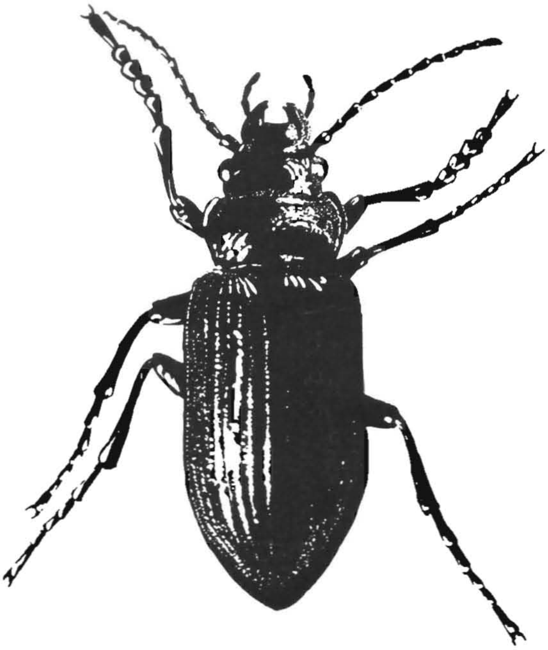
NORWEGIAN JOURNAL OF ENTOMOLOGY

Volume 24 · No. 2 · 1977



Universitetsforlaget

Norwegian Journal of Entomology

Norsk Entomologisk Tidsskrift

PUBLISHER

Universitetsforlaget: P. O. Box 7508, Skillebekk, Oslo 2, Norway.
P. O. Box 142, Boston, Massachusetts 02113, U.S.A.

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Studies of terrestrial chironomids (Diptera) from Spitsbergen

ERLING SENDSTAD, JOHN O. SOLEM & KAARE AAGAARD

Sendstad, E., Solem, J. O. & Aagaard, K. 1976. Studies of terrestrial chironomids (Diptera) from Spitsbergen. *Norw. J. Ent. 24,* 91–98.

The chironomid fauna in five different plant communities on the tundra (about 79°N, 12°E) was investigated qualitatively and quantitatively. The dry *Saxifraga oppositifolia – Cetraraia delisei* community was characterized by an impoverished chironomid fauna dominated by *Smittia* sp. A. The richer and wet *Dechampsia alpina* community and the moss tundra were dominated by *Paraphenocladius impensus, Limnophyes* spp., and *Metriocnemus ursinus.* In the wet *Carex ursina* community close to the shore and affected by the sea, *Smittia brevipennis* was a typical species. Life cycles seem to be two years for *Limnophyes borealis, L. eltoni,* and *L. globifer,* and three years for *P. impensus, M. ursinus,* and *S. brevipennis.* The production of *Limnophyes* spp., *M. ursinus, P. impensus,* and *S. brevipennis* was roughly estimated to 0.8, 1.0, 0.3, and 2.5 g/m^2 per year, respectively.

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Spitsbergen, situated between 77 and 80°N, is one of our best-known areas in the Arctic with regard to fauna composition. Hitherto, nearly all knowledge about the invertebrates has been based on qualitative sampling. Bengtson et al. (1974) published late summer abundance estimates for higher taxonomic units of soilliving arthropods from different types of coastal tundras at Spitsbergen. Quantitative studies reported by Sendstad (1975) showed the chironomid larvae to make a considerable contribution to the abundance and biomass of the soil faunas. But, due to taxonomical difficulties, the larvae of chironomids have hardly been recognizable at the species level and consequently their ecology has been unknown. To learn more about the ecology of the different species and also their importance in the tundra ecosystem, we set up a research program that gave us associations between larvae and adults at five sites which were selected according to the broad lines in plant sociology. In this way we aimed to overcome some of the taxonomical difficulties for the soil-living stages of chironomids.

RESEARCH AREA

The investigations were carried out at the Brøgger peninsula near to Ny-Ålesund, Spitsbergen, about 79°N, 12°E. When using the biotic classification of Spitsbergen proposed by Summerhays & Elton (1928), the research area belongs to the outer fjord zone. On the tundra five common plant communities were selected for sampling:

Site 1. *Saxifraga oppositifolia – Cetraria delisei* community. The community is a dry lichen heath and has a continuous plant cover. Investigated in 1975.

Site 2. *Deschampsia alpina* community. The community was very wet, and the vegetation was characterized by the turfs formed by *D. alpina.* Between these turfs the soil was more or less covered by mosses. Investigated in 1975.

Site 3. *Rupestri – Dryadetum* community. This site belonged to the plant-sociological association Dryadion, and it was the driest site in the study. The plant cover was continuous. Investigated in 1975.

Site 4. *Moss tundra.* This site was fairly wet and the vegetation was dominated by mosses. Here there was no real soil development, only an accumulation of dead mosses over the permafrost. The water was very unequally drained. The effect was that life conditions for the hygrophilic fauna varied considerably. This was clearly demonstrated in the catch of the emergence traps. The vegetation was affected by the lack of nutrients from bird cliffs. Investigated in 1976.

Site 5. *Cariecetum ursinae.* This was a beach area, affected by the sea. *Carex ursina* dominated the vegetation by forming characteristic turfs. As to soil humidity conditions, the community was intermediate between the dry *Saxifraga oppositifolia – Cetraria delisei* and the wet *Deschampsia alpina* communities. Investigated in 1976.

All these vegetation types are described botanically in detail in Brattbakk et al. (1975).

METHODS

The larvae were collected from the soil as core samples, and following O'Connor (1971) a wet funnel extraction method was used to separate the larvae from the soil. The diameter of the cores was 5.5 cm, and the samples were taken only from the uppermost 3 cm of the soil profile, because earlier sampling showed that small numbers of chironomids were normally found below that depth (Sendstad 1975). Each series of samples consisted of 12 replicates. The soil cores were taken in a vegetation type as homogenous as possible. This means that, e.g. in the *D. alpina* community, the soil cores were taken in the turfs.

The wet funnel extraction process is a so-called active process, as the animals move themselves out of the soil. The efficiency of the extraction is therefore dependent on the state of activity of the different specimens.

To get the association larvae – adults, modified emergence traps after Ryen (1972) were used. The traps consisted of a square wooden frame on which a tent of dark cloths was raised. The wooden frame was carefully dug down about 5 cm into the soil. On the top of the tent a box of plexiglass was placed. In the centre of this box was a funnel which made it possible for the emerging insects to pass from the tent into the box where they were trapped in 10% formalin. Each emergence trap covered one m^2 and collected the flying insects emerging from the particular area covered by the wooden frame. Inside each emergence trap we also placed a pitfall trap to collect insects creeping in and on the vegetation. With the exception of *Smittia brevipennis* (at site 5), which was collected both in the box at the top of the tent and in the pitfall traps, all species occurred in the box at the top of the tent. In 1975 five emergence traps were placed in the *D. alpina* community and four in the *S. oppositifolia – C. delisei* community, and in 1976 five traps in each of the other plant communities were operated. The collecting boxes of the emergence traps were emptied every 5th day and the core samples were taken with 10 days interval. The 1975 sampling was carried out in the time period of 30 June to 12 August, while we started on 19 June and stopped on 13 August in 1976.

TAXONOMICAL REMARKS

All the species recorded belong to the tribus Metriocnemini (sensu Brundin 1956) of the subfamily Orthocladinae. Due to the poor knowledge of the taxonomical status of most of the species recorded, it seems necessary to make some remarks concerning the identification.

Chaetocladius perennis Meig.

The hypopygial structure of the specimens from Spitsbergen is close to the drawing given by Brundin (1947). This species has formerly been reported from Spitsbergen (Hirvenoja 1967).

Limnophyes glofiber (Lundstr.) sensu Brundin 1947

The species is characterized by its circular basal appendix in the hypopygium. However, Sæther (1975) mentions that there is at least one unnamed species with a similar appendix known from Norway.

Limnophyes eltoni (Edw.)

The species is identified through its apically notched anal point, and by its having both a small fingerlike dorsal lobe and a ventral brood and rounded lobe (Sæther 1975).

Limnophyes borealis Goetgh.

The specimens in our collection seem close to the species as described and figured by Oliver (1962).

Metriocnemus ursinus (Holmgren)

The species of the genus *Metriocnemus* are sometimes difficult to tell apart, due to a missing revision of the genus. The species group, including *M. ursinus,* however, can clearly be separated by having only the tips of the wings covered with macrotrichia. According to Hirvenoja (1967), there may be more than one species in this group.

Paraphaenocladius impensus (Walk) Edw.

The figure of the hypopygium given by Brundin (1956) seems to agree very well with the structure found in the present material. The species is well known from Spitsbergen (Hirvenoja 1967).

Smittia brevipennis (Bohemanni) Holmgren

The species is described from Spitsbergen and is only known as a shortwinged, parthenogenetic form. The identification of our material is based on these two characters.

Smittia sp. A

An identification of the *Smittia* species is at present difficult, but the hypopygium of the species agrees well with the drawing given by Edwards (1922) for *S. extrema.* However, until the taxonomical problems have been worked out, we prefer to call this species *Smittia* sp. A. For further notes on these taxonomical problems, see Hirvenoja (1967, p. 58).

Pseudosmittia sp.

A few females of *Pseudosmittia* were captured at site 5. Unfortunately no males were found, and an identification is therefore impossible.

Notes on the larvae

The larval collections have been identified after the key given by Thienemann (1944) and Pankratova (1970). The larvae of *Paraphaenocladius, Metriocnemus,* and *Limnophyes* were collected in great numbers at site 2. A few larvae of *Smittia, Pseudosmittia,* and some unidentified specimens occurred in the samples from sites 1, 3, and 4. At site 5 a high number of *Smittia* larvae (certainly *S. brevipennis)* were found together with a few *Pseudosmittia* sp.

Table I. Emergence trap collections showing mean number ($\bar{N}$) and standard error (SE) for males and females, and the total mean number. All numbers per m^2

	Males		Females		
	$\bar{N}$	SE	$\bar{N}$	SE	$\bar{N}/m^2$
Site 1					
Smittia sp. A	4.0	2.1	3.0	1.1	7
M. ursinus	1.5	1.5	-	-	2
Chironomidae indet	-	-	5.0	0.7	5
Chironomidae total					14
Mycetophelidae					26
Muscidae					1
Site 2					
P. impensus	122.6	57.8	247.4	125.4	370
M. ursinus	9.6	3.8	8.6	2.6	18
L. eltoni/globifer	5.0	1.2	-	-	5
C. perennis	7.5	5.1	-	-	8
Chironomidae indet.	-	-	9.8	3.3	10
Chironomidae total					411
Mycetophilidae					8
Muscidae					9
Hymenopt. paras.					12
Site 3					
Smittia sp. A	3.6	1.2	21.0	4.3	25
Chironomidae indet.	0.2	-	0.2	-	1
Chironomidae total					26
Mycetophilidae					12
Hymenopt. paras.					2
Symphyta					1
Site 4					
M. ursinus	43.0	29.8	54.6	17.3	98
L. borealis/globifer	81.2	49.9	86.8	53.4	168
Smittia sp. A	-	-	2.4	0.4	2
P. impensus	-	-	0.4	0.3	1
Chironomidae total					269
Mycetophilidae					2
Muscidae					1
Hymenopt. paras.					3
Site 5					
S. brevipennis	-	-	1.8	0.6	2
Pseudosmittia sp.	-	-	8.0	3.7	8
Chironomidae indet.	-	-	0.5	-	1
Chironomidae total					11
Mycetophilidae					2
Coelopidae					3

The larvae of the *Chaetocladius (Dyscamptocladius* sensu Thienemann) were not found. However, the *Chaetocladius* larvae are not known as terrestrial larvae (Thienemann 1944), and the occurrence of this species in the emergence traps at site 2 may be explained by the occurrence of water assemblies in the areas covered by the traps. The soil cores were all taken exclusively in dryer parts of the soil, and that must be the reason why the larvae did not turn up in the soil samples. If this assumption is right, it also demonstrates the sharp boundary that may occur in the microdistribution of species.

RESULTS AND DISCUSSION

The chironomid communities

The results of the capture in the emergence traps are shown in Table I and in Fig. 1.

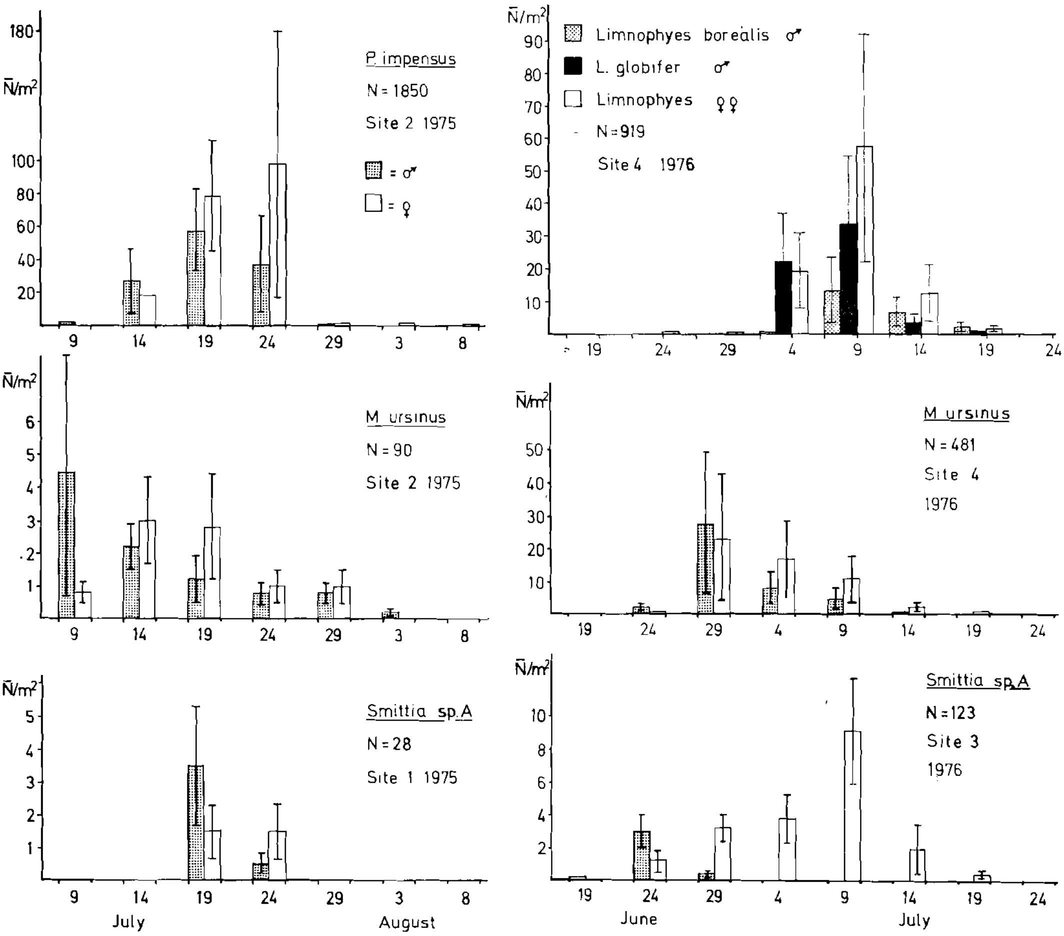

Fig. 1. Mean number per m², with standard errors, collected in emergence traps at different localities.

The data in Table I are given as mean values with standard error calculated from four traps at site 1 and five traps at the other sites. All data are presented as number per m².

The standard deviations calculated indicate a clumped distribution of the chironomids. It may be mentioned that in the period 9–24 July 1975, one trap in the *D. alpina* community captured 289 males and 582 females of *P. impensus*. That was more than 50% of the total capture of this species in all traps throughout the summer. Likewise, in 1976, 98.4% of *M. ursinus* and 100% of *Limnophyes* spp. at site 4 occurred in two traps only.

In both years the emergence of chironomids was in late June and July (Fig. 1). It may be noticed that there was a time difference in the main emergence period of the species occurring together at the same sites, e.g. 2 and 4. The dominant species emerged later and had a short main emergence period, as more than 90% of *P. impensus* in 1975 and of the two species of *Limnophyes* in 1976 emerged within a period of two weeks.

In the three species *P. impensus, M. ursinus,* and *Smittia* sp. A, the emergence peak of males occurred earlier than that of the females. This is a feature that has been reported several times for insects (e.g. Dahl 1973, Müller & Ulfstrand 1970), and which is most conspicuous in populations with a short adult life (Remmert 1962). The significance of an adaptation like that could be that there are always males ready for copulation at the time when the females emerge. In areas with extreme climatic conditions and in populations with a short adult life it may be an adaption of vital importance to exploit all suitable moments for life-demanded activities. However, with the time intervals for collecting samples in the present study, the *Limnophyes* species showed synchronized emergence of males and females.

The five different plant communities clearly showed differences in species composition of chironomids. In the two plant communities of the dry tundra, the *S. oppositifolia* – *C. delisei* (site 1) and the *Dryas* communities (site 3), the chironomid fauna was dominated by *Smittia* sp. A. A third community where the genus *Smittia* occurred was in the *C. ursina* community (site 5) at the beach, and here *S. brevipennis* was a typical species. *S. brevipennis* was not caught in representative numbers in the emergence traps, which must be a consequence of its brachyptery. One pitfall trap inside each emergence trap caught, however, as a mean, 50 specimens of *S. brevipennis* throughout the summer.

The wet tundra communities, the *D. alpina* community (site 2) and the moss tundra (site 4), was characterized by *P. impensus*, *M. ursinus*, and *Limnophyes* spp. In both communities on the wet tundra *M. ursinus* and *Limnophyes* spp. were important, even dominant in site 4. The dominant species in site 2 was *P. impensus*, while only two females were trapped at site 4.

Strenzke (1950) gave in his basic study on terrestrial chironomid communities a classification of the different biocoenosis investigated by him in Ost-Holstein and Lunzer Seengebiet. The different communities in the present work may be considered as arctic variations within the scheme given by Strenzke (1950). The species composition in sites 2 and 4 indicates a Mesophiles Hemiedaphon, and the fairly high number of *Metriocnemus* and *Limnophyes* shows a hygrophilic variation of this biocoenosis not unlike the type found in different beach communities in Ost Holstein. The dry tundra communities (sites 1 and 3) showed a chironomid fauna poor in species, and *Smittia* sp. A was the only species with reasonably high numbers. This could be an arctic variation of the Xerophiles Hemiedaphon.

The community in site 5, totally dominated by *S. brevipennis*, is close to the haline variation of Mesophiles Hemiedaphon described by Strenzke (1950) from the coast of the Baltic. The *Smittia (Euphanocladius)* sp. *aquatilis* group is replaced by the parthenogenetic brachypterous *S. brevipennis*, which seems to tolerate a fairly high concentration of NaCl.

All the different Diptera trapped can be related to the four families Chironomidae, Mycetophilidae, Muscidae, and Coelopidae. Chironomids clearly dominated the wet sites 2 and 4, and made up more than 90% of the collections (Table I). The chironomids also had the highest abundance at site 5, the wet sea shore area, but reliable quantitative values on the emergence of the dominating brachypterous species *C. brevipennis* were not obtained. On the dry tundra Mycetophilidae was an important part of the emerging dipterous fauna, as they counted for about 64% and 30% on sites 1 and 3, respectively.

The Diptera fauna on the Spitsbergen tundra is very poor compared with that on the alpine tundra communities on Hardangervidda, Norway, where Solhøy et al. (1975) recorded 19 Diptera families at a dry and wet meadow. The data are not strictly comparable because other collecting methods were used on Hardangervidda, but they give an idea of the reduction and low number of taxa occurring on the arctic tundra.

Life history and secondary production

The data of the extraction of larvae from soil cores are shown in Table II. It should be emphasized that the table shows year-classes and not instars. Data are given as numbers per m² of the most common chironomid species from site 2 (the *D. alpina* community) and *S. brevipennis* from site 5 (the beach community). It is, however, remarkable that the number of each year class seems to increase during the summer. Except for the first year, this must be an artifact, depending on greater ability of the larvae to leave the soil during the extraction process in late- than in early summer. Because of this artifact, we have found it meaningful only to use late summer abundances and the highest number per m² obtained with regard to secondary production. However, they must still be considered as minimum values, due to inaccuracy in the methods. In our opinion these late summer abundances are closest to the real abundances,

Table II. Number of Chironomidae larvae per m^2 extracted from soil samples. Each species is divided in year-classes. (0+ = first year, 1+ = second year, ...) The data are from Site 2 in 1975 and Site 5 in 1976.

	Site 2				Site 2			Site 2					Site 5			
	Paraphenocladius impensus				Limnophyes eltoni/globifer			Metriocnemus urcinus					Smittia brevipennis			
Date	0+	1+	2+	3+	0+	1+	2+	0+	1+	2+	3+	Date	0+	1+	2+	3+
1/7	70	70	-	-	-	180	600	-	70	70	140	24/6	-	170	40	-
11/7	110	-	210	460	-	630	1200	-	-	70	250	4/7	-	250	90	-
21/7	600	530	-	-	-	630	740	-	910	240	140	14/7	40	-	40	-
31/7	880	950	110	-	880	2000	-	-	880	630	-	24/7	1600	-	340	-
10/8	1100	380	210	-	930	3900	-	-	2000	1300	-	3/8	6400	-	130	-
												13/8	13000	560	2600	-

and therefore will give the best production estimates.

Larval weights are presented in Fig. 2. The variation in individual weight within each year-class at a given date was relatively low, and consequently no variation data are given. The larval weight studies (Fig. 2) of *Limnophyes* at site 2 clearly point to a conclusion that these species use two years to develop. Considering the *P. impensus, M. ursinus,* and *S. brevipennis* larvae, the results indicate a growth period of three years. This apprehension may be verified by the low weight of the larvae of the first summer.

If we know the number and weight of the larvae from different stages of development from one cohort, a production model can be constructed using the Allen curve method (Allen 1951). The number per m² plotted on the ordinate and the mean individual weight on the abscissa give the cohort production as the area under the curve.

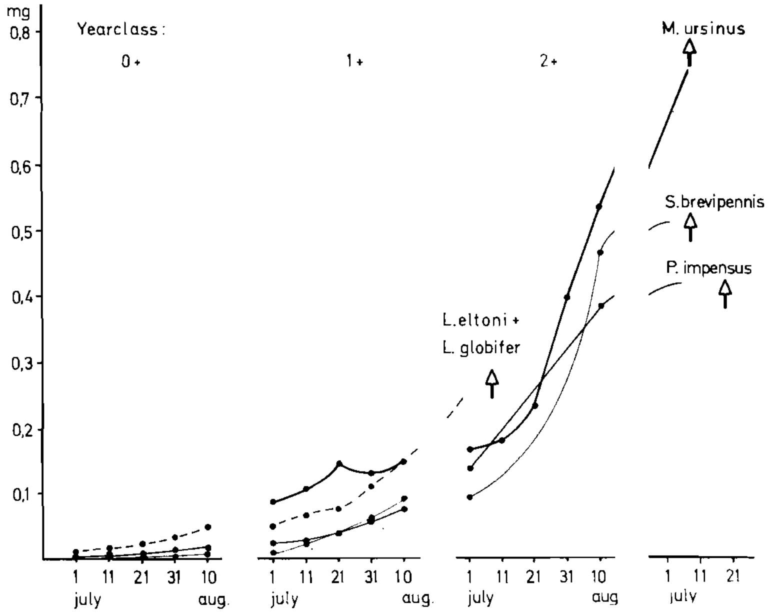

Fig. 2. Growth patterns of chironomid species on the tundra. Arrows show date of emergence.

In the present study we obtained, during one summer only, several year-classes belonging to different cohorts of a species. However, each year-class represents only one cohort, and we have therefore made the approximation that these different year-classes of a species found during one summer, are representative for the successive year-classes within one cohort. At least this will give an idea of the magnitude of the production, because conditions that favour or disfavour life-demanded functions will, in any case, give variations from year to year.

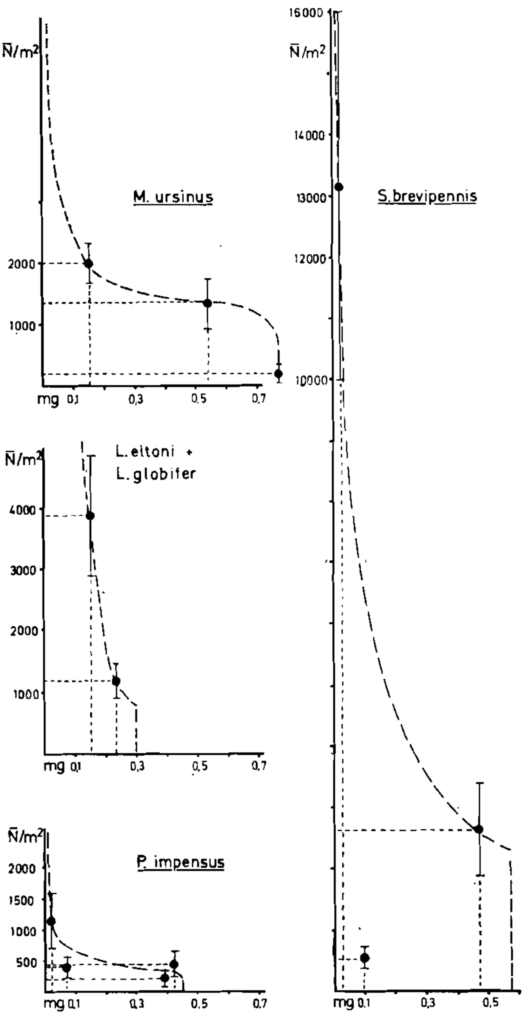

Fig. 3. Production, roughly estimated from mean weight and numbers of different year-classes, of various species. Standard error of numbers indicated. The highest abundances, obtained in late summer, were used in the calculation.

Considering reasons discussed earlier, we have few points on an 'Allen curve', but the method gives an indication of the production. The estimates are definitely lower than the real values, because of the limitation of the extraction method; nevertheless, the results from the emergence traps indicate the production estimates to be fairly reasonable. From Fig. 3 the production of *Limnophyes* spp., *M. ursinus, P. impensus,* and *S. brevipennis* is roughly estimated to 0.8, 1.0, 0.3, and 2.5 g per m^2, respectively. Except *S. brevipennis,* which occurred at site 5, the other three species lived within site 2. The production of *C. perennis* in site 2 could not be estimated, as no larvae were found in the soil samples. In site 2 (the *D. alpina* community), the turfs from which the soil samples were taken cover only about 30% of the area, i.e. the chironomid larvae from 70% of the area are strictly speaking not studied.

The mean weight of males of *P. impensus,* based on 50 specimens, was about 0.19 mg/specimen, and then a biomass of about 0.11 g/m^2, wet weight, emerges from the soil each summer. *P. impensus* was the only species that occurred in sufficiently high numbers in the emergence traps for us to get reliable data on the emerged biomass.

Lumping the estimate of secondary production of *Limnophyes, M. ursinus,* and *P. impensus* together, we get a mean estimate of about 2 g wet weight per m^2 in site 2. A maximum estimate will then be about 4 g/m^2 (Fig. 3). We find it reasonable that the production is of a magnitude somewhere between these estimates. In site 4, the production of *S. brevipennis* alone (Fig. 4) was estimated to be between 2 and 3 g/m^2.

If we transform our wet weight data on production to dry weights, they should be equivalent to 0.4–0.8 g/m^2 when assuming that the dry weights are about 20% of the total wet weight. That the dry weight is about 20% of the wet weight seems reasonable, as Jonasson (1972) assumed the dry weight to represent 10–20% of the total wet weight of profundal animals in the Esrom lake, and Edwards (1966) for terrestrial Diptera estimated the percentage to be 25.4. Our dry-weight data on production are thus close to the chironomid production estimated for a polar lake, 'Char Lake', Resolute, Northwest Territories (78°42'N) (Welch 1976). Chironomid production in eutrophic lakes in temperate regions is usually within the range 15–42 g/m^2 dry weight (Potter & Learner 1974).

ACKNOWLEDGEMENTS

This work received financial support from The Norwegian Research Council for Science and the Humanities and the Ministry of Environment. Technical help was received by the Norwegian Polar Institute. To these institutions we express our gratitude. We also wish to thank Tore Bergvik and Arvid Heggstad for collecting the data.

Our work at Spitsbergen is part of the Norwegian 'Man and Biosphere' project and is designed to contribute to better understanding of the invertebrate soil fauna in an Arctic ecosystem.

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Received 4 April 1977

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Emergence of chironomids from a small man-made lake in northern Sweden

T. WIEDERHOLM, K. DANELL & K. SJÖBERG

Wiederholm, T., Danell, K. & Sjöberg, K. 1977. Emergence of chironomids from a small man-made lake in northern Sweden. *Norw. J. Ent. 24,* 99–105.

The chironomid fauna of a newly created shallow lake was studied for two years by means of emergence traps operated over the entire ice-free season. Eight species were found during the first year and ten the second year. Both years, three species comprised more than 80% of the material. The quantitatively most important species were *Einfeldia dissidens, Glyptotendipes paripes,* and three species of *Chironomus*. Fifty percent of the total emergence took place within less than eight days. The species succession was similar during both years with males emerging slightly earlier than females. Sex ratios were uneven for most species. Community composition, species number, phenology, and sex ratios are discussed and related to the low maturity of the ecosystem.

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In northern Sweden the water level in many lakes has earlier been lowered and regulated to produce hay from sedges *(Carex* spp.) and water horsetail *(Equisetum fluviatile* L.). However, nowadays this agricultural practice has been abandoned, the dams are decayed, and the drained sedge communities are often invaded by willow shrubs *(Salix* spp.). During recent years there has been an increasing interest in restoring the dam constructions to improve duck production. When the terrestrial vegetation is inundated many plant species die and offer, at least for some years, good conditions for aquatic invertebrates, especially detritus feeders. These man-made shallow lakes are further characterized by a stable water level, a highly fluctuating water temperature, temporarily poor oxygen conditions, and freezing to the bottom during winter.

In such a man-made lake in northern Sweden, the ecology of the breeding duck population has been studied. Special attention has been given to the chironomids which are abundant and valuable as duck food, both as larvae and adults. In this study, the chironomid fauna, investigated by use of emergence traps during the ice-free part of the year, is presented.

STUDY AREA

Lake Veittijärvi (66°3′N, 23°46′E) (Fig. 1) is situated in the northeastern corner of Sweden (province of Norrbotten) close to the Finnish border. The area belongs to the main boreal (central taiga) biotic zone (Sjörs 1963) with coniferous forests of Norway spruce *(Picea abies* (L.) Karst.) and Scots pine *(Pinus silvestris* L.). The lake lies in a flat region where large expanses of mires are interrupted by thin coniferous forests.

The mean annual temperature is 0–1 °C (Ångström 1953b) and the precipitation is 500–550 mm (Wallén 1953). The temperature for the warmest month (July) is 15–16 °C (Ångström 1953a). In general, ice covers the lakes in this part of Sweden from about 10 October to about 20 May, or 200–220 days (Ångström 1958).

Fig. 1. Lake Veittijärvi in northern Sweden (23 July 1974).

The lake, situated 35 metres above the sea level, has an area of about 45 hectares. It is surrounded by an outer belt of birch (*Betula pubescens* Ehrh.) and an inner belt of willows (*Salix lapponum* L. and *S. phylicifolia* L.). About 1930 the lake was drained and then used for hay production (*Carex* spp.) up to the beginning of the 1950's. It was restored in 1971 and the subsequent flooding resulted in the sedges dying off.

The lake bottom consists of clay, and during our studies in 1975 and 1976, a mat of more or less decomposed sedges was lying on the bottom. During late spring and early summer most parts of the lake have a water depth of 0.3–0.5 m. The water has a brown colour. Data on the water chemistry are summarized in Table I. The water temperature and the ice cover during 1975 and 1976 are shown in Fig. 2.

The vegetation on the shore is dominated by sedges (*Carex rostrata* Stokes, *C. aquatilis* Wahlenb. and *C. canescens* L.). The emergent vegetation is at the present successional stage very scanty, and consists of some stands of water horsetail and some scattered clones of sedge (*Carex aquatilis*). Floating plants are absent. Submerged plants such as pondweeds (*Potamogeton pusillus* L. and *P. obtusifolius* Mert & Koch) have colonized the lake during the last years, but are abundant only in the shallowest part near the shoreline.

Table I. Water chemistry of Lake Veittijärvi. Water samples were taken at the outlet from late May to early October 1975.

Chemical parameter	Range (mg/l)
K	0.9 - 1.5
Ca	2.9 - 3.4
Mg	1.5 - 1.8
Na	4.0 -10.1
SO_4	9.0 -20.1
Cl	0.1 - 2.8
NH_4-N	0.03-0.54
Organic-N	1.13-1.96
NO_3-N	0.02-0.32
NO_2-N	0.00-0.01
Total-N	1.18-2.83
PO_4-P	0.01-0.02
Total-P	0.01-0.04
pH	6.0 - 6.3
Specific conductivity (µS/cm, 20°C)	36 - 65

METHODS

Chironomids were caught by means of ten emergence traps operated from spring to fall. The traps were placed in open water at ten positions chosen at random. The positions were the same in 1975 and 1976. Two sets of traps were used, and they were usually changed every 5–7 days, more frequently at peak emergence.

The traps were specially constructed for this study. The main parts of the trap, a bucket and a funnel, were made of polyethylene. Two holes were cut in the bucket, which had a volume of about 5 litres. The holes were covered by a nylon gauze of 280

Table II. Percentage composition of chironomid emergence from Lake Veittijärvi in 1975 and 1976.

Species	1975	1976
Tanypodinae:		
Anatopynia plumipes (Fries)	-	0.7
Procladius sp.	-	0.1
Psectrotanypus varius (Fabr.)	5.8	11.8
Orthocladiinae:		
Cricotopus sylvestris Fabr.	1.0	-
Psectrocladius edwarsii Brund.	-	0.4
Chironominae		
Chironomus ? longistylus Goetgh.	4.1	30.6
C. cf. pilicornis Fabr.	53.6	2.9
C. tentans Fabr.	3.7	9.9
C. macani Freeman[1]	-	1.2
Einfeldia dissidens Walk.	6.8	40.5
E. pagana (Meig)	2.4	-
Glyptotendipes paripes (Meig)	20.0	1.9
Total number of species	8	10
Total number of individuals	295	1122

[1] Note: All individuals identified as *C. macani* differ from literature descriptions of this species (Freeman 1948, Erbaeva 1968) in being completely black or very dark brown. The L.R. is lower (1.3-1.4) . . the A.R. higher (4.6-4.9). The front tarsi of the males have a long but very thin and fragile beard (B.R. = 4.7-6.1) The male genitalia resemble those of *C. macani* except in having a more pronounced process on appendage 1. At present these differences do not seem to motivate the erection of a new species. Until more material or a charyosystematic identification of the larval salivary chromosomes are available, the differences are best regarded as reflecting those of northern phenotype of *C. macani*.

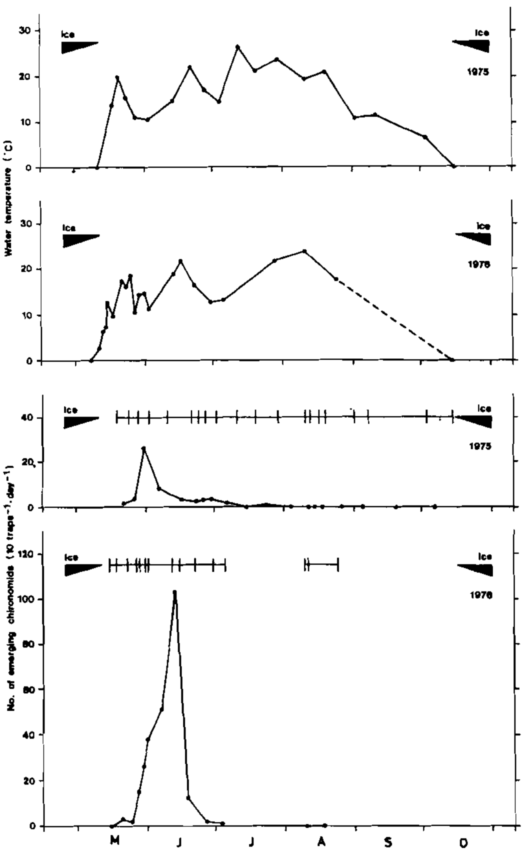

Fig. 2. Duration of ice cover, water temperature and total emergence of chironomids in Lake Veittijärvi for the years 1975 and 1976. Sampling periods are indicated by horizonal bars with times of collection marked.

µm mesh. The container was closed by pressing a funnel into the bucket. The funnel covers an area of 0.036 m². The trap is described in detail by Danell & Sjöberg (1977).

RESULTS

Species composition

Table II shows the percentage composition of the chironomid emergence during the two years of investigation. The low number of species reflects the extreme environmental conditions in the lake, i.e. with solid freezing during the winter and great temperature fluctuations in the summer. Most species found are known to occur in the lake littoral or in small and eventually ephemeral water bodies rich in vegetation and decaying plant material. Among these are *Anatopynia plumipes, Psectrotanypus varius, Cricotopus sylvestris, Chironomus tentans, Einfeldia dissidens, E. pagana,* and *Glyptotendipes paripes* (Brundin 1949, Fittkau 1962, Reiss 1968, Hirvenoja 1973).

The total number of species emerging during the first year was 8 and the second 10. In both years, three species made up more than 80% of the total number of individuals. The dominating species in 1975 were *C. cf. pilicornis, G. paripes,* and *E. dissidens.* In 1976, *E. dissidens, C. ? longistylus,* and *C. tentans* were the most frequent ones.

Total emergence and phenology of the individual species

The total emergence of chironomids and the temperature of the lake water are shown in Fig. 2. After thaw, water temperature increases rapidly, and within less than a week after ice-break the first chironomids were

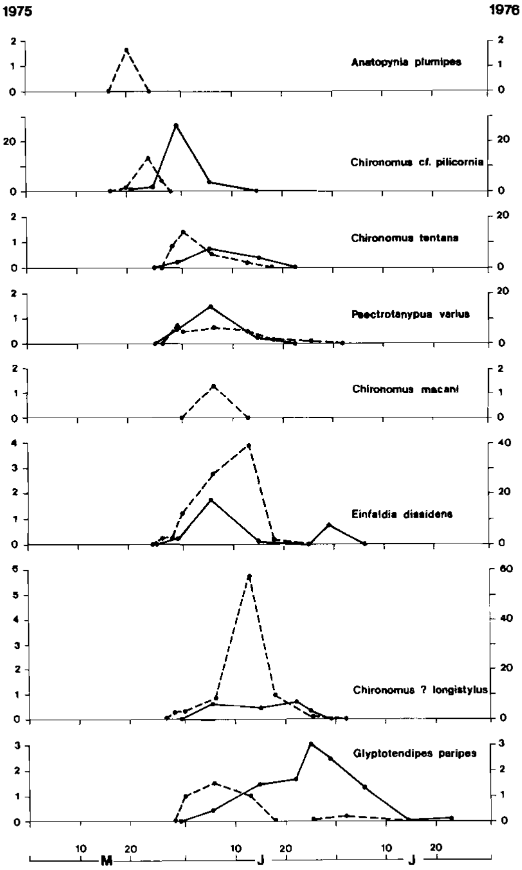

Fig. 3. Emergence of individual chironomid species (numbers/10 traps · days) from Lake Veittijärvi in 1975 (solid lines) and 1976 (broken lines).

caught. Peak emergence was reached within 2.5–4 weeks after thaw, when the temperature had already reached a maximum of nearly 20 °C. Ninety percent of the emergence had taken place within 5–7 weeks after thaw. During the remaining 3.4–4 months of open water, only 10 % of the annual emergence took place. In both years, 50 % of the total annual emergence happened within 6–8 days during peak periods.

The number of chironomids emerging per m^2 lake bottom was estimated to 840 ± 157 ($\bar{x} \pm$ S. E.) for 1975 and 3121 ± 568 for 1976. As a control of the efficiency of the traps, the number of chironomid larvae and pupae on the bottom was checked before onset of emergence in May 1976. Seven samples with a Rzoska corer gave 2088 ± 655 individuals per m^2. There is no significant difference between the estimates of larvae and emerging adults (Mann–Whitney U-test, $P>0.05$, $U=17$).

The emergence of individual species is seen from Fig. 3. It appears that different species succeed each other from the beginning to the end of the emergence period in both years. Most species have a synchronized period of emergence. With few exceptions, the species succession is similar for each year.

The first species that emerge are *A. plumipes* and *Psectrocladius edwardsii,* the last one not included in the figure. Both species are represented by single individuals from 1976 only. They are followed by *C. cf. pilicornis* and, somewhat later, *C. tentans* and *P. varius. E. dissidens* and *C. ? longistylus* have their peak emergence even later. In 1975, *G. paripes* was the last species to emerge, whereas in 1976 it occurred before *E. dissidens* and *C. ? longistylus.*

Difference between sexes in total emergence and phenology

In Table III, the sex ratios for the most common species are expressed as the percentage of males from two years of emergence. It appears that the male: female ratio is unequal in all cases. In some species either males or females dominate strongly.

The most pronounced dominance of females occurred in *E. dissidens,* where only 25 % of the individuals emerging during two years were males. Also *P. varius* had a strong dominance of females with only 34 % males. *C. tentans, C. ? longistylus,* and *C. cf. pilicornis* had a more balanced sex ratio with between 40 and 60 % males. Finally, in *Glyptotendipes paripes,* the females were in minority, with only about a third of the total number of individuals.

Table III. Sex ratios of the most abundant Chironomidae from Lake Veittijärvi 1975-76

Species	Number of individuals	Percent of males
Einfeldia dissidens	474	25.3
Psectrotanypus varius	149	33.6
Chironomus tentans	121	44.6
C. ? longistylus	355	53.8
C. cf. pilicornis	199	59.3
Glyptotendipes paripes	80	68.8

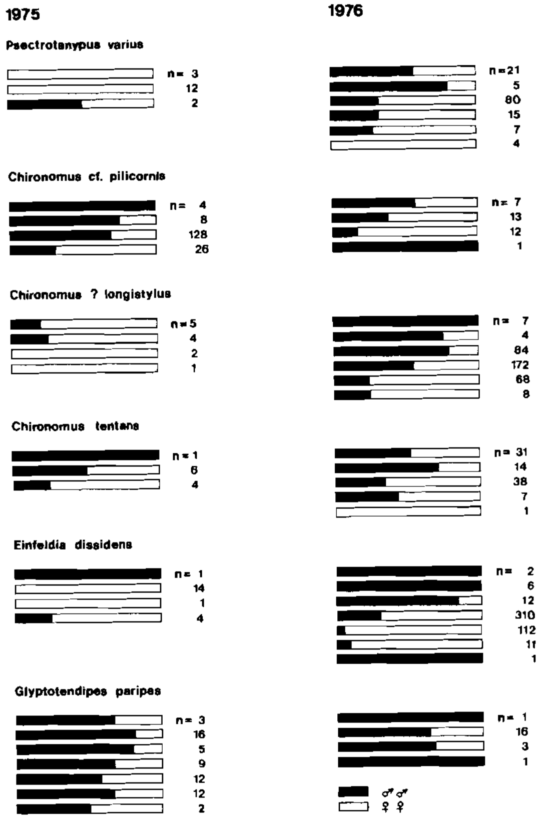

Fig. 4. Balance between males and females among the most abundant chironomid species at successive dates of emergence (top to bottom), Lake Veittijärvi, 1975 and 1976.

Common to all species is a tendency to an earlier emergence of males than of females. This is seen from Fig. 4, which shows the balance between the sexes on all occasions when the particular species occurred. Generally, the males dominate during the first days of a species' emergence whereas the females dominated during the end of the period. The difference between the emergence peaks for both sexes amounts to only a few days.

DISCUSSION

Lake Veittijärvi constitutes a young lake ecosystem with extreme environmental conditions. The lake has been permanently flooded for a relatively short period of time. Remains of the previous terrestrial vegetation have not yet decomposed fully, and truly limnic sediments have not been deposited to any large extent. The bottom substrate is made up of clay with remains of the previous vegetation. The temperature varies greatly during the year. During winter, water and upper sediment layers are frozen solid. In summer, variations in air temperature and the shallow water depth bring about large fluctuations in the temperature at the sediment surface, with maxima occasionally reaching 25°C or more.

Altogether these factors enable few species to colonize the lake. On the other hand, population density of those species adapted to existing physical conditions and able to utilize available nutrient resources may become fairly high, particularly since the predation is restricted to waterfowls and single individuals of fish.

The low degree of maturity of the ecosystem and the widely fluctuating physical conditions may also be expected to result in large variations in the numbers of species and the composition of the biota. Further, population density and community composition will not be balanced in this early stage of development of the ecosystem. Internal control mechanisms will probably be overridden by the widely varying environmental factors also in the future, even after an eventual further colonization, and thus more complex biotic interactions. During the two years of investigation, differences in population density were reflected most markedly in the emergence of *C. tentans, E. dissidens,* and particularly *C.* ? *longistylus.* All these species were far more numerous in 1976 than in the preceding year. Similarity in the temperature and chemical data for each of the two years suggests that these changes are part of the normal biological succession during the development and eventually the senescence of the lake.

The immaturity of the ecosystem, and/or eventually the extreme environmental conditions, may also account for the observed deviations in the sex ratio from unity. In the material from the two years, there are great variations between different species regarding the proportion of males to females. The extremes are made up of *E. dissidens* with strong dominance of females (75 %) and *G. paripes* with an equal overweight of males

(69%). Even if the total number of individuals is admittedly low (less than 500 for any species), the material covers two complete seasons and a representative surface of the lake bottom.

As pointed out by Oliver & Danks (1972), sex ratios near unity occur in most normal bisexual insects, but departure from unity is well established for many chironomid species. Predominance of females would result from development of unfertilized eggs (parthenogenesis), predominance of female-determined fertilized eggs, or differential mortality during development. Parthenogenesis has been reported for several chironomid species (see literature cited in Danks & Oliver 1972), but it is not yet clear whether cases of predominance of male or female larvae (Acton 1957, Martin 1962) are due to sex determination in the egg stage or differential mortality during development.

It is interesting to note that the species with the most unbalanced sex ratio in the present investigation also show the largest fluctuation in numbers between the two years. Further, the four (reasonably abundant) species with females dominating in 1975 all emerged in considerably higher numbers in 1976, whereas the two species with males predominating had a lower emergence the last year.

In a developing ecosystem, not yet inhabited to its full potential, such a predominance of females would promote the further spreading of those species fit to utilize available resources, particularly in the early stage of colonization when all eggs may develop and contribute to population growth. In such a case, an inherent predominance of female-determined eggs, either through parthenogenesis or through predominance of normal fertilized but female-determined eggs, would be advantageous. Differential mortality resulting in a lower number of males would be of no adaptive value during a period of population growth with an overabundance of natural resources.

Also, increased mortality of male-determined eggs or larvae seems unlikely to occur under conditions permitting an expansion of the population as a whole, and, as indicated above, it has not yet been demonstrated to occur. During less favourable conditions, however, differential mortality of *female* eggs and larvae would bring about an exponential decrease of population size and ultimately the disappearance of the species.

From the above it can be concluded that further investigations are needed for a better understanding of the causes of unbalanced sex ratios and their eventual role in regulating population size, particularly in the absence of serious predators. Ecosystems with extreme conditions, like the one discussed here, are suitable objects for such studies because of their relative simplicity and limited size.

As seen from the data presented earlier, the total chironomid emergence in Lake Veittijärvi takes place within a relatively short period of time in spring or early summer. Virtually no adults appear during the remaining three months of open water. Bottom samples taken after thaw in May 1976 contained mostly 4th instar larvae, but a few *Chironomus* larvae in the 2nd and 3rd instars were also present. This shows that the majority of chironomids are univoltine and overwinter as mature larvae.

The presence of single immature larvae may indicate that a few adults have emerged later in the season and avoided the emergence traps. In that case, a small second generation and a bivoltine pattern of development would exist for a minor part of the *Chironomus* population. It seems less likely that eggs laid by females emerging in May and June would not have developed further than to 2nd and 3rd instar larvae in the two or three months available with water temperatures between 10 and 20 °C.

The factors that regulate onset and timing of emergence in chironomids are little known. Temperature and food conditions are decisive for the time needed for development from egg to pupa. A diapause regulated by temperature or light conditions and the existence of specific thresholds for final development and pupation would ensure simultaneous emergence of the various species (cf. Danks & Oliver 1972). Because of the great similarity in temperature during the two separate years reported here, the existence of such temperature thresholds cannot be fully evaluated. However, the occurrence of a similar emergence succession of the various species during both years does indicate that a specific minimum temperature or number of day degrees is needed for final development and thus controls the pattern of emergence.

ACKNOWLEDGEMENTS

This investigation was financially supported by the Research Committee of the National Swedish Environment Protection Board (contract 6-34/74-76) and the Swedish Sportsmen's Association.

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Auchenorrhyncha and Psylloidea collected in strawberry fields

GUDMUND TAKSDAL

Taksdal, G. 1977. Auchenorrhyncha and Psylloidea collected in strawberry fields. *Norw. J. Ent. 24,* 107–110.

In southern Norway 1680 sampled strawberry plants yielded 1804 Auchenorrhyncha and 65 Psylloidea comprising 34 and 9 identified species, respectively. The Psylloidea were mainly associated with weeds. Breeding on strawberry is indicated for *Aphrophora alni* (Fallén), *Philaenus spumarius* (Linné), *Aphrodes* sp., *Evacanthus interruptus* (Linné), *Emelyanoviana mollicula* (Boheman), *Edwardsiana* sp., and *Macrosteles* sp. Of the total Auchenorrhyncha, *P. spumarius* and *E. interruptus* each made up 45%. In both species nymphal development took place between first flower and first harvest of the strawberry crop. Azinphosmethyl and dimethoate controlled *P. spumarius* better than did fenthion and malathion. *Edwardsiana alnicola* (Edwards) and *Zygina schneideri* (Günthart) are recorded for the first time from Norway.

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In 1968 and 1969 an investigation was carried out in southern Norway to study the influence of Miridae on strawberry fruits (Taksdal and Sørum 1971). Other arthropod groups also appeared in the samples, such as a fairly high proportion of spiders (Taksdal 1973). This paper presents the collected material of leafhoppers and other Auchenorrhyncha, and Psylloidea.

MATERIAL AND METHODS

The samples were collected with a sweepnet with an opening diameter of 32 cm. The net was placed at an angle with the soil surface at the base of a strawberry plant, and the plant was then bent into the bag and shaken. This method yielded a much higher proportion of the arthropod fauna than did ordinary sweeping, and collecting directly from possible weeds could be avoided. Further details are given elsewhere (Taksdal & Sørum 1971).

Information on insecticide applications was collected from all sampled fields. Samples were also taken from spraying experiments to control capsids (Taksdal 1971). Sampled localities and numbers of samples are given in Table I. Most of the samples were collected in the Oslofjord area (Østfold, Akershus, Vestfold), while some were taken further inland (Oppland) or on the western coast (Hordaland, Møre og Romsdal).

RESULTS

The numbers of sampled plants and collected Auchenorrhyncha and Psylloidea at the different localities are given in Table I. In total, 1680 sampled plants yielded 1804 specimens of Auchenorrhyncha and 65 of Psylloidea.

The material comprised 34 and 9 identified species of Auchenorrhyncha (Table II) and Psylloidea (Table III), respectively, and a number of nymphs and females identifiable only to genera. The list of Auchenorrhyncha has been arranged according to Nast (1972),

Table I. Numbers of samples, sampled fields and plants and collected specimens of Auchenorrhyncha and Psylloidea at each locality and date

Localities	Dates	Samples taken	Sampled fields	Sampled plants	Auchenorrhyncha	Psylloidea	Collector 1)
Østfold							
1.Fredrikstad	27 June 1969	24	1	120	224	1	G.T.
2.Råde	23 July 1968	1	1	50	2	0	O.S.
3.Rygge	27 June 1968	3	3	150	230	4	O.S.
4.Moss (Jeløy)	23 July 1968	2	2	100	43	0	O.S.
5.Askim	15 July 1968	2	2	100	43	0	O.S.
Akershus							
6.Ås	25 June 1968	3	1	150	33	0	O.S.
7.Asker	14 June 1968	2	1	100	224	9	G.T.
	4 June 1969	1	1	50	54	0	G.T.
	9 June 1969	1	1	25	58	2	G.T.
	16 June 1969	1	1	25	88	0	G.T.
	24 June 1969	1	1	25	99	0	G.T.
	24 June 1969	12	1	60	179	0	G.T.
	30 June 1969	1	1	25	78	0	G.T.
	7 July 1969	1	1	25	37	0	G.T.
	14 July 1969	1	1	25	34	0	G.T.
	7 Aug. 1969	1	1	25	17	0	G.T.
Oppland							
8.Gjøvik (Biri)	3 July 1969	1	1	25	22	20	G.T.
	3 July 1969	5	1	100	19	22	G.T.
Vestfold							
9.Stokke	5 July 1968	3	3	150	24	0	O.S.
10.Sem	5 July 1968	2	2	100	100	1	O.S.
11.Nøtterøy	5 July 1968	1	1	50	2	3	O.S.
Hordaland							
12.Ullensvang	10 July 1968	1	1	50	153	2	G.T.
Møre og Romsdal							
13.Norddal	5 Aug. 1968	3	3	150	41	1	O.S.
		73		1680	1804	65	

1) O.S.: Olav Sørum
G.T.: Gudmund Taksdal

Table II. Numbers and species of males, females, and nymphs (n) of Auchenorrhyncha collected at the various localities

	Found at localities 2)	Nos.collected ♂♂	♀♀	n
Cixiidae				
Cixius cunicularius (Linné)	12,13	1	1	
Delphacidae				
Dicranotropis hamata (Boheman)	7	2	2	
Javesella pellucida (Fabricius)	9	1	1	
Cercopidae				
Neophilaenus lineatus (Linné)	10	1	1	
Aphrophora alni (Fallén)	1,3,4,10		4	2
Philaenus spumarius (Linné)	all loc.	289	256	267
Cicadellidae				
Oncopsis flavicollis (Linné)	6		1	
Macropsis fuscula(Zetterstedt)	7	1		
Idiocerus sp.	1			1
Aphrodes sp.	1,3,5,7,10			34
Evacanthus acuminatus (Fabricius)	13		1	
E. interruptus (Linné)	1,7,9,12,13	67	106	636
Alebra albostriella (Fallén)	4	1		
Emelyanoviana mollicula(Boheman)	1,5,7	14	27	23
Kybos lindbergi (Linnavuori)	8	1		
K. populi (Edwards)	8	2		
K. smaragdulus (Fallén)	8	1		
K. sp.	3			1
Empoasca vitis (Göthe)	3		2	
Edwardsiana alnicola (Edwards)1)	13	1		
E. geometrica (Schrank)	13	1		
*E.*sp.	1,4,13		5	4
Ribautiana ulmi (Linné)	7		1	
Eurhadina concinna (Germar)	4	1		
Zygina hyperici(Herrich-Schäffer)	7	1		
Z. schneideri(Günthart)1)	7	1		
Balclutha punctata (Fabricius)	5,8,9		4	
Macrosteles cristatus (Ribaut)	7,8	4		
M. laevis (Ribaut)	7	1		
M. sp.	6,7,8,10	1	4	2
Deltocephalus pulicaris(Fallén)	7	1		
Doratura stylata (Boheman)	7		1	
Elymana sp.	4,5,7,8,10		3	7
Hesium domino (Reuter)	5		1	3
Streptanus aemulans(Kirschbaum)	9		1	
S. sordidus (Zetterstedt)	13	1		
Psammotettix alienus (Dahlbom)	7	2		
P. confinis (Dahlbom)	7	1		
Diplocolenus abdominalis(Fabricius)	5		1	
Arthaldeus pascuellus (Fallén)	5,10,13	3	1	
		400	424	980

1) The first record from Norway

2) Numbers according to Table I.

while that of Psylloidea mainly follows Dobreanu & Manolache (1962). The majority of the species was taken in low numbers, thus only one or two specimens were found of 25 Auchenorrhyncha spp. and of 6 Psylloidea spp. No nymphs were taken of Psylloidea, while 980 nymphs of Auchenorrhyncha were collected representing 11 genera and 5 identified species.

Philaenus spumarius (Linné) was the only species found in all localities (Table II). *Evacanthus interruptus* (Linné), however, occurred in equal numbers, but was taken in only 5 of the 13 localities. The appearance of these two species in a series of samples at Sem, Asker, Akershus in 1969 is given in Fig. 1. Nymphs of *E. interruptus* appeared about two weeks before nymphs of *P. spumarius,* but the major nymphal development of both species took place between first flower and first harvest of the strawberry crop. Both species exhibited marked protandrie with the first males collected by the end of June, while females only remained in early August.

In Table IV the catch is arranged according to the information given on insecticide application by the growers during the field survey, and Table V gives the material collected in the spraying experiments. Obviously the insecticides have generally depressed the catches. However, *P. spumarius* was apparently less affected than *E. interruptus,* which occurred almost exclusively on nonsprayed plants. The high number of *P. spumarius* after the use of DDT + dicofol in Table IV was caused by a high population on a few plants which may have escaped spraying.

Table III. Numbers and species of Psylloidea collected at the various localities

	Found at localities[1)]	Nos. collected ♂♂	♀♀
Aphalaridae			
Rhinocola aceris (Linné)	7		1
Aphalara polygoni Förster	8	11	
A. sp.	8,10		12
Craspedolepta latior Wagner	11		1
Psyllidae			
Psylla mali Schmidberger	7		2
P. sorbi (Linné)	13		1
Triozidae			
Trioza urticae (Linné)	7,8,11	17	12
T. cirsii Löw	7	1	
T. femoralis Förster	12	2	
T. apicalis Förster	1,3	2	3
		33	32

1)Numbers according to Table I.

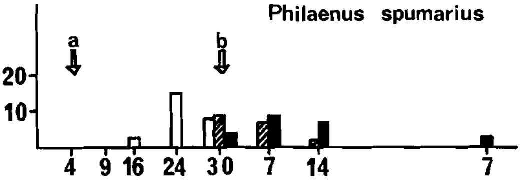
Table IV. Auchenorrhyncha and Psylloidea collected per 10 plants in strawberry fields after different insecticide applications

Insecticide application	No of samples	No of sampled plants	Auchenorrhyncha: All species	*Philaenus spumarius*	*Evacanthus interuptus*	Psylloidea: All species
None	19	750	14.8	3.9	8.8	0.5
DDT	4	200	2.9	2.6	0	0.2
DDT + dicofol	3	150	12.1	11.7	0	0
DDT + organophosphate[1)]	3	150	0.9	0.7	0.1	0.1
Demeton-S-methyl	1	50	8.4	6.4	0	0
Demeton-S-methyl + parathion	3	150	2.2	2.1	0	0

1)azinphos-methyl, demeton-S-methyl, or diazinon

DISCUSSION

Many of the species which were collected in low numbers, and from few localities, may be associated with surrounding plants, especially trees or shrubs, or with weeds in the strawberry fields. Thus, according to Ossiannilsson (1946), the following Auchenorrhyncha are usually found on deciduous trees: *Cixius cunicularius* (Linné) (preferably *Salix), Oncopsis flavicollis* (Linné) *(Betula* and *Alnus), Alebra albostriella* (Fallén) *(Quercus* and *Alnus), Kybos smaragdulus* (Fallén) *(Alnus), K. populi* (Edwards) *(Populus), Edwardsiana alnicola* (Edwards) *(Alnus glutinosa), E. geometrica* (Schrank) *(A. glutinosa), Ribautiana ulmi* (Linné) *(Ulmus),* and *Eurhadina concinna* (Germar) *(Quercus, Fagus, Acer, Alnus).* For *Hesium domino* (Reuter), *Idiocerus* sp., and *Kybos* sp. also the collection of nymphs may be connected with surrounding trees or shrubs. *Zygina schneideri* (Günthart) is known from *Prunus, Malus,* and *Sorbus* (Günthart 1974).



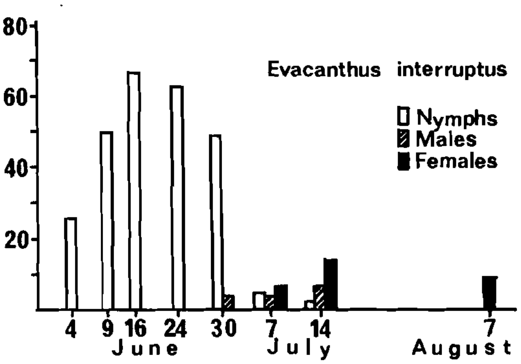


Fig. 1. The development of *P. spumarius* and *E. interruptus* at Sem, Asker 1969 in relation to first flower (a) and first harvest (b) of the strawberry crop. 25 plants sampled at each date.

Auchenorrhyncha which are more likely to be associated with weeds are *Dicranotropis hamata* (Boheman), *Javesella pellucida* (Fabricius), *Zygina hyperici* (Herrich-Schäffer), *Balclutha punctata* (Fabricius), *Elymana* sp., and *Streptanus aemulans* (Kirschbaum). *Neophilaenus lineatus* (Linné) has also in Finland been found on weeds in strawberry fields (Raatikainen & Vasarainen 1970).

Mainly based on the numbers of finds, and the presence of nymphs, the following catches are believed to signify breeding on the straw-

Table V. Auchenorrhyncha and Psylloidea collected per 10 plants in spraying experiments

Treatment[1)]	% active ingredient	FREDRIKSTAD: All species	*Philaenus spumarius* a	*Philaenus spumarius* n[2)]	ASKER: All species	*Philaenus spumarius*	*Evacanthus interruptus*
Azinphos-methyl (35 % W.P.)	0.05	13	11.5	1			
Dimethoate (50 % E.C.)	0.03	13	10.0	1.5	13	2	9
Fenthion (50 % E.C.)	0.05	18	10.0	5.5			
Malathion (60 % E.C.)	0.07	25	17.5	6.5	33	2	25
Methomyl (25 % W.P.)	0.025	16	11.5	3	15	5	13
No treatment		32	20.5	6	47	3	42

1)W.P. = wettable powder; E.C. = emulsifiable concentrate

2)a = adults; n = nymphs

berry plants: *Aphrophora alni* (Fallén), *P. spumarius, Aphrodes* sp., *E. interruptus, Emelyanoviana mollicula* (Boheman), *Edwardsiana* sp., and *Macrosteles* sp. *A. alni* is common on deciduous trees and shrubs, but nymphs are also found on a diversity of herbaceous plants (Ossiannilsson 1946) and has been observed feeding on strawberry plants in Finland (Raatikainen & Vasarainen 1970). *Edwardsiana* sp. nymphs may be *E. rosae* (Linné) which is a pest of roses, and is also common on a number of other Rosaceae, including strawberries (Ossiannilsson 1946).

The only species found in sufficient numbers to be potential pests are *P. spumarius* and *E. interruptus*. Each of the two species made up 45% of the total catch of Auchenorrhyncha. *E. interruptus* is known as a pest of hops in England (Massee 1954), but no record from strawberry has been found. The species hibernate in the egg stage, and according to Massee (1954) oviposits in dead woody tissue in fence poles, old posts etc. The early appearance of high numbers of nymphs in strawberry (Fig. 1), however, indicates oviposition in the strawberry field. Its almost total absence from all sprayed fields implies minor importance, at least in commercial growing.

P. spumarius is distributed over a large part of the Northern Hemisphere, and has a wide range of host plants (Halkka et al. 1967). In strawberries the nymphs feed in spittle masses on the uppermost part of the inflorescence, and reduce the fruit size (Raatikainen & Vasarainen 1970). It prefers humid and non-windy conditions. The nymph catches given in Table V indicate better control with azinphos-methyl and dimethoate than with fenthion and malathion. The numbers of adults are of less significance for the evaluation of insecticides, since adult mobility may obscure the differences between treatments on small plots.

Number of collected Psylloidea (65) was small compared to the Auchenorrhyncha (1804). No psyllid nymphs were taken, and the host plants of the species do not indicate any breeding on the strawberries. Thus the most numerous species normally occurs on plants which are common weeds in strawberry fields, like *Aphalara* spp. on *Polygonum* and *Rumex,* and *Trioza urticae* (Linné) on *Urtica dioica* and *U. urens* (Dobreanu & Manolache 1962).

Two leafhopper species, *Edwardsiana alnicola* (Edwards) and *Zygina schneideri* (Günthart) are recorded for the first time from Norway. *E. alnicola* was taken in Norddal, Møre og Romsdal 5 August 1968. *Z. schneideri* was recently described from Switzerland (Günthart 1974) and was collected in Sem, Asker, Akershus 4 June 1969. It has also been found in Skåne, Östergötland, and Uppland in Sweden (Ossiannilsson, in litt.).

Also the psyllid *Trioza cirsii* Löw is a rare species, taken in Asker, Akershus 9 June 1969. One earlier find, given as *T. viridula* (Zetterstedt) from southern Telemark, probably denotes *T. cirsii* (Ossiannilsson, in litt.).

ACKNOWLEDGEMENTS

I am greatly indebted to Professor Dr. Frej Ossiannilsson for identification of the insects, and for other valuable information. Part of the material was collected by Olav Sørum.

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Received 21 April 1977

Mire invertebrate fauna at Eidskog, Norway. VII. Opiliones

HANS KAURI

Kauri, H. 1977. Mire invertebrate fauna at Eidskog, Norway. VII. Opiliones. *Norw. J. Ent. 24,* 111–112.

Seven species of Opiliones were pit-fall trapped in thirteen different mire habitats at Eidskog, Hedmark county, south Norway. The open mire habitats were almost without Opiliones, and practically all specimens were taken in the transition zone between mire and forest, or in forest habitats protruding into open mire. Two of the transition zones yielded 5 and 6 species, respectively, illustrating an ecotone effect.

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This paper is part of a study on the invertebrate fauna in thirteen mire habitats at Eidskog, south Norway. Locality, habitat description, and the aim of these investigations are given by Pedersen, Hågvar & Bakke (1976).

The material of Opiliones, consisting of 370 specimens, was collected in pit-fall traps. Further information on the method, and explanation of the symbols used in this paper for the different habitats, are given by Pedersen, Hågvar & Bakke (1976).

The sites 1, 2, 4, 5 were located on ombrotrophic mire habitats, I, II, III on topogenous mire, sites 3 and 6 in pine bog forest, and A, B, C, D in ecotones between mire and forest.

A total of seven species were collected (Table I). No Opiliones were caught in the following five habitats: 1, 2, 5, A, and II.

Most of the species are common and widespread in Norway and northern Europe.

The short-legged ground dweller species, e.g. *Nemastoma lugubre, Oligolophus tridens,* and *Lophopilio palpinalis,* were probably well trapped with this method and the results may be considered reliable. The long-legged species of somewhat greater body-size, however, as for instance *Rilaena triangularis,* are probably not well represented. Especially in the habitats with dense, tall vegetation in the field-layer, they may easily escape.

No species are related to the proper mire habitats. Consequently, no Opiliones were trapped on the mire expanses and only three accidental individuals were caught on the open mire, sites 4, I and III (Table I).

The two habitats of pine bog forest, 3 and 6, presented two species, i.e. *Oligolophus tridens* and *Lophopilio palpinalis.* The former was caught only in a few specimens while the latter occurred in a considerable number – equally represented on the two sites.

The greatest number of species occur in the ecotones, i.e. the transition zones between forest and mire expanses (B, C. D). Six species were traced in this transition zone, two of which, however, only as accidental components, namely *Lacinius ephippiatus* and *Rilaena triangularis* (Table I). The remaining four representatives of the ecotone habitats

Table I. Pit-fall catches of Opiliones in mire habitats at Eidskog, south Norway.

Species:	Habitat[1] 3	4	6	B	C	D	I	III	No. per species
Nemastoma lugubre (O.F.Müller)	-	-	-	22	7	-	-	-	29
Mitopus morio (Fabr.)	-	-	-	6	3	-	-	-	9
Oligolophus tridens (C.L.Koch)	1	-	2	144	1	-	-	-	148
Lacinius ephippiatus (C.L.Koch)	-	-	-	1	1	-	-	-	2
Lophopilio palpinalis (Herbst)	22	1	22	79	49	5	-	-	178
Rilaena triangularis (Herbst)	-	-	-	-	1	1	-	1	3
Phalangium opilio L.	-	-	-	-	-	-	1	-	1
Total no. of specimens per habitat:	23	1	24	252	62	6	1	1	370
Total no. of species per habitat:	2	1	2	5	6	2	1	1	7

[1] The sites where from no harvest-spiders were caught are excluded from the table.

are *N. lugubre, Mitopus morio, O. tridens,* and *L. palpinalis. O. tridens* and *L. palpinalis* occur in greater abundance, while the population of *N. lugubre* and *M. morio* is less numerous (Table I). The absence of Opiliones from site A is difficult to explain; it may depend on the location chosen for the traps in the microhabitats.

The ecotone effects are neither unexpected nor unusual. The human influence in these mire and forest habitats may be considered insignificant. It is the 'untouched' environment and the poverty of the ecological conditions that make the ecotone effects noteworthy. The whole area is characterised by low pH (3.5–4.0). Only in the habitat B, with the richest community, was a somewhat higher pH value (4.8) measured.

The composition of plant species in the ecotones is richer than on the mire expanses, and the soil seems to be dryer, which may be considered favourable for the Opiliones.

Received 20 December 1976

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Mire invertebrate fauna at Eidskog, Norway. VIII. Trichoptera

JOHN O. SOLEM

Solem, J. O. 1977. Mire invertebrate fauna at Eidskog, Norway. VIII. Trichoptera. *Norw. J. Ent. 24,* 113–115.

Forty-three species of caddisflies were collected, with light traps, in a mire and a forest habitat at Eidskog, Hedmark county. Of these, 26 were new to Hedmark. In view of the variety of habitats that may occur on the mire, adaptations to temporary ponds and/or small bodies of permanent water are mentioned.

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The investigation was undertaken by the Norwegian Entomological Society, and is part of a study on the invertebrate fauna in mire habitats (Pedersen, Hågvar & Bakke 1976). In addition, the material gives a valuable contribution to the knowledge of the caddisfly fauna in Hedmark county. Since Brekke (1946) and Forsslund (1951), only scattered notes on the caddis fauna in this county have been presented, e.g. Solem (1970, 1971).

METHODS, MATERIAL, AND HABITATS

The material was collected with one light trap (Robinson model) situated in the northern part of Momyra bog, at the site marked with X in Fig. 1 in Pedersen, Hågvar & Bakke (1976), and another in spruce forest, about 300 m north of the bog station. The collection comprises 806 specimens.

NOMENCLATURE

The nomenclature follows Svensson & Tjeder (1975), except for the members of the family Leptoceridae. Here I follow Morse & Vallace (1976), as they divide the old genus *Leptocerus* (McLach., 1815) into the genera *Athripsodes* Billberg, 1820 and *Ceraclea* Stephens, 1829. Morse & Wallace's (1976) conclusions are based on the study of both larval and adult diagnostics, and agree with my own reflections through studies on leptocerid larvae. Therefore the following Scandinavian species, which by Svensson & Tjeder (1975) are considered to belong to the genus *Athripsodes* Billberg, 1820, should be transferred to the genus *Ceraclea* Stephens, 1829, *albogutta* (Hagen, 1860), *fulva* (Rambur, 1842), *nigronervosa* (Retzius, 1783), *senilis* (Burmeister, 1839), *dissimilis* (Stephens, 1836), *excisa* (Morton, 1904), and *perplexa* McLachlan, 1877). This includes all the three leptocerid species trapped in the present study.

RESULTS AND DISCUSSION

In total, 43 species of caddisflies were collected (Table I), and 26 belong to fam. Limne-

Table I. Trichoptera collected at Eidskog, Norway. Species marked with an asterisk are new to Hedmark county

	Collecting period	Wood ♂/♀	Bog ♂/♀
Fam. Phryganeidae			
Phryganea bipunctata Retzius	26 Aug.	1/0	
* Phryganea grandis Linnaeus	22 July-10 Aug.	4/1	
Agrypnia obsoleta (Hagen)	27 July-24 Aug.	2/0	1/1
* Agrypnia varia Fabricius	30 July	1/0	
* Trichostegia minor (Curtis)	22 July	1/0	
Fam. Rhyacophilidae			
Rhyacophila nubila (Zetterstedt)	13 Aug.		0/1
Fam. Polycentropodidae			
* Plectrocnemia conspersa (Curtis)	22 July-26 Aug.	65/9	13/15
* Polycentropus irroratus (Curtis)	27 July-23 Aug.	2/0	
Cyrnus flavidus McLachlan	23 Aug.	0/2	
* Ecnomus tenellus (Rambur)	23 Aug.	0/1	0/2
Fam. Psychomyidae			
* Tinodes waeneri (Linneanus)	13-23 Aug.	3/5	3/1
Fam. Hydropsychidae			
* Hydropsyche newae Kolenati	27 July-24 Aug.	2/4	1/3
Fam. Molannidae			
* Molannodes tinctus (Zetterstedt)	3 Aug.		1/0
Fam. Leptoceridae			
* Ceraclea alboguttata (Hagen)	14-24 Aug.	2/0	
* Ceraclea fulva (Rambur)	24 Aug.	0/1	
* Ceraclea dissimilis (Stephens)	23-24 Aug.	3/1	
Fam. Lepidostomatidae			
* Lepidostoma hirtum (Fabricius)	14-23 Aug.	0/3	0/2
Fam. Limnephilidae			
* Limnephilus borealis (Zetterstedt)	2-28 Aug.	11/0	58/11
Limnephilus centralis (Curtis)	26 July-24 Aug.	13/0	5/0
Limnephilus coenosus (Curtis)	26 July-28 Aug.	18/0	128/6
* Limnephilus elegans Curtis	26 July-24 Aug.	10/0	8/1
Limnephilus extricatus McLachlan	26 July-28 Aug.	8/0	12/0
* Limnephilus flavicornis (Fabricius)	11-28 Aug.	13/0	20/1
Limnephilus fuscicornis (Rambur)	30 July-26 Aug.	4/0	1/0
* Limnephilus ignavus McLachlan	26 Aug.		1/0
* Limnephilus lunatus Curtis	15-26 Aug.	9/1	4/0
Limnephilus marmoratus Curtis	3-25 Aug.	3/0	7/0
Limnephilus picturatus McLachlan	28 Aug.		1/0
* Limnephilus rhombicus (Linnaeus)	3-28 Aug.	4/1	31/4
Limnephilus sericeus (Say)	3-28 Aug.	22/2	33/0
* Limnephilus sparsus Curtis	23-28 Aug.	0/2	1/2
Limnephilus subcentralis Brauer	28 Aug.		1/0
Glyphotaelius pellucidus (Retzius)	9-28 Aug.	9/0	6/0
* Nemotaulius punctatolineatus (Retzius)	27 July	2/0	
* Phaecopteryx brevipennis (Curtis)	14-24 Aug.	2/1	
* Anabolia concentrica (Zetterstedt)	20-28 Aug.	1/0	1/0
* Rhadicoleptus alpestris (Kolenati)	26 July-26 Aug.	18/0	27/1
Potamophylax latipennis (Curtis)	13-28 Aug.	3/0	14/2
Potamophylax nigricornis (Pictet)	29 July	1/0	
* Micropterna lateralis (Stephens)	22 July-22 Aug.	4/0	
Micropterna sequax McLachlan	22 July-28 Aug.	46/0	9/4
* Halesus radiatus (Curtis)	17-28 Aug.	3/0	37/0
Halesus tesselatus (Rambur)	23-25 Aug.		2/0

philidae, five to Phryganeidae, four to Polycentropodidae, three to Leptoceridae, and one species to each of Rhyacophilidae, Psychomyidae, Hydropsychidae, Molannidae, and Lepidostomatidae.

Except for a few species, the males outnumbered the females in the collections. Svensson (1972) found higher numbers of males than of females in light traps located some distance from the water. This effect should be taken into consideration in the present study, as a lake was situated about 250 m from the light trap on the bog. However, the proportion of females of *Plectotrocnemia conspersa* was 54% in the bog area, but only 12% in the wood, indicating that *P. conspersa* inhabits the small stream close to the light trap in the bog area. This also seems to be the case for *Limnephilus borealis,* as more individuals of that species were captured in the bog area. These results are in agreement with that obtained by Göthberg (1973) and Svensson (1974). The most abundant species in the present collection was *Limnephilus coenosus,* which appeared in highest numbers in the bog area. This species was found by Göthberg (1973) to have a very strong dispersal from its emergence places, so the specimens may be immigrants from other areas. Although *Limnephilus rhombicus* and *Halesus radiatus* were captured in higher numbers in the bog than in the wood, while the opposite was the case for *Micropterna sequax,* an immigration from other areas is just as likely as an emergence near the collecting sites.

Except for *Plectrocnemia conspersa* and *Limnephilus borealis,* the ability of strong flight and dispersal over large areas make it difficult to state which species belong to the waters within the mire itself.

In general, the composition of the species shows a fauna belonging to slowly running and/or standing water. The three families represented with the highest number of species – Limnephilidae, Phryganeidae and Polycentropodidae – have members, worldwide looking, that are adapted for a life in temporary pools (Wiggins 1973), and *Trichostegia minor* is an example from the present collection (Wichard & Reichel 1970).

Adaptive mechanisms for a life in temporary pools or, perhaps, small bodies of permanent water that occur in the mires, may be plural, but one of them is oviposition behaviour. According to Wiggins (1973), who has compiled data on biology of caddisflies living in temporary pools, nine of the 26 limnephilid species may oviposit above the water surface. Other adaptations to a life in shallow or small water bodies, may be the ability to survive although surrounded by ice at wintertime. I have picked *Nemotaulius punctatolineatus* larvae from a frozen bottom in shallow water in Målsjøen, South Trøndelag. The larvae were completely surrounded by ice, and had been in that condition for at least three weeks. When the ice melted, the larvae were in full vigour and acted quite normally. Wiggins (1973) picked gelatinous egg-matrices with larvae of *Limnephilus in-*

divisus Walker from beneath snow in the basin with no surface water of a temporary vernal pool.

Adaptations like these, which seem to have evolved most frequently in Limnephilidae, make it possible to inhabit a wide variety of habitats, including those occurring in a mire. Some species live both in permanent ponds and marches, and in temporary pools (Wiggins 1973), and reflect the range and flexibility of adaptation that may occur within one species. The present collection is certainly a mixture of species inhabiting the mire, the lake nearby, and probably other nearby waters.

The collected species are widely distributed; 26 of them, marked with an asterisk in Table I, are new to the fauna of Hedmark county. This clearly demonstrates how poorly known the caddis-fly fauna is in that county.

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Received 14 May 1977

Observations of *Somatochlora arctica* (Zett.) (Odonata) in western Norway

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Midttun, B. 1977. Observations of *Somatochlora arctica* (Zett.) (Odonata) in western Norway. *Norw. J. Ent. 24,* 117–119.

New localities, including breeding sites, for *Somatochlora arctica* (Zetterstedt) in western Norway are listed. The species seems to be rather common in some of the lowland areas investigated. The flying season is restricted to the last three weeks of June, July, and the first week of August. Emergence mainly occurs during the second or third week of June.

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Somatochlora arctica is, together with *Aeshna coerulea* (Strøm), regarded by Sømme (1937a) as a boreo-alpine species.

Records of *S. arctica* from western Norway are rather sparse (Sømme 1937a, Tjønneland 1952), but Tjønneland found it to be a common species near Meråker, Nord-Trøndelag, and Sømme (1937b) stated that it was common throughout Finnmark. Valle (1927) regarded it as an alpine and subalpine species in Finland, and his observations that it is confined to moorlands in southern areas agree with mine from lowland areas in western Norway. A total of 86 specimens were caught and of these 42 were newly emerged ones. The summers of 1970 and 1971 were predominantly dull and rainy, and this, at least partly, explains the long periods during which no specimens were caught.

LOCALITIES

The specimens of *S. arctica* were caught at the following localities in Hordaland (Fig. 1) (UTM references are given in parenthesis): Lauvåstjernet (32VKM960967) and the surrounding pine forest, Kanadaskogen; the south-western slopes of Lauvstakken (32-VKM960950), surroundings of Jordavatnet, Fanafjell (32VKM998858), Eidsvågsfjellet (32VKN972047), Kleppe, Osterøy (32VLN-110143), Njåstad, Osterøy (32VLN128154), Lommatjønn, Lysekloster (32VKM997824). The tarns where *S. arctica* was found to breed are situated on rather extensive areas of boggy ground surrounded by pine forests and moors with scattered pine trees. Lauvåstjernet is situated about 50 m a.s.l., the other localities between 50 and 350 m a.s.l..

OBSERVATIONS AND DISCUSSION

In the list below newly emerged specimens are indicated by (em).

1970: Lauvstakken 15 June 1 ♀, Kanadaskogen 16 June 1 ♀ 2 ♂♂, Lauvåstjern 16 June 1 ♂ (em) 1 ♀ (em), Kanadaskogen 17 June 1 ♀, Lauvåstjern 19 June 8 ♀♀ (em) 9 ♂♂ (em), Lauvåstjern 20 June 3 ♀♀ (em) 2 ♂♂ (em), Kanadaskogen 23 July 3 ♂♂, Lauv-

Fig. 1. Map of the area investigated.

stakken 24 July 1 ♂ 2 ♀♀, Kleppe 1 August 1 ♂, Njåstad 3 August 1 ♂, Lauvåstjern 7 August 1 ♂, Jordavatnet 12 August 1 ♂. 1971: Lauvåstjern 9 June 6 ♀♀ (em) 1 ♂ (em), Lauvåstjern 10 June 4 ♀♀ (em) 3 ♂♂ (em), Jordavatnet 2 July 1 ♀ (em) 4 ♀♀ 3 ♂♂, Jordavatnet 3 July 1 ♀ 1 ♂ 1 ♂ (em), Lauvstakken 8 July 5 ♀♀ 6 ♂♂, Lauvstakken 20 July 1 ♂, Lauvstakken 23 July 1 ♀ 2 ♂♂, Lauvstakken 28 July 2 ♂♂. 1972: Lommatjønn 24 September 1 ♀. 1976: Eidsvågsfjellet 17 June 2 ♀♀ (em), Jordavatnet 5 July 2 ♂♂.

Emergence

The study of emergence mainly took place at Lauvåstjernet where in total 38 specimens were observed in 1970 and 1971. Ecdysis mainly occurred between 0830 and 1000 hrs. on days with morning air temperatures as low as 12–14 °C, but the five newly emerged specimens found were ready for their maiden flight when I arrived at the tarn (at 0830 hrs.) on the warm morning of 20 June 1970. According to Corbet (1962) the Corduliidae tend to emerge in the early morning, if the weather permits. The low morning temperatures may explain the peak emergences observed as late as 0830–1000 hrs. On 2 July 1971 a newly emerged specimen was found as late as 1400 hrs., although this was a hot day.

The larvae usually emerge on a straw about 4–10 m from open water, and although the ground surrounding the tarn is rather boggy, the larvae must in most cases have crawled several metres across dry ground. Although there was ample opportunity for the larvae to emerge on vegetation growing in the water, they were never observed to do so. It seems that *S. arctica* in this respect differs from the general observations that larvae usually emerge very close to the water, presumably on the first suitable support (Corbet 1962). At Lauvåstjernet, very few other dragonflies were seen to emerge at the times when *S. arctica* did, and at least on 19 June 1970, it was the dominating species.

During July and the first half of August 1970 and 1971, tarns at which emergence was known to occur were visited every day when weather conditions were favourable, but only two newly emerged specimens were found in this period. This, together with histological data on the degree of development of the reproductive organs (Midttun 1974), indicates that emergence in this area is restricted to the last three weeks of June and the first few days of July, with a peak during the second or third week of June. The distance flown on the maiden flight is at least several hundred metres (observations from Lauvåstjern). The dragonflies rose at a rather steep angle and flew until they were out of sight.

Adult life

S. arctica spends a considerable part of the day in feeding flight, usually flying in open areas in pine forests or on moors with scattered pine threes. The feeding flight usually takes place about 2–8 m above the ground, above the level occupied by other species at these localities (with the exception, perhaps, of *S. metallica*). In hot weather (above 23–24 °C) *S. arctica* often seemed to prefer hilltops with a rather strong breeze. No specimens were seen flying when the temperature was below 14–15 °C (except newly emerged ones).

My observations were mainly done between 0700 and 1700 hrs. and if, as is the case with other Corduliidae (Corbet 1962), reproductive behaviour tends to occur at dawn or dusk, then it is not surprising that only two specimens were observed showing reproductive behaviour. At noon on 24 July 1970, a female was observed ovipositing amongst partly submerged moss. A male observed early in the afternoon on 7 August 1970 most probably showed territorial behaviour. It patrolled a stretch of about 30–40 m along the eastern shores of Lauvåstjern, 10–15 m from open water and at a height of 1–2 m. It flew vigorously back and forth at great speed, behaviour that differs from the more leisurely performed feeding flight. Apart from newly emerged ones, only three other specimens were caught near tarns, and Tjønneland (1952) remarked that he has never seen it flying at standing water.

Although previous records of *S. arctica* from western Norway are sparse (Sømme 1937a, Tjønneland 1952), my observations show that it is a comparatively common species, at least at some lowland localities.

Its rather inconsipicuous appearance, the fact that it flies rather high above the ground and is not easily caught, and that adults are rarely seen near standing water, may explain why so few specimens have been recorded previously from this area.

Only very few individuals were caught in August, despite good weather, and this indicates that the flying season is largely restricted to June and July.

Received 4 March 1977

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Se

A collection of aphid parasites and hyperparasites (Hym.) from Iceland

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Couchman, J. R. 1977. A collection of aphid parasites and hyperparasites (Hym.) from Iceland. *Norw. J. Ent. 24,* 121–124.

Twelve species of primary parasites and hyperparasites of aphids are reported from a variety of habitats in Reykjavík and northern Iceland. Of these, six are new records for Iceland. A record of the aphid host species is also given. The aphid parasite fauna is of a predominantly boreal nature and is clearly related to that of northern Europe.

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Whilst literature on the Icelandic aphid fauna is now quite comprehensive – Prior & Stroyan (1960) and Heie (1964) adding extensively to the previously existing knowledge reviewed by Hills Ris Lambers (1955) – the aphid parasite fauna has received little attention. Peterson (1956) reviewed the Hymenoptera of Iceland and listed ten species each of primary parasites and hyperparasites. These have been recorded as a result of general insect collections, and not by specific collections of parasitised aphid material.

The aim of this work was to elucidate the Icelandic aphid parasite fauna more fully, and to produce information on the host-parasite relationships, for which there was no record. During late July and August 1975 parasitised aphids which had become 'mummified' were collected from as many habitats as possible. The two areas of collection were around Reykjavík, and the central northern part of Iceland. Collected 'mummies' were stored individually and the emergent adult together with the aphid host were identified on return to Britain.

PRIMARY PARASITES

Fam. Aphidiidae

Aphidius picipes (Nees)

Occurrence in Iceland: Akureyri, in a suburban street, 1 Aug. 75, from parasitised *Acyrthosiphon malvae* (Mosl.) s.lat. on *Achillea millefolium* 32 ♀♀ and 9 ♂♂. Akureyri botanic gardens, 2 Aug. 75 and 4 Aug. 75, from parasitised *Acyrthosiphon malvae* (Mosl.) s.lat. on *Potentilla crantzii,* 6 ♀♀, 5 Aug. 75, from parasitised *Acyrthosiphon malvae* (Mosl.) s.lat. on *Geum* sp., 3 ♀♀ and 5 ♂♂, 6 Aug. 75, from parasitised *Acyrthosiphon malvae* (Mosl.) s.lat on *Alchemilla alpina,* 1 ♂, 6 Aug. 75, from parasitised *Acyrthosiphon malvae* (Mosl.) s.lat. on *Thalictrum alpinum,* 1 ♀. Dalvík, in coastal sand dunes, 10 Aug. 75, from parasitised *Acyrthosiphon auctus* (Walker) on *Honkenya peploides,* 1 ♀.

A. picipes was the most numerous of all the species taken, the *Achillea* and *Geum* samples having dense colonies of *A. malvae* on them with a high percentage of parasitism. The females had 15 articulated antennal segments and the males 20, a somewhat larger differential than usual. Eady (1969) gives 18 as the usual number of articulated antennal segments in the female *A. picipes*, but this feature is subject to variation in many members of the Aphidiidae. In all other respects the material was found to be in good agreement with that located in the British Museum (Nat. Hist.).

This is the first record of *A. picipes* from Iceland.

Aphidius ribis Haliday

Occurrence in Iceland: Reykjavík, in a suburban garden, 30 July 75, from parasitised *Cryptomyzus galeopsidis* (Kaltb.) s.lat on *Ribes* sp., 3 ♂♂.

This species was not found in the north of Iceland despite frequent searching for the abundant *Ribes* in suburban areas. Unfortunately, no females were collected but the material agrees well with that in the British Museum (Nat. Hist.) and with the descriptive notes given by Starý (1973), who states that *A. ribis* is a specialised parasite of *Cryptomyzus* spp.

This species is a new record for Iceland.

Aphidius salicis Haliday

Occurrence in Iceland: Reykjavík, in a suburban street, 30 July 75, from parasitised *Cavariella archangelicae* (Scop.) on *Salix* sp., 11 ♀♀ and 9 ♂♂, 30 July 75, from parasitised *Cavariella konoi* Takahashi on *Salix* sp., 1 ♀. Akureyri botanic gardens, 6 Aug. 75, from parasitised *Cavariella archangelicae* (Scop.) on *Salix* sp., 1 ♂.

A. salicis is a new record for Iceland. A large proportion of 'mummies' of *Cavariella archangelicae* yielded hyperparasites, particularly *Alloxysta fuscipes* (Thomson).

Monoctonus caricis Haliday

Occurrence in Iceland: Akureyri botanic gardens, 4 Aug. 75, from parasitised *Jacksonia papillata* Theobald on grass amongst *Saxifraga*, 1 ♀. Víkurbakki, Eyjafördur, in a thufur area, 9 Aug. 75, from parasitised *Fimbriaphis latifrons* (C. B.) on *Empetrum nigrum*, 1 ♂. Reykir, Skagafjördur, by the side of a hot spring, 18 Aug. 75, from parasitised *Jacksonia papillata* Theobald on *Agrostis stolonifera*, 1 ♀.

This species has been recorded from most regions of Iceland, and Peterson (1956) states that it is rather common.

Praon volucre Haliday

Occurrence in Iceland: Akureyri botanic gardens, 6 Aug. 75, from parasitised *Acyrthosiphon brachysiphon* H. R. L. on *Arctostaphylos uva-ursi*, 1 ♀.

This species is uncommon in Iceland and has been previously recorded once in the north by Gígja (1945).

Superfam. Chalcidoidea

Fam. Aphelinidae

Aphelinus abdominalis (Dalman)

Occurrence in Iceland: Almenningsnöf, near Siglufjördur, on exposed coastal cliffs, in scrub characterised by *Vaccinium uliginosum, Empetrum nigrum, Betula nana* and grasses, 5 Aug. 75, from parasitised *Fimbriaphis latifrons* (C. B.) on *Vaccinium uliginosum*, 1 ♀.

This is the first record of a member of this family from Iceland. This species is however found in most European countries as far north as Sweden and U.S.S.R., Ferrière (1965) lists known hosts of this species, and *Fimbriaphis latifrons* is a new record.

HYPERPARASITES

Superfam. Chalcidoidea

Fam. Pteromalidae

Asaphes vulgaris Walker/*suspensus* (Nees) complex.

Occurrence in Iceland: Reykjavík, in a suburban garden. 30 July 75, from parasitised *Cryptomyzus galeopsidis* (Kaltb.) s.lat. on *Ribes* sp., 1 ♀. Akureyri, in a suburban street, 1 Aug. 75, from parasitised *Acyrthosiphon malvae* (Mosl.) s.lat on *Achillea millefolium*, 2 ♀♀. Akureyri botanic gardens, 1 Aug. 75, from parasitised *Betulaphis quadrituberculata* (Kaltb.) on *Betula nana*, 3 ♂♂, 2 Aug. 75 and 23 Aug. 75, from parasitised *Acyrthosiphon malvae* (Mosl.) s.lat. on *Potentilla crantzii*, 3 ♀♀ and 3 ♂♂, 5 Aug. 75, from parasitised *Acyrthosiphon malvae* (Mosl.) s.lat. on *Geum* sp., 3 ♀♀ and 3 ♂♂, 5 Aug. 75, from parasitised ?*Metopolophium festucae* (Theob.) on *Sibbaldia procumbens*, 1 ♀, 6 Aug. 75, from parasitised *Cavariella archangelicae* (Scop.) on *Salix* sp., 1 ♂. Modruvellir, Eyjafjördur, on a flat stony island in a fast running stream, 21 Aug. 75, from parasitised *Acyrthosiphon auctus* (Walker), 2 ♀♀ and 1 ♂. Grodrarstödin, Akureyri, in mature gardens, 22 Aug. 75, from parasitised *Metopolophium festucae* (Theob.) on *Poa annua*, 1 ♂.

This species was taken frequently and has a wide range of suitable hosts, a characteristic feature of some hyperparasites. The Icelandic specimens showed considerable morphological variation especially between specimens of different sizes, and between individuals of the same sex from the same sample. Many specimens were close to *A. suspensus* (Nees) (Graham, 1969) and others were intermediate between *A. vulgaris* Walker and *A. suspensus* (Nees). Since variation was related particularly to size, which is in part determined by host size, and due to the difficulty of assigning material of one sample to one species, all the specimens were designated as *A. vulgaris* Walker/*suspensus* (Nees) complex.

Superfam. Ceraphronoidea

Fam. Megaspilidae

Dendrocerus bicolor (Kieffer)

Occurrence in Iceland: Akureyri, in a suburban street, 1 Aug. 75, from parasitised *Acyrthosiphon malvae* (Mosl.) s.lat on *Achillea millefolium*, 4 ♀♀ and 6 ♂♂.

This is a new species for Iceland. The material was taken from a sample which included *Aphidius picipes* as the only primary parasite. The specimens were determined by Mr. N. D. M. Fergusson (B. M. N. H.).

Dendrocerus bifoveatus (Kieffer)

Occurrence in Iceland: Modruvellir, Eyjafjördur, on a flat stony island in a fast running stream, 21 Aug. 75, from parasitised *Acyrthosiphon auctus* (Walker), 2 ♀♀ and 2 ♂♂.

This species has been taken before in Iceland by H. Anderson (Dessart, 1972). The specimens were determined by Mr. N. D. M. Fergusson (B. M. N. H.).

Superfam. Cynipoidea

Subfam. Alloxystinae

Alloxysta fuscipes (Thomson)

Occurrence in Iceland: Reykjavík, in a suburban street, 30 July 75, from parasitised *Cavariella archangelicae* (Scop.) on *Salix* sp., 8 ♀♀ and 1 ♂. Akureyri botanic gardens, 1 Aug. 75, from parasitised *Cavariella archangelicae* (Scop.) on *Rhododendron* sp., (vagrant), 1 ♂, 1 Aug. 75 and 23 Aug. 75, from parasitised *Betulaphis quadrituberculata* (Kaltb.) on *Betula* sp., 2 ♂♂, 2 Aug. 75, from parasitised *Betulaphis quadrituberculata* (Kaltb.) on *Stellaria media*, (vagrant), 1 ♀, 6 Aug. 75, from parasitised *Cavariella archangelicae* (Scop.) on *Salix* sp., 1 ♀ and 1 ♂.

The material was compared with Thomson's three syntypes (all female) by Dr. H. H. Evenhuis and was found to be in good agreement. This species has been recorded from Iceland previously and is believed to be widespread in Western Europe. This species hyperparasitised arboreal aphids and was found only in wooded areas.

Alloxysta marshalliana (Kieffer)

Occurrence in Iceland: Akureyri botanic gardens, 5 Aug. 75, from parasitised *Metopolophium festucae* (Theob.) on *Festuca* sp., 1 ♂. Grodrarstödin, Akureyri, in mature gardens, 23 Aug. 75, from parasitised *Metopolophium festucae* (Theob.) on *Deschampsia* sp., 1 ♂.

This species has been recorded in north Iceland once previously, by Jansson (1950) and has been found also in southern and eastern Iceland.

Phaenoglyphis piciceps (Thomson)

Occurrence in Iceland: Akureyri botanic gardens, 23 Aug. 75, from parasitised *Metopolophium festucae* (Theob.) on *Poa annua*, 1 ♀.

The single specimen was examined by Dr. H. H. Evenhuis and was found to be in good agreement with the Thomson syntype series. This is the first record of a member of this genus from Iceland.

DISCUSSION

Four species of primary aphid parasites and two of hyperparasites are recorded for the first time from Iceland, and all of these can be classed as boreal species, being found widely in Europe. A large proportion of the aphid parasite species are boreal, and Starý (1970) designates only two of the Icelandic Aphidiidae as holarctic, namely *Aphidius cingulatus* Ruthe, a parasite of *Pterocomma* spp., and *Trioxys compressicornis* Ruthe, which parasitises *Euceraphis* spp. Furthermore, several members of the holarctic Aphidiidae have been proposed as occurring in Iceland but are not yet recorded. Starý included in this group *Trioxys betulae* Marshall, *T. ibis* Mackauer, *Lysiphlebus salicaphis* (Fitch), *Ephedrus brevis* Stelfox, and *Aphidius aquilus* Mackauer. However it is unlikely at present that *T. betulae* will be found in Iceland since its hosts, *Betocallis, Symydobius,* and *Kallistaphis,* have not been recorded. Similarly *Chaitophorus,* the host of *L. salicaphis,* is as yet unknown in Iceland. Moreover the Aphidiidae did not show any widening of host range in Iceland, a feature which was present to a degree in some aphid species. None of the recorded hosts of the Aphidiidae was different from that found in Britain and Europe. Of the hyperparasites only *Asaphes vulgaris* Walker/*suspensus* (Nees) complex had a wide range of suitable hosts.

The presence of parasitised *Betulaphis quadrituberculata* would strongly indicate that *Aphidius aquilus* or *Trioxys ibis* or perhaps both, occur in Iceland. Unfortunately all of the collected material yielded hyperparasites or there was a failure to emerge.

In conclusion it may be said that in common with other members of the Hymenoptera, the Icelandic aphid primary and secondary parasite fauna are of a predominantly boreal nature, and are related very much to the fauna of Britain and northern Europe.

It is unlikely that the Icelandic aphid parasite fauna has been fully elucidated, and since the number of Hymenoptera species recorded from southern and western areas is greater than from other parts of Iceland, more species will probably be found there. Since the introduction of conifers to Iceland, conifer aphids have been subsequently reported (Peterson 1960, Heie 1964), and a study of these for parasites may prove rewarding.

ACKNOWLEDGEMENTS

I should like to thank Professor E. W. Knight-Jones in whose department this work was carried out, and the Science Research Council for financial support. I should also like to gratefully acknowledge Mr. R. N. B. Prior for assistance in the collection of material, Dr. H. L. G. Stroyan (MAFF. Harpenden) for identifying the aphid hosts, Mr. N. D. M. Fergusson and Dr. J. Noyes (British Museum, Natural History) and Mr. R. E. Eady (Commonwealth Institute of Entomology) for their assistance with identification. Thanks must also go to Dr. H. H. Evenhuis (Instituut Voor Plantenziektenkundig Onderzoek, Wageningen) for confirming the identifications of the Alloxystinae, and Mr J. Quinlan (British Museum, Natural History) for assistance with identifications and helpful criticism of the manuscript. Finally I should like to express my gratitude to Dr. H. Hallgrimsson for the provision of facilities at the Katla Field Centre, Eyjafjördur during August 1975.

Received 28 March 1977

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Cold-hardiness of the bark beetle, *Scolytus ratzeburgi* Jans. (Col., Scolytidae)

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Ring, R. A. 1977 Cold-hardiness of the bark beetle *Scolytus ratzeburgi* Jans. (Col., Scolytidae). *Norw. J. Ent. 24,* 125–136.

The birch engraver, *Scolytus ratzeburgi* Jans. overwinters beneath bark in more than one larval instar and appears to lack a diapause. The larvae are not frost resistant and therefore must rely on their ability to supercool for survival over winter. This ability to supercool is considerable, ranging from about 13°C in prepupal larvae in the spring to about 34°C in larvae collected outdoors in midwinter. However, all developmental stages exhibit supercooling points well below the lowest temperature normally experienced by that stage. In larvae with the greatest depression of supercooling points, glycerol is the most abundant cryoprotectant identified, amounting to about 9% of fresh body weight. In the absence of glycerol but where the potential to supercool still exists to a great degree, in pupae and adults for example, trehalose levels are high and smaller amounts of sorbitol are present. It is proposed that *S. ratzeburgi* relies on a multi-factorial cryoprotectant system and that this is somehow related to reducing possible toxic effects of large concentrations of any one cryoprotectant. It appears that the concentration of glycerol in the overwintering larvae of *S. ratzeburgi* is regulated by temperature. Glycerol and the other carbohydrates studied, sorbitol, glucose and trehalose, continue to be synthesized or metabolized at subzero temperatures down to -10°C. This suggests that enzymatic reactions of frost resistant and supercooled insects would be worthy of further investigation.

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Few investigations on bark beetles have been carried out in Norway (Bakke 1968), and virtually no information is available on the general ecology or physiology of the birch engraver, *Scolytus ratzeburgi* Jans., the largest of the Scandinavian species. *S. ratzeburgi* is specific to weakened or newly felled birch and presumably has a wide distribution in Norway, whose forests range from sea level to an elevation of about 1000 m and extend from about 58° to 70°N. It experiences a wide variety of climatic conditions, and in particular must be capable of surviving the low temperatures typical of winter in northern Norway or at high altitudes. Furthermore, *S. ratzeburgi* overwinters as a 'more-or-less last instar larva' (Lekander 1968) while still in the galleries beneath the bark, and thus lacks the insulative protection of snow cover. Bark itself provides relatively little insulation and the temperatures operating above snow level fluctuate considerably due to solar radiation (Bakke 1968).

The purpose of the present investigation was to study cold adaptations in *S. ratzeburgi* with respect to its natural overwintering environment; to test for frost resistance and supercooling potential in this species when acclimated at different low temperatures for varying periods of time, and to study any concomitant changes in blood sugars and sugar alcohols. Although *S. ratzeburgi* is intrinsically of no great economic importance to the forest industry in Norway, it is one of the few species that overwinters above snow level in the larval stage, and also one of the few insects that was available in the field at the beginning of the study period in the winter of 1972–73. According to Yuill (1941), Salt (1961), Sømme (1964, 1965), Chansler (1966), Bakke (1968), Asahina (1969), Østbye and Sømme (1972), and Zachariassen (1973), however, this is the period when cold-hardiness, as reflected by the lowest supercooling points, is at its greatest degree in many other species of insects, including scolytids.

MATERIALS AND METHODS

A well-infested birch tree was felled on 17 January 1973 and cut into seven 2 ft. bolts. Three bolts were kept outdoors under the naturally prevailing conditions of temperature and photoperiod, while the remaining four were brought into the laboratory on 22 January 1973. Three of these were maintained in darkness at 3°C and the other was maintained at room temperature (23°C) and natural daylength. The logs were gradually debarked as larvae were required for acclimation experiments, supercooling point determinations, or tissue analyses.

Acclimation

Groups of 4–6 larvae were acclimated at 3°C, –4°C, –10°C, or –30°C for varying periods of time and compared with the development of larvae maintained under natural conditions outdoors or at room temperature for the same duration. The larvae exposed to sub-zero treatments were isolated in petri dishes and layered between sheets of filter paper, whereas those maintained at 3°C, room temperature, or outdoors were retained within the logs. At the end of the test period larvae were tested for viability, their supercooling points were determined, and chemical analyses were carried out.

Supercooling point determination

Supercooling points were measured with a 32-gauge copper-constantan thermocouple attached to a recording potentiometer. The insects were placed in a narrow glass tube with the thermocouple in contact with the surface of the abdomen, and held in a fixed position by a plug of cotton. In order to reduce the cooling rate to approximately –2°C per minute the glass tube was placed within two larger tubes before being immersed in the ethanol coolant of a Hetofrig unit previously cooled to approximately –43°C. The supercooling point is denoted by the rebound, that is, the point at which spontaneous freezing occurs in the tissues, thus giving off heat of crystallization. The mean supercooling point of at least 5 specimens was normally used in each determination.

Chemical analyses

Specimens used in the analyses were generally those which had been used first for supercooling point determinations and then subsequently stored in the deep-freeze at –30°C until ready for use. A minimum of 3 larvae per sample was used. After allowing them to thaw at room temperature, the samples were weighed, homogenized with 320 mesh carborundum powder in 70% ethanol and centrifuged at 5000 r.p.m. for 15 minutes. Two further washings in 70% ethanol were carired out; the combined supernatants were evaporated to dryness and the residue redissolved in a known quantity of distilled water (Sømme 1964).

Separation of various compounds was achieved by thin-layer chromatography and paper chromatography. Quantification of sugars was carired out by TLC on silica gel plates developed according to the technique outlined by Mansingh & Smallman (1972). Sugar spots from unsprayed areas were eluted in distilled water and centrifuged to remove the silica gel. After two washings, the combined supernatants were mixed with phenol-sulphuric acid reagent (Dubois et al. 1956). Concentrations of each sugar were measured colorimetrically at 490 nm on a spectrophotometer and values read from a prepared standard curve for each sugar. Rf values for the respective compounds were: glycogen, no measurable migration; trehalose, 0.26; sorbitol, 0.36; glucose, 0.47; glycerol, 0.54; and glyceraldehyde, 0.74. Polyols were quantified by paper chromatography essentially according to the method of Sømme (1964), but as slightly modified by Zachariassen (1973); that is, spot weight measurements were taken as a measure of the amount of polyol in the spot rather than spot size as measured by a planimeter.

RESULTS

Acclimation

At room temperature (23°C) larvae began to feed almost immediately when brought into the laboratory from the field. The particular larvae first excavated under these conditions were significantly smaller (1.5–3 mm) than subsequent larvae (6–8 mm) from all other gallery systems. As opposed to the larger more mature larvae, these larvae were in the feeding condition and readily identified by the presence of reddish-brown gut contents visible through the semi-transparent cuticle. Within 4 weeks at room temperature all larvae had pupated and adult emergence was completed. Adults lived for 2–3 weeks under laboratory conditions (Table I).

When larvae were maintained at a constant temperature of 3°C, pupation did not occur in any individual over the 22-week test period. However, when larvae which had been exposed initially to 3°C for 15 weeks were transferred outdoors in the early part of May, pupation was completed in all larvae within 2½ weeks. Similarly, when larvae were transferred to room temperature after spending 10 weeks at 3°C, pupation occurred in all larvae within 4 days. In contrast to these results, larvae which had been maintained outdoors began to show signs of apolysis 9 weeks after the beginning of these tests, and pupation was completed in all individuals in 12 weeks, i.e. in the first half of April. Although the original number of larvae is unknown, it is presumed that there was 100% survival since no dead or moribund larvae were discovered in the logs during the complete removal of bark.

Larvae were able to survive acclimation at –4°C for up to 16 weeks, the end of the test period (see Table II). One hundred percent survival occurred if the larvae were held in petri dishes containing dry filter paper. If the filter paper was moistened, however, there was a significant reduction in survival rate, presumably due to inoculative freezing. Similarly, there was 100% survival rate among larvae acclimated at –10°C for periods up to 12 weeks if maintained in dry conditions which can be considered comparable to their natural surroundings within the larval galleries. However, larvae did not survive exposure to –30°C for even brief periods. Larvae could survive a brief exposure to temperatures equivalent to their supercooling point if removed immediately during the sudden increase in temperature associated with the rebound. If allowed to cool back to the original supercooling point, however, this proved fatal even for brief exposures. A temperature of –30°C was below the supercooling point of most of the larvae at the time of this experiment and since *S. ratzeburgi* is not frost tolerant, this resulted in 100% mortality.

Supercooling and chemical analyses

The present techniques revealed the presence of glucose, trehalose, glycogen, glyceraldehyde, sorbitol, glycerol, and small but

Table I. Changes in supercooling points, sugars and sugar alcohols during metamorphosis of S. ratzeburgi at room temperature (23°C).

Stage	Time (days)	n	Survival			Tissue Analysis µg/mg Fresh Weight				Supercooling Point	± s.d.
			Alive	Dead	%	Glucose	Trehalose	Sorbitol	Glycerol		
larva	2	5	5	0	100	11.3	25.5	17.0	23.3	-25.5°	± 4.07
	4	5	5	0	100	1.4	19.8	3.0	0	-21.2°	± 0.35
	6	5	5	0	100	16.3	25.8	12.1	0	-16.5°	± 2.56
	7	6	6	0	100	10.4	5.6	33.7	0	-16.6°	± 3.34
	8	5	5	0	100	10.9	21.2	Trace	0	-15.0°	± 3.15
pupa	17	5	5	0	100	7.3	12.6	3.7	0	-21.1°	± 0.21
	21	5	5	0	100	9.2	19.5	4.8	0	-22.1°	± 0.66
adult	28	10	10	0	100	4.0	3.9	8.5	Trace	-18.9°	± 2.29
	35	8	8	0	100	2.5	3.7	4.3	0	-15.7°	± 1.97
	42	5	5	0	100	2.6	4.2	1.4	0	-15.7°	± 0.75
*larva	0	6	6	0	100	3.6	4.4	6.4	86.9	-36.4°	± 1.42

*Larvae were brought into the laboratory from outdoor conditions on January 23.

consistent amounts of three unidentified compounds with Rf values of 0.06, 0.18, and 0.82 in tissue extracts of mature larvae. Although qualitative analyses and supercooling point determinations were carried out for each sample, detailed quantitative analyses were made only on sugars and sugar alcohols. These data for different life stages are presented in Table I, and for different acclimation treatments of larvae in Table II and Figs. 1–2.

In Table I, it can be seen that when larvae are brought into the laboratory (23°C) from the field, development towards pupation begins almost immediately and is completed within two weeks. Adults emerge about 10 days later and can survive for approximately 3 weeks under laboratory conditions. During this period, glycerol levels drop rapidly from 86.9 μg/mg Fresh Weight (F.W.) to zero within 4 days, with concurrent changes in supercooling points which rise from –36.4°C ± 1.42 to –15°C ± 3.15 within 8 days. There is a significant increase in supercooling ability during pupal and early adult development, before returning to pre-pupal levels in mature adults. This phenomenon has been noted in other insects (Ring 1972) and may be associated with the histogenic changes that occur during the formation of the pharate adult. The other major chemical constituents show a great degree of variation, particularly during late larval development. Trehalose is the most abundant of these, although it is interesting to note that the inordinately high level of sorbitol in the larval group sampled after 7 days at 23°C was synthesized at the expense of trehalose. This was the highest level of sorbitol measured in any group during these experiments, amounting to al-

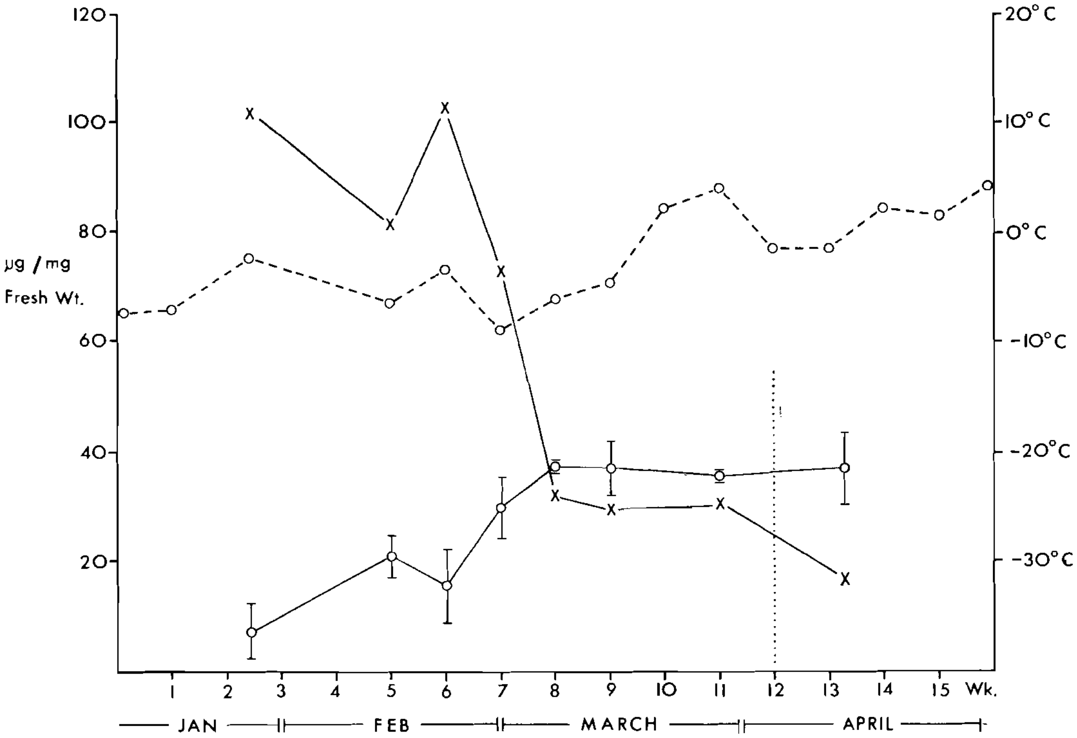

Fig. 1. Supercooling points, total sugar plus sugar alcohol contents, and minimum air temperatures during acclimation of *S. ratzeburgi* larvae maintained in logs under natural conditions of photoperiod and temperature from January – April, 1973. Each s.c.p. is the mean of 5 larvae or pupae ± standard deviation. The vertical dotted line indicates the point of pupation.

0– – – – –0– – – – –0minimum air temperatures

X———X———Xtotal sugars + sugar alcohols

ϙ———ϙ———ϙsupercooling points ± s. d.

most 3.4% of the fresh body weight. Glucose levels increase sharply when larvae are brought into the laboratory from the field at the end of January, reaching a maximum of 16.3 μg/mg. However, these levels gradually drop during metamorphosis from around 11 μg/mg in the late larva to 2.6 μg/mg in mature adults, with pupae having intermediate amounts. A similar pattern is observed in trehalose and sorbitol levels, but with sorbitol there are distinctly lower levels in the pupal stages than in adults during their early development.

In larvae maintained within logs under outdoor conditions the first visible sign of pupation, apolysis, is apparent after 9 weeks and pupation is complete in approximately 12 weeks (Fig. 1). Under field conditions, therefore, preparations for pupation begin in the latter half of March and are completed by mid-April. According to meteorological data this is the time of year when there are no longer consistent, subzero overnight low air temperatures, and daily maxima are in the region of 7–10°C. In Fig. 1 the supercooling points of larvae maintained outdoors are plotted against total sugar and sugar alcohol content over a 14-week period. The daily minimum temperature for each sample period is also given to provide a basis for comparison between supercooling points and prevailing air temperatures during the test period. It is apparent that supercooling points remain significantly below minimum air temperatures and that the difference is most accentuated during the coldest part of the winter in January and February. Indeed, the dip in supercooling from –29.5° to –32°C that occurred near the end of February was preceded by one of the coldest spells of that winter with overnight low temperatures consistently in the range of –3° to –9°C. During a 2-week period in late February/early March, weeks 6–8 of the test period, supercooling points rose from –32.1°C to –21.5°C and total sugar and sugar alcohol content decreased from 102.6 μg/mg to 31.3 μg/mg. The sharp decline in the sugar and sugar alcohol content is principally due to the rapid disappearance of glycerol which decreases from 86.9 μg/mg at 6 weeks to 9.9 μg/mg at 8 weeks. Glycerol levels continue to decline, reaching 1.5 μg/mg in larvae sampled at 11 weeks and only a trace in pupae at 13½ weeks. During the month of March average daily temperatures increase from 0°C to 6–8°C, and daily maxima range from 10–15°C in the latter half of the month, thus allowing morphogenesis to proceed towards pupation. During this period supercooling points reach a plateau around –22°C and this is correlated with a levelling-off of carbohydrate content. As glycerol, sorbitol and glucose levels decline, there is an increase in trehalose so that the amount of these carbohydrates remains constant at opproximately 30 μg/mg. Following pupation, around the 12 week mark, there is a further decline in carbohydrate content to 16.8 μg/mg, but the supercooling point remains at –21.7°C, virtually the same as pre-pupal levels. The major difference between these larvae and those which were allowed to pupate in the laboratory at 23°C is that the outdoor prepupae do not exhibit such a decrease in supercooling ability prior to pupation, their average supercooling point being measured at –22.3°C ± 0.42°C as opposed to –15.0°C ± 3.15 (see Table I).

Figure 2 presents the data obtained by maintaining larvae in logs held at 3°C for 22 weeks. The graph compares supercooling points with changing levels of sugars (trehalose and glucose) and sugar alcohols (glycerol and sorbitol). All larvae survived the acclimation treatment and although biochemical adjustments took place during the test period no visible signs of morphogenesis were observed. The most significant changes occur during the first 4½ weeks after transfer from the field. Supercooling points remain low initially, being –27.6°C ± 1.17 and –33.1°C ± 4.24 after 1 week and 2½ weeks respectively, but then rise to –22.4°C ± 1.19 at 4½ weeks and remain around this level until week 20. At this point, which coincides with the beginning of June, there is a further increase to –15.6°C ± 4.33 at 20½ weeks and –19.0°C ± 3.24 at 21½ weeks, levels which are reminiscent of pre-pupal larvae maintained at 23°C (see Table I). Concomitant changes occur in the sugars and sugar alcohols. Glycerol levels are high initially, being 33.3 μg/mg and 82.4 μg/mg at 1 week and 2½ weeks respectively, before falling to 10.7 μg/mg at 4½ weeks and 4.1 μg/mg at 6½ weeks. Thereafter glycerol declines to a trace at 14½ weeks and is com-

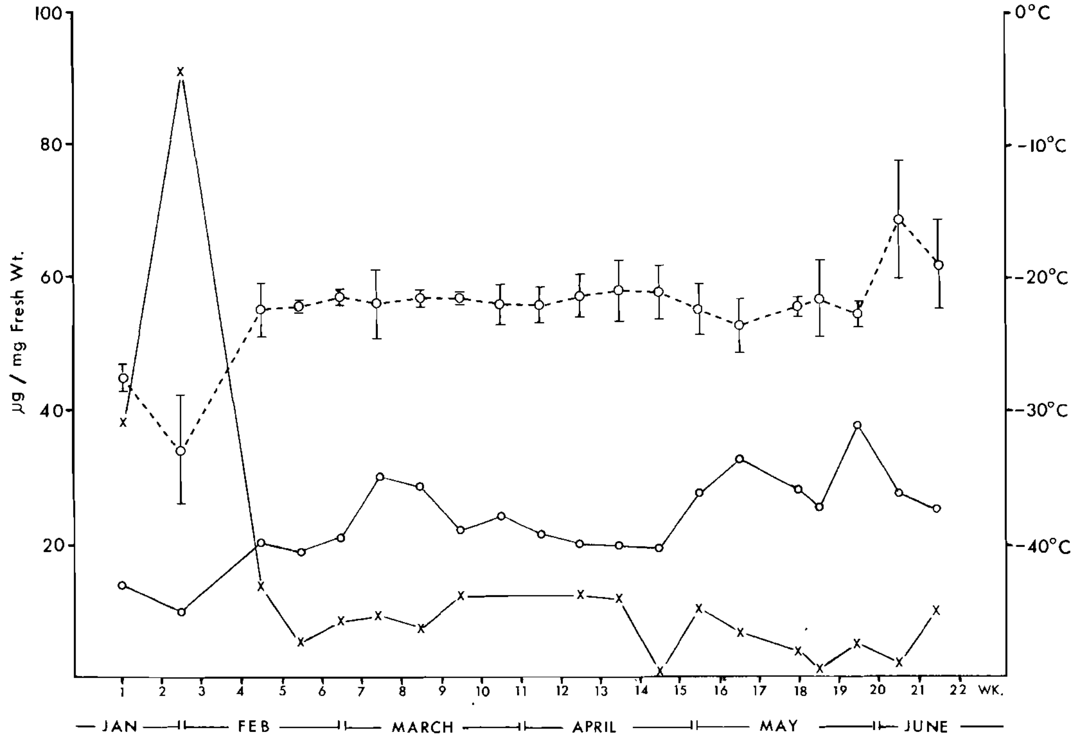

Fig. 2. Supercooling points, sugars, and sugar alcohols in the larvae of *S. ratzeburgi* maintained in logs at 3°C for 22 weeks. Each s.c.p. is the mean of 5 larvae ± standard deviation.

ϕ- - - - -ϕ- - - - -ϕsupercooling points ± s. d.

X————X————Xglycerol + sorbitol.

0————0————0trehalose + glucose

pletely absent at 18½ weeks. Sorbitol levels vary within the range of 2.2–9.2 µg/mg, although at 14½ and 18½ weeks it is reduced to a trace and 0.8 µg/mg respectively. From 15½ weeks until the end of the test period sorbitol is the only sugar alcohol present in measurable quantities. As the sugar alcohols decline in amount, glucose plus trehalose levels increase. This is mainly due to relatively large amounts of trehalose, the main blood sugar of this species. Trehalose declines from 12.1 µg/mg at 1 week to 6.9 µg/mg at 2½ weeks, but then increases to 17.8 µg/mg at 4½ weeks and is never less than 20 µg/mg for the remainder of the test period, reaching a peak of 32.4 µg/mg at 19½ weeks. Glucose levels vary within the range of 0.2–7.2 µg/mg.

Table II presents the data from a number of acclimation experiments in which larvae were maintained under different temperature regimes for varying periods of time. When larvae are exposed to –4°C in moist conditions the survival rate is generally low, and it has already been suggested that this may be due to inoculative freezing. The anomalous result of 100% survival in the larval group sampled at 98 days remains difficult to interpret. At time zero, larvae held at 3°C for 15 days prior to acclimation, the average supercooling point is –33.1°C ± 4.24, glycerol content is 82.4 µg/mg, sorbitol 8.9 µg/mg, glucose 3.4 µg/mg, and trehalose 6.9 µg/mg. Supercooling points remain relatively low averaging –26.3°C within a range of –24.5° to –28.8°C throughout the period of acclimation, which is a somewhat higher level than the original –33.1°C. Accompanying these low supercooling values, glycerol levels remain high, averaging 60.1 µg/mg within the range of 34.0–82.4 µg/mg; sorbitol 7.2 µg/mg within the range of 4.5–10.9 µg/mg;

Table II. The survival rate, supercooling points, and sugar and sugar alcohol levels of *S. ratzeburgi* larvae acclimated at different temperatures for varying periods of time.

Acclimation Temperature and Treatment	Time (Days)	Survival				Tissue analysis µg/mg fresh weight				Supercooling Point (°C)	± s.d.
		n	Alive	Dead	%	Glucose	Trehalose	Sorbitol	Glycerol		
-4°C; moist conditions. Larvae held at 3°C for 15 days prior to acclimation.	0	6	6	0	100	3.4	6.9	8.9	82.4	-33.1°	± 4.24
	28	6	4	2	67	1.9	13.8	5.9	76.5	-25.9°	± 1.54
	42	6	3	3*	50	1.1	6.4	4.5	41.4	-28.8°	± 2.82
	56	6	4	2	67	2.5	9.5	10.9	79.0	-25.5°	± 3.11
	70	6	4	2*	67	1.4	7.7	8.0	58.6	-25.7°	± 0.86
	84	5	2	3	40	2.1	5.9	6.9	71.3	-27.4°	± 0.49
	98	6	6	0	100	4.1	6.8	5.1	34.0	-24.5°	± 0.58
-4°C; dry conditions. Larvae held at 3°C for 48 days prior to acclimation.	0	5	5	0	100	1.3	24.9	4.2	4.3	-21.7°	± 0.50
	14	5	5	0	100	1.9	11.6	6.1	15.8	-24.5°	± 0.11
	28	5	5	0	100	2.1	12.5	9.7	42.5	-23.4°	± 2.71
	45	5	5	0	100	2.1	10.8	5.5	38.9	-27.0°	± 2.75
	56	5	5	0	100	3.1	10.5	5.0	54.3	-25.3°	± 0.46
	70	7	7	0	100	0.9	13.3	3.4	43.5	-25.6°	± 1.05
	112	9	9	0	100	1.9	13.1	1.4	15.4	-23.3°	± 2.08
-10°C; dry conditions. Larvae held at 3°C for 37 days prior to acclimation.	0	6	6	0	100	0.4	18.8	3.0	1.9	-22.1°	± 0.33
	18	6	6	0	100	0.9	20.4	5.8	38.4	-24.7°	± 0.54
	28	5	5	0	100	2.2	7.6	7.2	55.6	-23.8°	± 1.68
	42	6	6	0	100	2.5	19.0	8.7	80.9	-25.7°	± 0.24
	56	6	6	0	100	3.3	14.4	5.5	38.9	-26.5°	± 0.61
	70	6	6	0	100	2.9	11.4	4.9	42.3	-25.9°	± 1.11
	89	5	4	1*	80	1.8	9.2	4.8	45.1	-23.4°	± 1.61
-10°C; dry conditions. Larvae maintained under OUTDOOR conditions for 50 days prior to acclimation.	0	5	5	0	100	0.8	13.4	4.7	46.7	-24.6°	± -
	15	5	5	0	100	2.4	19.1	6.2	18.2	-25.3°	± 1.26
	29	4	3	1	75	4.2	12.5	9.9	73.1	-26.9°	± 1.29
-30°C; dry conditions. Larvae maintained under OUTDOOR conditions for 42 days prior to acclimation.	0	6	6	0	100	2.9	6.9	5.8	87.0	-31.0°	±3.73
	14	4	1	3*	25	1.4	7.7	7.1	61.6	-27.8°	±2.24
	28	4	0	4*	0	2.4	14.4	5.8	39.6	-25.5°	±1.20
	42	4	0	4	0	3.4	5.5	10.7	79.3	-27.9°	±2.43
	56	4	1	3	25	0.7	7.4	4.7	40.2	-25.9°	±2.39
	70	4	0	4*	0	2.4	8.2	4.0	47.8	-25.5°	±3.18
	84	4	0	4	0	2.4	6.5	0.5	54.6	-26.7°	±2.92
-30°C; moist conditions. Larvae held at 3°C for 15 days prior to acclimation.	0	6	6	0	100	3.4	6.9	8.9	82.4	-33.1°	±4.24
	42	9	0	9	0	3.0	4.8	5.0	78.7	-32.4°	±5.47

*includes moribund larvae.

glucose 2.2 µg/mg within the range of 1.1–4.1 µg/mg; and trehalose 8.4 µg/mg within the range of 5.9–13.8 µg/mg. Supercooling point determinations and carbohydrate analyses were carried out only on surviving larvae, but it is interesting to note that dead larvae maintain the ability to supercool. The mean supercooling point of the 12 larvae that failed to survive this acclimation treatment is –30.8°C ± 2.55, which is only slightly higher than at time zero, perhaps indicating that they died early during the acclimation treatment. Similar results are obtained with larvae exposed to –30°C under moist conditions. None of the group of 9 larvae survives 6 weeks at –30°C but the mean supercooling point remains low at –32.4°C ± 5.47, and sugar and sugar alcohol contents are almost identical to pre-test levels.

It was obvious within 4 weeks that moist conditions at sub-zero temperatures contributed towards increased larval mortality. All further acclimation experiments, therefore, were carried out using dry conditions for larval storage. It is assumed that this more closely simulates natural conditions under bark. After 16 weeks at –4°C in dry conditions there is 100% larval survival (Table II). The larvae used in this test were taken from the 3°C room after 48 days, and at this point, time zero, the mean supercooling point is –21.7°C ± 0.50, glycerol content is 4.3 μg/mg, sorbitol 4.2 μg/mg, glucose 1.3 μg/mg, and trehalose 24.9 μg/mg. It can be seen that within 2 weeks at –4°C the supercooling point is lowered to –24.5°C ± 0.11, and is maintained at an average value of –24.9°C for the remainder of the acclimation period; glycerol levels increase to 15.8 μg/mg within 2 weeks and reach a peak of 54.3 μg/mg after 8 weeks; sorbitol increases to 6.1 μg/mg in 2 weeks and a peak of 9.7 μg/mg in 4 weeks; glucose increases to a peak of 3.1 μg/mg in 8 weeks; and trehalose decreases in amount, maintaining an average value of 12.0 μg/mg throughout the acclimation period.

When acclimation at –10°C for 89 days is carried out, 97% survival occurs among the test larvae. The larvae used in this experiment were taken from the 3°C room after 37 days and at time zero exhibit a mean supercooling point of –22.1°C ± 0.33, a glycerol level of 1.9 μg/mg, sorbitol 3.0 μg/mg, glucose 0.4 μg/mg, and trehalose 18.8 μg/mg. Within 18 days at –10°C the mean supercooling point is lowered to –24.7°C ± 0.54 and remains at an average value of –25.0°C throughout the acclimation period; glycerol levels increase to 38.4 μg/mg in 18 days and 80.9 μg/mg in 42 days (average = 50.2 μg/mg); sorbitol increases to 5.8 and 8.7 μg/mg after 18 and 42 days respectively (average = 6.2 μg/mg); glucose increases to 0.9 and 3.3 μg/mg after 18 and 56 days respectively (average = 2.3 μg/mg); and trehalose tends to decline in quantity from 20.4 μg/mg after 18 days to 9.2 μg/mg after 89 days (average = 13.7 μg/mg). A similar acclimation treatment for 29 days was provided for larvae which had been maintained outdoors for 50 days prior to acclimation (Table II). At the time of transference, which coincides with the beginning of March when overnight low temperatures are in the region of –1° to –6°C and daily maxima are 2°–9°C, significant changes are occurring in the field population. Within 7 days (weeks 7–8 in Fig. 1) the supercooling point of outdoor larvae rises from –25.2°C ± 3.05 to –21.5°C ± 0.29 and total sugar and sugar alcohols decline from 72.7 to 31.3 μg/mg. Extrapolating from these data, the following baseline for time zero in this experiment is used; average supercooling point –24.6°C; glycerol content 46.7 μg/mg; sorbitol 4.7 μg/mg; glucose 0.8 μg/mg; trehalose 13.4 μg/mg. It can be seen by comparing Table II and Fig. 1, therefore, that if larvae are returned to a sub-zero temperature such as –10°C, which is significantly below the prevailing temperature in the field, then there is a pronounced decrease in the supercooling point, –26.9°C ± 1.29 after 29 days compared with –22.3°C ± 0.49 in outdoor larvae at 11 weeks, and a significant increase in glycerol levels, 73.1 μg/mg compared with 1.5 μg/mg in outdoor larvae. The increase in glycerol content accounts for the major increase in carbohydrate levels that occurs in acclimated larvae. Compared to a relatively constant level of around 30 μg/mg of sugars plus sugar alcohols in outdoor larvae, the level in acclimated larvae increases to 45.9 μg/mg after 2 weeks and 99.7 μg/mg after 4 weeks at –10°C.

Finally in Table II, it can be seen that there is a very low survival rate in larvae acclimated at –30°C in dry conditions for 12 weeks. These larvae were transferred to the experimental regime after spending 42 days under outdoor conditions. At the time of transference a sample of 6 larvae from outdoors was tested to provide the baseline data. At time zero, therefore, the mean supercooling point was –31.0°C ± 3.73, the individual values being –25.0°C, –29.2°C, –29.8°C, –33.0°C, –34.0°C and –35 0°C. Thus half of the larvae in the sample have supercooling points above the acclimation temperature. It can be seen from Table II that the mean supercooling point of each group lies within the range of –25.5° to –27.9°C (average value = –26.6°C) which is significantly above the acclimation temperature. It is interesting to note that the larva which survived 14 days and that which survived 56 days at –30°C had supercooling points of –30.0°C and –28.6°C respectively, the lowest in their respective groups. Glycerol levels at time zero are in the region of 87 μg/mg but are lowered during acclimation to an average level of 53.9 μg/mg; sorbitol remains relatively constant with a value of 5.8 μg/mg at time zero and an average value of 5.5 μg/mg during acclimation; glucose also remains constant, 2.9 μg/mg at time zero and an average of 2.1 μg/mg during acclima-

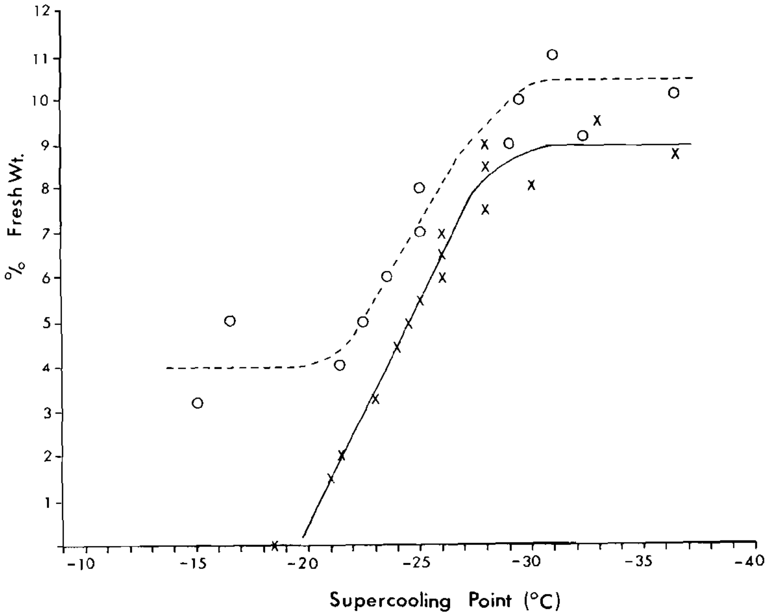

Fig. 3. Relationship between supercooling ability and glycerol concentration (X) or total sugar + sugar alcohol concentration (0) in the larvae of *S. ratzeburgi*.

tion; but trehalose increases slightly from 6.9 μg/mg at time zero to 8.3 μg/mg during acclimation.

Fig. 3 illustrates the relationship between glycerol content, as percentage of fresh weight, and the supercooling ability of larvae. The graph is constructed from the combined data from all acclimation experiments and it shows that there is a close and direct correlation between increasing glycerol levels and decreasing supercooling points, but only where there is a depression of supercooling to –21°C or below. In larvae with supercooling points above –21°C, there is at the most only trace amounts of glycerol present. This occurs in the field around the end of March (see Fig. 1) and it also occurs during metamorphosis (see Table I). Although pupae have supercooling points in the –21.0° to –22.8°C range, there is no glycerol present in their tissues, and there is a similar lack in adult beetles which have supercooling points in the –15.0° to –20.0°C range. For comparison, total sugar plus sugar alcohol contents have been plotted against supercooling points over the entire range measured in *S. ratzeburgi*.

DISCUSSION

Scolytus ratzeburgi is not frost resistant during any stage of development and must therefore rely on the supercooling ability of the hibernating larvae for overwintering success. Unlike *Scolytus ventralis* (Scott & Berryman, 1972), *Scolytus kirschi* (Andrionova & Makhmadzieev, 1972), and *Dendroctonus obesus* (Dyer 1970), all of which have a larval diapause, there is no apparent diapause in this species. Larvae started to feed, develop, and complete morphogenesis when brought into the laboratory from the field in January. However, one must be cautious when trying to define the presence or absence of diapause since it is largely a dynamic state that can decrease in intensity as the season progresses, and can be terminated in mid-winter rather than in the spring (Tauber & Tauger, 1976). There can also be considerable variation in diapause intensity both within and between populations of the same species (Ring 1971). *Scolytus kirschi* overwinters as both mature F_1 larvae (3–4 mm) and small F_2 larvae (1.5–2 mm) (Andrionova & Makhmadzieev, 1972) and, contrary to the rather nebulous statement by Lekander (1968) about overwintering as a 'more-or-less last instar larva', it is possible that this is also the case with *S. ratzeburgi*. In the log taken into the laboratory from the field in January there were two distinct larval populations. The first comprised small, immature, feeding larvae ranging in size from 1.5 to 3.0 mm all taken from the same gallery system, and the second comprised mature, non-feeding larvae in the 6.0–8.0 mm size range taken from the remaining gallery systems.

S. ratzeburgi possesses considerable supercooling potential during all life stages from larva to adult. The highest supercooling points recorded were around –14.3°C in pre-pupal larvae and adults, and the lowest was –37.7°C recorded at the end of January in a larva maintained outdoors. Preliminary studies had indicated that melting points in individuals similar to the above were –0.7°C and –4.0°C respectively. If the degree of supercooling is defined as the difference between the melting point (or freezing point) and the supercooling point, then this species can supercool about 13°–34°C depending upon stage of development and history of exposure to low temperatures. The larvae contained large amounts of glycerol when collected outdoors in January, and it was in these larvae that the lowest supercooling points were recorded. In larvae stored in birch logs outdoors continuously the glycerol disappeared almost entirely in 11 weeks, about the end of March. When the logs were maintained at 3°C the glycerol content declined more gradually, but had disappeared entirely in 18 weeks, coinciding with mid-May in terms of field conditions. Although there were no visible signs of development in this population of larvae even after 21½ weeks at 3°C, it was noticed that larvae in the last 2 weeks of the sample period contained small amounts of material in the gut. These larvae were intermediate in size between the two larval types found earlier, being 3–6 mm long, and the presence of gut contents could account for the increase in the supercooling points that was observed at that time. It is well known that feeding insects are less able to supercool than non-feeding insects (Salt 1961, Sømme 1964, Bakke 1968). This observation adds further evidence to the suggestion made earlier that overwintering in *S. ratzeburgi* occurs in more than one larval instar. The lack of morphogenesis in larvae at 3°C indicates that the threshold temperature for development lies above 3°C. This is consistent with results reported from some other bark beetle larvae, e.g. 2.2° to 4.4°C for *Dendroctonus ponderosae*, 6.1°C for *D. rufipennis*, and 6.1° to 9.4°C for *D. pseudotsugae* (McCambridge 1974). When larvae were brought into the laboratory from the field and maintained at 23°C, glycerol decreased very rapidly and was lost within 2–4 days. However, when larvae which had been maintained at 3°C long enough for glycerol to be reduced to low levels were exposed to –4°C and –10°C, glycerol re-appeared in large amounts. It apears, therefore, that the concentration of glycerol in *S. ratzeburgi is* regulated by temperature. Similar results have been reported by Dubach et al. (1959) for *Camponotus pennsylvanicus*, by Sømme (1964) for *Dendroctonus monticolae*, by Krunic & Salt (1971) for *Megachile relativa*, by Mansingh & Smallman (1972) for *Isia isabella*, and by Baust & Miller (1972) for *Pterostichus brevicornis.*

In *S. ratzeburgi* there was a linear correlation between amount of supercooling and glycerol concentration from 0 to 9%, which is in direct contrast to results obtained by Sømme (1964) for *Dendroctonus monticolae.* In that species a direct relationship existed only at higher glycerol concentrations. Comparison between the two species is difficult, however, since experimental results are expressed using different criteria. A plateau around 9% glycerol was observed in *S. ratzeburgi* – 11% if sorbitol, glucose, and trehalose are included – at a supercooling point of approximately –30°C. A greater degree of supercooling did occur, however, in the absence of further increase in concentration of these solutes. Perhaps other chemicals could be implicated in this depression of supercooling points, such as unsaturated fatty acids (Pantyukhov, 1964), amino acids (Sømme 1967), or perhaps other carbohydrates (Redway & Lapage 1974).

Even when glycerol had disappeared from the system, larvae, pupae, and adults of *S. ratzeburgi* retained the ability to supercool to relatively low levels (–14° to –22°C). This is not unique of course, since there are many examples of insects that supercool to this extent without glycerol. However, it is of ecological interest since it indicates that all stages exhibit supercooling points well below the lowest temperature normally experienced by that stage, and that pupae and adults could survive the sudden cold spells that may occur in spring or early summer at 61°N. Similar results are reported by Bakke (1968) for other Norwegian species of bark beetles. When glycerol was absent, the major carbohydrate component present was the regular blood sugar, trehalose. This has been shown to have considerable cryoprotective properties in a number of previous studies (Asahina & Tanno 1964, Sømme 1967, Redway & Lapage 1974, Morrissey & Baust 1976). A multifactorial protectant system such as this in *S. ratzeburgi* possibly offers many advantages (Morrissey & Baust 1976), the most important of which is related to reducing the toxic effect of any one cryoprotectant. As Baust (1973) points out in his review, although glycerol has many valuable properties as a cryoprotectant, it can be lethal in doses high enough to afford protection in living systems.

It is apparent that the sugar alcohols, glycerol and sorbitol, and the sugars, trehalose and glucose, can be synthesized or metabolized at sub-zero temperatures. Changes in the amounts of these solutes occurred during each of the acclimation treatments, and although it was not the purpose of this paper to study the metabolic pathways of glycerol synthesis, it was noted that as glycerol accumulated at low temperatures, sorbitol and glucose levels also tend to increase but trehalose levels decline. This tends to support the biosynthetic schemes proposed by Wyatt & Meyer (1959), Chino (1960, 1961), and Frankos & Platt (1976). However, insufficient data are available to formulate a conclusive argument, and the possibility that glycerol may be synthesized from triglyceride sources, as proposed by Baust & Miller (1972) for *Pterostichus brevicornis* and Morrissey & Baust (1976) for *Eurosta solidagensis*, cannot be precluded. The fact that cryoprotectants can continue to be synthesized at sub-zero temperatures has important theoretical as well as ecological consequences. Overwintering larvae of *S. ratzeburgi* experience prolonged exposures to severe temperatures, particularly in their more northerly range and at high altitudes, and may also encounter frequent thaw-freeze cycles during late winter or early spring. The ability to synthesize glycerol and other cryoprotectants under those conditions is of obvious selective advantage. In the gall fly, *Eurosta solidagensis*, sorbitol synthesis was initiated at 0°C and trehalose production continued at –30°C (Morrissey & Baust, 1976), and Ziegler & Wyatt (1975) have reported the activation of glycogen phosphorylase, an enzyme affecting glycerol production, at 0°–4°C in the diapausing pupae of the silk moth, *Hyalophora cecropia*. All of these results indicate that a re-appraisal of enzyme function in insects at sub-zero temperatures is necessary.

ACKNOWLEDGEMENTS

I am grateful to Dr. A. Bakke for the supply of infested birch and to Dr. L. Sømme for the use of his laboratory facilities. I thank Dr. Sømme for his interest and enthusiasm for the project and for the many fruitful discussions that took place between us. This research was funded by the N. R. C. of Canada, with suplies being provided by the Zoological Institute, University of Oslo.

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Prostigmate mites (Acari, Prostigmata) from Sverdrupfjella, Dronning Maud Land, with description of four new species

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Strandtmann, R. W. & Sømme, L. 1977. Prostigmate mites (Acari, Prostigmata) from Sverdrupfjella, Dronning Maud Land, with description of four new species. *Norw. J. Ent. 24,* 137–146.

Four new species, and one previously described, of terrestrial prostigmate mites were collected in Sverdrupfjella, Dronning Maud Land, Antarctica during the austral summer of 1970/71. The following species are described as new: *Eupodes angardi, Eupodes winsnesi, Nanorchestes brekkerista,* and *Nanorchestes bellus.*

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The Sverdrupfjella mountain range in Dronning Maud Land is situated at about 72° to 73°S and from 0°30'W to 1°30'E (Fig. 1). The range consists of a large number of peaks or nunataks, some of them reaching an elevation of more than 2500 m a.s.l. The Sverdrupfjella was visited by the Norwegian Antarctic Expedition 1970–71 (Winsnes 1972). During this expedition several samples of collembolans and mites were collected by Mr. J. Angar. A report on the collection of Collembolans will be published later, while the present paper gives an account of the prostigmate mites in the samples.

The terrestrial arthropod fauna of Dronning Maud Land is poorly investigated. Only one oribatid mite is known from the area (Dalenius & Wilson 1957), and previously no collembolans have been found. Four species of prostigmate mites were collected at Heimefrontfjella by personnel from the British Antarctic Survey (Bowra et al. 1966). These included *Nanorchestes antarcticus* Strandtmann, which is widespread in Antarctica (Strandtmann 1967), *Tydeus erebus* Strandtmann, which has also been found in East Antarctica, as well as two previously undescribed species *Nanorchestes bifurcatus* Strandtmann and *Eupodes tottanfjella* Strandtmann.

The mites for the present study were collected from the underside of stones with an aspirator and preserved in alcohol. They were stored at the Norwegian Polar Research Institute until cleared and identified by one of the authors (Strandtmann).

The holotypes and paratypes of the new species are deposited in the Zoological Museum, University of Oslo, Norway. The number of specimens recorded are not always the total number collected. Some specimens remain in alcohol, and are deposited at the Zoological Museum University of Oslo. For holotypes and paratypes the numbers given in brackets refer to the original number of the sample.

Genus *EUPODES* C. L. Koch, 1835

Small, soft-bodied, slender-legged herbivorous mites. All body setae with short ciliations. Femora IV generally greatly swollen.

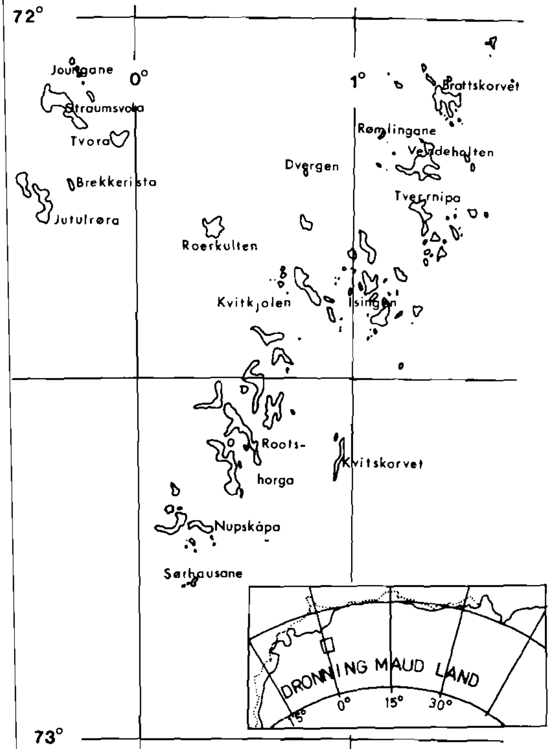


Fig. 1. Map of Sverdrupfjella, and their position in Dronning Maud Land, Antarctica.

Eupodes angardi sp. novo. (Figs. 2 a–l).
A medium sized *Eupodes*, approximately 0.5 mm long, with short, slender setae. Legs relatively short, legs I no longer than the body. Femur IV not swollen.

Female (Figs. 2a.b). Length 500 to 600 μ. *Dorsum* (Fig. 2a). Without ornamentation or obvious striations. Optical pigment not evident in preserved specimens. Suture between pro and metapodasoma not obvious. Dorsal setae filiform, finely ciliated, relatively short. Trichobothria slender, sparsely ciliated. Average lengths of dorsal setae in microns: v.i.–22, v.e.–30, sc.–35, tr.–60, h.i.–44, h.e.–44, d_1–45, d_2–48, l.i.–52, s.i.–50, s.e.–50. *Venter* (Fig. 2b). Coxal setae 3–1–4–3, slightly enlarged apically but not truly clavate; somewhat more coarsely ciliated than dorsals. All the coxal setae of about equal length (ca 30 μ) except the outer apical seta of coxa I, which is only half as long. *Genitalia.* Genital setae, 6 + 6 (occasionally 6 + 7 or 7 + 7), paragenital setae 5 + 5. Two pairs of genital knobs and several pairs of internal (or eugenital) setae. *Anal pore* terminal. Anal seta 1 about 1/3 as long (15 μ) as anal seta 2 (44 μ). Anal seta 3, 50 μ and inserted on dorsal side. *Gnathosoma.* Hypostome conical, with 2 pairs small, ciliated setae; one pair apical, the other basilateral, typical of the genus. Chelicera with small shears, the movable digit stronger, and the fixed digit weak, typical of the genus. Cheliceral seta nude. Pedipalpal setae 0–2–3–8. (The pedipalpal tibiotarsus has either 8 or 9 setae. They are difficult to distinguish). *Legs.* (Figs. 2 e–l). Slender and shorter than the body. Leg I from 440 to 500 μ. Femur IV not enlarged. Tarsal claws basally ciliated. Tarsi I and II each with 2, tandem, rhagidial organs subtended by a stellate seta on tarsus I and a spine on tarsus II (see Figs. 2e, f). Tibia I has a small dorsoapical rhagidial organ with apical spine, tibia II with a dorsoapical r.o. without the spine. A solenidion on the dorsobasal aspect of tibiae I–IV and genua I–III. The solenidia are prominent in the male but are difficult to find in the female. The normal leg setae are filiform, ciliated, and of moderate length. Tarsi III and IV each with a single dorsobasal seta, tarsi I and II with paired dorsobasal setae.

Male. Length 450 to 580 μ. Differs from the female only in the genitalia (Fig. 2c) and in having more prominent solenidia (tibia I–IV and genua I–III, Figs. 2i–l). The genital covers are slightly smaller than in the female and the eugenital setae more tightly clustered. The sperm sac about as long as the genital covers and typically clavate. The genital setae of 6 + 6 are arranged 5 in a row and one more lateral, on each cover. In one male, one cover has 2 lateral setae making the count 6 + 7. Another male has 2 lateral setae on each cover, 7 + 7.

Deutonymph. One specimen, somewhat crushed. Approximate length, 375 μ. Dorsal setae ca. 30 μ. Genital setae 2 + 2, paragenital setae 2 + 2. Coxal formula 3–1–4–2, trochanters 1–1–1–0. Rhagidial organs on tarsi I and II as in the adult.

Holotype. Female. Brattskarvet, Sverdrupfjella, Dronning Maud Land, Antarctica, 8 Jan. 1971 (No. 20). Collected on north-facing slope, breeding grounds for snow petrels, 1600 m a.s.l.

Paratypes. 8 ♀♀, 6 ♂♂, 1 deutonymph. Same locality as holotype.

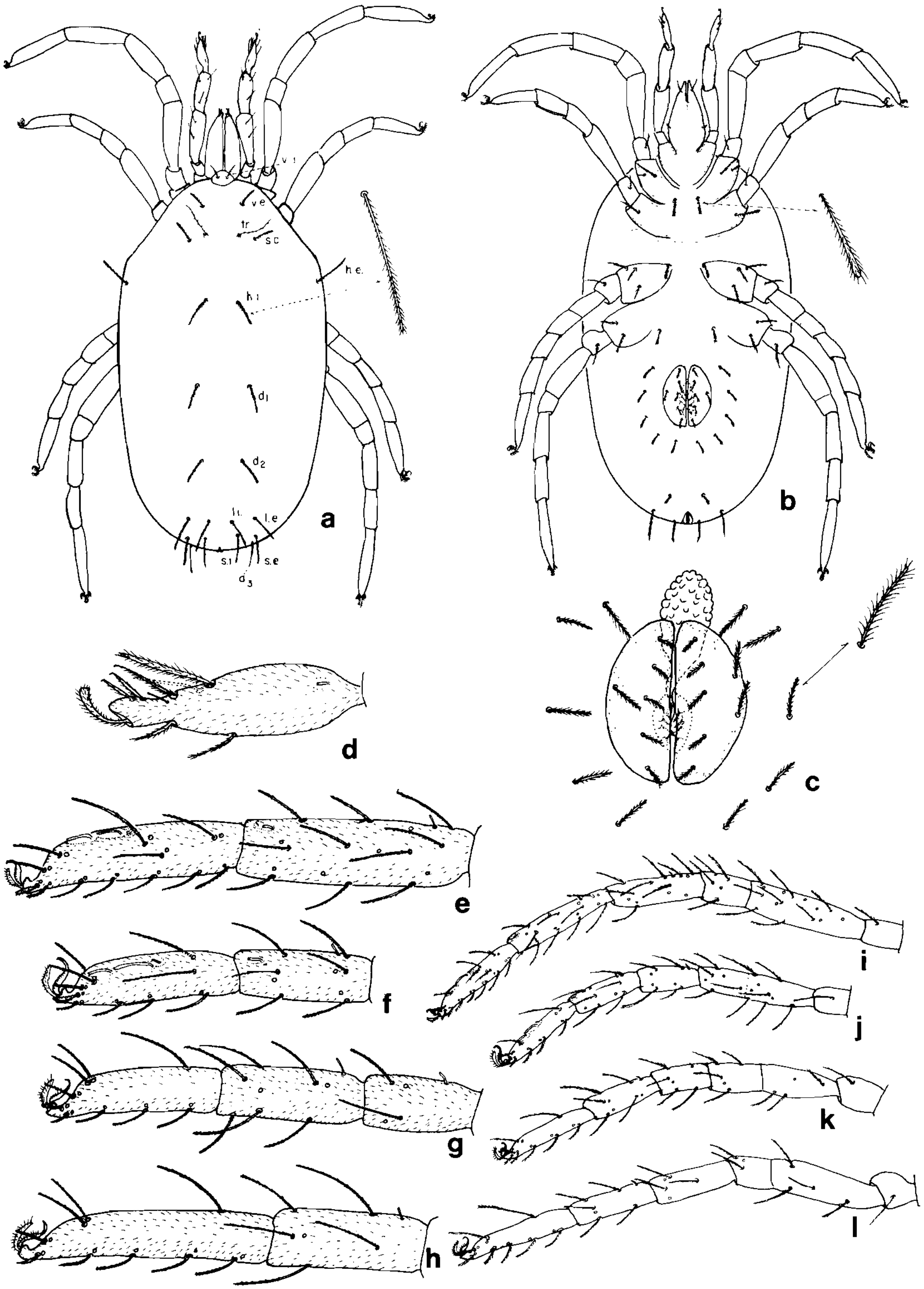


Fig. 2. *Eupodes angardi* sp. novo. a. dorsum; b. venter of female, c. male genitalia, d. tibiotarsus of pedipalp, e. tarsus and tibia of leg I, f. tarsus and tibia of leg II, g. tarsus, tibia and genu of leg III, h. tarsus and tibia of leg IV, i, j, k and l. side view of legs I to IV respectively. Abbreviations: a_3, anal seta; d_1 and d_2, first and second dorsal setae; h.e., humeralis externa; h.i., humeralis interna; l.e., lumbar externa; l.i., lumbar interna; sc., scapularis; s.e., sacral externa; s.i., sacral interna; tr., trichobothrium; v.e., verticalis externa; v.i., verticalis interna.

Type locality. Queen Maud Land, Antarctica, Brattskarvet.

Remarks. This species differs from all others of the genus by the combination of short legs, short dorsal setae, and slender femora IV.

It is named after J. Angard, the collector of these specimens.

One might question whether this species is truly a *Eupodes* but there is no other place to put it without drawing the limits of *Eupodes* too fine to be meaningful.

Eupodes winsnesi sp. novo. (Figs. 3a–h).

A medium-large mite, about 0.5 millimeters long, with long legs and long dorsal setae. Legs I about 0.7 mm long; femur of leg IV slightly swollen. Suture between pro and metapodium evident.

Female. (Figs. 3a–b). Length. 485–525 μ. Leg I, 640–690 μ. *Dorsum* (Fig. 3a). No obvious ornamentations or striations. Optic pigment not apparent in preserved specimens. Transverse suture apparent but not pronounced. Setae filiform, finely ciliated. Opisthosomal setae very long, overlapping bases of succeeding setae. Setae l.i. shorter and noticeably more slender than l.e. Trichobotrium slender, sparsely ciliated. Average lengths of the dorsal setae: V.I.–30, v.e.–50, s.c.–45, tr.–75, h.i.–125, h.e.–80, d_1–130, d_2–140, l.i.–95, l.e.–115, s.i.–115, s.e.–90, setae a_3–90. *Venter* (Fig. 3b). Coxal setae 3–1–4–3; trochanters 1–1–1–1. All the coxal setae narrowly clavate; the trochantal setae filiform and longer. Genital setae 6 + 6, of which one pair is lateral to the other 5 pairs. Paragenital setae 5 + 5. All ventral setae finely ciliated but more coarsely so than the dorsals. Anal pore terminal; setae a_1–25 μ and ventral, a_2–65 μ and terminal, a_3–90 μ and dorsal. *Gnathosoma.* With no unusual features. *Legs* (Figs. 3e–h). Long and slender. Leg 1 approximately 700 μ, leg IV about 550 μ. Setae long, mostly filiform, finely ciliated. Some of the ventral setae slightly enlarged apically. Femur IV slightly but noticeably swollen. Tarsi I and II each with 2 tandem rhagidiforms, subtended by a stellate seta in I and a spine in II. Tibia I with a small spine-and-rhagidiform combination anteriorly; tibia II with the rhagidiform only. Small solenidia basally on tibiae I–IV and mediobasally on genua I–III but they are difficult to find in the female. In the male they are more obvious.

Table I. Leg Chaetotaxy of 3 species of *Eupodes*

Leg	ta.	ti.	gen.	fem.
		winsnesi n.sp.		
I	22	20–23	20	28–30
II	16	9	6–7	16
III	17	9	5	9
IV	15	6	5	7
		angardi n.sp.		
I	22–24	17	12–13	20
II	16	9	7	15
III	15	8	5	9
IV	15	6	5	7
		tottanfjella Strandtmann		
I	22	16	15	20
II	16	9	7	15
III	15	8	4	9
IV	15	7	5	7

Male. Length 470–500; leg I 655–720. Similar to the female except a trifle smaller, legs a bit longer, and the dorsal setae a few microns shorter. The solenidia of tibia I–IV and genua I–III small but more easily found than in the female. Sperm sac relatively short (Fig. 3c).

Tritonymph. 370–400 μ long. Coxal setae 3–1–4–3; trochantal setae 1–1–1–1; genital setae 3 + 3; paragenitals 4 + 4. Setae d_1 and d_2 from 80 to 100 μ.

Holotype. Female. Brattskarvet, Sverdrupfjella, Dronning Maud Land, Antarctica 8 Jan. 1971 (No. 20). Collected on north-facing slope, breeding grounds for snow petrels, 1600 m a.s.l.

Paratypes. 9 ♀♀, 14 ♂♂, 7 tritonymphs, all from Sverdrupfjella, Dronning Maud Land, as follows: Brekkerista 29 Jan. 1971, scree facing north, 1150 m a.s.l. (No. 1), 1 ♀, 2 ♂♂, 5 Ny III. Brekkerista 24 Jan. 1971, in vegetation of moss and lichens, facing north, 1150

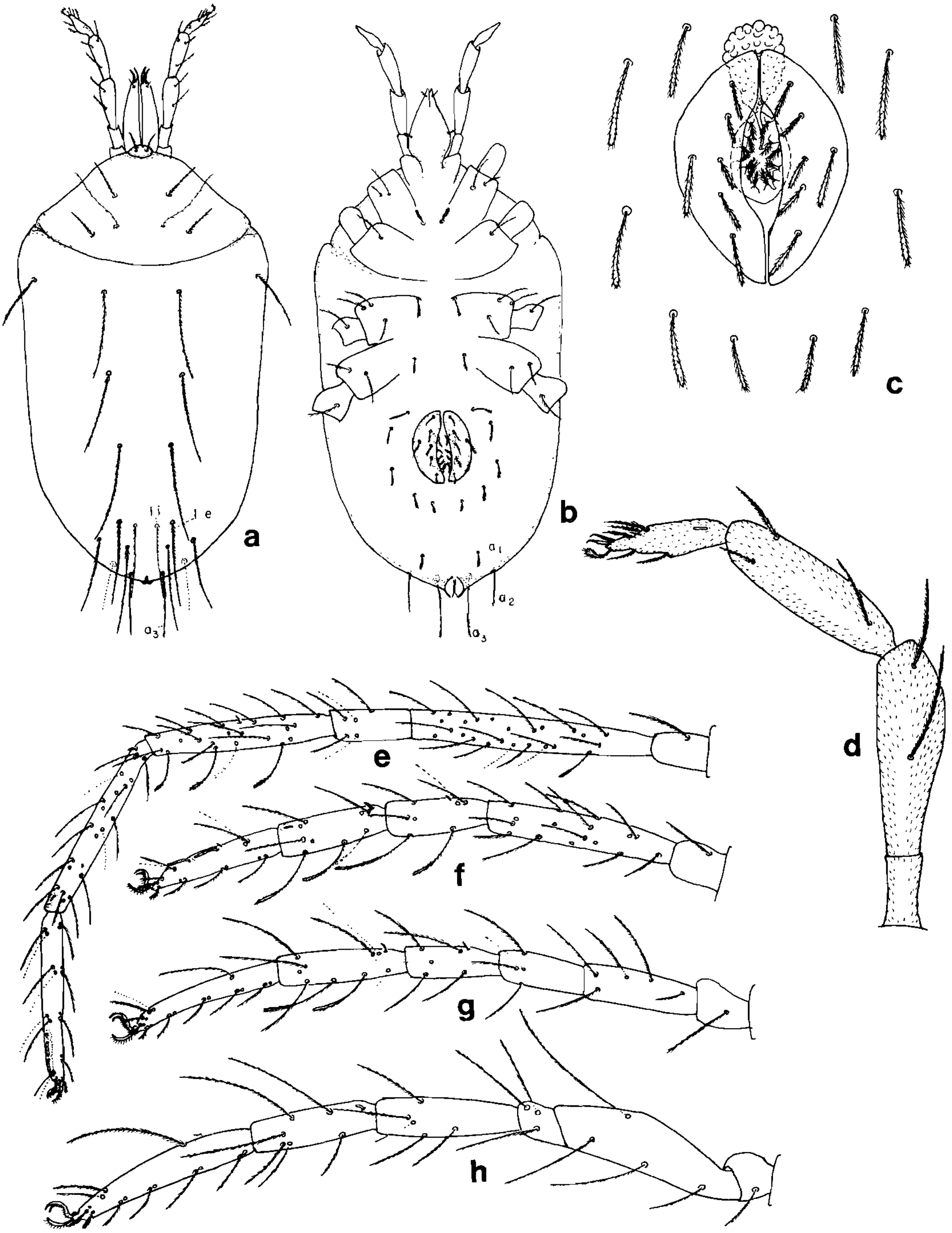


Fig. 3. *Eupodes winsnesi* sp. novo. a. dorsum, b. venter of female, c. male genitalia, d. dorsolateral view of left pedipalp, e, f, g and h. side views of legs I to IV respectively. Abbreviations: a_1, a_2, a_3, anal setae; l.e., lumbar externa; l.i., lumbar interna.

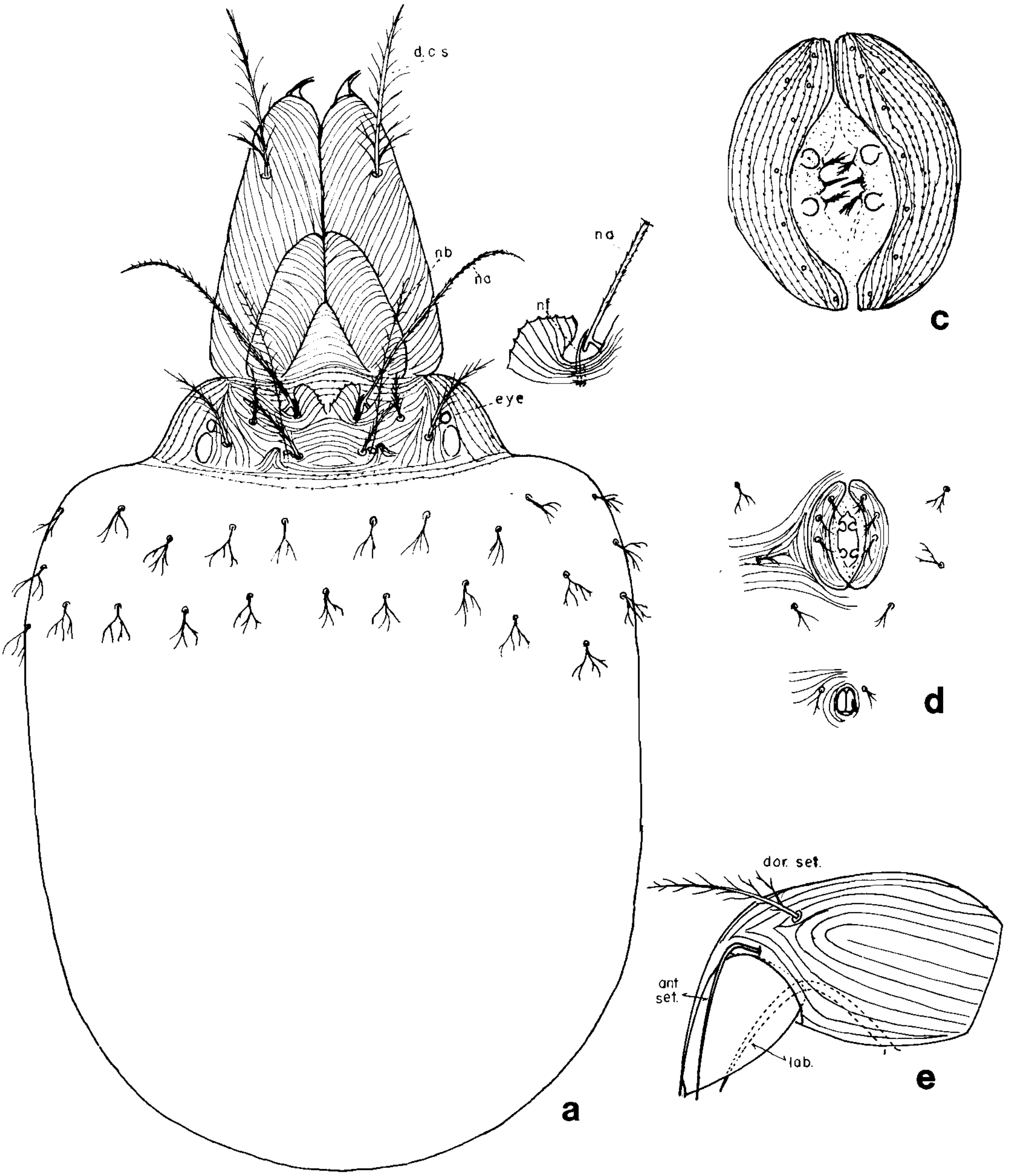
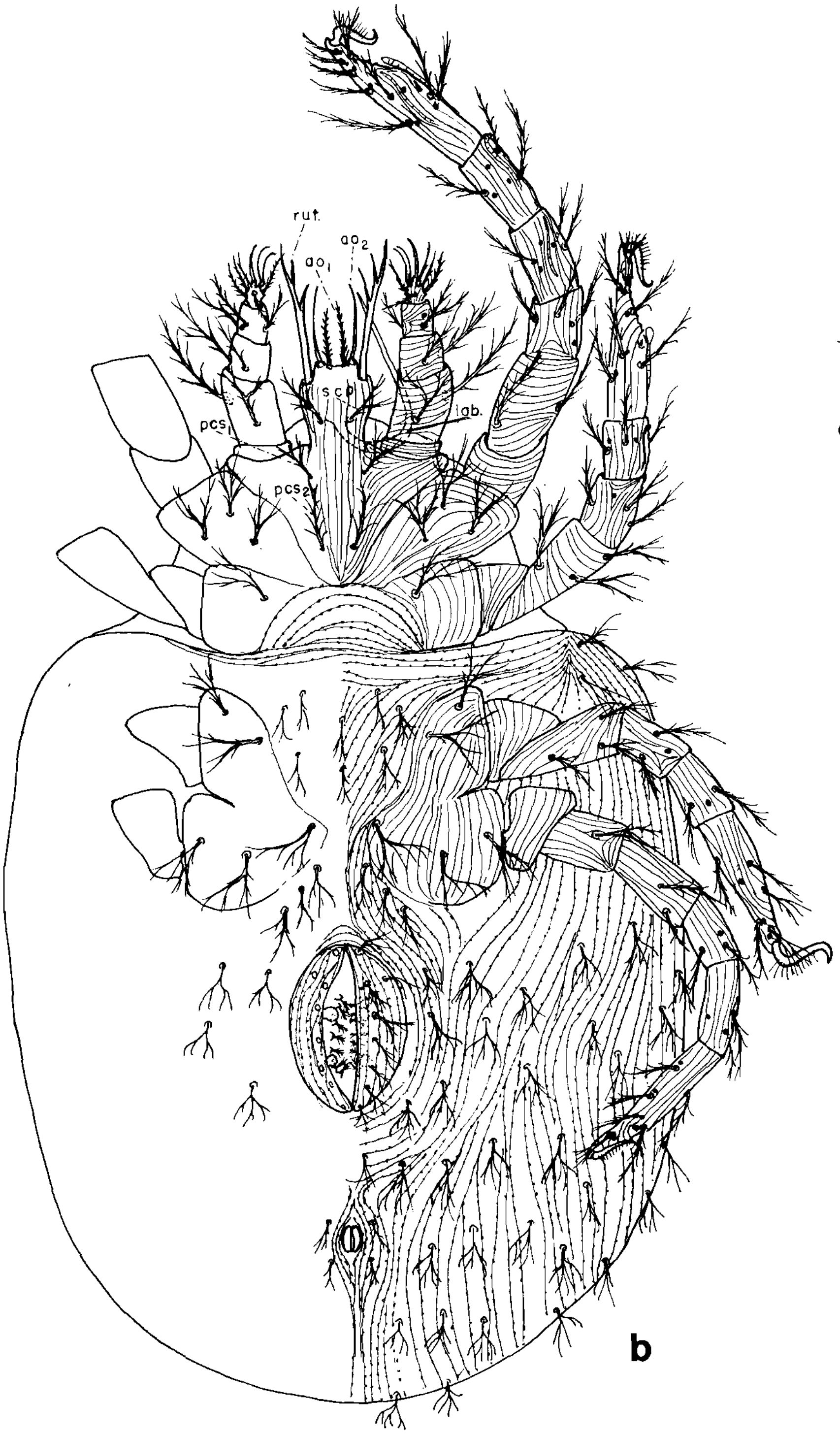
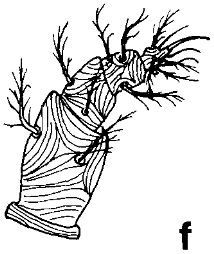


Fig. 4. *Nanorchestes brekkerista* sp. novo. a. dorsum with an enlarged view of the anterior sensory complex and part of the nazo, b. venter of male, c. female genitalia with the external genital setae omitted, d. genital and anal pores of the deutonymph, e. side view of chelicera, f. pedipalpus, g. tarsus of pedipalp, h. dorsal view of tarsus II, i. empodial claw of leg. Abbreviations: ao1, ao2, adoral setae; ant. set., anterial cheliceral seta; d.c.s.; dorsal cheliceral seta; dor. set., same as d.c.s.; lab., labrum; na, trigger seta for anterior sensilla; nb, posterior sensilla; nf, anterior sensilla; pcs1, pcs2, first and second pedipalpal coxal setae; rut., rutellum; scp, subcapitular seta.

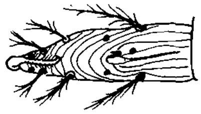


b



f

g



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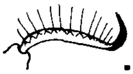

i

m a.s.l. (No. 32), 9 ♂♂, 1 ♀. Tvora 25 Dec. 1970, north-facing slope, 1500 m a.s.l. (No. 7) 1 ♂. Straumsvola 21 Dec. 1970, scree facing north, 850 m a.s.l. (No. 3), 6 ♀♀, 1 Ny III. Straumsvola 21 Dec. 1970, scree facing north, 880 m a.s.l. (No. 5), 1 ♀, 2 ♂♂. Vendeholten 4 Jan. 1971, scree NW side, 1600 m a.s.l. (No. 14), 1 Ny III.

Type locality. Bratskarvet, Queen Maud Land, Antarctica.

Remarks. This new species resembles *E. tottenfjella* Strandtmann, 1967 in having long dorsal setae, but *E. winsnesi* is larger, has longer dorsal setae, and has more setae on tibia, genu, and femur I. For a comparison of the leg chaetotary of *E. angardi, E. winsnesi* and *E. tottanfjella,* see Table I. Average lengths of dorsal seta 1 (d_1) of the 3 species are: *E. angardi* 50 μ, *E. tottanfjella* 75 μ, *E. winsnesi* 125 μ.

Named after Dr. T. S. Winsnes, leader of the Norwegian Antarctic Expedition 1970–71 to Dronning Maud Land.

Genus *NANORCHESTES* Topsent and Trouessart, 1890.

Very small, globular mites with numerous branched body setae. Legs short, tarsi with only one claw.

Nanorchestes brekkeristae sp. novo. (Figs. 4a–i)

Adult (Figs. 4a–i). Average length 300 μ, including chelicerae (250–340). Prominently striated; idosomal striae punctulate; striae of appendages, gnathosoma and chelicerae, smooth. Dorsal seta of chelicera not furcate. Chelate portion of chelicera comprises 1/3 of the total length of chelicera. *Dorsum* (Fig. 4a). Propodosoma about twice as wide as long. Distance between bases of anterior sensillae (nf), 20 μ. Posterior sensilla (nb) shorter and finer than seta na; both are uniformly ciliated from base to apex. Seta na is 75 μ, sensilla nb is 55 μ. The cuticular flap (naso) between bases of ng is coarsely striate and medially divided. Eye and post-ocular orb well developed. Dorsal hysterosoma punctato-striate, the striations longitudinal laterally and transverse medially. The setae numerous, not in rows, arborescent, about 15 μ long– (10–18). *Venter* (Fig. 4b). Genital pore about 50 μ long, each cover with 8 arborescent setae. 2 pairs of small genital knobs. Female with 3 pairs eugenital (internal) setae of which the outer 2 are ciliated, the middle pair simple (Fig. 4c). Male with 7 pairs coarsely ciliated eugenital setae borne on papillae. Anal pore less than 10 μ, bracketed by 2 pairs branched setae. Coxal setae 3–1–2–3, large and branched. About 8 pairs of branched setae not unlike those of the dorsum. *Gnathosoma* (Figs. 4e, f, g). Pedipalps typical for the genus, with 5 segments beyond the coxa. The trochanter is small and easily overlooked. Setal formula, troch. to tarsus, is 0–2–2–3–8. The eight setae include 3 that are nude and sickle-shaped, and one that is claw-like and bornon a prominent tubercule. The setae of the other segments are all coarsely plumed. The chelicerae are long, with a dorsal, non-furcate, coarsely plumed seta, and a long, nude, needle-like anterior seta. The chela is large, comprising about 2/5 of the total length of the chelicera. The movable digit is massive and scoop-like, the immobile digit is long, narrow, needle-like. The long anterior cheliceral seta arises at the base of the chela and extends forward as far as the tip of the immovable digit. The antlered rutella of the hypostome are long, extending beyond the tips of the pedipalps. The inner adoral setae (ao_1) are coarsely ciliated and a bit shorter than the nude outer adoral setae (ao_2). The subcapitular setae (sc) are branched and subequal. *Legs* (Figs. 4b, h, i). Relatively long for the size of the body. Empodial claws with 8–10 rays each side. Tarsi I & II each with a small, middorsal sensory seta (the famulus). Tarsus I with one middorsal and 2(?3) lateral sensory ridges, none of which curve transversely over the segment. Tibia I with 2 sensory ridges, one of which curves over the top of the segment. Genu I with 2 longitudinal ridges. Tarsus II with a longitudinal ridge that is slightly inflated apically. Tibia II & III each with a sensory ridge. Femora I and IV are divided. All leg setae are strong and coarsely plumed. Those of the femora tend to be branched. All trochanters are without setae. Chaetotaxy, from tarsus to femur: Leg I, 16–6–5–6(4+2); leg II, 11–5–4–3; leg III, 8–3–3–3; leg IV, 11–3–3–3(2+1).

Holotype. Female. Brekkerista, Sverdrupfjella, Dronning Maud Land, Antarctica, 26 Jan. 1971 (No. 34) (one of two specimens mounted on the same slide. The other specimen is a male, the allotype.)

Allotype. Male. Same data and mounted on the same slide as the holotype.

Paratypes. 8 ♀♀, 9 ♂♂, 1 deutonymph, all from Sverdrupfjella, Dronning Maud Land, as follows: Brekkerista 26 Jan. 1971 (No. 34), 3 ♀♀, 1♂. Brekkerista 24 Jan. 1971, scree with lichens, 1150 m a.s.l. (No. 30), 2 ♀♀, 6 ♂♂. Joungane 23 Dec. 1970, north-facing slope, 1000 m a.s.l. (No. 6), 2 ♀♀, 2 ♂♂, Roerkulten 17 Jan. 1971, north-facing slope, 1500 m a.s.l. (No. 25), 1 deutonymph.

Remarks. The chelicerae, and (especially) the long, needle-like fixed digit serve to distinguish this species from all others. It is nearest *N. amphibius* T. & T. in size but in *amphibius* the branches of the body setae are heavy, finger-like, whereas in *brekkeristae* they are fine and hairlike.

The specific name is for the locality in which it was found.

Nanorchestes bellus sp. novo. (Figs. 5a, b)

Dorsal seta of chelicera not furcate. Propodosoma about 1/3 as long as wide. Idiosomal setae numerous, branched, about 8 microns long.

Male. (Figs. 5a, b). Length, including chelicera, 300 μ. *Dorsum* (Fig. 5a). Idiosomal striae mostly transverse medially and longitudinal laterally; punctulate except in the sensory area. Distance between bases of sensory setae nf 10 μ. Setae nm inserted posterior to, and on the same longitude as, the bases of sensillae *nb*. Seta *na* and sensilla *nb* of equal length, ca. 38 μ. Both are of equal thickness but *na* has short, close, fine ciliation, whereas *nb* has more sparse, coarse, and long ciliations. The intersensillary flap (naso) is convex, entire. Hysterosomal setae arborescent, about 7 to 9 μ long, numerous (*ca* 250). *Venter* (Fig. 5b). Genital pore 50 μ long; the 7 pairs of eugenital (internal) setae are bifurcate and weakly plumed. The genital setae (external) are arborescent and 8 on each flap, one of which is more lateral. Anal pore with 2 pairs of setae, similar to the body setae. Coxal seta formula, 3–1–2–3. All are large and all are furcate except the inner posterior seta of coxa IV, which is single. About 11 furcate or arborescent setae in the intercoxal region between coxae III & IV; 2 setae medially between coxae II & III. Ventral hysterosomal setae numerous, similar to the dorsals. *Gnathosoma.* Pedipalps typical for the genus; setae 0–2–2–3–8. Chelicera rather short and broad. Dorsal seta coarsely plumose not bifurcate. Anterior seta and chela not decipherable. Striations prominent, smooth. Hypostoma with weakly antlered rutella that barely reach the tips of the pedipalps. The smooth external adoral setae (AO_1) much longer than the ciliated internal adoral setae (AO_2). *Legs.* Empodial claws with 6–8 rays each side. Tarsi I & II each with a small, middorsal famulus. One of the sensory lines on tibia I curves over the top of the segment. Femora I & IV are divided. All the leg setae, except one or two on femora III & IV are single and coarsely plumose. Chaetotaxy of legs I to IV, tarsus to femur, respectively: I, 16–6–5–6(4+2); II, 11–5–4–3; III, 8–3–3–3; IV, 11–3–3–2(1+1).

Holotype. Female. Tvora, Sverdrupfjella, Dronning Maud Land, Antarctica 25 Dec. 1971 (No. 7). Collected from underside of stone, north-facing slope, 1500 m a.s.l.

Paratype. Male. Same locality as holotype.

Remarks. One cannot determine from only two specimens whether the characters used for differentiation will hold true, we can only assume, and hope, they will.

Only 2 setae on femur IV, the short, very broad chelicerae, equal thickness and length of seta na and sensilla nb, the absence of unusual modifications on the pedipalps are characters which, when used in combination, serve to differentiate this species.

This struck us as an unusually pretty little mite, hence the name, *bellus.*

Nanorchestes antarcticus Strandtmann, 1963.

Brekkerista 24 Jan. 1971, facing north, in vegetation of lichens, 1150 m a.s.l., 1 ♀, 1 ♂. Tvora 2 Jan. 1971, scree facing north-west, 1200 m a.s.l., 1 ♀, Tverrnipa 4 Jan. 1971, scree facing north-west, 1700 m a.s.l., 1 ♀, Dvergen 11 Jan. 1971, slope facing north, 1500 m a.s.l., 2 ♂♂.

ACKNOWLEDGEMENTS

We are most grateful to Mr. Tore S. Winsnes and The Norwegian Polar Research Institute for permission to publish the present material, and to Mr. J. Angar, who collected the mites.

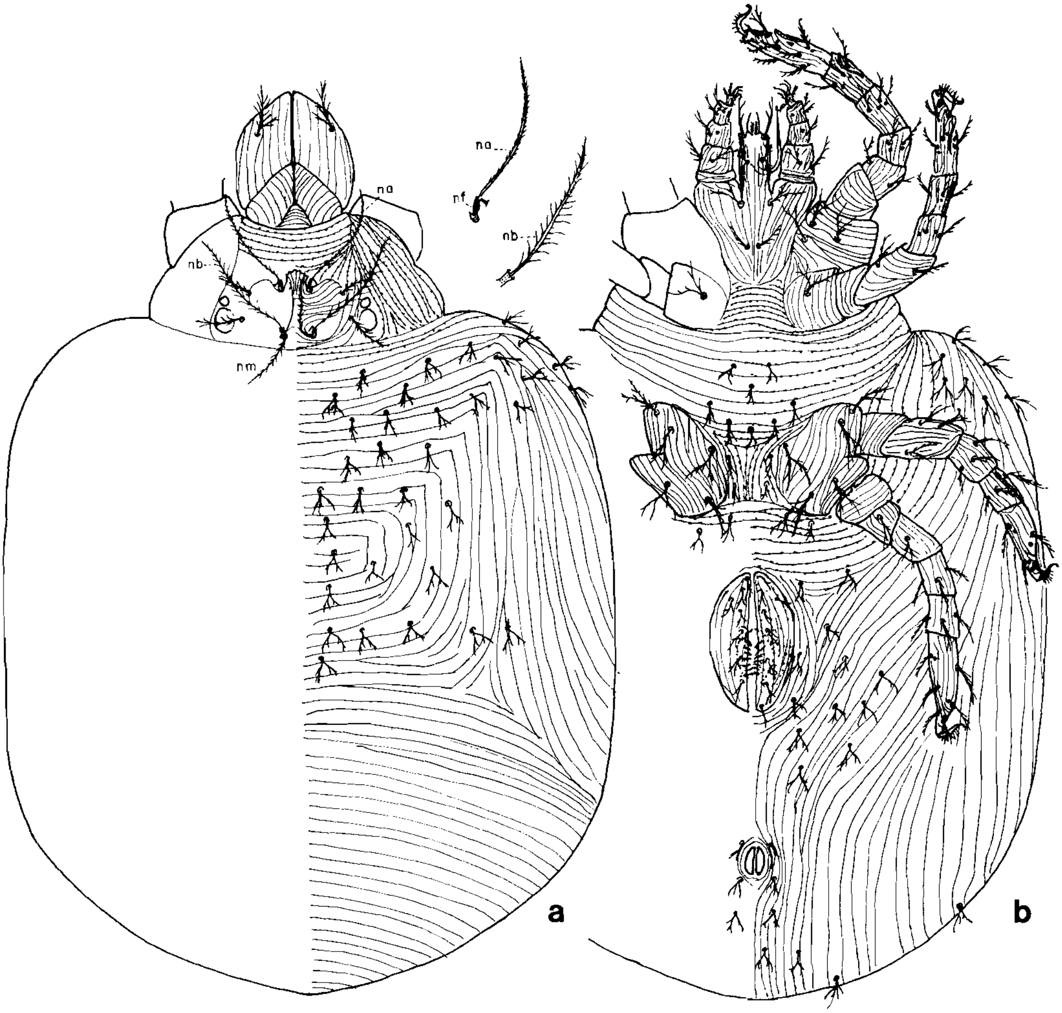

Fig. 5. *Nanorchestes bellus* sp. novo. a. dorsum, with enlarged view of the anterior sensory complex and the posterior sensilla. Abbreviations: na. trigger seta for anterior sensilla; nb, posterior sensilla; nf, anterior sensilla; nm, posterior seta in the dorsal sensory area.

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Received 25 August 1977

Nye funn av Coleoptera i Norge

KARL ERIK ZACHARIASSEN

Zachariassen, K. E. 1977. New finds of Coleoptera in Norway. *Norw. J. Ent. 24,* 147–148.

This paper presents a list of 45 finds of Coleoptera which have not previously been reported from the respective Norwegian districts. Three of the species reported (*Scaphidium quadrimaculatum* Ol., *Agrilus pratensis* Ratz. and *Colydium elongatum* F.) are new to Norway.

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I denne artikkelen rapporteres 45 funn av biller i Sør-Norge, som representerer ny utbredelse for vedkommende art i henhold til Lindroth (1960) og senere korreksjonslister. Tre av artene, *Scaphidium quadrimaculatum* Ol., *Agrilus pratensis* Ratz. og *Colydium elongatum* F., er nylig publisert som nye for landet. Distriktsforkortelsene er i overensstemmelse med Strand (1943). Funnene er gjort i tidsrommet 1967 til 1977, og materialet befinner seg i forfatterens samling.

Leistus rufescens F. NTy: Vikna, 26. juni 1976. To eksemplarer tatt på gressmark. Leg. A. E. Ofstad.

Nebria brevicollis F. MRy: Kortgård, 20. august 1973. Leg. T. Yttrehus.

Notiophilus biguttatus F. NTy: Vikna, 26. juni 1976. På gressmark. Leg. I. A. Ofstad.

Clivina fossor L. MRy: Kortgård, 29. april 1973. Under sten ved fjæra. NTy: Vikna, 26. juni 1976. På gressmark. Leg. A. E. Ofstad.

Trechus rubens F. NTy: Vikna, 26. juni 1976. Ett eksemplar på gressmark. Leg. I. A. Ofstad.

Harpalus affinis Schrk. MRy: Kortgård, juni 1974. Leg. T. Yttrehus.

Pterosticus melanarius Ill. NTy: Vikna, 20. juni 1973. Leg. M. Bronndal.

Agonum ericeti Panz. Os: Bagn, 14. august 1976. På bredden av myrvann over tregrensen.

Lebia crux-minor L. TEy: Kragerø, 13. juli 1973. Et dødt eksemplar i edderkoppspinn på husvegg.

Dromius quadrinotatus Zenk. MRy: Kortgård, 31. mars 1974. I kvae på furustubbe.

Graphoderes zonatus Hoppe. AK: Sørumsand, 23. april 1973. I lite skogsvann.

Scaphidium quadrimaculatum Ol. TEy: Kragerø, 21. juni og 14. juli 1973. (Zachariassen 1973). AAy: Risør, 5. juni 1976. I antall under bark på liggende soppinfisert bjerkestamme.

Brachygluta helferi Schm. – G. MRy: Kortgård, 31. mars 1974. Under sten ved fjæra.

Hister merdarius Hoffm. MRy: Kortgård, juni 1974. Leg. T. Yttrehus.

Hister ventralis Mars. TEy: Kragerø, 25. mai 1969. I hestelort.

Elater ferrugatus Lac. HEs: Rotnesjøen, Finnskog, 21. juni 1969. Under bark av tørr furustubbe.

Elater hjorti Rye. Ø: Rauøy. Puppe funnet 11. juli 1974 i løsmateriale i hul eikestubbe. Klekket ca. 1. august.

Melanotus rufipes Herbst. MRy: Kortgård, juni 1974. Leg. T. Yttrehus.

Melanophila acuminata DeG. HEn: v. Røa, Femundsmarka, 10. juli 1977. I stekepanne ved bål. Leg. S. Zachariassen.

Anthaxia morio F. VE: Vassbotn, 4. juni 1976. To eksemplarer tatt på løvetann.

Agrilus pratensis Ratz. TEy: Kragerø, 11. juli 1973, 3. juni og 6 juli 1974. (Bjørnstad & Zachariassen 1975).

Rhizophagus dispar Payk. MRy: Kortgård, 29. april 1973. Under bark.

Rhizophagus parvulus Payk. HEn: Alvdal, 22. juni 1976. Under bark av bjerkestokk.

Typhaea stercorea L. VE: Nevlunghavn, 11. juli 1976. Svermende om ettermiddag.

Synchita humeralis F. Ø.: Rauøy, 11. juli 1974. Under bark på dødt eiketre. AAy: Risør, 5. juni 1976. Under bark av dødt bjerketre.

Colydium elongatum F. AAy: Risør, 5. juni 1976. Under bark på stående ringbarket osp. (Påsche & Zachariassen 1976).

Cerylon deplanatum Gyll. TEy: Kragerø, 24. juli 1969. To eksemplarer tatt under bark på ospestokk.

Cerylon histeroides F. MRy: Kortgård, 29. april 1973. Under bark av død furustokk.

Paramysia oblongoguttata L. NTy: Vikna, 26. juni 1976. I hytte.

Lyctus linearis Gze. VE: Nevlunghavn, 3. juli 1974. På vedstabel om ettermiddag.

Orchesia undulata Kr. TEy: Kragerø, 13. juli 1973. Sittende på bakken.

Mycetochara flavipes F. AAy: Risør, 5. juni 1976. Under bark på liggende morken bjerkestamme.

Donacia versicolorea Brahm. NTy: Vikna, 26. juni 1976. I antall på blad av *Potamogeton* i et lite tjern.

Zeugophora scutellaris Suffr. TEy: Kragerø, 2. juni 1974. Banket av vegetasjon.

Cryptocephalus distinguendus Schneid. STi: Sørvika, Femunden, 16. juli 1973. På blad av ungbjerk.

Cryptocephalus pini L. STi: Sørvika, Femunden, 17. juli 1973. På ungfuru.

Rhynchites tomentosus Gyll. AK: Lørenskog, 11. august 1971. To eksemplarer banket av vegetasjon.

Sitona lineellus Bonsd. TEy: Kragerø, 27. juli 1967. MRy: Kortgård, 29. april 1973. Under sten ved fjæra.

Dryophthorus corticalis Payk. AAy: Risør, 16. juli 1974 og 5. juni 1976. Tallrik under plankebiter i gammel sagflishaug.

Hylobius piceus DeG. MRy: Kortgård, juni 1974. Flere krypende på husvegg. Leg. T. Yttrehus.

Scolytus laevis Chap. Bø: Sylling, 15. juni 1974. I antall om aftenen på vedstabel.

Scolytus ratzeburgi Jans. HEn: Alvdal, 22. juni 1976. Under bark av bjerkestokk.

Jeg vil takke Dr. phil.h.c. Andreas Strand for å ha kontrollert deler av materialet.

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Mottatt 25. august 1977

Variations in the cold-hardiness of hibernating *Ips acuminatus* Gyllenhal (Col., Scolytidae) related to the sun exposure of the habitat

UNN GEHRKEN & KARL ERIK ZACHARIASSEN

Gehrken, U. & Zachariassen, K. E. Variations in the cold-hardiness of hibernating *Ips acuminatus* Gyllenhal (Col. Scolytidae) related to the sun exposure of the habitat. *Norw. J. Ent. 24,* 149–152.

Adult bark beetles of the species *Ips acuminatus* Gyllenhal were collected from different sides of a sun-exposed log of Scots pine in March, and examined with respect to supercooling points and haemolymph osmolality. These values were related to the subcortical temperature conditions at the different sides of the log. The mean supercooling point of beetles collected at the exposed south side of the log was about –23°C and about –28°C for beetles from the unexposed north side. The mean haemolymph osmolality was about 1500mOsm for beetles from the south side and about 2700mOsm for beetles from the north side. For supercooling points as well as for haemolymph osmolality the difference was significant on level $p<0.01$. The high osmolality values indicate that the beetles have high concentrations of polyols in their body fluid, and the parallel variation in osmolality and supercooling points indicates that the difference in supercooling points is due to different levels of polyols. The differences in the level of polyols are probably caused by the high day temperatures at the exposed south side compared to those at the unexposed north side.

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Many species of insects show seasonal variations in supercooling points and polyol concentration during the year. The ambient temperature seems to be one of the main factors determining the polyol level and supercooling capacity of the insects. Thus, insects kept at high temperatures tend to have lower polyol levels and higher supercooling points than insects kept at lower temperatures (Dubach et al. 1959, Salt 1959, Sømme 1964, 1965, Asahina 1966, Krunich & Salt 1971, Mansingh & Smallman 1972).

The subcortical temperatures at different sides of trees and logs vary appreciably according to solar radiation (Bakke 1968). These temperature variations might lead to different supercooling points and polyol levels in insects having their winter habitat under the bark. The present paper concerns the effect of the sun exposure of the winter habitat on the cold tolerance of adult bark beetles of the species *Ips acuminatus* Gyllenhal, which hibernates under the bark of logs of Scots pine *(Pinus silvestris* L.).

MATERIAL AND METHODS

Thin barked logs of Scots pine, infested by *Ips acuminatus,* were collected near Kongsberg (SE Norway) in the autumn 1976. The logs were transported to Oslo, where they were stored, standing against the east facing side of the trunk of an oak tree.

At the end of March, samples of approximately 10 beetles were collected within squares of about 0.01 m^2 in the bark of a log. The squares were located at the north, east and south sides of the log, about 0.4 m above the ground. Each square represented a sector of about 40° of the circumference of the log.

The supercooling points of the beetles were measured by means of a copper constantan thermocouple, connected to a recording potentiometer. The beetles were cooled at a rate of about 4°C per min, and the supercooling point was indicated by the sudden temperature increase, caused by the release of heat of fusion from freezing water.

The polyol concentration of the beetles

was monitored by measuring the osmolality of the haemolymph of the beetles. The osmolality was determined by measuring the melting point of small samples of haemolymph on a Clifton nanoliter osmometer. Each haemolymph sample was obtained from 1–3 beetles, the supercooling points of which had previously been determined.

The subcortical temperatures at various sides of the log were investigated by means of a Grant temperature recorder. The thermistors were inserted under the bark on the same sides of the log and at the same distance from the ground as the squares from which the beetles were collected. The air temperature was recorded by means of a separate thermistor probe.

RESULTS

Fig. 1 shows the mean supercooling point of beetles collected at different sides of the log. Although the temperature ranges overlap, the mean supercooling point of beetles from the north side was significantly lower than that of beetles collected at the east and south sides, as assessed by Student's t-test (N vs E: t=3.52, df=16, p<0.01; N vs S: t=6.52, df=16, p<0.01). Furthermore, the mean supercooling point of beetles from the east side was significantly lower than that of beetles from the south side (t=2.34, df=16, p<0.05). The mean supercooling point of beetles from the north side was about 5°C lower than that of beetles from the south side of the log.

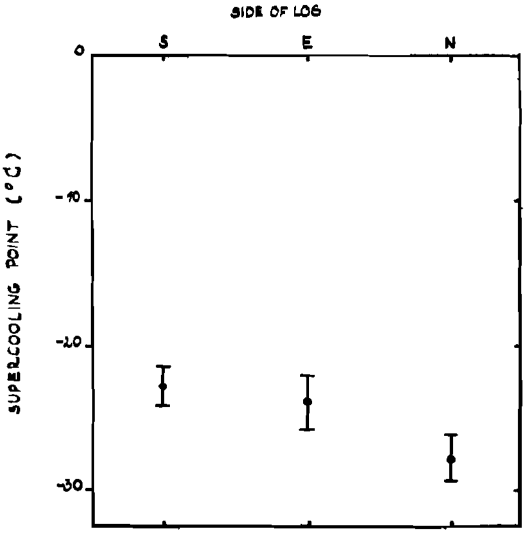

Fig. 1. Supercooling points (Mean ± S.D.) of *I. acuminatus* collected at the south (S), east (E) and north (N) sides of a log of Scots pine.

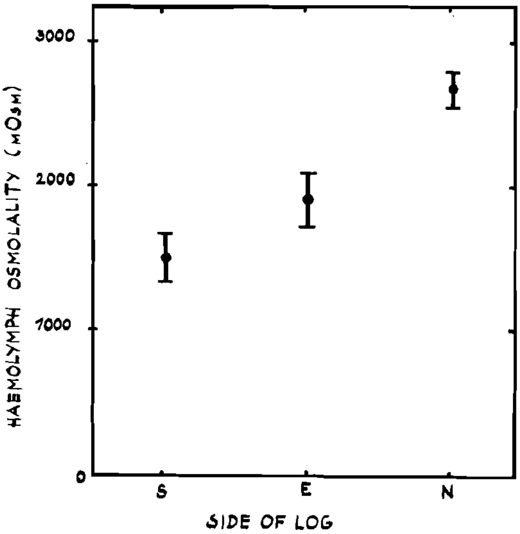

Fig. 2. Haemolymph osmolality (Mean ± S.D.) of *I. acuminatus* collected at the south (S), east (E) and north (N) sides of a log of Scots pine.

The osmolality of the body fluid of the beetles related to the position of the sample is shown in Fig. 2. The mean osmolality of beetles from the north side was significantly lower than that of beetles from the south and east side (N vs S: t=14.85, df=12, p<0.01: N vs E: t=8.83, df=10, p<0.01), whereas the mean osmolality of the beetles from the east side was significantly lower than that of beetles from the south side (t=3.99, df=10, p<0.01). The difference in mean osmolality of beetles from the north and the south sides was about 1000 mOsm.

Prior to the registrations of the subcortical temperatures of the log here were several days of cloudless sky, but only one cloudless day occurred within the registration period. The temperature registrations from this day, which is probably representative of the temperature conditions during the period to the sampling of the beetles, are shown in Fig. 3. As expected, the registrations reveal that the highest day temperatures occurred on the exposed south side of the log. This side also had the lowest temperatures during the night.

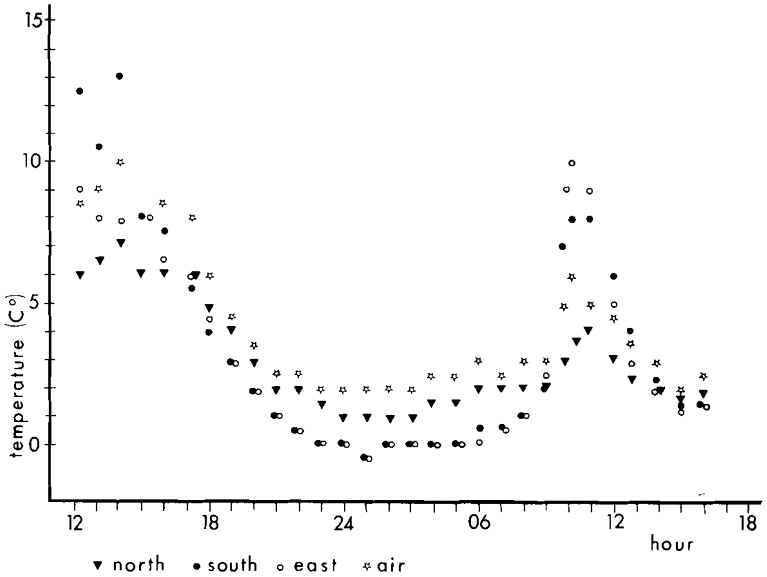

Fig. 3. Subcortical temperatures at different sides of a log of Scots pine.

The temperature at the unexposed north side followed the air temperature more closely than did the temperature at the other sides.

DISCUSSION

The present data indicate that the position of the winter habitat of *I. acuminatus* has a marked effect on the supercooling point of the beetles. Thus, the supercooling points range from a minimum of about -30°C for beetles collected at the north side of the log to a maximum of about -20°C for beetles from the south side.

The high values of haemolymph osmolality indicate that the beetles have high concentrations of polyols in their body fluid. The parallel variations in osmolality and supercooling points indicate that differences in polyol levels are responsible for the differences in supercooling points. This is in agreement with results obtained by other investigators (Sømme 1964).

In spite of experiencing the lowest temperatures during the night, the beetles collected at the exposed south side had the lowest osmolality. However, the day temperatures at the south side were considerably higher than those at the unexposed north side, indicating that the polyol decreasing effect of the high day temperature dominates over the polyol increasing effect of the low night temperature. This seems likely, since (1) the rate of chemical reactions increases exponentially with the temperature, and (2) during late winter and spring there is a prevailing tendency, increasing with temperature, to metabolize the accumulated polyols (Sømme 1964).

The observed differences in cold tolerance might lead to variations in the winter survival of beetles having their winter habitat at different sides of the log. A sudden drop-in temperature in the spring might cause cold death in beetles positioned on the south side of the log, whereas those at the north side remain unaffected.

Beetles at the south side probably have an accelerated development compared to the beetles from the other sides. Thus, beetles at an exposed south side of a log are likely to commence eating and swarming earlier in the summer than beetles hibernating at less exposed habitats. Bakke (1968) observed that the swarming of *I. acuminatus* was dispersed over a period of more than four weeks. This extended swarming period might be due to differences in the rate of development of the beetles, caused by different temperature conditions in their winter habitats.

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The biology and seasonal activity of the tundra species in the Scandinavian bumble bee fauna (Hym., Apidae)

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Løken, A. 1977. The biology and seasonal activity of the tundra species in the Scandinavian bumble bee fauna (Hym., Apidae). *Norw. J. Ent. 24,* 153–157.

The tundra species in the Scandinavian fauna are represented by *Bombus alpinus* (L.), *B. arcticus diabolicus* Friese, *B. balteatus* Dahlbom, *B. hyperboreus* Schönherr, and *B. lapponicus* (Fabricius). The rate of the colony development and the length of the seasonal activity are estimated on the basis of the appearance of the hibernating queens and records of males throughout the season. It is stated that *B. hyperboreus* has a flexible mode of life varying from social to social parasitic behaviour.

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The tundra species in the Scandinavian bumble bee fauna comprise five species, of which four species, viz. *Bombus alpinus* (L.), *B. arcticus diabolicus* Friese, *B. balteatus* Dahlbom, and *B. hyperboreus* Schönherr belong to the subgenus *Alpinobombus* Skorikov. The fifth is *Bombus (Pyrobombus) lapponicus* (Fabricius). The distribution of the individual species, being circumpolar or limited to the Eastern Hemisphere, is confined to the arctic/subarctic zone and alpine/subalpine areas. In Scandinavia they have a more or less scattered distribution along the mountain chain which dominates the peninsula (= Norway and Sweden) and ranges from approximately 58° 30′N to the arctic in northeast, reaching the northern coast at 71° 11′ N. The chain consists of undulating mountainous plateaux and mountainous massifs with peaks and glaciers intersected by canyons and valleys. The actual species, particularly the *Alpinobombus* spp., have accordingly a discontinuous distribution which impedes thorough investigations. The mountain chain is roughly separated in a southern and a northern part by east-west directions of wooded passes at approximately 63° 30′ N which support a more or less pronounced ‘bicentric’ distribution of the tundra species (Løken 1973, the dot maps).

The representatives of *Alpinobombus* are of particular interest. Lack of information on nests and the scarcity of workers favoured for years the theory of only small colonies being produced. In order to complete the colony development during the short season of growth the number and size of worker broods would be strongly reduced or even omitted (Schneider 1909, Pittioni 1942), the species locally reverting to temporary solitary living. However, recent information on colonies, in addition to an increasing number of records of workers, has revealed that the species regularly produce worker broods with the exception of *B. hyperboreus* (Løken 1973). Nevertheless, the suggestion of the latter being adapted to solitary living is now disputed, cf. below.

The annual life cycle of bumble bees can in general be divided into several phases: Posthibernation (when the awakened queen at first consumes nectar and pollen from flowers and then searches for a nesting site); nest establishment; colony development; decline; hibernation. Attention should be drawn to the fact that when the male and queen broods are produced, no more worker broods are reared. As the hatching of the sexual forms has ended, there follows a steady decline in the population of the colony, which soon dies out. Thus the time the individual hibernating queen needs to pass the phases of post hibernation, nest establishment, and colony development – below termed the rate of the colony development – may roughly be indicated by estimating the number of days ranging from the moment the queens begin to emerge from hibernation to the short-living males appear in the field.

There is a local as well as an annual variation in the time of the beginning and duration of each phase of the life cycle according to the environmental conditions, but some species-specificities exist in the temperate *Bombus* spp. In the lowlands of southern and central Scandinavia, for instance, there is a specific difference in the appearance of the hibernating queens. The bumble bees are roughly divided into early and late-appearing species, corresponding to an emergence from hibernation at the beginning and end of spring season. The seasonal length of activity is, moreover, specific, ranging from about four months in some species to about seven months in other members of the genus.

The tundra species are related to areas with pronounced seasonal changes of climate, and the turnover intervals between winter and summer, i. e. the spring turnover, are short. There is no specific difference in the appearance of the hibernating queens except that *B. hyperboreus* apparently emerges somewhat later than the remaining species. *B. alpinus, B. arcticus diabolicus, B. balteatus, B. lapponicus,* and some other *Bombus* spp. locally reaching the same areas appear at the same time, i. e. as soon as the snow is locally melted. The earliest records of the individual species are about the middle of May in either of the southern and northern parts of the 'bicentric' distribution, where the queens may be observed searching for food *(Salix)* in between the snowdrifts. A delay in the winter season postpones the emergence of hibernating queens accordingly.

Although the relevant data are meagre, the available material has led to a comparative study of the biology and seasonal activity of the tundra species, mainly based on the time of appearance of the hibernating queens and records of males throughout the season. The material from the southern area of distribution refers mainly to records from Hardangervidda–Jotunheimen–Dovrefjell in southern Norway. That from the northern area of distribution comprises records north of the Polar Circle and mainly from the northernmost provinces in Norway, viz. Troms and Finnmark. A phenological study of sex and caste of the individual species indicates a seasonal activity of about equal length throughout Scandinavia. The material from either of the southern and northern areas of distribution which at first was studied separately, is therefore kept together below.

RESULTS AND DISCUSSION

The seasonal activity is illustrated by scatter diagrams where the frequency of males throughout the season (based on records from various years) is related to the number of days succeeding the earliest appearance of hibernating queens.

The diagrams of *Alpinobombus* spp. (Fig. 1) reveal that the rate of the colony development may not vary much between *B. balteatus, B. alpinus,* and *B. arcticus diabolicus* (Fig. 1A), all of which produce 2–3 worker broods (Løken 1973). Males recorded 50–60 days after the earliest appearance of hibernating queens (dated to 15 May) roughly indicate the time a queen needs to complete the colony development. Considering the sparse material, the first records of males in early seasons may not have been observed, i. e. the rate of colony development may be somewhat shorter than the estimated 50–60 days. Moreover, males recorded throughout the season (Fig. 1A) demonstrate activity up to about 115 days. Thus the seasonal length of activity would be about the same for the three species, ranging from 3 to $3^1/_2$ months depending on the local and annual variations.

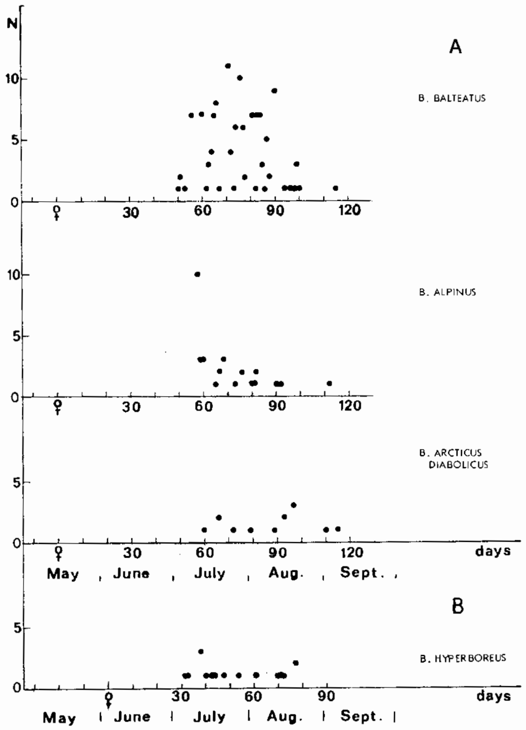

Fig. 1. *Bombus (Alpinobombus)* Skorikov. Frequency of males throughout the season, related to the number of days succeeding the average date for earliest emergence of hibernating queens. ♀ indicates the appearance of queens. A: *B. balteatus* Dahlbom, *B. alpinus* (L.) and *B. arcticus diabolicus* Friese. B: *B. hypeboreus* Schönherr.

Information about the high-arctic *B. hyperboreus* having a pronounced 'islet' distribution needs further support. The earliest appearance of the hibernating queens is, for instance, uncertain. The earliest recorded specimens examined were collected by me 17 and 20 June respectively. One of the individuals was a pollen collector and both specimens had slightly worn wings, i. e. they had passed the posthibernation phase. They may have emerged from hibernation early in June. Owing to absence of observations the appearance of queens estimated to 4 June (Fig. 1 B) needs to be adjusted. The few males recorded about 30 to 80 days succeeding the estimated date and queens observed at the end of August (see below) might indicate a seasonal length of activity up to 3 months.

Record of *B. hyperboreus* males early in July (Fig. 1 B) might indicate a workerless life cycle of the species. A recent contribution to the biology of the species disproves, however, an adaptation to solitary living. The species is an obligatory usurper of *B. a. arcticus* Kirby at Lake Hazen, Ellesmere Island, Canada, 81° 49′ N (Richards 1973). A *B. hyperboreus* queen usurping a colony of *B. a. arcticus* was located in Vegasund, Greenland (Løken 1973). A colony of *B. (Pyrobombus) jonellus* (Kirby) traced in Swedish Lappland: Virihaure area in Lule Lappmark about 67° 10′ N (Bergwall 1970) was likewise occupied by the same species. These observations might indicate a social parasitic mode of life in the total area of distribution of *B. hyperboreus;* a suggestion which is supported by the fact that *B. hyperboreus* is only observed in areas where one or several members of the genus have also been recorded.

A few *B. hyperboreus* workers, less than a dozen, are, however, known from the eastern Hemisphere (Løken 1973), all of which were recorded more than 50 years ago. I have examined five of the actual specimens being collected in the following areas: Norway: Dovrefjell in Oppland county about 62° 10′ N; Swedish Lappland: Sarek in Lule Lappmark 67° 30′ N, Vassijaure in Torne Lappmark 68° 30′ N, and an unknown locality in Lappland; Kola peninsula. In addition I have examined a total of four queens with pollen loads kept in the collection of Zoological Museum, University of Bergen. They were recorded in the northern area of Dovrefjell (cf. above) 21 June 1926, 29 August 1948, 20 June 1967, and in Swedish Lappland: Nuolja in Torne Lappmark about 68° 20′ N 30 June 1972 respectively, i. e. they were observed in the same areas as the workers. The pollen-collecting behaviour indicates a contribution to the social welfare of a colony.

As mentioned above, *B. hyperboreus* is stated to be a *Psithyrus*-like parasite in Ellesmere Island (Richards 1973). The records of workers, pollen collectors in addition to a queen usurping a colony of *B. jonellus* emphasize, however, a more flexible mode of life of the species in Scandinavia where the environmental conditions are completely different. The previous suggestion of local adaptation to solitary living must, however, be disputed.

On the whole, a more pronounced adaptation

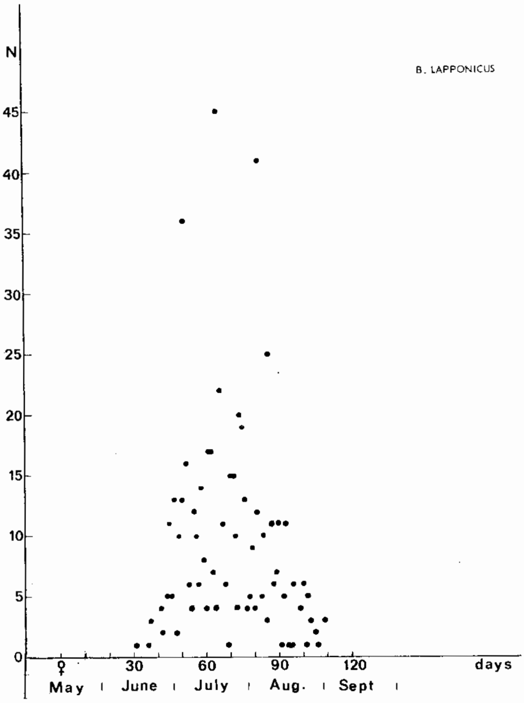

Fig. 2. *Bombus (Pyrobombus) lapponicus* (Fabricius). Frequency of males throughout the season, related to the number of days succeeding the average date for earlist emergence of hibernating queens. ♀ indicates the appearance of queens.

to extreme arctic conditions is observed in Ellesmere Island (Richards 1973). The area is inhabited by only two *Bombus* spp., viz. *B. a. arcticus* and *B. hyperboreus. B. arcticus* is regularly producing workers, yet only one brood. *B. hyperboreus,* appearing 1–2 weeks later in the season than *B. a. arcticus,* is regularly observed usurping colonies of the latter. The seasonal length of activity of *B. a. arcticus* ranges from 2–$2^1/_2$ months and is 1–2 weeks less for *B. hyperboreus.*

B. lapponicus has a wider distribution and a greater abundance than the remaining tundra species, a fact being reflected in the frequency of males in the studied material (Fig. 2). Records below the timberline were not included. Males observed 30 to 40 days succeeding the appearance of hibernating queens (dated to 15 May) reveal a rapid life cycle known from other members of the subgenus *Pyrobombus* Dalla Torre. In addition to colony development completed in about 40 days, the diagram shows a high frequency of males from early July to early August and a duration of seasonal activity up to about 115 days. The observations emphasize a long period of nest establishment. Males appearing late in August would refer to nests being established at the middle of July. The study supports the suggestion put forward by Løken (1973): Posthibernation may extend for an unusually long period of time (ranging from the middle of May to the middle of July in early seasons, and from middle of June to the middle of July when the spring turnover is much delayed) or the species may produce two generations of queens under prosperous conditions as stated for *B. jonellus* cf. below.

In the diagram (Fig. 3), referring to males of the ubiquitous *B. jonellus,* the specimens observed in the lowlands are kept separate from those recorded in the zones above and beyond the timberline. The diagram reveals that the earliest males were observed nearly 50 days succeeding the earliest appearance

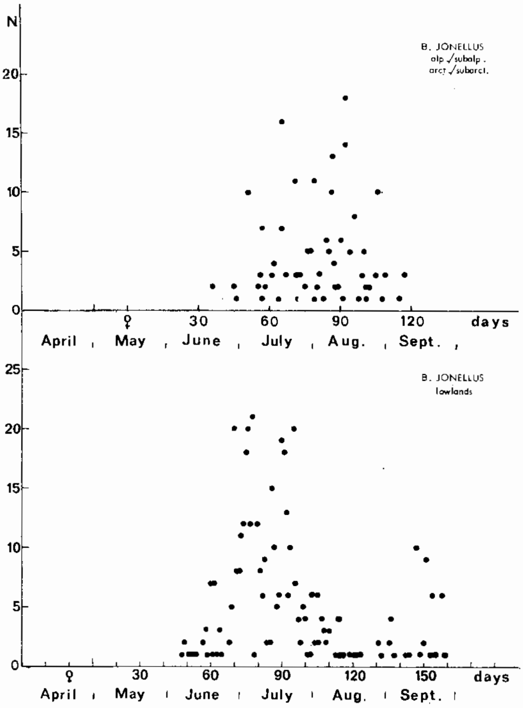

Fig. 3. *Bombus (Pyrobombus jonellus)* (Kirby). Frequency of males throughout the season, related to the number of days succeeding the earliest emergence of hibernating queens. ♀ indicates the appearance of the queens.

of the queens (dated to 20 April) in the lowlands. The corresponding time for males at higher altitude and in the north was about 35 days (appearance of the hibernating queens dated to 15 May). The difference in the rate of the colony development, estimated to about 50 days in the lowlands and 35 days in alpine and arctic areas, needs further investigation.

As for *B. lapponicus,* the frequency of *B. jonellus* males related to the number of days succeeding the appearance of hibernating queens indicates a long period of nest establishment. The diagram reveals a seasonal length up to 120 days above and beyond the timberline. Males observed late in August and even in first half of September would belong to nests established about the middle of July, perhaps later. Whether this means production of two queen generations is so far not proved. The extremely long duration of seasonal activity in the lowlands – up to about 160 days succeeding the appearance of hibernating queens – demonstrates an even longer period of nest establishment. It is, however, stated that *B. jonellus* produces two generations of queens (Meidell 1968), a fact clearly confirmed in the diagram (Fig. 3). The peak of frequency during July represents males produced by hibernating queens. The smaller peak in the middle of September refers to the second generation; the males have emerged from colonies founded by the young queens.

Another ubiquitous species locally occurring together with the tundra species is *B. (Pyrobombus) pratorum* (L.). The species has a life cycle and a seasonal length of activity rather like that of *B. jonellus,* but the production of a second generation of queens is not proved.

With the exception of *B. hyperboreus,* the phases in the life cycle of the tundra species in the Scandinavian bumble bee fauna correspond to that of *Bombus* spp. in temperate zones. The duration of the seasonal activity, ranging from 3 to 3½ months according to local and annual variations, is adapted to the flowering of the local food plants. Production of 2–3 worker broods and emergence of sexual broods throughout August, sometimes later, reveal that when the short spring turnover is delayed 3 to 4 weeks (from about middle of May to beginning or middle of June), the actual species have sufficient time to produce worker broods and complete the life cycle.

The information gained about *B. hyperboreus* in Scandinavia where the species have a flexible mode of life, varying from social to social parasitic behaviour, should stimulate further investigations. The behaviour of the species presents an interesting phenomenon, particularly from an evolutionary point of view.

Received 17 June 1977

ACKNOWLEDGEMENTS

My thanks are due to Professor H. Kauri for stimulating discussions and to Miss Sisel Dommersnes for various technical assistance.

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Additions and corrections to the Norwegian part of Catalogus Coleopterorum Fennoscandiae et Daniae. Second series

ANDREAS STRAND

Strand, A. 1977. Additions and corrections to the Norwegian part of Catalogus Coleopterorum Fennoscandiae et Daniae. Second series. *Norw. J. Ent. 24,* 159–165.

Nomenclatural corrections and distributional additions are given for the Norwegian part of Catalogus Coleopterorum Fennoscandiae et Daniae (Lindroth 1960).

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This is the second series of additions and corrections to the Norwegian part of Catalogus Coleopterorum Fennoscandiae et Daniae (Lindroth 1960). The additions and corrections made by Strand (1970) should be considered as first series. The pages refer to the original catalogue.

Page 6

5. *Cychrus caraboides* L.: HEs, SFy. 40. *Notiophilus germinyi* Fauv.: HOi, SFy.

10

1. Read *N. aestuans* Mtsch. *(pusillus* Wat.). 13. *Loricera pilicornis* F.:SFy. 19. *Dyschirius globosus* Hbst.: Nnø. 30. *D. septentrionum* Munst.: TRy.

14

4. *Bembidion bruxellense* Westm.: SFy. 14. *B. femoratum* Sturm: SFi. 32. Read *B. mckinleyi* Fall ssp. *scandicum* Lth. *(macropterum* 1939). 36. *B. nitidulum* Mrsh.: SFi.

18

26. *Tachys bisulcatus* Nic.: HEs. 27. *Tachyta nana* Gyll.: HEs. 32. *Trechus obtusus* Er.: SFi. 35. *T. rubens* F.: AAy.

26

25. *Bradycellus collaris* Payk.: AAi, SFy, Nnø. 29. Read *B. ruficollis* Steph. *(similis* Dej.) and add SFy. 31. *Trichocellus cognatus* Gyll.: HEs., HEn. 34. Read *Dicheirotrichus gustavi* Crotch *(pubescens* Payk.).

30

5. *Amara brunnea* Gyll.: HOi. 15. *A. eurynota* Panz.: AAy. 35. *A. quenseli* Schönh.: Nnø. 40. *A. torrida* Ill.: Delete NTy.

34

10. *Pterostichus diligens* Sturm: SFy. 27. Read *Abax parallelepipedus* Pill. & Mitt. *(ater* Vill.). 29. *Calathus erratus* Sahlb.: HOi. 32. *C. micropterus* Dft.: SFy.

38

4. *Agonum dorsale* Pont.: Ø, AAy, delete VAy. 5. *A. ericeti* Panz.: HEs, SFy. 7. *A. fuliginosum* Panz.: SFy. 20. *A. munsteri* Hellén: Delete TRi. 24. Read *A. albipes* F. *(ruficorne* Gze.).

42

2. Read *Dromius notatus* Steph. *(nigriventris*

Th.). 5. *D. quadrinotatus* Panz.: SFy. 36. *Haliplus obliquus* F.: Nsi.

50

23. *Deronectes alpinus* Payk.: HOi.

54

22. *Agabus solieri* Aubé: VAi. 37. *Ilybius crassus* Th. Delete HEs.

58

23. *Graphoderes zonatus* Hoppe: AK. 29. *Dytiscus lapponicus* Gyll.: Bv, Nnø. 40. *Gyrinus opacus* Sahlb.: HOi.

62

26. *Limnebius truncatellus* Thbg.: Bv. 33. Read *H. longitarsis* Woll. (*erichsoni* Bach). 34. Read *H. sibiricus* Mtsch. (*fennicus Gyll.*).

66

2. Read *H. brevipalpis* Bed. 9a. Read *H. strandi* Angus. 19. *Cercyon analis* Payk.: SFy. 35. *C. terminatus* Mrsh.: HOi. 37. *C. unipunctatus* L.: Nnø. 39. *Megasternum* obscurum Mrsh.: AAi, HOi.

70

11. *Laccobius minutus* L.: SFy. 22. *Chaetarthria seminulum* Hbst.: SFy. 37. *Necrodes litoralis* L.: On, TEi.

74

3. *Oeceoptoma thoracica* L.: TRy. 11. *Pteroloma forsstroemi* Gyll.: NTy. 28. *Choleva fagniezi* Jeann.: Os. 34. *C.septentrionis* Jeann.: Os. 39. *Catops alpinus* Gyll.: HOi, SFy.

78

1. *C. coracinus* Kelln.: SFy. 2. Read *C. nigriclavis* Gerh. (*dorni* Reitt.). 3. *C. fuliginosus* Er.: Delete AAy. 4. Read *C. borealis* Krog. and add AAy. 10. *C. morio* F.: HEs. 12. *C. nigricans* Spence: HEs, Os, HOi. 16. *C. tristis* Panz.: SFy. 18: *C.fumatus* Spence: HEs. 19. *C. watsoni* Spence: Bv, SFy, MRi. 25. *Colon bidentatum* Sahlb.:HEs. 29. *C. delarouzei* Tourn.: AK. 30. *C. denticulatum* Kr. Delete AK. 32. Read *C. barnevillei* Kr. (*dubiosum* Ihssen). 33. *C. latum* Kr.: TEy. 38. *C. viennense* Hbst.: HEs, TEi.

82

12. *Liodes calcarata* Er.: SFy. 16. *L. dubia* Kug.: Delete AAy. 17. *L. flavescens* Schm.: HEs. 21. *L. litura* Steph. Os, TEi. 24. *L. obesa* Schm.: HOi. 25. *L. oblonga* Er.: SFy. 26. *L. ovalis* Schm.: TEi. 28. *L. parvula* Sahlb.: HEs. 32. *L. rhaetica* Er.: TEi.

86

1. *Anisotoma axillaris* Gyll.: HEn. 17. *Agathidium mandibulare* Sturm: For Bø and STi read ?. 20. *A nigripenne* Kug.: HEs. 25. *A. seminulum* L.: HEs. 31. *Clambus pubescens* Redt.: HEs. 33. *Euthia linearis* Muls.: Delete On. 36. *E. scydmaenoides* Steph.: On.

90

1. *Neuraphescoronatus* J. Sahlb.: HEs. 25. *Microscydmus nanus* Schaum: Delete Ø, AK, Bø, VE, AAy and add HOi. 31. Delete (*atomarius* Heer). 33. Read *O. mundus* Matth. (*improvisus* Bruce). 35. Read *O. punctulatus* Rtt. and delete TRi, Fi. 35a. *O. punctatus* Wank.: HEs, Os, On, Bø, TRi, Fi.

94

20. *Euryptilium saxonicum* Gillm.: HEs, HEn, Os. 24. *Nanoptilium kunzei* Heer: SFy. 39. Read *Baeocrara litoralis* Th.(*variolosa* Muls.).

98

6. *Acrotrichis dispar* Matth.: HEn. 8. Read *A. sitkaensis* Motsch. (*fratercula* Matth.) and add MRy. 9. *A grandicollis* Mnh.: HEn. 16. *A. cognata* Matth.: Os. 16a. *A. parva* Rossk.: AK, HEn, On, TRi. 16b. *A. rosskotheni* Sundt: MRy. 20. *A. sjøebergi* Sundt: AK. 22. *A. suecica* Sundt HOy. 23. *A. thoracica* Waltl: AAy. 25. *Scaphidium quadrimaculatum* Ol.: TEy. 26. Read *Scaphisoma* instead of *Scaphosoma*. 29a. *S. inopinatum* Løbl: AK, Bv, AAy?. 30. *S. subalpinum* Rtt.: SFi.

102

1. *Megarthrus denticollis* Beck: SFy. 3. *M. fennicus* Lath.: HEn. 6. *M. sinuatocollis* Lac.: SFy. 7. *M. strandi* Scheerp.: HEs. 12. *Proteinus crenulatus* Pand.: HEn, On. 21. *Anthobium sorbi* Gyll.: SFy. 24. *Acrulia inflata* Gyll.: AAi, HOi.

106

1. *Omalium brevicolle* Th.: Os. 14. *Phloeonomus lapponicus* Zett.: Nnø. 15. *P. monilicornis* Gyll.: HEs, Nnø. 19. *P. sjoebergi* A. Str.: HEs. 25. *Cylletron nivale* Th.: TEi. 32. *Lathrimaeum atrocephalum* Gyll.: Os. 40. *Olophrum piceum* Gyll.: SFy. 41. *O. rotundicolle* Sahlb.: Bø.

110

2. *Arpedium brunnescens* J. Sahlb.: HOi. 6. *Acidota crenata* F.: Nnø. 7. *A. cruentata* Mnh.: Os. 11. *Lesteva longelytrata* Gze.: SFi. 18. *Anthophagus alpinus* F.: VAi. 22. *Coryphium angusticolle* Steph.: SFi. 23. *C. hyper-*

boreum Mäkl. Nnø. 25. *Syntomium aeneum* Müll.: Os, HOi.

114

17. *Aploderus caelatus* Gr.: HOi. 19. *Oxytelus clavatus* A. Str.: HEs. 21. *O. fairmairei* Pand.: Os. 22. *O. fulvipes* Er.: HEs. 26. *O. laqueatus* Mrsh.: VAi, SFy. 39. *Platystethus arenarius* Fourcr.: SFy.

118

1. Read *P. nodifrons* Mnh. 3. *Bledius arcticus* J. Sahlb.: Nnø. 16. Read *B. fontinalis* Bernh. 26. *B. litoralis* Heer: Nnø.

122

6. *Stenus aterrimus* Er.: VE. 12. *S. bimaculatus* Gyll.: Nsi. 26. Read *S. vinnulus* Casey (*confusoides* Renk.). 38. *S. fossulatus* Er.: HEs.

126

1. Read *S. ageus* Casey (*gerhardti* L. Bck.). 2. Read *S. subarcticus* Popp. (*gibbicollis* J. Sahlb.). 10. Read *S. juno* Payk.

130

2. *S. crassus* Steph.: HOy. 5. *S. sibiricus* J. Sahlb.: Fi. 7. Read *S. pusio* Casey (*simillimus* L. Bck.). 13. Read *S. cautus* Er. (*vafellus* auct. nec Er.). 22. Read *Astenus gracilis* Payk. (*angustatus* Payk.). 32. *Medon apicalis* Kr.: HEs. 14. *Dianous coerulescens* Gyll.: SFy.

134

8. *Lathrobium brunnipes* F.:SFy. 27. *Leptacinus formicetorum* Märk.: HEn. 30a. *L. sulcifrons* Steph.: Delete AK.

138

2. *Baptolinus longiceps* Fauv.: Bv. 3. *B. pilicornis* Payk.: HOi. 16. *Philonthus atratus* Gr.: HEn. 21. *P. chalceus* Steph.: TRi. 22. *P. concinnus* Gr.: STy. 35. *P. fimetarius* Gr.: HEn.

142

7. *P. longicornis* Steph.: Os. 11. *P. nigrita* Gr.: SFy. 13. *P. nigriventris* Th.: Ry. 15a. *P. parcus* Sharp: TEi. 23. *P. rectangulus* Sharp: Os.

146

12. *Staphylinus fulvipes* Scop.: Os. 14. Read *S. melanarius* Heer (*globulifer* auct.). 23. *S. stercorarius* Ol.: HOy. 40. *Quedius boops* Gr.: SFy, SFi. 41. *Q. brevicornis* Th.: HEs.

150

1. *Q. brevis* Er.: HEs. 4. *Q. curtipennis* Bernh.: Bø. 7. *Q. fuliginosus* Gr.: SFy. 20. *Q. maurus* Sahlb.: HEs. 24. *Q. nigriceps* Kr.: Os, SFy. 26. *Q. nitipennis* Steph.: SFi. 39. *Q. umbrinus* Er.: SFi.

154

13. *Mycetoporus clavicornis* Steph.: Os. 22. *M. maerkeli* Kr.: HEs. 36. *Bolitobius exoletus* Er.: SFy. 41. *B. thoracicus* F.: HOi.

158

2. *Bryocharis analis* Payk.: HEs. 6. Read *Sepedophilus bipunctatus* Gr. 7. Read *S. bipustulatus* Gr. 8. Read *S. immaculatus* Steph. 9. Read *S. litoreus* L. 9a. Read *S. marshami* Steph. 10. Read *S. pedicularius* Gr. 10a. Read *S. constans* Fowl. (*strigosus* J. Sahlb., *stoeckli* Lok.). 11. Read *S. testaceus* F. (*pubescens* Gr.). 24a. *Tachyporus quadriscopulatus* Pand.: HOi. 30 *T. transversalis* Gr.: HOy. 35. Read *Tachinus elongatus* Gyll. (*ochsi* Coiff.) and add Ri. 42. *T. proximus* Kr.: SFy.

162

3. *T. rufipes* DeG.: HEs. 33. Read *O. picipes* Steph. (*atomaria* auct. nec Er.) and read ? for HEs. 40. Read *O. pusillima* Gr. (*atomaria* Er.). 23. *Myllaena kraatzi* Sharp: SFy. 42. *Encephalus complicans* Westw.: SFy.

166

1. Read *Gyrophaena affinis* Mnh. 27. Read *Placusa atrata* Mnh. 28a. *P. cribrata* S. Lundb. i. l.: Fø. 29. *P. depressa* Mäkl.: HEs. 33. *Homalota plana* Gyll.: HOy.

170

2. *Euryusa castanoptera* Kr.: HEs. 9. *Bolitochara lunulata* Payk.: SFy. 40. *Schistoglossa curtipennis* Sharp: Os.

174

7. *Notothecta anceps* Er.: HEs. 15. *Atheta acutangula* H. K. Hans.: HEs. 17. *A. allocera* Epp.: HEn, Os. 18. *A. alpestris* Heer: Bv, SFy. 22a. *A.* (27) *amplicollis* M. & Rey: Ø, MRy, Nsi, Nnv, TRi. 27. *A. arcana* Er.: HEs. 28. *A. arctica* Th.: SFy.

178

5. *A britanniae* Bernh.: Ri, SFy. 9. *A. cadaverina* Bris.: HEs. 13. *A. dadopora* Th.: Os. 19. *A. corvina* Th.: HEs. 23. *A. cribripennis* J. Sahlb.: HEs. 29. *A. depressicollis* Fauv.: TEi. 31. *A. divisa* Märk.: TEi. 33. *A. dwinensis* Popp.: HOi. 38. *A. excellens* Kr.: TEi.

182

13. *A. granigera* Kies.: Os. 19. *A. harwoodi* Will.: Delete Fn and add SFy. 21. *A. eremita* Rye: Delete VE. 27. *A. hypnorum* Kies.: Os. 40. *A. lapponica* J. Sahlb.: HEn. 41. *A. lateralis* Mnh.: SFy.

186

20. *A. monticola* Th.: SFy. 26. *A. nesslingi* Bernh.: HEs, HEn. 27. *A. nidicola* Johans.: SFi. 30. *A. nigricornis* Th.: Bv. 32. *A. nigripes* Th.: HEn. 37. *A. oblongiuscula* Sharp: SFy. 40. *A. orbata* Er.: HOi.

190

8. *A. parapicipennis* Brd.: Delete TEy. 11. *A. pertyi* Heer: SFy. 28. *A. scapularis* Sahlb.: HEs. 32. *A. sodalis* Er.: Bv.

194

5a. *A.* (21) *sundti* A. Str.: AK. 13. Read *Lundbergia trybomi* J. Sahlb. 25. *Thamiaraea cinnamomea* Gr.: VE. 34. *Zyras lugens* Gr.: AAy. 41. *Atemeles pubicollis* Bris.: AK.

198

2. *Phloeopora angustiformis* Baudi: HEs. 6. *P. testacea* Mnh.: HEs. 7. *Ilyobates nigricollis* Payk.: SFy. 17. *Chilopora rubicunda* Er.: Nnø. 24. *Ocalea picata* Steph.: Os. 30. *Meotica apicalis* G. Bck.: SFy. 41. *Ocyusa nivicola* Th.: Bv.

202

17. *Oxypoda funebris* Kr.: HEs. 18. *O. haemorrhoa* Mnh.: HEs, SFy. 26: *O. lugubris* Kr.: HEs, Os. 31. *O. procerula* Mnh.: SFy.

206

10. *Thiasophila angulata* Er.: HEs. 19. *Microglotta nidicola* Frm.: Ø, Bø, Bv, AAy, VAy, MRi. 20. *M. picipennis* Gyll.: AAy. 21. *M. pulla* Gyll.: HEs, Bv, STi. 22. *Tinotus morion* Gr.: SFy. 31. *Aleochara fumata* Gr.: HEs. 35. *A. intricata* Mnh.: HEs. 41a. *A. peeziana* Lohse: AK.

210

25. *Bibloporus bicolor* Denny: HEs.

214

17.*Tyrus sanguineus* L.: HEs. 28. *Plegaderus vulneratus* Panz.: HEs.

218

14. *Gnathoncus nannetensis* Mars.: HEs. 15. *G. nanus* Scriba: Ry, HOi, MRy. 17: *G. schmidti* Rtt.: HEs. 18. *Myrmetes piceus* Payk.: HEs, Nnø. 20. *Dendrophilus pygmaeus* L.: HEs. 21. Read *Carcinops pumilio* Er. (*14-striata* Steph.) and add HEs. 25. *Platysoma angustatum* Hoffm.: HEs. 27. *P. deplanatum* Gyll.: HEs. 29. *P. lineare* Er.: HEs. 40. *Hister merdarius Hoffm.: MRy.*

222

19. *Podabrus alpinus* Payk.: Bv. 25. *Cantharis decipiens* Baudi: SFi.

226

15. *Rhagonycha testacea* L.: HOi. 17. *Podistra pilosa* Payk.: SFy. 23. *Malthinus frontalis* Mrsh.: AK. 28. *Malthodes flavoguttatus* Kies.: SFy. 29. *M. fuscus* Waltl: HOi. 30. *M. guttifer* Kies.: SFy. 33. *M. minimus* L.: HEs. 34. *M. mysticus* Kies.: SFy.

230

16. *Haplocnemus tarsalis* Sahlb.: HEs. 24. *Dasytes obscurus* Gyll.: TEi. 34. *Opilio mollis* L.: SFi. 35. *Thanasimus formicarius* L.: NTi.

234

9. *Hylecoetus dermestoides* L.: HEs, Nnø. 23. *Elater ferrugatus* Lac.: TRi. 24. *E. hjorti* Rye: Ø. 29. *E. pomonae* Steph.: HEs.

242

6. *Corymbites impressus* F.: Os. 9. *C. nigricornis* Panz.: VE. 10. *C. pectinicornis* L.: SFi. 22. *Agriotes sputator* L.: AK. 29. *Denticollis linearis* L.: SFy.

246

4. *Throscus carinifrons* Bonv.: HEs. 22. *Melanophila acuminata* DeG.: HEs, TRy. 23. *Phaenops cyanea* F.: VE. 25a. *Anthaxia godeti* Cast. & Gory: HEs. 26. *Chrysobothris affinis* F.: VE. 38. *Agrilus laticornis* Ill.: TEy.

250

5. *Agrilus pratensis* Ratz.: TEy. 24. *Cyphon padi* L.: TEi.

254

20. *Heterocerus flexuosus* Steph.: Nnø.

258

18a. *Reesa vespulae* Mell.: TRy. 34. *Morychus dovrensis* Munst.: TRy.

262

12. *Nemosoma elongatum* L.: HEs. 23. *Byturus tomentosus* F.: Nnø. 30. Read *Brachypterolus linariae* Steph. (*cornelii* Spornraft).

266

8. *Meligethes coeruleovirens* Forst.: AAy. 17. *M. denticulatus* Heer: HEs. 39. *Carpophilus hemipterus* L.: TEy (i). 39a. *C. marginellus* Mtsch.: VE, AAy.

270

7. *Epuraea angustula* Sturm: Bv. 10. *E. boreella* Zett.: TEy. 22. *E. laeviuscula* Gyll.: HEs. 25. *E. longipennis* Sjøb.: HEs. 28. *E. melina* Sturm: HEs. 29. *E. muehli* Rtt.: HEs. 33. *E. placida* Mäkl.: HOi. 34. *E. pusilla* Ill.: Bv. 35. *E. pygmaea* Gyll.: Bv. 38. *E. silacea* Hbst.: HEs. 40. *E. terminalis* Mnh.: TEy. 41.

E. thoracica Tourn.: HEs. 42. *E. unicolor* Ol.: Bv, Fn.

274

4. *Soronia grisea* L.: TEy. 7. *Cychramus luteus* F.: Bv. 14. *Librodor hortensis* Fourcr.: Nnø, delete HEn. 16. *Glischrochilus quadripunctatus* L.: Nnø. 17. *Pityophagus ferrugineus* L.: Bv. 18. *Cybocephalus politus* Gyll.: Ø. 24. *Rhizophagus dispar* Payk.: Nnø. 25. *R. ferrugineus* Payk.: Bv. 33. *Monotoma angusticollis* Gyll.: Nnø. 36. *M. conicicollis* Guér.: HEs. Nnø. 37. *M. longicollis* Gyll.: HEs.

278

1. *M. picipes* Hbst.: HOi. 13. *Silvanoprus fagi* Guér.: HEs, Os. 25. *Laemophloeus alternans* Er.: HEs, Bø.

286

1. *Cryptophagus lapponicus* Gyll.: Bv. 11. *C. pubescens* Sturm: HEs. 16. *C. setulosus* Sturm: SFy. 21. *Emphylus glaber* Gyll.: HEs. 24. *Antherophagus pallens* F.: HEn. 36. *Atomaria bella* Rtt.: HEs. 37. *A. berolinensis* Kr.: Delete HEn. 40. *A. diluta* Er.: AAy. 41. Read *A. fimetarii*. F. 42. *A. fusca* Schnh.: Bv, TEi.

290

8. *A. lewisi* Rtt.: Os. 18. *A. peltataeformis* Sjøb.: Ø, HEs. 34. *A. umbrina* Gyll.: Ri.

294

25. *Lathridius lardarius* DeG.: Bv. 26. *L. nodifer* Westw.: TEi, SFy. 28. *L. pandellei* Bris.: Bv, TEi. 29. *L. rugicollis* Ol.: HOi.

298

1. *Enicmus fungicola* Th.: HEs. 2. *E. hirtus* Gyll.: HEs. 6. *E. nidicola* Palm: HEs. 7. *E. planipennis* A. Str.: HEs. 10. *E. testaceus* Steph.: HEs. 11. *E. transversus* Ol.: HEs. 28. *Corticaria interstitialis* Mnh.: HEs. 34. Read *C. orbicollis* Mnh. (*munsteri* A. Str.). 36. Read *C. fagi* Woll. instead of *C. pietschi* Gglb. 37. *C. pubescens* Gyll.: TEi. 41. Read *C. planula* Fall instead of *C. strandi* Palm.

302

2. *Corticarina gibbosa* Hbst.: Bv, TEi. 13. *Mycetophagus decempunctatus* F.: HEs. 15. *M. multipunctatus* F.: On. 16. *M. piceus* F.: Delete Ø, AK, HEs. 19a. *M. salicis* Bris.: Ø, AK. 20. *Typhaea stercorea* L.: HEs. 29. *Ditoma crenata* F.: On. 31. *Colydium elongatum* F.: AAy.

306

13. *Endomychus coccineus* L.: Nnø. 14. *Subcoccinella 24-punctata L.:* TEi. 16. *Coccidula rufa* Hbst.: Bv. 21. *Scymnus ater* Kug.: Delete all particulars concerning Norway. 24. *S. bisignatus* Boh.: HOi. 24a. *S. femoralis* Gyll.: Ø, AK, HEs, VAy. 30. *S. limbatus* Steph.: Ø, AK, On, Bø. 33. *S. quadrimaculatus* Hbst: Delete Ø, AK. 35. *S. rubromaculatus* Gze.: Delete all particulars concerning Norway. 36. *S. mimulus* Capra & Fürsch: TEi, VAy.

310

3. *Hyperaspis pseudopustulata* Muls.: HEs. 11. *Aphidecta obliterata* L.: SFi. 18. *Coccinella hieroglyphica* L.: SFy.

314

2. *Aspidiphorus orbiculatus* Gyll.: HEs. 5. *Cis. bidentatus* Ol.: AAy, Nnø. 7. *C. comptus* Gyll.: HEs. 10. *C. festivus* Panz.: HEs. 13. *C. hispidus* Gyll.: HOi. 18. *C. linearis* Sahlb.: Fn. 24. *Rhopalodontus perforatus* Gyll.: AAy.

318

17. *Ernobius nigrinus* Sturm: HEs. 19. *Episernus angulicollis* Th.: HEs.

322

11. Read *Stagetus borealis* Isr. and add HEs. 24. *Niptus hololeucus* Fald.: HEn. 25. *Tipnus unicolor* Pill.: HOi. 26. *Ptinus bicinctus* Sturm: TEi. 33. *P. sexpunctatus* Panz.: TEi. 34: *P. subpilosus* Sturm: HEs, TEi.

326

20. *Pytho depressus* L.: Nnø. 24. *Rabocerus foveolatus* Ljungh: SFi, Nnø. 25. *R. gabrieli* Gerh.: HEs. 28. *Salpingus castaneus* Panz.: Nnø. 32. *Rhinosimus ruficollis* L.: TEi.

334

3. *Curtimorda maculosa* Naez.: On. 21. *Anaspis frontalis* L.: Bv. 27. *A. rufilabris* Gyll.: SFy. 28. *A. schilskyana* Csiki: AAy. 33. *Hallomenus axillaris* Ill.: HEs. 34. *H. binotatus* Quens.: TRi. 35. *Orchesia fasciata* Ill.: HOy. 37. *O. micans* Panz.: HEs, SFy.

338

4. *Wanachia triguttata* Gyll.: MRi. 9. *Xylita laevigata* Hellen.: STi. 11. *Serropalpus barbatus* Schall.: VE. 21. *Osphya bipunctata* F.: TEy.

342

§. *Blaps mucronata* Latr.: VAy. 26. *Tribolium destructor* Uytt.: Nnø. 33. *Uloma rufa* Pill. & Mitt.: Ø. 39. *Hypophloeus linearis* F.: Delete HEn and add Bv, Nnø, TRi.

346

24. *Geotrupes stercorosus* Scriba: Bv.

350

1. *Aphodius fossor* L.: TEy. 4. *A. haemorrhoidalis* L.: HEs. 5. *A. icterícus* Laich.: Delete STi. 17. *A. plagiatus* L.: Ø.

354

6. *Trox scaber* L.: HEs. 7. *Serica brunnea* L.: Bv, SFy.

358

8. *Criocephalus rusticus* L.: TEi. 13. *Rhagium inquisitor* L.: Nnø. 24. *Acmaeops pratensis* Laich.: NTi. 31. *Grammoptera ruficornis* F.: TRy. 37. *Leptura maculicornis* DeG.: HOi. 40. *L. sanguinolenta* L.: Bv.

362

2. *L. virens* L.: Fi. 8. *Strangalia melanura* L.: Bv. 9: *S. nigra* L.: HOi. 17. *Molorchus minor* L.: Bv. 27. *Phymatodes testaceus* L.: TEy.

366

3. Read *M. urussovi* Fisch. (*rosenmuelleri* Cederh.). 5. *M. sutor* L.: Fv. 27. *Saperda scalaris* L.: Nnø. 31. *Stenostola dubia* Laich.: HOy. 35. *Tetrops praeusta* L.: SFi. 36. *Macroplea appendiculata* Panz.: STi.

370

11. *Donacia impressa* Payk.: STi. 20. *D. versicolorea* Brahm: TEy. 25. *Plateumaris discolor* Panz.: HOi. 30. *Syneta betulae* F.: HOi.

374

34. *Cryptocephalus pini* L.: STi.

378

39. *Plagiodera versicolora* Laich.: Ø.

382

9. *Phytodecta intermedius* Hellies.: HOi. 19. *Phyllodecta polaris* Sp. Schn.: Nnø. 21. *P. vittelinae* L.: SFy. 22. *P. vulgatissimus* L.: SFi. 30. *Galerucella aquatica* Geoffr.: Fi. 31. *G. tenella* L.: Fo.

386

3. *Luperus longicornis* F.: SFy. 15. *Phyllotreta ochripes* Curt.: Bø.

390

31. *Batophila rubi* Payk.: NTi. 35a.: Delete *Crepidodera interpunctata* Mtsch.

394

13. *Chaetocnema concinna* Mrsh.: TEi. 32. *Psylliodes chrysocephala* L.: VE.

402

1. *Dissoleucas niveirostris* F.: VE. 4. *Brachytarsus nebulosus* Forst.: HEs. 21. *Coenorrhinus tomentosus* Gyll.: AK. 25. *Deporaus betulae* L.: VAi, SFy. 26. *D. mannerheimi* Humm.: SFy.

406

3. *Apion cerdo* Gerst.: Bv. 15. *A. facetum* Gyll.: HOi.

410

28. *A. violaceum* Kby.: TEi, AAi. 34. *Otiorhynchus dubius* Strøm: TEy. 39. *O. porcatus* Hbst.: SFy.

414

3. *O. scaber* L.: Bv. 4. *O.singularis* L.: HEs. 22. *Phyllobius calcaratus* F.: Delete Ry. 25. *P. oblongus* L.: Fi. 28. *P. urticae* DeG.: Ry. 29. *P. virideaeris* Laich.: TRi. 41. *Polydrosus undatus* F.: SFy.

418

1. *Sciaphilus asperatus* Bonsd.: SFy. 2. *Brachysomus echinatus* Bonsd.: HOi. 7. *Barypithes pellucidus* Boh.: Ø. AAy. 23. *Sitona lineellus* Bonsd.: HOy. 26. *S. hispidulus* F.: TEy. 29. *S. ambiguus* Gyll.: Bø. MRy.

422

13. Read *Rhopalomesites* instead of *Mesites*. 16. *Eremotes ater* L.: VAi, NTi.

426

10. *Dorytomus affinis* Payk.: Fn. 11. *D. dejeani* Faust: Delete AK and add Ry. 20. *D. salicinus* Gyll.: Bv. 22. *D. taeniatus* F.: HOi. 27. *Notaris aethiops* F.: HEn. 28. *Elleschus bipunctatus* L.: Bv.

430

37. *Brachonyx pineti* Payk.: SFy.

434

3. *Pissodes gyllenhali* Gyll.: HEs. 7. *P. piniphilus.* Hbst.: HEn, TRi, 13. *Magdalis duplicata* Germ.: Os. 22. *M. ruficornis* L.: Bv, NTi. 23. *M. violacea* L.: TRi. 36. *Phytonomus arator* L.: STy. 39. *P. elongatus* Payk.: TEy.

438

42: *Micrelus ericae* Gyll.: SFy.

446

35. *Eubrychius velatus* Beck: TRy.

450

26. *Miarus campanulae* L.: NTi. 29. Read *M. portae confusus* Solari i. l. A. Str.

454

8. *Rhynchaenus pilosus* F.: Ø. 10. *R. quercus* L.: Bø. 13. *R. rusci* Hbst.: HOi. 26. *Scolytus ratzeburgi* Jans.: On, VE, Nnø. 30. *Leperisinus varius* F.: HOy. 36. *Blastophagus piniperda* L. Nnø.

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14. *Crypturgus cinereus* Hbst.: HEs. 17. *C. subcribrosus* Egg.: HEs. 19. *Cryphalus saltuarius* Weise: Os. 33. *Dryocoetes alni* Georg.: Nnø. 40. *Pityophthorus lichtensteini* Ratz.: Os.

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3. *Xyloterus domesticus* L.: Nnø. 5. *X. piceus* A. Str.: Bø. 7. *Pityogenes bidentatus* Hbst.: Nnø. 10. *P. quadridens* Hart.: Nnø.

Received 8 July 1977

ACKNOWLEDGEMENTS

My thanks are due to the contributors, particularly Dr. Alf Bakke, Vollebekk, and universitetsstipendiat Arne Fjellberg, Bergen.

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Ecophysiological studies on beetles from arid regions in East Africa

KARL ERIK ZACHARIASSEN

Zachariassen, K. E. 1977. Ecophysiological studies on beetles from arid regions in East Africa. *Norw. J. Ent. 24*, 167–170.

Temperature preference, lethal temperatures, and rate of water loss of tenebrionid and curculionid beetles from arid regions in Kenya were investigated. Nocturnal or crepuscular beetles showed a temperature preference in the range from 30 to 35°C, diurnal *Zophosis* beetles in the range from 35 to 38°C. The lethal temperatures were in the range from 47 to 49°C for the nocturnal or crepuscular species, and near 53°C for the *Zophosis* beetles. The results indicate that the *Zophosis* beetles should be regarded as maxitherms.

Tenebrionid beetles with fused elythra showed greater ability to resist dehydration than those with normally developed elythra. The only curculionid species included in the study showed a much higher rate of water loss than did the tenebrionid species living in the same dry environments.

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To animals living in arid tropical regions overheating and dehydration appear to be the most important forms of stress.

Most insects living on the ground in these areas seek to avoid these dangers by hiding during the day under stones, under fallen trees etc., or by digging themselves down into the sand. A few species of insects are active on the surface during a shorter or longer part of the day (Buxton 1924, Edney 1971). Hamilton (1973) found that diurnal insects in the Namib desert maintained a nearly constant body temperature from 37 to 41°C, which was about 10°C below their upper lethal limit. Based on these observations, he established the so-called maxithermy hypothesis. This hypothesis states that some insects are so-called maxitherms, in that they maintain their body temperature as high as possible for as long as possible by means of behavioural thermoregulation.

In this way the maxitherms obtain maximum rates of growth and reproduction, which are assumed to give the insects advantages relative to their competitors. The maintained body temperature (= the preferred body temperature) seems to be within the range from 37 to 41°C for all maxitherms, whereas the upper lethal temperature generally seems to be within the range from 47 to 52°C.

This paper presents data regarding the preferred and lethal temperatures of beetles living in arid regions in East Africa. The data have been viewed in the light of Hamilton's maxithermy hypothesis. Data regarding the ability of some species to resist dehydration are also presented.

MATERIALS AND METHODS

The experiments were performed with tenebrionid and curculionid beetles which were collected in highland forest and semi-desert bush in Kenya, East Africa. The species used are illustrated in Fig. 1, and the respective finding localities and activity periods are listed in Table I.

Studies of preferred temperature and resistance to dehydration were performed in the laboratory with beetles which had been

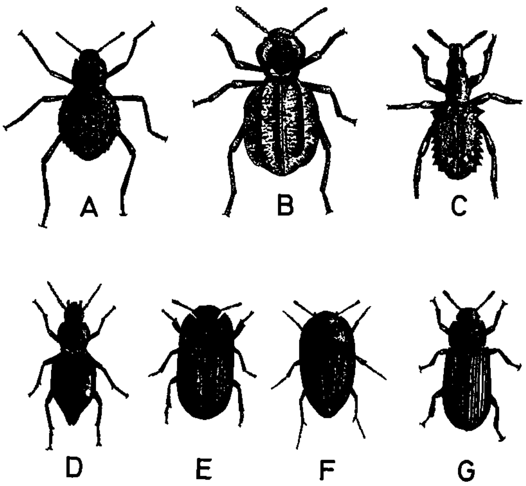

Fig. 1. Illustrations of beetles used in the present investigation. A: *Oncosoma* sp. B: *Phryanocolus somalicus* Wilke C: *Microcerus* sp. D: *Rhytinota praelonga* Reiche E: *Gonocephalus* sp. F: *Zophosis* sp. G: *Tenebrio* sp.

transported alive from Kenya to Oslo. The beetles were kept in the laboratory at +20°C for up to 3 months before they were used for the experiments. During this period they were fed by pieces of apple, and they seemed to be in a good shape when they were used for the experiment.

The temperature preference of the beetles was studied by using a temperature organ, with a temperature gradient running from about +20°C to about +50°C. The beetles were allowed to move freely in this gradient, and their position was recorded at intervals of 10 minutes.

In order to determine the upper lethal temperature of the beetles, they were placed inside small glass tubes, which were immersed into water. The temperature of the water was increased in steps of 3°C, and the beetles were exposed to each temperature for 10 minutes. After each exposure, the beetles were taken out from the tubes and observed at room temperature. The temperature at which the beetles showed the first sign of uncoordinated walking was taken as the lethal temperature.

The ability of the beetles to resist dehydration was investigated by measuring the rate of weight loss at +20°C in beetles exposed to a current of dry air. The air was dried by leading it through a tube containing

Table I. Data for beetles used in the present investigation.

Species	Finding location and landscape	Finding conditions	Period of activity [x]
Tenebrionidae:			
Gonocephalus sp.	Highland Forest, Mt. Marsabit	Under stone	N or T
Oncosoma sp.	Semidesert shrub, Isiolo	Under fallen Acacia	
Phryanocolus somalicus Wilke	" " "	" " "	N or T
Rhytinota praelonga Reiche	Semidesert, Laisamis	Under stone	N or T
Tenebrio sp.	Semidesert shrub, Narok	In rotten wood	N or T
Zophosis sp.	" " Isiolo	On sun-exposed sand	D
Curculionidae:			
Microcerus sp.	" " Narok	Under stone	N or T

[x] N: Night T: Twilight D: Day

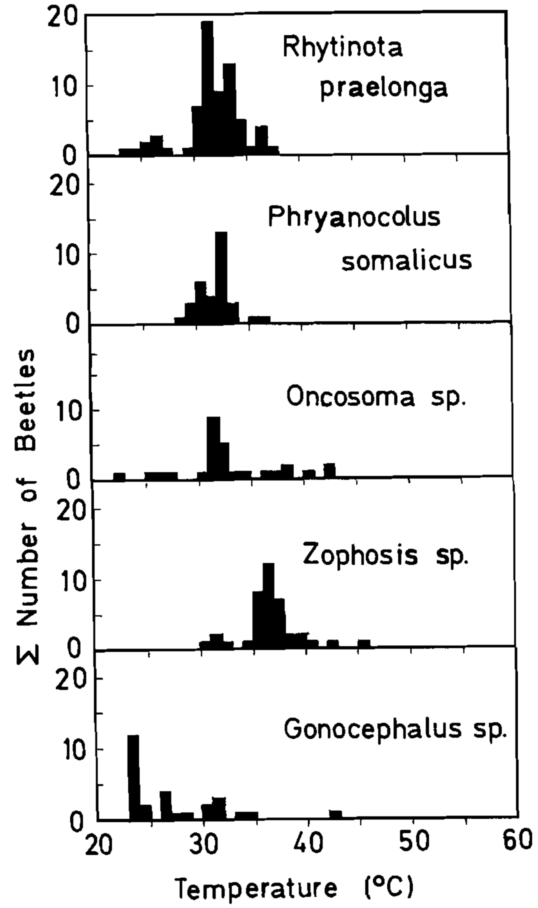

Fig. 2. Preferred temperatures of tenebrionid beetles as determined in a temperature organ.

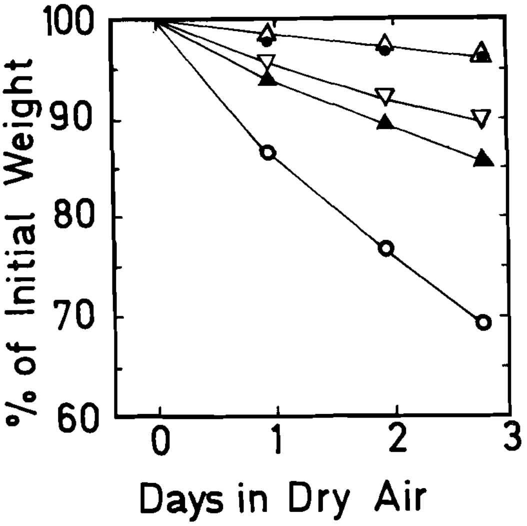

Fig. 3. Relative weight loss of beetles exposed to a current of dry air. ● : *Phryanocolus somalicus.* △ :*Rhytinota praelonga* ▽ : *Gonocephalus* sp. ▲: *Tenebrio* sp. ○ : *Microcerus* sp.

silica gel, from which it was distributed to five small plastic tubes, arranged in parallel, and each containing one beetle. To prevent influence from fecal weight loss during the observation period, the beetles were starved for two days before the measurements started. The beetles were starved also during the observation period.

RESULTS

The distribution of beetles of the various species in the temperature organ is shown in Fig. 2. The nocturnal beetles from the arid areas *(Oncosoma, Phryanocolus* and *Rhytinota)* seem to prefer temperatures in the range 30 – 35°C, whereas the diurnal *Zophosis* beetles had their temperature preference in the range 35 – 38°C. The *Gonocephalus* beetles from the mountains preferred temperatures below 20°C, in that they seemed to gather at the coldest end of the temperature organ.

The nocturnal tenebrionid beetles of the genera *Rhytinota* and *Oncosoma* had upper lethal temperatures of 49 and 47°C, respectively, whereas the diurnal *Zophosis* beetles had an upper lethal temperature of 53°C.

The relative weight loss of beetles exposed to a current of dry air is shown in Fig. 3. The ground-living beetles of the species *Phryanocolus somalicus* and *Rhytinota praelonga* showed the lowest relative weight loss, whereas it was markedly higher in the *Tenebrio* beetles which live in rotten wood and in the *Gonocephalus* beetles, which were found under stones in the mountains. The highest relative weight loss was observed in the *Microcerus* beetles, which are the only beetles which do not belong to the Tenebrionidae.

DISCUSSION

The preferred temperature of the diurnal *Zophosis* beetles is in agreement with the preferred temperatures reported by Hamilton (1975) for diurnal tenebrionid beetles from the Namib desert. However, in their natural habitat the *Zophosis* beetles are active during the day on bare ground, where they are exposed directly to the sun, and where the surface temperature can exceed 60°C (Buxton 1923). Under these circumstances the beetles regulate their body temperature at a value near 50°C (Zachariassen, in prep.), which is just below the upper lethal temperature of the beetles. Thus, they maintain a body temperature which is higher than that of all maxitherms reported by Hamilton (1975). Consequently, the *Zophosis* beetles should be regarded as maxitherms.

The discrepancy between the preferred temperature of the *Zophosis* beetles as observed in the temperature organ and the temperature at which the beetles are active in their natural habitat is difficult to explain. One explanation might be that the preferred temperature of the beetles was lowered by the relatively long period during which the beetles were kept at room temperature before the laboratory experiments started.

The preferred temperature of the nocturnal tenebrionid beetles is about 5°C lower than that of the diurnal beetles. Consequently, the nocturnal beetles should probably not be regarded as maxitherms.

The upper lethal temperatures observed in the present study correspond well to the values reported by Hamilton (1975). Thus, the upper lethal temperature seems to be common to many species of tenebrionid beetles, which are active at different hours during the day and under different temperature conditions.

The tenebrionid beetles with fused elythra (*Phryanocolus somalicus* and *Rhytinota praelonga*) showed markedly greater ability to resist water loss during the dehydration experiment than those with normal elythra. This gives support to the view that fusion of the elythra, which is quite common in desert tenebrionids, increases the ability of the beetles to reduce their water loss.

The ability of the curculionid beetles to resist dehydration was markedly lower than that of the tenebrionid beetles. The curculionid beetles were found in the same environments as were the highly resistant tenebrionid beetles. The ability of the curculionid beetles to survive in this dry environment is probably based on special, highly effective mechanisms for compensating loss of water. The nature of these mechanisms is not known.

ACKNOWLEDGEMENTS

The material was collected during travel in Kenya which was supported by the Norwegian Research Council for Science and the Humanities. The material was classified at the Museum of Natural History in Nairobi; I would like to thank Dr. Clifton at the Entomology department for giving me access to the collections. I am most grateful to Erling Killingbergtrø, Institute of Zoology, University of Oslo, for lending me the temperature organ.

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Faunistical notes on Norwegian gall wasps (Hym., Cynipidae)

TROND ANDERSEN & ARNE FJELLBERG

Andersen, T. & Fjellberg, A. 1977. Faunistical notes on Norwegian gall wasps (Hymenoptera, Cynipidae). *Norw. J. Ent. 24,* 171–173.

A list of 20 species of cynipids, mainly collected in the counties of Vestfold and Hordaland, is given.

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Apart from species injuring crops, and thus of economic interest, there is very little information about gall-making insects in Norway. Most cynipids attack wild plants and trees of small interest to agriculture or forestery, so the knowledge of their biology and distribution in Norway is scanty. A summary of published and unpublished plant galls from Norway was given by Leatherdale (1959). He lists 15 species of Cynipidae.

The last three years we have collected cynipids mainly around Bergen in West Norway and in Vestfold in East Norway. The identifications are made on individuals collected with sweep net in the field, specimens bred from galls or on the plant galls alone. Nomenclature follows Eady & Quinland (1963).

Phanacis centaureae Foerster
VE: Tjøme, Sønstegård Vasser (UTM: 32VNL828484) May 1976. Bred from *Centaurea* sp.

Aulacidea hieracii (Bouché)
VE: Tjøme, Mostranda (UTM:32VNL801497) 15 May 1975. Bred from galls in stems of *Solidago virgaurea* L. HOy: Bergen, Fjellvegen (UTM:32VKN983013) 24 Aug. 1975. Galls in stems of *Hieracium* sp. HOy: Bergen, Kittebakkane (UTM:32VKN954121) 10 May 1977. Bred from galls in stems of *Solidago virgaurea* L.

Isocolus jaceae (Schenck)
VE: Tjøme, Sønstegård Vasser (UTM: 32VNL828484) May 1976. Bred from *Centaurea* sp.

Liposthenus latreillei (Kieffer)
VE: Tjøme, Kjære (UTM:32VNL806529) 5 July 1977; Barkvika (UTM:32VNL797522) 5 July 1977. Numerous galls on leaves of *Glechoma hederacea* L.

Periclistus brandtii Ratzeburg
VE: Tjøme, Verdens Ende (UTM:32VNL 806478) Oct. 1975. VE: Sem, Skallevoll (UTM:32VNL856739) Oct. 1975. Bred in spring 1976 from galls of *Diplolepis rosae* L.

Periclistus caninae Hartig
VE: Tjøme, Sønstegård Vasser (UTM: 32VNL828484) Oct. 1975. Bred in spring 1976 from galls of *Diplolepis* sp. on leaf of *Rosa* sp.

Synergus spp.
Several species bred from galls on *Quercus*.

Diplolepis rosae (Linnaeus)
Bø: Hurum, Sundby (UTM:32VNM898131) 1976. VE: Tjøme, Verdens Ende (UTM: 32VNL806478); Mostranda (UTM:32VNL 801497); Kjære (UTM:32VNL805529); Sønstegård Vasser (UTM:32VNL828484) 1970–77. VE: Sem, Skallevoll (UTM:32VNL 856739) 1975. VE: Borre, Løvøya (UTM: 32VNL815914) 1975. Galls on *Rosa* sp. Galls collected during the autumn have been bred the following spring.

Diplolepis sp.
VE: Tjøme, Sønstegård Vasser (UTM: 32VNL828484) Oct. 1975. Small, smooth galls on the underside of leaves of *Rosa* sp. VE: Tønsberg, Frodeåsen (UTM:32VNL 802724) 9 June 1975. Some spiked red galls on leaves of *Rosa* sp., may be of the species *D. nervosa* (Curtis), but no individuals hatched from the galls. HOi: Voss, Voss (UTM: 32VLN584244) 6 July 1975. Smooth galls on leaves of cultivated *Rosa* sp.

Neuroterus numismalis (Geoffroy)
VE: Tjøme, Kjære (UTM:32VNL805529) 1 Sept. 1975. VE: Brunlanes, Kløtre (UTM: 32VNL509390) 5 July 1975. Ri: Sand, Ropeid (UTM:32VLL414982) 4 Aug. 1975. HOi: Kvam, Omastrand (UTM:32VLM318793) 15 Aug. 1975. HOy: Fana, Ådland (UTM: 32VKM928883) 9 Aug. 1975. Galls on Oak leaves.

Neuroterus quercusbaccarum (Linnaeus)
Ø: Idd, Idd church (UTM:32VPL396522) 6 Oct. 1975. VE: Tjøme, Mostranda (UTM:32 VNL801497) 24 Apr. 1975. VE: Nøtterøy, Herstad (UTM:32VNL803681) 6 Sept. 1975. Ri: Sand, Ropeid (UTM:32VLL414982) 4 Aug. 1975. HOi: Kvinnherad, Rosendal (UTM:32VLM335543) 3 May 1975. HOi: Kvam, Omastrand (UTM:32VLM318793) 15 Aug. 1975. HOy: Ølen, Utbjoa (UTM:32 VLM093206) 4 Aug. 1975. HOy: Bergen, Skeie (UTM:32VKM958888) 17 Aug. 1975; Ådland (UTM:32VKM928883) 9 Aug. 1975; Stend (UTM:32VKM968874) 24 Apr. 1975; Myravann (UTM:32VKM989945) 7 May 1975; Mulen (UTM:32VKN982024) 17 Aug. 1975. SFy: Gulen, Iledalselva (UTM:32VKN 524902) 19 Aug. 1973. Galls of both sexual and agamic form found on Oak leaves. Some agamous females were taken in the spring.

Andricus callidoma (Hartig)
Ri: Sand, Ropeid (UTM:32VLL414982) 4 Aug. 1975. HOy: Bergen Salhus (UTM:32 VKN948135) 8 Aug. 1975. Agamous galls on Oak.

Andricus curvator Hartig
VE: Tjøme, Moutmarka (UTM:32VNL 802492) 1 June 1977. VE: Nøtterøy, Herstad (UTM:32VNL805676) 6 Sept. 1975; Rosanes (UTM:32VNL813689) 18 July 1975. HOi: Kvinnherad, Rosendal (UTM:32VLM335543) 3 May 1975. HOi: Kvam, Ålvik (UTM: 32VLN593024) 20 July 1975; Vikøy (UTM: 32VLM448938) 15 Aug. 1975. HOy: Ølen, Utbjoa (UTM:32VLM093206) 4 Aug. 1975. HOy: Bergen, Ådland (UTM:32VKM928883) 9 Aug. 1975; Mulen (UTM:32VKN982024) 17 Aug. 1975; Botanisk Hage (UTM:32VKN 974004) 17 July 1975. Galls of sexual form on leaves and twigs of Oak.

Andricus fecundator (Hartig)
VE: Tjøme, Eidene (UTM:32VNL806521) 15 Apr. 1975. Ry: Skudenes, Blikshamn (UTM:32VKL898685) 10 May 1977. Ry: Avaldsnes, Kvalavåg (UTM:32VKL851823) 10 May 1977. HOy: Bergen, Mulen (UTM: 32VKN982024) 17 Aug. 1975. Old agamous galls on Oak twigs.

Andricus inflator Hartig
Ø: Idd, Idd church (UTM:32VPL396522) 6 Oct. 1975. AK: Asker, Konglungen (UTM: 32VNM838343) 10 Apr. 1976. Bø: Røyken, Beston (UTM:32VNM856182) 10 Apr. 1976. VE: Tjøme, Kjære (UTM:32VNL805529) 15 Apr. 1975. VE: Tønsberg, Frodeåsen (UTM:32VNL802724) 15 Apr. 1975. VE: Brunlanes, Kløtre (UTM:32VNL509390) 15 July 1975. Old galls of sexual form on Oak twigs.

Andricus ostreus Hartig
VE: Nøtterøy, Herstad (UTM:32VNL803681) 6 Sept. 1975. HOi: Kvam, Omastrand (UTM:

32VLM318793) 15 Aug. 1975; Vikøy (UTM: 32VLM448938) 15 Aug. 1975. HOy: Samnanger, Årland (UTM:32VLN005215) 15 Aug. 1975. Agamous galls on Oak leaves.

Andricus quadrilineatus Hartig
VE: Tjøme, Mostranda (UTM:32VNL801 497) June 1975; Kjære (UTM:32VNL805529) June 1975. VE: Tønsberg, Frodeåsen (UTM: 32VNL802724) 9 June 1975. VE: Brunlanes, Kløtre (UTM:32VNL509390) 5 July 1975. HOy: Bergen, Ådland (UTM:32VKM928883) 9 Aug. 1975; Salhus (UTM:32VKN948135) 8 Aug. 1975. Agamous galls on leaves and catkins of Oak.

Andricus quercusradicis (Fabricius)
VE: Tjøme, Kjære (UTM:32VNL805529) Apr. 1975. Agamous females bred from galls on Stem-base of Oak saplings. HOy: Os, Solstrand (UTM:32VLM063785) 7 May 1975; Hetleflotsvann (UTM:32VLM031810) 7 May 1975. HOy: Bergen, Stend (UTM:32VKM96 8874) 28 Apr. 1975; Myravann (UTM:32 VKM989945) 3 May 1975; Skeie (UTM:32 VKM958888) 17 Aug. 1975. The spring records are agamous females, the August record refers to galls on Oak leaves from which males and females were bred.

Andricus quercusramuli (Linnaeus)
Ø: Berg, Halden (UTM:32VPL3457) 6 Oct. 1975. VE: Tjøme, Mostranda (UTM:32VNL 801497 Aug. 1975. VE: Tønsberg, Frodeåsen (UTM:32VNL802724) 9 June 1975. AAy: Øyestad, Engene (UTM:32VMK823733) 7 July 1975. HOi: Kvam, Omastrand (UTM: 32VLM318793) 15 Aug. 1975. Galls of sexual form on Oak catkins.

Received 21 July 1977

Andricus testaceipes Hartvig
Bø: Røyken, Beston (UTM:32VNM856182) 10 Apr. 1976. VE: Tjøme, Kjære (UTM:32 VNL805529) 15 Apr. 1974. Conical galls on stem-base of Oak saplings. Imago bred after few days.

Cynips quercusfolii Linnaeus
VE: Tjøme, Moutmarka (UTM:32VNL802 492) Sept. 1976; Kjære (UTM:32VNL805529) 1 Sept. 1975. VE: Tønsberg, Sentralsykehuset (UTM:32VNL811715) Sept. 1976. HOy: Fana, Ådland (UTM:32VKM928883) 9 Aug. 1975. Agamous galls on Oak leaves, some bred during the winter.

Biorhiza pallida (Olivier)
Ø: Berg, Halden (UTM:32VPL3457) 6 Oct. 1975. AK: Asker, Konglungen (UTM:32VNM 838343) 10 Apr. 1976. Bø: Røyken, Beston (UTM:32VNM856182) 10 Apr. 1976. Bø: Hurum, Kongsdelene (UTM:32VNM879157) 10 Apr. 1976. VE: Tjøme, Mostranda (UTM: 32VNL801497) 12 Apr. 1976. VE: Nøtterøy, Herstad (UTM:32VNL803681) 12 Apr. 1976. VE: Tønsberg, Frodeåsen (UTM:32VNL802 724) 9 June 1975. VE: Brunlanes, Kløtre (UTM:32VNL509390) 5 July 1975. AAy: Øyestad, Engene (UTM:32VMK823733) 7 July 1975. AAy: Landvik, Molland (UTM: 32VMK730647) 7 July 1975. RI: Sand, Ropeid (UTM:32VLL414982) 4 Aug. 1975. HOi: Kvam, Vikøy (UTM:32VLM448938) 15 Aug. 1975. Agamous galls on Oak buds, some bred.

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Norw. J. Ent. Vol. 24, No. 2, 1977

Short Communications

Ryggsvømmeren *Notonecta glauca* L. (Hem., Notonectidae) funnet på Nord-Møre

DAG DOLMEN & HANS ARVE OLSVIK

Notonecta glauca L. has previously been reported from the most southern and inner parts of Norway. It was therefore surprising to find it in two small ponds in Kristiansund in Møre og Romsdal county during the summers 1975–76. The insect has been observed the whole ice-free season of the year, and the life cycle agrees with what has been found for the species in Denmark.

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Warloe (1925) skriver om utbredelsen av ryggsvømmeren *Notonecta glauca* L. i Norge at den er funnet i Kristiania, Asker, Norderhov, Eidsvold, Odalen, Grue, Elverum, Fron, Sarpsborg, Stavanger, Gjøvik, Drøbak og Risør. Økland (1964) omtaler arten fra Borrevann, Horten.

Ut fra dette var det overraskende å finne *N. glauca* på Nord-Møre under Olsviks undersøkelser i 1975 og 1976. Funnet ble gjort i Folkeparken i Kristiansund N, i to dammer like ved gymnaset (UTM: 32VMR 363005 og 365007)., begge ca. 250 m fra sjøen og henholdsvis ca. 18 og 30 m oh.. Størrelsen på dammene er ca. 3 m^2 og 20 m^2, og de er ca. 50 cm og 150 cm dype. Lokalitetene ligger på berg delvis bevokst med furutrær, røsslyng og moser. Vegetasjonen i dammene er hovedsaklig moser og starr.

Imagines av *N. glauca* (som overvintrer) dukker opp allerede ei uke eller to etter at isen er gått av dammene i Kristiansund N; dette skjer som oftest i slutten av april eller i begynnelsen av mai. Egglegginga foregår om våren og om forsommeren, larvene klekker tidligst i overgangen juni/juli, og mot slutten av august og i september forvandles nymfene til imagines. I begynnelsen av oktober 1976 ble to fullvoksne nymfer sett og etter den tid bare imagines. Sammen med virvlerne (*Gyrinus:* Coleoptera, Gyrinidae) har det vært ryggsvømmerne som har holdt aktiviteten gående lengst utover høsten, og i 1976 ble *N. glauca* fanget minst et par dager etter at isen la seg for alvor, i begynnelsen av desember. Kaiser (1966) sier at arten i Danmark ikke har noen diapause og kan tas hele året. Han noterer et liknende livsforløp fra Danmark som det som er beskrevet fra Møre. Det samme gjør Wesenberg-Lund (1915). Denne livscyklus er helt ulik den for *N. lutea,* en mer nordlig og circumpolar art som også er utbredt i Norge; denne overvintrer som egg og klekker tidlig på sommeren (Dolmen & Aagaard 1973).

Received 12 August 1977

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Abnorm hann av *Aeschna juncea* (L.) (Odonata)

DAG HOLMEN & PETER VARGA

An abnormal male of the dragonfly *Aeschna juncea* (L.) is described, having two sets of copulatory organs; the second is on the 4 fourth abdominal segment.

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Sommeren 1975 fanget P. Varga ved Madsjø, Tunga i Trondheim en hann av øyenstikkeren *Aeschna juncea* (L.) som var noe utenom det vanlige. Ved nærmere øyesyn viste det seg at foruten det hannlige kopulasjonsorgan på undersida av 2. (og delvis 3.) abdominalsegment (a, fig. 1) fantes et organ på 4. abd. segment (b) som i prinsipp syntes å være oppbygd på samme måte som førstnevnte. På 5. abd. segment fantes ytterligere et vedheng (c) som ikke er sett på andre individer.

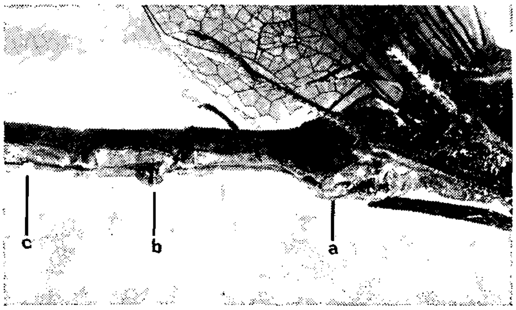

Fig. 1. *Aaschna juncea* (Odonata), hann med ekstra kopulasjonsorgan på 4. abdominalsegment og et vedheng på 5. abd.-segment. Foto P. E. Fredriksen.

Micronecta poweri (Dgl. & Sc.) (Hem., Corixidae) a species new to Norway

DAG DOLMEN

Micronecta poweri (Dgl. & Sc.), a species new to Norway, is reported found in two lakes in Agdenes (Sør-Trøndelag county) and from the River Glomma at Fetsund (Akershus county).

D. Dolmen, University of Trondheim; Zoological Institute, Rosenborg, N-7000 Trondheim, Norway.

During investigations summer of 1969 at Lake Storvatnet, Agdenes in Sør-Trøndelag county, in connection with the yearly courses in biology at the University of Trondheim, a great number of small water bugs were found which turned out to be *Micronecta poweri* (Dgl. & Sc.). The species had previously not been reported from Norway. During the summers of 1976 and 1977 *M. poweri* was found in Agdenes not only in Lake Storvatnet, but also in Lake Litlvatnet. Both these lakes are eutrophic to a certain extent. Some physical/chemical data for the lakes are given in Table I.

Table I. Physical/chemical properties of Lake Storvatnet and Lake Litlvatnet.

	Area km^2	Depth m	Altitude m	pH	K_{18} µS/cm
L.Storvt.	ca 1,5	30-40	6	>6,9	ca 100
L.Litlvt.	0,43	3,5	5	7,0-7,6	ca 120

M. poweri is also distributed in south-eastern parts of Norway. I have taken specimens from the River Glomma, at Fetsund in Akershus county, where the species was abundant both in 1974 and 1977.

This little water bug is presumably more or less common in South Norway. Its small size (adults about 2 mm) makes it almost unnoticeable, and it can easily escape through the net.

Received 23 August 1977

Horse flies (Dipt., Tabanidae) new to Norway

TROND ANDERSEN & HANS KAURI

Chrysops divaricatus Loew. and *Hybomitra muehlfeldi* Brau. (Dipt., Tabanidae) are recorded for the first time in Norway. Both species were collected in Vestfold county, south-eastern Norway, during the first few days of July 1977.

T. Andersen and H. Kauri, Zoological Museum, University of Bergen, N-5014, Bergen-Univ., Norway.

Two species of Tabanidae, *Chrysops divaricatus* Loew and *Hybomitra muehlfeldi* Brau. were collected by T. Andersen in Vestfold county, south-eastern Norway, during the first few days of July 1977. These species have not previously been recorded from Norway. Both species were caught on peat bogs or near ponds in coniferous forests.

Chrysops divaricatus Loew, 1858
Localities: Andebu, Vegger (UTM:32VNL 625755); Sem, Ilebrekke (UTM:32VNL 839729); Stokke, Gjennestadmyra (UTM:32 VNL718668); Sandefjord, Bjørnummyra (UTM:32VNL689627); Sandefjord, Napperødtjern (UTM:32VNL672611). Together 12♀♀ were collected. *C. divaricatus* is an inhabitant of the taiga, its western border of distribution lies in Bayern, Bohemia and Denmark (Chvala, Lyneborg & Moucha, 1972).

Hybomitra muehlfeldi (Brauer, 1880)
Localities: Sem, Ilebrekke (UTM:32VNL 839729); Sem, Akersmyra (UTM:32VNL 758710); Stokke, Gjennestadmyra (UTM: 32VNL718668); Sandefjord, Bjørnummyra (UTM:32VNL689627). 5♀♀ were collected. *H. muehlfeldi* is widely distributed in Europe and in Asiatic parts of USSR.

Received 20 July 1977

REFERENCE

Chvála, M., Lyneborg, L. & Moucha, J. 1972. *The horse flies of Europe.* Ent. Soc. Copenh., Copenhagen.

Pityophthorus traegardhi Spessivtseff, a new bark beetle to the fauna of Norway

ALF BAKKE & TORSTEIN KVAMME

Galleries with several specimens of the bark beetle *Pityophthorus traegardhi* were found in small twigs of newly dead Norway spruce at Galten in Engerdal, county of Hedmark. This is the first record of the species from Norway. Other bark beetles from spruce in the same area are mentioned.

Alf Bakke and Torstein Kvamme, Norwegian Forest Research Institute, P. O. Box 61, N-1432 Ås-NLH, Norway.

Pityophthorus traegardhi Spessivtseff 1921 is known from several localities north of latitude 58 in Sweden and in Finland (Lekander et al. 1977), but has never been recorded from Norway. On 1 June 1977 we collected the beetle from newly dead Norway Spruce (*Picea abies*) at Galten in Engerdal, county of Hedmark. Galleries were established in 4–6 mm thick twigs in the upper part of exposed trees, 4–6 m high. Thicker twigs and upper stem sections were colonized by *Pityophthorus micrographus* Linnaeus. Stem sections of slowly dying trees in the same area were occupied by *Polygraphus poligraphus* L., *P. subopacus* Thoms., *Dendroctonus micans* Kug., *Cryphalus saltuarius* Weise, *Xylechinus pilosus* Ratz., *Phthorophloeus spinulosus* Rey and *Ips typographus* L. These species were previously not recorded from the northern part of Hedmark. *Pityogenus chalcographus* was common in the area.

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Received 29 August 1977

Stenamma westwoodi Westwood (Hym., Formicidae) new to Norway

TORSTEIN KVAMME & ALF BAKKE

Two nests of *Stenamma westwoodi* Westwood were found at Omre, Grimstad in Aust-Agder county, South Norway. Both nests were recorded under stones, about 10 m inside an oak stand. These are the first outdoor records in Norway.

Torstein Kvamme and Alf Bakke, Norwegian Forest Research Institute, P. O. Box 61, N-1432 Ås-NLH, Norway.

Two nests of *Stenamma westwoodi* Westwood were recorded 28 July 1977 at Omre in Grimstad, county of Aust-Agder, South Norway. Both nests were situated under stones, lying only a few metres away from each other. The underside of the stones, which were about 20 × 30 cm in width, was about 10 cm under the soil surface. The nests were found in an oak stand, limited to the south by a meadow and to the north by a little cliff. Both nestplaces were well shadowed, about 10 m inside the border of the stand.

Myrmica schencki Em. and *Leptothorax muscorum* Nyl. were also found in the same forest.

These are first secure outdoor records of *S. westwoodi* in Norway. However, the species was found in a greenhouse in the Botanical Garden at Bergen in 1937 (Collingwood 1974). The specimens which are in the collection of the Zoological Museum at Bergen were examined. They were remarkably small and pale.

Holgersen (1944) did not list this record and Collingwood (1974) listed it as introduced.

Received 29 August 1977

S. westwoodi is known up to western Götaland in Sweden (Forsslund 1957), approximately the same latitude as Grimstad.

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Legnotus picipes (Fall.) new to Norway, and some notes on *Cyphostethus tristriatus* (F.) and *Eurygaster testudinuria* (Geoffr.) (Hem., Pentatomoidea)

SIGMUND HÅGVAR & TORSTEIN KVAMME

Legnotus picipes (Fall.) is reported new to Norway from Østfold county. *Cyphostethus tristriatus* (F.) has been found in great numbers on two species of cypresses: *Chamaecyparis lawsoniana* (A. Murr.) Parl. and *C. nootkatensis* (Lamb.) Spach. Probably the introduction of these cypress species to Europe has offered new host plants to the bug, which otherwise is believed to be monophagous on juniper (*Juniperus communis* L.). A record of *Eurygaster testudinaria* (Geoffr.) from Hedmark county is reported. The species has been found only a very few times earlier in Norway.

Sigmund Hågvar & Torstein Kvamme, Norwegian Forest Research Institute, N-1432 Ås-NLH.

Legnotus picipes (Fall.) was collected at Jeløya, Østfold county, 25 May 1976 (one specimen by sweep-netting) and 1 May 1977 (one specimen flying and one recorded on a stone). The habitat was a dry shore meadow, with *Galium* sp., *Geranium* sp. and grasses. These are the first records of the species in Norway. In Sweden the species has been recorded northwards as far as Uppland (Coulianos & Ossiannilsson 1976), which is roughly at the same latitude as the Norwegian locality.

At Ås, Akershus county, great numbers of *Cyphostethus tristriatus* (F.), both juveniles and adults, were recorded 16 September 1976 on the two cypress species *Chamaecyparis lawsoniana* (A. Murr.) Parl. and *C. nootkatensis* (Lamb.) Spach. The specimens must have developed on the actual cypresses. According to Wagner (1966), the host plant of the species is *Juniperus communis* L. This is also stated by Southwood & Leston (1959), and they add that there is no evidence to indicate that the bug ever feeds upon any other plant.

C. tristriatus is known only from Europe

(Wagner 1966). The two cypress species are American, but have to some degree been introduced to Europe. Probably this is an example of a case in which a primary monophagous insect has become polyphagous by taking into use additional plant species introduced by man. The authors will acknowledge reports about any further records of *C. tristriatus* on cypresses.

Eurygaster testudinaria (Geoffr.) has been recorded only a few times in Norway (Coulianos, pers. comm.). One specimen of this species was taken 27 June 1976 at Slettemoen, Eidskog, Hedmark county, by sweep-netting on a moist meadow in spruce forest. In Sweden, the species has been taken northwards to Dalarna (Coulianos & Ossiannilsson 1976). *E. testudinaria* can probably be found in several new localities in southernmost Norway, if only suitable habitats are investigated. According to Southwood & Leston (1959) and Wagner (1966), the species prefers damp habitats where the grass is tall and the vegetation rank.

ACKNOWLEDGEMENTS

We are indebted to Prof. Frej Ossiannilsson, Uppsala, for confirming the identification of *L. picipes* and *E. testudinaria,* and to Dr. Carl-Cedric Coulianos, Stockholm, for information on earlier records of *E. testudinaria* in Norway.

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Received 31 August 1977

Bokanmeldelser

Ragnhild Sundby. 1976. *Insekter*. 2. utgave, 122 p. Scandinavian University Books. Universitetsforlaget, Oslo. Pris kr. 56.–.

Bokens omslag er meget tiltalende. Lektor Tore R. Nielsens tegning, en blomsterflue, er vakker og tilfredsstiller høyt stilte estetiske krav. Utformingen av trykksidene er tiltalende og plasseringen av illustrasjoner med nesten sløsende plassbruk, muliggjør en bra oversikt.

Ifølge forfatterens forord er boken ment som førsteinnføring i norsk entomologi. Teksten er deretter også meget knapp og kortfattet. Den er imidlertid lettlest og instruktiv. Ettersom bare norske insekter behandles byr det på visse vanskeligheter å anvende den ved universitetskursene. Viktige insektordener som mangler representanter i Norge, er ikke med. Jeg kan imidlertid tenke meg at denne lille lærebok finner anvendelse ved landbrukshøgskoler, distriktshøgskoler og også som tilleggslesning på biologilinjer ved gymnaser, og den er også en nyttig informasjonskilde for hver interessert naturvenn.

Med tanke på en slik viktig funksjon som tilkommer boken, er det nødvendig å peke på noen feil og framlegge ønskemål. Første opplag ble anmeldt i dette tidsskrift 1971, side 77–78. Det som der ble sagt og de feil som ble påpekt har forfatteren ikke kunnet ta hensyn til. Tross dette skal jeg mest mulig unngå gjentakelser.

Den andre utgaven er noe utvidet: dels har det kommet et nytt kapittel om hårmygg, dels har det her og der blitt tilføyet kompletterende opplysninger angående levesett, morfologi o. l. Nye tekstbilder fins også. Alt dette har økt bokens verdi og anvendelse. En fordel hadde det vært om teksten også hadde omfattet de øvrige landlevende leddyr. Dette ville vært betydningsfullt ut fra miljøbiologiens og naturverns synspunkt, særlig med tanke på undervisningen ved distriktshøgskoler, gymnaser m. v. Dette hadde ikke medført noen større økning i volumet ettersom de norske edderkoppdyr, landlevende krepsdyr, tusenbein og skolopendrer er små grupper. Forøvrig er bokens innhold det samme som i foregående opplag. I den allmenne delen er stoffet oppdelt i kapitlene ytre bygning, indre bygning, forplantning og utvikling. I den spesielle delen gis bestemmelsestabeller, hvorpå følger en systematisk gjennomgåelse av ordener og et utvalg av familier. Behandling av stoffet bygger først og fremst på morfologi etter klassisk snitt. Oppgaven blir visselig lettest på den måten, men nåværende systematikk har som grunn det biologiske artsbegrepet og nye idéer og metoder har kommet til anvendelse. Evolusjonsprosessen har blitt nærmere utforsket og gransket i detalj av den nye populasjonsgenetikken og økologien. Intet av dette gjenspeiles i teksten. Man hadde i det minste i andre utgaven ventet seg en noe nærmere kontakt med økologiske synspunkter og insektenes rolle i naturen. Små antydninger over økologiske forhold, først og fremst over fødevalg, forekommer visst her og der, men en konsekvent linje savnes. Viktige økologiske relasjoner som pollinering, spredning av sykdommer, insekter som balansefaktorer m. m. er i det hele tatt ikke nevnt. Noen linjer om slike funksjoner ville beriket teksten i den taksonomiske delen, gitt leseren/studenten en oppfatning og orientering om studieobjektets rolle og påskyndet tilegnelsen av stoffet ved at interessen ble vekket. Omfanget hadde derved ikke økt nevneverdig ettersom den plass som trenges kunne gjenvinnes gjennom gruppering av illustrasjonene. Nå får man et inntrykk av teksten som noe foreldet.

Feil angående betegnelsene av illustrasjonene i den allmenne delen henvises til ovennevnte anmeldelse fra 1971. Kompletteringene som er gjort i denne utgaven, har økt teksten med en side. Dette er det ikke tatt hensyn til ved redigeringen av innholdsfortegnelsen. Følgene er at samtlige sidehenvisninger fra og med side 99 er feil. Den nytilkomne taxonen hårmygg (Bibionidae) er ikke tatt med i registeret. Bestemmelsestabellen (s. 25–29), bør gjennomses og korrigeres på ny. Vingbærende lusfluer (Hippoboscidae) f. eks. kan ikke determineres ved hjelp av tabellen. De mindre bestemmelsestabellene inne i teksten krever komplettering og flere forklarende illustrasjoner. I bestemmelsestabellen over høyerestående fluer f. eks. henvises til en eneste tegning, «postscutellum» (fig. 114 B), det skal være 114 A i stedet, men noen omtale av postscutellum i teksten forekommer ikke. De nye figurene 130b og 131b henger i luften, de henvises ikke til noensteds, og bildeteksten opplyser ikke til hvilken insektgruppe de hører. I beskrivelsen av bladteger står det: «kjennes fra de fleste andre teger ved at de har cuneus (fig. 46)», men hva er cuneus? På tegningen ser vi en liten hvit flekk betegnet med c, og i bildeteksten finner man at c = cuneus. Men hva cuneus er, opplyses det intet om. Det synes å være mindre heldig at de avbildete insektene i den spesielle delen forsynes bare med familienavn. Artsnavnet gis ikke. Denne anonymitet, som forresten begynner allerede med omslagsbildet, etterlater en følelse av ufullkommenhet. På en slik måte blir oldenborre og skarabide (fig. 82, s. 77), fleskebille en klanner (fig. 73, s. 71), praktkåpe en dagsommerfugl (fig. 99, s. 90) osv. All heder til knapp og kortfattet tekst, men man kan ikke forstå hvorfor disse insekter som blir avbildet, ikke skal nevnes ved navn, særlig fordi de ofte er økonomisk viktige dyr. I stedet gis i teksten rikelig med eksempler med artsnavn både på norsk og latin, men uten illustrasjon og uten nærmere kommentarer.

Den danske entomologen C. A. Jensen-Haarup hadde hatt en ulykke i arbeidet. I hans bok, Danmarks Fauna, 1912, var en skadet vannskorpion blitt avbildet med kløvet pusterør. Det er et skjebnens pek at samme skadete insektbilde atter dukker opp 65 år senere i en norsk lærebok i entomologi (fig. 38, s. 47). Dette innebærer feil informasjon om vannskorpionen. Feil informasjon gis også på fig. 128, s. 114. Det er avbildet en maur med vinger som tilhører en annen insektorden, formodentlig nettvinger. Dessuten er vingene feilaktig påtegnet. Fig. 127, s. 114, skal ifølge teksten forestille en arbeider-bie. Bie er den, men solitær sådan. Hvorfor skal den da betegnes som arbeider? Forøvrig er mange, kanskje de fleste, bildene i den spesielle delen fordervet gjennom svart farge som har klattet på de avtegnete figurene. Dette gjør at de detaljene man har villet vise, ikke syns (fig. 49, s. 53) og bildene selv er blitt dårlige. Dette er vel tegnerens feil, men forfatteren kunne kanskje gitt råd.

En del av de påpekte feil hadde kunnet unngås ved redigeringen. Illustrasjonene bør imidlertid byttes ut mot bedre slike. Håper anmerkningene vil være til noen hjelp ved omarbeidelsen av 3. utgaven.

Hans Kauri

H. H. Rees. 1977. *Insect Biochemistry*. 64 pp. Chapman and Hall, London. Pris £1.50.

Denne lille boken er utkommet i en serie som kalles «Outline studies in biology», og som tar for seg spesielle temaer innen faget. De er beregnet på studenter eller andre interesserte, som forutsettes å ha en del bakgrunnskunnskaper. Bøkene er ikke ment som «textbooks», men betegnes som «guide books», og kan betraktes som en slags review artikler for folk som ikke er spesialister på området.

I den foreliggende bok gir H. H. Rees en oversikt over insektenes biokjemi, og legger hovedvekten på de områder som er spesielle og særpregete for denne dyregruppen. Mer tydelig enn i mange andre fremstillinger, blir leseren klar over de mange biokjemiske tilpasninger som følger med insektenes spesielle levevis. Dette er i første rekke visse trekk ved flygeinsektenes metabolisme, og den hormonale regulering av vekst og metamorfose, men også temaer som feromoner, resistens mot insekticider og kutikulas kjemi.

Insektenes flygemuskler har en høyere metabolisme enn man kjenner fra noen annen organisme innen dyreriket. Hos Diptera og Hymenoptera kan oksygenopptaket øke med 50–100 ganger under arbeid. Stor flygeaktivitet kan opprettholdes opptil flere timer uten at insektet utvikler en oksygengjeld, og blir andpusten slik som vi mennesker. Den biokjemiske forklaring på dette har i første rekke å gjøre med den spesielle reoksydering av NADH, som dannes av glyceraldehyd-3-fosfat dehydrogenase. Hos andre dyr er tilgangen på NAD+ så og si en flaskehals i metabolismen, og reoksyderingen foregår under dannelse av melkesyre. I insektmusklene fins et usedvanlig aktivt cytoplasmatisk enzym, som omdanner dihydroksyacetonfosfat til glycerol-3-fosfat under oksydasjon av NADH. Fornyet tilgang på dihydroksyacetonfosfat sikres gjennom en spesiell reaksjon i mitochondriene. Disse forholdene har vært kjent ganske lenge, og blir her fremstilt oversiktlig og utførlig av H. H. Rees. Likeledes de nyere resultater og teorier som knytter seg til prolin og dets rolle i metabolismen ved overgangen fra hvile til aktiv tilstand i muskelen.

De prosesser som tar utgangspunkt i tyrosin, og som fører til dannelsen av sklerotin i kutikula, er også utførlig fremstilt. Men både avsnittet om nitrogenmetabolisme i forbindelse med ekskresjon, og avsnittet om resistens mot insekticider kunne etter min mening vært noe mer omfattende.

I bokens neste kapittel tar forfatteren for seg den hormonale regulering av insektenes utvikling. Den rolle hjernehormonet, hudskiftehormonet (ecdysön) og det juvenile hormon spiller, har blitt demonstrert gjennom noen av de mest elegante eksperimenter som har blitt utført innen insektfysiologi. For de to sistes vedkommende har det også lykkes å klarlegge deres kjemiske struktur. Når det gjelder ecdyson vet man også en hel del om hormonets biokjemiske virkemåte. Særlig spennende er teoriene om hvorledes ecdyson kan tenkes å utøve en effekt direkte på bestemte gen, og hvorledes dette igjen utløser en kjede av reaksjoner. Insektene har vist seg spesielt egnet for grunnleggende studier av hormonenes virkemåte, og resultatene har stor interesse innen alle områder av zoologien. Forståelsen av det juvenile hormons biokjemiske effekter er vagere, men det foreligger en rekke resultater, som gir grunnlag for forskjellige teorier. Ialt gir dette kapitlet en utmerket oversikt over disse hormonenes dannelse og fysiologiske og biokjemiske virkemåte.

Bokens to siste kapitler er kanskje noe skuffende sammenlignet med de foregående. Kapitlet om feromoner blir knapt mer enn en oppramsing av de forskjellige typene man kjenner. Man savner mange forhold som nå er grundig undersøkt, som f. eks. aggregasjonsferomoner og seksualferomoner hos barkbiller. Det aller siste kapitlet tar for seg nye metoder i insektbekjempelsen. Bortsett fra at både hormoner og feromoner har vært aktuelle så lenge at de ikke lenger representerer nye ideer, er den oversikt som her er gitt altfor kortfattet til å gi noen tilfredsstillende innføring i emnet.

Men til tross for slike innvendinger er boken nyttig lesning om insektenes biokjemi. Den kan anbefales ikke bare for studenter, men også for de som arbeider innen andre grener av entomologien, og som gjerne vil komme ajour med utviklingen på det biokjemiske området.

Lauritz Sømme

R. N. B. Prior & J. R. Morrison. 1977. Key for the Field Identification of Brassica, Potato and Sugar Beet Aphids with Photographic Illustrations. 28 pp. Ministry of Agriculture, Fisheries and Food, Middlesex. Pris £3.50.

I 1975 utga de samme forfattere en nøkkel vedrørende bladlus i korn, anmeldt i NJE nr. 1, 1976. Boken ble en suksess og idag foreligger altså bok nr. to i serien som gjelder bladlus på korsblomstrede vekster, poteter og beter. Ialt 9 bladlusarter er omtalt og samtlige er aktuelle også i Norge. Blant de 9 artene finner vi velkjente arter som ferskenbladlus, kålbladlus, betebladlus og løkbladlus. Av hver art er det både fargefoto i 17 × forstørrelse og en strektegning som fremhever de viktigste kjennetegn. Fotos og tegninger er av samme gode kvalitet som i foregående utgave. En vanlig håndlupe vil være tilstrekkelig for å identifisere artene.

Nøkkelen inneholder 14 blad (28 sider) innlagt i solid plast og således beskyttet mot fuktighet. Formatet er 21 × 13 cm. Boken er således en hendig sak å ta med seg i åkeren, og den anbefales alle som er interesert i bladlus på disse vekstene.

Boken kan bestilles hos MAFF, Tolcarne Drive, Pinner, Middlesex HA5 2DT, England.

Trygve Rygg

Ole A. Sæther. 1975. Nearctic and Palaearctic *Heterotrissocladius* (Diptera: Chironomidae). *Bull. Fish. Res. Board Can. 193,* 67 pp. Pris $4.20.

Ole A. Sæther. 1976. Revision of *Hydrobaenus, Trissocladius, Zalutschia, Paratrissocladius* and some related genera (Diptera: Chironomidae). *Bull. Fish. Res. Board Can. 195,* 287 pp. Pris $8.40.

Ole A. Sæther. 1977. Taxonomic studies on Chironomidae: *Nanocladius, Pseudochironomus* and the *Harnischia* complex. *Bull. Fish. Res. Board Can.* 196, 143 pp. Pris $6.00.

Ole A. Sæther. 1977. Female genitalia in Chironomidae and other Nematocera: morphology, phylogenies, keys. *Bull. Fish. Res. Board Can. 197,* 209 pp. Pris $ 7.20.

Disse fire taksonomiske arbeidene som er utgitt i Canada, er meget velkomne også i Skandinavia.

Chironomidae er en sentral gruppe i ferskvannsøkologisk sammenheng. Ulike slekter innen denne familien ble for rundt 50 år siden foreslått brukt som indikatororganismer i den da nyetablerte innsjøtypologien. Da dette systemet senere kom noe i miskreditt, skyldtes dette delvis den sviktende taksonomiske kunnskapen en hadde, særlig om de mere nordlige gruppene.

En omfattende taksonomisk revisjon av de slekter og slektsgrupper som er viktige/vanlige i våre innsjøer, vil ennå i lang tid fremover være nødvendig før alle chironomidegrupper kan sies å være godt kjent.

De tre første arbeidene (Bulletin 193, 195 og 196) tar opp enkelte slekter og gir en up to date revisjon av disse. Artsbeskrivelsene omfatter vanligvis hanner, hunner, pupper og larver. De beskrivende data er gitt i et oversiktlig og gjennomført system som gjør det enkelt å finne de opplysningene en ønsker. De mange målingene som presenteres angir variasjonsbredden (range) og gjennomsnitt og også hvor mange målinger som er foretatt. Det kan hevdes at det gies unødvendig mange mål på karakterer som til nå ikke har vært av identifikasjonsmessig betydning. Men verdien av å ha slike mål med variasjoner tilgjengelige når en skal gi en beskrivelse av en ny art, oppveier fullt ut et slikt argument.

Bestemmelsesnøklene virker greie og oversiktige og er, med den erfaring bruken av Bulletin 193 har gitt, gode å bruke. De inneholder riktignok en lang rekke forkortelser for de ulike morfologiske karakterene, men forkortelsene er definert på godt synlige steder i arbeidene og med noe trening byr dette ikke på problemer. Sympatiske trekk ved nøklene, som i grunnen burde være obligatorisk for slike arbeider, er sidetallshenvisning til artsbeskrivelsen og angivelse av utbredelsesregionen.

Bulletin 193 gir en revisjon av den for oss økologisk viktige slekten *Heterotrissocladius.* Interessante nyheter her er etablering av *H. oliveri* som en amerikansk søsterart til *H. subpilosus* og utskillingen av *H. scutellatus* som egen alpin motpart til vår nordlige *H. grimshawi.*

I Bulletin 195 har de igjen økologisk viktige slektene *Hydrobaenus, Trissocladius, Zalutschia* og *Paratrissocladius* fått et nytt og bedre innhold. Nå har juniorsynonymet *Orthocladius naumanni* Brundin forhåpentligvis fått sin endelige nomenklatur avklaret og skal i fremtiden hete *Zalutschia zalutschicola* Lipina.

I Bulletin 196 er revisjonen av *Nanocladius* (syn. *Microcricotopus)* av størst interesse når det gjelder de nearktiske artene, de palearktiske er tidligere revidert. Langt de fleste *Pseudochironomus-artene* er også nearktiske, bare to, *P. nigrimanus* og *P. prasinatus* er palearktiske. Revisjonen av *Harnischia*-komplekset er derimot meget sentral også for våre hjemlige forhold. Personlige erfaringer fra hvor vanskelig det er å ta seg frem i denne jungelen av synonymiserte slektsnavn gjør at en spesielt er takknemlig for oppklaringstabellen på side 85. Her er den nye inndelingen av komplekset sammenlignet med eldre fremstillinger og dessuten er fire nye slekter kommet til.

Bulletin 197 stiller i en særstilling, ikke bare blant disse fire arbeidene, men også blant taksonomiske arbeider innen Chironomidae i dag. Mens bruken av de hannlige genitaliers strukturer til artsbestemmelse nå i en mannsalder har vært obligatoriske, har de hunnlige tilsvarende strukturer ikke vært viet særlig oppmerksomhet. Bulletin 197 gir en meget omfattende sammenstilling av de hunnlige genitalier, ikke bare fra 123 slekter Chironomidae, men også for sammenligning eksempler fra 16 andre Dipter-familier. Dette bringer oss i den litt paradoksale situasjon at det nå foreligger nøkler til slekt for de fleste hunnene av Chironomidae, mens de velstuderte hannene ennå ikke er samlet i en tilsvarende oversiktsnøkkel.

Også i Bulletin 197 finnes det utførlige kladogram etter Hennigs mønster med tilhørende lister over de ulike trends apomorfi-plesimorfi. Denne måten å fremstille taksonomiske data på er absolutt tillitsvekkende. Taksonomen tvinges her til å legge frem sine overveininger og dokumentere sin oppfatning om hva som er nært slektskap på en måte som tidligere var ukjent. Dermed kan diskusjonen føres rett på de ulike enkeltvurderingene som om et trekk er apomorft eller plesimorft. Konklusjonene kommer dermed nærmest av seg selv hvis enighet om enkelthetene oppnås. De kladogrammene som finnes særlig i Bulletin 197 burde være av generell interesse også for de som arbeider med taksonomi innen andre grupper. Et mer spesielt moment i denne publikasjonen skal imidlertid nevnes, *Sergentia* er ført opp som synonym eller subgenus til *Phaenopsectra.*

Det er vanskelig å komme med innvendinger som teller noe særlig når en har en så stor stoffmengde så godt behandlet foran seg. Å hekte seg opp i et mindre vellykket detaljbilde av en mentum er i grunnen pirk. Det er den praktiske bruk av arbeidene til det de er bestemt for, å bestemme fjærmygg, som i tidens løp vil vise hvor sentrale de er i chironomidetaksonomien. Bulletin 193 har forsåvidt allerede bestått denne prøven.

Kaare Aagaard

H.-J. Hannemann. 1977. Kleinschmetterlinge oder Microlepidoptera III. *Die Tierwelt Deutschlands, 63. Teil.* 275 pp., 37 tekstfigurer, 148 plansjefigurer, 17 fotplansjer. VEB Gustav Fischer Verlag, Jena. Pris 68.– M.

De sommerfuglfamiliene vi kaller microlepidoptera er ennå relativt lite studert i Norge. Sammenlignet med de andre nordiske landene vet vi lite om faunaens sammensetning og utbredelsen av de ulike artene. Microlepidopterne kan derfor være et interessant studiefelt både for fagentomologer og for sommerfuglsamlere.

Denne boken er et verdifullt bidrag til den ellers sparsomme litteraturen som finnes om microlepidopterne. Boken omfatter familiene fjærmøll, Pterophoridae, spinnmøll, Yponomeutidae, og ekte møll, Tineidae. Først er det gitt en kort omtale av dyrenes bygning, levemåte og systematikk. Det er utarbeidet bestemmelsesnøkler frem til art og hver art er beskrevet. Larvens utseende er kort omtalt og dens vertsplanter er nevnt, likeledes sommerfuglens flygetid og biotopvalg. Det er laget gode tegninger av både hunnlige og hannlige genetalier. Imago av hvert art er gjengitt som fotografi på svart/hvitt plansjer. Disse plansjene kunne utvilsomt ha vært av bedre kvalitet, helst burde de ha vært i farger. Selv om boken bare omfatter de artene som finnes i mellom-Europa, vil den også være av stor verdi for alle som studerer de tre sommerfuglfamiliene i Norge.

Alf Bakke

Kenneth A. Spencer. 1976. The Agromyzidae (Diptera) of Fennoscandia and Denmark. *Fauna Ent. Scand. 5,* part 1 and 2, 606 pp., 922 Figs. Scandinavian Science Press, Klampenborg, Danmark.

Det femte bind av Fauna Entomologica Scandinavica har blitt så omfattende at det måtte utgis som to bøker, del 1 og 2. Forfatteren er en verdenskjent spesialist på familien Agromyzidae, minerfluene. Han har særlig interessert seg for europeiske og nord-amerikanske arter, men har også arbeidet med materiale fra andre verdensdeler.

Det ligger flere års arbeid bak utgivelsen av disse to bøkene, og det var meget heldig at K. A. Spencer hadde anledning til å påta seg denne oppgaven. Arbeidet ble utført med støtte fra forskningsrådene i de nordiske land. Forfatteren har gått igjennom alt tilgjengelig museumsmateriale, såvel bestemt som ubestemt. For å supplere materialet fra Norge foretok han en tre ukers innsamlingsreise, som bl. a. resulterte i tre nye arter for vitenskapen og 25 nye arter for Norge.

Bøkene er preget av grundighet, og forfatterens store kunnskaper på området garanterer for kvaliteten. I likhet med de andre bindene i serien, får man her en ajourført oversikt over utbredelse og forekomst av de insekter det gjelder. Denne form for faunistisk litteratur gir et fundament av stor betydning for videre studier. Som så ofte før, viser det seg at relativt få arter er funnet i Norge, og deres utbredelse innen landets grenser er mangelfullt undersøkt.

Alle Agromyzider lever på planter hvor larvene gnager ganger eller minerer i bladene. Minene har ofte en karakteristisk form, og i tillegg til at de fleste arter er monofage eller oligofage, er dette til stor hjelp ved bestemmelsen. Det er imidlertid ofte forutsetning at planten kan identifiseres, og ved innsamling av materiale bør angrepne blader tas med og presses. Metoder for klekking av fluer fra angrepne planter er beskrevet i boken.

Det er vanskelig å gi en kritisk vurdering av bøkene uten å ha prøvd dem som bestemmelseslitteratur i praksis, men ved gjennomlesning ser det ut til at de inneholder alt man kan vente og ønske av moderne faunistisk litteratur. Bøkene har en rekke bestemmelsestabeller basert på imagines, og det fins en indeks på plantenavn, som gjør det mulig å finne frem når man har en angrepet plante foran seg. Hver art er detaljert beskrevet, og dens utbredelse angitt i detalj for de nordiske land, og mer generelt for verden forøvrig. Videre gis en oversikt over vertsplanter og minenes form.

Til hjelp for bestemmelsen fins over 900 figurer tegnet med stor dyktighet av forfatterens kone, Ann Spencer. For gjenkjennelse av imagines er ofte hannens genitalier av stor interesse, men figurene viser også detaljer fra puppenes spirakler og minenes form i angrepne blad.

Bøkene avsluttes med en katalog som viser utbredelsen av de forskjellige artene i Danmark, Sverige, Norge og Finland, samt Nord-Tyskland, England og Sovjet Unionen. De har også en rikholdig litteraturliste, som vil være nyttig for den som vil fordype seg i stoffet.

Selv om serien Fauna Ent. Scand. allerede har et stort antall abonnenter, kan man neppe vente at et så spesialisert verk som dette vil bli en bestseller. Dette til tross for at minerfluene er en meget interessant gruppe biologisk sett. Men bøkene bør iallfall være tilgjengelig i biblioteker på universiteter og skoler som satser på biologisk litteratur. Det ville være å håpe at de kan inspirere til større innsats når det gjelder denne delen av Norges fauna.

Lauritz Sømme

E. Holm (red.) 1977. *Biologisk bekæmpelse af skadedyr.* 144 pp. Kaskelot Biologiforbundets forlag, Gedved. Pris d.kr. 62.–.

En rekke danske biologer, og en svensk, har gått sammen om å utgi denne boken. Hensikten er å belyse spørsmål om i hvilken grad biologiske metoder kan erstatte kjemiske midler til bekjempelse av skadedyr. Dette er ingen ny problemstilling, men boken gir en ajourført oversikt over hvor langt man er kommet på de forskjellige områder innen dette problemkompleks. Fremstillingen er populærvitenskapelig, og det er viktig at vi her har fått en utførlig oversikt på et nordisk sprog.

Jørgen Jørgensen gir den historiske bakgrunn for skadedyrbekjempelse, og siterer bl. a. Christian VI's tillatelse til å avholde en spesiell bededag «i Aggershuus Stiftt, for at formilde Guds vreede og Plage med usædvanlige Orme som fortære Markens afgrøde». Samme forfatter fortsetter med et kapittel om skadedyrenes økonomiske betydning. Hvilken reduksjon av avlingene skadedyrene egentlig forårsaker er meget vanskelig å beregne, både for enkelte land og for verden som helhet. Ofte må man nøye seg med enkelte eksempler, og forsøk på en verdensomfattende statistikk har ikke blitt gjort siden Cramers bok fra 1967. Det ville være interesant å vite om man siden den tid har kommet lenger i å holde skadedyrene i sjakk.

Tidlig i boken fins også et kapittel om skadedyr og økologi, skrevet av Broder Bejer-Petersen. Det er viktig at leseren allerede fra begynnelsen lærer å vurdere problemene ut fra en økologisk synsvinkel. Dette gjøres også i Holger Philipsen's kapittel om forebyggende metoder. Betydningen av jordbehandling, gjødsling, sædskifte, såtid m. m. for skadedyrenes velvære eller vantrivsel må ikke glemmes selv om man har kjemiske midler til rådighet. Utvikling av resistente plantesorter er også en viktig metode til å redusere skadedyrenes ødeleggelser. Dessverre tar det lang tid å utvikle slike sorter, men bl. a. har nematoderesistente potetsorter fått stor betydning.

Selv om bokens tittel er «Biologiske bekæmpelse af Skadedyr» er det viktig at det også gis en oversikt over de kjemiske midler og metoder. Johannes Keiding og Erik Kirknel har gitt en nøktern beskrivelse av deres bruksområde, om den betydning de har, og om de forskjellige problemer de avstedkommer. Til disse hører skadedyrenes resistens mot kjemiske midler. Ingen insekter kan fremvise et slikt register av resistens mot forskjellige midler som de danske husfluer. Keidings diagram over fluebekjempelse og resistensutvikling på danske gårder fra 1945 til 1972 er en interessant oversikt av det som har funnet sted.

Ole Zethner og Reinhold Charpentier beskriver den mikrobiologiske bekjempelse. Bruk av basiller og sopp har kanskje ikke gitt de resultater man hadde håpet, og iallfall her i Norden synes bruk av virus å være mer lovende. Men dette er en komplisert metode, som må tilpasses de enkelte forhold. Hvor vanskelig det kan være framgår av beskrivelsen av hvorledes man skal samle inn og dyrke insektpatogener.

Etter en kort innføring i hva det menes med naturlige fiender, skrevet av Mikael Münster-Swendsen, tar Gösta Nachman for seg bruk av predatorer og parasitter i praksis. Det innledende eksempel fra 1888 om bekjempelse av skjoldlus på citrusfrukter i California, synes å gå igjen i all litteratur om biologisk bekjempelse, og kunne gjerne erstattes med eksempler fra nyere tid. Forfatteren tar videre for seg prinsippene for innsamling, formering og utslipp av skadedyrenes fiender. For nordiske lesere er det spesielt interessant at Nachman beskriver danske undersøkelser innen området. Eksemplene fra veksthus er like aktuelle under norske forhold. Dessverre har utslipp av parasitter og predatorer på friland ennå ikke gitt de forventete resultater under nordiske forhold. Situasjonen har egentlig ikke forandret seg på mange år, og det er tvilsomt om rendyrket biologisk bekjempelse på friland vil få større utbredelse her i landet. Det fremgår forøvrig av kapitlet at metoden har hatt størst fremgang i tropiske og subtropiske områder.

Mulighetene for genetisk skadedyrbekjempelse arbeides det med i mange deler av verden, ifølge neste kapittel av Henri Mourier. Den velkjente bruk av sterile hanner hører inn under denne overskrift, men bortsett fra de resultater som her er oppnådd, hører de genetiske metoder foreløpig hjemme på det teoretiske plan.

Kapitlet om attraktanter og repellanter av Jens Kvist Nielsen, og om feromoner av Peter Esbjerg er også interessant lesning. De viser noen av de mange veier og muligheter man har for å finne nye bekjempelsesmetoder. Barkbiller har kanskje ikke den samme betydning i Danmark som i Norge, men allikevel savnes et avsnitt om disse insektenes feromoner.

Kristian Arevad tar for seg bruk av insekthormoner i bekjempelsen. Dette er også et avansert område, hvor bl. a. kjemisk forskning har resultert i en rekke syntetiske forbindelser med hormonal effekt. De beste resultater er i praksis oppnådd mot mygg. Som forfatteren påpeker kan hormoner få en viss betydning til erstatning av andre kjemiske midler.

Boken avsluttes med fire korte kapitler om integrert bekjempelse, skrevet av Peter Esbjerg, Broder Bejer-Petersen og Holger Philipsen. For en lekmann er det ofte vanskelig å få tak på hva som ligger i dette begrepet, men den oversiktlige fremstilling i disse kapitler burde være lett forståelig. Kanskje kunne det vært ofret noe mer plass på beskrivelsen av eksempler fra frukthager, hvor integrert bekjempelse har fått størst anvendelse.

Boken viser tydelig hvor omfattende dette område er. Etter min mening har forfatterne klart å gjøre stoffet populært og lettlest. Figurene er stort sett klare, men noen er forminsket for mye, og har blitt utydelige. Boken kan anbefales for alle som vil sette seg inn i dette området. Den vil være egnet for skolebiblioteker, og bør også være tilgjengelig ved universiteter og høyskoler.

Lauritz Sømme

NORWEGIAN JOURNAL OF ENTOMOLOGY

EDITOR
LAURITZ SØMME

VOLUME 24, 1977

UNIVERSITETSFORLAGET

Norwegian Journal of Entomology

Norsk Entomologisk Tidsskrift

PUBLISHER

Universitetsforlaget: P. O. Box 7508, Skillebekk, Oslo 2, Norway.
P. O. Box 142, Boston, Massachusetts 02113, U.S.A.

CONTRIBUTIONS

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NORWEGIAN JOURNAL OF ENTOMOLOGY

Volume 24, No. 2, 1977

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NO ISSN 0029-1897