densely vegetated aspen stand close to a small river. When approaching the location, some 500 m from it, JM spotted a large willow with two trunks close to the river next to the bicycle path. One of the trunks, DBH 50 cm, was broken at about 5 m. The tree appeared suitable

Fig. 1. *Hylochares cruentatus,* emergence holes on Bay Willow (*Salix petandra*). Scale bar 10 mm. Finland, Vantaa.

and on closer inspection dozens of round emergence holes of varying size were found on a barkless region of the trunk. The holes were 2 to 3.5 mm in diameter (Fig. 1). Most of the insects had emerged from a region close to the border between sound wood and barkless soft wood about 1.5 to 2 m from the ground. The trunk was quite exposed, but because of high vegetation and shading by nearby trees, only the top was in full sunshine before late afternoon. No trace of the beetle or its larvae was found and no signs of the beetle were seen close to the original finding locality either. Fortune came the next year, when P. Rassi, visited the same tree on 18.VI.2006. The beetles were out and several were seen running on the tree trunk in broad daylight. Rassi alerted JM to the site and he spent about 20 hours on different occasions at the location during the next two weeks in order to observe this species in more detail.

The first visits were on 19. and 20.VI.2006 from 13.00 on. The weather was sunny and warm,

Fig.. 2. *Hylochares cruentatus* male searching for females on the host tree in late afternoon. Finland, Vantaa.

+26 °C. About ten beetles were seen moving actively around the barkless region of the tree (Fig. 2). They frequented the lowermost three meters of the trunk. New emergence holes could be seen close to the border of the bare trunk and the region with bark, some 25 altogether. Fresh frass was visible underneath the holes. Several copulations were seen. The female searched for a small crevice on the surface of the wood and having found a suitable one placed herself in it, head facing out. Soon a male would approach and after a short antennal tapping series, to which the female replied, placed himself on the top of her. The matings observed lasted only 10 to 15 seconds. They appeared to end when the female again rapidly tapped her antennae, the males then leaving. Once a male tried to remount the same female after making a 30 cm detour, but the female was not responsive to the antennal tapping and the male left. Females were not observed to mate with several males.

The next visits were on 25. and 26.VI.2006, from noon on. The weather was sunny and quite warm, +24 °C. On both occasions activity had almost ceased and only a few females were present. On the 26.VI.2006 JM had a chance to observe egg-laying. Initially no beetles could be seen but when the sun started warming the upper broken trunk at the height of about four meters, the first female came to light. It appeared to come from inside the hollow trunk and soon vanished into a crack. A second female crept out from a crevice lower down and moved slowly around on a fairly secluded area of the trunk. Then, at a spot where the surface wood was damaged and appeared to have fungal hyphae, she placed the short

Fig. 3. *Hylochares cruentatus* female laying an egg on damaged surface wood in a secluded spot of a broken Bay Willow trunk. Finland, Vantaa.

ovipositor in the wood by pressing it downwards with the help of the exposed last sternite (Fig. 3). One egg was laid. After that the female moved towards a hollow next to it. She searched for a suitable site underneath a lid-like large splinter of wood with fungal hyphae and then laid another egg about 15 cm away from the first site. After this she moved deeper in the cavity and could not be observed anymore.

The fourth visit took place in early July. No trace of the beetles could be seen during a three-hour stay at the location, although the weather was appropriate, warm and sunny.

The tree *H. cruentatus* breeds in is a large, partly hollow and broken *Salix pentandra* infested with the fungus *Phellinus igniarius*. It stands close to the water-line next to a small river, but its base is not regularly inundated. Although alive and flourishing, parts of the trunk are dead and the fungal infestation is strong. All emergence holes seen are on the barkless region of the trunk, facing south. *H. cruentatus* had used the tree more than two years judging from the condition of the holes. When JM first visited the location in 2005, he removed a section of the soft surface wood to look for larvae. No larvae were present in that section. An unidentified wasp had used the galleries seen for depositing large numbers of homopterans at the end of them.

Traces of the species in the region around the main find were searched for in 2006 and 2007. Four further trees with infestation were observed by searching all trees on both banks of the river for about a 1, 5 km section starting from the source of the river downstream. One infested tree was found 1 km further south and three trees a further kilometre downstream. Eight of the trees were *S. pentandra*, six of them with DBH 9 – 12 cm, two about 50 cm, one a *Salix myrsinifolia,* DBH an estimated 8 cm – the trunk being sawn off. We were not able to detect *H. cruentatus* on any of the *Alnus*, *Populus* and *Salix fragilis* and *S. caprea* growing on the site, although the work of several cerambycid and elaterid species was discovered. Dozens of suitable appearing, barkless *Salix caprea*, *Alnus* and *Betula* were examined, as well as half a dozen of large suitable appearing *S. fragilis*. Kangas & Kangas (1944) and Siitonen *et al*. (1996) have shown that *H. cruentatus* breeds in *Populus tremula*, but also in *S. caprea*. The new Finnish locality proves that it breeds in *S. pentandra* and *S. myrsinifolia* as well. The bracket fungus *Phellinus igniarius* never attacks aspen (T. Niemelä, pers.com.), thus proving that at least this eucnemid species is not restricted to wood infected by one fungus species only.

Kangas & Kangas (1944) observed *H. cruentatus* developing in three huge *P. tremula* trunks (DBH 50, 60, 80 cm). The emergence holes appeared to be in groups and vary considerably in size (2 mm to 3.5 mm). They concluded about the life of the larvae "…rindenloses, oberflächenfaules Espenholz, möglicherweise mit Vorlieb oder ausschliesslich grosse, auf dem Stock vertrocknete Espen zu bewohnen, deren Stammgründe von ihm besiedelt warden. Die Larven dringen aus dem oberflächenfaulen Gebiet nicht in das darunterliegende gesunde Holz ein." On the other hand, Siitonen *et al*. (1996) reported the larvae from two aspens with "rather hard and sound surface wood". They also reported having found the species on three different locations in identical giant aspens (Advejevo) as well as fifteen aspens in different locations, all being large, dead standing trunks (Kivach). Their single *S. caprea* observation referred to a smaller tree, about 15 cm in diameter.

In the Mätäjoki region the species breeds only in hard, sound appearing wood. The emergence

holes of the adults remain visible for a long time and consequently can be found on quite soft, rotten wood as well. Whether the larvae ever work galleries in typical soft eucnemid substrate is questionable. Their structure and behaviour are similar to those of hardwood boring other beetles, *Melasis* spp. and *Isorhipis* spp. as well as Buprestidae (pers. obs.). No evidence of breeding on large, surface-rot Salix trees was observed in Vantaa.

The new location for *H. cruentatus* is a 4.5 km stretch of a small river called Mätäjoki, on the bank of which the first discivored infested tree grows. The river Mätäjoki is small and shallow today, but it has a glorious and well-studied history (Tikkanen & Ruth 2003) – the following short synopsis is based on their work.

The present-day Mätäjoki valley emerged from the sea about 4000 BP. Between 3000 BP and 2000 BP the valley formed the main channel to the sea for the largest present-day local river, Vantaa. The Vantaa river opened into the valley, first forming a narrow lake held back by the Pitäjänmäki threshold further south. Later a river 8 km long, up to 70 m wide and 8 m deep was formed here. Apparently in connection with unusually strong flooding the Vantaa river opened to another valley east of the present day Mätäjoki later on. The flow in the Mätäjoki river came to an end at about 2200 BP, at which time considerable amounts of fluvial sediments had been deposited already.

The Mätäjoki river starts from a natural swamp today and is an important outlet for rainwater in the western Helsinki–Vantaa region – water from several brooks have been directed to empty in it for this purpose. In addition, water from the Helsinki–Vantaa main water supply is directed to Mätäjoki in order to increase its flow, both to keep up the water quality and for recreational reasons. The spring flooding is pronounced along the upstream stretch. The width of the present-day Mätäjoki river is difficult to describe, as the flow is slow and it is often hard to differentiate between the numerous ponds and the actual channel at different points. All the finding spots of the beetle are along the first 4.5 km of the river within the limits of the city Vantaa. Further downstream the river becomes wider and has partly cleared, steeper banks.

3. Conservation aspects

H. cruentatus is undoubtedly a rare or very rare species with a limited range in Western Palaearctic. Within the European Union, the only known extant populations of this rarity are in Finland. Measures to secure the future of this species should be taken immediately. Such measures must be based on a good understanding of the biology of the species. *H. cruentatus* provides an example of the problems involved in dealing with relatively scant, even if solid information.

The view that *H. cruentatus* is a specialist preferring to breed in large, dead aspens originated in the paper by Kangas & Kangas (1944). Kangas & Kangas (1944) strongly emphasized the large size of the aspens the beetles were found on (also E. Kangas, pers. com.). They hesitantly cited Mannerheim (1823) for willow as the host tree (”vielleicht”), although Mannerheim’s statement is quite definite and not to be rejected only because written a long time ago. Siitonen & Martikainen (1994) showed that *H. cruentatus* survived in large aspens in Russian Karelia, but could not be found in similar situations in Northern Karelia in Finland. They concluded that it, together with other species, may have vanished because of the decline in the number of large, dead trees in Finland – aspen as a species having not declined. In our view their conclusion was a bit stretched with respect to *H. cruentatus*, as there is no evidence it ever occurred as far north in Finland as the regions they used for the study.

The observations from Russian Karelia have been seen as typical for *H. cruentatus*. This does not seem to be the case in Finland. It appears that from the conservation point of view at least, the presence of over-aged surface-rot aspens is not relevant for this species in present day Finland.

The first Finnish record (Mannerheim 1823) and the new Finnish records all refer to willows, both large and small trees, DBH 9 to 50 cm, standing close to water. Siitonen *et al*. (1996) took the species from *S. caprea*, the tree being of smaller dimensions than the aspens otherwise reported from the sites. It is clear from the recent two main sources that the authors either expressly studied aspen (Siitonen & Martikainen 1994) or searched for the species from large aspens (Kangas & Kangas 1944). Whether *H. cruentatus* requires

large trees or not, cannot really be judged with these data.

As it is clear on the basis of the new Finnish data that willows can be favoured when both willow and other deciduous trees are available, the explanation Siitonen & Martikainen (1994) provided should be reconsidered. It appears unlikely that *H. cruentatus*, if an aspen specialist Finland, would have gone undetected here for close to a century. First, in the 19th century, entomologists collected in Finland most of the aspen specialists known from present-day Karelia, but not *H. cruentatus*. Second, several localities with a long continuum of large aspens exist in Southern Finland today. Well-known aspen specialist beetles are known from one or several of these sites, e.g. *Cucujus cinnaberinus*, *Cossonus* species, *Wagaicis wagai*, *Agrilus ater*, *Leptura thoracica* and *Saperda perforata*.

However, *H. cruentatus* has not been found at these sites, although it appears to be more frequent in Karelia than species like *Cucujus cinnaberinus* and *Leptura thoracica*, which still survive in Finland. Siitonen & Martikainen (1994) probably point out the crucial thing about *H. cruentatus* in Karelia when noting that its presence "is attributable ... particularly to the **abundance** ... of large, dead aspen". There is no indication in Siitonen *et al*. (1996) suggesting they searched for *H. cruentatus* from medium to large willows on temporarily flooding habitats. It is quite possible the species frequents them in Karelia as well and if large aspen are available, attacks them too. From the conservation point of view the question which of these is the primary host is not the important one in Finland, although it might be so in Russia. In Finland large aspen trees are not available for the species, but flooding small waters are.

Records from Finland indicate *H. cruentatus* is a species favouring *Salix* trees standing on regularly flooding habitats, with barkless regions on the trunk. The need for a continuum of large aspens may be less important than previously stated for this species, such trees being a host for *H. cruentatus* only when available. It is unlikely these trees are needed for the survival of the species, provided dying *Salix* in wet, possibly regularly flooding habitats are available. From the conservation point of view this is a positive thing. Such habitats have been of little economic importance and still exist at several locations.

In order to clarify the distribution and conservation status of *H. cruentatus*, we need to scan willows growing along rivers and other small waters in Southern Finland. This can be done effectively and fairly quickly during the winter and in early spring. The emergence holes and the pattern they form are characteristic, although care should be taken not to confuse them with those of small serropalpids or large mordellids.

It is essential that these suitable habitats are not "cleaned" before their fauna is studied. *H. cruentatus* may not be the only surprise hiding in our tiny suburban jungles.

H. cruentatus is difficult to detect without searching for actual trees it breeds in due to the short life-span and patchy distribution. Regions around the Baltic Sea with suitable habitats should be studied to clarify, whether it still exists in other regions. Considering it has lived undetected within the limits of the Helsinki–Vantaa region, it may be present along the Northern coast of the Baltic states and Poland, perhaps even in Germany.

4. Evolutionary considerations

H. cruentatus has only two close relatives, the Far-Eastern and Japanese *Hylochares harmandi* Fleutiaux and the Nearctic *Hylochares nigricornis* (Say). Superficially these species are similar, both as adults and larvae.

H. harmandi has been bred from one willow species in Far Eastern Russia, *Chosenia arbutifolia* (Mamaev 1976). This tree is in the IUCN threatened species list in the category VU A1c, meaning that its distribution and/or habitat, river valley forests, have seriously declined or are so declining. It is a specialized river-bank tree, often partly flooded in its native habitats. *Chosenia* has been regarded a taxon separate from *Salix* and closer to *Populus* than *Salix*. Recent DNA-analysis (Azuma *et al*. 2000) suggested that this species belongs within the present genus *Salix*, but it is retained as a separate taxon in major catalogues presently. In any case, within Salicaceae, it is closer to *Salix* than *Populus*, whichever categorical rank is chosen for it. There seems to be a clear

similarity in the way of life between *H. cruentatus* and *H. harmandi*. Both breed in willows and seem to prefer hosts that grow to considerable size and stand close to the edge of water, possibly being adapted to seasonal flooding. *H. nigricornis* is a rarely collected species. Muona (2000) knew of only 12 records from the Central and Eastern United States, the newest being from 1971. Four host records are known, two from *Salix sp.*, one each from *Fagus* and *Ulmus*. One of the *Salix* records referred to a "snag", the other to a "log", the *Ulmus* record referred to a mass emergence from a log (label data, larvae, Smithsonian Institution). "Snag" is a term that mostly refers to dead branches or trunks and often ones situated over or partly in water. Unfortunately the exact meaning remains unknown in this case. It is tempting to suggest that this species favours river-bank willows as well.

The Eucnemidae species in the Holarctic region represent less than 10% of the known diversity of the family. The ones present form an interesting, mixed lot. In the evolutionary sense it is quite unbalanced and reflects major changes during the last 30 million years. This development has relevance to present-day conservation issues and should not be ignored. Muona (1993) has shown that during the formation of the Baltic Amber, the Eucnemidae fauna of the Baltic region was tropical and diverse, similar to that of South-East Asia and Australia today. Massive changes have taken place since. The Palaearctic lies within regions where continental climates dominate today, with the exception of much of Western Europe and parts of Japan and Korea, which have a temperate climate. Conifers and willows are abundant in the continental climate region. The dominant tropical eucnemid groups today, e.g. *Fornax*, *Dromaeolus* and the derived Eucneminae, were abundant in the Baltic Amber fauna, but have almost entirely vanished from the Palaearctic since and if present today, restricted to the temperate climate regions. The genera found today in the continental climate region all show adaptations that are unusual in the family.

Hylochares, Isorhipis and *Melasis* attack fairly solid wood and work real galleries as larvae, a very unusual feature within the family. Three genera, *Melasis*, *Hylis* and *Epiphanis* have species utilizing mainly brown-rot wood and attacking conifers as well, these being very rare phenomena in the family. Another Northern adaptation appears to be the use of Salicacae species as the host. Besides *Hylochares*, also *Otho*, *Microrhagus*, *Dirrhagofarsus* and *Rhacopus* are known from willows and poplars or are known to actually favour them.

A few lineages of the mainly tropical Eucnemidae appear to have survived in the North by adapting to one or several of the special features of the region: (1) abundance of conifers and brown-rot fungi, (2) abundance of Salicacae species and (3) readily available riverine habitats.

In addition, some of the Northern eucnemids are able to develop in hard wood, possibly infested by fungi, but not soft as of yet. We regard this as an advanced feature, which has developed in parallel in the mainly tropical genus *Nematodes* as well.

Hylochares seems to be an example of high specialization to the habitats of the region and as such it is of great interest from the conservation point of view. Other species, i.e. *Dirrhagofarsus attenuatus*, *Rhacopus sahlbergi*, *Hylis spp.* and *Otho sphondyloides* seem to be well adapted to the conditions in the continental region as well. Even in areas where they do not appear at threat today, their populations should be monitored.

In the Nearctic, a much more diverse fauna has thrived through time, lignicolous relict forms (*Proutianus*, *Palaeoxenus*, *Schizophilus)* as well as tropical elements (*Fornax, Onichodon, Golbachia* etc) being still present. However, the fauna of the areas with continental climate is very similar to that of the Palaearctic. The scarcity of *Hylochares* records suggests it may require attention in the US as well.

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References

Azuma, T, Kajita, T, Yokoyama, J & Ohashi, H. 2000: Phylogenetic relationships of *Salix* (Salicaceae) based on rbcL sequence data. — Am. J. Bot. 87:67–75.

Bonvouloir, H.A. de. 1875: Monographie de la Famille des Eucnémides, 3rd & 4th parts. — Annls Soc. Entomol. Fr. 40 (suppl.): 561–907, pls. 37–42.

Burakowski, B. 1989: Hypermetamorphosis of *Rhacopus attenuatus* (Maeklin) (Coleoptera, Eucnemidae). — Annales Zoologici 42 (5): 165–180.

Burakowski, B. 1991: Klucze do Oznaczania Owadów Polski. Czesc XIX. Chrzaszcze — Coleoptera. Zeszyt 35–37. Cerophytidae, Eucnemidae, Throscidae, Lissomidae. 91 pp. Polskie Towarzystwo Entomologiczne, Warsaw, 91 pp.

Burakowski, B. & Sliwinski, Z. 1981: Trzy nowe gatunki chrzaszczy (Coleoptera) dla fauny Polski. Three species of beetles (Coleoptera) new to the Polish fauna. — Przeglad Zoologiczny XXV (1): 107–119.

Godenhjelm, U.1897: Luettelo paikkojen nimistä Suomessa ynnä niiden postiosoitteet Suomen Postihallituksen toimesta tehnyt Uno Godenhjelm. Maarianhamina 1897, 140 pp. — Accessible in [www document] URL http://www.genealogia.fi/hakem/osoitteet/

Gyllenhal, L. 1808: Insecta Svecica. Classis I. Coleoptera sive Eleuterata. Tomus I. 660 pp. Scaris.

Horion, A. 1953: Faunistik der Mitteleuropäischen Käfer. Band III: Malacodermata Sternoxia (Elateridae bis Throscidae). 340 pp. München.

Kangas, E. & Kangas, J. 1944: Über die Lebensweise und die Larve von Xylophilus Cruentatus Gtll. (Col., Eucnemidae). — Suomen Hyönteistieteellinen Aikakauskirja 10 (1): 7–16.

Mamaev, B. M. 1976: Morphological types of xylophagous beetle larvae (Coleoptera, Eucnemidae) and their evolutionary importance. — In: Mamaev, B. M.: Evolutionary Morphology of Wood-Boring Larvae, pp. 136–155. Nauka, Moscow.

Mannerheim, C. G. 1823: Eucnemis, Insectorum Genus. Monographice tractatum iconibusque illustratum. 36 pp, 2 tabels. Petropoli.

Muona, J. 1993: Eucnemidae and Throscidae in Baltic Amber. — Entomologische Blätter für Biologi und Systematik der Käfer 89: 15–45.

Muona, J. 2000: A revision of the Nearctic Eucnemidae. — Acta Zoologica Fennica 212, 106 pp.

Poppius, B.R. 1899. Förteckning ofver Ryska Kareliens Coleoptera. — Acta Soc. Fauna Flora Fenn. XVIII.1. 125 pp. Helsingfors.

Saalas, U. 1956: Carl Reinhold Sahlberg. Luonnontutkija, yliopisto- ja maatalousmies 1779–1860. Historiallisia tutkimuksia 47. 480 + 19 p. Suomen Historiallinen Seura, Helsinki

Sahlberg, J. 1900: Alexander Günther, minnesord. — Med. Soc. Fauna Flora Fenn. XXVI: 147.

Sahlberg, C. R. [1824] 1817–1839: Dissertatio entomologica insecta Fennica enumerans. 52 leaflets. 519 + 288 p. Turku, Helsinki.

Siitonen, J. & Martikainen, P. 1994: Occurrence of rare and threatened insects living on decaying Populus tremula: a comparison between Finnish and Russian Karelia. — Scand. J. For. Res. 9(2) 1994:185–191.

Siitonen, J., P. Martikainen, L. Kaila, I. Mannerkoski, P. Rassi & I. Rutanen 1996: New faunistic records of threatened saproxylic Coleoptera, Diptera, Heteroptera, Homoptera and Lepidoptera from the Republic of Karelia, Russia. — Entomol. Fenn. 7: 69–76.

Tikkanen, M. & Ruth, O. 2003: Origins and development of the ancient outflow channel of the river Vantaanjoki, southern Finland, as indicated by fluvial sediments. — Fennia 181 (1): 69–83.