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A third karyosystematic investigation of the *Stictotarsus griseostriatus* (De Geer) group of sibling species (Coleoptera: Dytiscidae)

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Abstract. Karyological analysis has been carried out on *Stictotarsus griseostriatus* (De Geer, 1774) from Tjøme in southern Norway, one of the type localities of *Deronectes maritimus* Helliesen, 1890, as well as from the Canton of Valais in the Swiss Alps and Bavaria in the German Alps. True *S. griseostriatus* is shown to occur over much of the central Alps, and the synonymy of *S. griseostriatus* var. *nigrescens* Favre, 1890 is confirmed. Analysis of Corsican material shows that the species inhabiting the island is *S. ibericus* Dutton et Angus, 2007. The known distributions of the *S. griseostriatus* group species occurring in the Alps and on Corsica are given, and Pleistocene fossil material from Starunia in the Ukrainian Carpathians is figured and discussed. A syntype of *Potamodytes multilineatus* Falkenström, 1922, in Helliesen's collection in Oslo, is noted and a neotype designated for *Deronectes maritimus* Helliesen, 1890 as the original material on which the description was based cannot be found.

Key words: *Stictotarsus griseostriatus*, *S. ibericus*, Alps, Corsica, southern Norway, Dytiscidae, chromosomes, karyotypes, sibling species, Pleistocene fossils, neotype.

Introduction

The *Stictotarsus griseostriatus* group of sibling species was shown by Dutton and Angus (Dutton, Angus, 2007) to comprise seven species in Europe, effectively indistinguishable from one another morphologically, but with distinct karyotypes and clearly different distributions. In a subsequent publication Angus (2008) synonymised *S. creticus* Dutton et Angus, 2007 with *S. macedonicus* (Georgiev, 1959), and showed that *S. griseostriatus strandi* (Brinck, 1943) is chromosomally identical with nominative subspecies *S. griseostriatus*, and that *S. griseostriatus*, in a distinctly striped form reminiscent of *S. multilineatus* (Falkenström, 1922), occurs in Finnish Lapland. Angus further noted that since these Finnish *S. griseostriatus* had a facies resembling *S. multilineatus*, presumably habitat-determined, it seemed possible that coastal *Deronectes maritimus* Helliesen, 1890 (*S. maritimus*), might perhaps be a habitat-determined form of *S. multilineatus*. Angus further noted that *Hydroporus griseostriatus* var. *nigrescens* Favre, 1890 (*S. griseostriatus* var. *nigrescens*), from the Alps of Chandolin (Valais, Switzerland) seems to be an unknown species as *S. griseostriatus* itself did not occur in the Alps. The primary objectives of the present study were to establish the identities of *S. maritimus* and

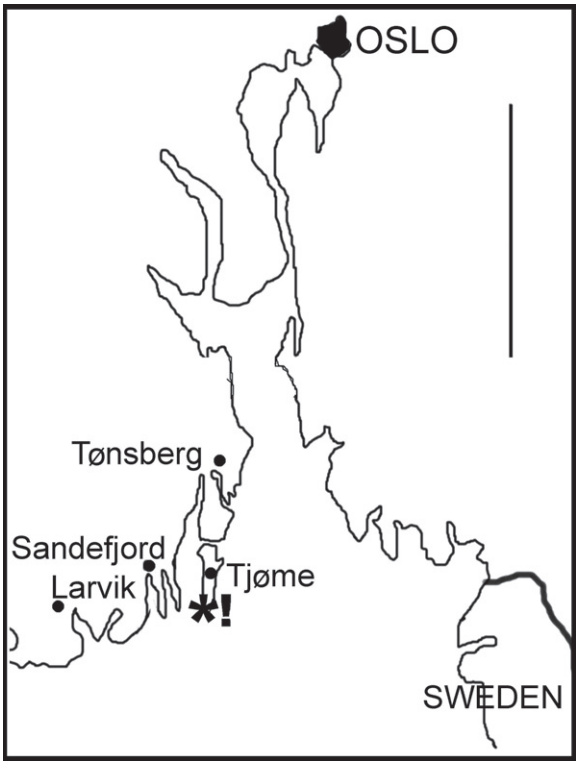

Fig. 1. Map showing the collecting locality for *S. griseostriatus* (*!) on Tjøme, southern Norway. Scale bar = 50 km. See also caption to Fig. 2.

S. griseostriatus var. *nigrescens*, and to find out which species occurs on the high mountains of Corsica.

Material and methods

The material used for chromosome analysis is listed in Table 1, and the localities are shown on the maps in Figs 1 and 2. The methods are as described by Dutton, Angus (2007) and unless otherwise stated the material is in the author's collection in the Natural History Museum, London. The Starunia fossil material is on loan from the Zoological Museum, Krakow.

Results

Mitotic chromosomes, arranged as karyotypes, are shown in Fig. 3.

***S. griseostriatus* (De Geer, 1774)**

Swedish reference material, first used by Dutton, Angus (2007) is shown in Fig. 3, a (plain) and Fig. 3, b (C-banded).

A plain male karyotype from Tjøme, Norway, is shown as Fig. 3, c. This karyotype shows no difference from those of the Swedish material, and confirms that *Deronectes maritimus* Helliesen, 1890, described from coastal rock pools on Tjøme and neighbouring localities, is indeed true *S. griseostriatus*.

Alpine material is shown in Fig. 3, d-g. Again, these karyotypes show no taxonomically important differences from those of the Swedish material, showing that true *S. griseostriatus* does occur in the Alps, contrary to Dutton, Angus (2007) and Angus (2008). The Swiss material (Fig. 3, d, e) is from two localities by Le Louché, just west of the hydroelectric Lac de Moiry in the canton of Valais. This locality is only about 12 km S of the Alpes de Chandolin by Mt Bella Tola, just the other side of the Val d'Anniviers, from where Favre (1890) described his *Hydroporus griseostriatus* var. *nigrescens*. This was described as having the elytra almost black (Elytres presque noires). In the lower of the Le Louché localities, a lake with a dark bottom with sparse submerged vegetation, some of the specimens, including the one whose karyotype is figured, had almost totally black elytra. This specimen may therefore be taken as confirming the identity of *Hydroporus griseostriatus* var. *nigrescens* as a form of *S. griseostriatus* (De Geer). The material in the higher of the Le Louché localities, a small silty pool, is all of the distinctly striped form, with the ground colour dull yellowish. First metaphase of

Table 1. Material used for chromosomal analysis.

Species	Locality	Number of specimens analysed
S. griseostriatus (De Geer)	Norway, Vestfold, Tjøme (Fig. 1)	6 ♂, 5 ♀
	Switzerland, Valais, Le Louché (Fig. 2)	8 ♂, 1 ♀
	Germany, Bavaria, Seeon Alm (Fig. 2)	3 ♂, 3 ♀
S. ibericus Dutton et Angus	France, Corsica, Haute Corse, lake and pools above Lac de Melo (Fig. 2)	8 ♂, 2 ♀

meiosis of the "*nigrescens*" form is shown as Fig. 4. The C-banded preparation (Fig. 4, b) shows the unpaired X chromosome, confirming the interpretation given by Angus (2008), using Finnish material.

Fig. 3, f, g shows the karyotype of a Bavarian male. This karyotype identifies the material as *S. griseostriatus*, indicating that this species is widely distributed over the main part of the Alps.

***S. ibericus* Dutton et Angus, 2007**

Karyotypes of Spanish and French paratypes are shown in Fig. 3, h, i. A karyotype of a Corsican male is shown in Fig. 3, j (plain) and k (C-banded). There is no taxonomically significant difference between these karyotypes. *S. ibericus* is characterised by a fusion-fission polymorphism involving autosomes 1 and 24, by the X chromosome not being the longest in the nucleus (as in other known karyotypes from the *S. griseostriatus* group), and by the small number of autosomes (5 pairs) with distinct centromeric C-bands. The Corsican material is referable to *S. ibericus* on all these characters (the material figured is all heterozygous for the fusion-fission polymorphism) and shows no other feature to distinguish it from *S. ibericus*.

Pleistocene fossil material

The identification of *S. griseostriatus* in the Alps shows it to be a true glacial relict. Fossils of *S. griseostriatus* group species are not uncommon in sites referable to colder episodes of the Last (Weichselian or Devensian) Glaciation in Britain, but more relevant to Alpine distributions is their occurrence in the mid-Weichselian deposits at Starunia near Lviv in the western Ukraine. This site, famous for the exceptional preservation of its insect remains because of a mixture of oil and salt (sodium chloride), was first described by Łomnicki (1914a). The initial interest in this site stemmed from the discovery of the mummified remains of a Woolly Rhinoceros, but the insect remains described by Łomnicki (1914b) were anomalous, all representing species living in that area at the present time. The matter was resolved by an expedition from the University of Krakow in 1929, leading to the discovery of a second Woolly Rhinoceros (Nowak, Panow, 1930) and the finding that the original insects were contaminants from surface material buried in the original shaft. The insects from this second site are a true Pleistocene assemblage, and have been radiocarbon dated to 23 255 ± 775 years B.P (SI-642). Angus (1973) gave an account of the *Helophorus* species (Helophoridae), and Zeuner (1934) described the Orthoptera. *S. griseostriatus* sensu lato is present among the unreported

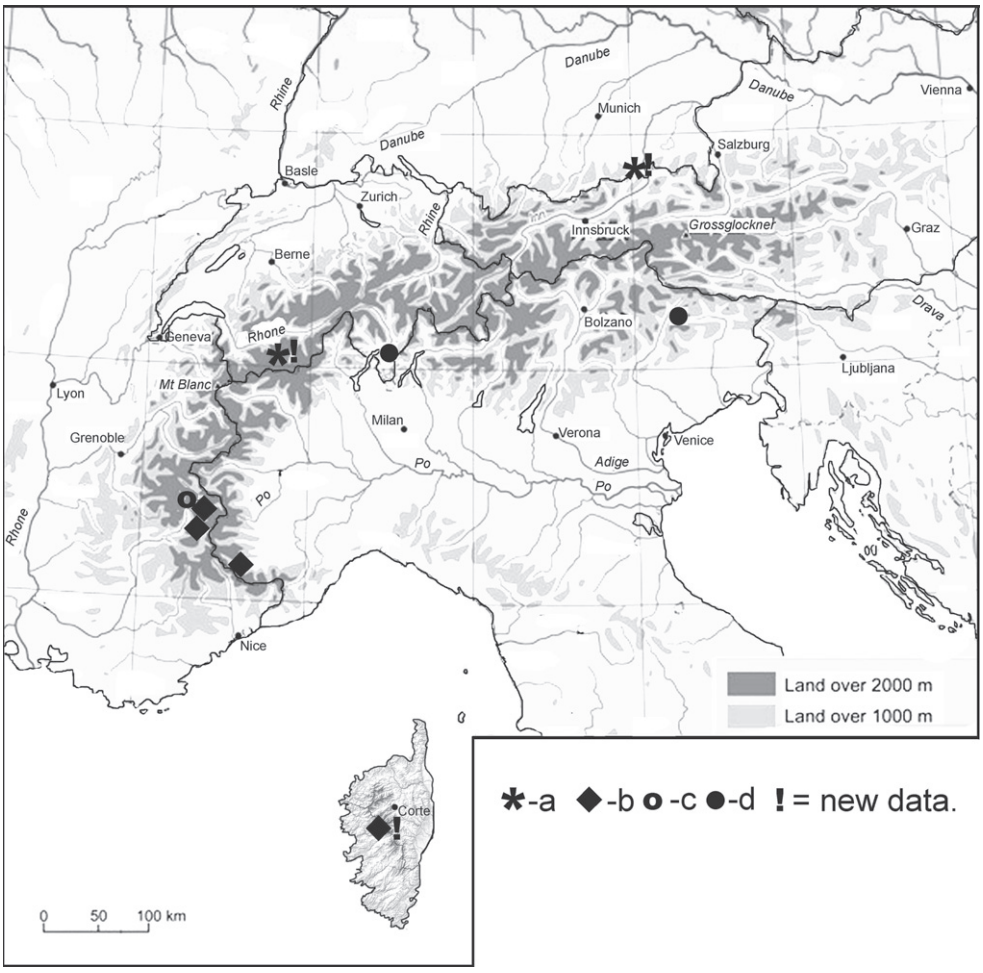

Fig. 2, a-d. Map showing the collection localities of *S. griseostriatus* group species in the Alps and on Corsica. **a** - S. griseostriatus. **b** - *S. ibericus* Dutton et Angus, 2007. **c** - *S. inexpectatus* Dutton et Angus, 2007. **d** - *S. alpestris* Dutton et Angus, 2007. New data points indicated by exclamation mark (!), others from Dutton, Angus (2007).

Coleoptera from Starunia at present in my possession. The material comprises one right elytron, about 3.6 mm long and with very distinct brown (faded) stripes on a pale background, and one abdomen complete with aedeagophore. The aedeagus, laterally compressed, and one paramere, also compressed, are shown in Fig. 5, with modern Scandinavian *S. griseostriatus* for comparison. The aedeagus (Fig. 5, a) is similar in size and shape to the modern Swedish specimen (Fig. 5, b), but is not sufficiently distinctive to allow identification within the *S. griseostriatus* group. However, the paramere (Fig. 5, c), although squashed and somewhat broadened artificially, does bear a reasonable resemblance to the modern Norwegian *S. griseostriatus* (Fig. 5, d), suggesting that it might in fact be true *S. griseostriatus*. The fossil elytron matches the paler striped Swiss material from the silty pool near Le Louché.

Fig. 3, a-k. Mitotic chromosomes of *S. griseostriatus* group species, arranged as karyotypes. **a-g** - *S. griseostriatus*. **a** - ♂, Öregrund, Sweden, mid-gut, plain, **b** - ♂, Järnäs, Sweden, mid-gut, C-banded (shown by Dutton and Angus (2007) as Fig. 2, a, b). **c** - ♂, Tjøme, Norway, mid-gut, plain. **d, e** - ♂, Le Louché lake, Switzerland, mid-gut, **d** - plain, **e** - the same nucleus C-banded. **f, g** - ♂, Seeonalm, Bavaria, Germany, testis, **f** - plain, **g** - the same nucleus, C-banded. **h-k** - *S. ibericus*. h - ♂, Peñalara, (paratype) mid-gut, plain, **i** - ♀, Lac du Lauzet supérieur (paratype), mid-gut, C-banded (shown by Dutton and Angus (2007) as Fig. 2, k, m). **j, k** - ♂, small lake above Lac de Melo, Corsica, mid-gut, **j** - plain, **k** - the same nucleus, C-banded. Scale bar = 5µm.

Discussion

The confirmation that material from southern Norwegian rock pools is true *S. griseostriatus* rather than a form of *S. multilineatus* (Falkenström, 1922), as seemed possible in view of the variation in appearance now known in *S. griseostriatus* (Angus, 2008), removes any lingering uncertainty over the identity of the Scandinavian forms. The situation may now be stabilised by reference to type material. Helliesen (1890) described his *Deronectes maritimus* from boldly marked material from coastal rock pools on Tjøme and near Hankø in southern Norway, and considered the paler, more clearly striped form from the southern Norwegian mountains (Gaustafjeld, Mjøsvand and Valders) to be the true *S. griseostriatus* of De Geer. Falkenström (1922) showed that De Geer's *S. griseostriatus* was in fact the boldly marked Swedish Baltic coastal form, and proposed the name *S. multilineatus* for the inland form, placing it as a variety of *S. griseostriatus* De Geer. He gave only a brief description and made no mention of type material, but simply referred to Helliesen's publication. Later (Falkenström, 1929) he raised *S. multilineatus*

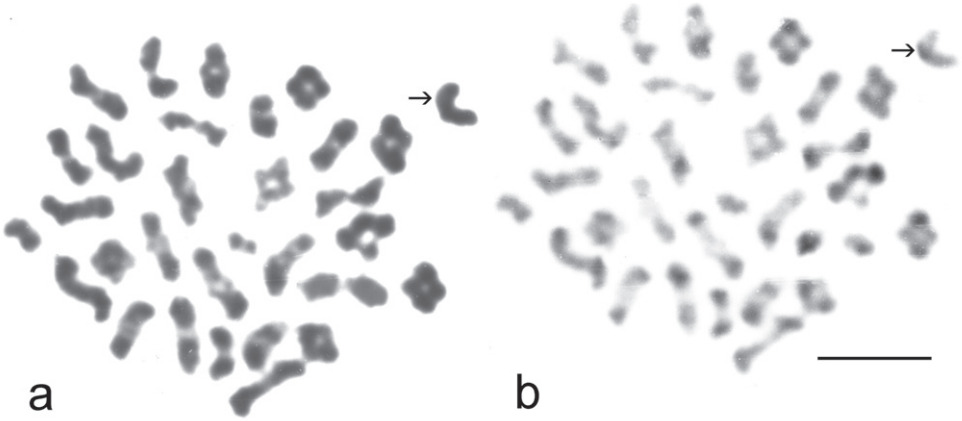

Fig. 4, a, b. First meiotic metaphase of *S. griseostriatus* ♂ from Le Louché, Switzerland. **a** - plain, **b** - the same nucleus C-banded, to show the unpaired X chromosome. Scale bar = 5μm.

to species rank and gave a detailed description and figures, but this is not the original use of the name, and in any event, no type was designated. Much of Helliesen's collection belongs to the Natural History Museum in Stavanger (Norway), and is at present on loan to the museum at Trondheim, where it is being curated. There is also material in the Zoological Museum in Oslo. However, there is no material of "*maritimus*" from the localities mentioned by Helliesen, in either of these collections. There is, however, one female "*griseostriatus*" in the Oslo collection, labelled "Gausta" (a handwritten label) and "Helliesen" (a printed label). Gaustafjeld is one of the localities from which Helliesen recorded his *S. griseostriatus*, so this specimen is part of the material for which Falkenström proposed the name *Potamodytes multilineatus*. It is therefore a syntype of *Potamodytes multilineatus*. It is a female, 4.3 mm long, with the elytra yellowish with distinct and well-separated blackish stripes, and the pronotum with the sides weakly but evenly curved, as in Nilsson and Holmen's habitus figure of *S. multilineatus* (Nilsson, Holmen, 1995, Fig. 347). Stripy *S. griseostriatus*, from Finnish Lapland and the Alps, has the pronotum with the sides straight over most of their length but then curved inwards in the basal fifth, as in Nilsson and Holmen's habitus figure of *S. griseostriatus* (Fig. 347). Thus both the morphology and the geographical origin of this specimen are in accord with its being *S. multilineatus* as currently interpreted. After discussion with Dr A. N. Nilsson (Umeå, Sweden), the leading Scandinavian expert on Dytiscidae, I am leaving this specimen as a syntype just in case a male syntype should be discovered somewhere, and am designating a neotype for *Deronectes maritimus* Helliesen as it seems very unlikely that type material still exists. The neotype is from the material I collected on Tjøme.

Neotype, ♂, *Deronectes maritimus* Helliesen, 1890. **Norway**, VE. Tjøme. Verdens Ende. Coastal rock pools. 20.iv.2009. R. B. Angus. Chromosome prep. 1. 26.iv.2009. R. B. Angus. *S. griseostriatus* (DeGeer). R. B. Angus det. 2009, deposited in the Zoological Museum, Oslo. This is the specimen whose karyotype is shown in Fig. 3, c.

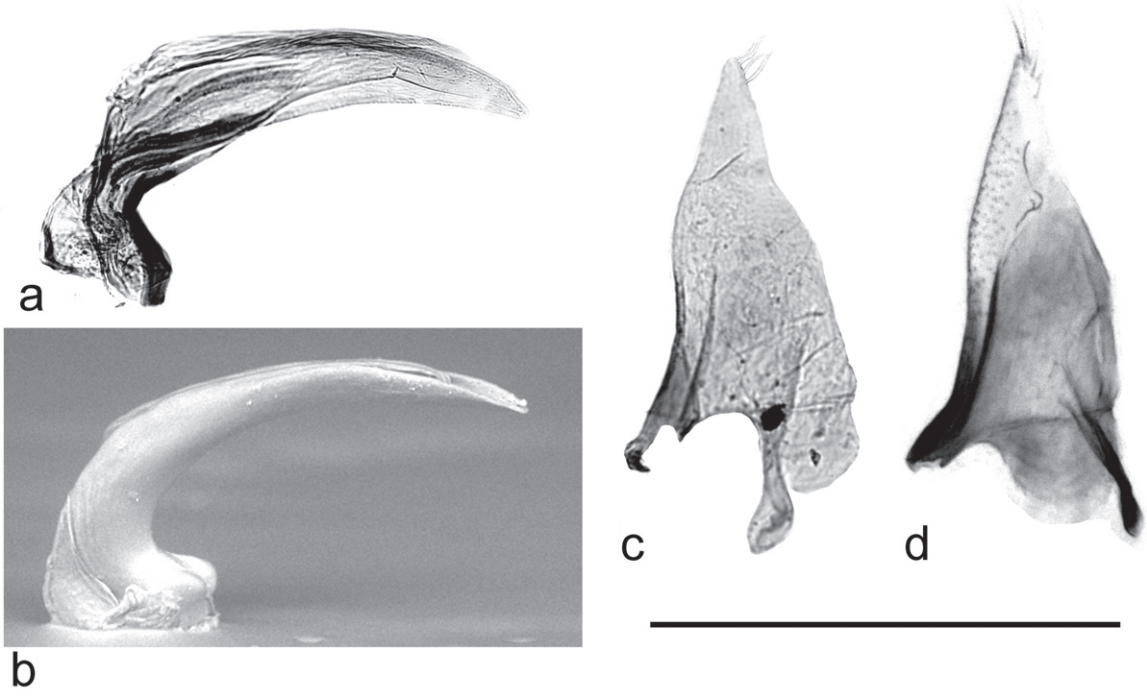

Fig. 5, a-d. Aedeagus (**a, b**) and paramere (**c, d**) of *S. griseostriatus* group beetles. **a, c** - Pleistocene fossil from Starunia. **b** - *S. griseostriatus* from Järnäs. **d** - *S. griseostriatus* from Tjøme. **a** is a scanning electron micrograph, **b-d** are photomicrographs. Scale bar = 0.5 mm

The discovery of true *S. griseostriatus* in the Alps was completely unexpected since all previously analysed material had belonged to other species of the *S. griseostriatus* group (Dutton, Angus, 2007). A map showing the known distributions of the *S. griseostriatus* group species in the Alps is given as Fig. 2, drawing on the data given by Dutton, Angus (2007) as well as those presented in this paper. Four species are involved. *S. griseostriatus* itself appears to be distributed over the main spine of the Alps, from Bavaria in the east to western Switzerland in the west. *S. alpestris* Dutton et Angus, 2007, inhabits the southern edges of the Alps, from the Italian Dolomites in the east to Ticino (Switzerland) in the west – and possibly further west, but no information is available. *S. ibericus*, an inhabitant of all the Iberian mountain ranges (Dutton, Angus, 2007), is found in the Maritime Alps and as far north as Briançon. It is interesting, but not surprising, that this is the species found on Corsica. The Alpine species with the most restricted known distribution is *S. inexpectatus* Dutton et Angus, 2007. This is still known only from the smaller of the two Lauzet lakes (Lac du Lauzet inférieur), while the larger lake, only about a kilometre distant, has *S. ibericus*. Clearly, more information on the *S. griseostriatus* group in the western French Alps is needed.

As yet there appear to be no records of the *S. griseostriatus* group from the arc of mountains running north and east of the Alps, the "Mittelgeberge" – the Sudeten Mountains, the Tatra and the Carpathians, though the High Ta-

tra, at least, appears to offer suitable habitats. However, even if the beetles do occur in some of these mountains, there is still a very large gap between their northern and Alpine distributions. The Starunia fossil material, from the Carpathians, may be true *S. griseostriatus*, and while this does not significantly close the gap between the northern and Alpine distributions, it does show that these beetles have been present in the area for thousands of years.

Acknowledgements

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