

***Galerucella (Neogalerucella) anserina* Ødegaard & Hanssen, sp. nov., a new species of Chrysomelidae (Coleoptera, Chrysomelidae, Galerucinae) from Norway**

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Abstract

A new chrysomelid beetle, *Galerucella anserina* Ødegaard & Hanssen, sp. nov., belonging to the *Galerucella tenella*-group (subgenus *Neogalerucella*) is described, illustrated and distinguished from similar species within the genus. The type specimens were collected in coastal wetlands in southeastern Norway. The species is associated with *Potentilla anserina* Rydb. (Rosaceae), and lives sympatrically with the closely related *G. tenella* (L.).

Key words: Coleoptera, Chrysomelidae, Galerucinae, *Galerucella*, *Neogalerucella*, West Palaearctic, Norway, taxonomy, description, new species, sibling species, cryptic diversity

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Introduction

The genus *Galerucella* Crotch, 1873 belongs to the tribe Galerucini within the subfamily Galerucinae (Chrysomelidae). The genus has a worldwide distribution with up to 50 described species (Rheinheimer & Hassler 2018). This group of phytophagous insects is associated with a wide range of plants, particularly within the Dicotyledonae, however more primitive plants as the Nymphaeaceae are also represented among the host plants of the genus (Jolivet & Hawkeswood 1995).

Neogalerucella Chujo, 1962 was originally described as a subgenus within *Galerucella*, but several authors (e.g. Lucht & Klasnitzer 1998; Arnett *et al.* 2002), treat *Neogalerucella* as a separate genus. Sometimes *Neogalerucella* is even treated as a subgenus within *Pyrrhalta* Joannis, 1865 (e.g. Poole & Gentili 1996, Warchalowski 2010). In this paper we follow Löbl & Smetana (2010) treating *Neogalerucella* as a subgenus within *Galerucella*. The subgenus *Neogalerucella* includes seven species in the Palaearctic zone and two species in the Nearctic zone (Löbl & Smetana 2010, Arnett *et al.* 2002). Keys to the four West Palaearctic species are given by e.g. Hansen (1927), Palmén (1945), Mohr (1966), and Warchalowski (2010), and for American species by Wilcox (1965) and Manguin *et al.* (1993). Recently, a new species, *G. medvedevi* Beenen, was described from eastern parts of Russia (Beenen 2008). In addition, two East-Palaearctic species (*G. fossata* Chen, and *G. semenowi* Rybakow) are reported from China and Mongolia (Beenen 2008, Löbl & Smetana 2010, Nie *et al.* 2013).

Neogalerucella can be distinguished from *Galerucella* s. str. by the coarsely punctate pronotal disk, very narrowly separated middle coxae, front coxae not separated by a prosternal process (Arnett *et al.* 2002), and the middle tibiae of males with a spur (Silfverberg 1974). The species are small in size (3.0–5.5 mm) compared with *Galerucella* s. str.. *Neogalerucella* can be divided into the *G. lineola*-group and the *G. tenella*-group based on the shape of the epipleura and genital characters (Silfverberg 1974). The *G. tenella*-group includes three common species in the West Palaearctic that can be found sympatrically in moist coastal areas. These are *Galerucella californiensis* (Linnaeus) and *G. pusilla* (Duftschmid), which are both associated with *Lythrum salicaria* L., and *G. tenella* (Linnaeus, 1760), which is associated with different plants in Rosaceae, particularly *Filipendula ulmaria* (L.) Maxim. (Borghuis *et al.* 2009, Rheinheimer & Hassler 2018).

As a result of an extensive survey of invertebrates in coastal wetlands in southern Norway (Evju *et al.* 2015), we found that material initially identified as *G. tenella* could be sorted into two groups distinct in several morphological characters, particularly a prominent difference in the shape of the aedeagus. Searching potential host plants showed that the normal *G. tenella*-morph (as described in the literature) was feeding on *Filipendula ulmaria* while the other morph was found exclusively on *Potentilla anserina* L. (= *Argentina anserina* (L.) Rydb.).

In the present paper we describe this new species of *Galerucella* (*Neogalerucella*), based on 90 specimens collected at nine different sites in southeastern Norway during 2012–2016.

Material and methods

The specimens were initially collected by the authors using sweep nets and pitfall traps at several sites along the coast in Norway (Evju *et al.* 2015). After concluding that this was a new species in 2013, additional manual searching was carried out on potential host plants (Rosaceae) at the same sites in 2014–2016.

The morphological study was conducted with Wild M10 and Leica M205C stereomicroscopes, measurements done with the M205C. Measurements in the description are based on ten specimens (five males and five females). The images of the body and male sternites were created using the photography technique of focus stacking. Several partially focused images were taken with a Nikon D850 mounted on a Nikon PB-4 Bellow with microscope objectives of different magnifications. The separate images were combined using Zerene Stacker 1.04 © (2009-2017) software.

The male genitalia were treated in 10 % potassium hydroxide solution, mounted in Euparal and imaged with a Olympus BX43F microscope, SC50 camera and the software cellSense Standard 1.18 © (2009-2017). The separate images were combined using the software Helicon Focus 6.8.0 © (2017).

The holotype male and 39 paratypes are deposited in the University Museum in Trondheim (NTNU). A total of 46 paratypes are deposited in the insect collection at the Norwegian Institute for Nature Research (NINA) in Trondheim. In addition, two paratypes are deposited in the Canadian National Collection of Insects, Arachnids and Nematodes in Ottawa (CNC), Ottawa, and two paratypes in The Museum of Natural History (BMNH), London.

Three specimens each of *G. tenella* and *G. anserina* were submitted for DNA-barcoding. All data are available through the public project Norwegian Coleoptera (NOCLP) in the Barcode of Life Data Systems 3.0 (BOLD, Ratnasingham & Hebert 2007). Comparisons of COI-sequences from this study with data on *Neogalerucella* present in other public BOLD-projects (119 specimens) were performed using a selection of tools provided by BOLD, including Neighbor Joining clustering using the Kimura 2-parameter substitution model (Kimura 1980). *Neogalerucella* species represented with barcodes in BOLD include *N. californiensis*, *N. lineola*, *N. pusilla*, *N. tenella*, *N. stefanssoni* Brown and *N. quebecensis* Brown.

Results

***Galerucella (Neogalerucella) anserina* Ødegaard & Hanssen, sp. nov.**

Holotype ♂: Norway, VESTFOLD [VE], Færder municipality, Ørahavna [EIS 19, E 10.43476° – N 59.09440°], 6 June 2013, leg. Oddvar Hanssen (NINA).

Paratypes 44 ♂♂ and 45 ♀♀: Norway, VESTFOLD [VE], Færder municipality, Ørahavna [EIS 19, E 10.43476° – N 59.09440°], pitfall trap 13 June – 5 July 2012, 1 ♀; 6 June 2013, 13 ♂♂ and 7 ♀♀; 11 June 2014, 9 ♂♂ and 10 ♀♀, leg. Oddvar Hanssen; Norway, VESTFOLD [VE], Færder municipality, Holme [EIS 19, E 10.43334° – N 59.11035°], 6 June 2013, 2 ♂♂ and 7 ♀♀; 11 June 2014, 3 ♂♂ and 8 ♀♀, leg. Oddvar Hanssen; 18 June 2015, 4 ♂♂, leg. Frode Ødegaard; Norway, VESTFOLD [VE], Færder municipality, Barkevika [EIS 19, E 10.38744° – N 59.10428°], 11 June 2014, 1 ♂, leg. Oddvar Hanssen; Norway, VESTFOLD [VE], Færder municipality, Taredyngerevet [EIS 19, E 10.39268° – N 59.06863°], 5 June 2013, 2 ♀♀; 11 June 2014, 1 ♂, leg. Oddvar Hanssen; Norway, VESTFOLD [VE], Sandefjord municipality, Bøkilan [EIS 19, E 10.27329° – N 59.11714°], pitfall trap 12 June – 5 July 2012, 1 ♂, leg. Oddvar Hanssen; Norway, AUST-AGDER [AAY], Grimstad municipality, Saulekilen [EIS 19, E 8.51105° – N 58.29232°], 4 June 2013, 1 ♂; 12 June 2014, 3 ♂♂ and 4 ♀♀, leg. Oddvar Hanssen; Norway, ØSTFOLD [Ø], Hvaler municipality, Landfastodden [EIS 20, E 10.93273° – N 59.04639°], 9 May 2016 1 ♂, leg. Frode Ødegaard; Norway, ØSTFOLD [Ø], Hvaler municipality, Vikerkilen [EIS 20, E 10.94004° –

N 59.04619°], 9 May 2016, 1 ♂ and 1 ♀, leg. Frode Ødegaard; Norway, ØSTFOLD [Ø], Fredrikstad municipality, Gonvad, [EIS 20, E 10.91653° – N 59.16834°], 7 June 2013, 1 ♂; 9 June 2014, 1 ♂ and 1 ♀; 27 June 2015, 1 ♂ and 4 ♀♀, 8 May 2016, 1 ♂, leg. Frode Ødegaard.

Description: Body length: 3.2–4.2 mm (linear distance from labrum to elytral apex); width: 1.37–1.62 mm (width across base of elytra) (Figure 1). Males are often smaller than females. Coloration: Head brown with large black spot on vertex that sometimes reach upper eye margin; pronotum brown sometimes with diffuse darker spot in middle; scutellum black; elytra brown, often with diffuse darker spots on shoulders (humeral calli). Central area of each elytron often darker; venter: mesosoma black except for pronotum; abdomen black except for sternite 5 brown; legs pale brown; antennae brownish black except for ventrally pale first four antennomeres. Mandibles pale brown with black apex; other mouthparts pale brown; palpomeres dark brown. Dorsum covered with dense, thick, white pubescence. Venter covered with white pubescence less dense near midline.

Head: Narrower than pronotum, densely and coarsely punctate, interstices with irregular microreticulation; with median depressed line from middle of vertex to below antennal sockets. Antennae 1.81–2.26 mm long; length ratio of antennomeres 1 to 11 (antennomere 2 set as length 1): 2-1-1.33-1.13-1.06-1-1-1-1-1-1.53.

Pronotum: Length 0.52–0.70 mm; width 1.03–1.22 mm. Wide depression on each side of disk. Smaller depressions along midline and at each side in front of posterior margin; pronotal disk margined all around. In dorsal view anterior 1/3 of lateral margins not visible. Lateral margin sinuate and pointed posterolaterally. Punctuation and microreticulation as on head, except for more elevated areas behind anterior margin, and at each side of middle depression before posterior margin, which are more scattered punctured with interstices larger than point diameter (Figure 8a).

Elytra: Length 2.11–2.86 mm; widest at apical 4/5, then broadly rounded to apex. In dorsal view elytral margin bent broadly upwards to apex. Punctuation irregular, coarse and distinct. Interstices narrower than puncture diameter, rather shiny with fine irregular microreticulation. Epipleuron broad basally and gradually narrowed towards apex, but still at breadth of middle part of metatibiae, at site where it fades towards apex. Hind wings fully developed.

Ventral surface: Mesosternum and metasternum smooth with fine punctuation. Mesepisternum and mesepimeron with white pubescence. Abdomen with fine punctuation; sternites 2–4 similar in length (Figure 1b). In males last sternite (St. 5) with more or less V-shaped cavity anterad of the posterior edge. Posterior margin with shallower and broader emargination in the middle (Figure 2). In females posterior margin of last sternite with variably deep and narrow emargination on midline (Figure 3). Legs: Mesotibiae of males with short spine bent outwards, like in other *Neogalerucella*.

Aedeagus: In dorsal view aedeagus parallel and slightly asymmetrical near the blunt tip (Figure 5a). Complex internal structures and Y-shaped sclerite of internal sac (Figure 6a). In lateral view, aedeagus broad, parallel and weakly curved in apical 2/3; apex blunt (Figure 7a). Spermatheca with short ductus with few windings, and a U-shaped capsule with subparallel head (Figure 3).

Comparative notes: *Galerucella anserina* matches diagnostic characteristics of the *G. tenella*-group of *Galerucella* (*Neogalerucella*) based on narrowly separated middle coxae, front coxae not separated by a prosternal process, the broad shape of epipleura, and the Y-shaped sclerite of the internal sac of the aedeagus (Silfverberg 1974, Arnett *et al.* 2002). The new species can be distinguished from the American species *G. quebecensis* and *G. stefanssoni*, by the black colored sternite 4, dark markings on elytra, and different shape of aedeagus (Manguin *et al.* 1993). The eastern Palaearctic species differ in several characters and particularly the shape of aedeagus (Beenen 2008, Nie *et al.* 2013). In European literature (Hansen 1927, Palmén 1945, Mohr 1966, Warchalowski 2010), the species will key out together with *G. tenella* from which the males can be

distinguished by the broad and parallel shaped aedeagus with a blunt tip seen in lateral view (Figure 7), and a more asymmetrical and blunt tip seen in dorsal view (Figure 5). The females of *G. anserina* have a more or less U-shaped emargination of the last sternite compared with *G. tenella*. The depth of this emargination covers more than 1/10 of the sternite length (Figure 3), compared with less than 1/20 of the sternite length in *G. tenella* (Figure 4). The spermatheca of the two species are variable and very similar, but in *G. anserina* (Figure 3) the spermatheca capsule has a deeper U-shaped neck, and a longer and more parallel head, than in *G. tenella* (Figure 4). In *G. anserina* the antennae are often darker than in *G. tenella*, with dark pattern also on the dorsal side of the first segments, the 3rd segment is 1.15–1.25 times longer than the 4th. In *G. tenella* the first segments are pale brown and the 3rd antennal segment is 1.30–1.40 times longer than the 4th. The dorsum has more evident and dense, pale pubescence than any other species in the group (Figure 9). The depressed areas of pronotum are larger and deeper than in *G. tenella*. The sides of the pronotum of *G. anserina* are dense and irregularly punctate, and the elevated areas are less shiny than in *G. tenella* due to more evident microreticulation (Figure 8). The coloration of the antennae, the shape of the last sternite and the pronotal punctures are characters shared with *G. calmariensis* and *G. pusilla*. However, *G. anserina* has a broader body shape than in *G. tenella*, and the antennae are very rarely as dark as in these species. The dense, white pubescence of the dorsum and the shape of aedeagus are otherwise unique characters of *G. anserina*.

DNA-barcoding: DNA-barcoding was successful and gave sequences of 658 bp for all specimens. All analyzed sequences were 100% similar, and BIN-clustered together with *G. tenella* (48 individuals) from other parts of Europe (BOLD:ACF3471). The nearest BIN-clade (BOLD:AAL2945), average distance 0.21%, includes European *G. calmariensis*, *G. pusilla* and undetermined *Neogalerucella* from North-America (79 individuals).

Etymology: The specific epithet (adjective) is derived from the host plant *Potentilla anserina*.

Distribution and bionomics: The new species was recorded at eight different coastal sites in the outer Oslofjord-area in the southeast of Norway, as well as one isolated site along the southern coast of Norway (Figure 10 and 11). At four of these sites *G. anserina* and *G. tenella* were found sympatrically. During an extensive search on potential host plants within Rosaceae at the sample sites, all specimens of *G. anserina* were found on *Potentilla anserina*, whereas *G. tenella* were found exclusively on *Filipendula ulmaria*. However, along the western coast of Norway, *G. tenella* was also found feeding on *Potentilla anserina* (pers. obs., F. Ødegaard 2019), confirming that *G. tenella* is an oligophagous species reported feeding on several species of Rosaceae (Rheinheimer & Hassler 2018). However, we expect that *G. anserina* has a wider distribution outside Norway that is to be revealed by revisions of collections and specific searching on the hostplant.

Discussion

The leaf beetles in the Palaearctic zone are probably quite well known in general, although new species are still described regularly, particularly from the East Palaearctic (Löbl & Smetana 2010). The Coleoptera inventory of the Nordic countries is very well studied over the last two centuries, and it is quite rare that new beetle species are discovered within this region. It is an open question whether *Galerucella anserina* has arrived to Norway as result of a recent range expansion, or if it is indigenous and previous overlooked in this area for a long time. As a result of Pleistocene glaciation events, species with restricted distributions in this area are not to be expected due to short immigration history. Since its closest relative, *Galerucella tenella* is a very common species occurring

widely in this region, the risk of overlooking a rare and restrictedly distributed sibling species within such a taxonomic complex would be obvious, as a large amount of material has to be examined. We expect *G. anserina* to occur elsewhere in the West Palaearctic, but this is not yet surveyed.

Within the subgenus *Neogalerucella*, the three species *Galerucella calvariensis*, *G. pusilla*, and *G. tenella* live sympatrically with *G. anserina* at several localities. An interesting feature distinguishing *G. anserina* from its close relatives is the dense and pale pubescence. Since the host plant *Potentilla anserina* has dense whitish pubescent leaves it may be that pale pubescence in *G. anserina* has evolved as a selective response to avoid predation by crickets.

Although the between species differences in *Neogalerucella* are supported by multiple independent morphological characters, they can hardly be separated genetically by COI and ITS sequences (Hambäck *et al.* 2013). Regarding COI sequences, there are no difference between *G. calvariensis* and *G. pusilla*, and a small difference (average 0.2%) between these two and *G. tenella* although morphological differences are clear. It is therefore not surprising that *G. anserina* is inseparable from *G. tenella* when it comes to COI DNA-barcoding. Closely related species are sometimes difficult to separate by DNA barcoding due to a young evolutionary history, historical interspecific hybridization or incomplete lineage sorting (van Velzen *et al.* 2012). However, the large and constant differences in male genitalia, as well as other morphological characters, between the two taxa, should be convincing evidence for assigning species status to *G. anserina*.

The genus *Galerucella* is not a large genus, and at least for the common species with a large geographical range, several aspects of taxonomy and ecological patterns are well studied (e.g. Maguin *et al.* 2003, Nokkala & Nokkala 1994, Ikonen *et al.* 2003). The abilities for race formation and eventually sympatric speciation due to host switch seems to be particularly pronounced in this taxonomic group (Nokkala & Nokkala 1994, 1998, Borghuis *et al.* 2009). The *Galerucella nymphaeae*-aggregate is still unsolved with regard to the taxonomic status of the different populations using different host plants, and the number of valid species in this complex varies in different literature (Lohse 1989, Nokkala & Nokkala 1994, 1998, Löbl & Smetana 2010, Rheinheimer & Hassler 2018). The lack of convincing evidence from morphological and molecular methods in this group indicate an early stage of speciation due to host switch (Nokkala & Nokkala 1998 Borghuis *et al.* 2009). Also in the subgenus *Neogalerucella* there is evidence for race formation due to host switch both in *G. lineola*, using *Alnus* and *Salix* (Ikonen *et al.* 2003), and *G. tenella*, using *Fragaria vesca* and *Filipendula ulmaria* (Stenberg & Axelsson 2008). However, we are not aware of such studies of *G. tenella* using *Potentilla anserina*. Based on similarity in DNA-sequences and abilities for race formation by relatives, we might then hypothesize that *G. anserina* is a young species evolved as a result of a host plant switch.

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CAPTIONS

FIGURE 1. Habitus, a) dorsal view of *Galerucella anserina*. holotype, male. b) ventral view, *G. anserina*. male. Photo: Arnstein Staverløkk/NINA.

FIGURE 2. Last sternite of *Galerucella anserina*, male. Photo: Arnstein Staverløkk/NINA .

FIGURE 3. Last sternite and spermatheca from two female paratypes of *Galerucella anserina*. Photo: Arnstein Staverløkk/NINA.

FIGURE 4. Last sternite and spermatheca of two different females of *Galerucella tenella*. Photo: Arnstein Staverløkk/NINA.

FIGURE 5. Aedeagus dorsal view a) *Galerucella anserina* and b) *G. tenella*. Photo: Arnstein Staverløkk/NINA.

FIGURE 6. Aedeagus ventral view a) *Galerucella anserina* and b) *G. tenella*. Photo: Oddvar Hanssen.

FIGURE 7. Aedeagus lateral view of a) *Galerucella anserina* and b) *G. tenella*. Photo: Arnstein Staverløkk/NINA.

FIGURE 8. Head and pronotum of a) *Galerucella anserina* and b) *G. tenella*. Photo: Arnstein Staverløkk/NINA.

FIGURE 9. Section of the elytral disk in central anterior area of left elytra of a) *Galerucella anserina* and b) *G. tenella*. Photo: Arnstein Staverløkk/NINA.

FIGURE 10. Four localities in Norway where *Galerucella anserina* has been found: a) Ørahavna, Færder municipality, Vestfold county. Photo: Oddvar Hanssen; b) Holme, Færder municipality, Vestfold county. Photo: Oddvar Hanssen; c) Saulekilen, Grimstad municipality, Aust-Agder county. Photo: Oddvar Hanssen; d) Gonvad, Fredrikstad municipality in Østfold county. Photo: Frode Ødegaard.

FIGURE 11. The geographical distribution of the known collection sites of *Galerucella anserina* in southern Norway.