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NORSK ENTOMOLOGISK FORENING

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Tipulidae (Diptera) from a high mountain area, Finse, South Norway

TROND HOF SVANG

Hofsvang, T. 1974. Tipulidae (Diptera) from a high mountain area, Finse, South Norway. *Norsk ent. Tidsskr.* 21, 1-4.

Tipulidae from the Finse area, 1210-1370 m a.s.l., were collected during four years. Eight different species were recorded. Some notes on the seasonal distribution of adults and the habitat of the larvae are given.

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The Tipulidae fauna of Norway is poorly known; the lists of species published are based on occasional collections from different parts of the country. Ecological information about the larvae, their habitats, the life cycle etc. are very few and often lacking. Mendl & Solem (1972) give a survey of the flight period of several species of Limoniinae from one locality in Sør-Trøndelag. This present study deals with Tipulidae from a high mountain area which constitutes parts of Norway where information about the total insect fauna are sparse.

DESCRIPTION OF THE AREA

Finse is situated in the inner part of Hordaland country, in the north-western part of the mountain plateau Hardangervidda (60°36'N — 7°30'E). The areas investigated were different vegetational types situated east and south of the eastern end of the lake Finsevatn, along the river, about 1200 m a.s.l., and in the southern direction near up to the

slope of the glacier Hardangerjøkulen, about 1370 m a.s.l. The summer in the Finse area is short, with a period without snow usually lasting from the first half of June until towards the end of September.

Some of the investigations were performed on one special habitat, a meadow with well-developed tussocks and moist soil. The border of the field consisted partly of more or less aquatic *Sphagnum* mosses.

MATERIAL AND METHODS

The work was carried out during the years 1969, 1970, 1972 and 1973. No adult Tipulidae were collected during the year 1971. In 1969 and 1970 parts of the area were investigated every day for periods lasting about 10 days. These periods of investigation were distributed throughout the summer with intervals of 1-2 weeks. In 1972 and 1973 the periods lasted 4-5 days with intervals of 2-3 weeks. The study started 24 June 1969 and ended 24 August 1973.

Adult tipulids observed were captured with a sweep-net with a diameter of 30 cm. A standard sweep-netting method was used in a special examination of the seasonal distribution of adults of the three most abundant species of Tipulidae in the area. Freeman (1968) used this method on tipulids. The sweeping was carried out along a special route in one habitat, the tussock field, and it lasted for 30–60 minutes. In this mountain area the vegetation is short, and the tipulids are easily seen when they are disturbed. The sweeping was only done when the vegetation was dry, with little or no wind and usually in sunshine. The catches are calculated as numbers of tipulids expected to be caught per hour.

NOTES ON THE SPECIES

Eight different species of Tipulidae were recorded from the Finse area during the four years of investigation.

Prinocera serricornis Zett.

Only a few specimens were captured: 1 ♀ 19 June 1970, 2 ♂♂ 20 June 1970, 1 ♀, 1 ♂ 22 June 1970, 1 ♀, 1 ♂ 3 July 1972, 2 ♂♂ 5 July 1973. All adults were taken from the border of the tussock field consisting of wet *Sphagnum*. Larvae and pupae of *P. serricornis* are unknown (Theowald 1967). I have found larvae from *Sphagnum* habitats at Finse, very much resembling the only known *Prinocera* larvae in Europe, *P. turcica*. According to Theowald (1967) these larvae live in especially wet *Sphagnum*.

P. serricornis have only been recorded once before from Norway, from Jotkajavre in the northern part of Norway (Tjeder 1948). This species seems to have a flight period at Finse in late June and in the beginning of July.

Tipula excisa Schum.

This is a common species all over the Finse area up to the glacier, 1370 m a.s.l. Adults of *T. excisa* were also observed in the end of July 1973 in great numbers all over the mountain areas east and south of the Hardanger-

jökulen glacier and westbound to Isdalen, in altitudes of 1000–1400 m a.s.l. The larvae seem to prefer habitats with moist soil, and they have a life cycle of two years in the Finse area (Hofsvang 1972).

Tipula grisescens Zett.

Four specimens were collected on wet meadows, 1210 m a.s.l. 2 ♂♂ 19 June 1970, 1 ♂ 13 July 1972, 1 ♂ 27 July 1973. No larvae were found. *T. grisescens* is reported from outer parts of Hordaland (Tjeder 1965).

Tipula invenusta Ried.

The adults of this species occurred in great numbers at Finse. They emerged late, in September. All the specimens were captured in areas with wet mosses, 1210 m a.s.l. Pupae which subsequently hatched and appeared to be *T. invenusta*, were found in the mosses. No adults were recorded in 1973 before 24 August, when this investigation ended.

Tipula subnodicornis Zett.

Adults of *T. subnodicornis* and *P. serricornis* are the first to be found in the Finse area after the snow has melted away. *T. subnodicornis* is one of the most common and abundant species at Finse. The captures of all specimens were from different *Sphagnum* bogs, about 1210 m a.s.l. In 1969 only two adults were recorded, 1 ♀ and 1 ♂ 26 June. The flight period was probably finished when this investigation started 24 June 1969. Some larvae were found in *Sphagnum* bogs. According to Coulson (1962) *T. subnodicornis* has a life cycle that is completed once a year in England. Adults occurred from the middle of May to the middle of June. Recorded from different places in inner and outer parts of Hordaland (Tjeder 1965).

Dicranota (s.str.) guerini Zett.

Adults were taken from different grassland habitats near Finsevatn lake, 1210 m a.s.l. and at glacial moraines with poorly developed vegetation (pioneer plant communities), 1370 m a.s.l. This species has been recorded from different places in the northern and southern part of Norway, also from inner part of

Table I. The period of capture of the different species of Tipulidae collected in the Finse area during four years.

	1969	1970	1972	1973
Tipulinae				
<i>Prinocera serricornis</i> Zett.	-	19-22 June	3 July	5 July
<i>Tipula excisa</i> Schum.	26 June-3 Aug.	18 June-24 July	30 June-14 July	4-29 July
<i>Tipula grisescens</i> Zett.	-	19 June	13 July	27 July
<i>Tipula invenusta</i> Ried.	2-9 Sept.	7-26 Sept.	2-5 Sept.	-
<i>Tipula subnodicornis</i> Zett.	26 June	19 June-9 July	29 June-14 July	3-29 July
Limoniinae				
Pedicini				
<i>Dicranota (s.str.) guerini</i> Zett.	5 July-11 Aug.	7 July	-	5 July
Hexatomini				
<i>Limnophila (Phylidorea) meigeni</i> Verr.	11-16 July	2-20 July	-	-
<i>Phyllolabis macrura</i> Siebke	9-10 Aug.	-	-	-

Hordaland (Tjeder 1965, Mendl & Solem 1972). No larvae were found at Finse. The larvae live in streams (Coulson 1959).

Limnophila (Phylidorea) meigeni Verr.

This seemed to be the most abundant species of Limnophila. The specimens were collected at the tussock field and similar habitats nearby. This is the second record of the species from Norway; it was reported from outer part of Hordaland by Tjeder (1965). According to Coulson (1959) the larvae live in peat soils in England. No larvae were recorded during this investigation.

Phyllolabis macrura Siebke.

Only two specimens were recorded, 1 ♂ 9 August 1969 and 1 ♂ 10 August 1969, both captured in a light trap placed in a dry grassland habitat near the eastern end of the lake Finsevatn, 1210 m a.s.l. *P. macrura* is earlier recorded from Finse (Tjeder 1965).

SEASONAL DISTRIBUTION

Table I shows the list of the eight species and the period of capture during the four years. The expected capture of adult tipulids per hour of the three most abundant species during the years 1969 and 1970 on the tussock field are shown (Fig. 1). In these two years the snow melted on this field during the first week of June.

DISCUSSION

In addition to these eight species, three other species of Tipulidae are recorded from the Finse area. *Tipula limbata* Zett. and *Tipula rufina* Mg. collected at Finse exist in the collection at the Zoological Museum, University of Bergen. Tjeder (1965) reports that *Tipula alpinum* Berggr. is found at Finse. During the four years of the present study a greater variety of species might have been recorded if different sorts of traps had been used; for example, *P. macrura* was only captured in a light trap, and other species of

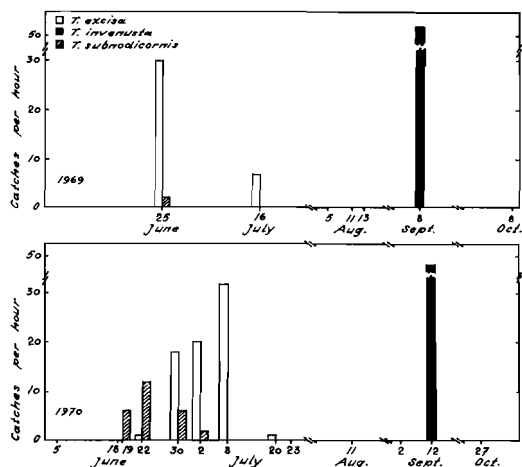


Fig. 1. The expected catches per hour at the tussock field during the years 1969 and 1970 of adults of the three most abundant species, *Tipula excisa*, *Tipula invenusta* and *Tipula subnodicornis*. The days when no adults were captured are also indicated.

small Limoniinae might have been recorded if light traps and sticky traps had been used on the various habitats during the summer. Coulson (1959) suggested that the species composition of Tipulidae of upland moorland in Britain has a close affinity with the upland fauna of northern Scandinavia. Of the 11 species recorded from Finse, 7 species are recorded from such an upland habitat in Britain.

The eight species seem to have one marked period of emergence during the summer. Table I and Fig. 1 indicate also that the flight period of the adult tipulids varies little from one year to the next. But the time for the peak of emergence may vary a bit more according to temperature and rainfall. Concerning the species that emerge from the pupae early in the summer, there might locally be great differences in flight period of the adults. The duration of the snow cover can delay emergence from the pupae by several weeks from one year to the next; during the years 1969, 1970 and 1972 the snow melted at the tussock field during first week of June. Adults of *T. excisa* were recorded as early as from 18 to 30 June these years at this field. In 1973 the snow melted away from the habitat in the period 25 to 30 June. On 3 July 1973, larvae of instar IV were found. These larvae had still at least two more weeks before they would have passed the pupal stage to emerge as adults (Hofsvang 1972, 1973). On the same day,

adults of *T. excisa* were collected on another habitat nearby where the snow had melted away earlier.

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I am greatly indebted to Dr. Bo Tjeder, University of Lund, for the identification of the species.

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Coleoptera on excrements of Brown bear (*Ursus arctos*) from Trysil, South Norway

IVAR MYSTERUD

Mysterud, I. 1974. Coleoptera on excrements of Brown bear (*Ursus arctos*) from Trysil, South Norway. *Norsk ent. Tidsskr.* 21, 5–6.

The beetle fauna on 24 excrements of Brown bear from Trysil, South Norway, have been investigated in 1973. A list of beetles comprising 30 species is presented.

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Few investigations of the coleopterous fauna in faeces of mammals other than horses and cattle have been undertaken in Norway, and some species, among them the Brown bear (*Ursus arctos*), have not earlier been investigated.

During field investigations connected with sheep predation by Brown bear in Hedmark County in 1973, a sample consisting of 24 scats was collected. The scats were collected in individual plastic bags and brought to the laboratory where the beetles were immediately removed.

The faeces samples were collected in Flendalen, Trysil, 21–23 July. Some were relatively fresh and none of the samples older than 3–4 weeks. One scat was collected from a sheep trail near the treeline 820 m a.s.l., while the 23 others were sampled from areas surrounding three different sheep carcasses. The sheep were located 770 m above sea level in different coniferous forest habitats.

The species list of the identified Coleoptera from bear faeces is given in Table I. As can be seen, the coleopterous fauna of bear faeces in this sample comprises 30 species. Some of

the sampled species are not very common in Norway (Lindroth 1960).

Megarthritis fennicus (one specimen) has earlier been reported from some locations in Fennoscandia, but the biology of the species is inadequately known. It is probably a species belonging to coniferous forest communities. The species has been sampled earlier from faeces of chickens and moose (*Alces alces*) (Palm 1948).

Proteinus crenulatus (one specimen) normally inhabits rotting fungi, but it has also been sampled earlier from faeces of badger (*Meles meles*) (Palm 1948).

Atheta nesslingi (one specimen) is a rare northern species distributed in the coniferous forest. In Norway it is known only from a very few locations in the eastern lowland. The species has earlier been sampled in faeces from horse, cattle, moose, and badger (Palm 1970, Sjöberg 1962, Strand pers. comm.).

Table I. Coleoptera sampled from faeces of Brown bear (*Ursus arctos*) in Trysil, South Norway 1973

Cercyon impressus Sturm
C. melanocephalus L.
Megasternum obscurum Mrsh.
Cryptopleurum minutum F.
Acrotrichis cognata Matth.
Megarathrus sinuaticollis Lac.
M. depressus Payk.
M. fennicus Laht.
Proteinus crenulatus Pand.
Omalium rivulare Payk.
Deliphrum tectum Payk.
Platystethus arenarius Fourcr.
Oxytelus laqueatus Marsh.
Philonthus puella Nordm.
Tachinus proximus Kr.
T. pallipes Grav.
Autalia puncticollis Sharp
Atheta allocera Epph.
A. celata Er.
A. cinnamoptera Th.
A. cribripennis J. Sahlb.
A. nesslingi Bernh.
A. nigripes Th.
A. parapicipennis Brund.
A. picipennis Mannh.
A. subtilis Scriba
Oxypoda nigricornis Motsch.
Atomaria analis Er.
Aphodius lapponum Gyll.
A. piceus Gyll.

Atheta allocera is also a rare species in Norway, mostly found in mountainous areas. The species has earlier been sampled in faeces from chickens, sheep and moose (Palm 1970, Strand pers. comm.).

Atheta parapicipennis is also a rare species, and has only been taken from a very few locations in the eastern lowland and in Målselv and Lakselv in northern Norway. The

species has earlier been sampled in faeces from moose, sheep and doves (*Columba livia domestica*) (Palm 1970, Strand pers. comm.).

Atheta cribripennis (one specimen) is a rare species which relatively recently has been demonstrated to occur in Norway, where it has been found on a very few locations in Akershus and Hedmark Counties. The species has earlier been sampled from faeces of moose, badger, cattle, and chickens (Palm 1970, Sjøberg 1962, Strand pers comm.).

The rest of the list comprises species that are well known in the Norwegian beetle fauna.

ACKNOWLEDGEMENT

I am indebted to dr. philos. h. c. Andreas Strand, Oslo, for identification of the material.

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Cocoon formation by larvae of *Chrysopa chrysops* L. (Neuroptera, Chrysopidae) in the laboratory

TURID KJØLSETH ANDRESEN

Andresen, T. K. 1974. Cocoon formation by larvae of *Chrysopa chrysops* L. (Neuroptera, Chrysopidae) in the laboratory. *Norsk ent. Tidsskr.* 21, 7-9.

The ability of the larvae of *Chrysopa chrysops* L. to spin cocoon apparently depends on the nutrition and a suitable place to put the cocoon. A higher percentage of cocoon formation was found in larvae supplied with aphids and a honey solution than in larvae given aphids only. Brewer's yeast solution did not increase cocoon formation in larvae supplied with aphids and honey. Dark paper folded in zigzag seems to be preferred instead of clean Petri dishes when placing the cocoon. All larvae failing to make the cocoon died within three months.

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Chrysopa chrysops has a palearctic distribution (Mors 1930), and is especially common in Fennoscandia with the exception of Lappland (Meinander 1962). Both larvae and imagines are important aphid predators, and probably exert a significant restraint on aphid damage to plants.

The biology of *Chrysopa chrysops* has not previously been investigated in Norway or under conditions representative of our climate. According to Killington (1937), the larvae complete two moults during the active or feeding period. The third moult occurs within the cocoon, in which the prepupal period is spent. The winter is passed as prepupae (Ickert 1968).

Third instar larvae are distinguished from the second instars by colour and size, third instars being dark coloured and about 8 mm long. For some larvae, however, the two instars are hard to distinguish. Easily identifiable exuvia eliminate this difficulty. Forming of the cocoon and the movements during spinning are described by Killington (1936).

In the laboratory some of the larvae showed anomaly in spinning the cocoon. This paper

deals with factors which influence this important part of the development.

MATERIAL AND METHODS

Imagines were captured outdoors during June to July 1970 at Vollebekk, Ås, and the larvae from these females were used in the examination of 1970. Further investigations were based on the off-spring of the 1970 material.

The experiments were carried out in the laboratory at fluctuating and constant temperatures. The fluctuating temperatures changed continuously from 8°C to 28°C and back to 8°C during 24 hours (Fig. 1). The constant temperature was 18°C. To secure sufficient humidity, the bottom of the Petri dishes (6 × 1.2 cm) was covered with filter-paper which was moistened each day. The photoperiod was 18 hours. Series of 20 or 30 larvae were obtained from eggs of several females. Soon after hatching, the larvae were placed in Petri dishes, one in each dish. The prey used was the aphid *Myzus persicae* (Sulzer) reared on *Brassica napus napobrassica*

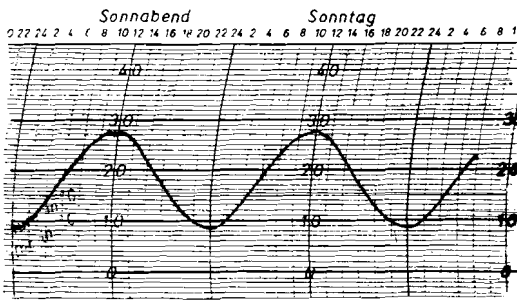


Fig. 1. Fluctuation of the temperature in the 8–28° C incubator.

cae (L.) Rchb. In addition a solution of honey and brewer's yeast was given.

Third and last instar larvae were in some series (Table I) supplied with a black paper (1 × 6 cm) folded in zigzag. When the spinning process began, the filterpaper was cautiously moistened but the larvae never touched.

In the statistical treatment differences are considered as significant if $p \leq 0.05$.

RESULTS

All the larvae in 1970 completed the development as far as the spinning of the cocoon. Several larvae, however, failed in forming the cocoon and died from 7 days to 3 months after they had reached the cocoon-making stage.

The larvae in 1971 were reared under different conditions, to test factors which could be of importance for the cocoon-making process. These factors were temperature, nutrition, and place to spin the cocoon. The number of larvae in each series and the percentage that spun cocoon are given in Table I. Table I clearly shows that honey is important for a successful cocoon formation (series D and F, $p < 0.01$). Presence of brewer's yeast did not increase the cocoon-making beyond what was achieved with honey and aphids (series E and F, $p > 0.05$).

The two temperature conditions had no different effect on cocoon formation (series A and C, series B and F, $0.3 < p < 0.5$).

Presence of zigzag paper increased the cocoon-making ability (series A and B, series C and F, $p < 0.05$). When zigzag paper was available, the larvae had several alternatives

for the placing of the cocoon. The sites of the cocoon formation in the dishes with such paper were recorded. Of the 67 larvae that spun cocoons, 65 of them made the cocoon in conjunction with the zigzag paper, and 47 of these were placed in the foldknee of the paper. In addition 18 larvae spun their cocoons between the paper and the glass wall, one at the filter paper at the bottom of the dish and one freely at the glass wall. The most favourable conditions for cocoon formation thus seem to be a combination of aphids, honey, and zigzag paper. The majority of the cocoons is then placed in the foldknee of the zigzag paper.

DISCUSSION

The beginning of the cocoon formation is indicated by spinning movements of the larvae. All the larvae showed such movements, except one in each of the series A, B, C, D, and E. The non-cocoon formation larvae produced either irregular spins all over the dish or made one to two half-done cocoons. In this way most of the silk available will be used, and their chances of making the cocoon later are reduced and probably lost. Similar observations have been made by Alderson (1907), Pariser (1917), Smith (1922), Bänisch (1964), and Ickert (1968).

According to Bänisch (1964), disturbance by shaking may cause irregularities in the process of cocoon formation. In the present study the larvae were daily disturbed when moistening the filterpaper, but otherwise they were not touched.

Table I. Influence of temperature, nutrition and place to spin the cocoon on the cocoon formation in *Chrysopa chrysops*. The total number (n) of the series and the percentage of larvae that succeeded in cocoon formation are given.

Series	Temp. ° C	Nutrition	Zigzag paper	n	Percent cocoon formation
A	18	Aphids, honey		49	44.9
B	»	Aphids, honey	x	29	79.3
C	8–28	Aphids, honey		29	34.5
D	»	Aphids	x	30	10.0
E	»	Aphids, honey, brewer's yeast	x	30	73.3
F	»	Aphids, honey	x	27	70.4

As shown by Bänisch (1964) and Ickert (1968), the larvae spin the cocoon, under natural conditions, between or on the leaves. Dark places or positions between the leaves are especially preferred (Bänisch 1964). Both authors, however, pointed out that larvae, living in cleaned dishes in the laboratory, make the cocoon directly at the glass wall or at the bottom. When zigzag paper is present in the dishes, as in the present investigation, there is a significant difference between percentage of cocoons formed in dishes with zigzag paper (series B, F) and those without such paper (series A, C). It seems that folds of the paper are preferred and that the dishes alone do not give satisfactory conditions.

A distinct increase in cocoon formation was seen when the larvae were supplied with honey (series F) compared to those without (series D). It is reasonable to conclude that honey contains nutrition components of importance for the development of the cocoon. Ickert (1968) pointed out that the quality of nutrition greatly affects the ability of spinning cocoons in larvae of *Chrysopa* sp. in general. No further increase was observed when brewer's yeast (series E) was added. This indicates that brewer's yeast solution hardly contains nutrition ingredients of importance in addition to those obtained from honey and aphids. The brewer's yeast solution, however, dried up in a few hours, and access to this nourishment may have been too short to affect possible increase of the cocoon formation.

Larvae who did not spin cocoons all died within 3 months, a phenomena described by several authors (Pariser 1917, Smith 1922, Bänisch 1964, Ickert 1968).

In rare cases, species of the genus *Chrysopa* pass into the prepupal stage without cocoon formation (Ickert 1964). During the present investigation this was observed once.

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Morphological changes caused by nematode parasitism in Tanypodinae (Diptera, Chironomidae)

KAARE AAGAARD

Aagaard, K. 1974. Morphological changes caused by nematode parasitism in Tanypodinae (Diptera, Chironomidae). *Norsk ent. Tidsskr.* 21, 11–14.

Of the sixteen species of Tanypodinae collected at lake Målsjøen, near Trondheim, Norway, the following six species were found to be parasitized by nematodes: *Procladius barbatus*, *P. signatus*, *Conchapelopia pallidula*, *C. melanops*, *Thienemanniomyia fusciceps*, and *Ablabesmyia monilis*.

Except for *C. melanops*, morphological changes of the antennae and/or hypopygonia were found in all the parasitized species.

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Morphological changes in sexually dimorphic characters (intersexuality) caused by nematode parasites are common in some subfamilies in the family Chironomidae. Rempel (1940), Thienemann (1954), and Wülker (1961) reported nematodes of the genus *Meremis* and *Parameris* from the subfamilies Orthocladinae and Chironominae.

The first record of parasitism of Tanypodinae-larvae by nematodes is probably that of Zschokke (1911) (cited from Thienemann (1954)), but until Roback (1963) found nematodes in five North American species, nothing seems to have been published on the subject.

The specimens treated in this paper were collected during investigations in lake Målsjøen, 25 km south of Trondheim, Norway. Imaginal chironomids were collected in funnel traps (described by Brundin (1949)) and in light traps (light tubes Philips TLA 20 w/05) facing the lake. The investigation was carried out during 1971 and 1972, and the traps were operated both years from ice thaw in early May to the end of October.

From the chironomid material collected, only the male Tanypodinae are examined and dealt with in this paper.

Among the sixteen species of Tanypodinae trapped, six species were parasitized by nematodes (Table I). Wülker (1961) described intersexuality to occur in three main different

Table I. Numbers of males of Tanypodinae collected at Målsjøen in 1971 and 1972.

	Light-traps		Funnel traps	
	Total	Para-sitized	Total	Para-sitized
<i>Macropelopia nebulosa</i>	2	0	0	0
<i>Apsectrotanypus trifascipennis</i>	1	0	0	0
<i>Procladius signatus</i>	22	9	59	4
<i>P. ? cinereus</i>	31	0	134	0
<i>P. ? nigriventris</i>	1	0	8	0
<i>P. barbatus</i>	17	1	13	0
<i>P. nudipennis</i>	20	0	2	0
<i>Thienemanniomyia fusciceps</i>	9	6	0	0
<i>Arctopelopia griseipennis</i>	161	0	9	0
<i>Conchapelopia pallidula</i>	22	20	0	0
<i>C. melanops</i>	2	1	0	0
<i>Rheopelopia maculipennis</i>	2	0	0	0
<i>Krenopelopia binotata</i>	2	0	0	0
<i>Paramerina cingulata</i>	20	0	2	0
<i>Ablabesmyia monilis</i>	110	35	14	0
<i>A. phatta</i>	13	0	2	0

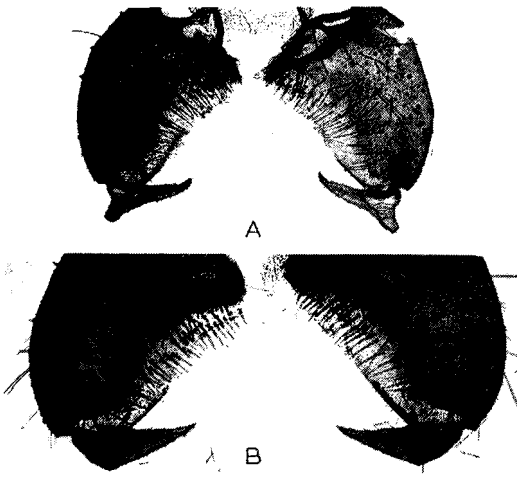


Fig. 1. Hypopygia of *Procladius barbatus*. a) normal male, b) parasitized male.

taxonomical characters: 1) the eight sternites, 2) the external genitalia, and 3) the antennae. Here only the external genitalia and the antennae have been examined.

The maximum number of nematodes found in any tanypodine was two specimens. This number is, however, uncertain because the parasites tended to leave the tanypodines when collected in the ethyleneglycol in the light-trap. Many nematodes were found on the bottom of the collecting jar.

Procladius barbatus Brundin 1949

A parasitized male specimen of the genus *Procladius*, collected in May 1971, most li-

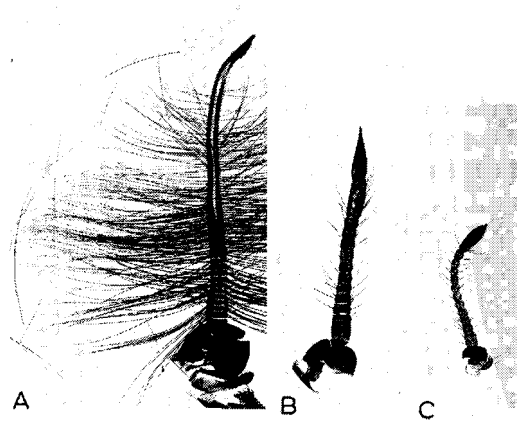


Fig. 2. Antennae of *Procladius barbatus*. a) normal male, b) parasitized male, c) normal female.

kely belongs to *Procladius barbatus*, which the parasitized specimen resembles most in colour and size. *P. barbatus* is also the most common *Procladius* species at Målsjöen in the spring; a total of 30 males were collected. The specimen parasitized has greatly reduced distal lobes of the stylus (Fig. 1); this makes the hypopygium not unlike the hypopygium of the seldom recorded northern species *P. appropinquatus*.

The antennae are typically intersexual, with its second last segment greatly reduced in length, as were also the plume hairs (Fig. 2).

Procladius signatus Zett. 1850

From a total of 81 males, 13 were found to be parasitized. The styli of the hypopygia

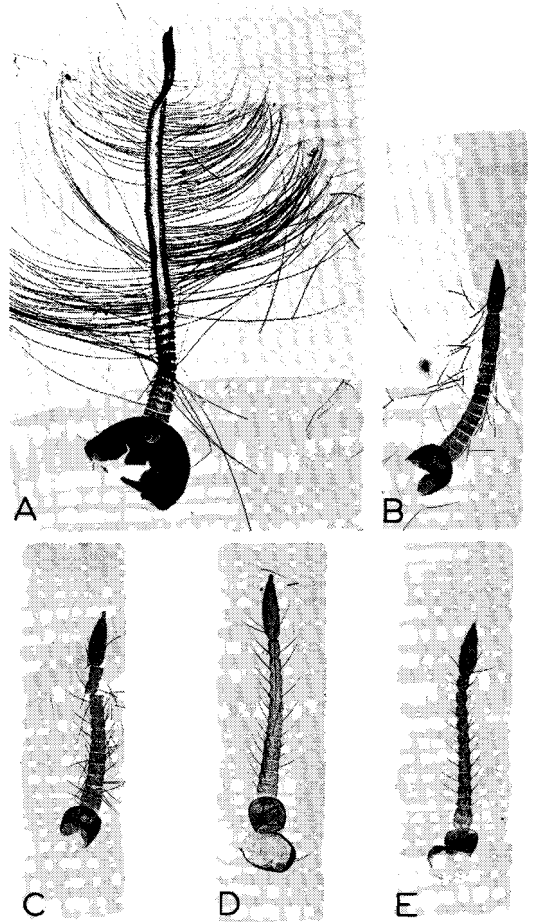


Fig. 3. Antennae of *Procladius signatus*. a) normal male, b), c) and d) parasitized male, e) normal female.

of some of these specimens seemed to be slightly reduced in length of the lobes. The antennae of the parasitized males were more or less reduced compared with a normal male (Fig. 3). In some of the parasitized specimens, the antennae were short and female-like, but with a 13-segmented flagellum in contrast to the 12-segmented female flagellum. In other specimens, the flagellum was 13-segmented, but with the second last segment only partly elongated.

Conchapelopia pallidula (Meigen) 1818

A series of 22 males included 20 parasitized specimens. No changes were found, however, on the hypopygonia, but 17 of the parasitized males had intersexual antennae. The antennae show the same variation as described in *P. signatus*.

Conchapelopia melanops (Wiedemann) 1818

Only two males, of which one was parasitized, were collected of this species. No changes of hypopygonia or the antennae were observed.

Thienemannimyia fusciceps (Edwards) 1929

Among the nine males found in the light traps, six were parasitized.

Roback (1971) noted some variation in the form of the stylus, but concluded that they might be artifacts caused by mounting. The specimens from Målsjöen also showed a slight degree of variation, but no correlation was found between the variation in the form of the stylus and the grade of parasitism. Intersexual antennae were found in three of the parasitized males. The same variation as described for *P. signatus* was demonstrated also in this species.

Ablabesmyia monilis (Linné) 1758

The collection of 110 males from the light traps included 35 parasitized males. The aedeagal blades of the hypopygium of one of the intersexual males were short and slightly curved, in contrast to the long and sinuate blades of the normal males (Fig. 4). Only four of them were found to have intersexual antennae. The same antennal variation as in *P. signatus* was also observed here.

DISCUSSION

The gonads are known to be severely damaged in parasitized chironomids (Wülker 1961). Therefore, a 'castration effect' could be assumed as an explanation for the variation in the antennae and hypopygonia. However, experimental castration of insects has given entirely negative results in almost all cases (Novak 1966). Apparently, the only demonstration of the existence of sexual differentiation hormones is that by Naisse (1963, 1965) (cited after Bergerard 1972). In *Lamprolaima noctiluca*, Naisse (1963, 1965) found that a mesodermic apical tissue of the testes must be the origin of an androgenic hormone.

In solitary Hymenoptera, absences of various secondary sexual characters have been recorded in parasitized females. The phenomenon has been explained as a result of a decrease caused by the parasite in the amount of food taken by the host (Novak 1966). Whether the morphological changes in the parasitized chironomids could be explained in the same way, is uncertain.

As Wülker (1961) noted, the behaviour of the intersexes seems to deviate from the normal imagines. In a similar way as the females, the parasitized males at Målsjöen seem to be

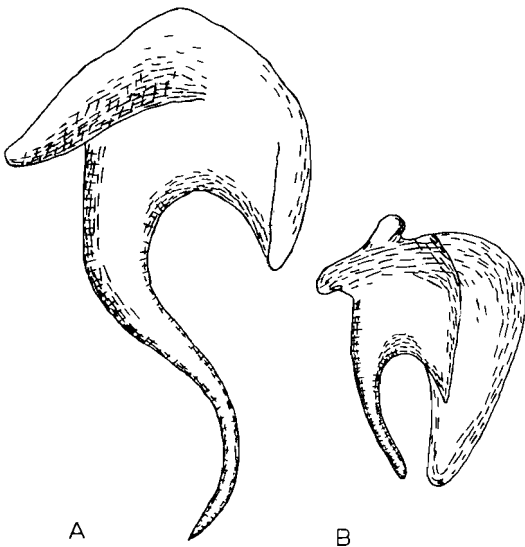


Fig. 4. Aedeagal blades of *Ablabesmyia monilis* a) normal male, b) parasitized male.

more easily caught in the lighttraps than normal males. Wülker (1961) noted that while the normal males were swarming at a few metres height above the water surface, the parasitized males were 'moving around' near the shore, at lower height. Thus, the lighttraps at Målsjön were situated more within the moving range of the parasitized males than of the normal males.

Some of the interspecific variation known from inter alia the genus *Procladius* (Brundin 1949) may be proved to be caused by nematode parasitism. Further, in all tanypodines a reduced or shortened male antenna or an 'abnormal' hypopygium should be considered with care as a taxonomical character as long as an examination of a possible parasitism has not been carried out.

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Karlstejnia norvegica. A new species of Collembola (Onychiuridae, Tullberginae) from the alpine regions in Southern Norway

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Fjellberg, A. 1974. *Karlstejnia norvegica*. A new species of Collembola (Onychiuridae, Tullberginae) from the alpine regions in Southern Norway. *Norsk ent. Tidskr.* 21, 15–18.

Karlstejnia norvegica, a new species of Collembola (Onychiuridae, Tullberginae), is described from the alpine regions of Southern Norway. It is closely related to the recently described *K. annae* Rusek, 1974 from Czechoslovakia, but differs from this in having only one sensilla between the two sensorial clubs of antennal organ III. It was found in the soil layer of a dry lichen heath in the lower alpine region.

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After Rusek's (1971) revision of *Tullbergia krausbaueri* (Börner) it has become evident that this complex consists of many different species. One group is recognized by its only 6 elongated sensorial bodies in the post-antennal organ. For these forms, Rusek (1974, in press) has established the new genus *Karlstejnia* (Onychiuridae, Tullberginae) with the type species *K. annae* Rusek, 1974 discovered in Czechoslovakia. During the study of the alpine tundra ecosystem at Hardangervidda in SW Norway (International Biological Programme) another form belonging to this genus was discovered. It is described below.

HOLOTYPE

Female, labelled: 'Norway: Hordaland. Eidfjord, 12. IX. 1970. Lichen heath at Stigstuv, 1225 m a.s.l. Soil sample No. 41, 3–6 cm. T. Solhøy et al. leg.' The specimen is conserved in alcohol and deposited at the Zoological Museum, Department of Entomology, Bergen, Norway.

PARATYPES

With the holotype in Bergen are deposited 31 paratypes on alcohol from the type locality sampled 12 June 1970 (15 specimens) and 12 Sept. 1970 (16 specimens). 4 paratypes on alcohol are deposited at British Museum (Natural History), London. They are sampled at the type locality, 12 Sept. 1970.

DESCRIPTION

Body slender, unpigmented. Furca and eyes not present. Post-antennal organ consists of 6 elongated sensilla in star-shaped arrangement in a deep furrow (Figs. 5 and 9). Antenna shorter than the head (about 55 : 65). Antenna IV with 5 sensorial hairs, a–e, of which e is distinctly thinner than the other (Fig. 4). Close to the seta a there are two small sensorial bodies in shallow depressions. The apical one is prolonged into the antennal body as a thin channel. In ventroapical position there is a roundish papilla. Antennal organ III has two large, bowed sensorial bodies

between which there is one small sensilla partly hidden by an integumentary fold. Ventrally antenna III has one single, large sensilla. Head ventrally with 3+3 setae along linea ventralis, labium with 4 setae (Fig. 3). Labrum with 6 spine-like setae along anterior edge and a transverse row of 5 thinner setae behind (Fig. 8). Mandibles with 3-4 apical teeth. Maxillae with 3 teeth and 7 ciliated lamellae of which two extend beyond apex of ungulum (Fig. 6 and 7). For dorsal chaetotaxy, see Fig. 1 (chaetotaxy follows Rusek (1971)). Thorax II-III lack seta m_2 and m_3 . Some of the macrosetae are distinctly widened at their base (S of Th. II-III, m_3 , of Abd. III, p_3 of Abd. IV, p_5 of Abd. V). On abdomen IV p_1 and p_2 are macro- and micro-seta, respectively. Anal-thorns shorter than claws. Pseudocellar formula: 11/022/11111. On thorax II-III the pseudocelli are in position $p_3 - p_4$ and $p_5 - m_5$, on abdomen I-IV in position $p_2 - p_3$. The ventral chaetotaxy of Abd. IV-VI is shown on Fig. 2. Ventral tubus with 6 setae at each side. Thorax II-III with one seta at each side of linea ventralis. Claws without teeth. Empodium reduced to a short papilla (Fig. 19). Body size as large as 0.5 mm.

AFFINITIES

Rusek has examined some specimens of the Norwegian form, and the only difference between *K. norvegica* and *K. annae* seems to be that the former has only one sensilla between the two sensorial clubs of antennal organ III, whereas *K. annae* has two sensilla in this position.

ECOLOGY

K. norvegica occurs in the soil layer of a dry lichen heath in the lower alpine region (1200 m a.s.l.). The vegetation is dominated by *Empetrum hermaphroditum*, *Salix herbacea*, *Vaccinium vitis-idea*, *Festuca ovina*, *Dicranum fuscescens*, *Cetraria*, and *Cladonia* species. The soil is a coarse glaci-fluvial deposit

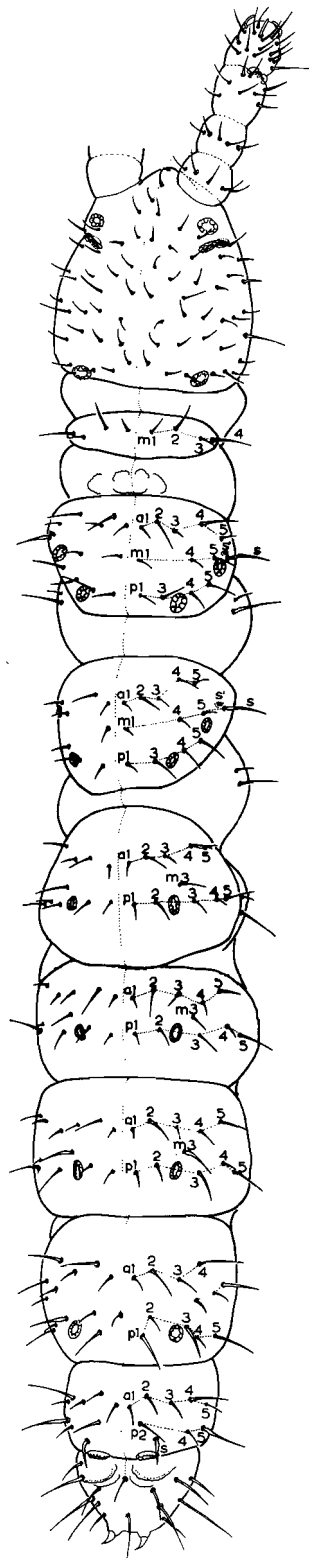
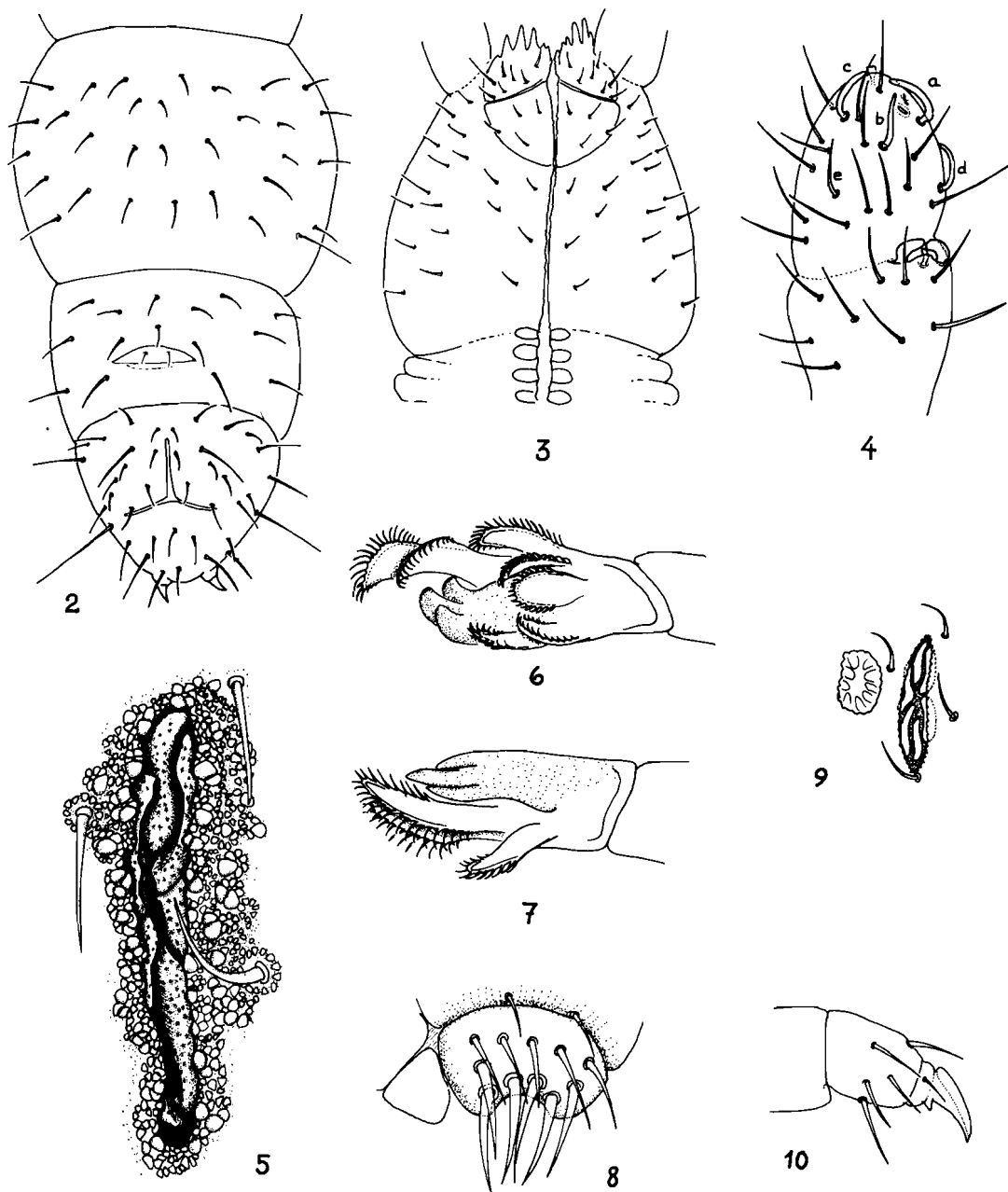


Fig. 1. Dorsal chaetotaxy of *Karlstejnina norvegica*, n.sp.



Figs. 2-10. *Karlstejnia norvegica*. 2. Ventral view of abdomen IV-VI, 3. Ventral view of head, 4. Dorsal view of right antenna III-IV, 5. Left post-antennal organ drawn from an electron scanning micrograph, 6. Proximal view of maxilla, 7. Lateral view of maxilla, 8. Labrum, 9. Left post-antennal organ and anterior pseudocellus, 10. Tibiotarsus III.

with pH = 4,1. The abundance of the species fluctuates between 1000-3000 specimens/m² in the period June - September, while the total number of Collembola fluctuates between

16,000-75,000. The fauna is dominated by *Folsomia brevicauda* Agrell, *Xenylla maritima* (Tullb.), *Anurophorus binoculatus* (Ksenem.), *Tetracanthella wahlgreni* Linnaniemi,

Isotoma violacea Tullb., and *Isotomiella minor* (Schäffer).

In the neighbourhood of the lichen heath we have also examined an eutrophic dry meadow and a wet *Carex* meadow. On these biotopes the Tullberginae is represented by *Tullbergia krausbaueri* (Børner) s.lat. *Karls-tejnia norvegica* is restricted to the dry lichen heath. The *K. annae* from Czechoslovakia was also recorded from a dry locality, a xerothermous steppe in the Bohemian Karst (Rusek, pers. comm.).

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I am indebted to Dr. Josef Rusek, Prague, for examining some specimens of the new species.

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Rusek, J. 1974. *Acta Zool. bohemoslov.* 71 (in press).

The larvae and pupa of *Helicoconis lutea* (Wallengren, 1871) (Neuroptera, Coniopterygidae)

LITA GREVE

Greve, L. 1974. The larvae and pupa of *Helicoconis lutea* (Wallengren, 1871) (Neuroptera, Coniopterygidae). *Norsk ent. Tidsskr.* 21, 19–23.

Three larval instars and the pupa of *Helicoconis lutea* (Wallengren, 1871) are described. The description is based on 182 preserved larvae and 1 pupa from three localities in the vicinity of Stigstuv, Hardangervidda, Western Norway. Despite the fact that no larvae have been reared in captivity, it is concluded that the larvae belong to *H. lutea* for the following reasons: one adult *H. lutea* was found together with larvae at one locality; one pupa which certainly belongs to *H. lutea* was found together with larvae at one locality; the distribution of *H. lutea* includes localities of a similar climate; no other *Helicoconis* species occurs in the area; and the larvae do not fit any of the hitherto described larvae belonging to Coniopterygidae genera.

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Neuropterous larvae belonging to the family *Coniopterygidae* have repeatedly been taken at three different localities at Stigstuv, Hardangervidda, under the survey of the International Biological Program, the Tundra project.

Detailed descriptions of localities I and II are given by Solhøy (1972). The first locality (I) is the 'Dry meadow', 1275 m a.s.l., morainic soil, profile iron podsol. The second locality (II) is the 'Lichen heath' 1225 m a.s.l., glacialfluvial soil, profile iron podsol. The third locality (III), not described by Solhøy, lies in the close vicinity of Stigstuv Tourist Hut, Stigstuv, 1230 m a.s.l., approximately 1 km from I and II. The vegetation on locality III is of the same type as II. The snow melts in this area at the end of May, and the first snow falls in September, with a good covering in October.

MATERIAL

The material consists of 182 larvae, 1 pupa, and 1 adult specimen. The adult was identified as a male of *Helicoconis lutea* (Wallengren) by A. Fjellberg.

10 of the larvae (marked T-N Q in the list

below) were caught by a Turnbull and Nicholls 'Quick-Trap' combined with the use of a suction pump (Kauri et al. 1969). The rest of the material was collected from tufts of *Festuca* cut off close to the roots, collected into cloth-bags, and kept in a refrigerator at 2–4 °C for approx. 5 days. All larvae were extracted in modified Tullgren funnels.

Although Coniopterygidae larvae are mostly described as having three larval instars, one species *Semidalis vicina* (Hagen 1861) is reported by Muma (1967, 1971) to have four larval instars. Since my description is based on preserved material only, no absolute number can therefore be given to the larval instars. The number in brackets in the following refers to the different instars: The smallest instar (1), medium instar (2) and final instar (3).

Locality I. 19 Sept. 1972: 1 (1), 1 (2) T-N Q. Total 2 larvae.

Locality II. 20 May 1970: 1 (3) T-N Q. 3 June 1971: 1 (1), 2 (2) T-N Q. 12 June 1970: 1 (3) T-N Q. 3 July 1972: 31 (3), one pupa and one *Helicoconis lutea* ♂. 14 July 1970: 2 (3) T-N Q. 10 Aug. 1972: 4 (1), 15 (2), 24 (3). 27 Aug. 1970: 1 (1) T-N Q. 1. Sept. 1972: 4

(2), 47 (3). 12 Sept. 1970: 1 (1) T-N Q. 20 Sept. 1972: 40 (3). Total 174 larvae. This locality was also surveyed on 15 April 1972, 3 May 1972, 20 July 1972, and 13 Oct. 1972 with negative results.

Locality III. 19 May 1972: 1 (3). 7 June 1972: 2 (2). 19 June 1972: 3 (3). Total 6 larvae. This locality was also surveyed on 17 March 1972 with negative results.

DESCRIPTION OF LARVAL INSTARS

Final instar. Length from 2 mm to 3 mm measured on alcohol preserved material (only preserved material seen by the author). General colour in alcohol, vivid pink. The whole surface with the exception of head, legs, and the posterior part of the last segment, covered

with a fine microsculpture, see Fig. 1A. Several setae present on head, body segments, and legs. On dorsal side of body segments, setae mostly arranged in transverse rows, see Fig 1B.

The head with pointed labrum, and two unclearly marked sutures in the front-clypeal region in front of the antennae (Fig. 2A). The whole length of the mandibles and the maxillae is covered by the labrum, which is partly transparent. Mandibles and maxillae forming piercing jaws. Maxilla with three posteriorly barbs directed apically, the first barb very small compared to the other two. Labium not so well sclerotized with two segmented palps (Fig. 2B). On the distal parts of the palps an oval plate with many short close-standing hairs. The position of this plate is on the inside and partly downward side of the palps. The plate probably functions as a sense organ. The antenna is two-segmented, basal segment about one-third of the length of the second segment. The second segment constricted about one-third from its base, this constriction is, however, more or less distinct in the different individuals. Eyes placed laterally behind the antennae and comprised of five ommatidia.

Thorax unsclerotized. Small tufts of setae are placed laterally on the segments. The microsculpture gives the body a prickly outline shown only in Figs. 2A, C. Abdomen is sclerotized in the posterior part of segment ten. This segment is seen from below in Fig. 2C.

Legs similar, but increasing somewhat in length from first to last pair (Fig. 1C, D and E). Tarsus with curved, simple claws and two long slender setae placed at base of the claws and extending further than the claws. Trochanter better sclerotized than outer segments of legs.

Earlier instars. Two earlier larval stages can be distinguished. The smallest instar (1. larval instar?) has a total length of 0.66–0.74 mm. Legs, head, and labial palps much longer compared to the body than in the final instar, viz. legs in this stage nearly half the length of the body. Colour more whitish, no sclerotized last part of tenth segment. Medium larval instar (2nd larval instar?) has a total length of 1–1.4 mm. This stage looks like a middle one between the smallest and the final instar.

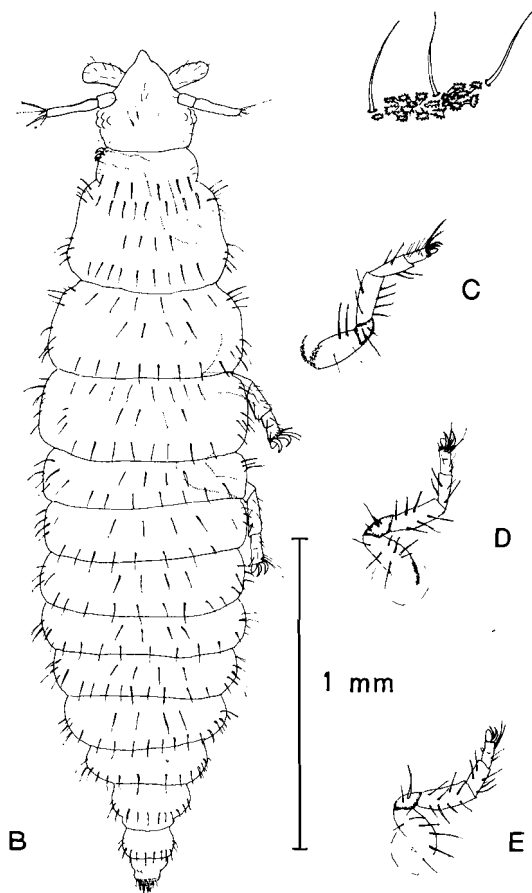


Fig. 1. Larvae of *Helicoconis lutea*. A. Detail of microsculpture and body setae. B. Final instar, dorsal view. Legs on left side omitted. C. First leg. D. Second leg. E. Third leg.

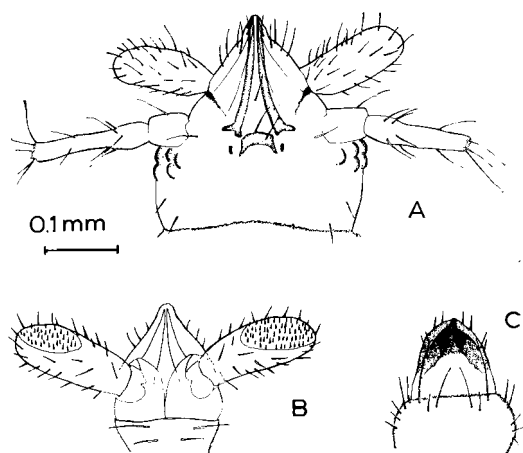


Fig. 2. Larvae of *Helicoconis lutea*. A. Dorsal view of head with maxillae and outer parts of mandibles shown. B. Ventral view of head with mandibles and labial palps. C. Ventral view of last body segment.

DESCRIPTION OF PUPA

The only pupa found is shown in Fig. 3. It has a total length of about 3.5 mm and is very slender. This is a contrast to the pupae of the family Coniopterygidae as a whole, where pupae are described as short and in profile somewhat square (Meinander 1972).

Head dark brown, bent to an angle with the thorax and well sclerotized. However, a large unsclerotized area on the frons extends around the basis of the antennae and runs into a long narrow slit to the clypeus. The form of this area is the same as in adult specimens of *Helicoconis lutea*. Antenna with 22 segments. Number of segments in adult *H. lutea* is from 22 to 27. Maxillary palps long and slender, with a last segment as broad as the others, the last segment of the labial palp long and slender. As a whole the head of the pupa fits very well with Meinander's (1972) drawing of the head of an adult *H. lutea*.

Legs slender with five-segmented tarsus, of which the fourth segment is flattened. Abdomen brownish/yellow.

DISCUSSION

Killington (1936) gives a general description of Coniopterygidae larvae, and accurate and

detailed descriptions are given by Rousset (1966) for *Aleuropteryx loewi* Klapalek, 1894, *Coniopteryx parthenia* (Navas & Marcet 1910) (= *C. pygmaea*), *Conwentzia psociformis* (Curtis, 1834), and *Semidalis aleurodiformis* (Stephens, 1836); and by Ward (1970) for *Aleuropteryx juniperi* Ohm, 1968. Of these genera, *Aleuropteryx* is not known from Norway, but has been found in southern Sweden. Two other Coniopterygidae genera, *Helico-*

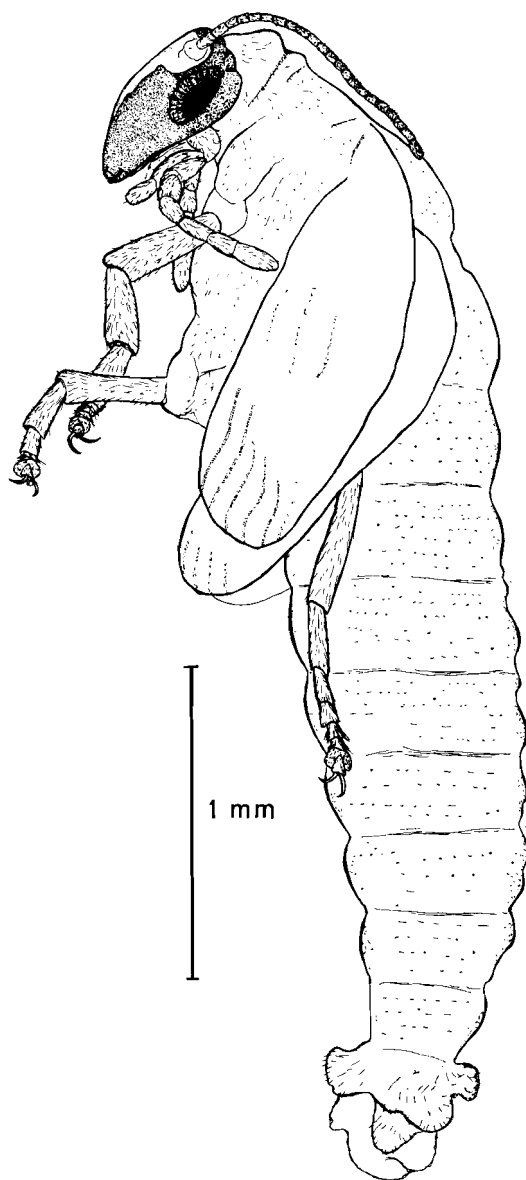


Fig. 3. *Helicoconis lutea*, pupa.

conis Enderlein 1905 and *Parasemidalis* Enderlein 1905, are known from Norway, represented by one species each. The eggs of *Parasemidalis* have been described, but further stages are unknown (Meinander 1972). All immature stages of *Helicoconis* are as yet undescribed (Meinander 1972 and pers. comm.).

The larvae from the present investigation are easy to distinguish from *Aleuropteryx* larvae, in which labrum only covers the mandibles and maxillae at the base. The larvae of *Semidalis* differ in having a distinct colour pattern of black and white (Killington 1936, Muma 1967). Furthermore *Semidalis* larvae have only four ommatidia (against five in the present material), and the form of the labrum is different (Rousset 1966). *Conwentzia psociformis* larvae (Rousset 1966) can be separated from the present material on account of much longer legs compared to body, a very long second antennal segment, different form of labrum with many long setae, small sense organs on the labial palps, and the first barb of the maxilla as big as the other two. Collyer (1951) gives a description of *C. pineticola* which lacks important details of the head and mouthparts, but as in *C. psociformis* the legs are longer compared to the body than in the present material. *Coniopteryx parthenia* (= *C. pygmaea*) described by Rousset (1966) differs as follows: much longer legs compared to the body, the different form of the labrum, and in size, *C. parthenia* final larval instar only about 1.6 mm. The *C. tineiformis* larvae described by Killington (1936) have long legs like *C. parthenia* and antennae about the double length of the labial palps, see also Rousset (1969).

Another possibility is that the larvae belong to *Parasemidalis fuscipennis* (Reuter, 1894) reported three times from one locality in the county of southern Trøndelag (Aagaard & Solem 1972, 1973). *P. fuscipennis* is apparently confined to conifers (Meinander 1972). I think it unlikely that larvae of this species would be found throughout the year and in large numbers on a high mountain plateau like Hardangervidda, with no coniferous trees.

My conclusion is, then, that the larvae from Hardangervidda do not fit any of the hitherto described larvae of Coniopterygidae genera belonging to Norway.

The only genus which can be seriously

considered is *Helicoconis*, represented in Norway by one species only, *H. lutea*. One specimen of *H. lutea* was actually found at locality II. Another specimen has earlier been reported from Hardangervidda (Greve 1969). *H. lutea* has a wide, though scattered distribution in northern Europe and the distribution extends into Siberia (Meinander 1972). *H. lutea* is found scattered over the whole of Finland. It has been reported from several places in southern and middle Sweden (Tjeder 1940, 1953), and has recently been found in northern Sweden by Mr. A. Fjellberg (Greve 1974). Tjeder (1945) reported this species from northern Norway, Troms county, and I have seen material (unpublished) from Finnmark.

In southern Europe there are several *Helicoconis* species, but only two others are known from Scandinavia: *H. hirtinervis* Tjeder 1960 (only one brachypterous female known), and *H. cimbrica* Ohm 1965 (only males known). Both species have only been reported from Jutland (Meinander 1972).

CONCLUSIONS

Based on the facts that a) one adult *H. lutea* was found together with larvae at locality II, b) one pupa which certainly belongs to *H. lutea* was found together with larvae at locality II, c) the general distribution of *H. lutea* includes localities of a similar climate, d) no other *Helicoconis* species occurs in the area, e) the larvae do not fit any of the hitherto described larvae belonging to Coniopterygidae genera known from Norway (or other places) — I conclude that the larvae very likely belong to *Helicoconis lutea*.

I am, however, aware of the fact that no larvae have been reared in the laboratory and that the life-cycle of the species has not been followed from egg to the adult.

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to Mr. Arne Fjellberg for drawing my attention to this most interesting material. Mr. Torstein Solhøy kindly lent me the material.

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Caddis flies (Trichoptera) from the outer part of Sogn and Fjordane

TROND ANDERSEN

Andersen, T. 1974. Caddis flies (Trichoptera) from the outer part of Sogn and Fjordane. *Norsk ent. Tidsskr.* 21, 25–29.

A list of 46 species of Trichoptera from the outer part of Sogn and Fjordane county is given. One species, *Oxyethira sagittifera* Ris, is new to Norwegian fauna, and 38 species have not previously been reported from the area. The distribution of *Oxyethira sagittifera* Ris, *Oxytrichia mirabilis* (Morton), and *Adicella reducta* (McLachlan) is briefly discussed.

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During the summer and autumn 1973 I collected adult caddis flies in Gulen, in the outer part of Sogn and Fjordane, Norway. Fourteen localities were visited (Table I). A map with the localities indicated is given in Fig. 1. The western parts of the investigated area are dominated by heaths. Slopes covered with *Juniperus communis* L. and *Calluna vulgaris* L. change to moist depressions with grass and herb vegetation. Scattered woods of deciduous trees occur in sheltered places, mainly along the fjords, and pinewoods extend in the south-eastern parts of the area. To the east the mountains rise to 400–600 m altitude. The vegetation in ponds and lakes is rather poor, *Nymphaea* sp. and *Lobelia dortmanna* L. dominate. The shores are either stony with hardly any vegetation, or muddy flats covered with low growths of *Eriophorum*, *Scirpus*, and *Carex*. The water-courses in the area are for the most part small stony streams. Grindevann is surrounded by cultivated fields and is richer in vegetation than other lakes visited. The locality Eide is a shallow brackish water area at the bottom of Eidefjorden.

METHODS

Sweep-nets were used in vegetation along streams and ponds, and probable hiding places such as stones and trees were searched. Some specimens, especially among the Leptoceridae, were also netted on the wing.

The light-trap used was a Robinson trap

Table I. Names of the localities shown in Fig. 1. All localities are situated in Gulen in the outer part of Sogn and Fjordane.

Loc. no.	Locality	UTM reference
1	Dale	32VKN928615
2	Dalsøyra	32VKN907617
3	Eide	32VKN892540
4	Glenjetjern	32VKN887572
5	Grinde	32VKN905588
6	Grindevann	32VKN905585
7	Haveland	32VKN943697
8	Iledalselva	32VKN902524
9	Merkesdal	32VKN865571
10	Nerdale	32VKN922611
11	Nordgulvann	32VKN943721
12	Steine	32VKN893535
13	Steinevann	32VKN886523
14	Svardal	32VKN876577

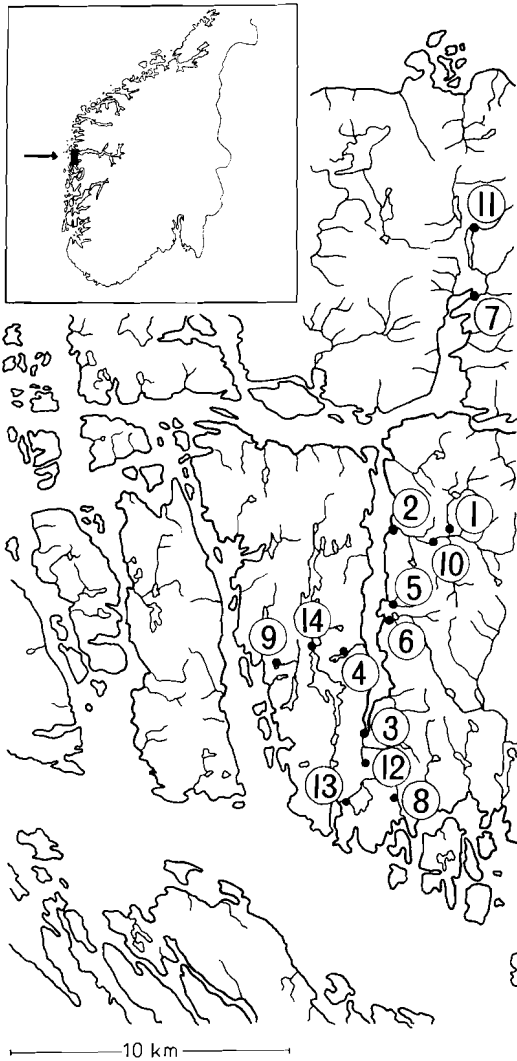


Fig. 1. Part of Gulen with the localities indicated. Names of the localities are listed alphabetically in Table I.

fitted with a mercury-vapour bulb (Philips HPW 125W). The batches were conserved directly in a container filled with aethylen-glycol. The trap was run at Grinde about 100 m from Grindevann 8 May–22 June, and at Steine 22–23 June and 26 June–31 October. The last locality lies about 1 km from the nearest lake. The trap was emptied 27 June, 29 July, 19 August, and 16 September.

The collection comprises 1440 adult specimens belonging to 46 species. The material is deposited at the Zoological Museum, University of Bergen.

RHYACOPHILIDAE

Rhyacophila nubila (Zetterstedt)

Dale 16 Sept. 1♂ 1♀; Dalsøyra 23 June 1♀; Grinde 8 May–22 June 1♀ (light-trap); Grindevann 22 June 1♂, 26 June 1♂, 30 July 1♂; Haveland 30 July 1♂; Steine 27 June–29 July 1♂, 16 Sept.–31 Oct. 1♂ (light-trap); Svardal 22 June 5♂♂, 16 Sept. 1♂ 2♀♀.

HYDROPTILIDAE

Oxyethira flavicornis (Pictet) (Syn.: *costalis* Eaton, nec Curtis)

Grinde 8 May–22 June 1♀ (light-trap); Grindevann 26 June 1♀, 30 July 2♂♂ 2♀♀; Steine 27 June–19 Aug. 2♂♂, 16 Sept.–31 Oct. 2♀♀ (light-trap).

Oxyethira frici Klapalek

Steinevann 23 June 1♂ 1♀.

Oxyethira sagittifera Ris

Merkesdal 22 June 11♂♂ 2♀♀.

Oxytrichia mirabilis (Morton)

Steine 27 June–29 July 1♂ (light-trap).

Hydroptilia tineoides Dalman (Syn.: *femoralis* Eaton)

Steine 27 June–29 July 1♂ (light-trap); Steinevann 23 June 1♂.

HYDROPSYCHIDAE

Hydropsyche pellucidula (Curtis)

Steine 27 June–19 Aug. 2♀♀, 16 Sept.–31 Oct. 1♀ (light-trap).

POLYCENTROPIDAE

Neureclipsis bimaculata (Linnaeus)

Grindevann 26 June 2♂♂, 30 July 1♀; Svardal 16 Sept. 1♀.

Plectrocnemia conspersa (Curtis)

Grindevann 22 June 1♂, 30 July 1♂; Steine 26 June–31 Oct. 28♂♂ 30♀♀ (light-trap); Svardal 22 June 1♂.

Polycentropus flavomaculatus (Pictet)

Dale 23 June 1♂; Dalsøyra 23 June 1♀;

Glenjetjern 30 July 1♂; Grindevann 26 June 1♂; Merkesdal 22 June 1♂; Nerdale 23 June 4♂♂; Nordgulvann 30 July 10♂♂; Steine 27 June–16 Sept. 3♂♂ 6♀♀ (light-trap); Steinevann 23 June 8♂♂; Svoldal 22 June 3♂♂, 16 Sept. 1♀.

Polycentropus irroratus (Curtis) (Syn.: *multiguttatus* McLachlan, nec Curtis)

Glenjetjern 22 June 2♂♂, 30 July 4♂♂; Steine 27 June–29 July 2♂♂ (light-trap).

Holocentropus dubius (Rambur)

Glenjetjern 22 June 2♂♂; Grindevann 26 June 28♂♂ 2♀♀, 30 July 1♂ 1♀, 19 Aug. 1♀.

Cyrnus flavidus McLachlan

Glenjetjern 30 July 1♀; Merkesdal 22 June 2♂♂.

PSYCHOMYIDAE

Tinodes waeneri (Linnaeus)

Steine 29 July–19 Aug. 1♂ (light-trap).

PHRYGANEIDAE

Agrypnia absoleta (McLachlan)

Steine 27 June–29 July 1♀ (light-trap).

Agrypnia varia (Fabricius)

Glenjetjern 22 June 2♂♂, 16 Sept. 1♀; Steine 29 July–19 Aug. 1♀ (light-trap).

Phryganea grandis Linnaeus

Merkesdal 22 June 1♂; Steine 27 June–29 July 1♂ (light-trap).

LIMNEPHILIDAE

Apatania stigmatella (Zetterstedt)

Steine 29 July–19 Aug. 2♂♂ (light-trap).

Apatania zonella (Zetterstedt)

Steine 16 Sept.–31 Oct. 1♀ (light-trap).

Limnephilus affinis Curtis

Eide 30 July 3♂♂ 3♀♀; Steine 27 June–16 Sept. 55♂♂ 26♀♀ (light-trap).

Limnephilus auricula Curtis

Steine 29 July–31 Oct. 44♂♂ 3♀♀ (light-trap).

Limnephilus binotatus Curtis (Syn.: *xanthodes* McLachlan)

Grindevann 26 June 1♀.

Limnephilus centralis Curtis

Grindevann 22 June 1♀, 26 June 2♀♀; Merkesdal 22 June 3♂♂; Nordgulvann 30 July 1♀; Steine 27 June–31 Oct. 10♂♂ (light-trap); Svoldal 22 June 1♂.

Limnephilus coenosus Curtis

Steine 29 July–31 Oct. 129♂♂ 1♀ (light-trap).

Limnephilus elegans Curtis

Steine 27 June–29 July 1♂ (light-trap).

Limnephilus extricatus McLachlan

Glenjetjern 22 June 2♀♀; Steine 27 June–19 Aug. 13♂♂ 5♀♀ (light-trap).

Limnephilus flavicornis (Fabricius)

Glenjetjern 30 July 1♀; Grindevann 16 Sept. 1♀; Steine 29 July–31 Oct. 50♂♂ 5♀♀ (light-trap).

Limnephilus griseus (Linnaeus)

Glenjetjern 16 Sept. 1♀; Steine 29 July–31 Oct. 14♂♂ 2♀♀ (light-trap).

Limnephilus lunatus Curtis

Grindevann 30 July 3♀♀, 31 Oct. 1♀; Steine 16 Sept.–31 Oct. 1♂ 1♀ (light-trap).

Limnephilus luridus Curtis

Steine 27 June–16 Sept. 5♂♂ (light-trap).

Limnephilus marmoratus Curtis

Glenjetjern 30 July 1♀, 16 Sept. 1♂ 1♀; Steine 27 June–31 Oct. 19♂♂ 5♀♀ (light-trap).

Limnephilus rhombicus (Linnaeus)

Grinde 8 May–22 June 3♂♂ (light-trap).

Limnephilus sparsus Curtis

Steine 22 June 1♀, 26 June–31 Oct. 245♂♂ 42♀♀ (light-trap).

Limnephilus stigma Curtis

Steine 27 June–16 Sept. 10♂♂ 3♀♀ (light-trap).

Limnephilus vittatus (Fabricius)

Nordgulvann 30 July 1♀; Steine 27 June–31 Oct. 6♂♂ (light-trap).

Rhadicleptus alpestris (Kolenati)

Steine 29 July–19 Aug. 1♂ (light-trap).

Potamophylax cingulatus (Stephens)

Steine 27 June–31 Oct. 24♂♂ 3♀♀ (light-trap).

Halesus radiatus (Curtis)

Steine 16 Sept.–31 Oct. 4♂♂ (light-trap).

Stenophylax permistus McLachlan

Steine 27 June–31 Oct. 54♂♂ 6♀♀ (light-trap).

Micropterna lateralis (Stephens)

Steine 22 June 1♂, 27 June–29 July 15♂♂ (light-trap).

Micropterna sequax McLachlan

Steine 26 June–31 Oct. 49♂♂ 3♀♀ (light-trap).

Chaetopteryx villosa (Fabricius)

Grindevann 31 Oct. 2♂♂ 2♀♀; Iledalselva 31 Oct. 1♂.

LEPIDOSTOMATIDAE

Lepidostoma hirtum (Fabricius)

Steine 27 June–29 July 1♂ (light-trap).

LEPTOCERIDAE

Mystacides azurea (Linnaeus)

Grindevann 26 June 1♀, 30 July 15♂♂ 3♀♀; Nordgulvann 30 July 1♂.

Adicella reducta (McLachlan)

Grindevann 22 June 3♂♂ 1♀, 26 June 4♂♂.

MOLANNIDAE

Molannodes tinctoria (Zetterstedt)

Grindevann 30 July 12♂♂ 1♀; Nordgulvann

30 July 25♂♂ 11♀♀; Steine 27 June–29 July 1♂ (light-trap).

DISCUSSION

Brekke (1946) reported 26 species of caddis flies from Sogn and Fjordane. Of these, four species (*Agrypnia picta* Kolenati, *Limnephilus griseus* (Linnaeus), *Limnephilus sparsus* Curtis, *Lepidostoma hirtum* (Fabricius)) were taken exclusively in the outer part of the county. Five species (*Rhyacophila nubila* (Zetterstedt), *Plectrocnemia conspersa* (Curtis), *Polycentropus flavomaculatus* (Pictet), *Limnephilus stigma* Curtis, *Halesus radiatus* (Curtis)) were common to both the inner and outer part of the county, while the remaining 17 species were collected only in the inner part. No further additions to the Trichoptera fauna of the area have been published. During my field work I failed to collect *A. picta*. Apart from *R. nubila*, *P. conspersa*, *P. flavomaculatus*, *L. griseus*, *L. sparsus*, *L. stigma*, *H. radiatus*, and *L. hirtum*, the remaining 38 species reported here are new to the area.

Oxyethira sagittifera Ris 1897 is new to Norwegian fauna. The species was observed in great numbers just before sunset, swarming close to the water surface or jumping and running on the stony shore of a little pond. The species is distributed in North, West, and Central Europe (Botosaneanu 1967). In Fennoscandia it is reported from a few localities north up to Lule Lappmark in Sweden and in the southern parts of Finland, where it is rare and local at lakes and streams (Forsslund 1953, 1954, Forsslund & Tjeder 1942, Nybom 1960, Tobias 1969).

In Norway *Oxytrichia mirabilis* (Morton 1904) has previously only been taken in South Varanger (Tobias & Tobias 1971). Elsewhere in Europe the species is reported from the Baltic, Finland, Sweden, and Scotland (Botosaneanu 1967, Forsslund 1953, 1954, Forsslund & Tjeder 1942, Macan 1973, Nybom 1960, Tobias 1969).

Adicella reducta (McLachlan 1865) was netted swarming over a small stony stream or sitting on the stems of alder shrubs along the water-course. In Norway the species has been reported from some localities in Rogaland (Forsslund 1936, Jensen 1942). The species is distributed in most parts of Europe except

the extreme northern and north-eastern parts (Botosaneanu 1967).

Although findings have not been published yet, the rest of the species recorded have been found in the outer part of Hordaland.

Because the light-trap was situated at a considerable distance from the nearest lake most of the summer, the catches were unusually small. If the trap had been placed at a more suitable locality the number of species would surely have been higher. On the other hand a thorough search for Leptoceridae species gave the poor result of only two species.

ACKNOWLEDGEMENTS

I am indebted to curator John O. Solem, Trondheim, for help with identification, and for criticism of the manuscript. Curator Solem identified the female of *Cyrnus flavidus*, and the three females of *Hydropsyche pellucidula*. He also verified the identification of Hydropsyche males, and the female of *Apatania zonella*. I also wish to thank Mr. Johannes Eide, Dalsøyra, for looking after the light-trap.

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A revised list of Norwegian ants (Hymenoptera, Formicidae)

CEDRIC A. COLLINGWOOD

Collingwood, C. A. 1974. A revised list of Norwegian ants (Hymenoptera, Formicidae). *Norsk. ent. Tidsskr.* 21, 31-35.

The 44 Norwegian species of Formicidae as at present known are listed with notes on nomenclature changes since Holgersen (1944). Additions to Holgersen's (1944) list include *Formica cinerea* Mayr, *F. transcaucasica* Nasonow, *F. forsslundi* Lohmander, *Lasius rabaudi* Bondroit, *Stenamma westwoodii* Westwood, and *Formica nigricans* Emery. Varietal names as used by Holgersen (1944) are excluded and replaced in the genus *Formica* by names of the equivalent species as now recognized, including *Formica aquilonia* Yarrow, *F. lugubris* Zetterstedt, and *F. lemani* Bondroit.

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The ants of Norway were keyed and listed by Holgersen (1943a, 1944). Subsequently, Yarrow (1954, 1955a) revised the taxonomy of some of the *Formica* species and his nomenclature was used to bring up to date the list of Swedish ants by Forsslund (1957), who also tabled the verified available records from neighbouring countries including Norway. Further information gained by two visits to Norway (Collingwood 1959, 1963), specimens sent me for identification by Dr. H. Holgersen himself and from other collectors, including Dr. N. Haarlöv, who added 11 species to the under-recorded province of Vestfold, and finally a large collection of ants loaned by Dr. A. Løken from the Zoological Museum, University of Bergen, now provide me with an opportunity to bring the list of verified Norwegian species up to date (Table I). The Bergen material includes some old specimens taken from a wide area, some of which were studied by Holgersen (1943a, 1944), and many recent collections mainly from the western coast of Norway and from Hardangervidda and adjacent territories. The whole includes samples from over 500 nest series and has provided a firm basis for the present survey. However, large areas of Nor-

way still remain relatively under-explored by collectors, so that the distribution by provinces given in Table I can only be regarded as provisional. As an example of further opportunities that may yet exist, a visit of a few hours in the neighbourhood of Elverum in Hedmark yielded 3 species new to the Norwegian list (Collingwood 1963).

NOTES ON THE SPECIES

Hypoponera punctatissima (Roger) was considered by Holgersen (1943b) to be a possible relict native species and is retained in the list, although it is almost certainly an introduction.

Stenamma westwoodii Westwood is represented by 4 specimens that were collected in a greenhouse in the Botanical Garden, Bergen in 1937. The specimens, which are exceptionally small and pale, were recognized but not listed by Holgersen (1943a). They were evidently considered as being accidentally introduced. However, this species occurs in South Sweden and its occurrence in the more sheltered districts of South Norway is perhaps not improbable.

Myrmica species include *M. rubra* (L.), now

the correct name according to Yarrow (1955b) for *M. laevinodis* Nylander. Holgersen (1942b) commented that the single record for Polmark in Finnmark in Northern Norway was perhaps doubtful but this species certainly occurs as far north as Narvik (O'Rourke 1949) and the Lofoten Islands (Collingwood 1959). *M. sabuleti* Meinert and *M. schencki* Emery are evidently rather local in South Norway but the other species listed including *M. ruginodis* Nylander, *M. sulcinodis* Nylander, *M. scabrinodis* Nylander, and *M. lobi-*

cornis Nylander are all widely distributed. I have excluded *M. rugulosa* Nylander since the only Norwegian record dates from 1880 and is not supported by specimens (Holgersen 1944). Other names used by Holgersen (1943a, 1944) that are now omitted include the varietal names *sulcinodo-scabrinodis* Forel, *ruginodo-laevinodis* Forel, and *M. laevinodis* var. *europa* Forel; subsequent critical examination has shown them to be minor variations of one or other of the main species.

Harpagoxenus sublaevis (Nylander) and

Table I. A revised list of Norwegian Formicidae and their distribution. The abbreviations refer to the names of the provinces, reading in full as follows: Østfold, Akershus, Hedmark, Oppland,

	Ø	AK	HE	O	B	VE	TE
<i>Hypoponera punctatissima</i> (Rog.)	—	×	—	—	—	—	—
<i>Stenamma westwoodii</i> Westwood	—	—	—	—	—	—	—
<i>Myrmica rubra</i> (L.)	×	×	×	×	×	—	×
<i>Myrmica ruginodis</i> Nyl.	×	×	×	×	×	×	×
<i>Myrmica sulcinodis</i> Nyl.	×	×	×	×	×	—	—
<i>Myrmica scabrinodis</i> Nyl.	×	×	×	×	×	—	—
<i>Myrmica sabuleti</i> Mein.	×	×	—	—	—	—	—
<i>Myrmica schencki</i> Em.	—	×	—	—	—	—	—
<i>Myrmica lobicornis</i> Nyl.	×	×	×	×	×	—	—
<i>Harpagoxenus sublaevis</i> (Nyl.)	×	×	×	—	×	—	—
<i>Formicoxenus nitidulus</i> (Nyl.)	—	×	—	×	×	—	—
<i>Leptothorax acervorum</i> (Fab.)	×	×	×	×	×	×	×
<i>Leptothorax muscorum</i> (Nyl.)	—	×	×	×	×	—	—
<i>Leptothorax tuberculatum</i> (Fab.)	×	×	×	×	×	—	×
<i>Leptothorax interruptus</i> (Sch.)	—	×	—	—	—	—	—
<i>Tetramorium caespitum</i> (L.)	×	×	×	—	×	—	×
<i>Camponotus herculeanus</i> (L.)	×	×	×	×	×	—	×
<i>Camponotus ligniperdus</i> (Latr.)	×	×	×	—	×	×	×
<i>Lasius niger</i> (L.)	×	×	×	×	×	×	×
<i>Lasius alienus</i> (Forst.)	×	—	×	—	—	—	—
<i>Lasius brunneus</i> (Latr.)	—	×	—	—	—	—	—
<i>Lasius flavus</i> (Fab.)	×	×	×	×	×	×	—
<i>Lasius mixtus</i> (Nyl.)	—	×	—	—	×	—	—
<i>Lasius umbratus</i> (Nyl.)	×	×	—	×	×	×	—
<i>Lasius rabaudi</i> Bond.	—	—	—	—	—	×	—
<i>Lasius fuliginosus</i> (Latr.)	×	×	×	×	×	—	×
<i>Formica rufa</i> L.	×	×	×	×	×	—	—
<i>Formica polyctena</i> Först.	×	×	—	—	—	—	—
<i>Formica aquilonia</i> Yarrow	×	×	×	×	×	×	—
<i>Formica lugubris</i> Zett.	×	×	×	×	×	×	—
<i>Formica pratensis</i> Retz.	×	×	—	—	—	—	—
<i>Formica nigricans</i> Emery	—	—	—	—	—	—	—
<i>Formica truncorum</i> Fab.	—	×	—	×	×	—	—
<i>Formica exsecta</i> Nyl.	×	×	×	×	×	—	—
<i>Formica pressilabris</i> Fab.	—	×	—	—	—	—	—
<i>Formica forsstundi</i> Lohm.	—	—	×	—	—	—	—
<i>Formica suecica</i> Adlerz	—	—	×	—	—	—	—
<i>Formica sanguinea</i> Latr.	×	×	×	×	×	×	—
<i>Formica fusca</i> L.	×	×	×	×	—	×	—
<i>Formica lemmani</i> Bond.	×	×	×	×	×	×	×
<i>Formica gagatoides</i> Ruzs.	—	—	—	×	×	—	—
<i>Formica transkaukasica</i> Nas.	—	—	×	—	—	—	—
<i>Formica rufibarbis</i> Fab.	×	×	—	—	×	—	—
<i>Formica cinerea</i> Mayr	—	—	×	—	—	—	—

Formicoxenus nitidulus (Nylander) are interesting inquiline or parasitic species found with *Leptothorax* species and with *Formica rufa* group species respectively. *H. sublaevis* is not uncommon in Scandinavia (Holgersen 1942a) but is distributed more sparsely through the mountains of Central Europe as far south as the Eastern Pyrenees and the Apennines.

Leptothorax species include *L. acervorum* (Fabricius), *L. muscorum* (Nylander), and *L. tuberum* (Fabricius), all of wide distribu-

tion in Europe. The old record for *L. interruptus* (Schenck) at Oslo (Holgersen 1944) may be doubtful, as the only properly verified Scandinavian records are from the Baltic islands of Gotland and Gotska Sandön, and this species is rather local in Central Europe. *L. acervorum* var. *nigrescens* Ruzsky is excluded as, in agreement with Holgersen (1944), I discount this as a trivial variant of *L. acervorum* which varies considerably in colour according to habitat from south to north. Similarly *L. tuberum* var. *negricephala*

Buskerud, Vestfold, Telemark, Aust-Agder, Vest-Agder, Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal, Sør-Trøndelag, Nord-Trøndelag, Nordland south, Nordland north, Troms, Finnmark western and inner district, Finnmark northern and eastern district.

AA	VA	R	HO	SF	MR	ST	NT	Ns	Nn	TR	Fv+i	Fn+ø
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	i	—	—	—	—	—	—	—	—	—
—	x	x	x	x	—	x	—	x	x	—	—	x
x	x	x	x	x	x	—	x	x	x	x	x	x
x	x	x	x	—	—	—	—	x	x	—	—	—
—	—	x	x	x	—	—	—	—	—	—	—	—
—	—	x	—	—	—	—	—	—	—	—	—	—
x	x	x	x	—	—	—	—	x	x	x	x	x
—	x	x	—	—	—	—	—	—	—	—	x	—
x	x	x	—	—	—	—	—	x	x	x	x	x
x	x	x	x	x	x	x	x	x	x	x	x	x
—	—	x	x	—	—	—	—	—	—	—	—	—
x	—	—	—	—	—	—	—	—	—	—	—	—
x	x	x	—	—	—	—	—	—	—	—	—	—
x	x	x	x	x	x	x	x	x	x	x	x	x
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
x	x	x	x	x	x	x	x	x	x	x	x	x
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	x	—	—	—	—	—	—	—	—	—	—
—	x	x	x	—	—	—	—	—	—	—	—	—
—	—	x	x	x	—	—	—	—	—	—	—	—
x	x	x	x	x	x	x	x	x	x	x	x	x
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	x	—	—	—	—	—	—	—	—	—	—
—	x	x	x	—	—	—	—	—	—	—	—	—
x	x	x	x	x	x	x	x	x	x	x	x	x
—	—	—	—	—	—	—	—	—	—	—	—	—
x	x	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—

Karawaiev is excluded as a useless distinction from *L. tuberum*.

Tetramorium caespitum (L.) tends to have a coastal distribution in North Europe but is evidently widely distributed inland in South Norway as at Kongsvinger in Hedmark.

Camponotus herculeanus (L.) and *C. ligniperdus* (Latreille) are common in Scandinavia but the latter has a more restricted distribution to warm sunny sites in the south. Holgersen (1943a, 1944) used the name var. *herculeano-ligniperda* Forel for forms he considered intermediate in colour and pilosity between the typical species. However these ants are more safely separated on pubescence and the existence of true intermediates has not been convincingly demonstrated, colour being too variable in these species to provide a useful distinction.

Lasius species include *L. niger* (L.) and *L. flavus* (Fabricius), both abundant and widely distributed in South Norway. *L. mixtus* (Nylander), *L. umbratus* (Nylander), and *L. fuliginosus* (Latreille) are more restricted and local in the south. *L. brunneus* (Latreille) is an interesting species characteristically found in old oak trees and very local in South Norway, from where I have seen no recent specimens. *L. alienus* (Förster) is another local species. Forslund (1949) confirmed it positively from Hvaler in Østfold and he himself collected it near Trysil in Hedmark. *L. rabaudi* Bondroit was collected among other species by Dr. N. Haarløv at Stolpestad in Vestfold. It is less common in North Europe than either *L. umbratus* or *L. mixtus* and appears to be restricted to fixed sand dune and lowland sandy heath in Sweden, Denmark, and southern England. Bourne (1971) considered that separatory characters between *L. umbratus* and *L. rabaudi* were too inconsistent to allow a species distinction, but the difference between them in habits, type of nest situation, and appearance in the field does not warrant his proposed synonymy, although, as with many other pairs of similar species, museum specimens may be hard to differentiate with certainty without much experience.

The *Formica rufa* group species have been the source of much confusion. Yarrow (1955a) and Betrem (1960) have clarified their taxonomy as far as is possible with this difficult group. Varietal names coined by Forel and

others have been synonymized where possible, but since they were largely based on colour, such names were used inconsistently by the older authors. *F. rufa* var. *nuda* Karawaiev from Hvaler (Holgersen 1940) is almost certainly a synonym for *F. polycytena* Förster. *F. rufa* var. *santschii* Wheeler is a direct synonym for *F. lugubris* Zetterstedt, which also includes many misidentifications of *F. pratensis* Retzius – certainly all records under that name from the northern part of Norway. *F. rufa* var. *rufo-pratensis* Forel is a name that may have been applied to any one of 4 species including *F. aquilonia* Yarrow. True *F. rufa* L. occurs here and there in South Norway and is to be found at low altitudes in the fjord country as far north as Sogn & Fjordane. *F. polycytena* Förster, the most hairless species, has occurred in Østfold and Akershus but is quite frequent in South Sweden and on Jutland in Denmark. *F. aquilonia* is probably the most common wood ant throughout the country from Østfold to Finnmark and all records of *F. rufa* northwards from Møre og Romsdal will refer to this species. *Formica pratensis* was treated by Holgersen (1943a, 1944) as a subspecies of *F. rufa*, and recorded over a wide area. However, examples of true *F. pratensis* from Norway are few and include only Bergen, Hvaler in Østfold, and Nesttun in Hordaland in the collections from Bergen; I have this species also from Halden and Svinesund in Østfold and from Hauer seter in Akershus. *F. nigricans* Emery (*F. cordieri* Bondroit) is represented only from Sauda in Ragaland, and from Måbødalen and Skånevik in Hordaland, these being the first authentic records for this species in Norway. *F. truncorum* Fabricius occurs widely from north to south in the country. Specimens from the Bergen collection named *F. truncicola-pratensis* Forel are normal examples of *F. truncorum*. *F. truncicola-pratensis* has been used as a name for more than one species, but in Forel's collection in Geneva examples so named are also *F. truncorum*.

Formica exsecta Nylander is widely distributed throughout Norway. According to Holgersen (1944) it is common in coastal areas and in the lowlands, but I found it abundant also on high moorland near the tree line, both in the Jotunheimen and on Dovrefjell where it was associated with *Juni-perus*. Holgersen (1940) found *F. pressilabris*

Nylander once only at Blindern, Akershus in 1938, since when the species has not been rediscovered in Norway. The interesting Scandinavian species, *F. suecica* Adlerz was found by Holgersen (1944) in a few localities in Rogaland and in the Østerdalen in Hedmark. I recorded *F. forsslundi* Lohmander from a peat bog near Elverum (Collingwood 1963) and commented that this species as well as *F. uralensis* Riezsky, another bog species not yet found in Norway, may well occur in suitable places in that general area.

Formica sanguinea Latreille, the slave-maker, is not uncommon in the south but is so far not recorded from North Norway, although I have taken this species in Swedish Lapland at Gällivare in Luleå Lappmark.

The *Formica fusca* species group is well represented in Norway with 6 species. Holgersen (1943a, 1944) did not distinguish *F. lemani* Bondroit from *F. fusca* L. as it was not recognized as a valid species until the revision of some members of this species group by Yarrow (1954). In fact *F. lemani* is one of the most common ants throughout Norway, occurring everywhere except in the most xerothermic places in the south. *F. fusca* itself has much the same range as *F. rufa* and is not known to occur further north than Sogn og Fjordane. Records by Holgersen (1942b) of *F. fusca* in Northern Norway are almost certainly ascribable to *F. lemani*. Holgersen (1943c) was the first to recognize that *F. gagatoides* Ruzsky was a distinct species and not a variety of *F. fusca* or *F. picea* Nylander as originally described. In the south, *F. gagatoides* occurs in mountain areas from 800 to 1500 m a.s.l. but is common at lower elevations to sea level in the north. *F. transcaucasica* Nasonov (syn. *F. picea* Nylander) is a common species in Sweden and Finland but has only been found near Elverum in Norway so far (Collingwood 1963). *F. cinerea* Mayr has also only one record for Norway, where I found it nesting in coarse sand along a railway line near Elverum in Hedmark (Collingwood 1963). *F. rufibarbis* Fabricius has been taken only on a few occasions in the extreme south of Norway.

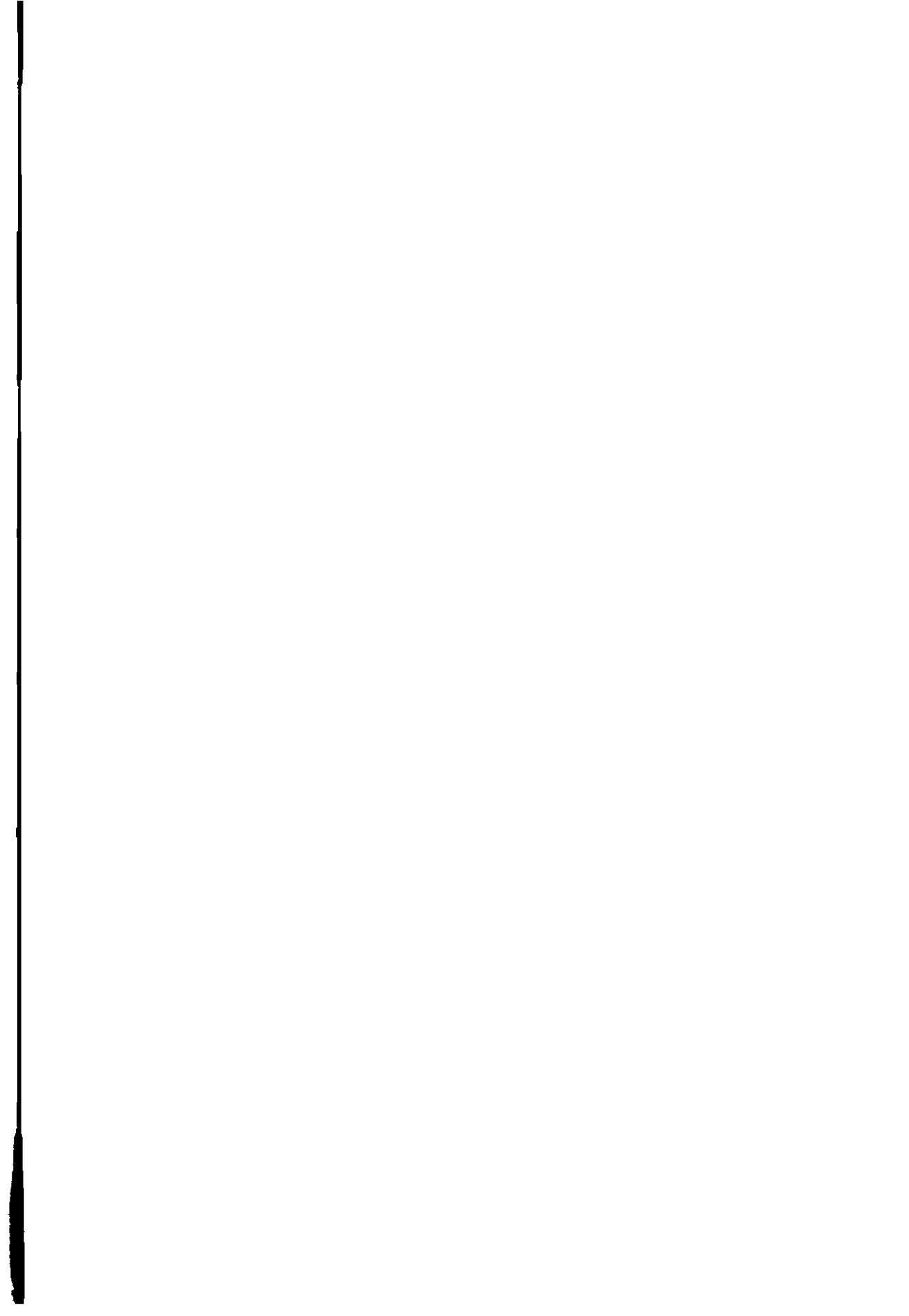
The list of Norwegian species now includes 44 species compared with 41 from the British Isles, and 60 from Sweden with a richer southern fauna.

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On the ecology and distribution of the Norwegian larvae of *Chaoborus* (Diptera, Chaoboridae)

JENS PETTER NILSSEN

Nilssen, J. P. 1974. On the ecology and distribution of the Norwegian larvae of *Chaoborus* (Diptera, Chaoboridae). *Norsk ent. Tidsskr.* 21, 37-44.

Species of the genus *Chaoborus* are reported from 29 localities throughout Norway of different trophic levels and different humic contents. The species seem to be correlated with dystrophy and eutrophy, and show no obvious correlation with the selected chemical parameters. *C. flavicans* is the only species that was reported from lakes deeper than 4 m. It is common in lentic habitats from sea level to mountain areas, and is the only species to withstand some predation pressure. *C. obscuripes* seems to be restricted to shallow, meso- and polyhumic ponds. *C. crystallinus* seems to favour the more eutrophic localities.

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INTRODUCTION

Four of the five known European species of *Chaoborus* s. lat. have hitherto been recorded from Norway. They are the holarctic species *C. nyblaei* (Zett.), *C. crystallinus* (De G.), *C. flavicans* (Meig.), and the palaeartic species *C. obscuripes* (v. d. Wulp).

The taxonomy of *Chaoborus* s. lat. has previously been revised by Sæther (1970).

Although considerable morphological variation seems to be the rule in the genus (Peus 1934, Sæther 1967, Parma 1970), identification of Norwegian larvae and pupae does not normally cause too many problems. The species *C. alpinus* Peus as described by Peus (1938), and first recorded from Norway by Økland (1963), is now considered as a form (Sæther 1967) or a synonym (Stahl 1966b) of *C. flavicans*.

MATERIAL AND METHODS

The material was collected during the period 6 July 1968 to 24 October 1973. The lakes and ponds surveyed are given in Table I.

Transparency was determined by means of a Secchi disc 32 cm in diameter. Lake colour was observed with the Secchi disc at half the vanishing depth and determined according to Strøm (1943). Water colour was observed by means of a BDH Lovibond Nessleriser. The values are given as mg Pt/l. pH was determined with a Radiometer pH meter 29. Specific conductivity was determined by means of a WTW Leitfähigkeitsmesser Modell LF 54. The values are given as κ_{18} and are expressed as $\mu\text{S/cm}$. Oxygen was determined according to the unmodified Winkler method. Alkalinity (HCO_3^-) was measured by means of direct titration with n/100 HCl to an end point pH 4.5. The water intended for the chemical analyses in the laboratory was tapped in polyethylene bottles. KMnO_4 consumption was measured according to Bøyum (1971). Calcium and magnesium were found by means of calcium hardness and total hardness, and determined with EDTA-titration. Sodium and potassium were analysed by means of the atomic absorption method (Perkin-Elmer). Chloride was found by potentiometric titration. Sulphate was deter-

Table I. The known distribution of *Chaoborus* spp. in Norway.

No. locality	Locality	District	County	UTM coordinates	Sampling method	<i>C. flavicans</i>	<i>C. obscuripes</i>	<i>C. crystallinus</i>	Number of identified specimen	Source**
1.	Prestevann	Tromsø	Troms	34W DC 200 294	?	X		X	7	Sæther 1970
2.	Rottvann	Balsfjord	Troms	34W DB 221 747	P	X			6	Sæther 1966
3.	Mjøntjern	Ullensaker	Akershus	32V PM 186 767	P	X			11	
4.	Pollen	Ås	Akershus	32V NM 985 240	P	X			10	
5.	Pond A	Gran	Oppland	32V NM 898 887	P*			X	15	
6.	Østensjøvann	Oslo	Oslo	32V PM 024 406	P&B	X			100	Sæther 1967
7.	Borre vann	Horten	Vestfold	32V NL 815 870	B	X			800	Økland 1963
8.	Stemtjønn	Fyresdal	Telemark	32V ML 411 478	P&B	X			41	
9.	Kroktjenn	Idd	Østfold	32V PL 522 533	B	X			21	
10.	Nordre Boksjø	Idd	Østfold	32V PL 530 500	B	X			16	
11.	Dypvann	Flesberg	Buskerud	32V NM 180 355	B	X			122	
12.	A 93	Flå	»	32V NN 231 088	P		X		11	
13.	A 107	»	»	32V NN 225 068	P	X	X		7	
14.	A 104	»	»	32V NN 230 080	P		X		5	
15.	A 85	»	»	32V NN 214 085	P	X			13	
16.	A 70	»	»	32V NN 213 104	P	X			3	
17.	A 15	»	»	32V NN 280 059	P*	X			5	
18.	A 30 (Cabin pond)	»	»	32V NN 255 082	P		X		25	Sæther 1970, present study
19.	A 46	»	»	32V NN 284 057	P		X		20	
20.	Østre Kalvvann	Gjerstad	Aust-Agder	32V NL 085 264	P	X			9	
21.	Lundvann	»	»	32V ML 975 314	P	X			5	
22.	Evjevann	»	»	32V NL 008 324	P	X			3	
23.	Kleivvann	»	»	32V ML 942 278	P	X			4	
24.	Åsvann	Vegårshei	»	32V ML 932 080	P	X			16	
25.	Lundevann	Tvedestrand	»	32V ML 985 030	P	X			22	
26.	Sagtjenn	Risør	»	32V NL 135 166	P*		X		9	
27.	Fievann	»	»	32V NL 116 045	P	X			61	
28.	Åkvågvann	»	»	32V NL 108 042	P	X			21	
29.	Kvennevann	»	»	32V NL 101 037	P	X			16	

Explanations: P: plankton net. B: bottom grab. *: It is reasonable to assume that the plankton net touched the bottom. **: Source is Nilssen (1974) or the present study if nothing is indicated.

mined as the difference between the concentration of total strong acid anions and chloride. In some instances also, nitrate and nitrite were included. The chemical analyses were carried out according to Golterman (1970) or Bøyum (1971).

In the localities surveyed, *Chaoborus* spp. were sampled with a plankton net, a bottom grab, or both. Since *Chaoborus* species carry out considerable diurnal vertical migrations (Teraguchi & Northcote 1966, LaRow 1968, 1969, 1970, LaRow & Marzolf 1970) and bury themselves in the bottom mud during the day, plankton net samples from the limnetic zone during daytime are insufficient to be certain of the absence of *Chaoborus* in a locality. In some of the lakes which had an oxygen level in the hypolimnion exceeding 1–2 ml/l during the summer stagnation period, *Chaoborus* were sampled using a plankton net. It is probable that the author has overlooked *Chaoborus* populations in some of these lakes.

In lakes devoid of oxygen in the hypolimnion there is reason to believe that net sampling should ascertain the presence of *Chaoborus*, since the genus seems to avoid to a certain extent environments with prolonged low oxygen or H₂S accumulation. The author has observed (Nilssen unpubl.) that larvae were concentrated just above the anaerobic water masses during the day.

Consequently one must use both bottom samplers and plankton nets to investigate the presence of *Chaoborus* in a locality.

DISTRIBUTION

Subgenus *Schadanophasma* Dyar & Shannon *C. nyblæi* was reported from Dovre and northern Norway by Zetterstedt (1840, 1851), and is supposed to have a northern distribution in Europe (Hirvenoja 1961, Sæther 1972).

Important taxonomic characters in the larval stage are: the absence of a dorsal process, the form of the pre-labral appendages, and the number of rays in the anal fan.

Subgenus *Chaoborus* s. str.

C. flavicans is probably distributed throughout Norway. It is common in ponds and lakes

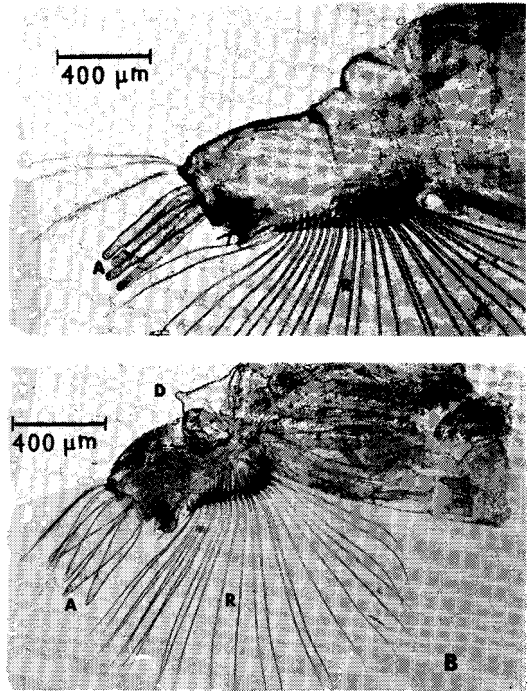


Fig. 1. Side view of abdomen of A) *C. obscuripes* and B) *C. crystallinus*. A: anal tubuli, D: dorsal process, R: rays in the anal fan.

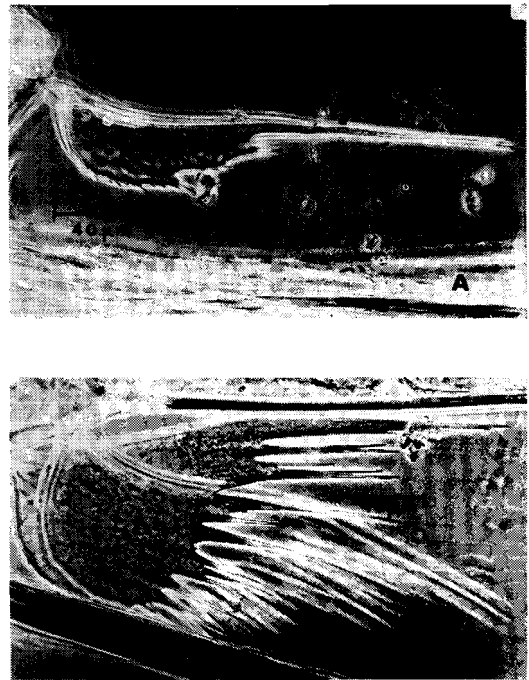


Fig. 2. Pre-labral appendage of A) *C. crystallinus* and B) *C. obscuripes*.

of different trophic levels and different humic content (Tables III, IV). It is the only species which the author has found in water bodies deeper than 4.0 m (Fig. 4). There is reason to believe that this species is the only species present in lakes deeper than 5 m in Norway which would agree with earlier suggestions (Stahl 1966b) based on larger areas.

Important taxonomic characters are the presence of a dorsal process, the form of the mandibles (Fig. 3B), and the structure of the pre-labral appendages.

C. obscuripes appears to be confined in Norway to more or less shallow humic localities (Fig. 4, Table IV).

Sæther (1972) considered this as a high mountain species. In the present study the species has been recorded from a shallow pond in southern Norway near the coast (Sagtjenn). Parma (1970) found this species in both eutrophic and oligotrophic waters, although it seemed to prefer the more dystrophic environments.

Taxonomic characters of importance are the absence of a dorsal process (Fig. 1A), the form of the pre-labral appendages (Fig. 2B), and the form on the anal-tubuli (Fig. 1A).

C. crystallinus is reported as a widespread species (Peus 1934), and seems to be resistant to saprobic conditions (Parma 1970). Sládeček (1972) mentions this species as having the largest saprobic index of the European species.

It has been found in Norway in two high-productive localities. The author has recorded it from a temporary pond where the environmental conditions are difficult. The records of Zetterstedt (1840, 1850) may be mis-identifications. He reported this species (*Co-rethra plumicornis* (Fabr.)) from all over Scandinavia. It was not until the key of Peus (1934), however, that identification of the larvae could be undertaken with certainty.

Characters of taxonomic importance are the presence of a dorsal process (Fig. 1B), and the form on the pre-labral appendages (Fig. 2A). Fig. 3A shows the form on the mandible of this species.

The Norwegian larvae are easily identified with the key of Sæther (1972).

In agreement with earlier authors (e.g. Sæther 1967, Parma 1970), the present study showed that the form on the pre-labral appendages and the anal tubuli varies consider-

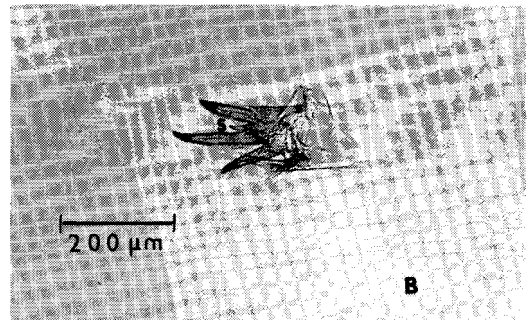
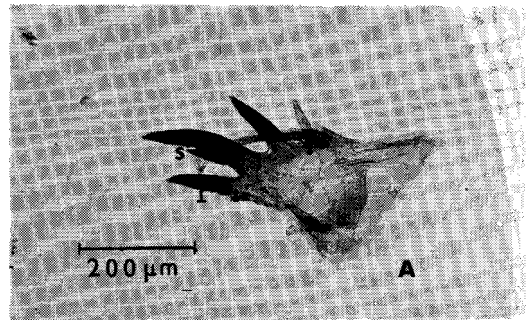


Fig. 3. Mandible of A) *C. crystallinus* and B) *C. flavicans*. Note the much heavier pigmentation on the mandible of *C. crystallinus*, and the position of the subordinate mandibular tooth (S) of *C. flavicans*.

ably. This seems to be the rule even in *C. obscuripes*. These characters may turn out to be of minor importance in Norway (Nilssen in prep.).

RESULTS

The genus *Chaoborus* is distributed throughout Norway. In most cases, however, identification of species was not carried out. Therefore Table I is not representative of the total distribution of *Chaoborus* in Norway. The new records (Table II) show the great ecological plasticity of the genus, as stressed earlier by Peus (1934), Stahl (1966b), and Sæther (1972). The present author found no single chemical parameter to have any pronounced effect on the occurrence of *Chaoborus*.

The classification of lakes as given by Hutchinson (1957, p. 439) seems to be useful when considering the ecology of *Chaoborus*. Class I lakes are stratified with a hypolimnion

Table II. Occurrence of *Chaoborus* spp. from 29 lakes and ponds in Norway in relation to selected physical and chemical parameters. In some cases the lower limit of a parameter is not available. This is indicated with?. The values for *C. crystallinus* must be somewhat arbitrary since the pond dries out.

Parameter	<i>C. flavicans</i> Range n ¹ = 22	<i>C. obscuripes</i> Range n ¹ = 6	<i>C. crystallinus</i> Range n ¹ = 1
Altitude m.a.s.l.	0.7-940	31-855	375
surface area, ha	0.1-58.5	0.1-0.5	0.6
maximum depth, m	2.5-60	1.3-4.0	0.6
Secchi depth, m	0.3-11	1.5-3.9	-
Ca++ mg/l	0.3-48	0.3-10.0	16.8-51
Mg++ mg/l	0.1-7.7	0.1-2.3	1.1-5.5
Na+ mg/l	1.7-21.6	?-10.2	0.6-0.7
K+ mg/l	0.4-1.7	?-0.8	7.1-7.5
κ ₁₈ μS/cm	9-550	9-175	85-246
pH	4.4-9.6	4.4-6.3	6.5-7.5
Cl ⁻ mg/l	2.8-25.1	?-15.9	3.7
SO ₄ ⁻ mg/l	?-18.2	?-12.7	-
alkalinity meq/l	0-2.6	-	0.4
KMNO ₄ consumption mg/l	9-45.1	?-45.8	-

¹ n = number of localities where the species has been found. Usually several measurements at various times of the year have been taken from each locality.

Table III. Number of lentic habitats in which *Chaoborus* spp. have been found in Norway. I-III, Hutchinson lake types; M, meromictic lakes, and P, ponds. See text for explanations.

	Lake types				
	I	II	III	M	P
<i>C. flavicans</i>	3	18	1	1	0
<i>C. obscuripes</i>	0	4	1	0	1
<i>C. crystallinus</i>	0	0	1	0	1

temperature not rising appreciably above 4°C during the summer. Class II lakes become stratified with a significant rise in temperature above 4°C in the hypolimnion. Class III lakes are not thermally stratified.

In addition to these classes, it is important to include M: the meromictic lake type, a lake with constantly stagnant deep water, and P: ponds. The difference between class III lakes and ponds is not always easily stated, but the extremes should offer no problems. Table III shows the lake categories in which *Chaoborus* have been found in Norway. Since the present findings differ to a certain degree from those of Stahl (1966b), the occurrence of *C. obscuripes* in lake type II needs further explanation. These lakes are situated in mountain areas (Fig. 4), and are stratified during the summer, in spite of their shallowness.

Fig. 4 demonstrates that only *C. flavicans* has been found in water bodies deeper than 5 m, which is in accordance with earlier suggestions (Stahl 1966b, Parma 1970). They consider *C. obscuripes* and *C. crystallinus* stenobatic species, which are unable to withstand a pressure of 0.5 atmosphere above normal, chiefly due to the morphology of their sacs (Stahl 1966b). Table IV gives the occurrence of *Chaoborus* spp. in relation to different humic contents and different trophic levels in the water bodies. The species seems

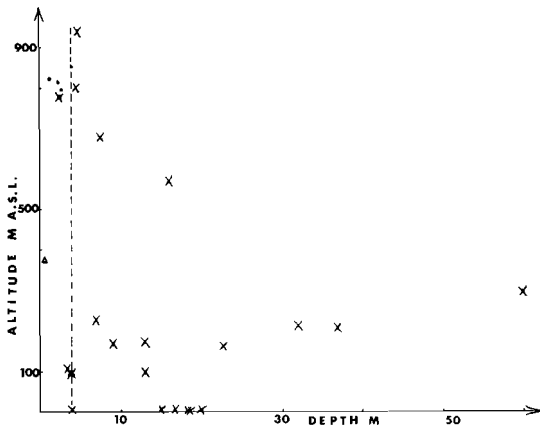


Fig. 4. The distribution of three *Chaoborus* species in Norway in relation to the depth of the water bodies and the height above sea level. A depth of 4 m is indicated. ×: *C. flavicans*. ●: *C. obscuripes*. Δ: *C. crystallinus*.

Table IV. Occurrence of *Chaoborus* spp. in relation to different humic contents and different trophic levels in the localities that have been surveyed.

Species	Trophic levels	Humic content		
		oligo-humic	meso-humic	poly-humic
<i>C. flavicans</i>	oligotrophic	0	10	1
	mesotrophic	1	0	3
	eutrophic	1	2	1
<i>C. obscuripes</i>	oligotrophic	0	1	4
	mesotrophic	0	1	0
	eutrophic	0	0	0
<i>C. crystallinus</i>	oligotrophic	0	0	0
	mesotrophic	0	0	0
	eutrophic	0	2	0

Table V. Fish species in Norway that are known to coexist with *Chaoborus* spp. (present study).

Fish species	<i>C. flavicans</i>	<i>C. obscuripes</i>	<i>C. crystallinus</i>
Trout, <i>Salmo trutta</i> L.	X	—	—
Eel, <i>Anguilla anguilla</i> (L.)	X	—	—
Perch, <i>Perca fluviatilis</i> L.	X	—	—
Whitefish, <i>Coregonus</i> sp.	X	—	—
Crucian carp, <i>Carassius carassius</i> (L.)	X	—	X
Roach, <i>Rutilus rutilus</i> (L.)	X	—	—
Pike, <i>Esox lucius</i> L.	X	—	—
Stickleback, <i>Gasterosteus aculeatus</i> (L.)	X	—	—

to prefer the more eutrophic and dystrophic localities.

Table V shows the fish species that were found in lakes and ponds where *Chaoborus* occur. It is reasonable to believe that most of these species prey upon *Chaoborus* populations, although only eel (*Anguilla anguilla* (L.)) (Berg 1937) and trout (*Salmo trutta* L.) (present study) are known as predators.

Only *C. flavicans* was found in localities with any considerable fish biomass. In most of the lakes surveyed, however, the fish biomass was very low.

DISCUSSION

Several parameters have been mentioned which may affect the distribution and abundance of *Chaoborus*: Secchi visibility (Brundin

1949), degree of dystrophy (Brundin 1949, Hofman 1971), degree of dystrophy and eutrophy (e.g. Kajak & Ranke-Rybicka 1970, Sæther 1972), degree of oxygen deficit in the hypolimnion (Stahl 1966b), zooplankton density (Parma 1970, Pope et al. 1973), and predation pressure (Parma 1970, Pope et al. 1973). These parameters are in most cases related and do not vary independently.

Considerable allochthonous production (dystrophy) and large amounts of autochthonous production (eutrophy) both give rise to reduced Secchi depth, considerable oxygen deficit in hypolimnion, large zooplankton biomass, and reduced numbers or total lack of fish. These statements are somewhat generalized, but they serve to show that earlier authors agreed in many respects about the occurrence of *Chaoborus* in the different water bodies.

In most of the studied localities where *Chaoborus* was found in larger numbers, the conditions seemed to be in accordance with the above statements.

Several authors have discussed in detail the ecology of sympatric populations of *Chaoborus* (e.g. Stahl 1966a, Roth 1968, Fedorenko & Swift 1972). In the present study only two localities were found with two co-existing species of the genus. There may be several reasons for this: 1. Most of the samples were taken in water bodies deeper than 5 m, thus excluding all species but *C. flavicans* (Stahl 1966b). 2. The number of specimens examined generally was too few to assure allopatric populations of *Chaoborus* (Table I). 3. Most of the samples, where one could expect sympatry, taken from localities having a depth less than 5 m, were situated in mountain areas (Fig. 4). Sæther (1972) mentions that *C. obscuripes* is probably the most common species from high mountains in the northern part of Fennoscandia. 4. Competitive exclusion exists between the species. The problem is not yet solved. Roth (1968) and Fedorenko & Swift (1972) favour the last explanation, but Stahl (1966a, 1966b) mentions that interspecific competition is insignificant as a factor controlling the distribution and abundance of *Chaoborus*.

The role of *Chaoborus* in lake metabolism is important, since they can consume very considerable quantities of zooplankton during

their night migrations as pointed out by Kajak & Ranke-Rybicka (1970). They showed that *Chaoborus* did not eat during the day, and suggested that low concentrations of zooplankton did not affect their food ration, but that growth was positively correlated with the production of zooplankton. Brundin (1949) found no obvious correlation between numbers of zooplankton and *Chaoborus*.

Fish may to a certain extent affect distribution and abundance of *Chaoborus* species by selective predation pressure, as mentioned by Parma (1970) and Pope et al. (1973). Pope et al. (1973) showed that the standing crop of *Chaoborus* was higher in lakes without fish than with fish, and that *C. flavicans* was the only species that was able to withstand a high predation pressure. In the present study only this species was found in lakes where fish biomass was high. Borgström (1972, and personal communication) found that in two lakes (Dypvann and Krokjtjenn) it appeared to be, in addition to *Bythotrephes longimanus* Leydig, the chief food for trout (*Salmo trutta* L.) during the summertime.

Our knowledge of *Chaoborus* species from Norway is scanty, and so further research is needed to establish their role and importance in lake metabolism.

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The author is indebted to the following persons: Mr. R. Borgström, Dr. J. Brittain, Mr. J. A. Eie, Mr. B. Faafeng, Mr. A. Hagen, Mr. G. Halvorsen, and Mr. A. Kloster for helping to supply unidentified material of *Chaoborus*; Mr. G. Bremmang for assisting with the chemical analyses; Mr. A. Bøyum, Dr. L. Sømme, and Mr. E. Østbye for useful discussions; Dr. J. Brittain and Mr. N. C. Stenseth for checking the English; and Mr. J. Basberg for help with the microphotographs.

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Quantitative studies of the invertebrate fauna in an alpine snow-bed community at Finse, south Norway

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The invertebrate fauna of an alpine snow-bed community was studied at Finse, south Norway, 1220 m a.s.l. Dominant plants are *Salix herbacea* and *Dicranum starkei*. The density of Collembola from soil samples taken at 0–6 cm varied between 6,210 and 28,500 per 0.5 m² in 1971 and between 6,810 and 14,010 in 1972. Corresponding values of Acarina were 59,970–88,620 in 1971 and 49,140–57,150 in 1972. Only a small percentage of the Collembola and Acarina occurred below 3 cm. Acarina showed a more constant density during the season and a smaller degree of aggregation than Collembola. Other groups bound to the vegetation and soil surface were collected with a suction sampler. Dominating groups were Araneida, Diptera, Hymenoptera, and Coleoptera. The density was only 4.5–6.8 animals per 0.5 m² in 1971, and 7.8–14.8 in 1972. Pitfall traps, however, gathered quite large samples of Opiliones, Araneida, and Coleoptera. This can be explained by active species invading from other habitats, and by a rich fauna, also containing active species, present under stones in the snow bed. Araneida occurred in much higher densities under, than between, stones.

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Quantitative studies on invertebrates from the vegetation and soil in alpine habitats in Norway have earlier been published from Stigstuv, Hardangervidda (Kauri, Moldung & Solhøy 1972). At Stigstuv, about 36 km SSE of Finse and at a similar altitude, the fauna of three different habitats were studied: dry meadow, wet meadow, and lichen heath. This paper deals with similar studies during 1971 and 1972 in a snow-bed community at Finse, Hardangervidda (60° 36'N – 7° 30' E), about 1220 m a.s.l., and is part of an analysis of a high mountain ecosystem.

S. Hågvar and E. Østbye shared the planning of the study and the sampling of the material. The material was treated by J. Melæen, who, together with S. Hågvar, performed the main task of writing.

THE HABITAT

The snow bed is a rather common type of habitat in the Finse area. It is characterized by large amounts of snow accumulating during winter, and by showing a distinct soli-

fluction during the melting period. The sampling site is situated in a north-facing slope, approximately 2.6 km north of the Hardangerjøkulen glacier. Fig. 1 gives a picture of the habitat (in the foreground). A closer view (Fig. 2) shows the dominant vascular plant, *Salix herbacea*. The actual habitat is representative of snow-bed communities in north-facing slopes in the Finse area. More rich snow beds can be found in south-facing slopes. *Salix herbacea* snow beds have a coverage of approximately 20% in north-facing and 25% in south-facing slopes in the Finse area (J. Schmidt and E. Østbye, in prep.).

Chemical soil analysis of the 0–2 cm layer and the 2–5 cm layer is given in Table I. The soil is weakly developed iron podsol on sandy moraine. The upper layer investigated is a humus horizon (raw humus, A₀) with a pH value of 4.2, the lower contains (A₂) and B, pH 4.3 (A. K. Veum, pers. comm.).

Botanically, the habitat can be described as a *Salix herbacea-Dicranum starkei* snow bed with a medium snow layer. Other species with a considerable cover are *Cetraria islandica*,



Fig. 1. The snow-bed community where the samples were taken (in the foreground). Photo: Hans-Jørgen Skar.



Fig. 2. A close view of the habitat, showing the dominant vascular plant, *Salix herbacea*. Photo: Hans-Jørgen Skar.

Cladonia ecmocyna, *C. mitis*, and *Stereocaulon paschale*. The vascular plants show a total cover of 25% and the cryptogams 95% (K. A. Lye, pers. comm.).

METEOROLOGICAL OBSERVATIONS

Mean temperatures measured 2 m above the soil surface and 2 cm below, together with precipitation data during the two field seasons, are given in Fig. 3. Precipitation was measured at Finse, about 0.8 km apart. The temperatures were measured in an oligotrophic dry heath community approximately 100 m apart (A. Skartveit, unpubl. data).

The temperature in the surface layer of the

Table I. Chemical soil data from the 0–2 cm layer and 2–5 cm layer. Total N and organic matter is given in per cent of dry earth.

Depth	P-Al	K-Al	Mg-Al	Ca-Al	Total N (%)	Organic matter (%)
0–2 cm	4.8	78	19	29	0.81	38.5
2–5 cm	1.5	8.5	2.2	4.0	0.17	8.5

snow bed may reach quite high values. On sunny days values up to 41°C have been recorded, using a shaded thermocouple.

METHODS

The vegetation layer was only a few mm thick, mostly 2–4 mm. Invertebrates from vegetation and litter were collected by a suction pump, each sample covering 0.5 m². In 1971 a 'quick-trap' pump (Kauri et al. 1969), and in 1972 a UNIVAC portable suction sampler were used. The removed mixture of animals and vegetation was immediately placed in modified Tullgren funnels for extraction of the animals. However, as the distribution of mosses and litter was rather unhomogenous within each sample area, it was impossible to take representative soil samples from the same plots. Therefore

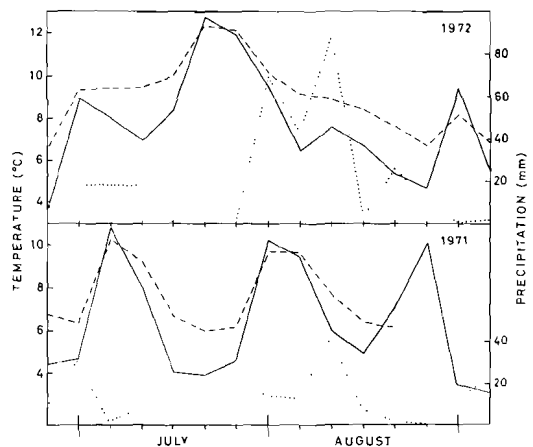


Fig. 3. Some climatic data from 1971 and 1972 (see text). Solid line: Air temperature 2 m above the ground. Stippled line: Earth temperature at –2 cm. Dotted line: Precipitation. The temperature values are given as pentad means, precipitation as pentad sums.

Table II. Number of Collembola and Acarina from the soil samples taken at 0-3 cm and 3-6 cm during 1971 and 1972. n = number of samples at each depth. Sample size = 16.6 cm². $N/0.5$ m² (0-6 cm) is estimated from \bar{x} .

	5 July 1971 $n = 12$				2 Aug. 1971 $n = 12$				15 Aug. 1971 $n = 12$				5 Sept. 1971 $n = 12$			
	\bar{X}	SD	Min.	Max.	\bar{X}	SD	Min.	Max.	\bar{X}	SD	Min.	Max.	\bar{X}	SD	Min.	Max.
Collembola																
0-3 cm	93.7	40.8	22	173	20.3	47.3	0	169	72.2	66.9	9	187	85.8	98.0	2	256
3-6 cm	1.3	1.5	0	5	0.4	0.7	0	2	5.5	8.4	0	31	1.5	2.3	0	8
0-6 cm	95.0	40.9	24	174	20.7	47.2	0	169	78.2	66.0	14	188	87.3	98.2	3	257
$N/0.5$ m ²	28,500				6,210				23,460				26,190			
Acarina																
0-3 cm	195.8	60.8	118	292	222.9	51.4	132	296	199.3	69.7	113	312	290.6	162.4	62	571
3-6 cm	4.1	7.1	0	26	3.3	1.4	2	5	7.2	3.4	2	14	4.8	1.6	2	7
0-6 cm	199.9	63.6	122	294	226.2	51.5	135	300	206.5	71.1	121	321	295.4	162.2	64	576
$N/0.5$ m ²	59,970				67,860				61,950				88,620			
	3 July 1972 $n = 14$				2 Aug. 1972 $n = 14$				3 Sept. 1972 $n = 12$							
	\bar{X}	SD	Min.	Max.	\bar{X}	SD	Min.	Max.	\bar{X}	SD	Min.	Max.				
Collembola																
0-3 cm		21.7	13.7	2	48	36.3	24.9	4	97	40.4	31.2	14	130			
3-6 cm		1.0	1.7	0	5	1.8	2.4	0	8	6.3	10.1	0	32			
0-6 cm		22.7	14.2	2	49	38.1	25.3	4	97	46.7	39.4	14	162			
$N/0.5$ m ²		6,810				11,430				14,010						
Acarina																
0-3 cm		162.5	71.5	65	314	163.9	62.1	24	258	184.9	97.1	37	398			
3-6 cm		1.3	1.2	0	4	2.1	2.1	0	6	5.6	4.4	0	13			
0-6 cm		163.8	71.2	67	314	166.0	62.2	25	259	190.5	96.4	37	399			
$N/0.5$ m ²		49,140				49,800				57,150						

a number of soil samples were taken at random points outside the suction trap plots. Thus the soil samples gave the density of Collembola and Acarina both from the soil, litter, and vegetation. Collembola and Acarina were not counted in the suction trap samples. The total invertebrate fauna in the habitat is calculated by adding the soil sample data to the suction trap data. Information about groups other than Collembola and Acarina from the soil samples is, however, lacking in this study. In the suction trap samples, Tardigrada, Enchytraeidae, and Lumbricidae were not counted.

Soil samples were taken with a split core tool with internal PVC rings, each 3 cm high and covering 16.6 cm². Two rings were filled with soil, so that the vegetation layer was included in the upper 3 cm. The soil depth in these samples is therefore only 26-28 mm. The samples were extracted immediately in a high gradient apparatus modified from Macfadyen (1961, 1962).

RESULTS

Collembola and Acarina

Table II shows the density of Collembola and Acarina at different times from July to September 1971 and 1972.

For both Collembola and Acarina, the deepest soil samples contained only a few per cent of the total fauna recorded. Except for Collembola in September 1972, when 13.5% of the total number of animals was found in the deepest soil sample, this layer of the earth never contained more than 7% of Collembola or Acarina. Often this percentage was lower than 2%.

The density of Collembola per 0.5 m² in 1971 varied between about 23,000 and 28,000 individuals, except 2 August when the density was only 6,200 per 0.5 m². The next year the density varied between 7,000 and 14,000 per 0.5 m², increasing from July to September.

Collembola always occurred in clearly lower densities than Acarina. In the series

Table III. Number of invertebrates (except Collembola, Acarina, Tardigrada, Enchytraeidae and Lumbricidae) from the suction trap samples. n = number of samples. Max. = maximum number in any sample. K = number of samples in which the group was represented. l = larvae, p = pupae. Nem. = Nematocera. Tip. = Tipulidae. Sample size = 0.5 m².

	5 & 9 July 1971 n = 12			13 & 16 Aug. 1971 n = 12			3 & 11 July 1972 n = 12			2 & 12 Aug. 1972 n = 12			3 Sept. 1972 n = 6		
	\bar{x}	SD	Max. K	\bar{x}	SD	Max. K	\bar{x}	SD	Max. K	\bar{x}	SD	Max. K	\bar{x}	SD	Max. K
Araneida	1.83	1.90	7 10	2.25	2.26	7 8	0.25	0.45	1 3	0.42	0.90	3 3	0.17	0.39	1 2
Opiliones							0.17	0.39	1 2				0.17	0.58	2 1
Psocoptera										0.08	0.29	1 1			
Coleoptera															
Carabidae							0.08	0.29	1 1						
Carabidae, l.				0.08	0.29	1 1	0.33	0.89	3 2	0.50	0.67	2 5	0.08	0.29	1 1
Staphylinidae	0.08	0.29	1 1	0.58	0.79	2 5				0.42	1.16	4 2			
Byrrhidae	0.08	0.29	1 1	0.08	0.29	1 1	0.17	0.39	1 2	0.08	0.29	1 1	0.17	0.39	1 2
Byrrhidae, l.							0.17	0.58	2 1				0.08	0.29	1 1
Chrysomelidae							0.08	0.29	1 1						
Curculionidae	0.08	0.29	1 1	0.08	0.29	1 1	0.17	0.39	1 2	0.17	0.39	1 2	0.08	0.29	1 1
Curculionidae, l.	0.08	0.29	1 1	0.25	0.45	1 3	0.08	0.29	1 1	0.17	0.39	1 2			
Coleoptera, l.				0.17	0.58	2 1	0.17	0.39	1 2				0.17	0.39	1 2
Lepidoptera, l.	0.08	0.29	1 1	0.25	0.62	2 2				0.58	0.24	4 3	0.17	0.58	2 1
Diptera															
Nematocera	1.08	1.73	6 6	1.17	1.27	4 8	2.75	2.67	8 10	2.92	2.02	7 11	0.33	0.65	2 3
Nem.-Tip., p.				0.08	0.29	1 1	0.58	1.00	3 4	0.67	0.98	3 5	0.17	0.39	1 2
Nem.-Tip., l.	0.17	0.58	2 1	0.08	0.29	1 1	5.67	6.41	24 11	2.92	6.30	22 6	3.17	7.28	18 2
Tipulidae, p.							0.08	0.29	1 1						
Tipulidae, l.	0.75	1.86	6 2	0.75	0.97	3 6	2.92	4.32	15 8	0.50	1.00	3 3	1.83	2.85	6 2
Brachycera, l.	0.08	0.29	1 1	0.08	0.29	1 1	0.58	1.00	2 5	0.42	0.67	2 4			
Cyclorrhapha							0.17	0.39	1 2						
Cyclorrhapha, l.							0.33	0.49	1 4	1.17	1.80	5 5	0.08	0.29	1 1
Hymenoptera															
Apocrita				0.33	0.65	2 4				0.25	0.45	1 3	0.75	1.06	3 5
Symphyta, l.				0.50	1.00	3 3				1.17	1.40	4 7	0.33	0.65	2 3
Insecta indet., l.										0.08	0.29	1 1			
Total number per 0.5 m ²		4.5			6.8			14.8			12.6			7.8	

taken in 1971, the densities of Collembola corresponded to from 9.2–47.5% of the Acarina densities. In 1972, the percentage varied between 13.9 and 24.6.

The density of Acarina per 0.5 m² was very stable from July to the middle of August in 1971 (60–68,000) and was somewhat higher in September. In 1972, the density was almost stable from July to September, varying between 49,000 and 57,000 per 0.5 m².

As both Collembola and Acarina are only very sparsely represented in the 3–6 cm layer, the differences between the two groups are not obvious here. In 1971, the mean density of Collembola in this layer was 2.2 and of Acarina 4.8 per sample. In 1972, when the mean total density of Collembola during the season represented only about 20% of the

mean density of Acarina, the mean density of both groups in the deepest layer was 3.0 per sample.

Except for Collembola at the beginning of August, the densities of both groups were lower in 1972 than in 1971 throughout the season. The density of Collembola and Acarina together was always lowest in the 1972 samples.

Apart from the drop in density of Collembola in early August 1971, the general trend for both groups is a rather stable density throughout the season or a slight increase.

Other groups

The occurrence of other groups bound to the soil surface, litter, and vegetation is illus-

trated by the suction trap samples in Table III. Except for September 1972, when only 6 samples were taken, each series consists of 12 samples, 6 being taken at one date and the other 6 a few days later.

Most of the material is made up by Araneida, Diptera, Hymenoptera, and Coleoptera. The total density is low throughout the season each year. No groups occurred in all 12 or 6 samples in a given series.

Diptera, including larvae, is the dominant group both years, and Dipterous larvae represent the major part of the fauna (July and September 1972).

Coleoptera is represented by six families. Byrrhidae and Curculionidae were found in all five series. Staphylinidae occurred in highest densities.

Including larvae, the density does not exceed 15 animals per 0.5 m² in any of the years. Different larvae represented a great part of the material in 1971 and dominated in 1972.

As it was impossible to avoid including some of the upper soil layer in the suction trap samples, some of the larvae, especially among Diptera, may come from this soil layer. If Diptera is excluded from the material, the density is quite similar during the two years. For July the densities become 2.4 (1971) and 1.7 (1972), for August 4.6 (1971) and 4.2 (1972), and for September 2.2 (1972).

DISCUSSION

Collembola and Acarina

The total densities of Collembola found in the snow bed roughly fall within the range measured in the wet meadow and the lichen heath at Stigstuv during 1969, including the fauna in the vegetation layer (Solhøy 1972). According to him, the maximum density in the dry meadow exceeded 60,000 per 0.5 m².

The density of Acarina in the snow bed was remarkably constant during each year, and altogether the densities varied between 49,000 and 89,000 per 0.5 m². These values are higher than the total found in the wet meadow (about 6,000–28,000) and in the lichen heath (about 17,000–27,000) (Solhøy 1972). The densities in the dry meadow varied between 17,000 and 80,000 per 0.5 m², thus overlapping with the data from the snow bed.

In the dry meadow and wet meadow the first sample in July showed rather low densities of both Collembola and Acarina. A corresponding effect was not observed in the snow bed, although the first sample each year was taken soon after snow melting.

As a whole, the soil fauna of the snow bed habitat may be characterized as rich, if we compare the densities with the data from the other alpine habitats studied at Stigstuv.

In most of the samples taken at Stigstuv, only a few per cent of the Collembola and Acarina were found in the vegetation layer. As the vegetation layer in the snow bed is even more weakly developed than in the Stigstuv habitats, a low percentage must also be expected for the snow bed. It is, however, a remarkable feature of both the dry and wet meadows that in the beginning of July, when the density of Collembola and Acarina is low, about one fourth of the Acarina and the major part of the Collembola are found in the vegetation layer.

According to Wallwork (1970), the density of Collembola in most habitats is between 5,000 and 50,000 per m². Most of the snow bed data lie within these limits. Wallwork also stresses that in most soils, Acarina occur in higher densities than Collembola. This is the case in all the samples from the snow bed, the Acarina/Collembola ratio ranging from 2.1 to 10.9 in 1971 and from 4.1 to 7.2 in 1972.

The dominance of Acarina was not so pronounced in the habitats at Stigstuv (Solhøy 1972). In several cases, the density of Collembola exceeded or was similar to the density of Acarina in the dry and wet meadow. In the lichen heath, Acarina dominate. Here only two samples had been taken, in August and September. Also at Stigstuv, only a smaller part of the fauna was found in the 3–6 cm layer. This trend was most pronounced in the dry and wet meadow. In the snow bed, the proportion of the Collembola and Acarina living deeper than 6 cm can probably be disregarded in population studies.

It is difficult to relate the changes in population size to climatic conditions. The total density of Collembola and Acarina together is quite stable throughout both years. The drop in the density of Collembola between the beginning of July and the beginning of August in 1971, however, occurs in a rather

cold, rainy period (Fig. 3). The low temperature reflected both from the atmospheric data and from the -2 cm layer throughout several weeks may have led to a decrease in the density. Correspondingly, the density of Collembola increased about four times during the next two weeks, which were warm and rainy. It is improbable that soil moisture was a limiting factor from the beginning of July to mid-August.

Solhøy (1972) found that during a warm period in July/August, the density of Collembola increased markedly in the wet meadow. The soil moisture was favourable (about 80 %) all the time.

It is a common feature from both Finse and Stigstuv that the density of Acarina is more stable than that of Collembola. Acarina seems to be less influenced by changes of temperature and soil moisture than Collembola.

Acarina and Collembola in the snow bed show a rather strong aggregation, as demonstrated by the SD values and the minimum and maximum values in Table II. (The calculation of SD values is somewhat doubtful as the distribution of data does not clearly follow the normal distribution curve.) Collembola show a greater degree of aggregation than Acarina. This was also the case for the three habitats at Stigstuv.

Other groups

Other groups collected from the vegetation layer are only sparsely represented. The mean density per m² was 11 in 1971 and 23 in 1972. Corresponding mean densities from Stigstuv, excluding Collembola, Acarina, Tardigrada, Enchytraeidae, and Lumbricidae, are: Lichen heath 180, wet meadow 190, and dry meadow 980. This difference is mainly caused by the absence of Hemiptera and Thysanoptera in the snow bed; these groups especially occur in high numbers in the dry meadow. If these groups are disregarded, the mean densities in the three habitats at Stigstuv become about 100–120 per m².

In extensive material from pitfall traps in the snow-bed habitat collected from 1969–71 (4–7 series every year, each series consisting of 15 traps standing for 14 days), Thysanoptera were totally absent. Hemiptera occurred only in very low numbers in some of the series.

The four groups predominating in the snow bed – Araneida, Coleoptera, Diptera, and Hymenoptera – are also among the dominant insect groups in the dry and wet meadows at Stigstuv when the other common groups mentioned are excluded. The data from the lichen heath are too sparse to allow a comparison.

The absence of Hymenoptera in July of both years corresponds to the pitfall data; in which this group is only sparsely represented in July and occurs mainly in August and September. Nematocera occur mainly in July and August pitfall-samples. The same trend may be traced from the suction trap material in 1972, if the mean density, maximum number per sample, and number of samples containing Nematocera are taken into consideration.

The total densities measured were higher in 1972 than in 1971. This difference may be caused by temperature, the summer of 1972 being warmer (Fig. 3).

A study of the invertebrate fauna under stones (the hypolithion) has been published earlier from the same site (Hågvar & Østbye 1972). Collembola, Acarina, Tardigrada, Enchytraeidae, and Lumbricidae were not collected. Stones cover 15–20 % of the habitat (Fig. 1), and most of them can be turned by hand. This investigation, performed in August and September 1969, and in August 1970, showed a density of invertebrates under stones, per m² habitat, ranging from 2.7 to 4.0. The mean density of larger invertebrates in the vegetation between the stones was about 9 per m² habitat in 1971 and about 19 per m² habitat in 1972, when we have corrected the values in Table III for the stone cover percentage. This shows that the fauna under stones may make up a considerable proportion of the total density and biomass per m² habitat.

If we look at the densities under stones, *per m² of stones overturned*, these values (27–41) are higher than the densities found *per m² between stones* (9–14 in 1971 and 15–30 in 1972).

The fauna under stones has a different composition from that between stones, *Araneida* always predominating markedly under stones. Looking at this group separately, we find that the density per m² of stones overturned ranges from 22–41, exceeding most

of the total densities of larger invertebrates measured per m² between stones. Per m² habitat, the number of Araneida under stones was found to be 2.4–3.5. Between stones the number of Araneida per m² of habitat (corrected for the stone coverage) ranged from 3.0 to 3.7 in 1971 and from 0.28 to 0.69 in 1972. Thus the major part of the Araneida may be found under stones, within a given square metre.

As the suction trap samples are all rather small, we will not try to relate them to the weather conditions during sampling. Coleoptera, Opiliones, and Araneida were collected in considerable numbers in the pitfall traps every year. Staphylinidae dominate among the Coleoptera families in the pitfall samples. Carabidae are also well represented. All these groups contain very active species, often resting under stones when not moving on the soil surface. This explains the low density in the suction trap samples and the rather high densities found under stones and in pitfall traps.

As many species between these active groups have been found in several other types of habitats, a part of the pitfall material probably also consists of animals migrating from other habitats in the neighbourhood.

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Lepidoptera new to Norway

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The authors report seven species of Lepidoptera new to Norway: *Eugraphe sigma* (D. & S.), *Xestia collina* (Bsd.), *Mythimna traminesa* (Tr.), (Noctuidae), *Sterrha humiliata* (Hufn.), *Acasis appensata* (Ev.) and *Ennomos quercinaria* (Hufn.), (Geometridae). New localities for *Sterrha muricata* (Hufn.) are given. Food plants and distributions are mentioned.

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During the years 1968 to 1971 we were able to add three species of Noctuidae and five species of Geometridae to the Norwegian fauna. All certainly belong to the indigenous fauna, as they have either been found in suitable biotopes on more than one occasion, or are not known to be vagrants or notorious migrants. Some of the species are the result of our own collecting in the counties of Vestfold and Hordaland. The remainder are the result of A. Fjeldså's determination of Lepidoptera collected by Arne Fjellberg, Gunnar Langhelle, and Asbjørn Mørch in the counties of Vestfold, Buskerud and Vest-Agder.

The collecting method for each species is given below. The light-traps used are either Jalas-traps (Jalas 1960), or our own modified Robinson type, all fitted with ordinary mercury-vapour bulbs. With some exceptions the material is deposited in the various collectors' collections. The abbreviations used for the collectors are: Trond Andersen = (ANT), Arild Fjeldså = (FJS), Arne Fjellberg = (FBG) and Asbjørn Mørch = (MØR).

EUGRAPHE SIGMA (Denis and Schiffermüller 1755)

Localities: VE: Mostrand, Tjøme (UTM:

32VNL801497) 14 June 1968 1♀ (ANT); 15 June 1968 2♂♂ (ANT); 4 Aug. 1968 1♂ (ANT); 10 Aug. 1968 1♀ (ANT); 20 July 1969 3♂♂ (ANT); August 1969 1♂ (ANT); 2 July 1970 19 specimens (MØR); VE: Kjære, Tjøme (UTM: 32VNL805529) 9 July 1969 1♂ (FBG); VE: Sandøysund, Tjøme (UTM: 32VNL830497) 27 July 1971 1♂ (ANT).

A. Mørch caught his specimens on sugar on a rainy night; all the other specimens have been collected in light-traps. The species have only been found once at Kjære, and never further north than at Herstad, Nøtterøy. Both localities have been fairly well studied compared to Mostrand. Abroad, *E. sigma* occurs chiefly on limestone or other calciferous ground. The solid rock at Mostrand consists of granites, but marine sediments and moraines give rise to meadows with a rich variety of different herbaceous plants. Sheltered places are covered with low and dense shrubs, mainly oak. All localities lie within a distance of 300 m from the sea.

There are practically no individual variations within our material. Specimens with brownish (f. *nubila* Esper) or flesh coloured (f. *terminalis* Strand) costa, reniform and

orbicular, have not been met with. The larva is reported to feed polyphagously on various shrubs and low plants, i.e. *Salix*, *Alnus*, *Atriplex*, *Clematis*, *Prunus*, *Rubus*, *Vaccinium* and *Lamium* (Beck 1960).

E. sigma is distributed throughout the Palaearctic region – from Amur (Warren 1909), Korea (Bryk 1948), and China (Boursin 1954) through Siberia to Armenia, the Balkans, North and Central Europe (Warren 1909). In Finland it has been reported from the south-east and extreme south-west parts, in Sweden along the south-east and south-west coasts north up to Öland and Bohuslän, respectively (Nordström et al. 1969). It has been encountered once in Denmark (Ivø, North Jutland, possibly having migrated from Sweden) (Johannesen 1954).

XESTIA COLLINA (Boisduval 1840)

(Syn.: *Agrotis peterseni* Krulikovsky 1908)

Locality: Bv: Hollerud, Sigdal (UTM: 32VNM187797) 7–11 July 1969 2 ♂♂ (MØR).

Both specimens were captured in a light-trap. Hollerud is situated about 560 m a.s.l., some 280 m above the bottom of the valley in a hilly landscape with many steep elevations. The area is covered with coniferous woods, mainly spruce, but they are mixed with hardwoods.

Fennoscandian and Baltic populations are drawn to subsp. *kenteana* (Staudinger 1892), but the subspecific rank of different populations of *X. collina* is subject to various opinions. Early reports of the species in Sweden are obviously erroneous, as it may be confused with some form of *Diarsia mendica* (Fabricius). The larva is polyphag. Recorded food plants are *Sorbus* and *Plantago* (Warren 1909, Zolotareno 1970).

X. collina is distributed in a considerable part of the Palaearctic region, from Kamchatka (Corti 1929) to Alsace and SE France (Kozhantshikov 1937), but mainly confined to mountainous areas. In Finland it is distributed north up to Koh: Munjärvi and westwards to Ka: Jääski (at present a part of USSR) (Nordström et al. 1969) in direct connection with localities in Russia and Estland. The Swedish localities (all since 1967) are Vrml: Ränneberget and Gättjärnklätten, Östmark (I. Svenson in litt.) and Dlr: Rättvik (Landin 1972).

MYTHIMNA STRAMINEA (Treitschke 1825)

Localities: VE: Mostrand, Tjøme (UTM: 32VNL801497) 3 July 1969 1 ♂ (FBG); 2 July 1970 1 ♂ (MØR); VE: Eidene, Tjøme (UTM: 32VNL807522) 11 Aug. 1972 1 ♂ (FJS & FBG); VAY: Lista, Farsund (UTM: 32VLK-5942) 5 Aug. 1969 1 ♂ (G. Langhelle leg., coll. Zool. Mus., Bergen).

While searching a reed locality at night by means of flash-light A. Fjellberg was able to collect the first Norwegian specimen. The other three specimens were captured on sugar, in a light-trap, and when sitting under a light column, respectively.

The habitats are restricted to fens and marshy places near the sea. Judging from our own experience the moth rarely leaves its biotope as a light-trap run by T. Andersen for long periods in 1968 and 1969 at Mostrand was unable to attract even a single specimen. The light-trap was situated at a distance of only 50 m from the fen where *M. straminea* occurred. At Kjære, since 1969, A. Fjellberg has run a light-trap about 300 m from the reeds at Eidene for long periods, but the species was not captured there until the trap was placed among the reeds for only one night in 1972.

The larva is reported to feed on *Phragmites communis* Trin., *Phalaris arundinacea* L. and other coarse grasses (Nordström 1938). The area of distribution includes parts of East, North, Central and West Europe (Warren 1910). In Denmark it is locally common, mainly along the shores; in Finland (since 1922) it is known on the Åland islands, the extreme south-east coast north to 61°N, and Tammerfors. It is found along the southern and eastern shores of Sweden north up to Västergötland, Östergötland, and Uppland (Nordström et al. 1969).

STERRHA MURICATA (Hufnagel 1767)

Localities: VE: Herstad, Nøtterøy (UTM: 32VNL803681) 5 July 1970 1 ♂ (ANT); VE: Akersmyra, Sem (UTM: 32VNL757713) 13 July 1970 1 ♂ (ANT).

The first specimen was caught in a light-trap in an urbanized area. A polluted rivulet runs through a small, wet meadow situated

some 200 m from the built-up area. The second specimen was netted when flying in a peatbog in the early afternoon. The species is known to be on the wing during the night as well as in the daytime, even in bright sunlight on a variety of wet biotopes. The larva probably feeds on dead or withering plants.

The range of distribution covers Eastern Siberia, Korea, China, Japan, Armenia, and Europe except the most northern and southern parts (Prout 1913). It is restricted to certain areas of the British Isles, but is widely distributed in Denmark, except Bornholm (Hoffmeyer 1966). In Sweden it has been reported north up to Värmland, Västmanland, and Gästrikland (Nordström 1943, 1953), in Finland sparsely as far north as Österbotten (Hoffmeyer 1966). In Norway the species was newly reported at Ak: Dyster, Ås 8 July 1973 (Opheim 1973).

STERRHA HUMILIATA (Hufnagel 1767)

Localities: VE: Fyn, Tjømme (UTM: 32VNL-834495) 1 July 1969 2 ♂♂ (FJS); VE: Bastøy, Borre (UTM: 32VNL867843) 2 July 1969 2 ♂♂ (FJS).

The species was observed in great numbers in both localities, from the waterline to a distance of approx. 50 m from the shore, flying in early dusk near the ground over vegetation of *Atriplex*, *Pulsatilla*, *Honckenya*, *Galium* etc. The species is readily recognized by its reddish costa. The larva feeds polyphagously on dry herbs.

Abroad it occurs in Transcaucasus, Anatolia, the Near Orient, NW Africa, SE, South, Central and North Europe, including the Baltic and the extreme south of England (Prout 1913). In adjacent areas it occurs locally along the shores of Denmark (Hoffmeyer 1966); along the southern and eastern shores of Sweden from Blekinge to Hälsingland (Nordström 1943) and along the south coast of Finland (Kaisila 1962).

ACASIS APPENSATA (Eversmann 1842)

Localities: HOi: Steinstø, Kvam (UTM: 32VLM510986) 24 May 1971 1 ♂ (FJS & MØR); HOy: Kleppe, Osterøy (UTM: 32VNL110150) 21 May 1972 1 ♂ (ANT & FJS); 3-7 June 1972 1 ♂ (Ant & FJS).

All specimens have been captured in light-traps. At Kleppe *A. appensata* and *A. viretata* (Hübner) fly together, but both seem to be rare. The locality is a steep south-west bent slope rising from approx. 50 to 230 m a.s.l. with dense growths of *Corylus*, *Betula*, *Fraxinus*, some *Prunus padens* L., and *Sorbus aucuparia* L.

Lonicera periclymenum L. and *Uiburnum opulus* L. grow more sparsely. The collecting site is at the top of the slope where meadows, ling heaths, and other unfavourable biotopes for *Acasis* spp. extend. This might explain the meagre result in spite of considerable collecting at the locality. The locality at Steinstø is also a south-exposed, steep hill-side, approx. 130 m a.s.l. close to the fjord. Thickets of nemoral trees, mainly *Corylus*, *Ulmus*, *Tilia* and *Fraxinus* cover the slope. The larva of *A. appensata* is reported to feed monophagously on *Actaea* (Prout 1914). Occurrence of *Actaea spicata* L. at Kleppe has not yet been ascertained, although it grows sparsely in contiguous areas. At Steinstø, *Actaea spicata* was not observed, but its existence seems probable. A number of food plants have been recorded for *A. viretata*, like *Spirea ulmifolia* L., *Acer pseudoplatanus* L., *Rhamnus catharticus* L. and *frangula* L., *Hedera helix* L., *Fraxinus excelsior* L., *Ligustrum vulgare* L., *Lonicera* spp., *Symphoricarpos rivularis* Suksd. and *Uiburnum opulus* L. (Bleszyński 1965, Nordström 1940, Prout 1914). *A. appensata* will possibly also prove not to be strictly monophagous. A vain search for the larva at HOy: Myravann, Fana strengthens this assumption. Not a single fruit of *A. spicata* with any sign of gnawing could be detected in spite of a thorough search on a number of plants. In Finland (Om: Jacobstad-district), *A. appensata* has also been recorded in regions where *Actaea* does not grow (Sjöholm 1949).

A. appensata is an eastern and continental species, distributed from Eastern Siberia (Ussuri) to Switzerland and Germany (Silesia and South Bavaria) (Prout 1914). In Finland it has been recorded north up to Petsamo at 69°20' N and westwards to the Åland islands (Kaisila 1947). It was recorded in Sweden (Upl: Älvkarleby) in 1938 (Nordström 1943), but it has not been met with in the last two decades (I. Svensson pers. comm.). It also seems to have disappeared from a number of

localities in Finland, for the present being restricted to a remote northern locality (Kuusamo-district). (A. Karvonen and K. Mikkola, pers. comm.).

PERIZOMA BIFACIATA (Haworth 1809)
(= *bifasciata* n. emend.)

Locality: VE: Mostrand, Tjøme (UTM: 32VNL801497) 27 July 1969 1 ♀ (ANT).

The specimen was caught in a light-trap. It belongs to f. *bifasciata* Hw. with light lines on both sides of the median fascia. It can be mistaken for a small second-brood *Xanthorhoe ferrugata* (Clerck) or some aberrative *Perizoma taeniata* (Stephens), but lacks the dentate antenna and twin spot on the wave-line of the former. A single dark spot is situated further up the boarder nearer the apex.

The larva feeds on seed-capsules of *Euphrasia*, *Odontites* and *Bartsia* (Nordström 1941). *Euphrasia* spp. are plentiful at Mostrand, and *Odontites littoralis* Fr. most likely occurs.

P. bifasciata is distributed in SE, Southern, Central and Northern Europe (Prout 1914, 1938). In Fennoscandia it has been reported north up to Blekinge, Uppland (Nordström 1943) and Southern Finland (Hoffmeyer 1966), but nowhere frequently.

ENNOMOS QUERCINARIA (Hufnagel 1767)

Localities: VE: Kjære, Tjøme (UTM: 32VNL-805529) 10 Aug. 1969 1 ♂ (FBG); 14 Aug. 1969 1 ♂ (FBG & MØR); VE: Herstad, Nøtterøy (UTM: 32VNL803681) 12 Aug. 1970 1 ♂ (ANT).

All specimens were caught in light-traps. The variation within our specimens is very slight, coming in between the nominate form and f. *equestraria* Fabricius, although nearer to the former.

The larva feeds preferably on *Fagus*, but is reported to thrive on a number of other deciduous trees, such as *Salix*, *Betula*, *Quercus*, *Tilia* etc. (Nordström 1941). *E. quercinaria* is by far the most common Central European *Ennomos* sp. Severe damage to beech woods has been reported in Germany.

The range of distribution includes Transcaucasus, Anatolia and most parts of Europe (Prout 1915), but not Finland and North European USSR (Ingermannland and further east). It occurs commonly in Denmark (Hoffmeyer 1966) and Skåne in Sweden, but is reported even as far north as Östergötland and Vestergötland (Nordström 1943).

DISCUSSION

The occurrence in Norway of the majority of these species could either be predicted from the present distribution in Northern and Central Europe, or from known demands for biotopes and food plants in adjacent areas. When *X. collina* was reported in Sweden close to the Norwegian border, its presence in eastern parts of Central Norway seemed rather natural, but we had not expected to find it in western parts of Central Norway, i.e. Buskerud (Bv). Further finds north and east of Oslo are to be expected. The two localities for *E. quercinaria* in the county of Vestfold probably constitute a new northern limit for the species. On the other hand, we consider the presence of *A. appensata* in Western Norway as most remarkable – the nearest locality is situated 630 km to the east in an entirely different climatic region.

There are no reasons to believe that any of the species are really new or recent additions to the Norwegian fauna as a result of a general expansion to the north and west, or discontinued establishment in new areas. Some of the species have increased their frequency in other parts of Fennoscandia, but they have not been proved to be true expanding species. On the contrary, the climatic situation in recent times must be expected to be unfavourable to *X. collina* and *A. appensata* which, although species of considerable Palaearctic distribution, are alpine and/or boreocontinental Europe. They occur in scattered and often quite isolated populations through their whole range of distribution. Both are surely old components of our fauna. Previously *L. straminea*, *S. humiliata* and *P. bifasciata* have been overlooked because of their biotopes or similarity to other familiar species. *E. sigma* is a conspicuous species, but is a decidedly local one. To our knowledge Lepidoptera have previously not been collected

to any extent in the southern part of Tjøme where the localities for *E. sigma* are situated. The circumstances must be somewhat similar with regard to *S. muricata*. Further finds of *E. sigma* can be expected in the county of Østfold, close to a number of Swedish localities in Bohuslän.

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Norwegian stoneflies. I. Analysis of the variations in morphological and structural characters used in taxonomy

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This work analyses the variation of morphological and structural characters of Norwegian species of stoneflies (Plecoptera). The material represent 34 species, 17 genera, and 7 families.

Some of the characters bound to wing venations are shown to be highly variable, and invalid for separation of both families and genera.

The shape of genitalia appendages, body length, wing length, and the short-wingedness are also highly variable, with marked local differences. The amount of variation differs according to species. Generally there is greatest variation in some of the most common and widespread species such as *Leuctra hippopus*, *Capnia atra* and *Amphinemura standfussi*, but there are also great variations in arctic *Nemoura* species such as *Nemoura arctica*, *N. sahlbergi* and *N. viki*.

The individual variation is high in the total material of each species. Most of the variations, however, are found within the single samples, which make up altogether a continuous variation but which produce local differences. The ratio of each variant from sample to sample is always different.

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INTRODUCTION

Since 1965 the author has been studying occurrence and distribution of stoneflies in Norway. Separation of species and subspecies based on characters commonly used in keys for identification is a great problem, since it is doubtful whether such characters are 'good characters' as defined by Blackwelder (1967): '(1) They are not subject to wide variation among known specimens, (2) They do not show a high intrinsic genetic variability, (3) They are not readily modified by the environment, (4) They are consistently expressed, (5) They are available in the specimens which must be used, (6) They are visible with a reasonable procedures, and (7) They can be effectively recorded'.

Mayr (1969) also insists that the key-characters should usually be present in preserved material. This is very important in work on insects.

The variation in characters seems to be of a high order in the Norwegian material of stoneflies, both within populations and between specimens from different localities. But we need to know whether there is a continuous variation, whether different populations form morphological units, and whether the variations are genetic or modified by the environment.

Mayr (1969) has this to say about the variations: 'Taxonomic characters are population characteristics. Within these there are variations which must be described. Such variations can be non-genetic as in ecological variation or genetic as in continuous variation or discontinuous variation (genetic polymorphism)'.

In the case of continuous variation, Mayr (1969, p. 147) considers: 'The most common type of individual variation is that which is due to the slight genetic differences which exist between individuals'. According to him, the study of this variation is one of the chief tasks of the taxonomist. In this, each character may show a different degree of variability within a single population. Likewise there are different degrees of variability among related species. Some are highly variable while others are not.

Discontinuous variation or polymorphism takes place when the members of a population can be grouped into very definite classes, determined by the presence of certain conspicuous characters. Important here are isolated parts of the population; as Mayr (1969, p. 49) says: 'The biological importance of the geographical isolate is that any isolate, regardless of its taxonomic rank, is an incipient species'.

It is not easy to predict whether variation is continuous or discontinuous. Blackwelder (1967, p. 120) comments: 'How to determine the variation within a species has always been the chief difficulty of taxonomy'.

In other words, one of the chief difficulties of the taxonomist is to decide whether one has continuous variation, a polymorphic species, or several species. Therefore, in the present paper, the author tested the characters used for identification and analysed variations within some of the commonly used taxonomic characters to see whether they constituted continuous variations or polymorphism. This work was carried out at the species level, using morphologic characters such as body length, wing length, wing factor, wing venation, and the form of the genitalia. It was also necessary to analyse characters, mainly in wing venation, used for families and genera. For each family, genus, and species, commonly used characters are then mentioned. The analysis of the Norwegian material is then given, followed by a discussion of the validity of these characters.

Variation in the genital appendages of some Plecoptera species was mentioned and illustrated by Kührtreiber (1934). Later authors such as Brinck (1949, 1952), Illies (1952) and Benedetto (1973) illustrated and discussed the variation in some species, but no statistical work has been carried out on the varia-

tion, either within a sample or between different samples of species.

Wing venation. Drawing of the wings have been made by several authors and are common in identification keys. From author to author there are some differences in the wing veins of the same species, but no statistical work has been done on the variation.

Body length. In keys maximum and minimum lengths of the sexes are given. Sample size is, however, very seldom given.

Wing length is often given in keys, but not as the mean of different samples. Wing dimorphism and short-wingedness have been discussed by several authors as Hynes (1941), Tjeder (1945), Brinck (1949), Khoo (1964) and Nebeker and Gaufin (1967). Hypotheses about which factors produce the reduction in wing length have been discussed.

The above-mentioned variations of taxonomical characters are treated in this article (Norwegian stoneflies, part 1). The ecology of the species and to what degree the ecological factors might influence the mentioned characters will be discussed in four subsequent papers (parts 2-5).

MATERIAL AND METHODS

Treatment of the material followed Mayr (1969, p. 165) with samples which are homogeneous, adequate and unbiased. The sample is unbiased when it contains the same frequency of pertinent characters as the population. An adequate sample is a sample which allows a reasonable estimate of the total variability of the species. In this work this means the variability in the part of the population which occurs in Norway.

The material consists of 24,968 specimens (12,956 ♂♂ and 12,012 ♀♀), collected from representative parts of Norway during the years 1965-1972. The material, which belongs to seven families, 17 genera, and 34 species is deposited at the Zoological Museum, Oslo. In addition to the material mentioned above I have had material for examination from the Royal Norwegian Society of Science and Letters, The Museum, Trondheim; Tromsø Museum, Tromsø; Zoological Museum, University of Bergen; Zoological Museum, Oslo; and from Mr. R. Dahlby, Ørlandet.

Sampling

To obtain adequate samples it was desirable to collect between 30 and 50 specimens of each sex from chosen localities in different parts of Norway. It was, however, not always possible to collect such numbers. The sample number is represented by 'N' in both text and tables. Sampling localities are plotted in Fig. 1. Data on the localities are given in Table I.

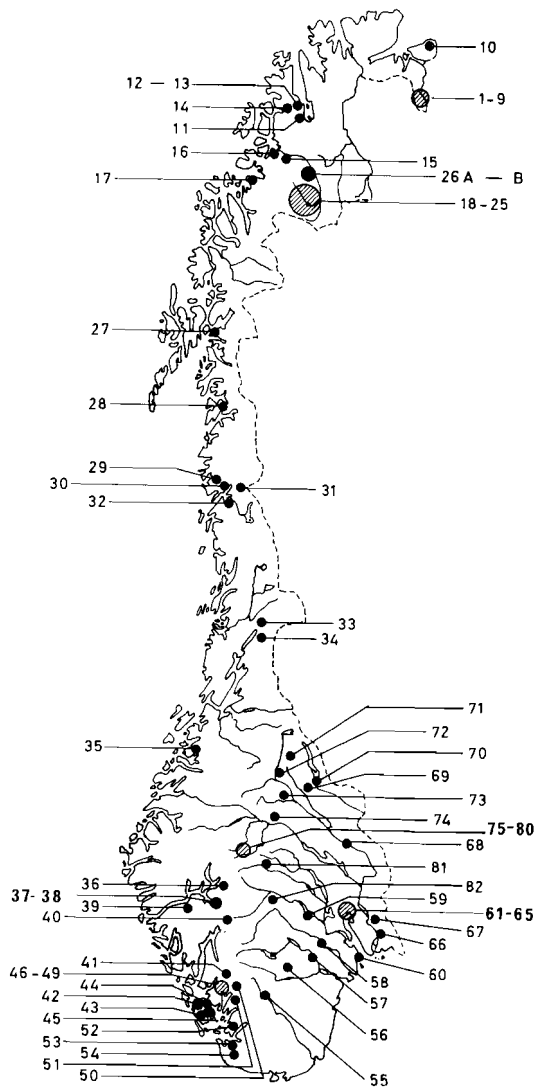


Fig. 1. The sample localities.

Table I. List of data on sample localities. Vegetation zones from Sjörs (1963, 1967)

Locality	County	S. = Stream L. = Lake	m above sea level	Vegetation zones, regions and belts	Vegetation along streams and lakes
1	Finmark	L. Vinterfiskevann	ca. 250	Sub-Alpine belt	<i>Salix, Betula</i>
2	»	S. from Spurv tjønn	ca. 100	Sub-Arctic and Boreo-mont. sub-zone	» »
3	»	S. from Ivargammevann	ca. 100	» » »	» »
4	»	L. Elnvann	95	» » »	» »
5	»	S. from Elnvann	ca. 80	» » »	» »
6	»	S. Pasvikelven	ca. 50	» » »	» »
7	»	L. Svartbrysttjern	ca. 90	» » »	» »
8	»	S. from Storkilden	ca. 50	» » »	» »
9	»	L. Spurvann	122	» » »	» »
10	»	L. at Korp fjell	200	Sub-Alpine belt	» »
11	»	S. Cinajokka	3	» » »	» »
12	»	S. at Myreng	3	» » »	» »
13	»	S. at Older fjord	2	» » »	» »
14	»	S. Guraelven	190	» » »	» »
15	»	S. Eiby lven, upper part	ca. 200	» » »	» »
16	»	S. Eiby lven, lower part	10 to 20	» » , isolated Pine wood	<i>Salix, Alnus</i>
17	Troms	S. at Tretten, Straumsfj.	ca. 5	Sub-Alpine belt	» »
18	Finmark	S. at Aiddejavrre	ca. 370	» » »	<i>Salix, Betula</i>
19	»	S. at Emmatjern	ca. 370	» » »	» »
20	»	S. Suoppatjokka	ca. 323	» » »	» »
21	»	S. Hannujokka	ca. 300	» » »	» »
22	»	L. Stuorajavrre	374	» » »	» »
23	»	S. at Caskijas	6-700	Middle Alpine belt	mainly grass
24	»	L. at Caskijas	ca. 400	Low » »	<i>Salix</i>
25	»	S. Roavvatjokka	370	Sub-Alpine »	» »
26A	»	S. Fidnatjokka	409	» » »	» »
26B	»	S. at Masi	ca. 300	» » »	» »
27	Nordland	L. at Narvik, Sjursheim	ca. 250	Sub-Arctic and Boreo-mont. sub-zone	<i>Alnus, Salix</i>
28	»	S. at Bonnå, Sørfold	ca. 60	» - - » - -	» »
29	»	S. at Svartisen glac.	-	- - -	- -
30	»	L. Langevatn	47	Sub-Arctic and Boreo-mont. sub-zone	<i>Alnus, Salix</i>
31	»	L. Raudvatn	448	Sub-Alpine belt	<i>Betula, Salix</i>
32	»	S. Røssåga	5-10	Sub-Arctic and Boreo-mont. sub-zone	<i>Alnus, Salix</i>
33	N.Trøndelag	S. Luru, Snåsa	ca. 600	Sub-Alpine belt	<i>Betula, Salix</i>
34	»	S. Jørstadelv, Snåsa	ca. 70	Sub-Arctic and Boreo-mont. sub-zone	<i>Alnus, Salix</i>
35	M. og Romsd.	S. Søya	10-50	N.-Atl. Pine-Birch woodl. and Heath reg.	» »
36	Sogn og Fjordane	S. at Maristua, Lærdal	811	Sub-Alpine belt	» »
37A	»	S. Langedøla, Aurland	ca. 1100	Low-Alpine belt	mainly grass
37B	»	L. Hornsvann, Aurland	1286	Low-Alpine/Middle-Alpine	» »
38	»	S. at Lovidalen, Aurland	ca. 800	Sub-Alpine »	<i>Alnus, Salix</i>
39	»	S. at Fosse fjell	ca. 900	Low/Sub-Alpine »	some <i>Salix</i>
40	Hordaland	L. at Finse	ca. 1480	Middle-Alpine »	mainly grass
41	»	L. Halvfjordingsv., Røldal	900	Low-Alpine »	» »
42	»	S. at Byrkjeland, Sveio	10-20	N.-Atl. Pine-Birch woodl. and Heath reg.	<i>Alnus</i>

43	Rogaland	S. at Haugesund	65	»	»	»	some <i>Salix</i>
44	»	S. at Sandeid, Vindafjord	ca. 10	»	»	»	<i>Alnus, Salix</i>
45	»	S. at Yrkje, Vindafjord	50	»	»	»	»
46A	»	S. at Risvold, Sauda	ca. 400	Sub-Alpine belt			<i>Betula, Salix</i>
46B	»	S. at Sauasjøen, Sauda	10-20	N.-Atl. Pine-Birch woodl. and Heath reg.			<i>Alnus, Salix</i>
47	»	S. Nordelva, Sauda	10-20	»	»	»	»
48	»	S. at Elgjuvet, Sauda	500	Sub-Alpine belt			»
49	»	S. at Botnavatn, Sauda	710	Low/Sub-Alpine belt			mainly grass
50	»	S. Suldalslågen	60	N.-Atl. Pine-Birch woodl. and Heath reg.			<i>Alnus, Salix</i>
51	»	S. at Hjelmeland	ca. 100	»	»	»	»
52	»	S. at Årdal	ca. 50	»	»	»	»
53	»	S. at Oltedal	150	»	»	»	mainly <i>Betula</i>
54	»	S. at Time	ca. 60	»	»	»	<i>Alnus, Salix</i>
55	V. Agder	S. Otra, Bykle	ca. 500	Sub-Arctic and Boreo-mont. sub-zone			»
56	Telemark	S. Svorta, Hjartdal	ca. 300	Boreo-nemoral zone			»
57	»	S. Tinnelv, Notodden	20-30	Boreo-nemoral zone			»
58	Buskerud	S. at Ravalen	ca. 500	-			-
59	»	S. Fosslielva, Krødsherad	750	-			-
60	Vestfold	S. at Tjøme	5-10	Boreo-nemoral zone			<i>Alnus, Fraxinus, Salix</i>
61	Akershus	S. at Semsvann, Asker	150	»	»		<i>Alnus, Salix</i>
62	»	S. Lomma, Bærum	ca. 160	»	»		»
63	»	S. Sæterbekken, Bærum	ca. 110	»	»		»
64	»	S. Lutdalsb., Oslo	ca. 200	»	»		-
65	»	S. Heggelielv, Oslo	ca. 150	»	»		<i>Alnus, Salix</i>
66	Østfold	S. at Tune	30-40	»	»		»
67	Akershus	S. at Søndre Høland	ca. 150	»	»		»
68	Hedmark	S. Glåma at Elverum	ca. 180	Sub-Arctic and Boreo-mont. sub-zone			»
69A	»	S. Renåa, Ø. Rendal	260	»	»	»	<i>Alnus</i>
69B	»	S. Renåskarvenbekken	660	»	»	»	mainly Pine
70	»	S. at Lake Istern	645	»	»	»	<i>Alnus, Salix</i>
71	»	S. at Narsjøen	724	»	»	»	<i>Salix</i>
72	»	S. at Tynset	490	»	»	»	<i>Alnus, Salix</i>
73A	»	S. at Atna, Haldogsenøyi	ca. 700	»	»	»	-
73B	»	S. at Atna, Sollia	ca. 800	»	»	»	-
74	»	S. at Venabu	ca. 950	Sub-Alpine belt			-
75A	Oppland	S. Flybekkin, Ø. Heimdal	ca. 1100	Low-Alpine belt			<i>Salix</i>
75B	»	S. Hestegjeterb., Ø. Heimdal	1090	Sub-Alpine belt			»
76A	»	L. Ø. Heimdalsv.	1090	Sub-Alpine belt			»
76B	»	S. from Ø. Heimdalsv.	1090-1052	Sub-Alpine belt			»
77A	»	L. Bløtjønn	1465	Middle-Alpine belt			mainly grass
77B	»	L. outlet of Blåtjønn	1465	Middle-Alpine belt			»
78	»	L. outlet of Brurskartjønn	1308	Low-Alpine belt			»
79	»	S. at Valdresflya	1350	Low-Alpine belt			»
80A	»	L. Gjende	984	Sub-Alpine belt			<i>Salix</i>
80B	»	S. at Maurvangen	980	Sub-Alpine belt			»
81	»	S. Leirelva at Fagernes	ca. 380	Sub-Arctic and Boreo-mont. sub-zone			<i>Alnus, Salix</i>
82	»	L. Steinbusjøen	ca. 1200	Low-Alpine belt			<i>Salix</i>

Biometric measurements

Body length was measured in alcohol-preserved material. The samples collected in different parts of the country were brought back to the museum for examination and had therefore to be preserved before dispatch. Careful attention was given to the influence of preservative fluids on the specimens, and it was decided to use only the females in the comparisons because they did not change as much as the males of certain species did. The abdominal tip of males of some species had a tendency to bend during the preserving process.

Wing length was measured from the right fore-wing, which was embedded in Euparal and slide-mounted. Wing venation was examined from these slides.

Both wing and body length varied to a considerable degree and the problem of short-wingedness cannot be studied solely in respect of the total length of the wing. For example, a specimen with a short wing length is not short-winged if the body length is also equally short. Therefore, a wing factor (w/b) = wing length/body length was used. The specimens are therefore considered to be short-winged if the wing length is clearly less than the body length. With values around 1.0 and above, the specimens have wings which extend well beyond the end of the abdomen and thus they are considered 'normal' or long-winged. In specimens with values around 0.90 there is a weak tendency towards short-wingedness. Specimens with values around 0.80 and below are markedly short-winged.

The wing factor was not used on the males because of the above-mentioned change of body length in preserved material.

The female sub-genital plate was examined in situ or embedded in Euparal. The latter method was most commonly used for *Diura bicaudata*, *D. nansenii* and *Arcynopteryx compacta*. The supra-anal lobe of the male was also studied in situ and embedded in Euparal.

The terms used on wing veins and genitalia refer to Brinck (1952, 1956, 1970).

SYSTEMATIC INDEX

All the species recorded in Norway belong to the suborder Arctoperlaria, divided into

the two groups Systellognatha and Euholognatha. The following systematic index, which follows Zwick (1973a), shows the taxa represented in the Norwegian stonefly fauna.

Suborder Arctoperlaria

Group Systellognatha

Superfam. Subulipalpia

Fam. Perlodidae

Subfam. Perlodinae

Genus *Arcynopteryx* Klapálek, 1904
A. compacta (McLachland, 1872)

Genus *Diura* Billberg, 1820
D. bicaudata (Linnaeus, 1758)
D. nansenii (Kempny, 1900)

Genus *Isogenus* Newman, 1833
I. nubecula Newman, 1833

Genus *Perlodes* Banks, 1903
P. dispar (Rambur, 1842)

Subfam. Isoperlinae

Genus *Isoperla* Banks, 1906
I. difformis (Klapálek, 1909)
I. grammatica (Poda, 1761)
I. obscura (Zetterstedt, 1840)

Fam. Perlidae

Subfam. Perlinae

Genus *Dinocras* Klapálek, 1907
D. cephalotes (Curtis, 1827)

Fam. Chloroperlidae

Subfam. Chloroperlinae

Genus *Siphonoperla* Zwick, 1967
S. burmeisteri (Pictet, 1841)

Genus *Xanthoperla* Zwick, 1967
X. apicalis (Newman, 1836)

Group Euholognatha

Superfam. Nemouroidea

Fam. Taeniopterygidae

Subfam. Taeniopteryginae

Genus *Taeniopteryx* Pictet, 1841
T. nebulosa (Linnaeus, 1758)

Subfam. Brachypterinae

- Genus *Brachyptera* Newport, 1851
B. risi (Morton, 1896)
- Fam. Nemouridae
- Genus *Amphinemura* Ris, 1902
A. borealis (Morton, 1894)
A. standfussi (Ris, 1902)
A. sulcicollis (Stephens, 1836)
- Genus *Nemoura* Latreille, 1796
N. arctica Esben-Petersen, 1910
N. avicularis Morton, 1894
N. cinerea (Retzius, 1783)
N. flexuosa Aubert, 1949
N. sahlbergi Morton, 1896
N. viki Lillehammer, 1972
- Genus *Nemurella* Kempny, 1898
N. pictetii Klapálek, 1900
- Genus *Protonemura* Kempny, 1898
P. intricata (Ris, 1902)
P. meyeri (Pictet, 1841)
- Fam. Capniidae
- Genus *Capnia* Pictet, 1841
C. atra Morton, 1896
C. bifrons (Newman, 1839)
C. pygmea (Zetterstedt, 1840)
C. vidua Klapálek, 1904
- Genus *Capnopsis* Morton, 1896
C. schilleri (Rostock, 1892)
- Fam. Leuctridae
- Subfam. Leuctrinae
- Genus *Leuctra* Stephens, 1836
L. digitata Kempny, 1899
L. fusca (Linnaeus, 1758)
L. hippopus Kempny, 1899
L. nigra (Olivier, 1811)

Separation of families named in the index

Wing venation is one of the most commonly used characters in family discrimination (Kühtreiber 1934, Despax 1951, Brinck 1952, Illies 1955, Aubert 1959, Hoffmann 1960, Zhiltsova 1964, and Hynes 1967).

In the suborder Systellognatha the Chloroperlidae are mainly separated on the weakly developed anal fan of the hind wing which is characteristic of this family and is used by all authors.

Illies (1955) and Zhiltsova (1964) separated the families Perlidae and Perlodidae by the fact that the former have more than two cross-veins between $C_1 = \text{costa}$ and $R_1 = \text{radius}$ and have no dark spots in the area of the cross-vein connecting R and $R_s = \text{radial sector}$. In addition, the lack of an irregular archediectyon at the apex of the fore-wing was also used. The wings of the Perlodidae have two or less cross-veins between C and R_1 , and may have dark spots or wings with irregular archediectyon in the apex of the fore-wings.

In separating the Perlodidae and Perlidae, Brinck (1952) used wing venation. He first separated the Perlidae by the vein $R_4 + 5$ which comes directly from the radio-medial cross-vein in the fore-wing, while in the two other families the vein $R_4 + 5$ originates distally from this cross-vein. Hynes (1967) used the same character.

In the Euholognatha, authors of keys mostly use the shape of the tarsal segments for separating specimens belonging to the Taeniopterygidae from the other families. The family Nemouroidae is separated mainly by the X-pattern in the wing veins. The most common argument used to separate the families of Leuctridae and Capniidae is that the former do not possess segmented cerci while the Capniidae have segmented cerci (with at least 6 segments). This difference is only helpful where the genus Capnioneura is absent, as in Fennoscandia. These characters are used by Brinck (1952) and Zhiltsova (1964). Brinck also used the reduction of the cross-veins in the cubital area in the Capniidae.

FAM. PERLODIDAE KLAPÁLEK

Zwick (1973a) states that it is difficult to give definitions solely on the apomorphy of the family, and Illies (1965) mentions that this family is 'very heterogeneous'.

The family is divided into two subfamilies: Perlodinae and Isoperlinae. While the Perlodinae are heterogeneous, the Isoperlinae are

very homogeneous and the males can be separated from the other Perlodidae by the bent, finger-shaped, paraproct and by the chitinous teeth on the penis.

Brinck (1952) distinguished between the two subfamilies Perlodinae and Isoperlinae by the shape of the $R_2 +_3$ wing vein. In Perlodinae it is forked while in the Isoperlinae it is unforked (Fig. 4.6 and 9). This character has also been used by other authors (Kimmins 1950, Hynes 1967 and Illies 1955).

SUBFAM. PERLODINAE KLAPÁLEK

Four genera with altogether five species are represented in the Norwegian fauna.

The genus of *Arcynopteryx* and *Perlodes* are separated from the other Perlodinae by the irregular wing venation in the apex of the fore-wing. *Arcynopteryx* is separated from *Perlodes* by the division of the 10th tergite into two lobes. Additionally in *Arcynopteryx* the anterior cubital area of the fore-wing should have only a few cross-veins, as opposed to several in the *Perlodes*.

Together with the genus *Isogenus*, the genus *Diura* does not have irregular veins in the apex of the fore-wings. Brinck (1952) separated *Diura* and *Isogenus* by the large subgenital plate of the *Isogenus* female which occupies almost the whole of the 9th tergite, and by the divided 10th tergite of the fully-winged male. The 10th tergite of the male *Diura* species is undivided and the subgenital plate of the female occupies only a small part of the 9th tergite.

No imago of *Isogenus nubecula* was taken in Norway and in this work only the taxonomical characters of the two *Diura* species will be dealt with.

Arcynopteryx Klapálek, 1904

In this genus there is only one species in Norway.

Arcynopteryx compacta (Mc Lachland, 1872)

The species is morphologically highly variable, a fact mentioned by several authors. Drawings of the species have been made by among others, Bengtsson (1933), Brinck (1952 and 1956), Zhiltsova (1964), Illies (1955) and Rauser (1968). Variation in the

female sub-genital plate has been figured by Brinck (1952) and Zhiltsova (1964).

The present taxonomic study is based on 85 ♂♂ and 72 ♀♀.

Morphological analysis

Genital appendages. There are marked variations in the form of the female subgenital plate (Fig. 2.4-2.5). In the male (Fig. 2.1-2.3) there is some variation in the copulatory organ and the chitinous parts of the cowl as pointed out by Brinck (1956, Fig. 6).

Body length. Males 10.5-16.0 mm, females 13-21 mm. The mean length of the female samples collected at different localities varies from 15.2 to 18.0 mm (Fig. 8). The individual variation is highest within the sample from Atna in Hedmark Loc. 73A, from 14.1 to 21.0 mm.

Wing length. Males 3.2-5.2 mm, females 12.5-16.5 mm. The mean of the female samples varies from 13.6 to 15.5 mm (Fig. 8).

The individual variation is highest within the sample from Atna in Hedmark, from 11.5 to 15.3 mm. The male is always brachypterous.

Wing factor (w/b). On average, the female samples display short-wingedness, with a wing factor from 0.89 to 0.82. However, the

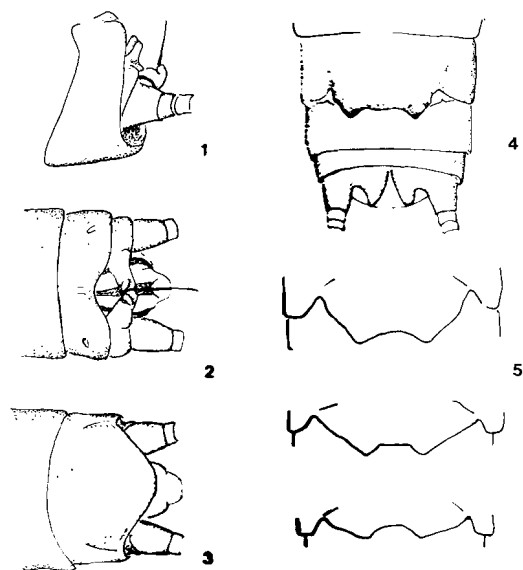


Fig. 2. *Arcynopteryx compacta*. 1-3 The abdominal apex of male. 1. Lateral, 2. Dorsal, 3. Ventral, 4. The abdominal apex of the female, 5. Different forms of sub-genital plate.



Fig. 3. Wings of *A. compacta*. A. Without cross-veins. B. With many cross-veins in the anterior cubital area.

individual specimens show values ranging from 0.70 to 1.11, the latter specimens being long-winged.

Wing venation (Fig. 3). In some specimens there are as many as 5 cross-veins in the anterior cubital (Cu) area of the fore-wing. There seem to be local differences in this character.

The genitalia characters of this species are valid, even if the female sub-genital plate varies, and there is some overlapping to the *Diura* species. The characters of the wings mentioned above, which separate *Arcynopteryx* from *Perlodes* – few cross veins in the anterior cubital area of *Arcynopteryx* and several in *Perlodes* – are not satisfactory as there are several cross-veins in the anterior cubital area in quite a few specimens of *Arcynopteryx* too. A wing of this type is shown in Fig. 3, B.

Diura Billberg, 1820

In this genus there are two species in Norway. Brinck (1952) separated females of *Diura bicaudata* from *Diura nanseni* on account of the short and broad sub-genital plate. The males of *D. bicaudata* are brachypterous with simple and finger-shaped sub-anal lobes. Females of *Diura nanseni* should have a narrower and longer sub-genital plate, whereas the male is long-winged and has sub-anal lobes which are medially swollen.

Diura bicaudata (Linnaeus, 1758)

Drawings of this species were made by Bengtsson (1933), Hanson (1940), Brinck

(1952, 1954 and 1956), Zhiltsova (1964), Illies (1955), Hynes (1967), Kimmins (1950) and Winkler (1957).

The variation in the form of the female sub-genital plate was figured by authors such

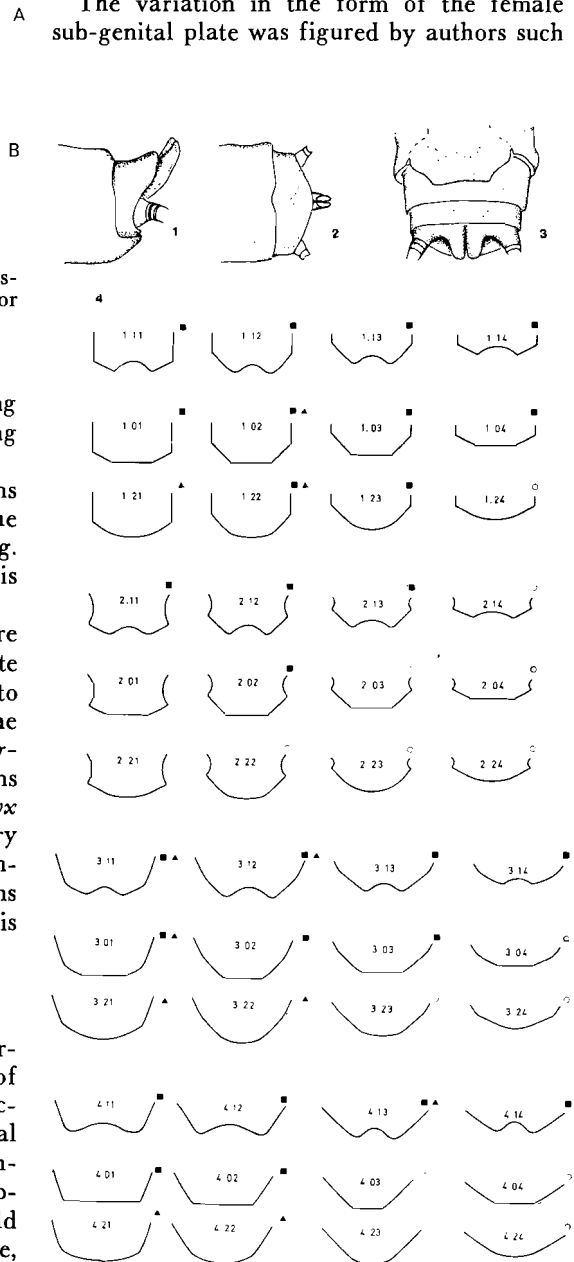


Fig. 4. *Diura bicaudata*. 1-2. The abdominal apex of male. 1. Lateral, 2. Dorsal, 3. The abdominal apex of female, 4. Different forms of sub-genital plate. The forms which belong to 1, 3 and 4 represent *D. nanseni* also. Those marked (O) are not found in *Diura* species, those marked (■) are found in *D. bicaudata*, those marked (▲) are found in *D. nanseni*.

as Brinck (1952), Zhiltsova (1964), Winkler (1957) and Benedetto (1973).

The present study of this species is based on 696 ♂♂ and 670 ♀♀.

Morphological analysis

Genitalia (Fig. 4). The morphology of the external male genitalia is fairly constant. The female sub-genital plate, however, has a highly variable shape and some look like those of *Diura nanseni*. However, the overlapping forms were only seen in a few specimens out of a total number of 343 of *Diura bicaudata* and 161 *D. nanseni* compared. The overlapping shapes are 1.02, 1.21, 1.22, 3.01, 3.11, 3.12, 4.01, 4.11 and 4.13 in Fig. 4.

In Fig. 4.4 the assumed variations in the sub-genital plate of *D. bicaudata* are arranged in the main forms 1, 2, 3 and 4. Those marked (○) are not found in the *Diura* species, those marked (■) are found in *D. bicaudata*, those marked (▲) are found in *D. nanseni*.

The following shapes of sub-genital plates were most common: 1.12, 1.13, 2.12, 2.13, 3.11, 3.12, 3.13 and 4.12. There are differences in shape between specimens taken at localities in Troms and Finnmark and those taken in southern Norway (Table II).

Body length. Males 9.2–17.0 mm, females 11.0–21.0 mm. The mean length of the female samples varies greatly, from 12.4–19.0 mm. The individual differences are greatest in the sample from Elenelv, Pasvik loc. 5 (13.0–19.5 mm), and from Øvre Heimdal loc. 76A (14.5–21.0 mm) (Fig. 8).

Wing length. Males 2.8–4.3 mm, females 8.8–16.0 mm. The mean lengths of the female samples display a lower degree of variation than those of body length, from 9.9 to 15.0 mm. The individual variation is also less, being 10.3–14.9 mm in the sample from Røldal, West Norway Loc. 41, which has the greatest variation (Fig. 8). The males of this species are always brachypterous.

Wing factor (w/b). The mean of the female samples varies from 0.70 to 0.96, and the females are mainly short-winged. The individual variation is high, from 0.59 to 1.12, and in several samples both short and long-winged specimens can be found such as from Røldal, West Norway Loc. 4, with wing factors varying from 0.64 to 1.04. Some samples have only short-winged specimens, as in those from Aurland loc. 37B, with values

from 0.64 to 0.79, and from Raudvann, Mo i Rana loc. 31, with values from 0.64 to 0.80.

Wing venation. There is a high degree of irregularity in the wing veins of this species, as shown in Fig. 5. In the fore-wings three or four cross-veins are present between C and R_1 to a high degree. In some samples there are marked variations in wing venation, especially in the samples from Southern Norway where there is a high degree of irregularity (Table II and Fig. 5).

The species seem to have local differences in respect of all the tested morphological characters, and in some localities they seem to be linked in a certain manner. In the male the characters mentioned are valid; all the males are brachypterous and the supra-anal lobes are simple and finger-shaped.

In the female, however, there are great variations, but the percentage of overlapping to *D. nanseni* is so low that also this character must be considered valid.

Diura nanseni (Kempny, 1900)

Drawings of the species and attention to the variation in the female sub-genital plate were given by Hanson (1940), Brinck (1949 and 1952), Zhiltsova (1964), Lillehammer (1965) and Benedetto (1973).

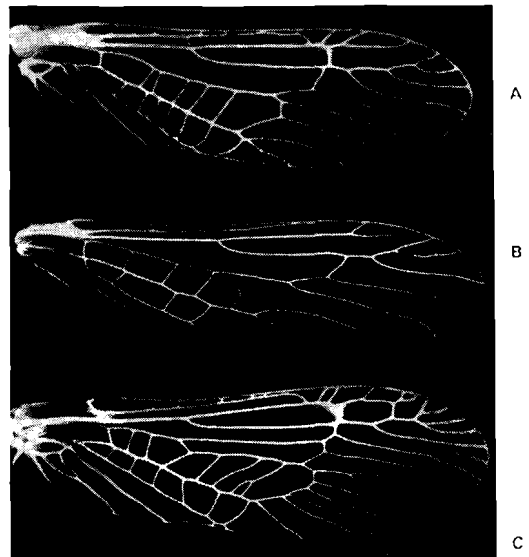


Fig. 5. The right fore-wing of *Diura bicaudata* with different venation. A. The common type from North Norway, B. Reduced form. C. Common form from South Norway.

Table II. Variations in shape of sub-genital plates and wing veins given according to frequency of occurrence in *Diura bicaudata* from different localities. The $(1/2)$, $(2/3)$ and $(3/4)$ are intermediate forms

(N)	Locality	Stream (S) Lake (L)	Types of sub-genital plate							Cross-veins in Radius area	Forking in Median area	Forking in Cubitus area	Reduction in Cubitus area
			1	$(1/2)$	2	$(2/3)$	3	$(3/4)$	4				
25	1	L. Vinterfiskev.	8	4	56	16	13	4	—	4	28	4	48
37	2	S. Spurvtjønn	19	3	38	13	19	—	8	13	24	0	13
35	3	S. Ivargammev.	11	—	31	9	14	9	26	6	17	40	37
30	4	L. Elnvann	13	3	10	13	48	—	13	13	17	13	8
37	5	S. from Elnvann	8	5	22	8	46	—	11	22	16	8	38
23	6	S. Pasvikelv	9	4	35	4	22	13	13	29	28	8	8
29	29	L. Langvatn	38	7	31	10	—	—	14	43	50	—	—
30	30	L. Raudvatn	7	7	10	3	43	3	27	43	17	—	—
33	41	L. Halvfjordingsv.	—	—	3	—	48.5	—	48.5	34	82	30	9
27	76A	L. Ø. Heimdalsvann	—	—	4	—	37	—	59	48	50	15	3
34	37	L. Hornsvatn	—	—	—	—	41	—	59	58	15	15	30

The material used in this study consists of 299 ♂♂ and 322 ♀♀.

Morphological analysis

Genital appendages (Fig 6). There are marked variations in the female sub-genital plate (Fig. 6.4), and there are local differences. The shapes which were most common were 2.21, 2.22, 5.21 and 5.22 in Fig. 6, and 3.22, 4.21 in Fig. 4. As seen from Figs. 4 and 6, it cannot be said that the female sub-genital plates of *D. nanseni* are usually narrower and broader than those of *D. bicaudata*; all shapes, both broad and narrow, occur. In the males, however, the variations are slight.

Body length. Males 10.5–15.0 mm, females 10.5–18.5 mm. The mean of the female samples varies from 12.8 to 16.2 mm (Fig. 8). The individual variations can be quite high, as in the sample from Notodden, Telemark Loc. 57, where the range is from 13.5 to 18.5 mm.

Wing length. Males 5.8–12.0 mm, females 11.2 to 17.7 mm. The mean of the female samples varies to an even higher degree than the body length, from 12.4 to 16.2 mm (Fig. 8). The individual variations are, however, less, the highest being in the sample from Rendal, Hedmark loc. 69B (11.2 to 15.0 mm).

The male of this species is usually long-winged and only one brachypterous male of *D. nanseni* has been taken in Norway in

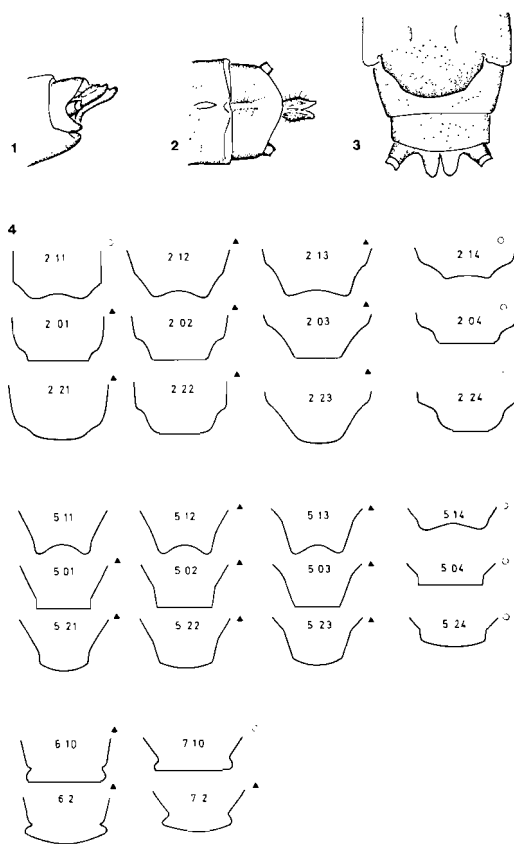
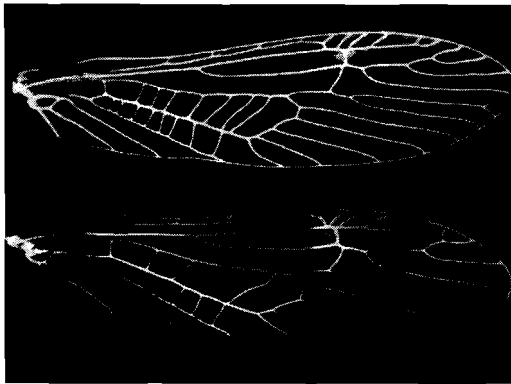


Fig. 6. *Diura nanseni*. 1–2. The male abdominal apex, 1. Lateral, 2. Dorsal, 3. The female abdominal apex with sub-genital plate, 4. Forms of sub-genital plates (see also *D. bicaudata*). Those marked (▲) are present in *D. nanseni*.

Table III. Variations in shape of sub-genital plates and wing veins given according to frequency of occurrence in *Diura nanseni* from different localities

(N)	Locality	Stream (S) Lake (L)	Types of sub-genital plates							Cross-veins in Radius area	Forking in Median area	Forking in Cubitus area	Reduction in Cubitus area
			1	2	3	4	5	6	7				
20	52	S. Årdalselv	25	45	20	5	—	5	—	15	35	—	40
16	57	S. Tinnelv	19	25	—	13	38	6	—	—	37	—	25
48	70	S. Renåskarvenbekk	6	47	13	15	13	2	4	15	28	4	46
12	47	S. Nordelva	—	75	—	8	42	—	—	—	—	—	—
13	53	S. at Oltedal	—	54	8	23	15	—	—	8	46	—	46
12	17	S. at Tretten	—	50	—	17	8	—	—	—	—	—	—
16	39	S. at Fossefjell	—	24	—	38	38	—	—	—	69	—	69
12	73A	S. at Sollia	—	33	—	17	50	—	—	—	27	—	36
12	16	S. Eibyelva	—	31	—	8	50	8	—	—	37	—	37

Fig. 7. The right fore-wing of *Diura nanseni* with different venation.

Kautokeino, Finnmark. Rauser (1968) mentioned brachypterous males from Mongolia, which was the first record of brachypterous males of *D. nanseni*.

Wing factor (w/b). The means of the samples range from 0.91 to 1.12. The individual variation is from 0.88 to 1.45. There are therefore both specimens with slight short-wingedness and distinct long-wingedness. There are also local differences.

Wing venation. There is a high degree of irregularity in the wing veins of this species. This is shown in Fig. 4.6 and Table III. The fore-wings of *D. nanseni* commonly have three or four cross-veins between C and R₁. There are local differences in the wing venation.

The characters of the male are valid. The supra-anal lobes of all specimens are medially swollen and the male is, with one exception, long-winged. As mentioned for *D. bicaudata*, there is some overlapping in the shape of the female sub-genital plates, but only in a few specimens is it difficult to separate the two species. However, the sub-genital plate of *D. nanseni* is not always narrower and longer than that of *D. bicaudata*. A great number of *D. nanseni* females have broad sub-genital plates.

Discussion of the *Diura* species

The wing veins of both species are highly variable (Tables II and III), and cross-veins between R₁ and R₂₊₃ and R₄₊₅ are common. There is also a strong tendency for forking in the median area and reduction in the cubital area to occur. There are clear local differences in these characters in both species.

The character mentioned by Illies (1955) — two or less cross-veins between C and R₁ — is invalid for the Perlodida as three or four cross-veins are more common for both species than two or less. In 163 wings of *D. nanseni*, 76% had three or more cross-veins between C and R₁, about 20% had four cross-veins and about 6% had five. A high number of cross-veins between C and Sc = sub-costa was also common and about 50% had 5 or more cross-veins between C and Sc. The maximum

number was seven. The highest total number of cross-veins was eleven. Dark spots of the fore-wings were not visible to any degree in the alcohol-preserved specimens of the two species. The character is therefore invalid.

As mentioned by Brinck (1949) and Benedetto (1973), the shape of the female sub-genital plates, both of *D. bicaudata* and *D. nanseni*, is highly variable. Figs. 4 and 6 show that the variation is much greater than mentioned by Brinck, and, in addition, some sub-genital plates having nearly the same shape as the North American *D. bicaudata* (*postica*) are represented in the Norwegian material.

The wing factor of the females shows that both short-winged and long-winged females of both species can be found. The difference is that *D. bicaudata* are mainly short-winged, while *D. nanseni* are largely normal to long-winged. There are clear local differences in these characters (Fig. 5).

In *D. bicaudata* there are greater geographical differences in body length than in *D. nanseni*, which is among the more stable species both in body-length, wing-length and wing-factor.

Isogenus Newman, 1833

Only one species belongs to this genus.

Isogenus nubecula Newman, 1833

Drawings of the male and female were made by Bengtsson (1933) and Brinck (1952).

The species has only been taken as a nymph in Norway (Lillehammer 1967). Nothing can therefore be said about the imago characters.

Perlodes Banks, 1903

Only one species belonging to this genus is recorded from Norway.

Perlodes dispar Rambur, 1842

Drawings of the genitalia were made among others by Brinck (1952, 1956).

The Norwegian material consist of only two specimens, 1 ♂ and 1 ♀ (Lillehammer 1967). The genitalia characters are as mentioned by Brinck. The variation is unknown.

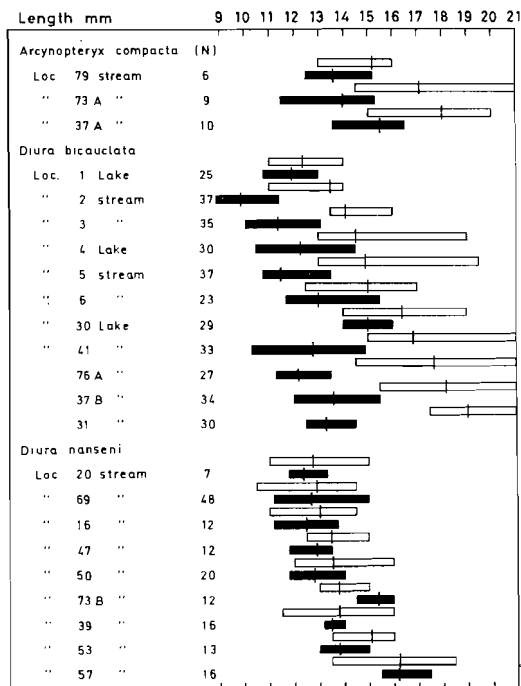


Fig. 8. Body-length and wing-length in different samples of *Arcynopteryx compacta*, *Diura bicaudata* and *D. nanseni*. White rectangle: body-lengths, dark rectangle: wing-lengths. Vertical line, the mean length of the samples. The samples are arranged after increasing body-length.

SUBFAM. ISOPERLINAЕ FRISON

Isoperla Banks, 1906

This genus with three species is the only representative of the subfamily Isoperlinae in Norway. The species are separated by the shape of the female sub-genital plate, and the males most commonly by the different shape of the penial armature of the copulatory organ (Brinck 1952, Illies 1952 and Zwick 1973a).

Isoperla difformis (Klapálek, 1909)

Drawings of both female and male genitalia were given by Brinck (1952), Illies (1955), Vasilin & Costa (1942), Winkler (1957) and Zhiltsova (1964). Detailed drawings of the male genitalia were made by Illies (1952) and Brinck (1956).

The present study of this species is based on 68 ♂♂ and 64 ♀♀.

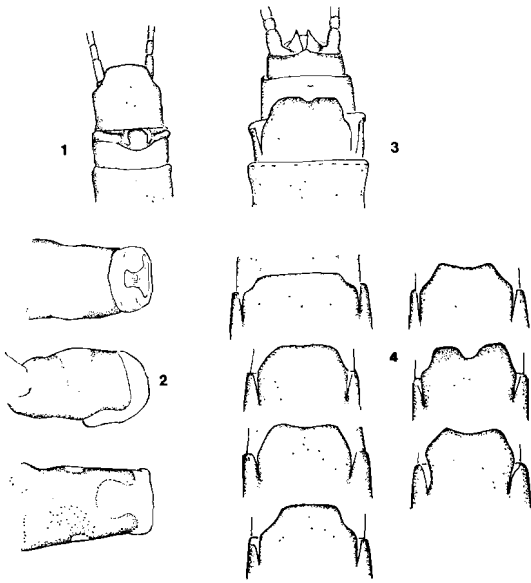


Fig. 9. *Isoperla difformis*. 1. The male abdominal apex, 2. Male copulatory organ with the penial armature, 3. The female abdominal apex with sub-genital plate, 4. Variations in the shape of the female sub-genital plates.

Morphological analysis

Genital appendages (Fig. 9). There are marked variations both in the males and in the females, especially with regard to the sub-genital plate of the females which varies to a high degree. The male copulatory organ (Fig. 9.2) has a somewhat different shape in the covering of the penial armature from that figured by Illies (1955) and Brinck (1956).

Body length. Males 6.6 to 8.7 mm, females 7.8 to 12.8 mm. The material is small and there are only valid samples from two localities. These samples show large differences in mean length, from 10.2 to 11.7 mm (Fig. 15). The individual variation is also marked; from 9.6 to 12.8 mm in the sample from Sæterbekken loc. 63, and from 7.8 to 11.0 mm in the sample from Kautokeino, loc. 18.

Wing length. Males 1.7–2.8 mm, females 9.0–11.8 mm. The wing lengths also vary to a great extent (Fig. 12). The means of the samples are 10.3 and 11.2 mm. The individual variation within the female sample from Sæterbekken is from 9.0 to 11.8 mm.

Wing factor (w/b). Taking the means, both

female samples are long-winged with wing factors of 1.03 (loc.) and 1.13 (loc.). There is considerable individual variation, and in the sample from Sæterbekken there are specimens with wing factors ranging from 0.90 to 1.23. The males are micropterous.

Wing venation. There are marked variations in the veins, especially in the wing apex (Fig. 12). The $R_2 +_3$ is forked in 14% of the specimens from one locality, Kautokeino in Finnmark, loc. 18, ($N = 28$).

Isoperla grammatica (Poda, 1761)

Drawings of male and female genitalia have been made by many authors including Despax (1951), Brinck (1952), Illies (1955), Aubert (1959), Hoffman (1960), Zhiltsova (1964) and Hynes (1967). Detailed studies on the male genitalia have been carried out by Illies (1952) and Brinck (1956). Most of the authors give drawings of the penial armature.

The present study of this species is based on 163 ♂♂ and 153 ♀♀.

Morphological analysis

Genital appendages. There are marked variations, both in males and females (Fig. 10).

Body length. Males 8.0–11.0 mm, females 8.0–12.0 mm. The mean of the female samples varies considerably, from 9.3 mm at Elnelva, Sør-Varanger, Loc. 5, to 11.4 mm at Narsjøen, Hedmark Loc. 71 (Fig. 15). The individual variation is greatest in the sample from Elnelva, where the shortest specimen is 8.0 and the longest 11.2 mm.

Wing length. Males 7.8–12.1 mm, females 9.8–13.3 mm. The variation is even greater

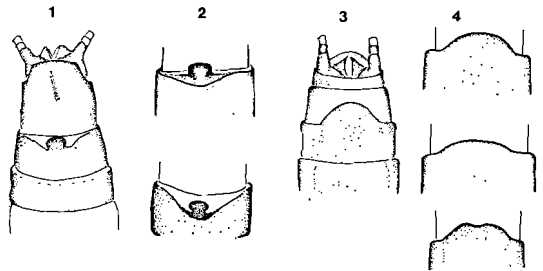


Fig. 10. *Isoperla grammatica*. 1. The male abdominal apex, 2. Variations in the form of the vesicle of the male, 3. The female abdominal apex, 4. Variations in the shape of the female sub-genital plate.

in the wings. The smallest mean of the samples is 10.0 mm and the greatest 12.6 mm. The individual variation is greatest in the sample from Elnelva, from 9.1 to 11.4 mm (Fig. 15).

Wing factor (w/b). All the samples, apart from that from Time, Jæren Loc. 54, have a mean wing factor of more than 1.0. The individual variation is between 0.96 and 1.18.

Wing variation. The same variation can be seen in this species as in *I. difformis*, but to a small degree – only 3% in a sample of 25 specimens had a forked $R_2 + 3$.

Isoperla obscura (Zetterstedt, 1840)

Drawings of this species have been published by authors such as Kimmins (1950), Brinck (1952), Illies (1952 and 1955), Aubert (1959), Zhiltsova (1964) and Hynes (1967). Most of them also give drawings of the penial armature.

The study of this species is based on 436 ♂♂ and 283 ♀♀.

Morphological analysis

Genital appendages. There are marked variations, both among males and females (Fig. 11).

Body length. Males 7.1–10.1 mm, females 8.0–11.8 mm. The means of the female samples vary from 8.8 to 11.1 mm (Fig. 15). The individual variation within a sample is greatest in the material from Øvre Heimdal Loc. 76B, from 8.8 to 12.0.

Wing length. Males 7.7–9.6, females 9.0–12.8 mm. The mean of the female samples varies from 10.6 to 12.1 mm (Fig. 15). This

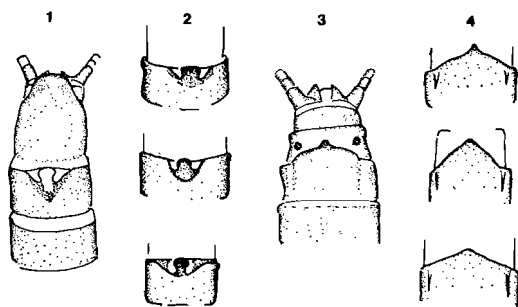


Fig. 11. *Isoperla obscura*. 1. The male abdominal apex, 2. Variation in the form of the vesicle of the male, 3. The female abdominal apex, 4. Variations in the shape of the female sub-genital plate.



Fig. 12. The right fore-wing of the *Isoperla* species. A. Unforked $R_2 + 3$, B. Forked.

is less than in the case of body length. The greatest individual variation is within the sample from Leirelva, N. Aurdal, Oppland, Loc. 81, which varies from 10.1 to 12.4 mm.

Wing factor (w/b). The means of the female samples always exceed 1.0. Some specimens in some samples display a weak tendency towards short-wingedness. This is also true for the sample from Øvre Heimdalsvann, where the lowest wing factor was 0.92. The highest wing factor was 1.38, in a specimen from Leirelva.

Wing venation. The same variation mentioned for the other *Isoperla* species also applies to *I. obscura*, but to a relatively small degree – 7% of a sample of 46 specimens.

Discussion of the *Isoperla* species

In all the species of *Isoperla* there are marked variations in the shape of the sub-genital plates of the females though there are no difficulties in separating them.

There are also variations in the morphology of the males. The micropterous males of *Isoperla difformis* can easily be separated from the other species, but with *I. obscura* and *I. grammatica* the only valid character is the shape of the penial armature of the copulatory organ.

Brinck (1952) separated the subfamily Perlodinae from Isoperlina on the basis of the forked $R_2 + 3$ in the wing veins of Perlodinae and the unforked $R_2 + 3$ in Isoperlina.

In the present material this character does not seem to be as valid as supposed. Especially in *Isoperla difformis* there occur specimens with a forked $R_2 + 3$.

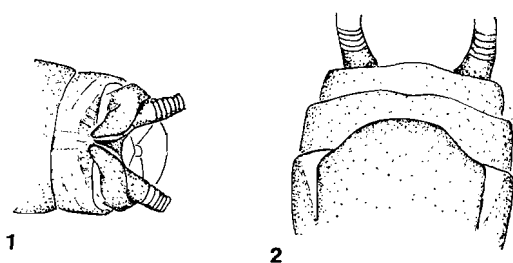


Fig. 13. *Dinocras cephalotes*. 1. The male abdominal apex, 2. The female abdominal apex.

FAM. PERLIDAE LATREILLE

Zwick (1973a) bases the synapomorphy of the family on four characters. Three of them will be mentioned here – the small number of abdominal gangliae (6), the pronounced glossa, and the broad mentum of the nymphs.

In Norway only one genus belongs to this family.

Dinocras Klapálek, 1907

Only one species in this genus is represented in the Norwegian fauna.

Dinocras cephalotes (Curtis, 1827)

Despax (1951), Brinck (1952 and 1956), Illies (1955), Winkler (1957), Aubert (1959), Hoffman (1960), Hynes (1967) and others have made drawings of this species.

The present study of this species is based on 70 ♂♂ and 30 ♀♀.

Morphological analysis

Genital appendages (Fig. 13). No marked variations were observed in the genitalia of either the females or the males.

Body length. Males 15–19 mm, females 20–25 mm, all from Øvre Heimdal, Oppland. The mean of 13 female specimens was 23.7 mm. The mean of 10 males was 16.8 mm.

Wing length. Males 9–11, females 19–24 mm, all from Øvre Heimdal. The mean of 13 females was 23.5 mm and the mean of 10 males was 10.1 mm.

Wing factor (w/b). The average wing factor of the females is nearly 1.0 and they have normal wing length. The male is brachypterous.

Wing venation. The wing venation is fairly constant, but there is some forking in the vein $R_4 + 5$ and the medial veins. However, the characters Brinck (1952) used to separate the Perlidae from Perlodidae are constant and valid for the *Dinocras cephalotes*.

FAM CHLOROPERLIDAE OKAMOTO

Zwick (1973a) mentioned two synapomorphs for the family: The reduced terminal segment of the maxillary palp, and the absence of the enteric Caeca.

The family is divided into two subfamilies: the Paraperlinae Ricker and the Chloroperlinae Okamoto. Only the Chloroperlinae occur in Europe.

SUBFAM. CHLOROPERLINAE OKAMOTO

Two genera are represented in the Norwegian fauna. The species are separated on the female sub-genital plate and the male penis and epiproct.

Siphonoperla Zwick, 1967

Only one species of this species is recorded from Norway.

Siphonoperla burmeisteri (Pictet, 1841)

Drawings of this species have been made by Bengtsson (1933), Brinck (1952), Illies (1955), Winkler (1957), Zhiltsova (1964) and Zwick (1971 and 1972 a).

The study on this species is based on 466 ♂♂ and 486 ♀♀.

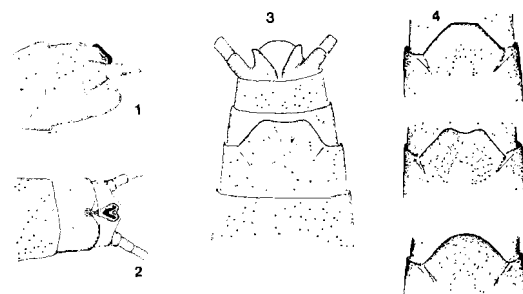


Fig. 14. *Siphonoperla burmeisteri*. 1–2. The abdominal apex of the male, 1. Lateral, 2. Dorsal, 3. The female abdominal apex, 4. Variations in the shape of sub-genital plates.

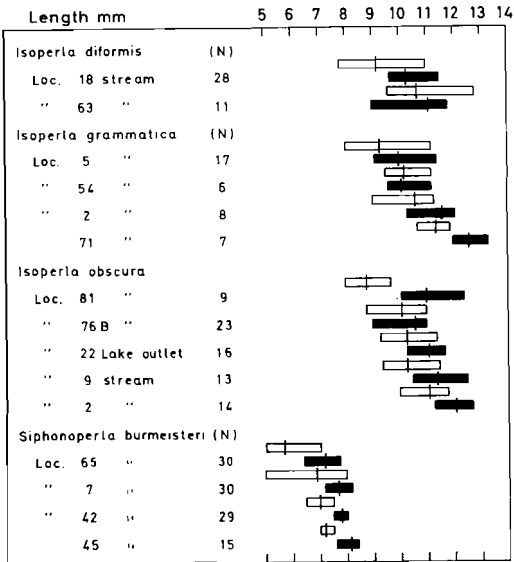


Fig. 15. Body-length and wing-length in different samples of *Isoperla difformis*, *I. grammatica*, *I. obscura* and *Siphonoperla burmeisteri*. White rectangle: body-length, dark rectangle: wing-length. Vertical lines, the mean of the samples.

Morphological analysis

Genital appendages (Fig. 14). There is some variation in the form of the female subgenital plate (Fig. 14.4).

Body length. Males 5.6–7.2 mm, females 5.0–8.0 mm. The means of the female samples vary from 5.6 to 7.2 mm (Fig. 15). The individual variation within a sample is greatest at Svartbrysttjern, in Pasvik, South Varanger, loc. 7 (5.0–8.0 mm).

Wing length. Males 6.3–7.0 mm, females 6.5–8.4 mm. The mean of the female samples varies from 7.2 to 8.2 mm. The individual variation is highest at loc. 65, Heggelielven, Oslo, from 6.7 to 7.7 mm.

Wing factor (w/b). The species were normal to long-winged. The means of the female samples range between 1.12 and 1.35. The individual variations were highest at loc. 7, Finnmark, from 0.96 to 1.52.

Wing venation. There are differences in wing venation also in this species. There is forking both in $R_2 +_3$ and in $R_4 +_5$. The percentage of forking is 15% at Sveio and Sandeid (N = 19) and 3% both from Sørkedalselva, Oslo (N = 30) and from Svartbrysttjern, Pasvik (N = 30).

Xanthoperla Zwick, 1967

This genus is only represented by one species in Norway.

Xanthoperla apicalis (Newman, 1836)

Drawings of this species by Kimmins (1950), Despax (1951, Brinck (1952 and 1956), Illies (1955), Aubert (1959), Zhiltsova (1964), Hynes (1967) and Zwick (1967).

The species was only captured twice by the author in Nord-Trøndelag, so nothing definite can be said about the variation.

FAM. TAENIOPTERYGIDAE KLAPÁLEK

Zwick (1973) mentioned the following apomorphies of the family: all three tarsal segments approximately equally long; the second tarsal segment straight; and the first cercal segment of the male more or less (often very) swollen and occasionally with hooks. Also, the vagina is free and open on the ventral side of the 8th sternite (Brinck 1956).

Zwick (1793a) divided the Tanyopterygidae into two sub-families. Taeniopteryginae and Brachypterinae. In Norway both subfamilies are represented by one genus each, *Taeniopteryx* and *Brachyptera*.

Brinck (1952) separated *Taeniopteryx* from *Brachyptera* on the following characters. In *Brachyptera* the anterior cubital vein sends 3–4 branches to the wing edge while *Taeniopteryx* has at the most 2 branches. Illies (1955) and Zhiltsova (1964) stated that there are usually 3–4, seldom 2, branches in *Brachyptera*. Brinck (1952) and Hynes (1967), to separate the genus *Rhabdiopteryx* from *Taeniopteryx*, used the following character: *Rhabdiopteryx* has 1–3 cross-veins between C and Sc. *Taeniopteryx* has none. Illies (1955) gave 2–4 or more cross-veins for *Rhabdiopteryx* and none for *Taeniopteryx*.

SUBFAM. TAENIOPTERYGINAE KLAPÁLEK

Zwick (1973a) mentioned the following four characters as apomorphic for the subfamily: the cercie of the male have only one segment;

the nymph has coxal gills; the respectaculum seminis consists of a rounded section and a sac-shaped section; and the abdomen has ventrally well-developed longitudinal tracheae.

Taeniopteryx Pictet, 1841

Only one species in the Norwegian fauna belongs to this genera.

Taeniopteryx nebulosa (Linnaeus, 1758)

Among the authors that have made drawings of this species are Aubert (1950), Brinck (1952 and 1956), Illies (1955), Zhiltsova (1964), Hynes (1957 and 1967) and Lillehammer (1965).

The study of this species is based on 431 ♂♂ and 432 ♀♀.

Morphological analysis

Genital appendages (Fig. 16). The Norwegian material agrees generally with the descriptions given by Brinck (1952 and 1956), Illies (1955) and Hynes (1967). There are no marked variations.

Body length. Males 6.9–10.0 mm, females 6.7–15.0 mm. The mean length of the female samples varies considerably from 8.4 to 12.9 mm (Fig. 19). The individual variation was highest in the sample from Ravalen, Buskerud loc. 58 (6.7 to 12.0 mm).

Wing length of the males 9.0–13.0 mm, females 10.2–15.8 mm. The variation in wing length was less than with body length (Fig. 19). There were also smaller differences between the mean wing length of the female samples, from 12.0 mm to 14.5 mm.

Wing factor (w/b). The females of this

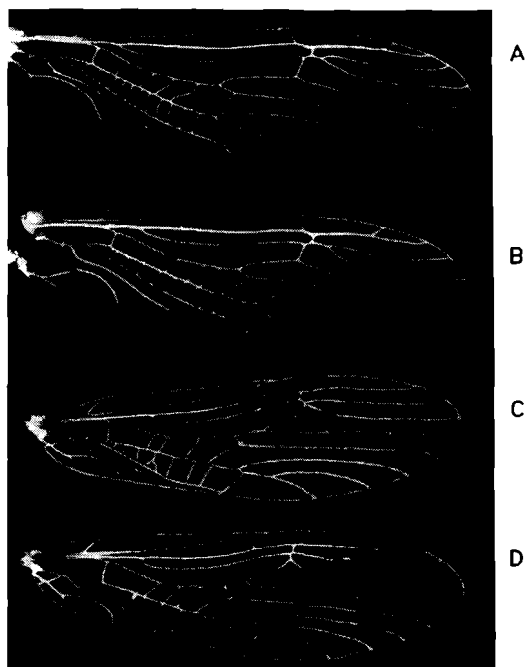


Fig. 17. The right fore-wing of *T. nebulosa* (A-B) and *B. risi* (C-D).

species were always 'normal' or long-winged. Taking the means of the sample, the lowest value was 1.11, and the highest 1.56. The individual variation was from 0.98 to 1.63.

Wing venation varies to some degree (Fig. 17), and it is not uncommon in the Norwegian material that specimens of *Taeniopteryx* have one cross-vein between costa and sub-costa. Of 50 specimens from three localities, cross-veins were present in 30% of the specimens. In one of the localities the percentage was as high as 40.

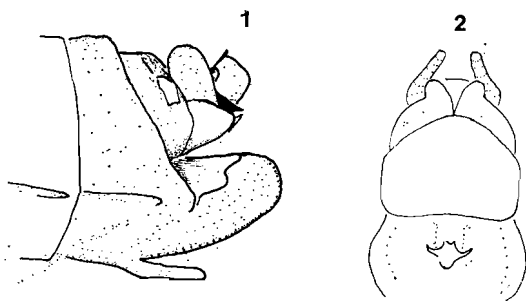


Fig. 16. *Taeniopteryx nebulosa*. 1. The male abdominal apex, 2. The female abdominal apex.

SUBFAM. BRACHYPTERINAE ZWICK

Zwick (1973a) mentioned the following characters as apomorphic for the subfamily: the special shape of the 9th sternite and the subgenital plate of the male and the post-genital plate of the female; the epiproct is strongly developed with incurved chitin sac and/or 'Borstentaschen'; the male paraproct is extremely complicated, richly segmented and asymmetrical.

Brachyptera Newport, 1854

Only one species belonging to this genus is recorded from Norway.

Brachyptera risi (Morton, 1896)

Drawings of this species by authors such as Morton (1911), Despax (1951), Brinck (1952), Illies (1955), Aubert (1959), Hoffman (1960), Zhiltsova (1964), Lillehammer (1965), Hynes (1967) and Berthélemy (1971).

The present study of this species is based on 150 ♂♂ and 143 ♀♀.

Morphological analysis

Genital appendages (Fig. 18). The Norwegian material agrees in most respects with earlier descriptions. There are only small variations. Only one problem is mentioned here; from earlier drawings the post-genital plate of the female seems to be a separate plate. However, although different pigmentation of the post-genital plate makes it look like a separate plate, it is in fact a part of the segment ring (Fig. 18.3).

Antennae. Hynes (1967) made a drawing of the basal segments of female and male antennae showing them to be different. He states that females have antenna as in Fig. 18.4 C, while males have antenna as in Fig. 18.4 A. Illies (1955), however, stated that *B. risi* has segments as in Fig. 18.4 C. In the

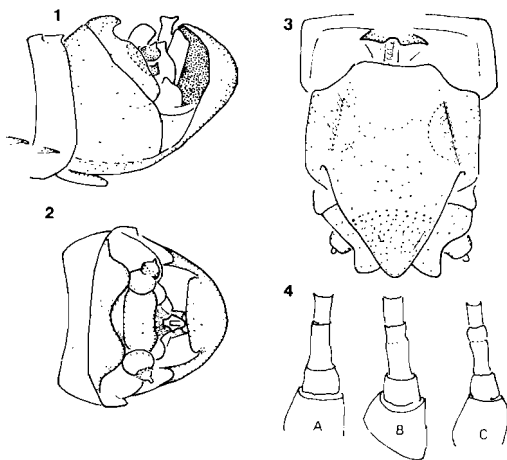


Fig. 18. *Brachyptera risi*. The male abdominal apex, 1. Lateral, 2. Dorsal, 3. The female abdominal apex, ventral, 4. The basal segments of the antennae, A, B and C different forms.

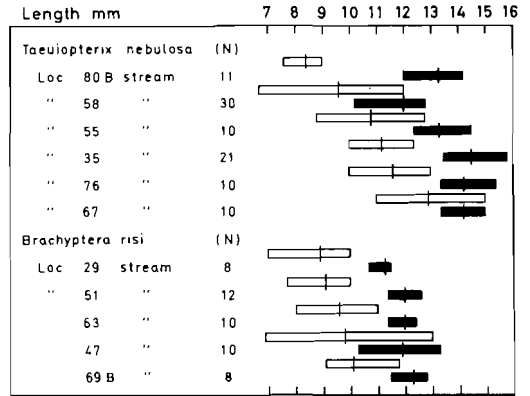


Fig. 19. Body-length and wing-length in different samples of *Taeniopteryx nebulosa* and *Brachyptera risi*. White rectangle: body-length, dark rectangle: wing-length. Vertical lines the mean length of the samples.

Norwegian material both females and males have antenna segments that vary as shown in Fig. 18.4 A-C. The right one may be as in Fig. 18.4 A, the left one as in C.

Body length of the males 6.3-10.0 mm, females 7.0-13.0 mm. Body length varies quite a lot within the samples (Fig. 19); Nordelva, Sauda loc. 47 has the greatest variation. The mean length of the female samples was between 9.0 and 10.2 mm.

Wing length of the males 10.0-11.7 mm, females 10.3-13.3 mm. Wing length is much more stable than body length. The greatest variation was within the sample from Nordelva, Sauda Loc. 47. The mean values of the samples have a quite small range, from 7.1 to 7.4 mm (Fig. 19).

Wing factor (w/b). The females of the species are constantly long-winged and no short-winged specimens were captured. There is, however, a small variation in the mean of the female samples, from 1.21 to 1.26. The individual variation was high and from 1.02 to 1.50 in the sample from Sauda, loc. 47.

Wing venation. The variation was marked; some wings had three, others only two branches of Cu I. However, if they had two branches, one of them was forked (Fig. 18).

Discussion of the Taeniopterygidae species

Both *Taeniopteryx nebulosa* and *Brachyptera risi* vary in body length, wing length and wing factor, although far more in *T. nebu-*

losa than in *B. risi* (Fig. 19). Wing venation varies to a high degree within some populations of both species, and the characters used by Brinck (1952) and Hynes (1967) to separate the genera of Taeniopterygidae are not valid ones. They state that *Brachyptera* has 3–4 veins in Cu and *Taeniopteryx* 2 veins.

In a comparison of the wings of the two Norwegian species, these characters overlapped. In a collection of 35 *Brachyptera risi*, 17 specimens (about 50%) had two veins, one of which was forked. In a collection of 20 *Taeniopteryx nebulosa*, 5 specimens (25%) had two veins, one forked. The high percentage of specimens with one cross-vein between C and Sc in *Taeniopteryx nebulosa* makes the character used by Hynes (1969) and Illies (1955) in separating *Rhabdiopteryx* and *Taeniopteryx* less valid, too.

FAM. NEMOURIDAE NEWMAN

Zwick (1973a) mentions the following apomorphic characters for this family: the special inner structure of the male genitalia (Zwick, Fig. 41 f); the reduction of the abdominal ganglia to five free gangliae; the flat saucer-like terminal segment of the labial palp; and the special form and position of the coxa.

According to Zwick, the Nemouridae X-pattern in the wing veins is an invalid character as it has also been observed in the families Taeniopterygidae, Capniidae and Notonemouridae.

Here, it is intended to test the X-character within the families Nemouridae and Capniidae to see how far it is present in the different species of the two families.

Four genera with altogether 12 species are represented in the Norwegian fauna.

The genus *Amphinemura* and *Protonemura* are separated from *Nemoura* and *Nemurella* by the vestiges of nymphal gills which are present on the prosterum of the two first-mentioned genera, three finger-like gill vestiges on each side in *Protonemura* and two bunches of five to eight filamentous gill vestiges in *Amphinemura*. In addition, Brinck (1952) and Zhiltsova (1964) also used the following characters: intermediate appendages of the male *Protonemura* are well developed

but reduced in *Amphinemura*, and in *Protonemura* the 7th sternum of the female does not extend posteriorly as it does in *Amphinemura*. *Amphinemura* also have narrow anal lobes in the hind wings, while in *Protonemura* species they are wide. Illies (1955), however, only separated the two genera by the shape of the gill vestiges.

To separate the genera *Nemoura* and *Nemurella*, Brinck (1952) and Zhiltsova (1964) used nearly the same characters. Zhiltsova used the following characters: In *Nemoura*; male cerci are short, as long as, or slightly longer than sternum 9, modified into copulatory hooks; intermediate appendages reduced; sub-anal valves (= sub-anal plates) broad; Sternum 8 and anterior margin of sternum 9 of the female elongated triangularly. In *Nemurella*, the male cerci are more than twice as long as sternum 9, without hooks; intermediate appendages membranous, digitiform; sub-anal valves narrow, leaf-shaped; Sternum 8 of the female with two lateral ridges; anterior margin of sternum 9 straight.

Besides testing the X-pattern in the wing veins and the variation within other morphological characters of the species to see whether they form local populations, the author will also evaluate some of the characters mentioned by Brinck and Zhiltsova for separating the genera of Nemouridae.

Amphinemura Ris, 1902

In this genus three species are recorded in the Norwegian fauna. Tobias (1973) described a fourth species *A. norvegica* from Pasvik. This species is not present in the author's collection from the same area.

The *Amphinemura* species is mainly separated on the form of the male and female genitalia, i.e. the sub-genital plate in females and the supra-anal lobe and the sub-anal plates in males.

Amphinemura borealis (Morton, 1894)

Drawings of the species have been made by Koponen (1916), Brinck (1949 and 1952), Illies (1955), Hoffman (1960) and Zhiltsova (1964).

The material of the present work consists of 326 ♂♂ and 278 ♀♀.

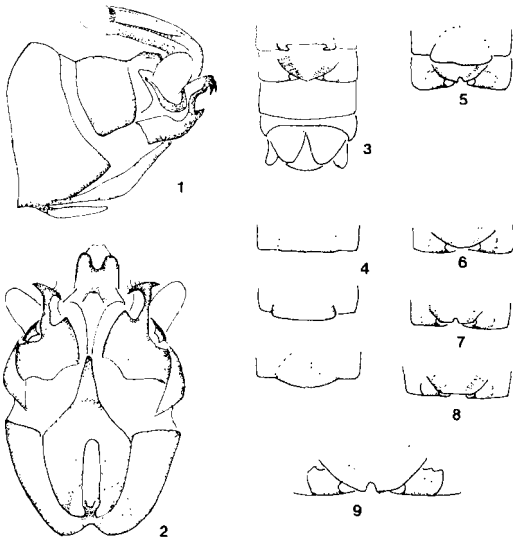


Fig. 20. *Amphinemura borealis*. 1-2. The male abdominal apex, 1. Lateral, 2. Ventral, 3. The female abdominal apex, 4. Different shape of the female 7th sternum. 5-8. Different forms of the female sub-genital plate, 9. Details of the sub-genital plate.

Morphological analysis

Genital appendages (Fig. 20). There are some variations within the Norwegian material, notably in the sub-genital plate of the females. Some of the specimens have nearly the same shape as described by Brinck (1952) and Illies (1955), while others display marked differences (Fig. 20.3-9). Within some of the samples most of the shapes can be found, while in other samples there is a tendency to form local differences. The differences are greatest between the samples from Ivargammevann, Pasvik, East-Finnmark (loc. 3) and Suldalslågen in Rogaland, south-west Norway (loc. 50). Fig. 20.3 shows the dominant form at Ivargammevann, which is found in 90% of the specimens, and the shape shown in Fig. 20.7 in 10%. In Suldalslågen the shape in Fig. 20.7 is found in 40% of the specimens, the shape in Fig. 20.8 in 25% of the specimens, and the shape in Fig. 20.5 in 35%.

Body length. Males 4.0-5.6 mm, females 4.3-8.2 mm. The greatest variation is within the population from Spurvtjønn, Pasvik (loc. 2), with a range of 5.0 to 8.2 mm (Fig. 24). The mean length of the samples also varies markedly, from 4.8 to 6.2 mm.

Wing length. Males 6.8-7.2 mm, females 7.6-9.5 mm. The wing length of the female samples varies to a lesser degree than the body length. The mean length of the samples varies even less, from 8.1 to 9.0 mm (Fig. 24).

Wing factor (w/b). The mean values of the female samples show that the species is long-winged, with values ranging from 1.31 to 1.75. Within the samples there are large differences, the greatest being at Vindafjorden in Rogaland (1.06-1.82 mm). This is largely due to the high variation in body length.

Wing venation. The veins vary quite a lot, especially in the median area (Fig. 23). The Sc 2 vein has a tendency to move towards the apex of the wing and make the X less visible.

In the variations mentioned here, there is a tendency to produce local forms, especially in the shape of the M 1+2 and M 3+4 veins. Some may have forked M 1+2 while some have M 1+2 and M 3+4 as separate veins. The percentage with forking in M 1+2 is 10% in the specimens from Suldalslågen and 92% in specimens from Ivargammevann, Pasvik (loc. 3).

The analysis shows that the species have distinct local differences both in genitalia and in wing venation which are especially marked between specimens from Suldalslågen and Ivargammevann.

Amphinemura standfussi Ris, 1902

Drawings of this species by Kührtreiber (1934), Kimmins (1950), Despax (1951), Brinck (1952), Illies (1955), Aubert (1959), Hoffman (1960), Zhiltsova (1964) and Hynes (1967). Zhiltsova (1966) made drawings of a specimen which in some aspects was different from the descriptions of Brinck (1952) and Illies (1955). The sub-anal valves (= sub-anal plate) and the intermediate appendages of the male were distinctly 3-lobed in the material which Zhiltsova examined.

The present study of this species is based on 611 ♂♂ and 645 ♀♀.

Morphological analysis

Genital appendages (Fig. 21). There are marked variations within the Norwegian material. In both sexes there is a tendency to form local 'types'.

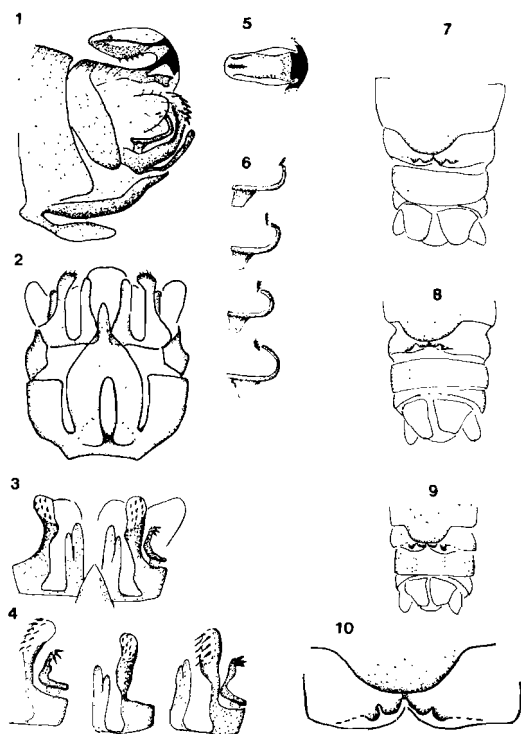


Fig. 21. *A. standfussi*, 1-2. The male abdominal apex, 1. Lateral, 2. Ventral, 3. Sub-anal plate and the intermediate appendage, 4. Different forms of the outer part of the sub-anal plate, 5. Supra-anal lobe from above, 6. Different forms of the intermediate appendages, 7-9. Female abdominal apex with different forms of the sub-genital plate, 10. Details of the sub-genital plate.

The male: Variations are seen in different parts of the supra-anal lobe, in the sub-anal plates and the intermediate appendages.

In the Norwegian material the shape of the sub-anal plate is generally as shown in Fig. 21.2. The valves may be more or less inserted, but never completely divided. The variation in the shape of the sub-genital plate is shown in Fig. 21.3-4. The Norwegian specimens have a form of the sub-anal plate which differs from the descriptions of Brinck (1952), Illies (1955) and Aubert (1959), being usually nearer the form described by Zhiltsova (1966). There are variations in the form of the intermediate appendages (Fig. 21.6).

The female: Variations in the sub-genital plates are shown in Fig. 21.7-9.

Body length. Males 4.00 to 6.6 mm, females 4.0 to 7.7 mm. The mean length in the female

samples from different areas varies from 4.5 to 6.8 mm (Fig. 24). Taking means, the specimens from Lærdal, Sogn (loc. 36), were smallest. The individual variation was highest in the sample from Elgjuset (loc. 48), from 5.1 to 7.7 mm.

Wing length. Males 3.3-6.1 mm, females 2.8 to 7.3 mm. The variations in the wing length were considerable in this species. The means vary between 3.4 and 6.5 mm (Fig. 24). The mean of the sample and the individual variation was highest from Elgjuset.

In this species there are greater variations in wing length than in body length.

Wing factor (w/b). There were large variations in the means of the samples. The lowest w/b value was 0.66 (very short-winged) and the highest was 1.2 (long-winged). The variation within a sample was marked in some populations and extremely small in others. In the sample from Lovidalen, Aurland (loc. 38), all the specimens were short-winged with w/b from 0.60 to 0.67, while in the sample from Maristuen, Lærdal (loc. 36), all the specimens were long-winged with w/b from 1.03 to 1.25.

In most of the samples there are both long-winged and short-winged specimens.

Wing venation has a high degree of irregularity, which is shown in Fig. 23. As in *A. borealis* the Sc 2 vein has a tendency to move towards the apex of the wing, but the R 4+5 also have a tendency to migrate down on the cross-vein between the radial and median area. This makes the X disappear completely. In the median area there is also a high degree of irregularity.

Amphinemura sulcicollis (Stephens, 1836)

Drawings of this species by Kimmins (1950), Despax (1951), Brinck (1952), Aubert (1954), Illies (1955), Aubert (1959), Hoffman (1960), Zhiltsova (1964) and Hynes (1967). Aubert described a new subspecies, which was figured in Aubert (1954).

The material used in the present work consists of 703 ♂♂ and 849 ♀♀.

Morphological analysis

Genital appendages (Fig. 22). There are also some variations in this species. These variations in the sub-genital plate of the

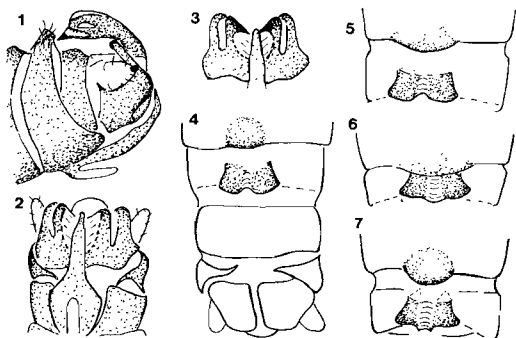


Fig. 22. *A. sulcicollis*. 1-2. The male abdominal apex, 1. Lateral, 2. Ventral, 3. Variant of the sub-anal plate of the male, 4. The female abdominal apex, 5-7. Different forms of the sub-genital plate and the 7th segment.

female are marked (Fig. 22.4-7). The males display some variation in the sub-anal plate (Fig. 22.2-3), which arises from uneven sclerotization. The sub-anal lobe is to some degree different from the description given by Aubert (1952).

Body length. Males 4.0 to 5.7 mm, females 4.8 to 7.3 mm. The range in the mean length of the female samples is between 5.2 and 6.6 mm (Fig. 24). The individual variation is highest in the samples from Haugesund (loc. 43) and Sauda (loc. 48) from 4.8 to 7.0 mm.

Wing length. Males 5.7 to 6.4 mm, females 6.1 to 8.8 mm. The means of the female samples varied from 6.9 to 7.8 mm (Fig. 24). The individual variation was highest at loc. 86 B, Ø. Slidre, from 6.9 to 8.8 mm.

Wing factor (w/b). According to the values, the species is long-winged, the mean being always greater than 1.10. Within samples variation is great.

Wing venation varies to a lesser degree than in the other *Amphinemura* species. The forking tendency in the median area is the same, but Sc 2 is more stable and does not have the strong tendency to migrate towards the apex of the wing as in the two other species of the genus (Fig. 23).

Discussion of the *Amphinemura* species

Among the three *Amphinemura* species the *A. standfussi* has the highest degree of variations in all characters mentioned.

All the three species have morphological

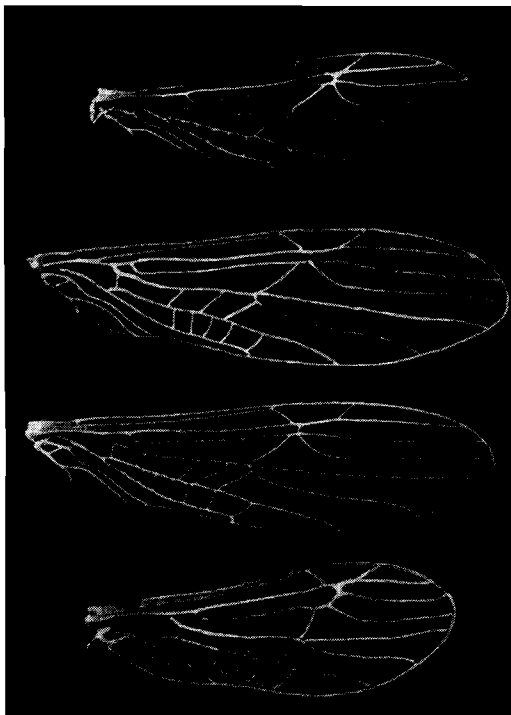


Fig. 23. Different wing venation in *Amphinemura borealis*, *A. standfussi* and *A. sulcicollis*.

variations in their genital appendages and at least two of them, *A. borealis* and *A. standfussi*, have a tendency to produce local morphological differences. There are no great differences in body length between the three species. In wing length, however, there are considerable differences between the species (Fig. 24).

Amphinemura borealis has the longest wings and the highest wing factor (w/b). Both *A. borealis* and *A. sulcicollis* are always long-winged, but *A. standfussi* may have extremely short wings and a low wing factor (w/b).

Wing venation shows large variations in the median area of all three species, and in Sc 2 and R 4+5 of *A. borealis* and *A. standfussi*. These characters result in the disappearance of the remaining X.

Nemoura Latreille, 1796

The *Nemoura* species are mainly separated from each other on the form of the supra-anal lobe, sub-anal plates and cerci in the

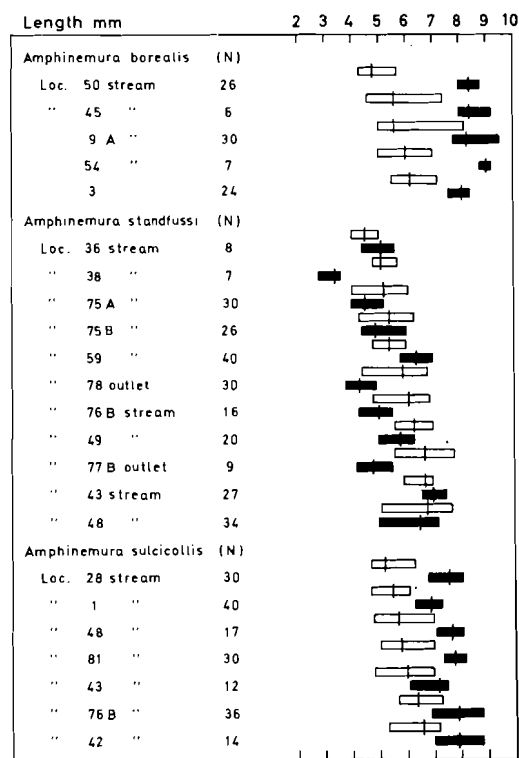


Fig. 24. Body-length and wing-length in different samples of *Amphinemura borealis*, *A. standfussi* and *A. sulcicollis*. White rectangle: body-length, dark rectangle: wing-length. Vertical line, the mean length of the samples.

male, and the sub-genital plate of the female. In this genus there are 6 species represented in the Norwegian fauna.

Nemoura arctica Esben-Petersen, 1910

Drawings of this species by Koponen (1949), Brinck (1952) and Zhiltsova (1964). Brinck (1958) made drawings of the sclerotized part of the supra-anal lobe of the subspecies, *N. arctica polaris* (Fig. 25.5 F). Lillehammer (1972) made drawings of the supra-anal lobe and the cercus. Zhiltsova (1972) described the subspecies *N. arctica mongolica*.

The present study of this species is based on 110 ♂♂ and 105 ♀♀.

Morphological analysis

Genital appendages (Fig. 25). *Nemoura arctica* displays a high degree of morphological variation, both in male and female.

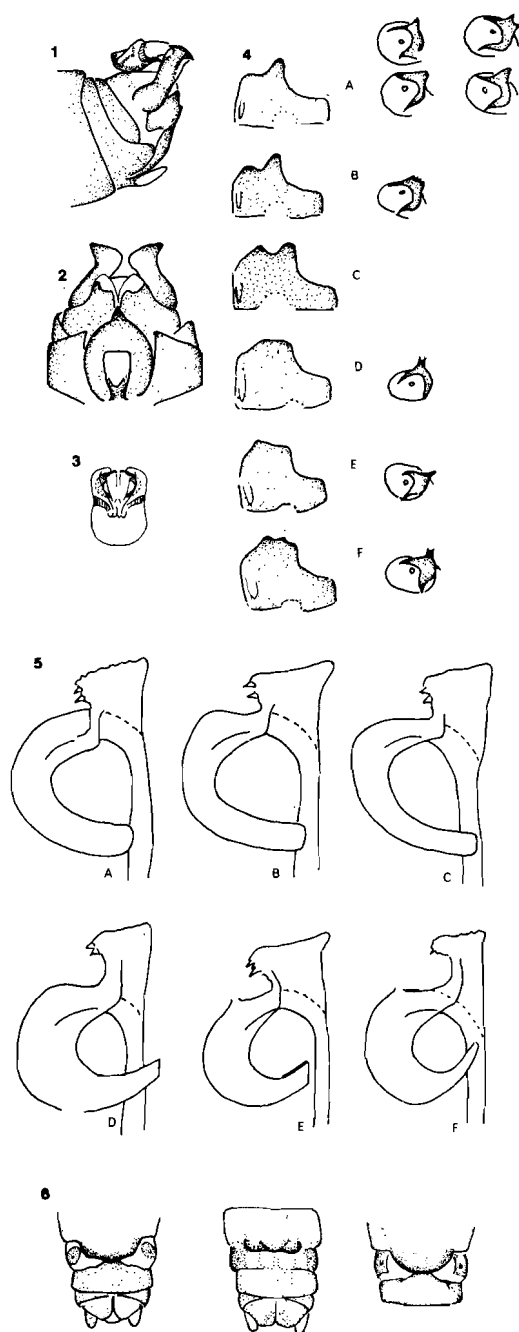


Fig. 25. *Nemoura arctica*. 1-2. The male abdominal apex. 1. Lateral, 2. Ventral, 3. The supra-anal lobe from above, 4. The sub-anal plates and cerci from different localities: A from stream at Caskijas, loc. 23, B and C small lake about 10 km from Caskijas, loc. 24, D from lake Stuorajavrre loc. 22, and E-F from Lake Suoparjavrre loc. 20, 5. The anterior apical part of the sclerotization of the supra-anal lobe: A and B from Caskijas loc. 23,

The male: The inner structure of the supra-anal lobe varies quite a lot (Fig. 25.5). The same is true of the sub-anal plates and the cerci (Fig. 25.4). In these characters there are clear local morphological differences, which may also differ from lake to lake within the same area. This is mostly in respect of the supra-anal lobe and the sub-anal plates. The cerci also vary considerably, but do not have the same tendency to show local differences. There are only small differences between the description on *N. arctica polaris*, Brinck, 1958 and some of the specimens from Kautokeino, Fig. 25.5.

The female: The form of the sub-genital plate varies as shown in Fig. 25.6. This character is highly variable but does not seem to have the same tendency to show local differences.

Body length. Males 5.4–7.0, females 6.6–9.6 mm. Within samples of females the greatest variation is in specimens from loc. 23, Caskijas, from 7.0 to 9.6 mm (Fig. 34). The variation in mean length of the female samples is small, from 7.3 to 8.0 mm, but the comparative material is small.

Wing length. Males 5.6–7.3 mm, females 6.5–8.6 mm. Within a single sample of females, from loc. 23 (Fig. 34), the variation is from 6.5 to 8.6 mm. The means of the two samples differ little (7.3–8.0 mm).

Wing factor (w/b). The species seems to have a tendency to short-wingedness. This is due to the females in the sample from loc. 23, with a mean of 0.91. The individual variation in this sample was from 0.86 to 1.15.

Wing venation (Fig. 33) is highly variable within this species. Samples from three localities in the Kautokeino area (loc. 22, 23, 24) show marked differences (Table IV).

The investigation has shown that there are pronounced variations in characters which are considered to be stable within the genus *Nemoura*, e.g. cerci, sub-anal plates and supra-anal lobe. The species has a tendency to short-wingedness and the wing venation is

Table IV. The occurrence of different forms of wing veins in some of the Nemouridae species in samples from different localities. For forms A, B and C, see Fig. 33.

N = size of sample

Species, localities	N	Form A	Form B	Form C	Forking in median area	Normal median area
<i>Nemoura arctica</i>						
Loc. 22, lake	12	0	78	22	53	47
Loc. 24, lake	12	39	50	11	56	44
Loc. 23, stream	30	24	13	63	79	21
<i>N. avicularis</i>						
Loc. 26A, stream	26	46	34	20	38	62
Loc. 76A, lake	29	81	19	0	76	24
Loc. 63, stream	25	64	20	16	36	64
Loc. 27, lake	29	40	50	10	60	40
<i>N. cinerea</i>						
Loc. 66, stream	50	41	18	41	0	106
Loc. 10, stream	31	29	71	0	18	82
Loc. 21, stream	16	44	56	0	0	100
Loc. 33, stream	50	57	36	7	11	89
<i>N. flexuosa</i>						
Loc. 12, stream	15	34	53	13	53	47
Loc. 63, stream	8	37	13	50	12	88
<i>N. sahlbergi</i>						
Loc. 21, stream	26	67	7	26	63	37
Loc. 11, stream	14	47	23	30	95	5
<i>N. viki</i>						
Loc. 19, stream	35	16	27	57	63	37
<i>Nemurella picteti</i>						
Loc. 73B, stream	30	92	0	8	96	4
Loc. 41, lake	30	84	8	8	39	61
Loc. 13, stream	13	71	0	29	71	29

highly variable. There is a strong tendency to produce local differences, both in genitalia and in wing venation.

Nemoura avicularis Morton, 1894

Drawings of this species have been made by Kimmins (1950), Despax (1951), Brinck (1952), Illies (1955), Aubert (1959), Zhiltsova (1964) and Hynes (1967).

The present study of this species is based on 240 ♂♂ and 240 ♀♀.

Morphological analysis

Genital appendages (Fig. 26). There are smaller variations in the genital appendages

C from a Lake 10 km from Caskijas, loc. 24, D from Lake Suopattjavrrre, loc. 20, E and F (after Brinck (1958)), E from Abisko, Swedish Lapland, F *N. arctica* ssp. *polaris*, from Dudinka, Siberia, 6. The abdominal apex of the female, with different forms of the sub-genital plate.

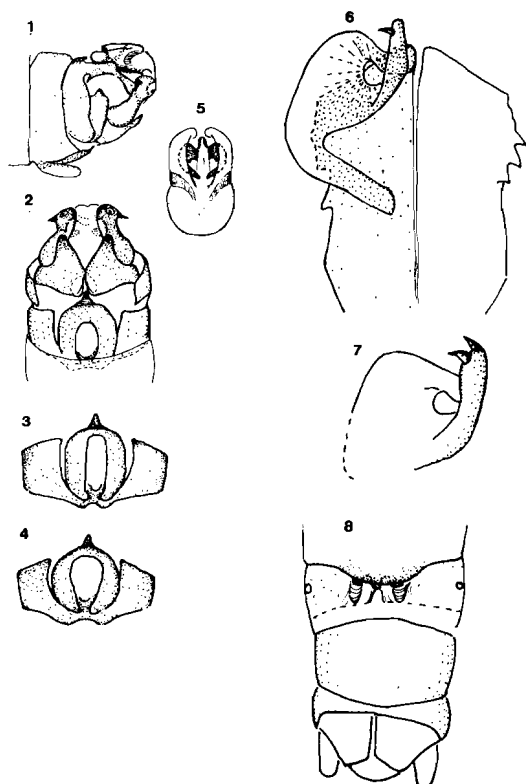


Fig. 26. *Nemoura avicularis*. 1-2. The abdominal apex of the male. 1. Lateral, 2. Ventral, 3-4. Different shape of the subgenital plate of the male, 5. Supra-anal lobe from above, 6-7. The sclerotized part of the supra-anal lobe from above. 6. The tip with one hook, 7. With two hooks, 8. The abdominal apex of the female.

of this species than in *N. arctica*. The supra-anal lobe of the male, with the inner sclerotic structure (Fig. 26.5-7), is distinctly different from the drawings made by authors such as Illies (1955) and Aubert (1959). The sub-genital plate of the male (Fig. 22.3-4) also shows marked differences. The variations seem to be of local distribution.

Body length. Male: 5.8-7.8 mm, females from 6.8-10.0 mm. The mean length of the female samples only varies from 7.8 mm to 8.3 mm (Fig. 34). The individual variation was highest in Sæterbekken, Bærum, loc. 63, from 7.2 to 10.0 mm.

Wing length. Male 6.8-9.5 mm, female 8.0-12.0 mm. The mean length of the female samples varies from 9.2 to 10.9 mm (Fig. 34). The individual variation was highest in Sæterbekken, from 9.8 to 12.0 mm.

Wing factor (w/b). All specimens were long-winged. Within a sample the variation may be relatively great as in loc. 63, Bærum, from 1.14-1.67. The mean of the sample is more constant, from 1.11 to 1.29 mm.

Wing venation (Fig. 33). There are the same variations in the wing veins of this species as with *N. arctica*, but there is a different percentage distribution (Table IV).

There are considerable differences from locality to locality and the material from Finnmark and Nordland differs from the others in the irregularity of the costa and sub-costa area in the fore-wing (Fig. 33 and Table IV).

Nemoura cinerea (Retzius, 1783)

Drawings of this species by authors such as Kührtreiber (1934), Kimmins (1950), Brinck

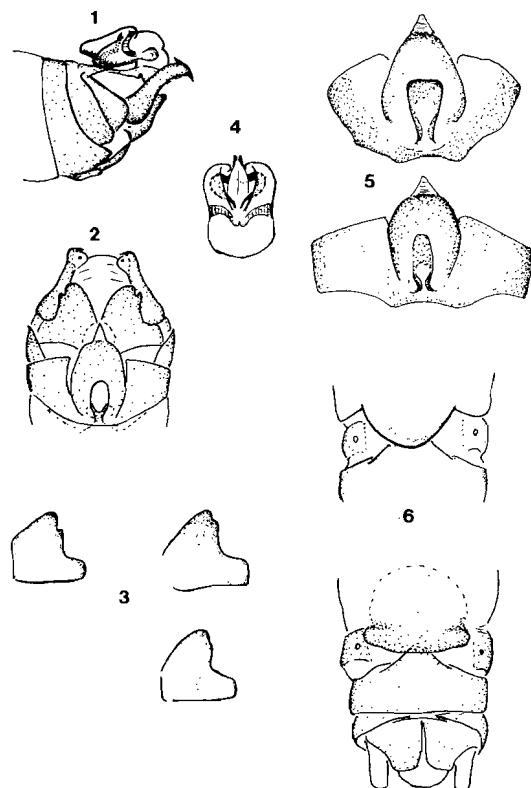


Fig. 27. *Nemoura cinerea*. 1-2. The abdominal apex of the male. 1. Lateral, 2. Ventral, 3. Different forms of sub-anal plates, 4. The supra-anal lobe from above, 5. Different forms of the sub-genital plate of the male, 6. The abdominal apex of female with different forms of the sub-genital plate.

(1952), Illies (1955), Aubert (1959), Consiglio (1959), who also described the subspecies *N. cinerea selene*, Hoffman (1960), Zhiltsova (1964), Hynes (1967), and Zwick (1971 and 1972a), who described subspecies *N. cinerea turcica* and *N. cinerea iberica*. Zwick (1973a) made detailed drawings of the supra-anal lobe.

The present study of this species is based on 662 ♂♂ and 597 ♀♀.

Morphological analysis

Genital appendages (Fig. 27). There are some differences in the cerci, sub-genital plate and sub-anal plates of the male and in the sub-genital plates of the female.

Body length. Male 4.8–7.4, female 5.3–9 mm. The mean length of the female samples varies a great deal, from 6.4 to 8.9 mm (Fig. 34). The individual variation is highest in the sample from Luru, Snåsa, loc. 33, from 5.4 to 9.0 mm.

Wing length. Male 5.0–8.0 mm, females 6.8–9.9 mm. The means of the female samples vary from 7.5 to 9.4 mm (Fig. 34). The individual variation in wing length is less than the variation in body length and highest in Luru, Snåsa, from 6.8 to 8.6 mm.

Wing factor (w/b). The species is usually long-winged with a high wing factor. In samples from Snåsa, however, there is a tendency to short-wingedness in some specimens, where the lowest wing factor is 0.89.

Wing venation. There are also marked variations in the wing veins of this species (Fig. 33). It is especially the radial veins which vary, the median veins being highly stable (Table IV and Fig. 33).

Nemoura flexuosa Aubert, 1949

Drawings of this species were made by among others Aubert (1949 and 1959), Brinck (1952 and 1956, *N. eratica* Class = *N. flexuosa* Aubert), Illies (1955), Hoffman (1960) and Zwick (1970).

The present study of this species is based on 28 ♂♂ and 47 ♀♀.

Morphological analysis

Genital appendages (Fig. 28). The variations are minute. The material is small and

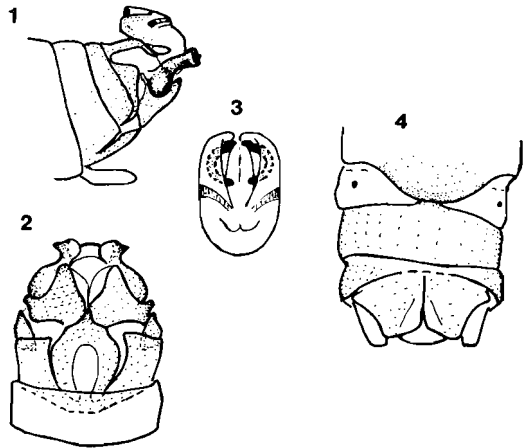


Fig. 28. *Nemoura flexuosa*. 1–2. The abdominal apex of the male. 1. Lateral, 2. Ventral, 3. The supra-anal lobe from above, 4. The female abdominal apex.

agrees with the description given by Aubert (1959) and Brinck (1952).

Body length. Males 4.30–5.20 mm, females 5.50–8.80 mm (Fig. 34).

Wing length. Males 3.78–4.89 mm, females 5.12–8.60 mm (Fig. 34).

Wing factor (w/b). of the two samples was 1.29 and 1.34, both long-winged.

Wing venation. The material was small. However, the same variations are present in the wing veins of this species as in the other *Nemoura* species (Table IV). There is a more pronounced disturbance in the radial veins than in the previously mentioned species (Fig. 33).

Nemoura sahlbergi Morton, 1896

Drawings of this species by authors such as Brinck (1952), Zhiltsova (1964), and Meinander (1965). Zhiltsova (1966) made drawings of specimens which were in some respects different from the descriptions given by the previously mentioned authors. Lillehammer (1972) described the variation in the Norwegian material and Benedetto (1973) made drawings of specimens from Sweden. Zwick (1973b) described a new subspecies *N. sahlbergi problematica* and made drawings of the cerci.

The study of this species is based on 91 ♂♂ and 87 ♀♀.

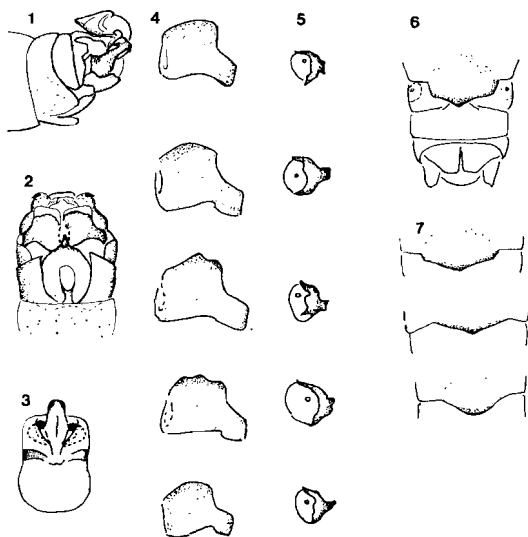


Fig. 29. *Nemoura sahlbergi*. 1-2. The abdominal apex of the male. 1. Lateral, 2. Ventral, 3. Supra-anal lobe from above. 4. Different forms of the sub-anal plate (4) and cerci 5., 6. The abdominal apex of the female, 7. Different forms of the sub-genital plate.

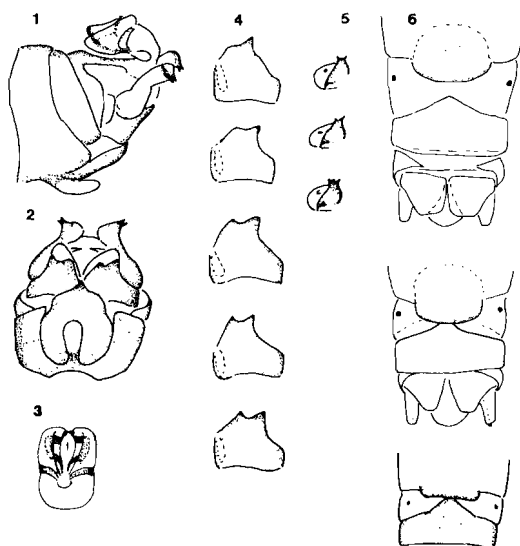


Fig. 30. *Nemoura viki*. 1-2. The abdominal apex of the male. 1. Lateral, 2. Ventral, 3. The supra-anal lobe seen from above, 4. Different shape of the sub-anal plates, 5. Cerci, 6. The abdominal apex of the female with different forms of the sub-genital plate.

Morphological analysis

Genital appendages (Fig. 29). There are marked variations in the shape of the cerci and the sub-anal plates of the male (Fig. 29.4 and 5). The sub-genital plate of the female also varies to a high degree (Fig. 29.6 and 7). The species forms local populations in respect to the mentioned characters.

Body length. Males: 3.8-6.2 mm, females: 4.2-7.0 mm (Fig. 29).

Wing length. Males: 5.7-7.2 mm, females: 6.5-8.5 mm (Fig. 29).

Wing factor (w/b). The species is usually long-winged.

Wing venation varies a great deal and there are local differences in the veins (Table IV).

Nemoura viki Lillehammer, 1972

Drawings of this species by Lillehammer (1972c).

The present study of this species was based on 51 ♂♂ and 82 ♀♀.

Morphological analysis

Genital appendages (Fig. 30). There are marked variations in the shape of the cerci

and the sub-anal plates of the male (Fig. 30.4 and 5). In the females there are variations in the shape of the sub-genital plate (Fig. 30.6).

Body length: Males: 4.2-7.0, females: 5.0-8.0 mm (Fig. 34).

Wing length. Males: 4.7-6.2 mm, females: 6.2-7.6 mm (Fig. 34).

Wing factor (w/b). The species is usually long-winged, but in some specimens there is a weak tendency towards short-wingedness, with a w/b of 0.94.

Wing venation. This species also displays the same variations in the wing veins as the other *Nemoura* species (Table IV)

The shape shown in Fig. 33 C was very common in this species.

Discussion of the *Nemoura* species

The variations in the morphology of the genital appendages are small in *N. flexuosa*, greater in *Nemoura acivularis* and *N. cinerea*, and of a high degree in *N. sahlbergi*, *N. viki* and *N. arctica*. The last-mentioned species has the greatest variation and there are clear local differences.

The great variation in characters which in

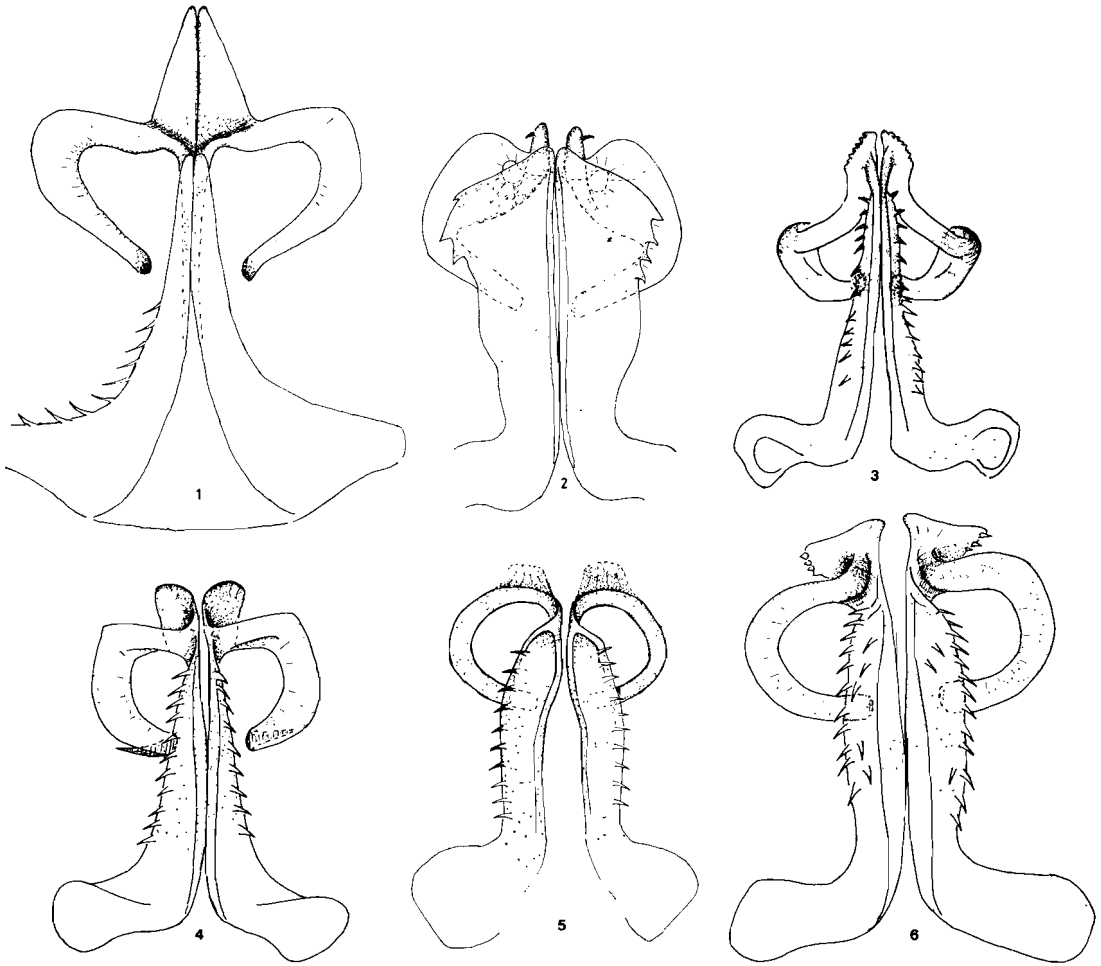


Fig. 31. The sclerotized parts of the supra-anal lobe of the *Nemoura* species, seen from below. 1. *Nemoura cinerea*, 2. *N. avicularis*, 3. *N. sahlbergi*, 4. *N. viki*, 5. *N. flexuosa*, 6. *N. arctica*.

the male are used for identifications in key-books, cerci, sub-anal plates and sub-genital plates, makes it necessary to rely on the shape of the supra-anal lobe for identification. The supra-anal lobe seems to be the best and most stable character in the *Nemoura* species, which also Zwick (1973b) mentioned.

This work shows some variations in the supra-anal lobe of *N. arctica*, and of some other species, but the basic form of the sclerotized parts of supra-anal lobe seems to be fairly constant. Fig. 31.1-6 shows the inner structure of the sclerotized parts of the supra-anal lobe seen from below. Here, *N. cinerea*, *N. avicularis* and *N. sahlbergi* seem to be quite different from each other and from the

other three species. *N. viki*, *N. flexuosa* and *N. arctica* seem to be more closely related.

The variation in body length was considerable in all species, as was wing length (Fig. 34). *Nemoura avicularis* and *N. sahlbergi* are always long-winged. *N. cinerea* and *N. arctica* have in some localities a weak tendency towards short-wingedness. This is most pronounced in *N. arctica*.

The wing venation of the species shows marked variations, and all of them contain specimens with the forms shown in Fig. 33. There are pronounced local differences (Table IV). The irregular veins in the radial area often result in the disappearance of the X-form in the veins. The high percentage of

irregularity in Table IV indicates the incomplete X-veins of those specimens. The character is therefore invalid.

Nemurella Kempny, 1898

In this genus there is only one species.

Nemurella picteti Klapálek, 1900

Drawings of this species by Kimmins (1950), Despax (1951), Brinck (1952), Illies (1955), Aubert (1959), Hoffman (1960), Zhiltsova (1964) and Hynes (1967). Zwick (1973a) made detailed drawings of the supra-anal lobe.

The present study of this species was based on 546 ♂♂ and 536 ♀♀.

Morphological analysis

Genital appendages (Fig. 32). The shape of the genital appendages of the male seems to be fairly constant. The sub-genital plate of the female, however, is highly variable, even within samples. The shapes in Fig. 28.3 were all found within the same sample.

Body length. Males 5.4–8.2 mm, females 6.0–11.4 mm. The mean of the female samples varies from 7.6 to 9.7 mm. Within the samples the variation is greatest at Hornsvann, Sogn og Fjordane, loc. 37 B, from 7.7–11.4 mm.

Wing length. Males 6.8–7.6 mm, females 8.5–10.5 mm. The mean of the female sam-

ples is fairly constant, from 9.7 to 9.9 mm. The individual variation is again highest in the sample from Hornsvann, from 8.5 to 10.5 mm.

Wing factor (w/b). The species is nearly always long-winged, though there are differences between the samples. The individual variation of w/b is from 0.95 to 1.50, the latter being extremely long-winged.

Wing venation. This species has the same variations as the other Nemourids (Fig. 33). The X-veins in the fore-wings are, however, nearly always well visible and the species is one of the most stable Nemourids as regards wing venation. There are, however, some differences between the samples (Table IV).

Protonemura Kempny, 1898

In this genus two species are recorded from Norway.

Protonemura intricata Ris, 1902

Despax (1951), Illies (1955), Aubert (1959), Hoffman (1960), and Zhiltsova (1964) are

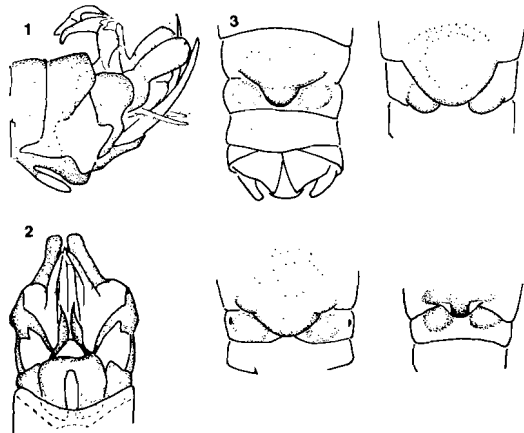


Fig. 32. *Nemurella picteti*. 1–2. The abdominal apex of the male. 1. Lateral, 2. Ventral, 3. The abdominal apex of the female with different forms of the sub-genital plate.

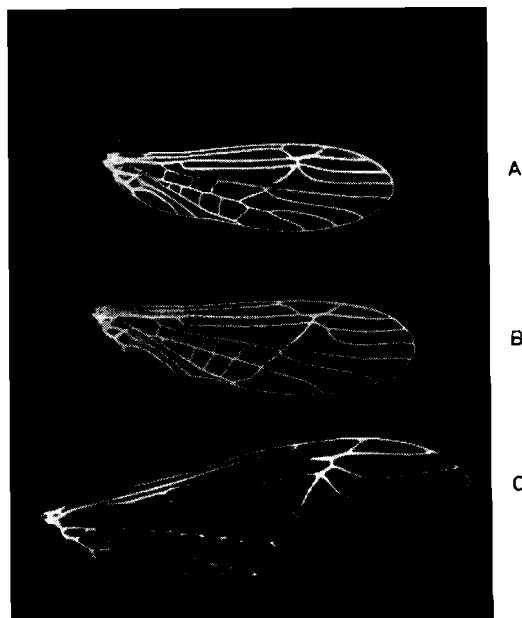


Fig. 33. Different forms of the wing veins present in *Nemoura* species. A – 'normal' wing venation, R_{4+5} comes from the cross-vein. B – R_{4+5} comes from R_{2+3} . C. Both R_{2+3} and R_{4+5} from the cross-vein. A and B have normal M_{1+2} and M_{3+4} . In C they go together and make a fork. The forking in the Median can occur in all three forms.

among the authors who have published drawings of this species.

The present material consists of only one male and one female and the drawings in Fig. 35 are made from those specimens. The male had a body length of 6.3 mm and the length of the fore-wing was 8.0 mm. The female had a body length of 6.7 mm and the length of the fore-wing was 8.3 mm.

They were both long-winged with a wing factor of 1.24.

Protonemura meyeri (Pictet, 1841)

Drawings of this species by authors such as Kimmins (1950), Despax (1951), Brinck (1952), Aubert (1959), Illies (1955), Rauser (1962a), Hynes (1967), Thorup (1967) and Vasiliu & Costea (1942).

The present study of this species was based on 108 ♂♂ and 142 ♀♀.

Morphological analysis

Genital appendages (Fig. 36). The Norwegian material differs to some degree from the description given by Brinck (1952), Illies (1955) and Hynes (1967), and there are marked variations in the morphology of the genitalia of both males and females. In the females it is especially the sub-genital plate which varies (Fig. 36.3 and 4). Some of them are of a shape similar to the description given by Aubert (1959), while other specimens have a form which is like the description given by Hynes (1967). The variations seem to arise from uneven chitination and the whole variation can be found in one sample.

In the male it is notably the form of the sub-anal plates and the tigellus which varies to the highest degree (Fig. 36.2). Also here differences in shape are found within the same samples.

Body length of the males 6.8–8.0 mm, females 7.0–9.9 mm. Body length varies to a fairly high degree, also within the samples. The mean length of the female samples is fairly constant and lies between 8.3 and 8.6 mm (Fig. 38).

Wing length of the males 8.7–9.5 mm, females 9.8–11.4 mm. The wing length varies less than the body length within samples of

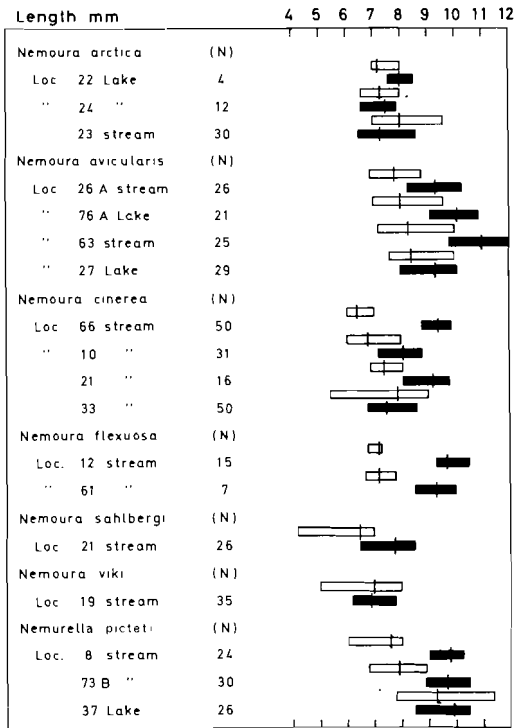


Fig. 34. Body length and wing length in different samples of *N. arctica*, *N. avicularis*, *N. cinerea*, *N. flexuosa*, *N. sahlbergi*, *N. viki*, and *Nemurella picteti*. White rectangle: body length, dark rectangle: wing length. Vertical line: the mean length of the sample.

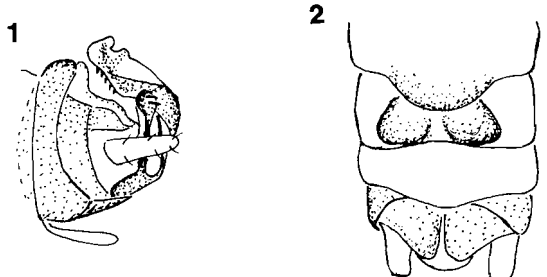


Fig. 35. *Protonemura intricata*. 1. The abdominal apex of the male, lateral, 2. The abdominal apex of the female, ventral.

females. However, the differences in the mean length of the samples ranges from 10.0 to 10.8 mm, somewhat larger than the difference in the mean body length (Fig. 38).

Wing factor (w/b). Within a sample the

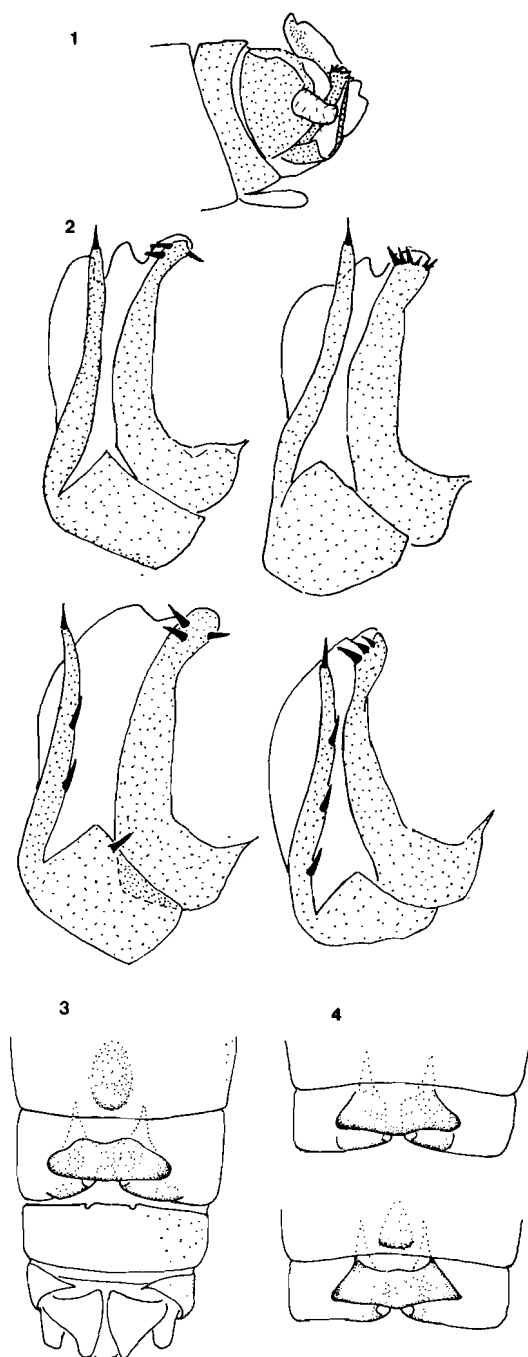


Fig. 36. *Protonemura meyeri*. 1. The abdominal apex of the male, lateral, 2. Different forms of the sub-anal plate, the tigellus and intermediate appendages, 3. The abdominal apex of the female, 4. Different forms of the female sub-genital plate.

greatest variation is from 1.18 to 1.44 mm. All the investigated specimens are long-winged. The smallest w/b is 1.10. The mean of the samples varies from 1.2 to 1.3.

The wing veins (Fig. 37) are fairly stable and there are only small variations in the radial area.

The X-pattern in the veins of the anterior wings is clearly visible in this species.

Discussion of the *Nemouridae* characters

The X-pattern of the wing veins is not a valid character for this family. This is documented in the text and in Table IV and Fig. 33.

For the male the characters used in separating the genus seem to be valid. In the females, some of them are less valid.

All the investigated *Amphinemura* and *Protonemura* specimens had the typical nymphal gill vestiges; this is a valid character. The character used for separating the females, however, is not valid, because *Protonemura* specimens might have the 7th sternum extended posteriorly as in *Amphinemura*, and the character might nearly be absent in some *Amphinemura* females (Fig. 20.4, 22.4). The shape of the intermediate appendages of the male is valid for separating the two genus.

The characters used by Brinck (1952) and Zhiltsova (1964) in separating the males of *Nemoura* and *Nemurella* (p. 80) are valid, but are less valid for the females as the anterior sternum of *Nemoura* specimens might be nearly straight as shown in Fig. 26.8, and in *Nemurella* might be elongated triangularly (Fig. 32.3).

FAM. CAPNIIDAE KLAPÁLEK

Zwick (1973a) used the following characters for defining the family: The reduction of the



Fig. 37. The right fore-wing of *Protonemura meyeri*.

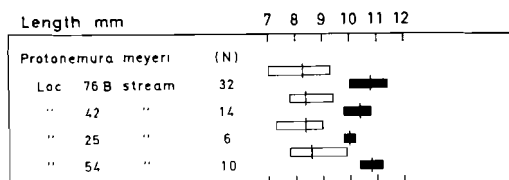


Fig. 38. Body-length and wing-length in different samples of *P. meyeri*. White rectangle: body-length, dark rectangle: wing-length, vertical line: the mean length of the samples.

Cu cross-veins; the special external male copulatory organ which he described in p. 42 and in Fig. 54; and the absence of a receptacula seminis in the female.

The two genera *Capnia* and *Capnopsis* can be separated on the anal lobe in the hind wing and on the cerci. Whereas *Capnopsis* lacks the anal lobe in the hind wing and has short, 7–8 segmented cerci, *Capnia* have an anal lobe and long cerci (Brinck 1952).

In Norway the Capniidae consists of two genera, *Capnia* and *Capnopsis*, represented by 5 species.

Capnia Pictet, 1841

The *Capnia* species are separated in females on the form of the sub-genital plate and in males mainly on the form of the sclerotization of the 7th, 8th and 9th segments and the supra-anal lobe. The wing veins are also used to some degree, as with *C. bifrons*. In this genus 5 species are recorded from Norway.

Capnia atra Morton, 1896

Drawings of this species by authors such as Morton (1929), Bengtsson (1933), Kimmins (1950), Brinck 1952 and 1956), Hynes (1955 and 1967) and Zhiltsova (1964). Brinck (1952) published drawings of different shapes of the sub-genital plate in this species and also gave (1956) a detailed description of the genitalia.

The present study of this species is based on 1446 ♂♂ and 1866 ♀♀.

Morphological analysis

Genital appendages (Fig. 39). The variation in the shape of the female sub-genital plate is marked (Fig. 39.8). In the male there are also marked variations in the sclerotized

parts of the 6th, 7th and 8th segments (Figs. 39.6–8). Those characters are used in description of this and closely related species.

Body length. Males 4.3–6.7 mm, females 4.5–10.0 mm. The mean of the female samples varies from 5.4 to 8.5 mm, which is a high variation (Fig. 45). The individual variation is even greater within the samples

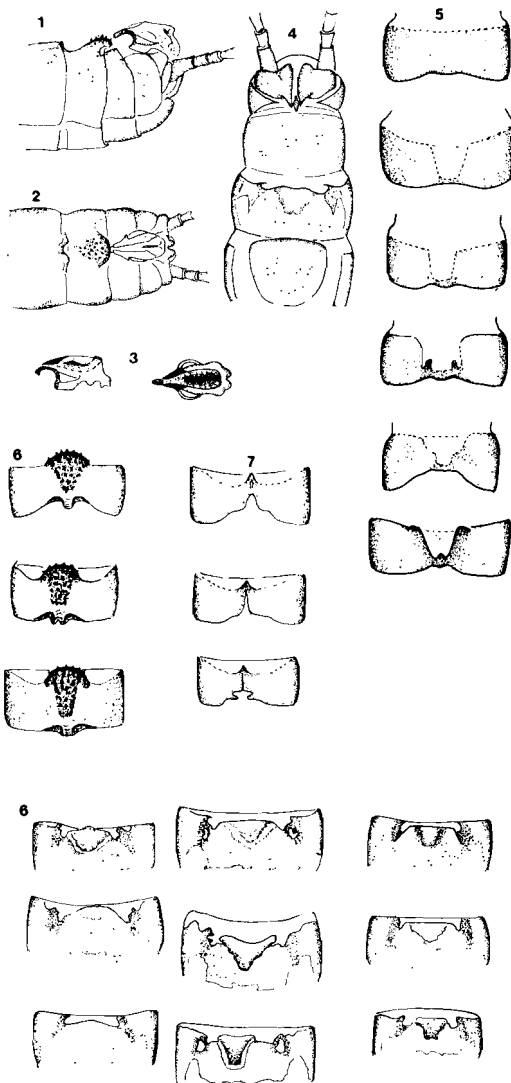


Fig. 39. *Capnia atra*. 1–2. The male abdominal apex, 1. Lateral, 2. Dorsal, 3. Supra-anal lobe, 4. The female abdominal apex, 5. Different forms of the male 6th tergum, 6. Different forms of the male 7th tergum, 7. Different forms of the male 8th tergum, 8. Different forms of female sub-genital plate.

from Øvre Heimdal, Oppland, loc. 75A and from Finse, Hordaland, loc. 40, 6.0–9.5 mm and 6.5–10.0 mm.

Wing length. Males 3.9–6.5 mm, females 4.2–8.3 mm. The mean of the females varies from 4.7 to 7.2 mm. The individual variation is highest in the sample from Gjende, Vågå loc. 80A with values from 4.2 to 8.0 mm (Fig. 45). In this species the variation in wing length is far greater than the variation in body length.

Wing factor (w/b). Most of the samples show an all over tendency towards a short-wingedness and the lowest mean is 0.71. However, in most of the samples there are both short-winged and long-winged specimens. The only constant short-winged sample was from Blåtjønn, Oppland 1465 m a.s.l. where the lowest w/b was 0.59 and the highest 0.89.

Wing venation. The wing veins have a considerable tendency to variation. The radial and cubital area have especially large variations (Fig. 44). The local variations in the comparisons between the Capniidae species are shown in Table V. The high percentage of type 3 (Fig. 44 and Table V) at loc. 40 and 31 must be mentioned. This is usually a *C. bifrons* character.

Capnia bifrons (Newman, 1839)

Morton (1896 and 1929, *C. nigra* Pictet = *C. bifrons* Newman), Kimmins (1950), Despax (1951), Brinck (1952), Illies (1955), Winkler (1957), Aubert (1959), Hoffman (1960), Zhiltsova (1964) and Hynes (1967) have all published drawings of this species.

The present study of this species is based on 396 ♂♂ and 231 ♀♀.

Morphological analysis

Genital appendages (Fig. 40). Variations are present both in males and females. There are marked differences and a tendency to produce local forms. This is most apparent in the specimens from Øvre Heimdal.

Body length. Males 5.3–8.7 mm, females 6.9–11.0 mm. The mean of the female samples varies from 8.4 to 9.4 mm, a moderate variation. The individual variation is high in some samples as from Sæterbekken, Bærum, Akershus loc. 63 with values from 6.9 to 10.7 mm (Fig. 45).

Wing length. Males 0.5–0.8 mm, females 6.0–8.0 mm. The mean varies from 6.6 to 8.2 (Fig. 45). The variation is higher here than

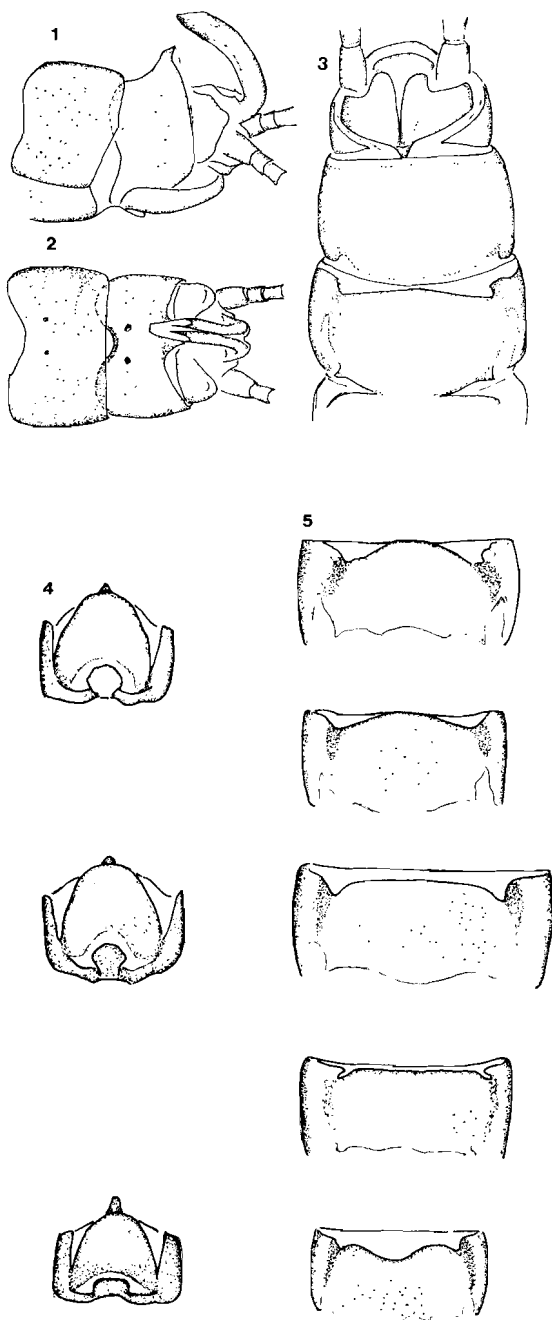


Fig. 40. *Capnia bifrons*. 1–2. The male abdominal apex, 1. Lateral, 2. Dorsal, 3. The abdominal apex of the female, 4. Different forms of the male sub-genital plate and vesicle, 5. Different forms of the female sub-genital plate.

with body length. The individual variation inside samples is lower than with body length. The highest variation was in the sample from Sæterbekken with values ranging from 7.1 to 9.0 mm.

Wing factor (w/b). On average, the samples vary from short-wingedness to normal wing length with a factor from 0.76 at Tynset loc. 72 to 0.98 at Sæterbekken, Bærum. The individual variation was high and the lowest measured wing factor was 0.67 at Tynset, and the highest 1.13 at Sæterbekken. In Sæterbekken, however, there are short-winged specimens with a wing factor of 0.82.

Wing venation (Fig. 44) of this species is highly stable, but there are some local differences (Table V).

Capnia pygmaea Zetterstedt, 1840

Drawings of this species by authors such as Esben-Petersen (1910), Bengtsson (1933), Brinck (1952), Zhiltsova (1964 and 1966).

The present study of this species is based on 387 ♂♂ and 377 ♀♀.

Morphological analysis

Genital appendages (Fig. 41). The variations in the male are marked both in the 6th and 7th terga (Fig. 41.3-4). The variation is also marked in the female as in the shape of the sub-genital plate (Fig. 41.5-6). There are local differences.

Body length. Males 3.7-5.7 mm, females 4.0-7.5 mm. The variation in the mean of the female samples was high, from 4.65 at Rendalen, Hedmark loc. 69A to 6.4 mm in the sample from Sauda, Rogaland loc. 46B (Fig. 45). The individual variation is highest in the sample from Sauda, with values from 5.2 to 7.5 mm.

Wing length. Male 4.7-6.2 mm, females 5.7-8.3 mm. The mean of the female samples varies from 6.2 to 7.5 mm (Fig. 45). The individual variation was highest at Sauda, from 6.5 to 8.3 mm.

Wing factor (w/b). On average the species is long-iwnged, with wing factors from 1.17 to 1.35.

Wing venation. The variations in the wing veins are marked, and there are clear local differences. The high percentage of shape 3 (Table V) at loc. 68, which is a *C. bifrons* character (Fig. 44), should be mentioned.

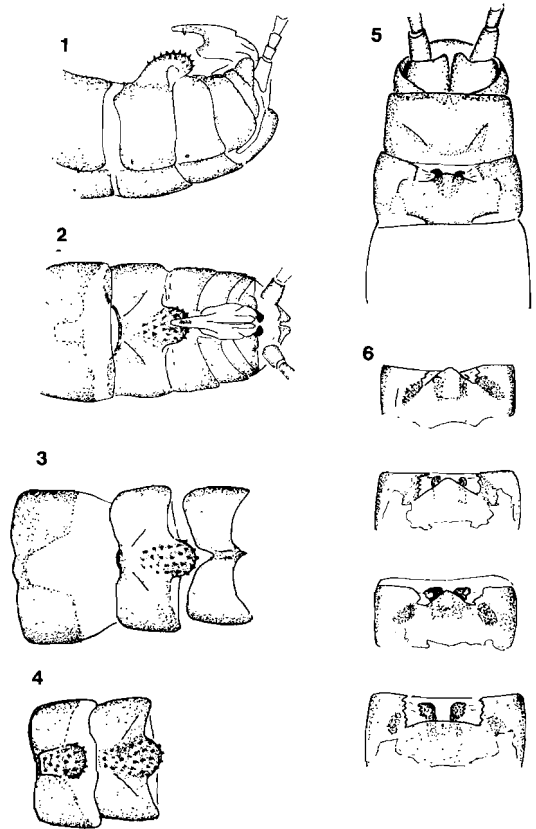


Fig. 41. *Capnia pygmaea*. 1-2. The male abdominal apex. 1. Lateral, 2. Dorsal, 3 and 4. Different forms of the 6th and 7th terga. 5. The female abdominal apex, 6. Different forms of the sub-genital plate.

Capnia vidua Klapálek, 1904

Drawings of this species by among others Morton (1929), Kühtreiber (1934), Aubert (1950 and 1959), Kimmins (1950), Despax (1951), Hynes (1955 and 1967), Illies (1955), Winkler (1957), Rauser (1962b and 1968), Meinander (1965) and Lillehammer (1972a). The sub-species *C. vidua vidua*, *C. vidua collarti* and *C. vidua anglica* are described by Aubert (1950), *C. vidua brachyptera* by Hynes (1955) and *C. vidua rilensis* by Rauser (1962b). Lillehammer (1972a) discussed the subspecies *C. vidua brachyptera* and *C. vidua anglica* together with the Scandinavian material.

The present study of this species is based on 5 ♂♂ and 11 ♀♀.

Morphological analysis

Genital appendages (Fig. 42). The morphology was discussed by Lillehammer (1972), who showed the species to be highly variable in the characters used for separating the sub-species.

Body length. Males 4.5–5.5 mm, females 5.8–7.7 mm (mean of the females 6.41 mm).

Wing length. Males 0.96–1.04 mm, females 4.2–6.0 mm (mean of the females 5.4 mm).

Wing factor (w/b). The mean value is 0.84. This makes the species on average short-winged. The individual variation is from 0.72 to 1.03.

Wing venation. There are marked differences in the wing veins of this species. A high degree of variation in the cubital area was typical of the examined specimens (Table V).

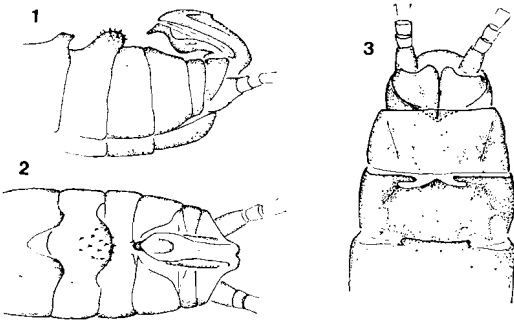


Fig. 42. *Capnia vidua*. 1–2. The male abdominal apex, 1. Lateral, 2. Dorsal, 3. female abdominal apex.

Capnopsis Morton, 1895

In this genus there is only one species.

Capnopsis schilleri (Rostock, 1892)

Drawings of this species by authors such as Morton (1896), Despax (1951), Brinck (1952), Illies (1955) and Zhiltsova (1964).

The present study of this species is based on 275 ♂♂ and 340 ♀♀.

Morphological analysis

Genital appendages (Fig. 43). The variation is small in both male and females.

Body length. Males 3.0–5.2 mm, females 3.8–6.0 mm. The mean of the female samples varies from 4.1 to 5.2 mm (Fig. 45). The individual variation is highest in the sample

from Sæterbekken, Bærum, loc. 63, from 5.6 mm to 7.0 mm.

Wing length. Males 5.2–5.85 mm, females 5.7–6.9 mm. The means of the female samples vary from 6.1 to 6.6 mm. The individual variation is highest at Sæterbekken, Bærum, from 5.8 to 6.9 mm (Fig. 45).

Wing factor (w/b). The species is long-winged, with a mean wing factor in the female samples from 1.27 to 1.61.

Wing venation is very constant in form, and in the three samples there are no marked differences (Table V).

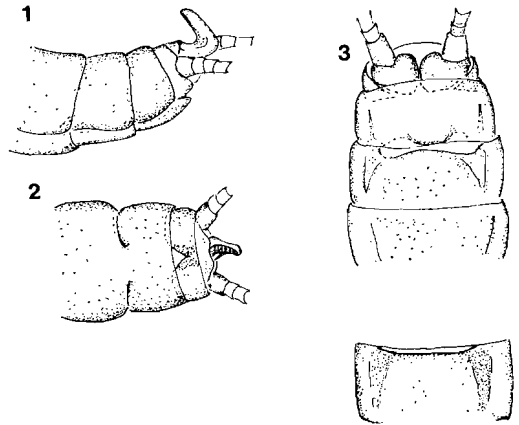


Fig. 43. *Capnopsis schilleri*. 1–2. The male abdominal apex, 1. Lateral, 2. Dorsal, 3. The female abdominal apex with different forms of the subgenital plate.

Discussion of the *Capniidae* species

The form of the genital appendages of both males and females varies to a high degree. It is especially high in *Capnia atra* (Fig. 39), but is also marked in *C. bifrons*, *C. pygmaea* and *C. vidua*. In *Capnopsis schilleri* there are only small differences.

The variation in the form of the male *C. atra* is so high that it seems that *C. ahngerii*, Koponen (1949) and Benedetto (1971) may fit within the variation of that species. However, comparisons of the species must be made to be sure of this. The female subgenital plate also varies to a high degree and some of the specimens have plates which are so irregular that they resemble that of *C. labradora*, Harper and Hynes (1971).

The wing factors of *C. pygmaea* and *Capnopsis schilleri* make the species long-winged. In *C. atra*, *C. bifrons* and *C. vidua* there are

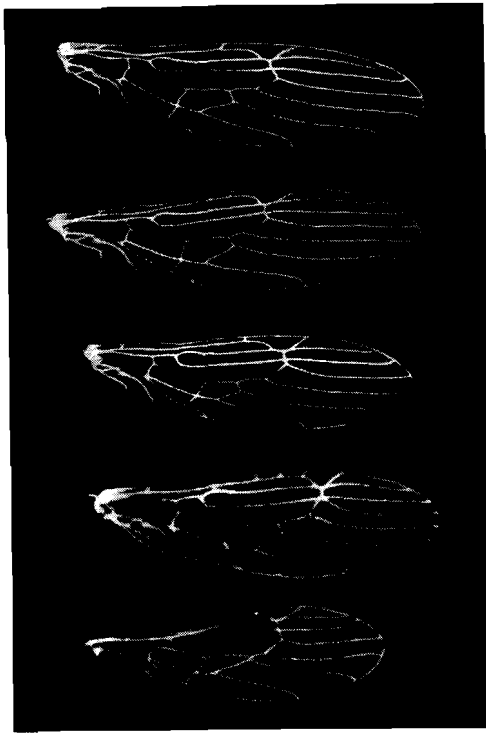


Fig. 44. Differences in wing veins observed in the Capniidae species. A-B. The wing veins in the radial and radial-median cross-vein areas (rs) 'normal' (1), the posterior cubital cell rectangular (4), the right anterior cubital cell 'normal' (5). C-D. The wing veins in rs area makes a Nemourid X (2), the posterior cubital cell triangular (3), the right anterior cubital cell 'normal' (5). E. The wing veins in rs area 'normal' (1), the anterior cubital cell triangular (3), the right anterior cubital cell irregular (6). Nos. (1)-(6) in Fig. 44, and Table V refer to the recognizable wing patterns found in the individual specimens.

specimens with wing factors which make them short-winged. In both *C. atra* and *C. bifrons* there are short-winged populations. This is most pronounced in *C. atra*.

The wing venation of *Copnopsis schilleri* and also of *Capnia bifrons* is highly regular. It is irregular in *C. vidua*, *C. pygmaea* and *C. atra*, and to the greatest extent in the last mentioned species (Table V).

The commonly used character for *C. bifrons*, the two rectangular cubital cells, seems to be a less valuable character as it appears to be common in both *C. atra* and *C. pygmaea*. About 50% of the *Capnia atra* specimens from Raudvann, Mo i Rana loc. 31 have the same character (Table V). In all the above

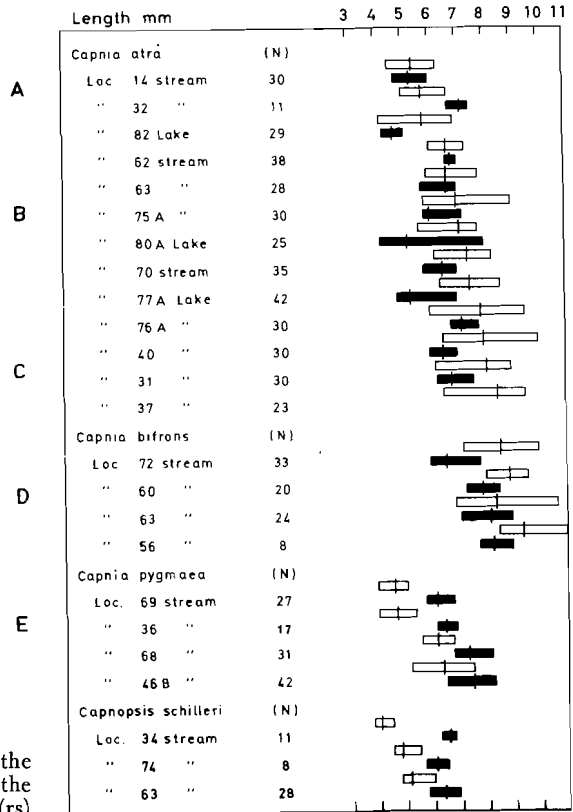


Fig. 45. Body length and wing length in different samples of *Capnia atra*, *C. bifrons*, *C. pygmaea* and *Capnopsis schilleri*. White rectangle: body length, dark rectangle: wing length, vertical lines: the mean of the samples.

mentioned characters there are local differences. In the fore-wings the veins vary considerably and they also frequently make a 'Nemourid-X' in some samples (Fig. 44). This makes the Nemourid character even less valid in separating the two families.

The characters used in separating the two genera, *Capnia* and *Capnopsis* (Brinck 1952 and page 93), are always present.

The character used by the same author to separate *Capniidae* from Leuctrida, the reduction of cross-veins in the cubital area, in the former is a good character and always present.

FAM. LEUCTRIDAE KLAPÁLEK

The family is characterized by the following synapomorphy: 1. The internal part of the

Table V. The occurrence of different forms of wing veins in the Capniidae species in samples from different localities. The forms 1-6 are described in Fig. 44

N = size of sample

Species, localities	N	Forms of wing veins					
		1	2	3	4	5	6
<i>Capnia atra</i>							
Loc. 14, stream	30	100	0	13	87	0	100
Loc. 82, lake	29	89	11	7	93	4	96
Loc. 62, stream	38	56	44	22	78	6	94
Loc. 75A, lake	30	60	40	20	80	0	100
Loc. 77A, lake	42	78	22	4	96	0	100
Loc. 40, lake	30	92	8	41	59	0	100
Loc. 31, lake	30	96	4	51	49	0	100
Loc. 37B, lake	23	87	13	17	83	0	100
Loc. 68, lake	21	90	10	32	68	0	100
<i>Capnia bifrons</i>							
Loc. 72, stream	33	88	12	100	0	0	100
Loc. 60, stream	20	95	5	100	0	0	100
Loc. 63, stream	24	100	0	100	0	0	100
Loc. 56, stream	8	100	0	100	0	0	100
<i>Capnia pygmaea</i>							
Loc. 69, stream	27	92	8	4	96	0	100
Loc. 68, stream	31	90	10	42	58	0	100
Loc. 46B, stream	42	76	24	20	80	5	95
<i>Capnia vidua</i>							
streams	11	100	0	11	89	56	44
<i>Capnopsis schilleri</i>							
Loc. 34, stream	11	100	0	100	0	-	-
Loc. 74, stream	8	100	0	100	0	-	-
Loc. 63, stream	28	100	0	100	0	-	-

paraproct that forms a tube is basally fused and expanded in a cluster form. 2. Leuctridae are characterized by a marked expansion of the Vasa deferentia which, at least in the distal portion, functions as an extra sperm sac (Zwick 1973a, p. 42, Figs. 42, 55 and 56).

The family is divided into two subfamilies: Megaleuctrinae, Zwick and Leuctrinae, Klapálek. Only Leuctrina are present in Europe. In Norway one genera and four species are recorded which belong to this family.

SUBFAM. LEUCTRIDAE KLAPÁLEK

Leuctra Stephens, 1836

The *Leuctra* species are separated on the shape of the genitalia appendages: The female on the sub-genital plate and the spermatheca, and the males generally on the form of the dorsal sclerotic parts of the 6th, 7th,

8th and 9th segments, the supra-anal plate, sub-anal lobes and the specillum.

Leuctra digitata Kempny, 1899

Drawings of this species made by Mosley (1932), Despax (1951), Brinck (1952), Illies (1955), Winkler (1957), Zhiltsova (1964), and Klotzek (1971).

The studies of this species were based on 641 ♂♂ and 473 ♀♀.

Morphological analysis

Genital appendages (Fig. 46). In the male there are pronounced variations in the characters used for taxonomy (Fig. 46.2-4). In the female the variation is less (Fig. 46.5-6). Generally most of the forms can be found

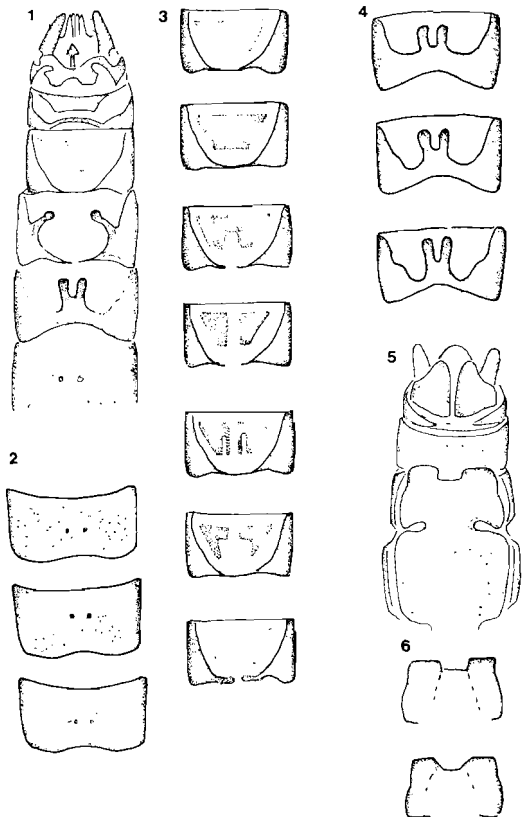


Fig. 46. *Leuctra digitata*. 1. The abdominal apex of the male, Different form of the 5th terga (2), the 6th terga (3), and the 7th terga (4), 5. The abdominal apex of the female, 6. Different forms of the sub-genital plate.

within a single sample, but there are also local differences.

Body length. Males 5.0–7.3, females 5.0–9.0 mm. The mean of the female samples varies from 7.0–8.2 mm. The individual variation is high within some samples, from 5.7 to 8.9 mm in the sample from Sæterbekken, Bærum, Akershus loc. 63 (Fig. 52).

Wing length. Males 6.8–8.3 mm, females 6.9–9.1 mm. The mean of the wing samples varies less than the body length and from 7.9–8.8 mm (Fig. 52). The individual variation, however, is less, ranging from 6.7 to 9.2 mm in the sample from Elgjuvet, Sauda, Rogaland, loc. 48.

Wing factor (w/b). The species are always 'normal' or long-winged, and the mean of the samples varies from 1.06 to 1.15. The individual variation is from 0.98 to 1.47.

Wing venation. In *Leuctra digitata* the variations in the wing veins are small. Differences between the samples are shown in Table VI and Fig. 51.

Leuctra fusca (Linnaeus, 1758)

Drawings of this species were made by Mosley (1932), Kühtreiber (1934), Kimmins (1950), Despax (1951 = *L. fuscoventris* Stephens), Brinck (1952), Illies (1955), Aubert (1959), Hoffman (1960), Zhiltsova (1964), Lillehammer (1965), Hynes (1967), Berthélemy (1969) and Klotzek (1971).

The study of this species was based on 1134 ♂♂ and 903 ♀♀.

Morphological analysis

Genital appendages (Fig. 47). In the male there are pronounced variations in the characters used for identification (Fig. 47.3–6). In the female the variation is less (Fig. 47.7). In the main a high number of the forms can be found within the samples, but there are also local differences. Comparison with some of the other species in the *fusca* group, (Aubert 1959, Fig. 161171) is very interesting, as it seems that some of the variants in characters of the male *fusca* overlap other species.

Body length. Males 4.4–6.8, females 4.2–8.5 mm. The mean of the female samples varies from 5.0 to 7.4 mm. The individual variation is high, from 5.0 to 8.2 mm in the sample from Øvre Heimdal loc. 76B (Fig. 52).

Wing length. Males 6.2–7.8 mm, females

6.8–9.3 mm. The mean of the female samples varies to a smaller degree, from 7.4 to 8.5 mm. The individual variation is higher – from 7.0 to 9.0 mm in the sample from Nordelva, Sauda loc. 47 (Fig. 52).

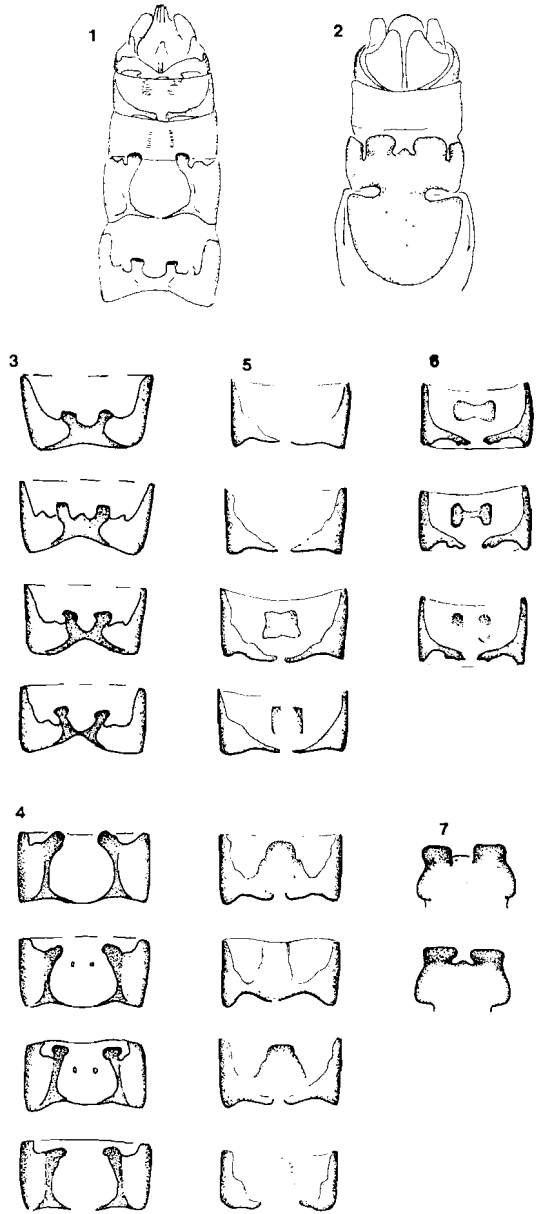


Fig. 47. *Leuctra fusca*. 1. The abdominal apex of the male. 2. The abdominal apex of the female. Different forms of the 6th terga (3), the 7th terga (4), the 8th terga (5) and the 9th terga (6). 7. Different forms of the sub-genital plate.

Wing factor (w/b). The species is always long-winged. The mean of the female samples varies from 1.09 to 1.47, while the individual variation ranges from 1.02 to 1.63.

Wing venation. In this species the variations are greater than in *L. digitata* (Table VI). In the specimens from Leirelva loc. 81, Valdres, Øvre Heimdal loc. 76B and Rendalen loc. 69B in eastern Norway the veins are fairly stable, while in the samples from Western Norway, Byrkjeland, Sveio loc. 42, Elgjuvet loc. 48 and Nordelva loc. 47, Sauda there are marked differences. In Nordelva the 'normal type' is only found in 46% of the specimens.

Leuctra hippopus Kempny, 1899

Drawings of this species by Morton (1929), Mosley (1932), Kimmins (1950), Despax (1951), Brinck (1952 and 1956), Illies (1955), Aubert (1956 and 1959), Hoffman (1960), Zhiltsova (1964), Lillehammer (1965), Rauser (1965, spermatheca) and Hynes (1967).

The present study of this species was based on 1923 ♂♂ and 1926 ♀♀.

Morphological analysis

Genital appendages (Figs. 48 and 49). Drawings of males and females made by different authors show no great differences in the genital appendages.

However, the Norwegian material shows a very high degree of variation and only a few specimens fit in completely with the descriptions of previous authors.

This made it necessary to make a special study of the morphological variation in this species.

In the last few years descriptions of new species in the 'hippopus group' have been published, but no description of the variation within *L. hippopus* has been given. Two of the new species are *L. pseudohippopus*, Rauser (1965) and *L. hippopoides* Kacanski and Zwick (1970).

An analysis of the variation in the genital appendages of the Norwegian material of *L. hippopus* is given below. Comparison with the two mentioned species is also carried out.

The analyses of the Norwegian material of *L. hippopus* made it clear that there was a high degree of variation in all characters used in the taxonomy of both males and fe-

males (Figs. 48 and 49). There is a tendency to produce local forms, this being most pronounced in the samples from loc. 70, Isternefoss (Table VI).

The male: The 7th abdominal segment. In the descriptions of Brinck (1952) and Illies (1955), the 7th abdominal segment has no tergal processes (Fig. 48.3A). In the Norwegian ma-

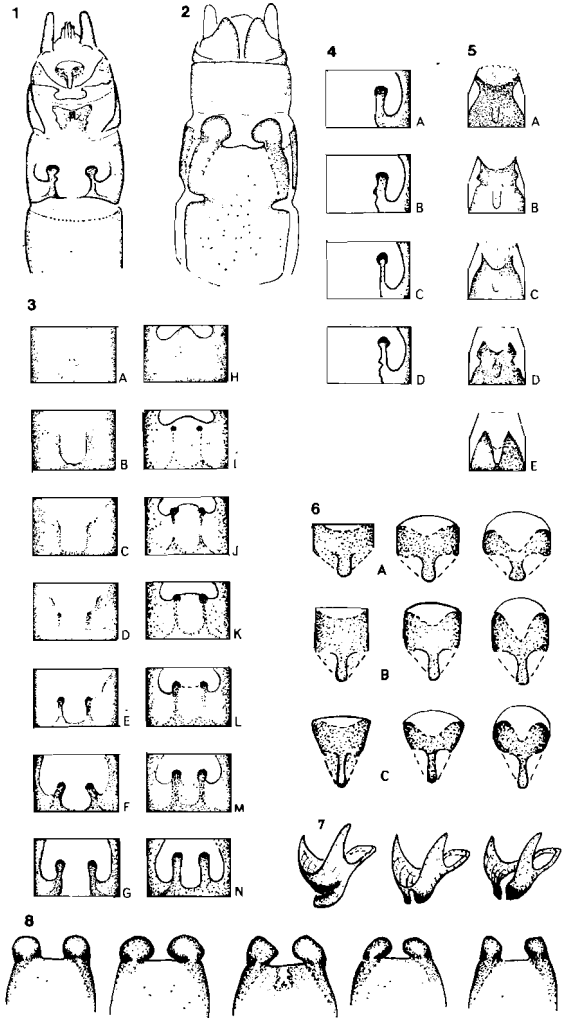


Fig. 48. *Leuctra hippopus*. 1. The abdominal apex of the male, 2. The female abdominal apex, 3. Different forms of the male 7th tergite, 4. Different forms of the male 8th tergite, 5. Different forms of the sclerotized plate of the male 9th tergite, 6. Different forms of the supra-anal plate. A, B and C indicate the basic form in each group of variants, in A with different sclerotization. 7. Different forms of the spermathec. 8. Different forms of the female sub-genital plates.

terial this is not so. There is a gradual change until a complete copy of the tergal process of the 8th segment is present (Figs. 48.3A-G and H-N). The ratio of each form is different in different samples. The shape of the 7th segment of *L. pseudohippopus* fits well within the variation described in Fig. 48.3. The form of the 7th segment shown in Fig. 48.3A is relatively rare. Aubert (1956) mentioned tergal processes on the 7th segment and made drawings of them. However, he maintained that they were a deformation. They are, however, normal and outermost points in a normal variation of *L. hippopus*.

8th abdominal segment (Fig. 48.4). This segment also varies to a certain extent. The tergal processes have a thin stalk and a rounded enlargement at the tip (C) or are more club-shaped, relatively thick, and lacking a clearly defined sphere at the tip (A) as in *L. pseudohippopus*. The internal wall of the stalk can either be smooth (A, C) or lacinate (B, D). In addition, in certain individuals remains of a weak connection at their base between the two outgrowths are present.

9th abdominal segment. The strongly chitinized section of the central plate varies considerably in form. In some individuals one can see the contours of a weakly pigmented basal plate (Figs. 48.5A-E and 49 A). A few of the variations in chitinization are very similar to *L. hippoides*.

The chitinized section often has a central groove which for the most part is equally strongly chitinized as the rest of the plate. On rare occasions this plate is so reduced and the groove so weakly pigmented that it appears to be divided in two and forms two triangular plates that are fused solely at their bases, but never so clear and strong as in *L. pseudohippopus*. However, the change to *L. pseudohippopus* does not appear to be especially large.

Supra-anal plate. This also varies considerably in form and degree of chitinization (as shown in Fig. 48.6 A, B, C and 49D). The shaft can be long and thin or short and thick, depending on the degree of chitinization.

Tiltators are longer, sometimes significantly, than the *paraprocts*, and the tiltators are blunt, while the *paraprocts* are pointed.

The female: The sub-genital plate varies considerably in form (Fig. 48.8). It appears to

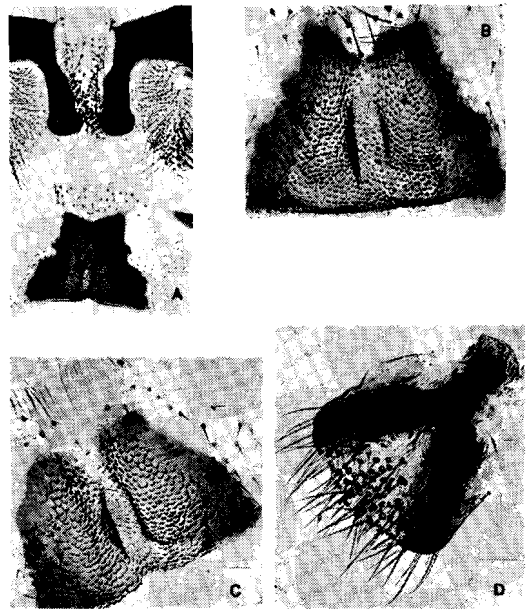


Fig. 49. A. Parts of the 8th and 9th tergite of *L. hippopus* male from Isterfoss. B. and C. different forms of the sclerotized plate of the 9th tergite. D. The supra-anal plate.

include *L. hippoides*, and approaches closely *L. pseudohippopus*.

The spermatheca (Fig. 48.7) also vary a great deal, and forms occur which approach closely that described for *L. hippoides*.

The described variations in the shape of the genital appendages are very considerable. Within the samples a great number of forms are found. There are, however, some samples which are different in that they only contain a small part of the variation, and these characters are highly linked.

This is illustrated by the sample from Isterfoss, loc. 70 (N = 30), where 70% of the male specimens had the combination 3J-4A-5c-6c, 16% 3I-4A-5c-6c, and 7% 3J-4c-5c-6c. This means that 77% had the form of the 7th segment shown in Fig. 48.3.J; 86% had the form of the tergal process shown in Fig. 48.4A; 100% the form of the plate shown in Fig. 48.5 C; and 100% the form of the sub-anal plate shown in Fig. 48.6 C. In all the specimens, the tiltator was longer than the *paraproct*.

Body length. Males 4.0-7.1, females 4.5-8.8 mm. The mean of the females varies from 5.4 to 7.6 mm. The individual variation is

extremely high in the sample from Øvre Heimdal loc. 76B, from 4.9 to 8.8 mm (Fig. 52).

Wing length. Males 5.3–6.9, females 5.0–8.2 mm. The mean of female samples varies from 5.6 to 7.7 mm. The individual variation is smaller; the highest is in the sample from Botnavatn, where it varies from 5.0 to 6.6 mm (Fig. 52).

Wing factor (w/b). In this species there are great variations. The mean of some samples shows clear short-wingedness, while others are clearly long-winged. The individual variation is high, and in most of the samples there are both long-winged and short-winged specimens. Only in the sample from Isterfoss loc. 70 are there solely short-winged specimens. The total variation in wing factor w/b is from 0.73 to 1.34.

Wing venation. In this species we can find the greatest variation in the genus *Leuctra* (Table VI). The high percentage of the form of wing veins shown in Fig. 51C, D. is special for this species. In some samples up to 72% have this type. Again the Isterfoss samples show a special tendency.

Leuctra nigra (Olivier, 1811)

The works of Morton (1929), Mosley (1932), Bengtsson (1933), Kühtreiber (1934), Kimmins (1950), Despax (1951), Brinck (1952), Illies (1955), Aubert (1959), Zhiltsova (1964) and Lillehammer (1965) contain drawings of this species.

The present study of this species is based on 634 ♂♂ and 607 ♀♀.

Morphological analysis

Genital appendages (Fig. 50). There are some variations in the taxonomical characters of both males and females, but far less than in the three other species of the genus. However, in some samples there might occur male forms as shown in Fig. 51.2.

Body length. Males 4.6–5.6, females 4.0–8.0 mm. The mean of the female samples varies from 5.0 to 7.2 mm (Fig. 52). The individual variation is highest in the sample from Risvold, Sauda, ranging from 5.0 to 8.0 mm. *Leuctra nigra* is one of the species with the greatest differences in body size.

Wing length. Males 5.0–6.1, females 5.7–1.9 mm. The mean of the female sam-

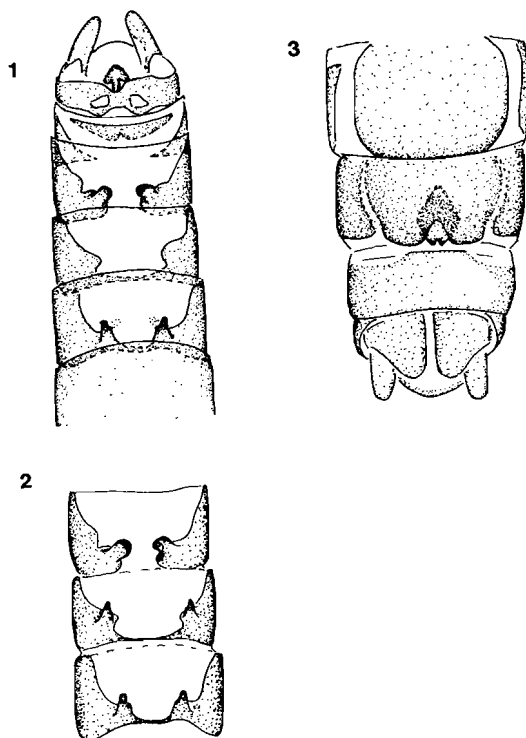


Fig. 50. *Leuctra nigra*. 1. The abdominal apex of the male, dorsal. 2. Different form of the 7th terga. 3. The abdominal apex of the female, with the sub-genital plate.

ples varies from 6.3 to 7.2 mm. The variation is far less than body length. Also individual variation is less. The highest variation is found in the sample from Sollia, Atna which varies from 6.5 to 7.9 mm (Fig. 52).

Wing factor (w/b). On average the species is always long-winged, with values from 1.01 to 1.26. The individual variation, however, is great, and values from 0.96 to 1.35 are found.

Wing venation (Fig. 51) shows the same variations present in other Leuctridae, but the stability of the normal type is marked (Table VI).

Discussion of the Leuctridae species

Within this genus there is a high degree of variation in the genital appendages of *Leuctra digitata* and *Leuctra fusca*. The variation is even higher in *Leuctra hippopus*

which has a clear tendency to form local types, which again is most pronounced in the Isterfoss sample. Less variation is found in *L. nigra*.

The *Leuctra* species display marked variations both in the body length and the wing length. The variation in body length is greater than in wing length, and there are differences between the species (Fig. 52). The differences between samples of the same species are marked, especially in the case of *Leuctra hippopus*.

On average the species *L. digitata*, *L. fusca* and *L. nigra* are long-winged. However, in most of the samples both long-winged and short-winged specimens are found. *Leuctra hippopus* also varies most in this character. Both short-winged samples and long-winged samples occur. The sample

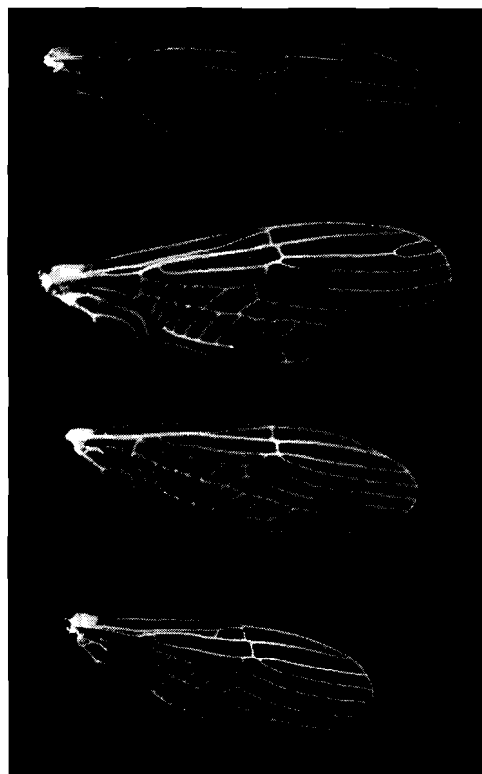


Fig. 51. Different forms of the wing venation in the *Leuctra* species. A. The normal form, B and C, the irregular forms which often are present in the samples. D, shape and wing venation seen in samples with short winged specimens, and common in *L. hippopus* specimens from Isterfoss.

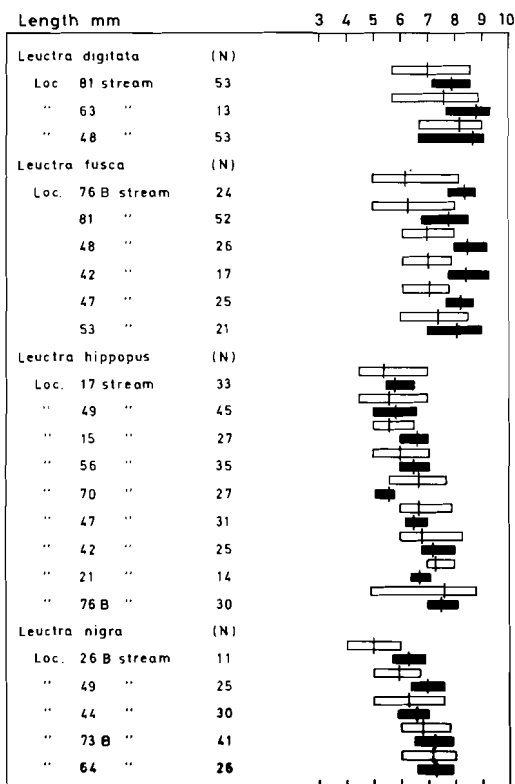


Fig. 52. Body-length and wing in different samples of *Leuctra digitata*, *L. fusca*, *L. hippopus* and *L. nigra*. White rectangle: body length, dark rectangle: wing length. Vertical line, the mean length of the samples.

from Isterfoss is also notable in this character since it contains only short-winged specimens.

There are large differences in wing venation between the species. Forms shown in Fig. 51 are common. The species *L. digitata* and *L. nigra* are most constant in respect of the normal form (Table VI). There are also small differences between the samples from different localities in these species. In *Leuctra fusca* there are marked differences between the samples, and normal form is less common at localities such as Sauda, Nordelva and Breiborg. The variation is even higher in *Leuctra hippopus*, which has the most marked differences in wing venation between the samples from different localities. The sample from Isterfoss, loc. 70 displays the most pronounced differences from the normal.

Table VI. The occurrence of different forms of wing venation found in *Leuctra* species and the local differences. For forms A, B, C and D, see Fig. 51. Form E, Sc₂ cross-vein present
N = size of sample

Species, localities	N	Form A	Form B	Form C and D	Form E
<i>Leuctra digitata</i>					
Loc. 69, stream	23	74	21	5	0
Loc. 81 »	31	74	16	10	0
Loc. 63 »	13	90	7	3	6
Loc. 48 »	53	95	5	0	0
<i>L. fusca</i>					
Loc. 76B »	22	80	20	0	5
Loc. 81 »	52	75	25	0	2
Loc. 48 »	22	59	41	0	5
Loc. 47 »	25	46	42	12	21
Loc. 42 »	17	68	32	0	0
Loc. 69B »	20	85	10	5	0
<i>L. hippopus</i>					
Loc. 17 »	33	15	28	57	0
Loc. 49 »	34	25	17	48	7
Loc. 70 »	27	0	15	85	8
Loc. 42 »	25	80	20	0	0
Loc. 76B »	30	52	34	14	0
Loc. 9B »	14	14	29	57	14
<i>L. nigra</i>					
Loc. 26B »	11	87	13	0	6
Loc. 49 »	25	88	8	4	4
Loc. 44 »	30	80	20	0	0
Loc. 73B »	41	83	17	0	5
Lok. 64 »	26	86	14	0	5
Lok. 46 »	19	84	16	0	5

CONCLUSION AND DISCUSSION

Many of the characters used by some authors in the separation of families and genera have been shown to be invalid. This is the case with the separation of the Perlodidae and the Perlidae on the number of cross-veins between C and R₁ and the dark spots in the area of the cross-vein connecting R and Rs. The last character is indistinct in preserved material.

The number of cross-veins between C and R₁, have been shown to be high in the *Diura* species of the family Perlodidae; three and four cross-veins were very common, and several specimens had five.

The wing character used by some authors in separating the subfamilies of the Perlodidae, the Isoperlinae, and the Perlodinae from each other is the presence of unforked R₂+₃ in the Isoperlinae (this character is

also used by some authors for the Chloroperlidae) compared with a forked R₂+₃ in the Perlodinae. This is, however, an invalid character as a forked R₂+₃ occurs in the Isoperlinae and also in the Chloroperlidae.

The Nemouridae-X wing vein pattern used in separating the family Nemouridae from the Capniidae and the Leuctridae is a character which is not quite typical of the Nemouridae. The character is absent to a high degree (up to 50%) in specimens of both *Amphinemura* and *Nemoura* species. In some localities the character is present to nearly the same extent in some Capniidae species (about 40%). The reduction in cross-veins in the cubital area of the Capniidae seems to be the best character to use; it also separates this family from the Leuctridae. This is also mentioned by Zwick (1973a).

The separation of the Leuctridae species from the Nemouridae species on wing venation does not present any problems so long as the X-pattern is present in the Nemouridae specimens, but it becomes invalid when it is absent. However, there are such great differences between the two families in the rest of the wing venation that it should not be difficult to separate them (Figs. 33 and 51).

In Perlodinae the separation of the genera is based partly on wing venation. Concerning this, separation of *Archynopteryx* from *Perlodes* on the number of cross-veins present in the anterior cubital area is less valid as also *Archynopteryx* may have several cross-veins (Fig. 3).

The separation of the Taeniopterygidae genera is based partly on wing venation. One of the differences used previously for the separation of *Brachyptera* and *Taeniopteryx* is that the former has 3-4 and the latter 2 veins constituting Cu. These characters overlap in the Norwegian material, which is represented by one species from each genus. Two veins, one of which is forked, are quite common in both species.

In separating *Taeniopteryx* from *Rhabdiopteryx* some authors have used the presence or absence of cross-veins between C and Sc. In *Taeniopteryx* they should be absent, but one cross-vein between C and Sc has been shown to be quite common in the Norwegian specimens of *Taeniopteryx nebulosa*.

In the separation of the Nemouridae genera there are also less valid characters. In sepa-

rating *Amphinemura* and *Protonemura* from the other two genera the presence of vestiges of the nymphal gills is a good character, as are the characters used in separating the males of these two genera. The separating of the females by the fact that the 7th sternum of *Protonemura* females does not extend posteriorly as it does in *Amphinemura* is not a valid character. Females of *Protonemura* may have the 7th sternum extended posteriorly (Fig. 35). The females of both genera, however, can be separated on the different shapes of the nymphal gill vestiges.

The characters used in separating the males of the genera *Nemoura* and *Nemurella* are good, but the character used in separating the females is less valid. In both genera female specimens occur with an anterior margin of the 9th sternum which is straight, or which is elongated triangular. In the genus *Nemurella*, however, there is only one species, *N. pictetic*. The female of this species can be separated from the *Nemoura* species on the characteristic sub-genital plate.

Many of the characters used in separating species have been shown to be highly variable and different species vary to different degrees. Variation is present in the genital appendages, body length (b), wing length (w), wing factor (w/b) and wing venation.

There is less variation in the shape of the genital appendages in the following species: *Taeniopteryx nebulosa*, *Brachyptera risi*, *Capnopsis schilleri*, *Dinocras pechalotes*, *Nemoura flexuosa* and *Leuctra nigra*. The specimens of *D. cephalotes* (70 ♂♂ and 30 ♀♀) were mainly taken from one locality, making the sample unrepresentative. The number of specimens of *N. flexuosa* is low, but they were taken from different localities and are therefore more representative than *D. cephalotes*.

In the remaining Norwegian species there are marked variations in the genital appendages, at least in one of the sexes. Species exhibiting a high degree of variation in the females are *Arcynopteryx compacta*, *Diura bicaudata*, *D. nanseni*, *Isoperla difformis*, *Amphinemura borealis*, *A. sulcicollis* and *Nemurella picteti*. Species with a high degree of variation in the males are *Leuctra digitata* and *Leuctra fusca*. The following species exhibit marked variations in both sexes: *A. standfussi*, *Nemoura arctica*, *N. sahlbergi*, *N.*

wiki, *Capnia atra*, *C. pygmea*, *C. bifrons*, *C. vidua* and *Leuctra hippopus*.

All species display considerable variation in body and wing length (Figs. 8, 15, 19, 24, 34, 38, 45 and 52). In this respect there are differences between specimens of the same species from different localities. Differences between species of the same genus are also marked and can be seen in the above-mentioned figures.

As a result of variation in wing length and body length the wing factor (w/b) shows a high degree of variation. Between species there are large differences. Some species always have long-winged females, while in other species there are both long-winged and short-winged specimens. In some species there are samples which have only or largely short-winged specimens, e.g. *Diura bicaudata* from locs. 3 and 31 (Fig. 6), *Amphinemura standfussi* from locs. 38 and 77B (Fig. 22), *Capnia atra* from loc. 77A (Fig. 41) and *Leuctra hippopus* from loc. 70 (Fig. 47).

At higher altitudes in southern Norway short-winged specimens of *Capnia atra*, *Amphinemura standfussi* and *Diura bicaudata* have been taken. Samples of *Capnia atra* containing mainly short-winged specimens have been taken in the central mountain areas (locs. 77A, 80A and 82, at altitudes from about 1000 to 1465 m a.s.l.). However, there does not seem to be a clear trend of decreasing wing length with increasing altitude. Between lakes with similar altitudes in the same area there are large differences.

The reason for this may be either that 1. the population in one lake is well isolated from those in nearby lakes, allowing it to develop differences in morphological characters, such as body length and wing length, or 2. there are connections between populations in different lakes, but differences in environmental factors affect the morphological characters to varying degrees. If this is the case, factors such as temperature and food are considered to be among the most important.

The three species mentioned above, *C. atra*, *A. standfussi*, and *D. bicaudata*, were mainly short-winged at higher altitudes. However, *Leuctra hippopus* shows another trend in respect to wing length and short-wingedness. In Rogaland (locs. 47, 48 and 49) the species has a greater body length and wing length

at lower altitudes, but body length decreases more than wing length with increasing altitude. Therefore at the highest altitudes the species is long-winged. In the distribution of this species there are some localities which contain specimens with short wings. This is most pronounced in the isolated population from Isterfoss (loc. 70), where all specimens are short-winged.

Nebeker & Gaufin (1967), who tested the short-wingedness character in *Capnia arana* Claassen at different altitudes and temperatures, could not find a factor which had a direct and immediate influence on wing development. They concluded: 'The populations exhibiting different wing length are probably genetically different and that is the factor which largely determines wing size at the present time'. Nor was a clear trend in short-wingedness at different altitudes apparent in the present study. Wing length may be genetically bound, but it seems that different environments act in different ways on the genetic diversity in wing length which is present in a normal population, producing populations which have their morphological peculiarities. It is likely that different environments act in the same way on other morphological characters. The nature of short-wingedness has been discussed by several authors. Tjeder (1945) suggested that the short-wingedness in *Capnia atra* from Lake Vättern is a result of isolation. Brinck (1952) was convinced that short-wingedness among stoneflies is a genotypic character, the structure of which may, however, be environmentally determined. Short-wingedness, in connection with ecological factors and the results of experimental work, will be discussed in part 5.

Wing venation has been shown to be highly variable and the degree of variation is often different in species of the same genera. Within the same species there are also large differences from locality to locality (Tables II, III, IV, V and VI). In some species, such as *Diura bicaudata*, there seems to be a geographical trend. It should be mentioned that there is a higher degree of similarity in the wing veins in the samples of *C. atra* and *C. pygmaea* taken at the same locality than between most samples of *Capnia atra* taken at different localities (Table V). This may indicate an ecological influence on the genetic diversity.

The individual variation is high in the total material of each species. Most of the variations, however, are found within the single samples that make up in total a continuous variation but which produce local differences. The ratio of each variant from sample to sample is always different. The northern species *Nemoura arctica*, *N. sahlbergi* and *N. viki* are of special interest in this respect. They all display a high degree of variation in their genitalia. It would be very instructive to compare them with closely related species such as *N. richeri*, described by Jewett (1971), *N. trispinosa* and with the subspecies of *N. arctica*, *N. arctica polaris* and *N. arctica mongolica*.

Some samples of species such as *Diura bicaudata* and *Leuctra hippopus* indicate polymorphism. The special shape of the genital appendages is often linked with certain form of wing venation and short-wingedness. This is probably a result of the selection process mentioned by Mayr (1970), but will be discussed in part 5, where the results of ecological studies from parts 2, 3, and 4 will be used, and where the variation in morphology both in respect of altitude and latitude will be compared and further discussed.

SUMMARY

The purpose of this study was to analyse the variation in morphological and structural characters used in the taxonomy of Plecoptera.

The analyses were carried out on 30 of the stonefly species in Norway. In four species there was not enough material for analysis.

The material comprised 24,968 specimens and was collected from representative parts of Norway during the years 1965-1972.

The analyses of variations are given on the shape of genital appendages, body length (b), wing length (w), wing factor (w/b) and wing veins.

Some of the characters used by previous authors are invalid for separation of Norwegian stoneflies. This is shown by the following examples:

1. The separation of the Perlodidae and Perlidae on the number of cross-veins be-

tween C and R₁ and the dark spots in the area of the cross-vein connecting R and Rs.

2. The separation of the subfamilies Perlodidae, the Isoperlinae and Perlodinae on the presence of unforked R₂+₃ occurrence in the Isoperlinae.

3. The separation of the family Nemouridae from the Capniidae and Leuctridae on the presence of a Nemouridae-X in the wings of species belonging to the family Nemouridae and not in the two other families.

4. The separation of the genera *Brachyptera* and *Taeniopteryx* on the different number of veins in the Cu area.

5. The separation of the females of the genera *Amphinemura* and *Protonemura* on the shape of the posterior part of the 7th sternum.

The analyses of the variations in the shape of genitalia appendage, body length, wing length and wing factor gave different results for each of the mentioned characters from species to species.

In the following species there is only small variation in the genital appendages: *Taeniopteryx nebulosa*, *Brachyptera risi*, *Capnopsis schilleri*, *Dinocras cephalotes*, *Nemoura flexuosa* and *Leuctra nigra*. In the rest of the species studied there are marked variations.

All species display considerable variation in body-length and wing-length, but there are great differences among the species.

The wing factor shows a high degree of variation both within the species and between different species. Short-winged populations are found among *Diura bicaudata*, *Amphinemura standfussi* and *Leuctra hippopus*.

Wing venation was also highly variable, and there were great differences between specimens from different samples of the same species.

The variation rate is high in most of the species. Most of the variations, however, are found within the separate samples that in total make up a continuous variation. The ratio of each variant, however, is always different from sample to sample.

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Short Communications

Notes on *Chalcis sispes* Linnaeus and *Haltichella rufipes* Olivier (Hym., Chalcididae)

TROND ANDERSEN

Chalcis sispes Linnaeus and *Haltichella rufipes* Olivier (Hym., Chalcididae) are reported for the first time from Norway.

Trond Andersen, Zoological Museum, University of Bergen, N-5014 Bergen-Univ., Norway.

During visits to Tjøme, Vestfold, I have collected two species of Chalcididae, which to my knowledge have not been reported from Norway before. Both species were captured while the vegetation was being swept with an insect net. The species, as other members of the family, are easily recognized by their greatly swollen hind femora and the correspondingly curved hind tibiae.

Ve: Mostranda, Tjøme (UTM: 32VNL800496) 9 July 1973, 1♀. According to Hedqvist (1967) *C. sispes* is distributed in most parts of Europe, and in Siberia and North Mongolia. The species has been found sparsely in Fennoscandia as far north as Stockholm in Sweden (K.-J. Hedqvist in lit.) and in southern parts of Finland (Hellén 1924). It parasitizes the larvae of *Stratiomyia* (Dipt., Stratiomyidae) (Thomson 1875).

Haltichella rufipes (Olivier 1790) (syn.: *armata* Panzer 1801)

Ve: Moutmarka, Tjøme (UTM: 32VNL803488) 4 Aug. 1969, 1♀. *H. rufipes* is reported from Central Europe (Germany, France, England) (Kerrich & Ramdas Menon 1949, Ferrière & Kerrich 1958). The species is common in the southern parts of Sweden, and is found north up to Dalälven (K.-J. Hedqvist in litt.)

Elsewhere in Fennoscandia it has been recorded from Åland in Finland (Hellén 1963). It parasitizes the pupae of Lepidoptera (Landin 1971).

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I am indebted to Dr. Karl-Johan Hedqvist, Stockholm, for information about the two species' distribution in Sweden.

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Some Braconidae (Hymenoptera) new to Norway

C. VAN ACHTERBERG

The author reports nine species of Braconidae new to the Norwegian fauna: *Eubadizon extensor* (L.), *Diospilus capito* (Nees), *Opius parvungula* Thomson, *Alysis brachycera* Thomson, *A. lucicola* Haliday, *A. luciella* Stelfox, *Phaenocarpa longicauda* (Thomson), *Aspilota stenogaster* Stelfox & Graham, *Aspilota (Synaldis) concolor* (Nees).

C. van Achterberg, Oosteinde 34, Waarder, Post Weerden, The Netherlands.

During a short visit during the middle of August 1973 to Selva, a small village near the entrance of the Trondheimsfjord, more than 100 Braconidae were collected. Some were unidentifiable (of which a part will be treated in my revision of *Blacus*), but largely owing to the excellent publications of Fischer (1970, 1971, 1972) it was possible to identify the following species which are new to the Norwegian fauna, except *Alysis frigida* Haliday and *Dacnusa lestes* Nixon.

Their locality label reads as follows: 'Norway, Selva, 63°36'N/9°43'E, nr entrance Trondheimsfjord, ± 150 m., 11-18. VIII. 1973, C. van Achterberg'.

Helconinae

Eubadizon (Eubadizon) extensor (Linné); 1♀, differs slightly from Dutch specimens.

Diospilus (Diospilus) capito (Nees); 1♀.

Opiinae

Opius (Liesosema) parvungula Thomson; 1♀.

Alysiinae-Alysiini

Alysis brachycera Thomson; 1♀. First record from outside the type locality (Småland, Sweden).

A. lucicola Haliday; 4♀♀.

A. frigida Haliday; 1♀.

A. luciella Stelfox; 1♀. First record outside Ireland.

Phaenocarpa longicauda (Thomson); 1♀. Second record from outside the type locality.

Aspilota (Aspilota) stenogaster Stelfox & Graham; 1♀. Only known with certainty from England (Surrey).

A. (Synaldis) concolor (Nees); 1♀ (with 21 antennal segments), 5♂♂. Differ from Dutch specimens only by the longer antennae; the species is very variable in colour.

Alysiinae-Dacnusiini

Dacnusa (Rhizarcha) lestes Nixon; 1♀. Already known from Rogaland, Assland, Time, August. (Nixon 1948).

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Nytt funn av *Simplocaria metallica* Sturm (Col., Byrrhidae) på Svalbard

ERLING SENDSTAD

Three specimens of *Simplocaria metallica* Sturm were captured in pit fall traps at Tsjermakfjellet, Nordfjorden, Svalbard. Earlier *S. metallica* has been reported only once from Svalbard – a dead specimen was collected at Ny-Ålesund in 1968.

Erling Sendstad, University of Trondheim, Royal Norwegian Society of Sciences and Letters, The Museum, Erling Skakkesgate 47b, N-7000 Trondheim, Norway.

Universitetet i Trondheim hadde sommeren 1973 en biologisk ekspedisjon til Svalbard.

Tre eksemplarer av *Simplocaria metallica* ble fanget i fallfelle satt ut i en vegetasjonsrik vestvendt bakke under fuglefjellet i Tsjermakfjellet, Nordfjorden. Fallfellen fanget i perioden fra midten av juli til midten av august 1973. Vegetasjonen var dominert av *Poa alpigena*, *Festuca rubra* og *Puccinellia angustata*. De tre individene av *S. metallica* er bestemt av professor dr. C. H. Lindroth, Lund.

Denne arten er rapportert første gang fra Svalbard av Strand (1969), på bakgrunn av

et dødt eksemplar funnet på Ossian Sarsfjellet, Ny-Ålesund.

Ifølge Strand (1969) er arten i Europa boreoalpin, og kjent utbredelse er nå: det nordlige Fennoscandia, de sentrale fjellområder i Syd-Norge, noen områder i det sydlige Finland med tilliggende arealer i Sovjet. Dessuten altså også på Svalbard.

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Notes on Norwegian spiders, IV.

ERLING HAUGE

Two species of spiders, *Centromerus dilutus* (Cbr.) and *Typhocraestus digitatus* (Cbr.), are reported for the first time in Norway. New records are presented for eight little known species.

Erling Hauge, Zoological Museum, University of Bergen, Muséplass 3, N-5014 Bergen-Univ., Norway.

Owing to the little knowledge we have about the Norwegian spider fauna, it very often happens that even the examination of small, more or less occasionally collected, samples of spiders reveals some species which are either new to Norway or at least very scarce-

ly known from a distributional point of view.

A short list of such species is presented in the present article. The specimens are partly collected by myself (E. H.), and partly by other collectors, to whom I am very much indebted.

Asthenargus paganus (Sim.)

Hitherto known only from Nordmarka near Oslo (Palmgren 1964), and from Ringsaker, Hedmark (Waalder 1972). New record: HOy: Stord, Mjelkeviki, Hago island, 1♀ 18 June 1967 (T. Solhøy leg.).

Erigonella hiemalis (Blw.).

Previously few records from Norway: Sogn (Kauri 1966), Son, Akershus (Waalder 1967), and Ringsaker, Hedmark (Waalder 1972). New record: TRy: Harstad. Three ♀♀ were collected 8 June 1971 in the litter of a birch forest (E. H.).

Monocephalus castaneipes (Sim.).

Previously reported as new to Norway (Hauge 1971). New records: 1♀ found at HOi: Varaldsøy, Hardanger, 7 June 1967 (T. Solhøy leg.) and 1♀ 23 July 1972 at VAY: Kristiansand (T. Nielsen leg.).

Wideria fugax (Cbr.).

The only published records are from Nordmarka near Oslo (Palmgren 1964), and from Ringsaker, Hedmark (Waalder 1972). New record: Ånuglo, HOy: Stord, 2♀♀ in the moss cover near a pine forest, 21 May 1971 (E. H.).

Wideria antica (Wid.)

Previously known from Eastern Norway (Palmgren 1964, Waalder 1967, 1972), and from Western Norway (Strand 1902, Kauri 1966). New record: TRy: Harstad, 8 July 1971, 1♀ in the litter of a birch forest (E. H.).

Centromerus dilutus (Cbr.)

One ♀ found in moss 25 April 1970, at the island of Herdla, northwest of Bergen (Jon Fjeldså leg.). Two ♀♀ 23 May 1970, 1♂ and 4♀♀ 21 May 1971, both records at the Ånuglo island, HOy: Stord, (E. H.). The species is new to Norway.

Typhlocraestus digitatus (Cbr.)

Two ♀♀ collected in moss at the island of

Herdla, 25 April 1970 (Jon Fjeldså leg.). The species is new to Norway.

Mangora acalypha (Walck.)

The only record in Norway is from Kristiansand and dates back to Collett (1876). New record: Indre Årsnes, AAy: Høvåg, 1♀ 28 May 1971 (K. Syvertsen leg.).

Thoenoe minutissima (Cbr.)

Previously one record from Western Norway (Hauge 1971). New records: 1♀ at the Hago island, Mjelkeviki, HOy: Stord, 18 June 1967 (T. Solhøy leg.). Two ♀♀ in the Skjomen fjord, Nnø: Ankenes, 17 July 1971 (E. H.), in a west faced slope on the northern side of the fjord. The area was open, with scattered pines and some small birches. The ground cover was rich in dry *Empetrum* sp. and some *Uccinium vitis-idae*.

Evarcha arcuata (Cl.)

Known from Halden (Collett 1875) and from Mostadmarka near Trondheim (Storm 1898). New record: Sokna, Bø: Ringerike, 1♂ 18 August 1972 (T. Nielsen leg.).

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Some observations on the food preference of *Dilta* sp. (Thysanura)

SIGMUND HÅGVAR

Dilta sp. (Thysanura) was kept in culture and offered dead leaves of hazel, willow, aspen, birch, and maple as food. Leaves of hazel were strongly preferred, and only the main nerves were not eaten. From leaves of willow and aspen the soft parenchyma layer on the under side was eaten. Only very small part of birch leaves were eaten, the leaf being attacked from both sides. Leaves of maple were not eaten.

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Dilta sp. has newly been recorded in Norway (Hågvar 1969), the species probably being *D. hibernica* Carpenter, which is the only Swedish species in the genus. Only females have been found in Norway, and the species can be identified accurately only by the males (Delany 1954), which are extremely rare.

At Valler, Bærum, thirteen animals were collected 28 October 1971. The ground in the actual habitat was at this time covered with dead leaves from different trees, of which the following dominated: hazel (*Corylus avellana* L.), birch (*Betula verrucosa* Ehrh.), maple (*Acer platanoides* L.), aspen (*Populus tremula* L.), and willow (*Salix caprea* L.). A simple experiment was performed during the following days to find out if dead leaves might serve as food, if there was any preference between leaves from different species of trees, and if the animals preferred special parts of the leaves.

The animals were placed in a petri dish containing a bottom layer of moistened plaster. Two small pieces (1 × 1 cm) of leaves from each tree species were placed on the plaster, one piece with the upper leaf side up and the other piece with the under side up. The culture, having a relative humidity of nearly 100%, was kept in darkness at 20°C for 19 days and was examined daily. One animal died after 15 days, and seven more died after 16–19 days. Several animals performed ecdysis while being in the culture.

After one day, there were small holes in both pieces of leaves from hazel, but the other pieces were untouched. After four days, still only hazel leaves had been eaten. There were several big holes in both pieces, mainly in

the piece that had been placed with the upper side accessible (Fig. 1). Always the animals had eaten through all layers of the leaf, also eating the smaller nerves. The pieces of hazel leaves were now removed to study the preference between dead leaves of the other trees.

At the end of the experiment, the situation was as follows. The upper side of the piece from willow was untouched, but most of the parenchyma layer on the under side had been eaten. The pieces from aspen had been treated in the same way. In both the birch pieces there were a few small holes, but the pieces from maple were untouched.

This Thysanura species evidently participates in the breaking down of dead leaves. However, the animals clearly distinguish between leaves from different species of trees, and they may also show strong preferences for special parts of the leaves.

Observations from the pieces of birch leaves

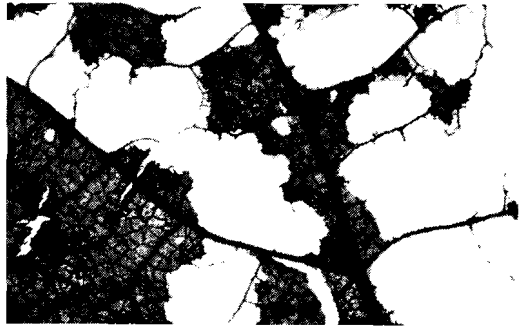


Fig. 1. Leaf of hazel having been eaten upon by *Dilta* sp.. All the layers in the leaf and even the smaller nerves have been eaten. Photo: Nils Arne Sundby.

indicate that mainly areas attacked by fungi are eaten. Small colonies of fungi might disappear very rapidly, and the holes in the leaves were often made where such colonies had been observed.

Agrell (1944) examined the gut content of individuals from different localities and characterized the species as a detritus feeder. He found unidentified plant material together with root hairs, algae, spores from mosses, and hyphae and spores from fungi. The present study shows that the species not only eats

microorganisms and finely divided plant material, but that it even participates in the first phases in the breaking down of leaves.

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Hågvar, S. 1969. *Dilta* sp. (Thysanura) in Norway. *Norsk ent. Tidsskr.* 16, 39–40.

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I. U. S. S. I.

(International Union for Study of Social Insects)

På IUSSI-kongressen i London 1973 ble det besluttet å lage en fortegnelse over dem som er interessert i sociale insekter eller sociale arthropoder (Hymenoptera, Isoptera, Orthoptera, o. a.), deres morfologi, økologi, fysiologi, genetikk, etologi m. m. Undertegnede er p. t. norsk medlem av IUSSI's International Committee og tar med takk imot navn, adresse, interesseområde for videreforsendelse til IUSSI-sekretariatet i England.

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Bokanmeldelser

Romoser, W. S. 1973. *The Science of Entomology*. 449 pp. Collier Macmillan Publishers, London. Pris £ 4.50.

Nye lærebøker i entomologi hører ikke med til de dagligdage begivenheter, og spesielt ikke bøker som favner over hele dette omfangsrike fagområde. Man skulle nesten tro det var en umulig oppgave å samle innen to permer et fag som spenner fra insektenes evolusjon og taksonomi til deres fysiologi og biokjemi. Den store kunsten må være å begrense seg til de vesentligste sider av faget, samtidig som fremstillingen ikke må bli så kortfattet at den er kjedelig. Til tross for disse vanskeligheter er det ingen tvil om at Romoser har lyktes i sitt ønske om å gi leseren en bred innføring i dette store fagområdet.

Boken er delt i tre hovedavsnitt. Det første, «Structure and function», tar for seg de forskjellige organsystemer og deres funksjon. I avsnittet «Unity and diversity» gis en oversikt over insektenes evolusjon og systematikk, og i det tredje hovedavsnittet gis en innføring i anvendt entomologi.

Den første delen er den største, og gir en ganske detaljert skildring av insektenes morfologi. Dette gir grunnlag for forståelsen av insektenes fysiologi, men forfatteren kunne kanskje gått noe videre på dette området enn han gjør. Teksten er greit og presist skrevet og er forsynt med tallrike illustrasjoner. Tegningene er usedvanlig klare og oversiktlige, og det er gjort utstrakt bruk av mikrofotografier for å illustrere forskjellige histologiske detaljer. Noen få scanning elektronmikroskopbilder avslører fascinerende overflatestrukturer. Foruten morfologi og fysiologi rommer bokens første del to viktige kapitler; det ene om insektenes adferd, og det andre om deres økologi. Begge deler er hver for seg store fagområder. Insektenes adferd omfatter bl. a. deres forplantningsbiologi, næringsøken, migrasjon, biologiske rytmer, og oppførsel hos sosiale insekter. Disse sider av insektenes biologi er av fundamental betydning for forståelsen av deres utbredelse og suksess som dyregruppe. Leseren får her et noe sporadisk kjennskap til de forskjellige problemene, og det samme kan man si om det økologiske kapitlet. Men dette er igjen et spørsmål om hvor langt man skal gå i en elementær innføring, og forfatteren gir rikelige referanser til den som ønsker å fordype seg i stoffet.

I bokens annen del fremheves først insektenes likheter i et kapittel om deres utvikling. Forfat-

teren beskriver både slektskapet til andre arthropoder, og utviklingen av de forskjellige insektordner. Forståelsen av insektenes innbyrdes slektskapsforhold blir også lettere ved at de i et taksonomisk kapittel presenteres i grupper av beslektede ordner. Romoser tar ikke standpunkt til hvorvidt insektene bør deles i flere klasser eller underklasser. På dette punkt er han kanskje noe konservativ, og likeledes når det gjelder oppdelingen i ordner og underordner. Romoser inkluderer f. eks. kakerlakker og knelere i ordenen Orthoptera, mens de fleste forfattere idag betrakter disse som egne ordner, relativt vidt adskilt fra hopperne. Et annet eksempel er opprettholdelsen av underordenen Cyclorrhapha, som nå vanligvis inkluderes i de brachycere Diptera. Men viktigere enn slike innvendinger er det at de enkelte insektordner beskrives klart og konsist. Presentasjonen av hver orden er kortfattet, men oversiktlig både med hensyn til karakteristiske kjennetegn og omfang. Også her må de klare og tydelige figurene fremheves som en viktig del av fremstillingen.

Det siste hovedavsnitt gir en oversikt over den anvendte entomologi. Her diskuteres først problemer med sykdomsoverførende insekter, insekter i hus og lagrete matvarer, og hvorledes skadeinsekter oppstår i landbruket. Derpå omtales de forskjellige biologiske og kjemiske bekjempelsesmetoder som man idag disponerer. Selv om teksten er kortfattet, er dette omdiskuterte tema klart og nøkternt fremstilt. Det er prisverdig at et avsnitt om anvendt entomologi tas med i en generell lærebok. De problemer den anvendte entomologi arbeider med angår alle, og bør komme med i entomologiundervisningen på et tidlig tidspunkt.

«The Science of Entomology» er en lærebok med stor bredde. De fleste engelsksproglige lærebøker i entomologi er mer spesielle, og behandler bare deler av fagområdet. For en skandinavisk leser er det interessant å merke seg at opplegget i høy grad minner om Carl H. Lindroth's «Entomologi», som kom ut i 1967. Romoser's bok kan med fordel anvendes som grunnlag for ett-semesterens entomologikurs ved universiteter og høyskoler. Siden de enkelte delene er relativt uavhengige av hverandre, kan de også brukes hver for seg. Den taksonomiske delen kan f. eks. brukes ved kurs i systematisk zoologi, som et supplement til andre lærebøker. Ved siden av å være en lærebok er Romoser's bok en nyttig håndbok, som kan anbefales alle med interesse for faget.

Lauritz Somme

Krieg, A. 1973. *Arthropodenviren* Georg Thieme Verlag, Stuttgart, 326 pp., lommeformat. Pris DM 17.80.

Boken omhandler arthropodevirus og er beregnet på fagområdene insektpatologi, plantevern samt human- og veterinærmedisin. Den omfatter virus morfologi, struktur, biologi og vekselvirkning mellom virus og vert. Det er videre en oversikt over kjente arthropodevirus. Denne del behandler både nomenklatur, taksonomi og evolusjon. Boken har også et kapittel om virusforskning, diagnostikk, og praktiske anvendelser og konsekvenser av forskningsresultatene.

Boken er oversiktlig og forsynt med tallrike instruktive illustrasjoner.

Chr. Stenseth

R. Rozkošný. 1973. The Stratiomyioidea (Diptera) of Fennoscandia and Denmark. *Fauna Entomologica Scandinavica*, Vol. 1, 140 pp. Scandinavian Science Press Ltd., Denmark. Pris d.kr. 40,60.

Med dette første bind om Stratiomyioidea (omfattende bl. a. våpenfluene), er det startet opp en serie skrifter som vil bli fulgt med adskillig spenning og interesse hos entomologer i mange land. *Fauna Entomologica Scandinavica* planlegger utgivelse av et stort antall bøker som tilsammen kommer til å dekke store deler av systematikken innen entomologi og arachnologi, og vedrørende grupper innenfor andre «ikke-insekter». I så måte vil serien avhjelpe et lenge følt behov angående moderne bestemmelseslitteratur.

Bind 1 omhandler familiene Solvidae og Stratiomyidae (våpenfluene), hvor det i det gjeldende område hittil er registrert 19 slekter og 50 arter. I Norge er den første familien ennå ukjent, mens det av våpenfluene er registrert 22 arter fra vår fauna, et ikke høyt tall sammenlignet med tilsvarende fauna i våre naboland.

Forfatteren har nedlagt et stort arbeide i å gjøre boken lett tilgjengelig, også for nybegynnere. I introduserende tekst og i figurer klargjøres termer og anatomiske trekk hos disse insektgruppene, og dette gjør bl. a. tabellene greie å arbeide etter. Videre skal fremheves det store antall utmerkede figurer (i alt 456), dyktig tegnet av fru Grete Lyneborg. Språkets begrensninger er også et stort problem bl. a. i beskrivningen av anatomi og systematiske karakterer, og i så måte er bokens tallrike strektegninger til uvurderlig nytte for å sikre en korrekt artsbestemmelse.

Forfatteren bruker videre et stort register av karakterer i klargjøring av slekter og arter, og gir også en skikkelig orientering i larvenes mor-

fologi, med egne tabeller for dette stadiet. Ellers vies det stor plass på hannlig genital-taksonomi, også her med rikelig figurmateriale. Verdifullt er det også at artenes forekomst er ordnet tabellarisk for de enkelte land bakerst i boken.

Bokens format er hendig og praktisk. Når det ellers gjelder dens utstyr kunne en imidlertid ha ønsket seg en bedre papirkvalitet, kanskje ikke minst i bokens permer. Dette skal likevel ikke berøve mye av det positive inntrykk dette første bind av serien gir. Boken vil utvilsomt bli en interessevekker og et verdifullt hjelpemiddel, og kan anbefales på det beste.

For den nye serien turde den være en lykkelig åpning.

Tore R. Nielsen

ERRATA

Astrid Løken: Studies on Scandinavian Bumble Bees (Hymenoptera, Apidae). *Norsk ent. tidsskr.* Vol. 20, No. 1, 1973.

The following corrections should be noted:

- p. 2 – First column, second section, 9th line:
For *Bombus* ssp. read *Bombus* spp.
- p. 9 – Second column, second section, 9th line:
For 40 x read 50 x
- p. 18 – First column, third section, 7th line:
For 24A read 24C, 25C
- p. 22 – Second column third section fourth line:
For stylus read coxite
- p. 23 – First column, second section, second line:
For stylus read coxite
- p. 37 – First column, third section, 8th line:
Insert lateral after well-defined
- p. 53 – Second column, fourth section, 6th line:
For d : f read d : e
- p. 82 – Second column, first section, 6th line:
Insert, T₁ after femora
- p. 117 – Second column, second section, 9th line:
Insert either after applies
- p. 117 – Second column, second section, 10th line:
Delete either
- p. 142 – Table XVII, number of specimens:
for 24 below Ög read 34 and for 18 below SDM read 41
- p. 153 – First column, eighth section, second line:
For *petterseni* read *liepetterseni*
- p. 154 – First column, first section, first line:
For 1793 read 1763
- p. 189 – Second column, first section 3rd. line:
Delete Yet
- p. 189 – Second column, first section:
For the 6th line read was established deep in the peat (Ander in litt).

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Brief *Acknowledgements* of grants and other assistance, if any, will be printed at the end of the text.

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All Figures and Tables should be referred to in the text by their number. Their approximate position should be indicated in the margin of the manuscript.

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In the text, Brown (1957), Brown & White (1961). If more than two authors, Brown et al. (1963). Multiple references: 'As several authors have reported (Brown 1957, Brown & White 1961, Green et al. 1963)', i.e. chronological order, no commas between names and year.

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Whitman, L. 1951. The arthropod vectors of yellow fever, pp. 229-298 in Strode, K. (ed.) *Yellow Fever*. McGraw-Hill, New York and London.

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