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Further 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 strandi* (Brinck, 1943) from the Varangerfjord, Norway, *S. griseostriatus* (De Geer, 1774) from near Inari in Finnish Lapland, *S. multilineatus* (Falkenström, 1922) from Northern Ireland and *S. macedonicus* (Georgiev, 1959) from the Šar Planina Mountains of Macedonia. The karyotype of *S. griseostriatus strandi* is shown to be identical with that of typical *S. griseostriatus* from the Swedish Baltic coast, and material from Finnish Lapland, although of the paler more distinctly striped pattern associated with *S. multilineatus*, is also shown to be *S. griseostriatus*. *S. multilineatus* from Northern Ireland has a karyotype identical with those of Scottish and Swedish material. *S. macedonicus*, from three lakes in the Šar Planina Mountains, has a karyotype indistinguishable from that of *S. creticus* Dutton et Angus, 2007, **syn. n.** and *S. creticus* is therefore placed in the synonymy under *S. macedonicus*. The description of *S. griseostriatus* var. *nigrescens* (Favre, 1890), from the Swiss Alps is noted. *S. griseostriatus* does not occur in the Alps, and *S. griseostriatus* var. *nigrescens* must be the valid name for either *S. alpestris* Dutton et Angus, 2007 or *S. inexpectatus* Dutton et Angus, 2007 but in the absence of chromosomally identified material from the type locality of *S. griseostriatus* var. *nigrescens* (Alps of Chandolin near Bella Tola), its true identity remains unknown.

Key words: *Stictotarsus griseostriatus*, Dytiscidae, chromosomes, karyotypes, sibling species.

Introduction

Dutton and Angus (Dutton, Angus, 2007) reported the results of chromosomal analysis of the *Stictotarsus griseostriatus* (De Geer, 1774) group of species, and were able to recognise seven species, of which five were described as new. They further mentioned the peculiar, apparently disjunct, distribution of *S. griseostriatus* itself, known from the Baltic coasts of Sweden and Finland, and the North Sea and Atlantic coasts of Sweden and southern Norway, with a geographically isolated subspecies, *S. griseostriatus strandi* (Brinck, 1943) from the southern Varangerfjord coast of Norway and adjacent Kola Peninsula coast of Russia, and suggested that the identity of this subspecies required chromosomal confirmation. They further mentioned the problem of names of taxa whose chromosomes were unknown, from Europe and adjacent areas. The European taxon mentioned was *S. macedonicus* (Georgiev, 1959). The present study answers some of the questions raised, in particular concerning *S. g. strandi* and *S. mace-*

donicus. It also confirms the presence of *S. multilineatus* (Falkenström, 1922) in Ireland. A further European named taxon, *S. griseostriatus* var. *nigrescens* (Favre, 1890) is noted, but not identified.

Material and Methods

The material used for chromosome analysis is listed in Table 1. The material was collected by the author, except for the Irish *S. multilineatus*, which was collected by Dr R. Anderson (Belfast). The faunal regions of Norway and Finland are as used by Nilsson and Holmen (Nilsson, Holmen, 1995), as follows: Fø, eastern Finnmark; Li, Lapponia inarensis. A map showing the locations of the collecting sites is shown as Fig. 1. All the specimens are at present in the author's collection.

The methodology was as described by Dutton and Angus (Dutton, Angus, 2007). Good C-banding was obtained from 2- and 3-day old slides stained in Giemsa, photographed and with the immersion oil removed by soaking in two changes of xylene and one of absolute ethanol, then drying. The slides were treated in saturated barium hydroxide for five minutes at 25° C without prior destaining in 2X SSC, then incubated for one hour in 2X SSC at 55° C.

Results and Discussion

S. griseostriatus

Representative karyotypes are shown in Fig. 2, a-c, and a C-banded preparation of first metaphase of meiosis as Fig. 3. Fig. 2, a shows the Öregrund (Sweden) specimen illustrated as Fig. 2, a by Dutton and Angus (2007),

Table 1. Material used for chromosomal analysis.

Species	Locality	Number of specimens analysed
S. griseostriatus (De Geer)	Finland, Li, Sevettijärvi, silt pond in pinewood clearing	9
S. griseostriatus strandi Brinck	Norway, Fø, Bugøynes, coastal rock-pools	5
	Norway, Fø, Lausklubben, coastal rock-pools	4
	Norway, Fø, Grense Jakobselv, coastal rock-pools	12
	Norway, Fø, Bugøynes, inland silt pond	3
S. multilineatus (Falkenström)	Ireland (Northern), County Antrim, Garron Plateau, Glenariff.	6
S. macedonicus (Georgiev)	Macedonia, Šar Planina, Karanikoličko Ezero	16
	Macedonia, Šar Planina, Crno Ezero	2
	Macedonia, Šar Planina, Bogovinsko Ezero	2

Fig. 1, a-d. Map showing the localities from which material has been collected. **a** - *Stictotarsus griseostriatus*. **b** - *S. griseostriatus strandi*. **c** - *S. multilineatus*. **d** - *S. macedonicus*.

while Fig. 2, b, c, show a female karyotype from Sevettijärvi, plain (b) and C-banded (c). There are no differences between any of these karyotypes. Meiosis (Fig. 3) confirms the chromosome number obtained from mitotic preparations and the use of C-banding allows identification of the unpaired X chromosome at first metaphase. A paramere of one of the Sevettijärvi males is shown as Fig. 4, c, and is of the normal slender pattern characteristic of this species.

S. griseostriatus strandi

A male karyotype is shown in Fig. 2, d (plain) and Fig. 2, e (C-banded). These karyotypes show no difference from that of typical *S. griseostriatus*, and neither does material from the other localities from which *S. g. strandi* was obtained (inland Bugøynes, Lausklubben and Grense Jakobselv. Parameres of males from Grense Jakobselv and Bugøynes are shown in Fig. 4, a, b. The main body of the paramere is broader and its lower margin more convex than in typical *S. griseostriatus*, but the paramere is still more elongate than that of *S. multilineatus*. It should be noted that the apical section of *S. griseostriatus*-group parameres shrivels on drying, and its shape is not always restored by wetting out. The aedeagus of *S. g. strandi* is very clearly of the *S. griseostriatus* rather than *S. multilineatus* form, with its apex a truncated triangle.

The confirmation that *S. griseostriatus* and *S. g. strandi* belong to the same species, and the discovery of striped (*S. multilineatus*-like) *S. griseostriatus* near Inari, cast new light on the distributions of *S. griseostriatus* and *S. multilineatus*, and suggest the possible derivation of *S. g. strandi* not from Baltic coastal *S. griseostriatus* but from the *S. griseostriatus* in Finnish Lapland. It also raises the question of how widely distributed a species *S. multilineatus* really is. This will be discussed further, after the account of the karyotype of Irish *S. multilineatus*.

S. multilineatus

Fig. 2, f shows a male karyotype, plain, from Åmsele, Sweden, which was shown as Fig. 2, c by Dutton and Angus (2007), and Fig. 2, g shows a female karyotype, also plain, from Northern Ireland. These karyotypes show no difference from one another.

Although the Irish locality is only about 100 km west of the Scottish locality recorded by Dutton and Angus (2007), it emphasises that *S. multilineatus* is a widely distributed western species. The name was originally proposed by Falkenström (1922) for the striped form from the southern Norwegian mountains, regarded by Helliesen (1890) as true *S. griseostriatus*, an identification refuted by Falkenström (1922) following his study of De Geer's type of *S. griseostriatus*. Falkenström showed, on the basis of the morphology of De Geer's

Fig. 2, a-o. Mitotic chromosomes from mid-guts of *Stictotarsus griseostriatus*-group species, arranged as karyotypes. **a-c** - *S. griseostriatus*, **a** - ♂, Öregrund (Sweden), plain (shown as Fig. 2, a by Dutton, Angus (2007)); **b, c** - ♀, Sevettijärvi, **b** - plain, **c** - the same nucleus, C-banded; **d, e** - *S. griseostriatus strandi*, ♂, coastal rock pool, Bugøynes, **d** - plain, **e** - the same nucleus, C-banded; **f**, **g** - *S. multilineatus*, **f** - ♂, Åmsele (Sweden), plain (shown as Fig. 2, c by Dutton, Angus (2007)), **g** - ♀, Glenariff, plain; **h-o** - *S. macedonicus*, **h** - ♂, Omalos, Crete, plain (*S. creticus* Dutton and Angus, holotype, shown as Fig. 2, n by Dutton, Angus (2007)), **i** - ♀, Omalos, Crete, C-banded (*S. creticus* Dutton and Angus, paratype, shown as Fig. 2, o by Dutton, Angus (2007)), **j** - ♂, Karanikoličko Ezero, plain, **k** - the same nucleus, C-banded, **l-n**, ♂, Crno Ezero, **l** - plain, **m** - plain, lacking one replicate of autosome 14, **n** - the same nucleus as m, C-banded; **o** - ♂, Omalos, Crete, plain, *S. creticus* Dutton et Angus, paratype, for comparison with **n**. Bar = 5 μm.

type, that Helliesen's material from the Atlantic coast of Norway, which he had described as a new species, *S. maritimus* Helliesen, 1890, was referable to the true *S. griseostriatus* of De Geer. However, the fact that *S. griseostriatus* itself has a paler striped inland form as well as a darker more blotchy coastal one, suggests that this could also be true of *S. multilineatus*, in which case *S. maritimus* of Helliesen would become the valid name for *S. multilineatus*. Clearly, more information (chromosomal and morphological) is needed to resolve this question.

S. macedonicus (Georgiev, 1959)

= *S. creticus* Dutton et Angus, 2007, **syn. n.**

Karyotypes of this species are shown in Fig. 2, h-o. Fig. 2, h is a plain karyotype from the holotype of *S. creticus*, shown as Fig. 2, n by Dutton and Angus (2007), and Fig. 2, i shows a C-banded karyotype from a paratype of *S. creticus*, shown as Fig. 2, o by Dutton and Angus (2007). Fig. 2, j, k, show a karyo-

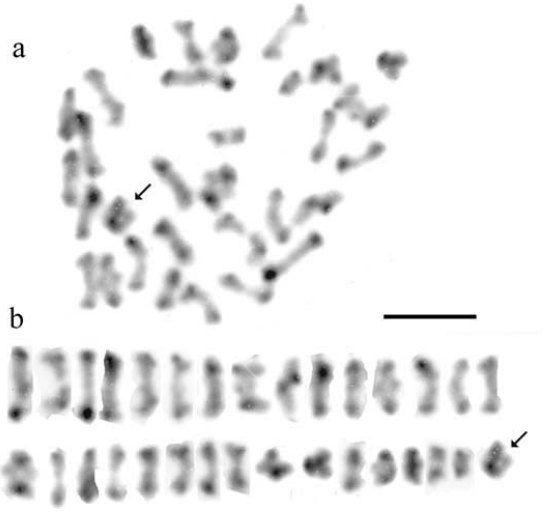

Fig. 3, a, b. Meiosis, first metaphase, C-banded, of *S. griseostriatus* from Sevettijärvi, showing the X chromosome (arrowed). **a** - nucleus as found; **b** - chromosomes arranged in rows. Scale bar = 5 μm.

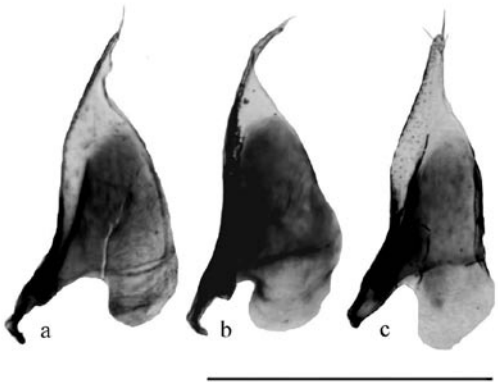

Fig. 4, a-c. Parameres of *Stictotarsus* spp. **a** - *S. griseostriatus strandi*, Grense Jakobselv; **b** - *S. g. strandi*, Bugøynes; **c** - *S. griseostriatus*, Sevettijärvi. Bar = 0.5 mm.

type, plain and C-banded, from Karanikoličko Ezero (Jezero) in the central Šar Planina mountains of Macedonia, about 25 km W of Livadičko Ezero, the type locality of *S. macedonicus*. Fig. 2, l-n, show karyotypes from two specimens from Crno Ezero in the western Šar Planina, about 16 km S of Karanikoličko Ezero, while a further karyotype from a paratype of *S. creticus* is shown in Fig. 2, o.

There is inevitably some individual variation in the appearance of various chromosomes in the karyotypes, but this appears to be random variation due to condensation effects, and does not show any greater differences between Cretan and Macedonian material than between different Cretan and different Macedonian preparations. In particular the Macedonian and Cretan karyotypes shown in Fig. 2, m, n and o appear to match each other precisely. There is thus nothing in the chromosomal data to suggest that the Cretan and Macedonian specimens do not belong to the same species. My visits to these Macedonian lakes are described by Angus (2007, 2008). Unfortunately I was not able to obtain any specimens from Livadičko Ezero when I visited the lake in September 2007. The lake has a population of the medium-sized Dytiscid *Agabus bipustulatus* var. *solieri* Aubé, 1836 so despite the presence of introduced fish (trout, *Salmo trutta*) the lake still supports beetles. *S. macedonicus* was described from two small males, 3.8 and 3.85 mm long, and there is a further specimen from the lake, a female 3.9 mm long (not a type as it was taken after the description was published) in the Natural History Museum in London. It may be that the Livadičko Ezero material is all small because of the rather barren nature of the lake. The material I took in Karanikoličko Ezero in 2006 comprised about 100 specimens, ranging in length from 3.9-4.3 mm, while in 2007 I took only four specimens (about 4-4.3 mm long) in Crno Ezero and a further two, both over 4 mm long) in the neighbouring Bogovinsko Ezero. Both of these lakes are more vegetated than Karanikoličko

Ezero and have introduced trout in them. All the lakes are at about the same altitude (about 2000 metres above sea level) but Livadičko Ezero is more stony and with less silt than the others. This could account for both the apparent paucity and the small size of the material taken there. In any event, Livadičko Ezero is at the eastern end of the Šar Planina, and there are no further high altitude lakes east of it until the Pirin Mountains of Bulgaria. There is thus no good reason to believe that the Livadičko Ezero material belongs to a species different from that in the other Šar Planina lakes, so the synonymy of *S. creticus* with *S. macedonicus* appears safe.

S. griseostriatus* var. *nigrescens

Favre (1890), included *S. griseostriatus* De Geer in his account of the Coleoptera of the Canton of Valais (Switzerland), and mentioned a *S. griseostriatus* var. *nigrescens* in which the elytra were almost black. He gave the locality for *S. griseostriatus* var. *nigrescens*, which he had collected himself, as in the Alps of Chandolin, at the foot of the mount Bella Tola. *S. griseostriatus* is a northern Scandinavian species, already discussed, and does not occur in the Alps. Two species are possible in this area – *S. alpestris* Dutton et Angus, whose nearest locality is in the Swiss Canton of Ticino, and *S. inexpectatus* Dutton et Angus, described from the Lac du Lauzet Inférieur in the French Alps. The Alps of Chandolin are almost exactly midway between these localities, and although I visited the area in August 2008, I was unable to obtain any material. So for the moment *S. griseostriatus* var. *nigrescens* must remain *incertae sedis*.

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