Dixella laeta (Loew, 1849) (Diptera, Dixidae) new to Norway, and some characters possibly useful in creating species groups

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The dixid midge *Dixella laeta* (Loew, 1849) has been found in Norway. The earlier published figures of the hypopygium and a character of the wing are discussed. *D. laeta* is compared to *Dixella dyari* (Garrett, 1924), *D. obscura* (Loew, 1849) and *D. autumnalis* (Meigen, 1818), and some differences are noted. The four species show similarity in the shape of one character, the cercus, which is not previously emphasized in descriptions of the male hypopygium. The possibilities and problems of using this character to define a species-group, are discussed, and the shape of the cercus is found to not be very useful in defining a species group.

Key words: Diptera, Dixidae, *Dixella laeta*, *Dixella dyari*, species group, Norway.

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Introduction

The genus *Dixella* Dyar & Shannon, 1924, is in need of being divided into several genera (Belkin 1962, Chaverri & Borkent 2007), but little has been done so far. A worldwide revision is a great task, so in the meantime a possible road towards this aim might be to seek to establish species groups by looking for morphological characters that can be used in the definition of these groups.

One such group could be the species examined in this study. An opportunity to do this arose as four male specimens of *Dixella laeta* (Loew, 1849) were discovered among the mounted material of *Dixella dyari* (Garrett, 1924) in the author's collection, making it possible to compare the four species suspected to be part of such a group.

Dixella laeta has earlier been found in Northern Finland (Salmela 2003), on the Kola Peninsula (Peus 1934) as well as in several countries of Europe, as far south as Greece (Rozkošný 1990). It is the only species of Dixidae on the Azores (Frey 1944, Viera *et al.* 2010). With such a wide distribution, it was also expected to be found in Norway.

Dixa laeta was described by Loew in 1849 on material from Posen, today in Poland (Poznan). In 1934 Peus separated *martinii* from *laeta* s. str. The figures given by Goetghebuer (1920), Martini (1929), Sicart (1959), and Mameli (1963) under that name are, however, not of *laeta* but of *martinii* (see Disney 1975, 1999). The descriptions given in the literature (Loew 1849, Peus 1934), correctly under the name *laeta*, give very few characters to separate *laeta* from *martini*, in fact only three: 1) the look of the hypopygium which will be analyzed here. 2) the lack/presence of a dark area between the lateral and the middle stripes on the scutum – this character is shared with several species, and 3) the length of the M-fork of the wings compared to its stalk, a character investigated here in comparison with many of the other Norwegian species. Published figures of the male *laeta* hypopygium are however given in connection with descriptions of proposed synonymous species, viz. *Dixa fuscifrons*

Edwards, 1928, *Dixa mediterranea* Martini, 1929, and *Dixa lateralis* Nielsen, 1937. This group of species should, however, be revised.

Dixella dyari was described by Garrett (1925) and redescribed by Peters and Cook, 1966. The last authors identified one male from Abisko in northern Sweden, indicating a holarctic distribution. The male genitalia of *D. dyari* has earlier only been figured by Peters & Cook (1966), in a publication somewhat difficult to obtain. The life cycle in the mountains of Southern Norway was investigated to some extent by Håland (2009). There is no published key separating this species from other European species.

Neither *laeta* nor *dyari* have been found in Great Britain, so they are not included in the keys to the British Dixidae (Disney 1975, 1999). Since the genitalia of *dyari* males may look quite like those of *laeta*, figures of both these species are necessary.

Material and methods

The material of *D. laeta*, 4 males and probably 3 females as judged from the long stalk of the M-vein, were found among mounted material of *D. dyari*. The females will not be examined here. No specimens were found that had not been mounted on microscope slides, with the consequence that only characters that can be seen on the slides will be considered. This limits the number of characters used and the angles in which these can be seen, and makes it necessary to borrow the figure of *Dixa lateralis* Nielsen, 1937, which is most probably a figure of *laeta*.

In Peters & Cook (1966) the M-branches are termed M_{1+2} and M_{3+4}, while Peters (1981) and Disney (1999) just call them M_1 and M_2, the last version is used here. Mst is used for the stalk, measured from the connection to the r-m vein to the branching point. This character was investigated on all the mounted male and female specimens of the authors collection, and the result is given in Table 1.

The terminology of the parts of the hypopygium is taken from McAlpine (1981), giving the terminology of Disney in parenthesis. Five different parts of the hypopygium were especially studied: A) The gonostylus (dististyle), B) the apical lobe of the gonocoxite (basistyle), C) the basal lobe of the same, D) the distal part of the 10th sternite (see Chaverri & Borkent, 2007, fig. 10), and E) a cercus that is only mentioned (as far as the author knows) by Wagner *et al.* (1992), and is situated ventrally to the gonostylus and dorsally to the 10th sternite (but because of the hypopygium inversum the sternite lies dorsally). The cercus is, in these four species, shaped like a lobe and is equipped with 4–5 very strong and dark setae, arranged in a row as a comb, and situated on an almost flat "foot" that seems to be of variable size, oriented vertically/sagitally, but tending to be more horizontal on the slide mounts. The cerci can be seen in the figures given by Martini (1929) (*Dixa mediterranea*), Edwards (1929) (*Dixa fuscifrons*) and Nielsen (1937) (*Dixa lateralis*), and are probably present in all species of *Dixella* but developed differently. The distal part of the 10th sternite has not been used to differentiate between species before, but seems to have some potential in showing a great diversity of shapes and pubescence.

All specimens are mounted in Euparal and are kept in the author's collection.

Results

The different parts of the hypopygium of the male of *D. laeta* is presented in dorsal view (ventral after the torsion of the distal part of the abdomen) in figures 1a–d. For comparison the same parts of the other three *Dixella* species are presented in figures 2a–c (*dyari*), figures 3a–c and 5 (*obscura*), and figures 4a–b (*autumnalis*). These four species, at least, thus seems to form a group as they are the only ones showing the cercus developed in such a way.

D. laeta

Proposed synonyms: *Dixella fuscifrons* Edwards, 1928 = *D. laeta* Loew, 1849 [Peus, 1934]; *Dixella mediterranea* Martini, 1929 = *D. laeta* Loew, 1849 [Peus, 1936]; *Dixella lateralis* Nielsen, 1937 = *D. laeta* Loew, 1849 [Rozkošný, 1990]

Wagner *et al.* (1992) described *D. fuscifrons* from

TABLE 1. The relative length of M_1/M_{st} of the wings (one wing in each specimen measured) of the species of *Dixella* Dyar & Shannon, 1924 in the author's collection, number of specimens measured (n). (Range of variation in parentheses).

Species	Males		Females	
Dixella aestivalis (Meigen, 1818)	0.45 (0.36-0.56)	n = 13	0.49 (0.32-0.79)	n = 22
Dixella amphibia (De Geer, 1776)	0.54 (0.50-0.70)	n = 9	0.56 (0.48-0.74)	n = 11
Dixella autumnalis (Meigen, 1818)	0.44	n = 1	-	n = 0
Dixella borealis (Martini, 1928)	0.49 (0.43-0.60)	n = 10	0.47 (0.35-0.68)	n = 16
Dixella dyari (Garrett, 1924)	0.71 (0.67-0.77)	n = 5	0.64 (0.53-0.73)	n = 4
Dixella hyperborea (Bergroth, 1889)	0.58 (0.50-0.79)	n = 12	0.70 (0.63-1.07)	n = 17
Dixella laeta (Loew, 1849)	0.85 (0.71-0.92	n = 3	0.90 (0.80-1.04)	n = 4
Dixella naevia (Peus, 1934)	0.59 (0.41-0.79)	n = 24	0.62 (0.47-0.85)	n = 20
Dixella nigra (Staeger, 1840)	0.48 (0.38-0.60)	n = 10	0.57 (0.48-0.65)	n = 8
Dixella obscura (Loew, 1849)	0.96 (0.65-1.18)	n = 6	0.88 (0.70-1.10)	n = 4
Dixella serotina (Meigen, 1818)	0.65	n = 1	-	n = 0

Greece as a species separate from *D. laeta*, thus not accepting the synonymy of Peus (1934).

At the end of the description of *Dixa mediterranea* Martini (1929) writes (p. 39): "Von F.W. Edwards aus Corsica beschrieben. Ich erhielt das stuck, ein ♂, nach dem vorstehende Beschreibung und Abbildung sind, durch seine Liebenswürdigkeit." It thus seems that the species of Edwards and that of Martini are from the same collection, and thus probably conspecific. Why they are given different names by the two authors is probably a misunderstanding between them.

Part of Nielsen's (1937) figure of *D. lateralis* is reproduced here (figure 8) to show the whole hypopygium, as none of the preparations in the author's collection were quite suitable to figure.

The gonostylus (dististylus) (Figure 1A) has a longitudinal lamella (lobe) on the outer side of the middle part. The distal end of the gonostylus has two somewhat crooked spines, that bend quite near the end. The apical lobe (Figure 1B) seems to be identical to that of *dyari*, with one spine at the end. The basal lobe (Figure 1C) is somewhat more square than in *dyari*. The cercus (Figure 1D) has five to six distinct spines, one at the end a bit shorter than the others, all placed at a low but distinct "foot". The distal end of the 10th sternite (Figure 6A) is roundish in outline, with two areas with long stiff and bent setae on each side of the middle point.

When comparing the figures published of *D. laeta* with the present specimens, one can notice at least one difference, namely the lack of the basal lobe on the gonocoxite in the published figure of *mediterranea* and it is hardly seen in the drawing of *fuscifrons*. This is probably just an omission as this lobe may be easily hidden by other parts of the hypopygium.

It can be seen from Table 1 that the character of M_1 being of the same length as Mst is not very good to separate it from other species, since several specimens of both *D. obscura* and *D. hyperborea* may show the same ratio. The hypopygia of these two species are clearly different, however, and in addition, the wing veins of *D. obscura* are also differing, so much that Enderlein (1936) created the new genus *Dixina* for this species, a genus that has not been recognized later on.

The lateral patch of the scutum is connected by a dark patch consisting of many small patches.

D. dyari

This species is very similar to *D. laeta* in its hypopygial characters, but differs in the structure of the "knee" on the gonostylus (dististyle) being much more robust in *dyari* (Figure 2A), being a clearly distinct part of the gonostylus, but like in *laeta* it is naked, i.e. without the pubescens that covers most of the hypopygium. The two spines at the distal end of the gonostylus are a bit thicker than in *laeta*, straight almost to the end. In one specimen there are three spines. The basal lobe (Figure 2B) seems to be more rounded than in

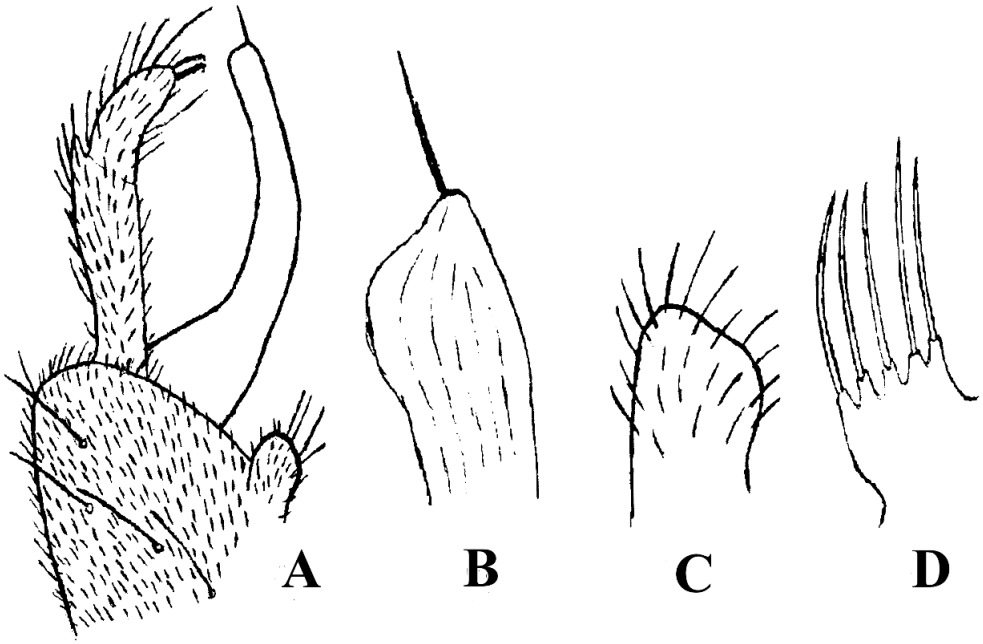

FIGURE 1. *Dixella laeta* Loew, 1849. **A**. Distal part of gonocoxite with gonostylus and apical lobe, lateral view; **B**. Detail of the distal end of the apical lobe; **C**. Basal lobe; **D**. Cercus.

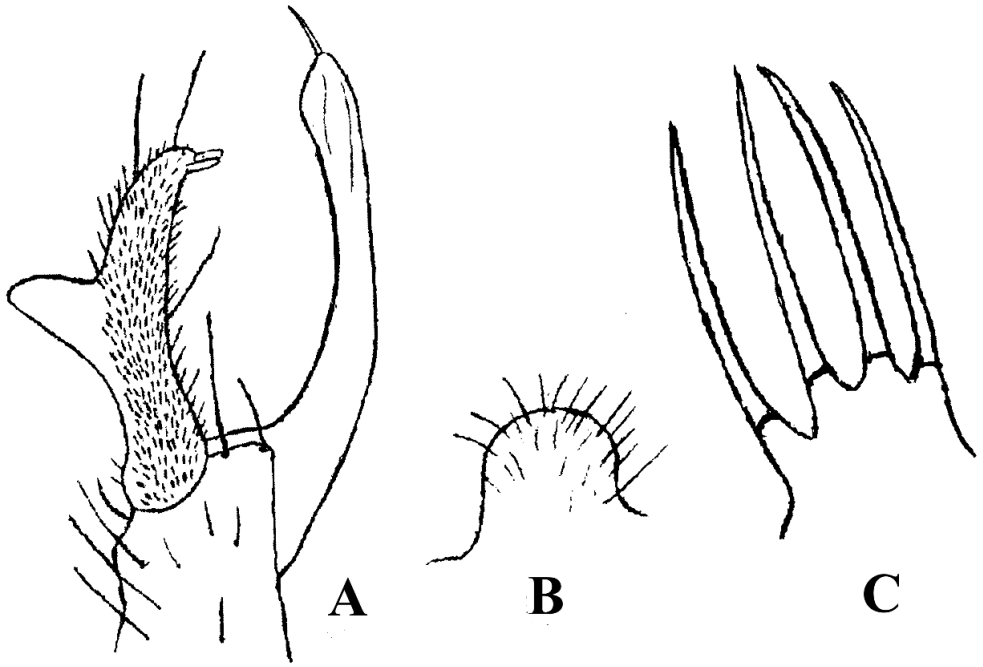

FIGURE 2. *Dixella dyari* Garrett, 1825. **A**. Distal part of gonocoxite with gonostylus and apical lobe; **B**. Basal lobe; **C**. Cercus.

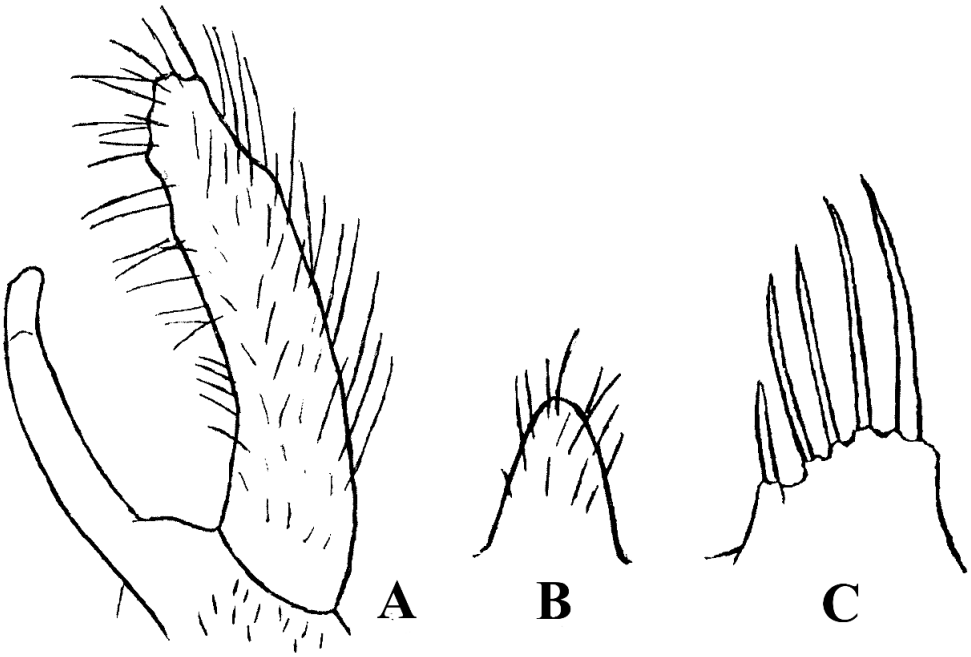

FIGURE 3. *Dixella obscura* Loew, 1849. **A**. Gonostylus and apical lobe; **B**. Basal lobe; **C**. Cercus.

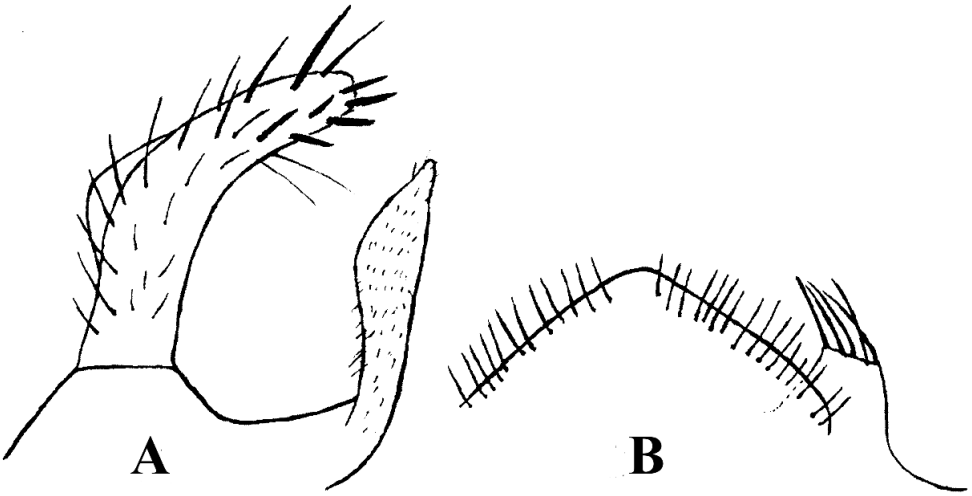

FIGURE 4. *Dixella autumnalis* Meigen, 1818. **A**. Gonostylus and apical lobe; **B**. Posterior end of 10th sternite with the cercus quite closely connected to it.

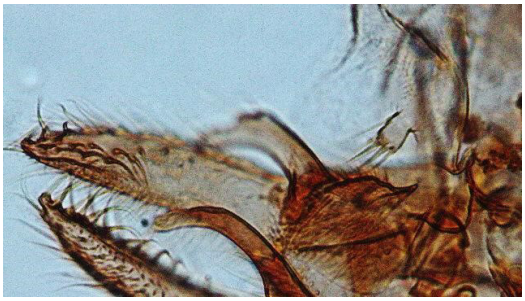

FIGURE 5. *Dixella obscura* Loew, 1849. The sharp bow of the apical lobes can be seen in this picture taken of the hypopygium seen in lateral position.

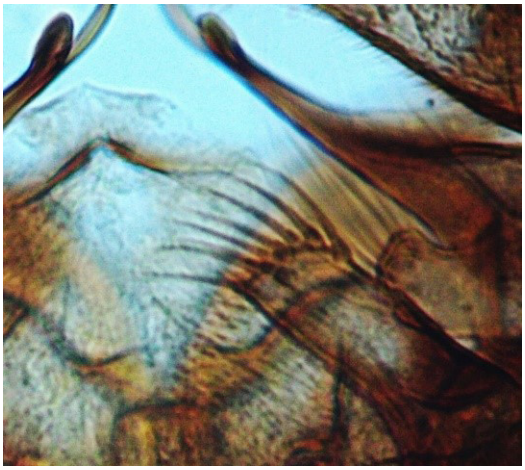

FIGURE 7. The cercus of Dixella naevia (Peus, 1934). The apical lobes and the distal end of the 10th tergite is also seen.

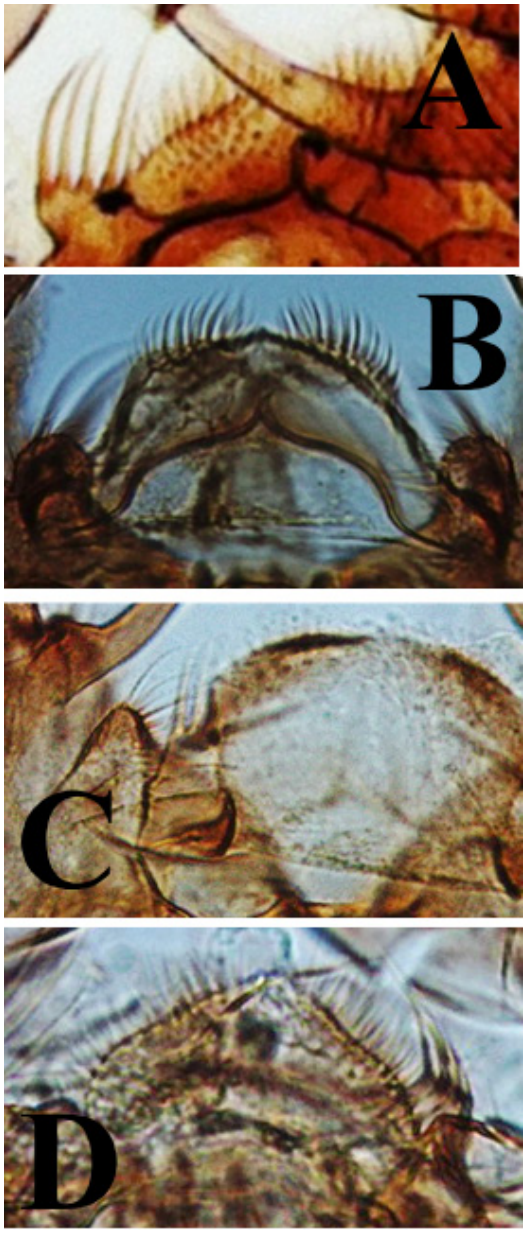

FIGURE 6. Distal end of 10th sternite of (**A**) *D. laeta*, (**B**) *D. dyari*, (**C**) *D. obscura*, and (**D**) *D. autumnalis*.

laeta. The shape of the cercus (Figure 2C) is a bit different, with four or five spines, and with a variable "foot" size. The distal part of the 10th sternite (Figure 6B) is very similar to the one in *D. laeta*, but seems to be a bit more square in outline.

On the thorax there is not a connecting dark area between the lateral and middle stripe.

D. obscura

This species has a distinct basal lobe (Figure 3B), and a cercus (Figure 3C) with five spines that seems to be progressively shorter towards one end. The apical lobe (Figure 3A) is bent more or less visibly in the distal 1/6 of the lobe (Figure 5), this can only be seen in lateral view. The gonostylus (Figure 3A) is evenly bowed and evenly thick in most of its length, with no thicker spines at the distal end. The outline of the distal end of the 10th sternite (Figure 6C) is rounded, with two areas of shorter and weaker hairs than in *laeta* and *dyari*.

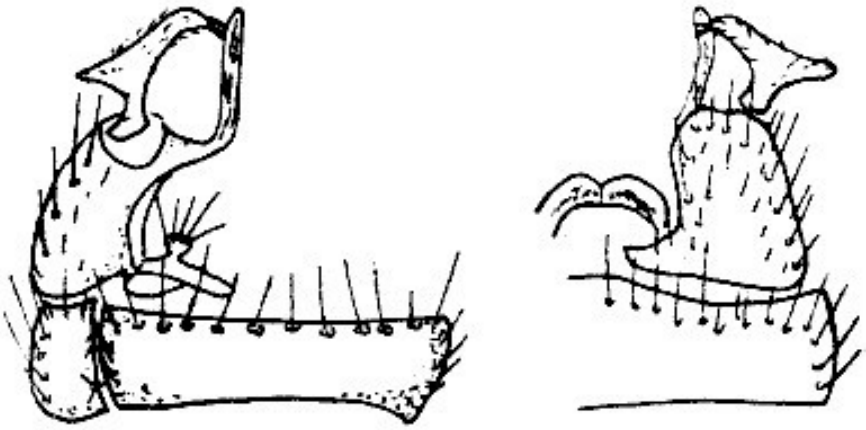

FIGURE 8. Reproduction from Nielsen (1937) of part of his figure 3 of *Dixa lateralis* sp. n.

The middle and lateral stripes on the scutum are connected by a much lighter area.

D. autumnalis

This species is figured by Disney (1975, 1999). In the author's collection there is only one mounted male (see Figure 1 in Håland (2013)). The cercus (Figure 4B) is prominent, with 5 bristles, one of them a bit weaker than the others, and all are placed on a prominent "foot". In the Figure 4B) it is visible how closely the cercus is a part of the 9th tergite, something that applies to all the four species. The basal lobe seems to be missing, but this may be an artefact of the mount. The apical lobe (Figure 4A) is bent in the proximal part, the rest is almost parallel-sided before its somewhat abrupt end. The gonostylus (Figure 4A) is evenly curved with a small triangular lamella at the outer side. There does not seem to be any strong bristles at the end of the gonostylus. The outline of the distal part of the 10th sternite (Figure 6D) is triangular, and equipped with many long hairs, clearly not so stiff as in *laeta* and *dyari*, but approximately of the same length and density.

The middle and the lateral stripes on the scutum is connected by a dark patch.

Records of the four species in Norway

Dixella laeta Loew: Adults were found 9-25. July in Buskerud BV in just two different ponds at almost the same height. One pond is small, without a name, surrounded by *Sphagnum* spp, situated close to the eastern end of lake Ossjøen in Hol municipality at 970 m a.s.l. 60.3822579 N 8.2535357 E. Other species of *Dixella* found in the same pond are *D. dyari, D. naevia* and *D. aestivalis.*

The other habitat is a much greater pond, also surrounded by *Sphagnum* but much of the lakesides are also stony or with willows. This lake, Solheimstultjørni, is in Jønndalen in Nore og Uvdal municipality, at 975 m a.s.l. 60.3035629 N 8.3515717 E. Other species of *Dixella* found here are *Dixella dyari, D. obscura* and *D. aestivalis*.

Dixella dyari Garrett: (earlier recorded from BV, NNI, TRY by Håland (1997), and from Finnmark (FV, FI and FØ) (Andersen *et al.* 2015). Adults are found 17-30. July and on one record, 6. October, indicating two generations each summer.

Dixella obscura Loew has been found in HEN, NSY, NSI (Håland, 1997), Finnmark in FV, FI and FØ (Andersen *et al.* 2015), and in HES, VE, ON, OS, BV, STI, and NNØ (unpublished data from the authors collection).

Dixella autumnalis Meigen has only been found in one locality (Håland 2013) in Vestfold (VE) as larvae collected 1 July. One of them pupated and a male hatched 12 July.

Discussion

It is not surprising to find *Dixella laeta* in Norway, given its records from many countries in Europe, including northern Finland (Salmela 2008). It is however strange that this species in the Nordic countries in the high north until now is only found at high altitudes, while in the far south in Europe it is found also at much lower altitudes. Moreover, why is it so seldom found between these areas, e.g. in Germany? A parallel phenomenon is found in *Dixella obscura*, which in Norway is most common in northern Norway along the coast, and in the mountains of southern Norway, but very rare in the forested areas, while it is also distributed far south in Europe. In my experience, it seems that maybe both species avoid shadowed ponds, possibly because of the food they eat or some other factor. In Norway, these unshaded ponds are most common where there are no trees, or very small trees, namely along the coast and in the treeless mountains. What factors determine such a distribution? The sunshine or maybe the food generated by the sunshine?

The specimens recorded in this study were probably not found in a preferred habitat, since very few specimens are recorded. Salmela (2008) found them more numerous in a rich fen, a habitat not typical for Dixidae and thus rarely investigated.

Other species could have been included in this study. *Dixella naevia* (Peus, 1934) (Figure 7) have a somewhat similar shape of the cercus, but the stiff hairs are 8-9 in number and not arranged in a single row (author's observation). In the very closely related *Dixella aestivalis* (Meigen, 1818) where the cercus seems to not be protruding at all, another indication that this character is not suited for delimiting species groups.

This "species group" is not obvious or even probable in the dendrogram of Disney (1999) showing the two British species well separated, so using the characters of his analysis this is not an obvious species-group. This is seen as an indication that the presence of such a protruding cercus is probably not useful as a group character. Wagner et al (1992) show quite a variable development of the cercus in all the species of *Dixella* in Israel. It is quite clear that *Dixella laeta* is closely related to *D. dyari*, but these two species are more distant relatives to the other two species regarded here, and thus do not form a natural species group. The 10th sternite is quite different from the others. This character, however, is not fully explored in the genus, and usually the figures given are not detailed enough to be of any use.

An analysis of the DNA of more species would be very valuable in this respect, but some of these species are quite rare, so it may take some time to get this done. Still, it's the author's opinion that more morphological characters, both external and internal, especially connected to the hypopygium of the male, is worth investigating to secure a good platform for the definition of species groups and eventually new genera.

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