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Larval morphology and development of *Aphidius colemani* Viereck and *Ephedrus cerasicola* Starý (Hym., Aphidiidae)

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Four larval instars and a prepupal stage are distinguished and described in both *Aphidius colemani* Viereck and *Ephedrus cerasicola* Starý. A detailed description is given of the tracheal system of 4th instar larvae. After one day of parasitization, the occurrence of egg and different larval instars was observed each day at 21°C. The parasites were obtained from dissected *Myzus persicae* (Sulzer).

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In previous papers (Hofsvang & Hågvar 1975 a, b, c, 1977), various aspects of the biology of *Aphidius colemani* Viereck and *Ephedrus cerasicola* Starý have been described. The present investigation deals with the development of the parasites inside the aphid.

Material and methods

In the present study, paprika plants (*Capsicum annuum* L.) in small cages were infested with *Myzus persicae* (Sulzer) from the laboratory stocks. The two parasite species had been reared in the laboratory for several generations.

The experiments were performed at 21°C, 16 hrs photoperiod, and humidity higher than 70% RH. The two parasite species were kept separately. 10–20 females and 10–20 males were allowed to parasitize aphids on an infested paprika plant for one day and were then removed. A small sample of aphids was thereafter taken from the plant at successive days after parasitization and dissected in saline solution under a stereo microscope.

Larvae from the dissected aphids were photographed through a differential interference-contrast microscope, and sketches and measurements of different structures were made. Some drops of Gisin's solution (Gisin 1960) were added to larvae of 3rd and 4th instar, making them more transparent so that the tracheal system could be easily distinguished. In addition, 2nd and 3rd instar larvae were also photo-

graphed with a Scanning electron microscope (SEM).

Having managed to separate the different larval instars of *A. colemani* and *E. cerasicola* and to distinguish the species, the developmental rate of these instars was studied in different series.

In several aphids, superparasitism was observed for both of the parasite species. In the study of developmental rate, only the oldest larvae in these aphids were noted, or if several larvae of the same instar were present, only one of these larvae was included.

Results

Morphology

Main characteristics of the four larval instars are illustrated for both species in Figs. 1–8 and are summarized below. Differences used to distinguish the two species are written in italics. Because corresponding morphological data on other aphidiid larvae are scarce, it is not known to what extent the characters below are specific for each of the two species.

A. colemani

1st instar. Mandibulate. Distinctly segmented with head, three thoracic, and 10 abdominal segments. First nine abdominal segments with a dorsolateral transverse *row of 2–8 hairs* on the

0.1 mm

A   1ST INSTAR
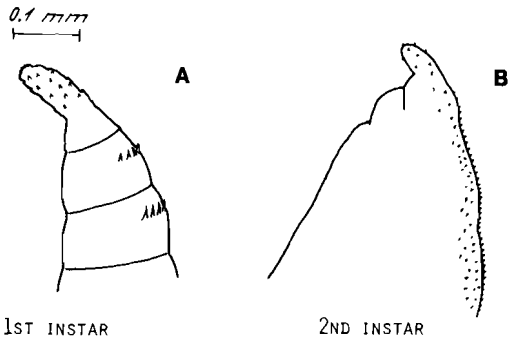
B   2ND INSTAR

Fig. 1. Caudal end of abdomen of 1st (A) and 2nd (B) instar larvae of *A. colemani*.

middle of each segment. The last abdominal segment with a well developed, *simple cauda* covered with spines (Fig. 1A).

2nd instar. Mandibulate. Rows of body hairs absent. Body segments covered with *numerous spines* dorsolaterally. Cauda present but reduced and covered with spines (Figs. 1B, 2).

3rd instar. Mandibles not visible. Body segments with *numerous spines* dorsolaterally, broadly covering the dorsum of each segment and narrowing laterally (Fig. 3). Cauda absent, caudal end of abdomen bluntly rounded, consisting of two small undifferentiated lobes. Tracheal system visible in some specimens, different stages of formation, but always closed without spiracles.

Fig. 3. Spines on body integument of 3rd instar larva of *A. colemani*. SEM 2200×.
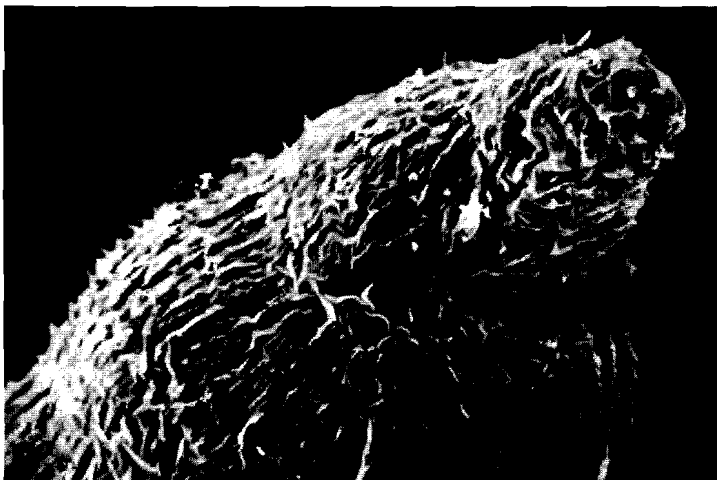
Fig. 2. Caudal end of 2nd instar larva of *A. colemani*. SEM 1000×.
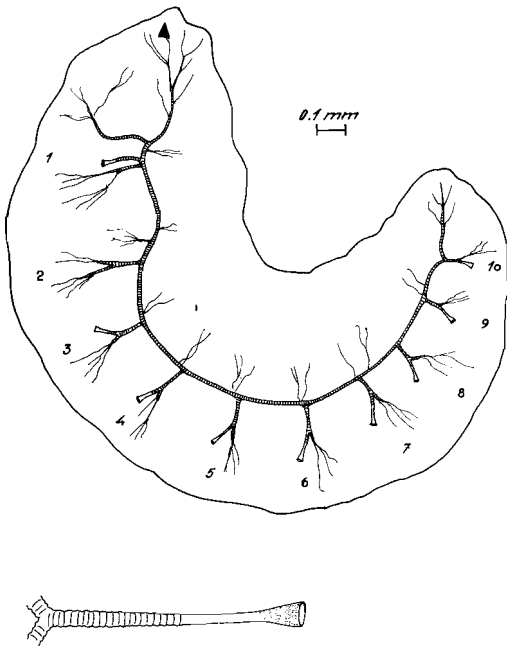
Fig. 4. Tracheal system of 4th instar larvae of *A. colemani*. Below: detail of spiracle.

Fig. 5. Anterior part of the tracheal system of 4th instar larva of *A. colemani*. S = spiracle No. 1.

4th instar. Mandibulate, jaws brown and strongly chitinized. Body cuticle densely covered with tubercles. Tracheal system and spiracles developed, different *ramification pattern* from that of *E. cerasicola* (Figs. 4, 5). Caudal end of abdomen bluntly rounded.

E. cerasicola

1st instar. Mandibulate. Distinctly segmented with head, three thoracic, and 10 abdominal segments. Metathorax and the first nine abdominal segments with a dorsolateral transverse *fringe of numerous hairs*, connected at their bases to form a saw-edged band on the middle of each segment. The last abdominal segment with a well developed cauda covered with spines, and with *two basal, ventrally directed prongs* (Fig. 6A).

2nd instar. Mandibulate. Fringes of body hairs absent. Body segments with some *scattered spines* dorsolaterally. Cauda and the *two prongs still present* but much reduced, cauda with spines. (Fig. 6B).

3rd instar. Mandibles not visible. Body segments with *sparsely scattered spines* dorsolaterally (Fig. 7). Cauda absent, caudal end of abdomen bluntly rounded, consisting of two small undifferentiated lobes. Tracheal system not visible.

4th instar. Mandibulate, jaws brown and strongly chitinized. Body cuticle densely covered with

1ST INSTAR   2ND INSTAR

Fig. 6. Caudal end of abdomen of 1st (A) and 2nd (B) instar larvae of *E. cerasicola*.
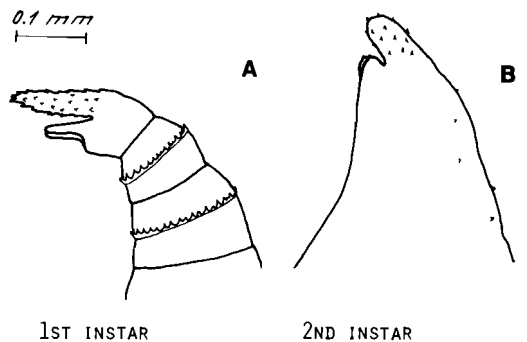
Fig. 8. Tracheal system of 4th instar larva of *E. cerasicola.*
Below: detail of spiracle.

Fig. 7. Scattered spines on the body integument of 3rd instar
larva of *E. cerasicola.* SEM 5250×.

tubercles. Tracheal system and spiracles deve-
loped, different *ramification pattern* from that of
A. colemani (Fig. 8). Caudal end of abdomen
bluntly rounded.

Some additional remarks: As the larva grows,
the segmentation becomes indistinct and the
larva gradually becomes more curved. The size
of the two last instars is obviously much depen-
dent on the size of its host. 4th instar larvae of *A.
colemani* are yellow-green, whereas those of *E.
cerasicola* are paler, yellow-white. The tracheal
system of *A. colemani* is most easily distin-
guished from that of *E. cerasicola* by the parallel
branch to spiracle No. 1, and by the side
branches to spiracle Nos. 3–10 (Figs. 4, 5, 8). In
both species, the spiracle No. 2 is replaced by a
closed branch, also this with a side branch in *A.
colemani.* When the larva is in the 4th instar, the
aphid mummifies, the cocoon being light brown
or black depending on whether the aphid has
been parasitized by *A. colemani* or *E. cerasi-
cola,* respectively. Thereafter the larva moults

to a prepupa, distinguished from the 4th instar
larva by its more pointed whitish head region,
and by the red eye pigment of the pupa gradually
becoming visible through the cuticle. At about
the time of prepupal formation, the larva empties
its undigested food, meconium, into the cocoon.

Development

Fig. 9 illustrates the time interval within which
eggs and the different larval instars were re-
corded, based on daily dissections of aphids
after one day of parasitization. Variation in size
of parasitized aphids probably explains the long
period during which each stage occurred. If
dissections of specially small aphids had con-
tinued, some instars might have proved to occur
even later than indicated in Fig. 9.

Eggs of *A. colemani* and *E. cerasicola* were
not discovered until 24 and 48 hrs after the end
of the parasitization period, when the eggs were
1–2 and 2–3 days old, respectively (Fig. 9). The
'embryo' stage in Fig. 9 is not regarded as a

□ *A. colemani*
■ *E. cerasicola*

Egg — n = 19 / n = 8

'Embryo' — n = 17 / n = 42

1. instar — n = 196 / n = 298

2. instar — n = 26 / n = 57

3. instar — n = 42 / n = 57

4. instar — n = 20 / n = 20

0-1 1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11 11-12 12-13 13-14 14-15
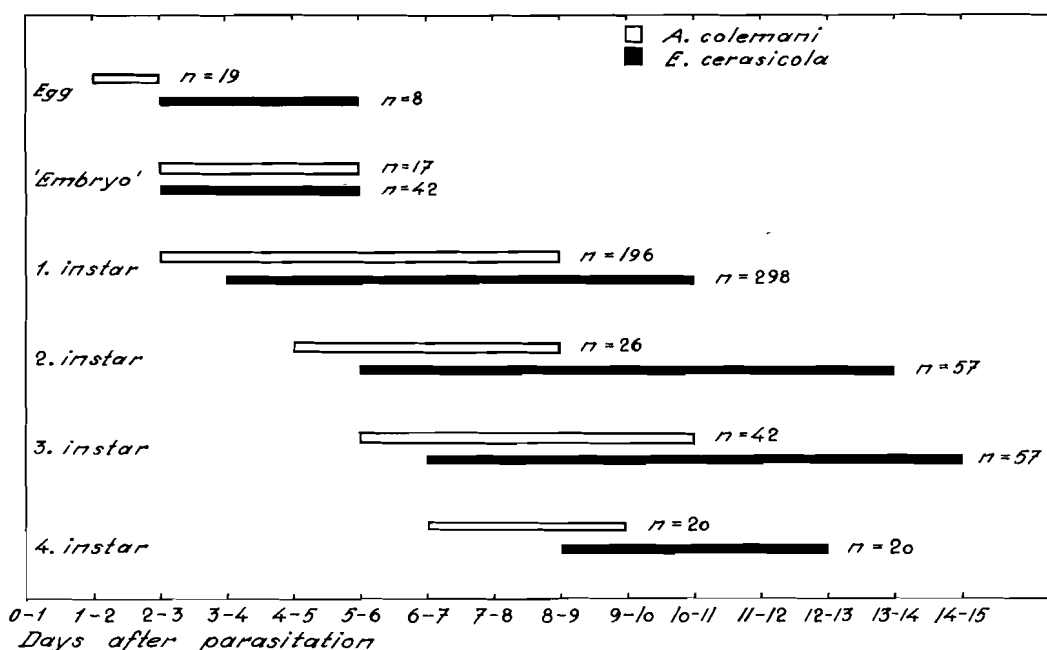*Days after parasitation*

Fig. 9. Daily occurrence of different developmental stages succeeding one day's parasitization at 21°C.

separate larval instar (see discussion). The first 1st instar larvae of *E. cerasicola* appeared one day later than the corresponding larvae of *A. colemani*. Thus, eggs of *A. colemani* are able to hatch at least one day before eggs of *E. cerasicola* at 21°C. Also the first 2nd and 3rd instars of *A. colemani* were recorded one day before the corresponding stages in *E. cerasicola*. Because the first mummies of *E. cerasicola* appeared the same day as the first 4th instar larvae, these larvae should obviously have been observed one day earlier than indicated in Fig. 9.

Compared with later stages, developmental rate of eggs and 1st instar larvae are probably little affected by aphid size. This may justify some quantification of developmental data in Fig. 9. Only one out of 298 1st instar larvae of *E. cerasicola* (=0.3%) was found the 3rd day after the parasitization period, while 24 of 196 1st instar larvae of *A. colemani* (= 12.2%) were observed the 2nd day. The difference in developmental rate is more closely treated in Table I, where the percentage of dissected aphids containing 1st instar larvae is shown. Two experiments with *E. cerasicola* which are included in Fig. 9 are omitted in Table I, because continuous dissections were not performed during the first period

Table I. Per cent of dissected aphids containing 1st instar larvae on successive days after parasitization at 21°C.

Days after parasitation	*A. colemani* Experiment no.				*E. cerasicola* Experiment no.			
	1	2	3	4	5	6	7	8
2-3	22	21	15	4				
3-4	64	92	23	14				
4-5	33			10	1	7	68	13
5-6					23	59	67	24
6-7					20	39	76	31

after parasitization here. Because early eggs are often difficult to detect, making the observed percentage parasitization unreliable, the number of 1st instars in Table I is related to number of dissected aphids. It is assumed, because parasitization was only allowed for one day, that the percentage parasitization in the daily samples of dissected aphids is fairly constant within each experiment. Fig. 9 illustrates that no eggs of *A. colemani* were recorded from day 3-4, and that the first 2nd instars occurred from day 4-5. The 2-4 fold increase of 1st instars of *A. colemani* from day 2-3 to day 3-4 is thus due to new 1st instars hatching from eggs in this period. Fur-

Table II. Number of 4th instar larvae, prepupae and pupae at successive days after mummification (mummies dissected: *A. colemani* = 64, *E. cerasicola* = 65).

Days after mummification	0–1	1–2	2–3	3–4	4–5	5–6
4th instar						
A. colemani	7	5				
E. cerasicola	9	6	3			
Prepupae						
A. colemani		15				
E. cerasicola			14	4	2	
Pupae						
A. colemani		7	11	18	1	
E. cerasicola			2	7	15	3

ther, the decrease in percentage 1st instars from day 3–4 to day 4–5 in Table I is due to that many 1st instars by this time have passed on to the 2nd instar. From the corresponding data for *E. cerasicola* in Fig. 9 and Table I, it is concluded that the majority of *A. colemani* eggs hatch after 3–4 days, whereas most *E. cerasicola* eggs hatch at least two days later.

Mummified aphids were dissected from the day of mummification and successive days thereafter (Table II). The first observation of prepupae and pupae was recorded one day earlier in *A. colemani* than in *E. cerasicola*. Previous investigations have shown that *A. colemani* has 5.5 days shorter total developmental period at 21°C than *E. cerasicola* (Hofsvang & Hågvar 1975 a, b). Most of this difference is due to a shorter period from mummification to emergence. From Table II it can then be concluded that the faster development in *A. colemani* is largely due to a shorter pupal period.

Discussion

The present morphological studies led to the conclusion that both *A. colemani* and *E. cerasicola* had four larval instars and a prepupa. The stage called 'embryo' in Fig. 9 was not regarded as a separate larval instar, although these 'embryos' were not surrounded by an egg envelope. Most of them had about the same size as ordinary 1st instar larvae and were found mainly from the day before the typical 1st instars appeared. However, they lacked the characteristics of 1st instars: distinct segmentation, body

hairs, and tail. Rather they had a granulous appearance with indistinct contours. A few 'embryos' were very elongate and resembled real embryonic stages described by Spencer (1926), Johnson (1959), and Starý (1970). The main reason why the 'embryos' are not considered as a separate larval instar between the egg and the 1st larval instar is that typical 1st instars have been observed within the egg envelope in both species. This observation is supported by Starý (1970), who states that segmentation of the body becomes easily distinguishable in the advanced embryo. Millian's (1956) description of 1st instar larva of *Aphidius platensis* Brèthes, synonymous with *A. colenani*, has some resemblance with the 'embryos', although his larvae had distinct tail with spines. Apart from Millan's study, such free 'embryos' have apparently not been described. Two interpretations of these 'embryos' are suggested: They may be real embryos with their egg envelope for some reason ruptured and probably unable to develop further, or dead 1st instar larvae in which their main characteristics have gradually disappeared.

The interpretation of morphological characters to determine the number of larval instars is to a great extent subjective. Most authors distinguish 3–5 instars in Aphidiidae. Starý (1970) states that aphidiids have 4 larval instars and a prepupa; this is supported by the present results. Larvae of *E. cerasicola* have not been described previously, whereas a short description of four larval instars in *A. platensis* has been given by Millan (1956). In his study, the two last instars correspond very well with the 3rd and 4th instars in the present study. However, his 1st instar corresponds nearest to 'embryos' and his 2nd instar to the 1st instars in the present study.

The different caudal ends in *A. colemani* and *E. cerasicola* are clearly a general difference between the two genera. *Praon* resembles *Ephedrus* in this respect and *Diaretiella* resembles *Aphidius;* this is in accordance with their phylogeny (Starý 1970). Absence of mandibles in the 3rd instar only is in agreement with Starý (1970). Most authors have found such emandibulate larvae in the 2nd or 3rd larval instar depending on total number of larval instars.

In the present study, an incomplete tracheal system, often branched, was observed in the majority of 3rd instar larvae of *A. colemani*, but never in 3rd instars of *E. cerasicola*. In both species, a branched tracheal system with 9 pairs of functioning spiracles was observed in the 4th

instars. The segmentation of 4th instar larvae was very difficult to observe. However, it is likely from the literature that these nine spiracles are situated on mesothorax and the first eight abdominal segments. In addition, metathorax has a closed branch in both species. Although some specimens showed slight deviations from the ramification pattern illustrated in Figs. 4 and 8, the species could always be identified from these figures. Very little precise information about the structure of the tracheal system in aphidiid larvae is available. Main ramification pattern has been rather insufficiently described for some species (Vevai 1942, Skriptshinskij 1930), and only one report has been published on spiracle morphology (Mackauer & Finlayson 1967).

Several authors have found a tracheal system, with spiracles, in the last larval instar only (Vevai 1942, Schlinger & Hall 1960, 1961, Tremblay 1964, Calvert & van den Bosch 1972). An additional closed system in the preceding instar has also been noticed for several *Aphidius* species (MacGill 1923, Millan 1956, Broussal 1961, 1966). Beirne (1942) observed a tracheal system in all except the first larval instar of *Praon volucre* (Haliday), but only spiracles in the last instar. The only description of a tracheal system of *Ephedrus* is given by Skriptshinskij (1930), where presence of such system both in 3rd and 4th instars does not agree with our findings.

The nine functioning spiracles in the present study are in accordance with the results of other authors (Vevai 1942, Beirne 1942, Millan 1956, Broussal 1961, 1966, Tremblay 1964, Calvert & van den Bosch 1972), although Schlinger & Hall (1960, 1961) observed 11 and 10 spiracles in *Praon palitans* Muesebeck and *Trioxys utilis* Muesebeck respectively.

Few data are available concerning developmental rate of the egg and separate larval instars of aphidiids. Johnson (1959) states that the egg of *A. platensis* in the aphid *Aphis craccivora* Koch hatches the 3rd day after oviposition at 20°C. This is in accordance with the first appearance of 1st instar larvae of *A. colemani* in this study. Johnson (1959) found that both 1st and 2nd larval instar of *A. platensis* last for only about one day each at 20°C and then followed about three further instars, which last for a total of 3–4 days.

There are great differences in the kind of embryonic development between *Aphidius* and related genera (*Diaretiella, Lysiphlebus*) on the

one hand and the relatively more primitive *Ephedrus* on the other (Starý 1970). This may be one explanation why eggs of *E. cerasicola* need longer time to develop than eggs of *A. colemani*.

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Diversity in diel periodicity of Collembola communities at Spitsbergen, Svalbard

JOHN O. SOLEM AND ERLING SENDSTAD

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Using pitfall traps in different localities in 1973 and 1974, diel rhythmic patterns of nine Collembola species were obtained. Three species appeared both years and of these *Hypogastrura hirsuta* was arhythmic both years, *Isotoma anglicana* rhythmic both years, while *Sminthurides malmgreni* was rhythmic in 1973 but arhythmic in 1974. The remaining species showed a definite periodicity the summer they were collected. It seems likely that temperature triggered the synchronization of *S. malmgreni* in 1973 but not in 1974. A temporal partitioning of the diel periodicity of the different species in the Collembola communities was found. The diel patterns of the morphologically very similar species *H. hirsuta* and *H. viatica* deviated considerably.

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It is well known that various kinds of activities of animals and plants are synchronized to the rotation of the earth, both around its own axis and around the sun. The strength of the external factors to which living organisms react varies with latitude and, for instance, light and temperature provide extreme conditions for them to cope with in arctic areas. Bünnig (1972) stated light to be a more effective synchronizer than temperature. At the latitude of Ny-Ålesund, Spitsbergen (79°N), the sun is continuously above the horizon for about four months around summer solstice. This smooths out the daily fluctuations in the light intensities compared with lower latitudes. Summer air temperature is normally only a few degrees Celsius above freezing point, and the arctic summer is short.

The following studies deal with diel periodicism of invertebrates on Spitsbergen: Remmert (1965) on birds and Diptera, Kurek (1966) on emergence in *Diamesa arctica* (Diptera), Rüppel (1968) on different terrestrial arthropods, and Syrjämäki (1969) on flight and swarming of dipterans. Krüll (1976) studied *Plectrophenax nivalis* (Aves), and Müller-Haeckel & Solem (1976) the drift of algae in a small brook. On Greenland, Møbjerg Kristensen & Vestergaard (1975) studied the collembolan species *Sminthurides malmgreni*.

The published data show that a rhythm occurs in the high arctic, and that low temperature and rain may alter or suppress the rhythm for invertebrates (Rüppel 1968, Møbjerg Kristensen & Vestergaard 1975).

The present study was part of a project on terrestrial invertebrate ecology on the arctic tundra. The objectives were to obtain information about the composition and diel periodicities within Collembola communities. Sendstad (1976) treated the composition of Collembola communities at Spitsbergen.

Investigated area and methods

The field work in 1973 was carried out on Kap Wijk (78°N) in a *Caricetum ursinae* society (Hadac 1946), greatly affected by the sea, and in 1974 in a moss area on the shore of Storvatn, Ny-Ålesund (79°N). At Kap Wijk ten pit-fall traps were operated and emptied manually every third hour during a 24-hr period per week, in July and 1–20 August. At Ny-Ålesund five pit-fall traps were emptied manually every second hour throughout a 24-hr period. In total six collections, that were evenly spaced in time from early July to late August, were carried out.

Air temperature and humidity measurements were recorded continuously on a thermohydrograph. Temperature at various levels was recorded by thermistors and one of them was placed on the soil surface and shaded against sunlight by an aluminium roof, to give the surface temperature. Additionally, remarks on
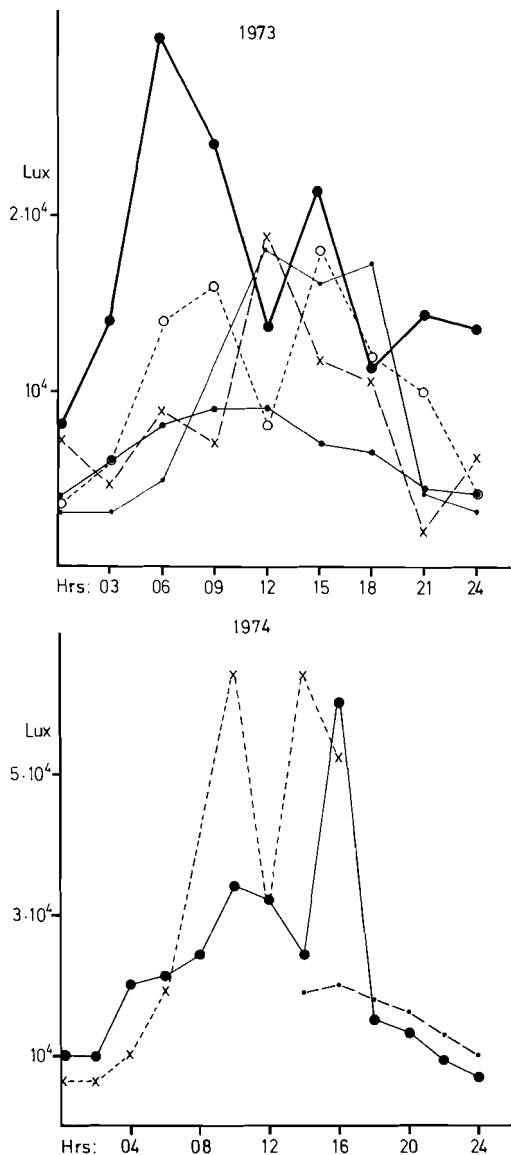
Fig. 1. Fluctuations in total light intensities at Kap Wijk 1973 and Ny Ålesund 1974, during selected 24-hr periods.

traps and thus may disturb the populations. However, special care was taken at this point. The collector used a definite route and did not step closer to the traps than 50–60 cm.

Environmental factors

During July and August the sun is well above the horizon all day and night and the elevation from a northern to a southern position is fairly small. Highest light intensities normally occurred around noon, but depending on the weather conditions, maximum values during a day were also obtained in the morning and/or the evening.

In the summer 1973 there was much cloudiness, fog, and rain at Kap Wijk, and the total light intensities ranged between 4,000 to nearly 30,000 lux. The corresponding values at Ny-Ålesund in 1974 were 6,000 to 64,000 lux (Fig. 1). In both years light measurements were taken on the days and nights when data for the diel periodicity were collected.

The temperature was continuously recorded, and showed regular daily fluctuations at the surface level (Fig. 2). In early July 1973, the daily amplitudes at the surface were about 3–4°C. These fluctuations increased successively to a maximum of 8–12°C from 10–20 July and decreased again to only about 3°C in August. In 1974 the daily temperature fluctuations were smaller than those of the previous year; the maximum range was only 4–5°C at the collecting area.

External factors like wind, humidity, and air temperature fluctuated irregularly as expected. For more information about the periodicity of external factors acting on animal and plant life on Spitsbergen, see Müller-Haeckel & Solem (1975) and Krüll (1975).

Results

The numbers captured at 2 or 3 hour intervals in the pit-fall traps are considered to reflect the locomotor activity of the invertebrates. In 1973 data on *Sminthurides malmgreni, Isotoma anglicana, Archisotoma besselsi, Hypogastrura hirsuta, H. viatica, Xenylla humicola,* and *Folsomia quadrioculata* were obtained, and in 1974 we got data on *S. malmgreni, I. anglicana, Agrenia bidenticulata, Z. hirsuta,* and *H. tullbergi.*

environmental factors like wind, cloudiness, and precipitation were made.

To record diel periodicity of Collembola, pit-fall traps were also used by Rüppel (1968) and Møbjerg Kristensen & Vestergaard (1975), and they reflect the locomotor activity in populations because only moving animals are captured. A critical point in the method is the time of emptying, when the collector approaches the

Fig. 2. Fluctuations in soil surface temperature at the sampling sites in 1973 and 1974. The time period with highest amplitudes has been selected.
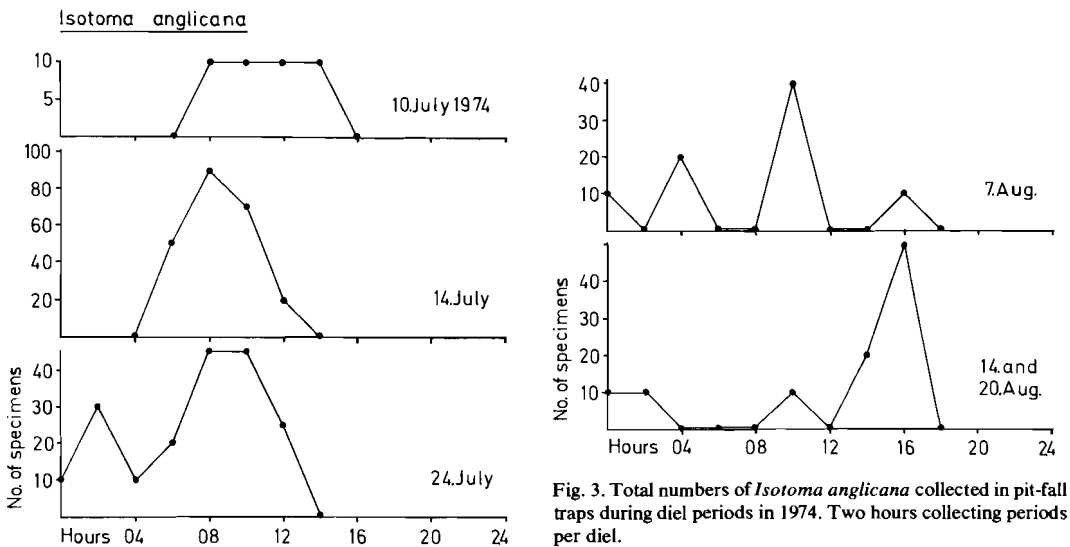
Fig. 3. Total numbers of *Isotoma anglicana* collected in pit-fall traps during diel periods in 1974. Two hours collecting periods per diel.

Sminthurides malmgreni
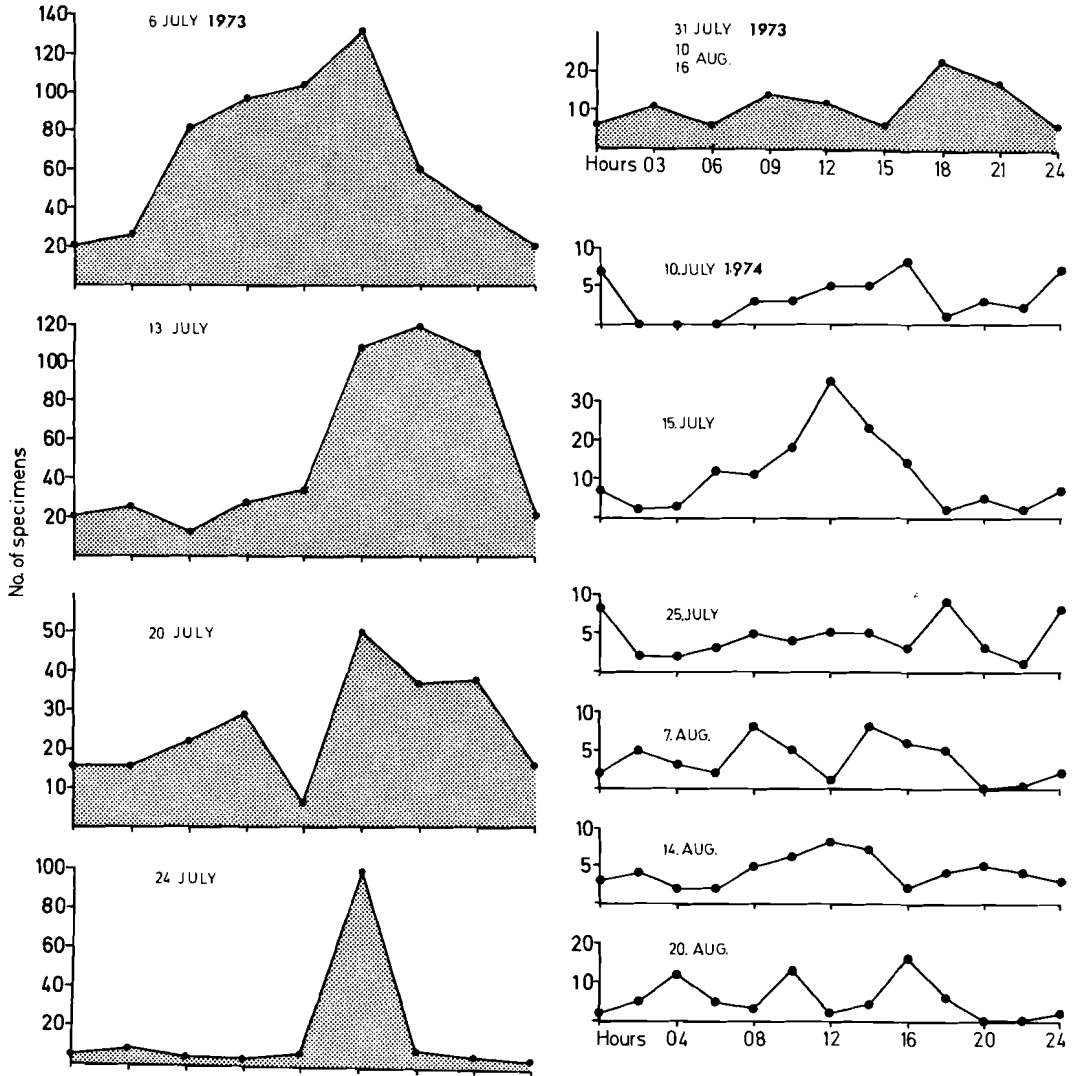
Fig. 4. Total numbers of *Sminthurides malmgreni* collected in pit-fall traps during diel periods in 1973 and 1974. Three hours collecting periods in 1973 and two hours in 1974 per diel.

Except for *Sminthurides malmgreni* and *Hypogastrura hirsuta,* the remaining species performed a definite periodicity as exemplified by *Isotoma anglicana* (Fig. 3). *Sminthurides malmgreni* was rhythmic in 1973 and arhythmic in 1974 (Fig.4), and *Hypogastrura hirsuta* was arhythmic in both years (Fig. 5).

Isotoma anglicana had its activity peak in the afternoon (1500 hrs) in 1973, while the peak

appeared in the morning around 0800 hrs in 1974. In 1973, when *Sminthurides malmgreni* exhibited a rhythmicity, the very peak of its activity shifted irregularly between 1500–1800 hrs, while *Hypogastrura viatica* and *Archisotoma besselsi* had a more regular shortening of their inactivity period as the peak drifted from 1500–1800 hrs to 1200–1500 hrs. This may indicate that the activity period run freely.

The locomotor activity of the two species *Hypogastrura hirsuta* and *H. viatica,* which appeared together in 1973 and are morphologically closely related, were temporally separated. *H. hirsuta* performed arhythmicity while *H. viatica* was rhythmic. The same pattern occurred also in 1974 when *H. hirsuta* and *H. tullbergi* were collected together.

Discussion

The presented data confirm earlier statements that most species are synchronized to the 24-hr cycle, but that some species in the high arctic lose contact with the Zeitgeber at summertime (Müller 1968, 1972), and show a free-running and/or arhythmic locomotor activity pattern. Among the Collembola at Spitsbergen only *Hypogastrura hirsuta* showed arhythmicity both years, while *Sminthurides malmgreni* was not synchronized during one summer only. Under natural conditions, the light cycle is the prime Zeitgeber entraining the circadian rhythms of most animals (Aschoff et al. 1972), but slight diurnal temperature changes are sufficient and may synchronize circadian rhythmicity (Bünning 1972). Because the fluctuations in the total light intensities had a wider range in the daily amplitude in 1974 than in 1973 (Fig. 1), and because the opposite was the case with temperature (Fig. 2), it is reaspnable to believe that temperature was the trigger for the different activity patterns of *Sminthurides malmgreni* these two years. That low temperature and/or rain may alter the activity rhythm for invertebrates was also demonstrated by Rüppel (1968) and Møbjerg Kristensen & Vestergaard (1975). In the present study the range between maximum and minimum values of surface temperature was of the order of 8–12°C in July (the summer month) in 1973, while the corresponding values in 1974 were 4–5°C. The lowest temperature recorded in this period in both years was about the same level, ca. 4–7°C. As *Sminthurides malmgreni* was synchronized in 1973 but not in 1974, this indicates that at this temperature regime the species needs daily temperature fluctuations exceeding 5°C to manage synchronization to the 24-hr cycle.

Neither changes in light intensities nor temperature managed to synchronize *Hypogastrura hirsuta* fully in these two years. Therefore, the species must be less sensitive to diel tempera-
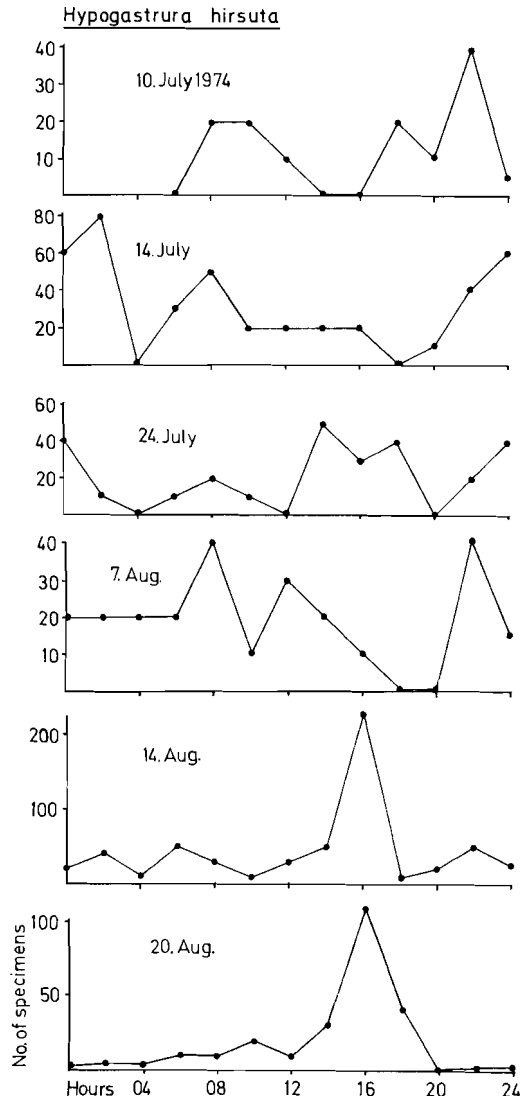
Fig. 5. The total numbers of *Hypogastrura hirsuta* occurring in pit-fall traps during diel periods in 1974.

ture fluctuations than *S. malmgreni.* The remaining species were synchronized to the 24-hr cycle and showed a higher sensitivity to daily amplitudes in temperature and/or light intensities than *S. malmgreni* and *H. hirsuta.*

The different reactions towards the Zeitgeber (s) of the various species should be of great importance to a community, because then we will have a daily temporal partitioning of the niches as well as a spatial one. In areas where physical factors control the communities to such

a degree as in the arctic, and where also nutrients are fairly homogenous and impoverished, the different diel patterns and some flexibility in the diel patterns ensure the collembolan society can exploit suitable time periods for particular locomotor activities. The temporal partitioning also causes a more definite separation of the niches between species. This is demonstrated by the species pairs *Hypogastrura hirsuta* and *H. viatica* in 1973, and *H. hirsuta* and *H. tullbergi* in 1974, and may partially explain the coexistence of morphologically very similar species. Species-specific activity times during a 24-hr period will also reduce the possibilities for cross breeding between different species.

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Cryptopygus sverdrupi n.sp. A new species of Collembola (Isotomidae) from Sverdrupfjella, Antarctica, with notes on related species in five genera

PETER N. LAWRENCE

Cryptopygus sverdrupi n.sp. is described from five localities in Sverdrupfjella, Queen Maud Land, Antarctica, c. 0°–1°30′ E, 72°–73°S where it occurred among scree. It is separated from its nearest relatives by reduction of the sixth eye and furcula, also by specialisation of tenent hairs and cuticular structure. The new species is at an extreme end of the structural range of the genus and its affinities with the three monotypic genera *Neocryptopygus, Gresittacantha, Weberacantha,* as well as with species in *Anurophorus,* are discussed.

The material was collected in Queen Maud Land by Mr. Jens Angard, biologist on the Norwegian Antarctic Expedition 1970–71.

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Type material

Holotype. Unsexed, darkly pigmented specimen returned to spirit. From a scree, N. W. Tverrnipa, 4 Jan. 1971, J. Angard, Coll. Sample 13 (Paratypes same data, 1 ex. on slide, 1 ex. on stub, 9 ex. in spirit).

Paratypes. Under single scree stone, Storkvaeven, 1800 m. 30 Dec. 1970, J. Angard, Coll. Sample 10 (1 ex. on slide, 3 ex. in spirit). N.W. slope of scree, Sørhausane, 1950 m. 31 Dec. 1970, J. Angard sample 11 (1 ex. on slide, 1 ex. on stub, 5 ex. in spirit). From a scree. Vendeholten, 1650 m. 4 Jan. 1971, J. Angard, sample 14 (1 ex. on slide, 4 ex. in spirit). Level ground scree, Nunatak W. of Tua, 7 Jan. 1971, J. Angard coll. sample 18 (1 ex. on slide, 1 ex. on stub, 6 ex. in spirit).

Holotype and half of the paratypes are deposited at the Zoological Museum, University of Oslo, remainder of the paratypes are deposited in the Department of Entomology, British Museum (Natural History).

Description

Length up to c. 1.2 mm. Colour dark blue black with pigment arranged in hexagonal blocks darker at their margins. The enclosed areas are paler intersegmentally and ventrally. Postantennal organ sometimes with weak median constriction. The ratio postantennal organ/nearest ocellus c. 1.25:1. Eyes 6 + 6 (sometimes 5 + 5?). Tibiotarsal tenent hairs 2, 2, 2 among the apical whorls of 7 setae. Claw with a pair of lateral teeth but apparently no inner tooth. Rami of tenaculum (Tn) tridentate with 2 setae on the corpus. Manubrium (Mn) with c. 16 posterior setae, anterior setae absent. Dens (D) less than half the length of manubrium with single anterior seta reaching beyond apex and pair of posterior setae of which proximal is about twice the length of the distal. A minute 3rd posterior seta exists midway between this pair. Mucro bidentate less than half as long as dens. Anal spines absent.

Cuticular structure

Examination of the cuticular structure was carried out using the Scanning Electron Microscope, but its general modification can be resolved using a phase contrast oil immersion objective of NA 1.3. Most of the dorsal surface of the tergites consists of irregularly placed fields of quadrangular granules each resulting from the fusion of a pair of primary triangular granules (Fig. 2D). Primary granulation can be seen at

the intersection of the fields, on intersegmental membranes, ventral surface, and appendages. The fusion of quadrangular granules into polygonal areas is common but not extensive and the distance between granules is approximately equal to their width. The cuticular structure of the eyes is of particular interest and can barely be resolved by the light microscope under which they appear to be almost smooth. In fact the eyes of this species are covered with extensively fused polygonal granules (Fig. 2C) strongly contrasting with the primitive structure of the primary granules at the antennal base.

Variation

The sixth eye is so reduced that it can only be resolved clearly using the Scanning Electron Microscope. Light microscope examination reveals the presence of only 5 eyes on each side of the head of some specimens. It may be that this is the actual number in some examples of this species where the 6th eye has completely degenerated.

Some tibiotarsal setae of the anteapical whorls are about twice the length of their neighbours and are apically recurved with a tendency to dilate. These setae are intermediate between common setae and tenent hairs in positions hitherto undescribed for the genus. However, among examples of *C. antarcticus* from Signy Is., South Orkneys, cultured at Monks Wood by the British Antarctic Survey, are individuals with weakly apically dilated 3rd tenent hairs on tibiotarsus III. An obviously additional clavate seta on *C. sverdrupi*, tibiotarsus iii (Tiii) from sample 18 is Bl, making the number of tenent hairs 2, 2, 3. Seta Bl on anterior legs (Tii, Ti) is progressively less clavate and it becomes a matter of opinion whether or not it is regarded as specialised. On tibiotarsus ii (Tii) B1 and B2 are more similar in length to each other and still about twice as long as B4 and B5. This stage of development of tenent hairs lends itself to being expressed as 2, 4, 3. The dens is sometimes as little as 1/5 the length of the manubrium and only about as long as the claw. The third minute posterior dental seta has thin walls and is likely to be invisible against dark pigment or macerated out of recognition by too harsh an attempt to clear the specimen. However, although this tiny seta can be resolved using the SEM or on a cleared and dissected furcula, viewed with an oil-immersion, phase-contrast objective of NA

1.3, its stage of degeneration is so extreme that its absence from some examples is quite possible.

Relationships

Within its genus, *C. sverdrupi* most nearly resembles *C. pilosus* (Womersley, 1934) from South Australia and *C. cisantarcticus* Wise, 1967 from Balleny Islands. *C. cisantarcticus* has 3 anterior and 4 posterior dental setae while *C. pilosus* has 3 anterior and 3 posterior and the further reduced *C. sverdrupi* dens carries only 1 anterior and 3–(?2) posterior setae. *C. pilosus* has 6 well developed eyes on each side of the head, while *C. cisantarcticus* has 6 of which one is reduced. The reduced 6th eye of *C. cisantarcticus* is situated between 3 anterior and 2 posterior ocelli, while the reduced 6th eye of *C. sverdrupi* is the most posterior of the group.

Since *C. sverdrupi* is the *Cryptopygus* least well adapted to leaping, it is here compared with other Isotomids which have abdomen V and VI fused and rudimentary furcas. These include three monotypic genera, 1) *Neocryptopygus*, 2) *Gressittacantha*, and 3) *Weberacantha*.

1) *N. nivicollis* Salmon, 1965, was described from 5 stations in S. Victoria Land. Salmon (1965) describes 5 eyes, mucro absent or fused to the dens and a 'peculiar, slit-like partial separation anterodorsally of abdomen VI from abdomen V'. Further examination may show this slit to be a modification of the anal valve, in which case the genus is simply a *Cryptopygus* with a mucro fused and reduced perhaps to nothing. It is curious that despite its more extremely degenerate mucro, the dens retains 2 anterior and 4 posterior setae, a number in excess of that in *C. sverdrupi*.

2) *G. terranova* Wise, 1967, was described from about 40 specimens collected on 6 dates in 1963 from South Victoria Land 74°55′S, 164°06′E. Wise (personal communication 10 March 1977) suggests that both *Gressittacantha* and *Neocryptopygus* might be regarded as synonyms of

Fig. 1. Cryptopygus sverdrupi sp. nov. A. Antenna, D. Dens, E. Eyes, F. Femur, Mc. Mucro, Mn. Manubrium, P. Postantennal organ, T. Tibiotarsus, Tn. Tenaculum.

1 A

Mc

D

Mn

E

P

F

F

F

Tn

Tiii

Tiii

Ti Tii Tiii
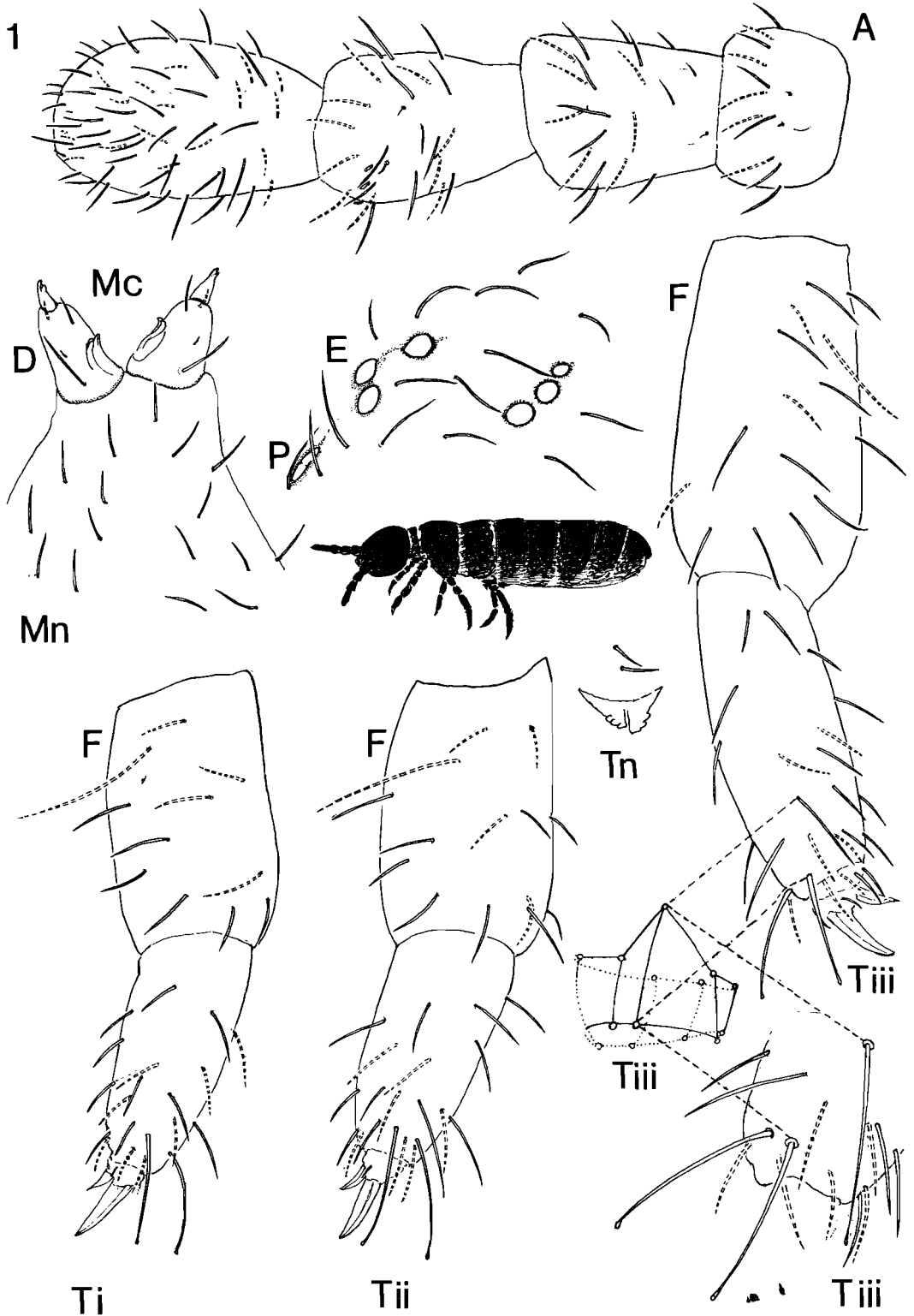
Cryptopygus. Certainly it is apparent from Wise's paratypes that abdomen V and VI are fused and *Gressittacantha* might therefore be regarded as a *Cryptopygus* with 6 slender abdominal spines (or stout setae). Wise describes the species with apparently 5 eyes on each side of the head but suspected the possibility of a 6th, which is now resolved with the SEM and found to be reduced and positioned as in *C. sverdrupi*. Wise interestingly figures tibiotarsus III with a third tenent hair in whorl B, more strongly developed than that of *C. sverdrupi*, with clavate apex greater than that of the pair of tenent hairs in whorl A. The dens of *C. terranova* has only 2 setae, both of which are on the posterior face. The eyes of *C. terranova* are mostly covered with triangular and quadrangular granules (Fig. 2E) in contrast to the more extensive polygonal fusion in *C. sverdrupi* (Fig. 2C). The cuticle of the tergites (Fig. 2F) shows more triangular granules and the flat quadrangular granules are mostly separated by less than their diameters.

3) *W. octa* Christiansen, 1951 was described from Arctic Alaska on the basis of 13 specimens. Christiansen (1951) remarks that the division between the 5th and 6th abdominal segments is sometimes obscure. The only trace of such a structure which appears on his figure of this species is so close to the margin of the anal valve that a situation similar to that of *Gressittacantha* is approximated. *Weberacantha* has 8 conical spines, while *Gressittacantha* has 6 slender spines. However, in other genera where abdominal setae have evolved into spines, e.g. *Friesea*, such a difference between species is not uncommon. *Weberacantha octa* has 1 anterior and 4 posterior or 3 anterior and 2 posterior dental setae, depending on which face one regards 2 internally-placed setae as occurring. It has a tridentate mucro and a pair of anterior manubrial setae which enable it to be distinguished from the species under discussion.

Discussion

The tergal cuticle in *C. sverdrupi* (Fig. 2D) is more similar to that of *C. cisantarcticus* (Fig. 2H) than to that of *C. pilosus* (Fig. 2B). However, the *C. sverdrupi* eye cuticle (Fig. 2C) is intermediate between *C. pilosus* (Fig. 2A) and *G. terranova* (Fig. 2E). All these three

species have 12–14 granules across the diameter of the eye, while *C. cisantarcticus* (Fig. 2G) has c. 36 granules conspicuously smaller than those of the surrounding cuticle.

The type of cuticular structure on *C. sverdrupi* eyes, which covers a larger part of the tergites of *C. pilosus*, resembles that of *Anurophorus laricis* and other xerophiles of the Northern Hemisphere. It is not clear if this is due to common ancestry or if freezing conditions in polar regions have created a similar shortage of available water to that experienced by corticole and lichen-inhabiting species in temperate climes. In order to conserve water, cuticular granules appear to have expanded and fused to cover the respiring surface. As eye number is reduced on a number of unrelated Collembola adapting themselves to sub-surface life, it is possible that the cuticular modifications following such reductions indicate relationships not always apparent from the study of gross structures. The furca of *C. cisantarcticus* is similar to that of *C. pilosus*, but the cuticular structure, particularly that of the eyes, is markedly different. The furca of *C. sverdrupi* is at the extreme end of the structural range in the genus. Were it missing entirely, *C. sverdrupi* would be an *Anurophorus*, like *A. sudpolaris* which Wise (personal communication) compares with *Neocryptopygus nivicolus*. The extra tenent hair of *C. sverdrupi* is also developed on *G. terranova* and such hairs are typical of *Anurophorus*. *C. sverdrupi* appears to occupy a position intermediate between *C. pilosus* and *Gressittacantha*. Its relationships to such genera as *Dagamaea, Isotomodella, Mucracanthus, Biacantha, Tuvia, Narynia, Weberacantha* and the Anurophorines pose interesting zoogeographical questions whose answers may contribute towards unravelling the possible polyphletic nature of the large genera *Proisotoma, Folsomia*, and *Cryptopygus*. *C. sverdrupi* has fused abdomen V and VI in common with *C. thermophilus*. This species, however, is much more similar to *Proisotoma tenella* and *Pseudisotoma* than it is to *C. sverdrupi, C. pilosus*, and the type-species of *Cryptopygus antarcticus*. The position of *C. sverdrupi* near spined and furca-less Isotomid

Fig. 2. Eye and tergal cuticle of *Cryptopygus pilosus* (A, B), *Cryptopygus sverdrupi* (C, D), *Gressittacantha terranova* (E, F), and *Cryptopygus cisantarcticus* (G, H).
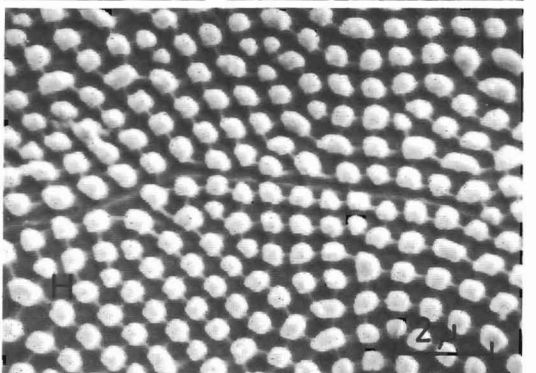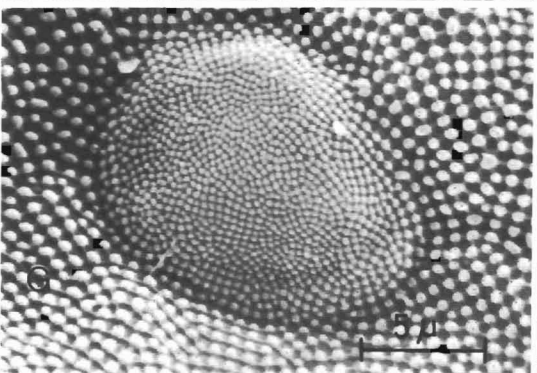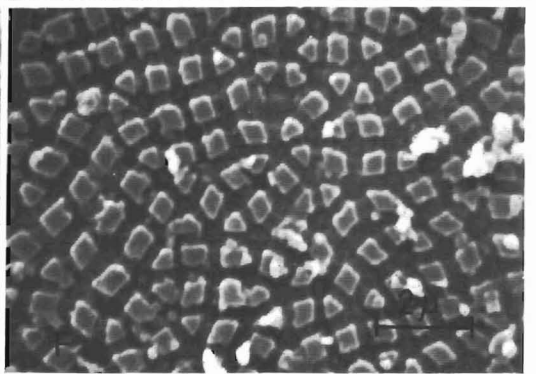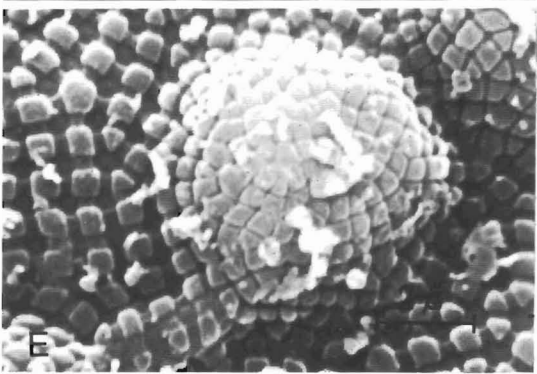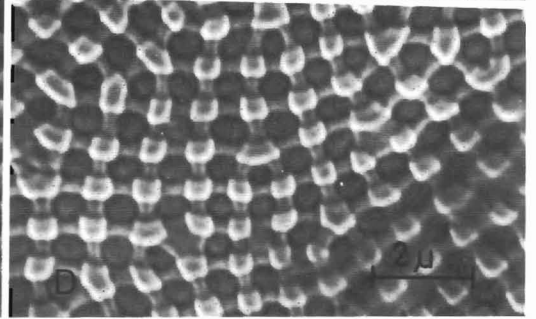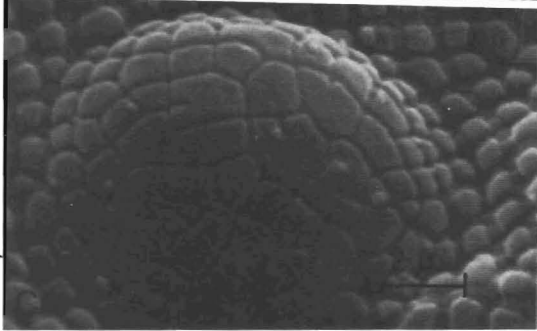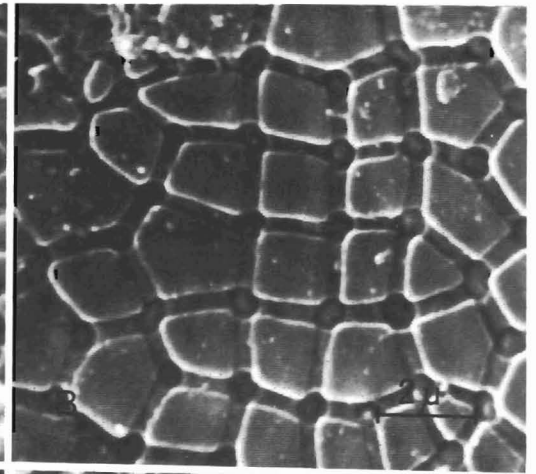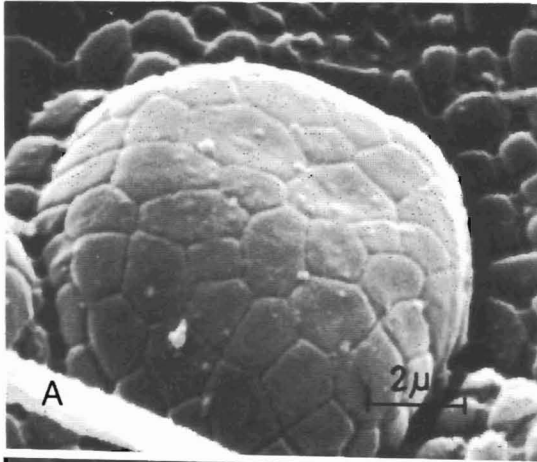
genera suggests routes by which such forms may have evolved. It is possible that with the reduction of the furca, some other way of evading predators has been devised. This reduction, like that of eyes, has occurred in a number of otherwise unrelated genera, for example *Onychiurus* (Protaphorura) (Onychiuridae), *Schaefferia* (Hypogastruridae), *Friesea* (Neanuridae). Each of these genera has, like *Gressittacantha, Weberacantha, Biacantha, Pseudofolsomia, Tuvia, Paruzelia, Uzelia,* and *Tetracanthella* (Isotomidae), accompanied reduced furca with developed spines on abdomen VI. It is possible that such spines function as a means of gripping the roof of a small space where the specimens can retreat to avoid predators.

The reduced furca of *C. sverdrupi* at the extreme end of the structural range in the genus, combined with the provision of an extra tenent hair, might be assumed to have special advantages in an extreme environment. Tenent hairs presumably aid balancing and are especially well developed on arboreal and herbivorous species. Furcal reduction is characteristic of species living deeper in the soil where there is no room to jump. Although *C. sverdrupi* occupies neither of these niches, its combination of characters probably enables it to balance over the loose scree among which it is found and to squeeze into small spaces under unfavourable condi-tions. The spaces among scree probably form small cavities in which a reduced furca may still serve some jumping function, so that the anal spines characteristic of the closely related *Gressittacantha* remain undeveloped.

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The chironomids of lake Målsjøen. A phenological, diversity, and production study

KAARE AAGAARD

A total of 76 species of chironomids is reported from lake Målsjøen, S-Trøndelag, Norway. The emergence season in Målsjøen can be divided into five periods, each of them shorter and more concentrated compared to southern lakes. Abiotic factors affecting the emergence periods seem to comprise both photoperiods and temperature, either separate or together. Spring-emerging species are clearly triggered by temperature, summer-emerging species more by photoperiod. Species which have a development time of more than one year seem to be less dependent on abiotic factors, but are still well synchronized within each lake.

The chironomid society of the littoral of Målsjøen comprises a large number of species (40–50) and shows a high diversity. The profundal is much poorer in species (8–9) and is largely dominated by *Stictochironomus rosenschöldi, Sergentia coracina,* and *Micropsectra insignilobus.* A production estimate for the total chironomid society in the profundal indicates values of 2–3 g dry weight per m² yearly.

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During the period 1970 to 1973, freshwater biological investigations were carried out in lake Målsjøen. These investigations, which aimed at giving information about the ecology of a small mesotrophic lake, typical for the lowland area of Trøndelag, were carried out by scientists and students from the University of Trondheim. The object of this paper is to present the results of the phenology, diversity, and production studies of the chironomids in Målsjøen.

Lake Målsjøen

Måsjøen (Fig. 1) is situated about 25 km south of Trondheim, on the border between Klæbu and Melhus municipalities, and is a natural, mesotrophic lake, surrounded by forest, moor, and cultivated land. The geographic coordinates are 63°14′N, 10°26′E (UTM: 32V NR8213). The lake is about 1.4 km long, 0.3 km broad, with a surface area of 0.25 km², a maximum depth of 13 m and the area with depths less than 3 m amounts to 67% of the total area of the lake. The altitude is 166 m a.s.l. There is no considerable through-flow of water; only a few small brooks enter or leave the lake.

The sediments in the first 4 m below the water level consist mainly of brown gytja, rich in organic particles. Below 4 m the sediments are black and rich in iron. In the transition zone, at about 5 m depth, the sediments are mixed with a large number of empty shells of *Pisidium* which make a typical mussel zone.

The temperature was measured continuously by copper constant-thermoelements at depths of 0.2, 1, 3, 5, 7, and 10 m. The measurements were taken at the maximum depth of the lake. This temperature registration covers the period from July 1971 to December 1972 (Koksvik 1975). The lake is ice-covered from the beginning of November until the beginning of May. The maximum thickness of the ice is about 70 cm and occurs in March–April. The surface temperature rises quickly to 10°C in May. A thermocline is usually established in June, with a temperature of 15–20°C in the epilimnion and 7–10°C in the hypolimnion. Metalimnion is usually situated at 5 m depth. This situation is supposed to be stable most of the summer, but may be disturbed a little by windy and rainy periods, as in July 1971. Målsjøen is a stable, dimictic lake.

Exhaustive hydrographic data are given by Reinertsen (1973). Therefore, only a few data are given here. The pH-values were found to lie

Fig. 1. Lake Målsjøen, South-Trøndelag (photo J. I. Koksvik).
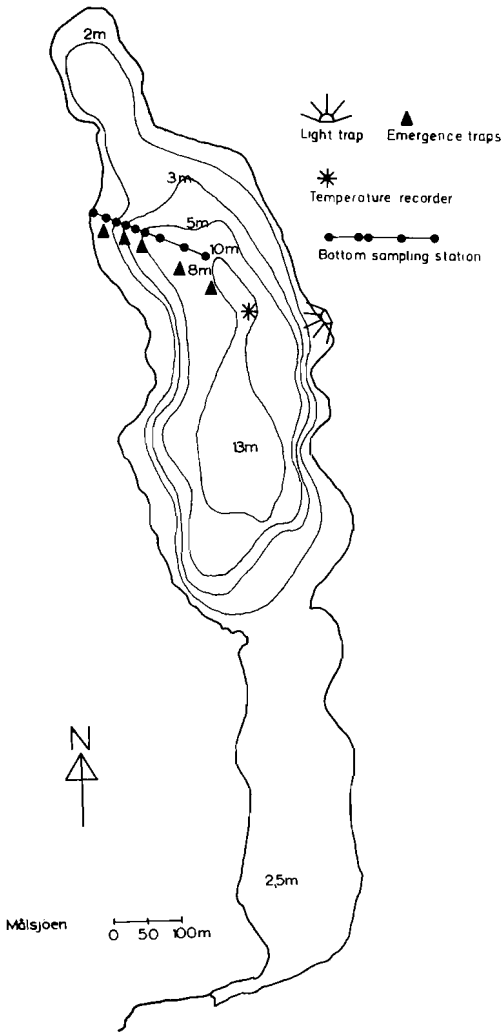
Fig. 2. Morphometric map of Målsjøen with bottom sampling stations and positions of emergence traps, light trap, and temperature recorder.

between 6.4 and 7.3. The O_2 saturation in the profundal was found to be less than 5% twice a year – at the end of the ice-cover period in April and in the late summer. The CaO content and $KMnO_4$ values indicate a soft mesohumic to polyhumic lake.

Light measurements give a 5 lux limit at 8–9 m depth in the summer (Reinertsen 1973).

Thorough macrovegetation analyses have been carried out by Sæther (1976). The zooplankton has been studied by Jensen (1976).

Extensive studies of the benthic fauna were made, and some of the results of the non-chironomid benthic studies have been published by Solem (1973) and Koksvik (1975, littoral Cladocera). The most diverse groups are the Gastropoda (5 species), the Ephemeroptera (8 species), and the Trichoptera (about 60 species). Less diverse was the fauna of Plecoptera, Oligochaeta, Pisidium, and Sphaeridium. *Gammarus lacustris* was found. Char (*Salvelinus alpinus* L.) and burbot (*Lota lota* L.) are the dominating fish in Målsjøen, in addition to a small number of trout (*Salmo trutta* L.).

Methods

Bottom samples were taken every month in a period from June 1970 until September 1971 (except December 1970) along a sampling transect (Fig. 2). Five grabs were taken every month at each depth: 0.2, 1, 2, 3, 4, 5, 6, and 8 m. For six months, samples were also taken at 10 m. Sometimes the sampling at the 0.2 m depth was impossible because of the ice thickness.

The samples were taken with a standard Ekman grab, covering an area of 200 cm². The five grabs, constituting each sample, were usually treated together. However, the grabs taken 18 March and 20 April 1971 were treated separately, and information about distribution is obtained from these samples for the most important species.

The material was sieved through a set of three screens, the smallest mesh width being about 0.5 mm. The animals were removed in a living state from the residue and preserved in 70% alcohol. As the bottom-sample programme was a part of the common freshwater ecological project, the sorting was carried out by many different people during the investigation period.

The use of a grab of the Ekman type has been thoroughly discussed in the literature, cf. Aare-

fjord (1972) and Edmonson & Winberg (1971), who point out that the Ekman grab is specially constructed for soft sediments. If the grab is lowered at a moderate speed, the disturbance to the sediments is supposed to be small.

The emergence traps used were of the submerged funnel type used by, among others, Brundin (1949). The traps used in Målsjøen were made from a brass screen with mesh width 0.5 mm. A collar of zinc kept the collecting glass, half-filled with air, in position. The trap covered 0.25 m² and the total height was 45 cm. The collar was destroyed by corrosion after ca. seven months' use, and had to be replaced. The efficiency of such funnel traps has often been discussed in the literature (Mundie 1956).

One trap was placed at each depth of 1, 3, 5, 7, and 9 m in Målsjøen (Fig. 2). They were operated in the period from 18 May to 15 October in 1971, and from 10 May to 20 September in 1972. In 1971 the traps were emptied every second to third day, in 1972 every third day in the periods of great emergence activity, otherwise every sixth day.

One light trap, described by Solem & Hauge (1973), was operated in 1972, and emptied every seventh day during its operation period, 22 April to 23 October.

The insects were trapped in bottles containing ethylenglycol. After removal, the animals were fixed in 70% ethanol. The efficiency of the light traps at this latitude is supposed to be rather low during midsummer (June–July). The results concerning the flight periods ending or beginning in this period are less accurate than the information obtained by the light traps in southern countries.

The material is deposited at the RNSSL, the Museum, Trondheim.

Results

A list of all the chironomid species hitherto recorded in Målsjøen is given in Table I. (The nomenclature of *Procladius* follows Brundin (1949).)

The species captured during 1972 in the light trap are shown (only ♂♂) in Table II.

The emergence period and total number of chironomids per m² and day for each of 5 depths are given in Fig. 3. The number of males and females of the most important species found in the emergence traps are given in Figs. 4–16.

For species treated in Figs. 10, 11, 14, and 16, only males were recorded, because of taxonomical difficulties.

Table I. Chironomid species recorded from Målsjöen, Klæbu, Norway

	Light trap (♂♂ 1972)	Emergence trap ♂♂+♀♀ 1971	Emergence trap ♂♂+♀♀ 1972	Bottom samples (larvae)
PODONOMINAE				
Parochlus kiefferi*				
TANYPODINAE				
Ablabesmyia monilis	24	16	9	x
Ablabesmyia phatta	9		2	x
Apsectrotanypus trifascipennis	2			
Arctopelopia barbitarsis	16	2	10	x
Conchapelopia melanops	1			x
Conchapelopia pallidula	3			x
Krenopelopia binotata	2			x
Macropelopia nebulosa	2			
Paramerina cingulata	1	1	1	x
Procladius barbatus	9	14	16	x
Procladius cinereus	14	135	140	x
Procladius nigriventris	1	2	15	x
Procladius nudipennis	5	2		x
Procladius signatus	16	55	68	x
Rheopelopia maculipennis	2			x
Thienemannimyia fusciceps	17			x
ORTHOCLADIINAE				
Bryophaenocladius sp.	1			
Chaetocladius perennis*				
Cricotopus spp.	5			x
Epoicocladius ephemerae		6	4	x
Gymnometriocnemus volitans	2			
Heterotanytarsus apicalis	1	1	100	
Heterotrissocladius marcidus	4	1	140	
Limnophyes spp.	12			
Metriocnemus spp.	15			
Monodiamesa bathyphila	2			x
Parakiefferiella bathophila	4	48	155	
Psectrocladius sordidellus	15	2		x
Species A	2			
Prodiamesa olivacea	1			x
Protanypus caudatus	2			x
Smittia cfr. aterrima	24			
Smittia cfr. edwardsi	1			
Thienemanniella sp.	1			
CHIRONOMINAE - CHIRONOMINI				
Chironomus sp.	3			x
Cryptochironomus sp.	1	1		x
Dicrotendipes nervosus	1			x
Dicrotendipes pulsus	1		1	x
Demicryptochironomus vulneratus	7	1	1	x
Endochironomus intextus	47			x
Endochironomus spp.			1	x
Glyptotendipes spp.				x
Microtendipes brevitarsis	23	1		x
Microtendipes chloris	9		5	x
Pagastiella orophila	3	6	2	x
Parachironomus arcuatus			3	x
Parachironomus digitalis	5	3	3	x
Parachironomus siljanensis	6	13	3	x
Parachironomus varus	1			x
Paracladopelma camptolabis	8		4	x
Paralauterborniella nigrohalteralis	3	3	2	x
Paratendipes nudisquama	9			
Pentapedilum tritum	5			x
Pentapedilum sp.	13			x
Phaenopsectra flavipes	2		3	x
Polypedilum bicrenatum	25	22	74	x
Pseudochironomus sp.				x
Sergentia coracina	90	22	27	x
Stictochironomus histrio	10			x
Stictochironomus rosenschöldi	71	90	48	x
Xenochironomus xenolabis	10			
CHIRONOMINAE - TANYTARSINI				
Cladotanytarsus spp.	24	64	1	
Constempellina brevicosta			2	
Corynocera ambigua*				
Micropsectra insignilobus	40	81	68	x
Parasectra nana	1			
Paratanytarsus penicillatus	4			
Paratanytarsus tenuis	3			
Stempellinella brevis	7		3	
Stempellinella minor	3	6		
Tanytarsus brundini	2			x
Tanytarsus chinyensis	13	7	11	x
Tanytarsus eminulus	2			x
Tanytarsus inaequalis	40			x
Tanytarsus lestagei-group	20	4	4	x
Tanytarsus norvegicus	3	5		x

*Occasionally recorded

Table II. Occurrence of Chironomidae species (only ♂♂) in the light trap at Målsjöen 1972. (+ = 1 specimen, O = 2-9 specimens, ● = 10 or more specimens)

| Species	Apr 20	Apr 28	May 5	May 12	May 19	May 26	Jun 2	Jun 9	Jun 16	Jun 20	Jun 28	Jul 7	Jul 12	Jul 18	Jul 24	Jul 31	Aug 9	Aug 15	Aug 24	Aug 29	Sep 4	Sep 9	Sep 13	Sep 20	Sep 27	Oct 3	Oct 10	Oct 12
TANYPODINAE																												
Procladius barbatus					+	O	O																					
Arctopelopia barbitarsis						+	O	O																				
Procladius nigriventris							O																					
Procladius nudipennis							O	O																				
Ablabesmyia monilis										+							●	●										
Procladius cinereus																	O	●										
Procladius signatus																	O	●										
Thienemannimyia fusciceps																	+											
Rheopelopia maculipennis																	+											
Krenopelopia binotata																	+	+										
Ablabesmyia phatta																	O	O										
Conchapelopia melanops																	+											
Conchapelopia pallidula																	+		O									
Apsectrotanypus trifascipennis																				+								
Paramerina cingulata																						+						
Macropelopia nebulosa																							+	+				
ORTHOCLADIINAE																												
Prodiamesa olivacea	+																											
Metriocnemus spp.				+													O	O	O				O					
Heterotrissocladius marcidus					+	+														O			O					
Heterotanytarsus apicalis					+																							
Limnophyes spp.					+			+	+	O							O				+	O	O					
Parakiefferiella bathophila						O	O																					
Gymnometriocnemus volitans								+	+																			
Cricotopus spp.								O											+		+			O				
Psectrocladius sordidellus						+	+										+	O	O	O								
Species A								O																				
Bryophaenocladius sp.															+													
Smittia cfr. aterrima																	O	O	+				O					
Smittia cfr. edwardsi																	+											
Thienemanniella sp.																			+									
Monodiamesa bathyphila																							+	+				
Protanypus caudatus																							+			+		
CHIRONOMINAE - CHIRONOMINI																												
Microtendipes cloris				O	O																							
Microtendipes brevitarsis				+	O	O	+																					
Stictochironomus histrio				●	O	O																						
Endochironomus intextus						O	●		O																			
Polypedilum bicrenatum						O	●							+	O	O	O											
Pagastiella orophila									+		+	+																
Dicrotendipes pulsus								+																				
Paralauterborniella nigrohalteralis											+						+	+										
Paratendipes nudisquama															O		+	O										
Pentapedilum spp.																	O	O	O									
Dicrotendipes nervosus																	+											
Chironomus sp.																	O	+										
Xenochironomus xenolabis																	+	O	+	+								
Paracladopelma camptolabis																	O	O			+			+				
Cryptochironomus sp.																	+											
Pentapedilum tritum																	O		+									
Phaenopsectra flavipes																	+	+										
Demicryptochironomus vulneratus																	O	O	+									
Parachironomus digitalis																	O											
Parachironomus siljanensis																	O	O						+				
Stictochironomus rosenschöldi																			+	●	●			O	+			
Sergentia coracina																			+	●	●	●	●					
Parachironomus varus																			+									
CHIRONOMINAE - TANYTARSINI																												
Micropsectra insignilobus				O	●	O																						
Paratanytarsus penicillatus					O														+	+								
Tanytarsus norvegicus					O																							
Stempellinella minor						+	O																					
Cladotanytarsus spp.						+	+	O		+				+	+		O	O	+	+								
Tanytarsus chinyensis							O	+										O										
Tanytarsus lestagei -gr.										O											●		+					
Parasectra nana										+																		
Tanytarsus inaequalis																		+	●	O								
Stempellinella brevis																			+	O								
Tanytarsus eminulus																			+			+						
Paratanytarsus tenuis																						+	+	+				
Tanytarsus brundini																							O					
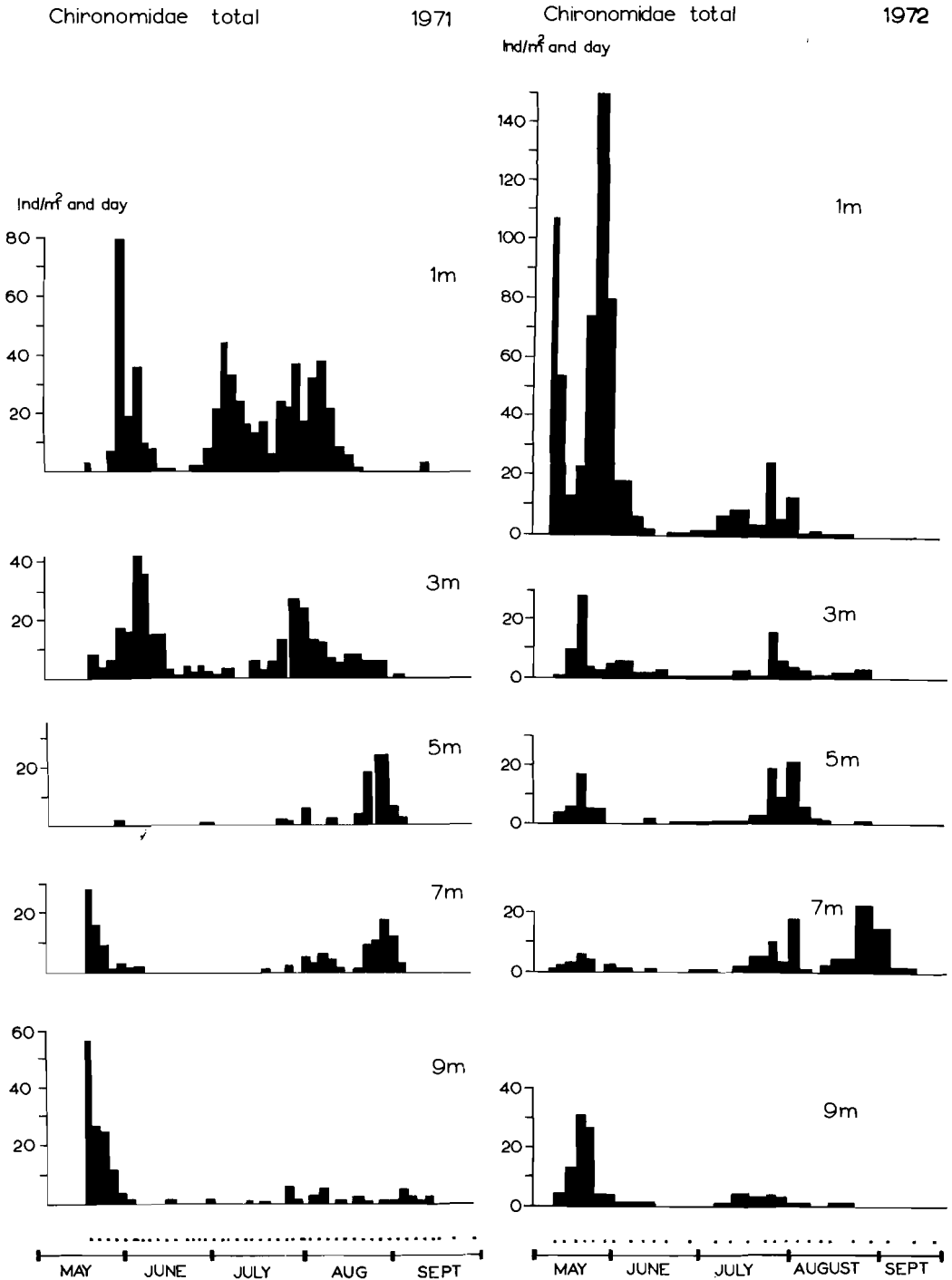
Fig. 3. Emergence diagrams for Chrionomidae total in Målsjøen 1971–1972. The points on the pointed line indicate emptying dates.

Table III. Winter depth distribution and densities of chironomid larvae in Målsjöen. The data are given as mean amd maximum densities of the records from 8 sampling dates in 1970 and 1971 (ind./m^2)

	0.2 m		1 m		2 m		3 m		4 m		5 m		6 m		8 m		10 m	
	$\bar{x}$	max	$\bar{x}$	max	$\bar{x}$	max	$\bar{x}$	max	$\bar{x}$	max	$\bar{x}$	max	$\bar{x}$	max	$\bar{x}$	max	$\bar{x}$	max
Chironomus	78	490																
Stictochironomus (histrio)	43	300																
Cryptochironomus	1	10	4	20			1	10										
Demicryptochironomus	7	50	29	70	14	30	20	40	6	20	1	10						
Dicrotendipes	17	130	10	30	15	100	5	10	11	30								
Endochironomus	12	50			2	20	15	30										
Glyptotendipes							4	20										
Microtendipes	4	30	10	60	51	220	126	720	4	20								
Pagastiella			9	40	18	100	16	70	13	30								
Parachironomus					1	10												
Paracladopelma			4	30	4	30												
Pentapedilum	1	10	5	40	1	10	38	90	4	30								
Phaenopsectra					1	10												
Polypedilum			163	400	266	690	120	220	39	70	1	10						
Pseudochironomus			1	10														
Tanytarsini indet.	10	30	98	250	40	140	88	200	32	80								
Cricotopus	23	180	22	110	14	50	15	70	5	20								
Epoicocladius	16	130	17	70	19	90	7	40	3	20								
Protanypus			5	20			3	10										
Psectrocladius	1	10	1	10	3	10												
Orthocladinae indet.	5	10	10	70	15	80	4	10	5	20								
Ablabesmyia	12	100			10	40	13	80										
Thienemannimyia-group	60	180	17	50	20	60	40	100	1	10								
Procladius	43	150	47	70	42	70	100	200	31	70	28	50	136	240	161	240	86	220
Micropsectra											4	20	109	300	419	1460	130	340
Monodiamesa											1	10	9	50	18	50	27	60
Sergentia													7	50			63	170
Stictochironomus (rosenschöldi)											741	1370	1298	2380	910	1600		

The results concerning the more abundant species (Figs. 5, 6, 9, 10, 12, 13, and 15) show good accordance in emergence time within the two sampling years, 1971 and 1972.

In 1971 the late operational start of the emergence traps caused a nearly total miss in catching the early spring species *Heterotrissocladius marcidus* (Fig. 7) and *Heterotanytarsus apicalis* (Fig. 8).

The occurrence of the species in the emergence traps usually agreed well with the records from the light traps.

The results of the bottom-fauna studies are given in Tables III and IV, which show the mean ($\bar{x}$) and maximum number of larvae found during the winter and summer seasons.

The occurrence of *Parachironomus* and other plant-living species in the bottom samples was rather occasional. However, larvae of *Parachironomus* were found free-swimming in the emergence traps at any depth. Some larvae of *Endochironomus* sp. were found as overwintering cocoons at 2 and 3 m depths on 21 January. *Corynocera ambigua* was only collected, swarming in great numbers, by J. W. Jensen, May 1977.

Phenology

The emergence season in Målsjøen may be subdivided into the following periods:

1) Ice-thaw–31 May   Spring
2) 1 June–14 June   Early summer
3) 15 June–14 August   Summer
4) 15 August–31 August   Late summer
5) September   Autumn

During spring, period 1, the temperature reached 10–12°C in the littoral and 4–5°C in the profundal, and a large number of specimens emerged. The maximum number of chironomids emerging per day for the total season was found in the last week of May (Fig. 3). Dominant species in this period were *Heterotrissocladius marcidus, Heterotanytarsus apicalis, Parakiefferiella bathophila, Polypedilum bicrenatum, Micropsectra insignilobus, Stictochironomus histrio, Procladius barbatus, Microtendipes cloris* and *Arctopelopia barbitarsis*.

Early summer, period 2, was characterized by the decreasing number of species emerging from the profundal. But littoral species like *Tanytarsus chinyensis, Pagastiella orophila, Epoicocladius ephemerae,* and *Stempellinella brevis* have their emergence maximum at this period.

During the summer (period 3) a large number of species emerge; the most numerous were *Procladius signatus, Procladius cinereus, Paralauterborniella nigrohalteralis, Pentapedilum* spp., the *Tanytarsus lestagei* group, and *Stempellinella minor.*

Table IV. Summer depth distribution and densities of chironomid larvae in Målsjöen. The data are given as mean and maximum densities of the records from 6 sampling dates in 1970 and 1971 (ind./m^2)

	0.2 m		1 m		2 m		3 m		4 m		5 m		6 m		8 m		10 m	
	x̄	max	x̄	max	x̄	max	x̄	max	x̄	max	x̄	max	x̄	max	x̄	max	x̄	max
Chironomus	461	2640																
Stictochironomus (histrio)	16	90	191	1130														
Cryptochironomus			2	10														
Demicryptochironomus	5	20	13	50	18	50	10	30	5	10	3	10						
Dicrotendipes	8	40	5	10			5	30	3	20								
Endochironomus	31	100	2	10	5	30	86	230										
Microtendipes	3	10			65	380	3	20	3	20								
Pagastiella							5	20	12	20	3	10						
Paracladopelma									3	20								
Paralauterborniella					8	50												
Pentapedilum	3	20	2	10	2	10												
Polypedilum	15	50	28	150	6	20			3	10	1	10						
Pseudochironomus			2	10														
Tanytarsini indet.	18	80	10	160	43	130	40	110	3	10								
Cricotopus	7	40			3	20												
Epoicocladius	5	20	10	20	5	20	3	10										
Protanypus							3	10	5	20	3	20	6	40				
Psectrocladius							1	10										
Prodiamesa	5	30			2	10												
Orthocladinae indet.	7	30			3	20	5	30	8	40								
Ablabesmyia					5	20	3	20	3	20	3	10	6	20				
Thienemannimyia-group	10	50	3	20	1	10	10	50										
Procladius	62	170	142	410	24	120	35	80	28	50	47	100	122	200	162	260	60	120
Micropsectra											6	40	107	390	102	310	5	30
Monodiamesa											2	10	31	100	2	10	10	40
Sergentia													1	10	15	50	50	90
Stictochironomus (rosenschöldi)											916	2030	1752	2410	754	1290		

Late summer (period 4) is totally dominated by *Sergentia coracina* and *Stictochironomus rosenschöldi,* both important species, and they continued their emergence into the last period (5), the autumn.

In Fig. 17 the subdivision of the season in Målsjøen is compared with the subdivision from other lakes, given by various authors. The emergence periods become shorter and more concentrated around midsummer, with increasing altitude and/or latitude. This is known to occur among other aquatic insect groups too, i.e. Trichoptera (Solem 1970) and Plectoptera (Lillehammer 1975a).

The temperature seems to be the most important ecological factor controlling the phenology during the spring season.

Abiotic factors determining the initiation of the emerging period

Water temperature has for a long time been considered by aqua-biologists as a determining factor for the emerging period. In most studies on annual periodicity of the chironomids, the temperature is mentioned as the only factor inducing emergence (Brundin 1949, Sandberg 1969, Laville 1971). Brundin (1949) showed that *Ablabesmyia monilis* in lake Innaren emerged from different depths at different times,

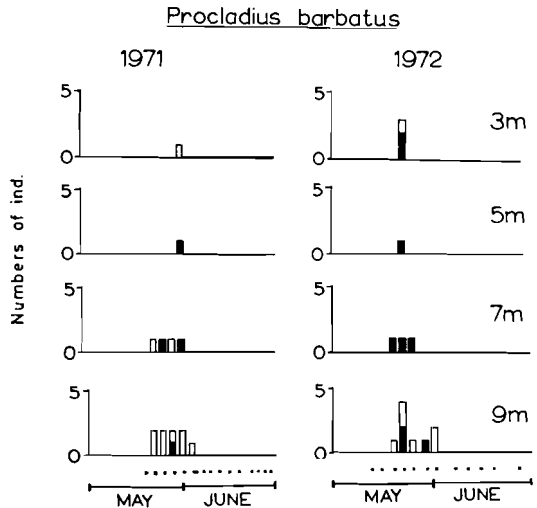Fig. 4. Emergence diagrams of *Procladius barbatus*. Black columns show number of males, white columns of females. Pointed line indicates emptying dates.

clearly depending on the temperature. On the other hand, Brundin (1949) also mentioned that *Procladius cinereus* in lake Innaren emerged from different depths with different temperatures at the same date. No explanation was given for these contradictory facts.

Procladius signatus
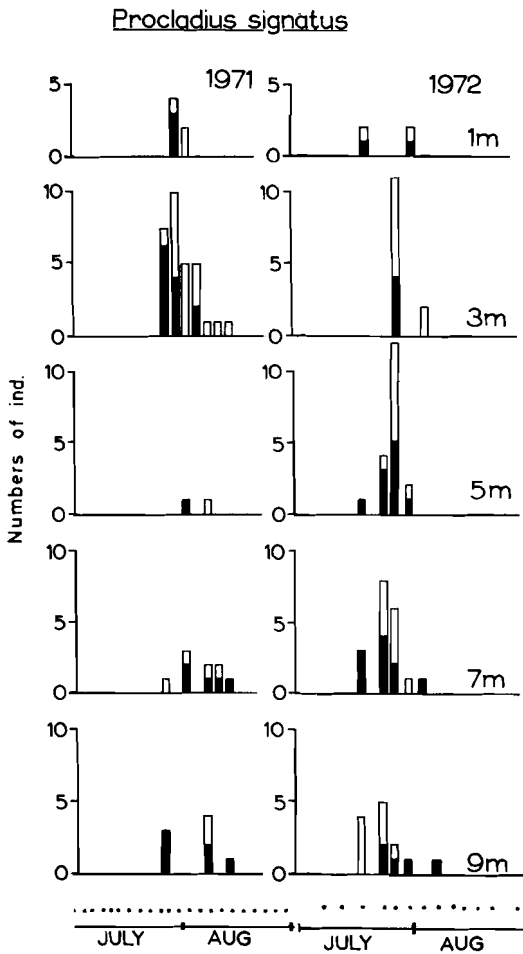
Fig. 5. Emergence diagrams for *Procladius signatus*. For further explanations see Fig. 4.

Procladius cinereus
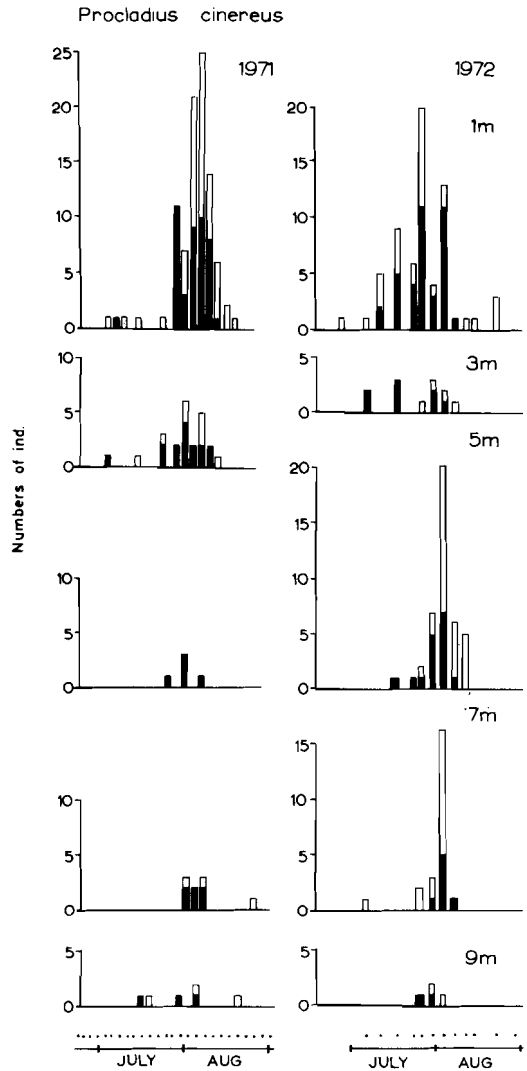
Fig. 6. Emergence diagrams for *Procladius cinereus*. For further explanations see Fig. 4.

Reiss (1968) mentioned lunar rhythms and day-length as factors which may influence the emerging period. The day-length as a regulating factor for metamorphotic changes in aquatic insects, has, during the last decade, been emphasized among others by Hynes (1970) and Pleskot (1963). Elvang & Madsen (1973) stressed in their work with *Taeniopteryx nebulosa* L. (Plecoptera) that both temperature and day-length must be of a given value before *T. nebulosa* is able to emerge.

Lillehammer (1975a, b) showed both experimentally and in field studies that different species of spring-emerging stoneflies had a clear dependence on temperature for their emergence. Lillehammer (1975a, b) also drew attention to

the influence of the amount of food on the development period. This has also been mentioned by Macan (1973) in his study of the damselfly *Pyrrosoma nymphula*. The difference in the amount of food could perhaps be an important factor in life cycles of the species with a development time of more than one year, i.e. *Sergentia coracina* and *Stictochironomus rosenschöldi*.

The more common chironomid species from Målsjøen may be grouped into three divisions:

1) Species with a short emergence period

Heterotrissocladius marcidus

Heterotanytarsus apicalis
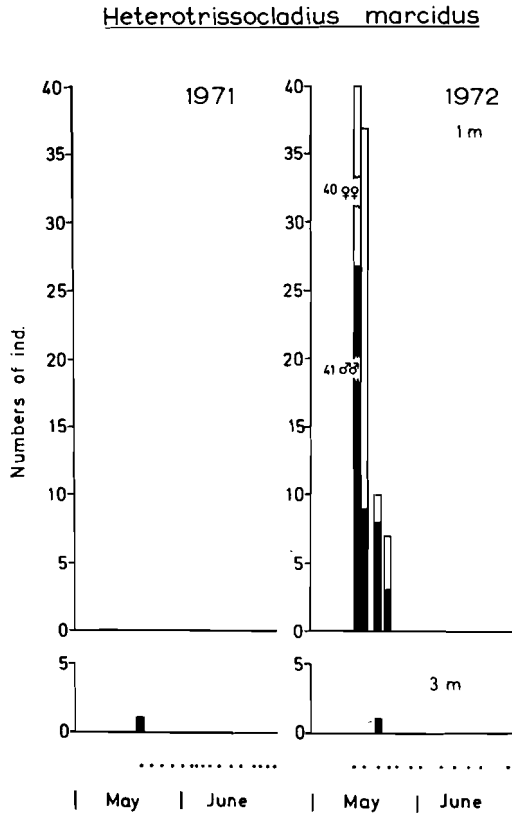
Fig. 7. Emergence diagrams for *Heterotrissocladius marcidus*. For further explanations see Fig. 4.
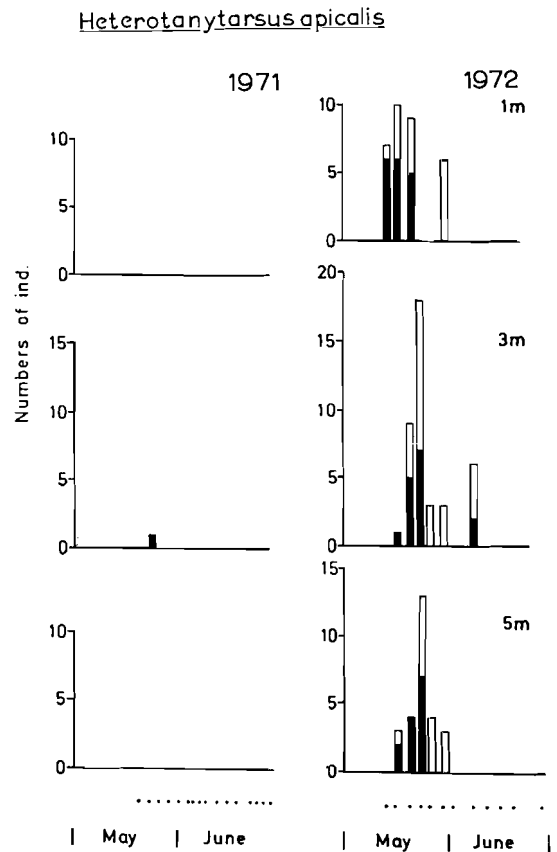
Fig. 8. Emergence diagrams for *Heterotanytarsus apicalis*. For further explanations see Fig. 4.

during the spring. In this group the following species may be listed: *Procladius barbatus* (Fig. 4), *Heterotanytarsus apicalis* (Fig. 8), *Heterotrissocladius marcidus* (Fig. 7), *Parakiefferiella bathophila* (Fig. 9), *Arctopelopia barbitarsis*, *Micropsectra insignilobus* (Fig. 15), and in period 2 *Pagastiella orophila* (Fig. 11).

These are all species which start to emerge immediately after the temperature rises, and it is typical that the emergence period begins later in northern or mountain lakes than in southern lowland lakes. The emergence seems well synchronized with the springtime and temperature rise (Table V).

2) Species with a wide emergence period. Examples are *Ablabesmyia monilis* and *Paramerina cingulata* (partly based on material from 1971).

These species emerge during such a long time that it is sometimes difficult to tell if they are univoltine or bimodale. A certain temperature requirement may exist for these species, e.g. *A. monilis* (Aagaard, in manus).

3) Species with a short emergence period in summer or autumn. Typical for these species is the well-synchronized emergence from all depths, in spite of a temperature difference of 6 or 8°C during most of the summer, and without any significant rise in the temperature, as in the spring.

Interesting examples are the two *Procladius* species *P. signatus* and *P. cinereus*. As shown by Figs. 5 and 6, these species emerge remarkably well synchronized from all the investigated depths, both years at the same time. These two species, which are both predatory chironomids, are quite mobile in the larval stage. A constant migratory activity between the littoral and the profundal zones may explain the capability of these species to reach the ripe stage at the same

Parakiefferiella   bathophila
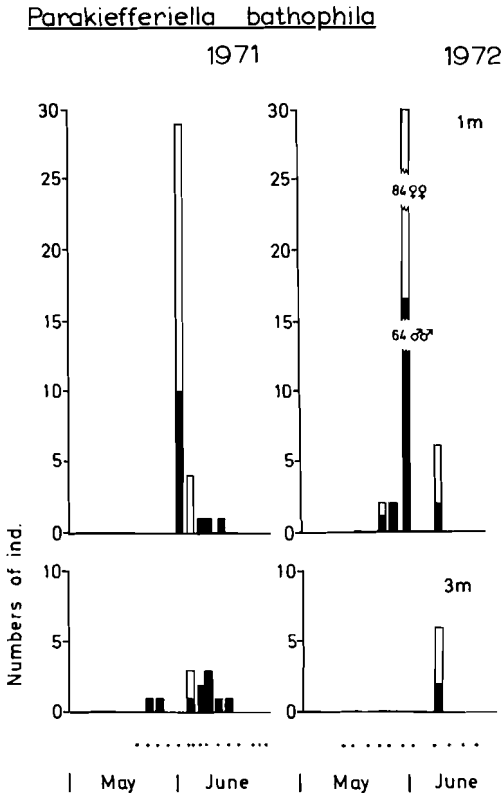
Fig. 9. Emergence diagrams for *Parakiefferiella bathophila*. For further explanations see Fig. 4.

time for the whole population. The function of the photoperiod as a time-signal ('zeitgeber') is obvious for these two species as the emergence take place at the same dates from all depths (Figs. 5 and 6).

A study of the emergence period of *P. signatus* at different lakes in Scandinavia (Brundin 1949, Sandberg 1969) indicates that *P. signatus,* in the same way as *T. nebulosa,* has certain requirements both regarding temperature and the photoperiod.

In the northern lakes in Upland, Jämtland, and Lappland in Sweden, and Oppland and Trøndelag in Norway, the larvae may not be able to complete their life cycle in the spring, due to the low temperature. Later, the night length, if we suppose the minimum length of the night to be the control factor, may make it impossible for the species to emerge until a certain night length again occurs in August. In the south of Scandinavia (lake Innaren in Småland), both the

Polypedilum bicrenatum

Fig. 10. Emergence diagrams for *Polypedilum bicrenatum*. For further explanations see Fig. 4.

Pagastiella orophila
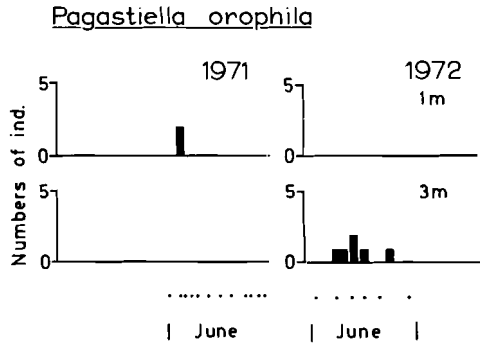
Fig. 11. Emergence diagrams for *Pagestiella orophila*. For further explanations see Fig. 4.

Sergentia coracina
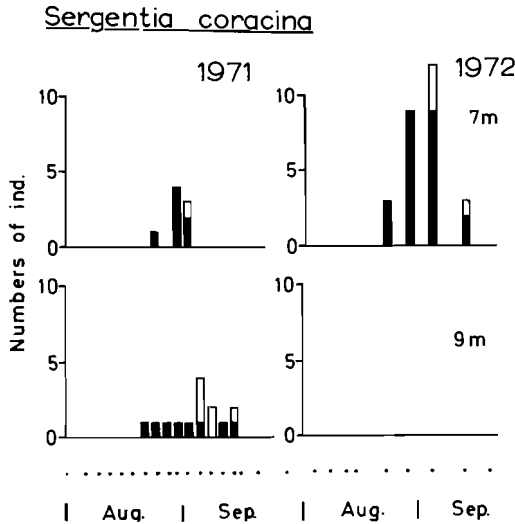
Fig. 12. Emergence diagrams for *Sergentia coracina*. For further explanations see Fig. 4.

Stictochironomus rosenschöldi
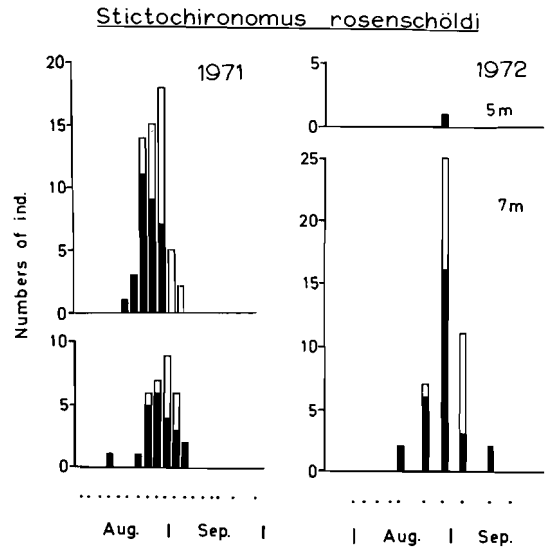
Fig. 13. Emergence diagrams for *Stictochironomus rosenschöldi*. For further explanations see Fig. 4.

temperature and the night-length make it possible for the species to emerge in the spring. In August, a single observation of emergence from Ringsjøen in Skåne might represent a second generation.

The two important profundal species *Sergentia coracina* and *Stictochironomus rosenschöldi* both emerge in the second half of August and the first half of September in Målsjøen. Comparing these emergence periods with emergence periods from other lakes (Tables VI and VII), some problems arise; *S. coracina* is, in most of the lakes, a typical spring species. Exceptions are the lakes Skären in Småland, Sweden and Målsjøen. *S. rosenschöldi* emerges during the spring in the subarctic lakes in Jämtland, and in the late summer in lowland lakes in Sweden and in Målsjøen.

These confusing data can be explained assuming that the *S. coracina* populations really are the same species (Wülker 1961), by the more than one year developmental life cycle of these species: 2–3 years for *S. coracina* (Wülker 1961), four years for *S. rosenschöldi* (see p. 35).

A developmental time of more than one year seems to be needed for chironomid species existing under harsh conditions (Welch 1976). It is obvious that the ability to emerge quite independent of abiotic factors is a prerequisite for these species and makes them able to colo-

Cladotanytarsus spp
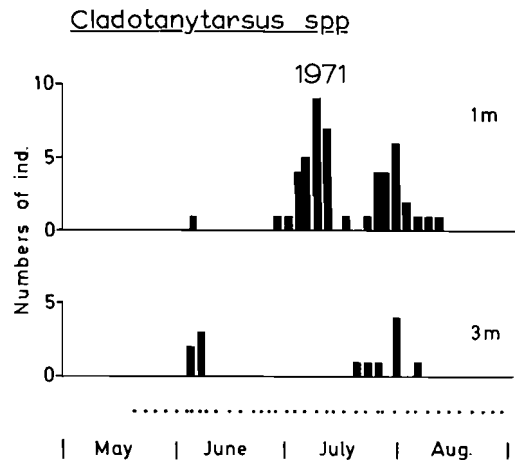
Fig. 14. Emergence diagram for *Cladotanytarsus* spp. For further explanations see Fig. 4.

nize lakes otherwise unsuitable to them. A similar argument may also explain the winter-divided emergence periods of the *Heterotrissocladius* species (Aagaard, in manus).

Diversity of the chironomid communities of the littoral and the profundal

The limnological zonation of Målsjøen is fairly stable with a epilimnion and hypolimnion during

Micropsectra insignilobus
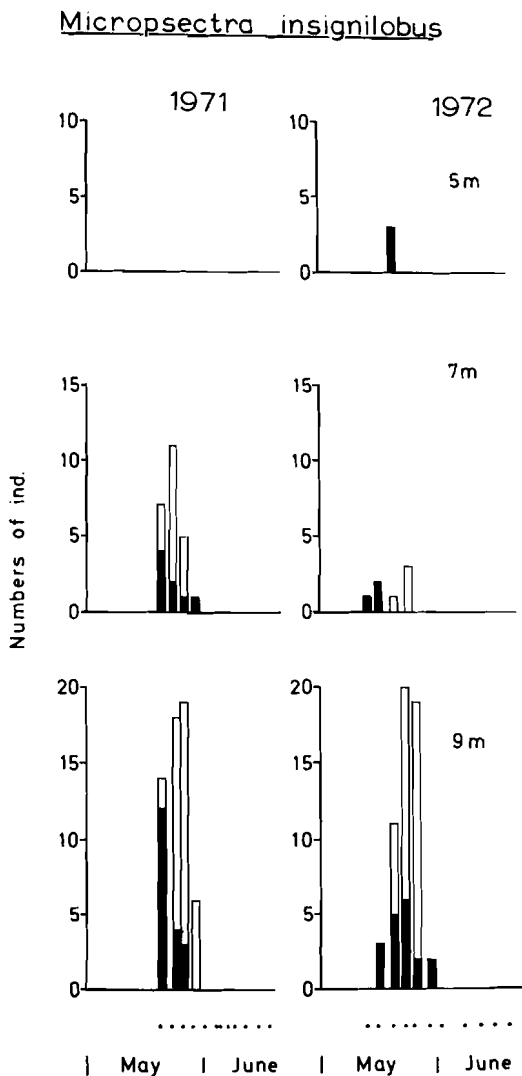
Fig. 15. Emergence diagrams for *Micropsectra insignilobus*. For further explanations see Fig. 4.

Tanytarsus chinyensis

Fig. 16. Emergence diagrams for *Tanytarsus chinyensis*. For further explanations see Fig. 4.

and a more moderate number of *Stictochironomus histrio* larvae were only taken in this upper part. In addition, among the species found in the light traps, there are more species which are known to occur only in this moss edge. However, most of the species found elsewhere in the littoral do also occur here.

b) *The main littoral.* Målsjøen is, as mentioned, a mesotrophic lake, perhaps with some parts of an even higher trophic status. These mainly mesotrophic conditions usually give quite high diversity values expressed by the Shannon (H_1) or Simpson (λ) indices for the chironomid communities (Aagaard & Engen, in press). The results of Målsjøen (1 and 3 m) conform well with this experience.

In most of the littoral, down to 4–5 m, the species number is high (30–50 species, Tables III–IV). The rich species composition reflects the great number of available ecological niches. The chironomid species in the littoral comprise detritivorous species, species living within plants (endophytic) or upon plants (epiphytic), species which are experts on sponges, species symbiotic with *Ephemera* spp. or snails, and carnivorous species.

The depth distribution of each of the species (or genus) recorded by the grab samples seems to be rather uniform throughout the littoral (Tables III–IV). A full description of the ecology of the species or species group occurring in the littoral requires investigations considerably larger than those carried out in this scheme. The occurrence of a number of other invertebrates of different classes or orders does also complicate the picture. The littoral is ended by

most of the summer, and with the metalimnion at about 5 m depth. The environmental conditions at the bottom, which mainly may be considered as a result of the zonation and the light, give two clearly separable chironomid communities in the littoral and the profundal. In addition, the edge effect makes the inner part of the littoral different from the rest of it. Roughly, the chironomid species seem to indicate three different communities (Tables III–IV).

a) *The inner part of the littoral* (down to 1 m). A large number of *Chironomus* spp. larvae

Fig. 17. Subdivision of the flying season in some lakes, from France after Laville (1971), Bodensee after Reiss (1968), Grosser Plöner See after Humphries (1938), Ö. Heimdalsvatn after Aagaard (in manus), Innaren after Brundin (1949), Erken after Sandberg (1969), Jämtland after Brundin (1949), Målsjøen, and Torneträsk after Thienemann (1941). (Black lines indicate summer, hatch lines indicate early or late summer. ES, S, LS, EA, A, and LA mean early spring, spring, late spring, early autumn, autumn, and late autumn, respectively.)

a 'mussel-zone', poor in species, at about 5 m depth.

c) *The profundal.* The profundal in Målsjøen is well defined, with a few chironomid species (8–9 species) and a small number of other invertebrate species, like Oligochaeta and *Pisidium*.
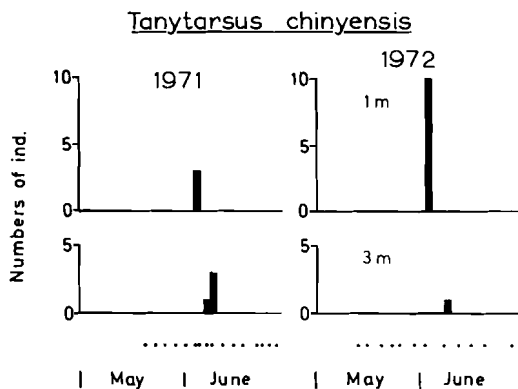
There seems to be a zonation within the profundal too. *Stictochironomus rosenschöldi* is dominating the field from 5 to 8 m depth, but decreases in number in the deepest parts, where *Sergentia coracina* is more abundant.

The simple composition of the profundal fauna, with some of the species occurring in quite high numbers of specimens, makes the construction of an ecological model possible.

Assuming that each of the chironomid species

Table V. Flight records for Arctopelopia barbitarsis. (Based on Brundin 1949)

	MAI	JUNE	JULY	AUG
Möckeln, Sm	●			
Innaren, Sm		▭		
Helgosjön, Sm	●			
Bolmen, Sm	●			
Allgrunnen, Sm	●			
Toftasjön, Sm	●			
Siljan, Dlr			●	
Målsjöen, Trlag			▭	
Storsjön, Jmtl			●	
Kallsjön, Jmtl			●	
Leipikvattnet, Jmtl				●
Friningen, Jmtl				●
St. Blåsjön, Jmtl				●
Ankarvattnet, Jmtl				●
Abiskojaure, Torn.lp				●

Table VI. Flight records for _Sergentia coracina_.
(Based on Brundin 1949 and Reiss 1968)

	MAY	JUNE	JULY	AUG	SEPT	OCT
Bodensee, BRD	▭	▭				
Skären, Sm						●
Skälsjön, Vstml			●			
Målsjøen, Trlag				▭		
St. Blåsjön, Jmtl			●			
Kallsjön, Jmtl		●				
Leipikvattnet, Jmtl			●			
Semningsjön, Jmtl			●			
Torrön, Jmtl			●			
Akkajaure, Lul.lp			●			
Abiskojaure, Tom.lp		●	●			
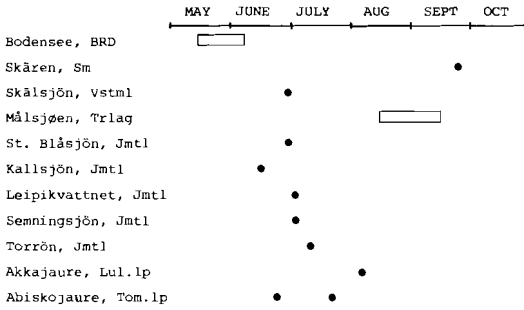
Table VII. Flight records for _Stictochironomus rosenschöldi_.
(Based on Brundin 1949)

	MAY	JUNE	JULY	AUG	SEPT	OCT
Vättern, Sm			●		● ●	
Mälaren, Uppl		●				
Skälsjön, Vstml					●	
Siljan, Dlr					●	
Målsjøen, Trlag				▭	▭	
Ankarvattnet, Jmtl				●		
Ansjön, Jmtl		●	●			
St. Blåsjön, Jmtl		●●				
Bodsjön, Jmtl		●				
Hällesjön, Jmtl		●				
Jormvattnet, Jmtl		●●				
Juvuln, Jmtl		●				
Kallsjön, Jmtl		●				
Kvarnborgsvattnet, Jmtl					● ●	
Semningsjön, Jmtl					● ●	
Ströms Vattudal, Jmtl	●				●	
Vuoksajaure, Lul.lp					●	
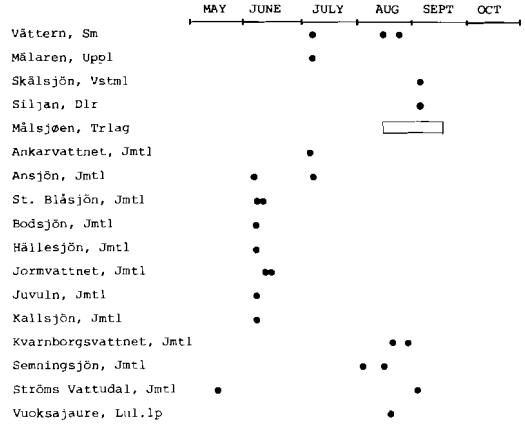
follows a rather similar mortality rate, only with modification in abundance and life-length (Fig. 18), a model of the total number of specimens per m² occurring at 6 m depth through the year may be constructed (Fig. 19).

As shown by these figures, the estimated number of specimens in the profundal varies between 5500 and 9700 individuals per m². However, the number registered during the investigation in the grab samples is about 2000 individuals per m². These differences are mainly due to the great number of minor larvae which are able to pass the sieve (0.5 mm). This stresses the importance of stating properly the kind of treatment which has been carried out in the samples.

The variation of the diversity index of Shannon during the year was calculated based on the model in Fig. 18. The different coexistent cohorts of i.e. _S. rosenschöldi_ and _S. coracina_
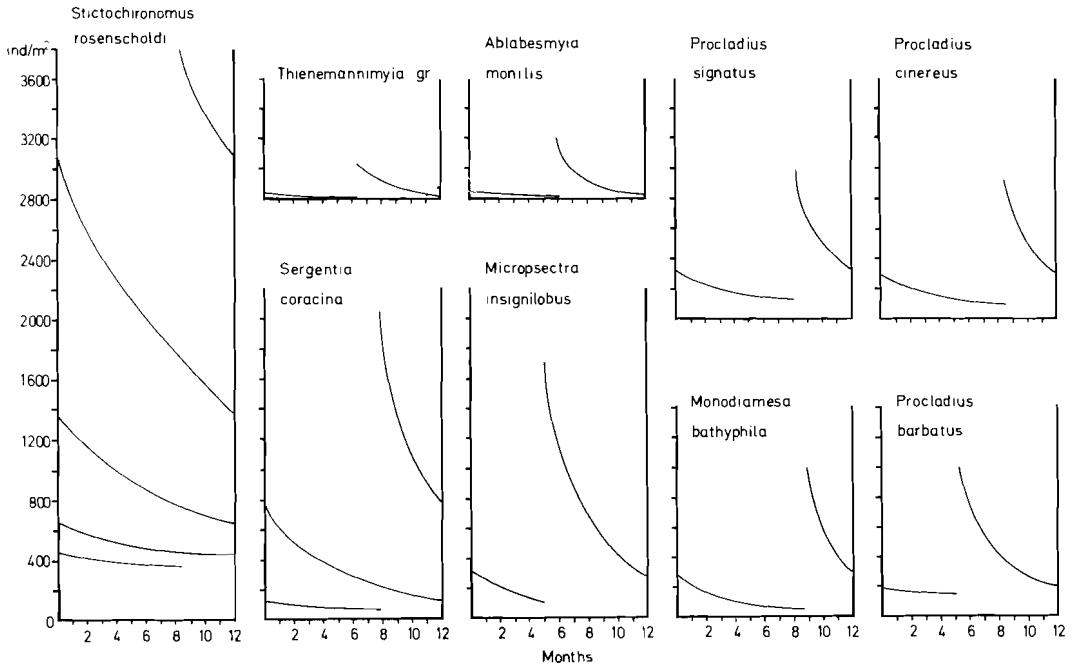
Fig. 18. Estimates of number of individuals of chironomid larvae at 6 m depth in Målsjøen during the year. Based on data from emergence traps and bottom samples. (_Sergentia coracina_ does possibly use more than two years to develop.)
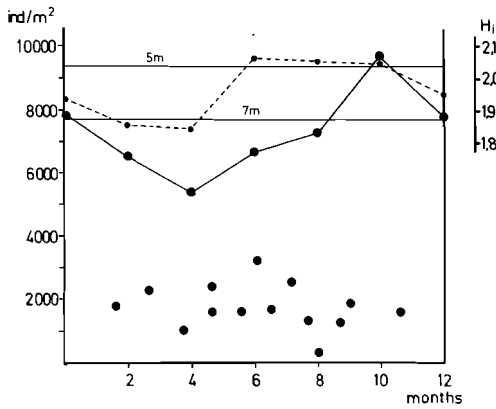
Fig. 19. Estimates of number of individuals at 6 m depth ●────●, of diversity ●----●----, and recorded number of larvae in the bottom samples ●. Lines marked 5 m and 7 m show diversity values (H_i) in the emergence traps at 5 m and 7 m depths.

Fig. 20. Growth curves for *Stictochironomus rosenschöldi.* Triangles and circles indicate different year classes (cohorts).

were calculated as different gamodemes. The results (Fig. 19) show that the moment diversity, i.e. the diversity which theoretically could be found in a sample taken at a given day, varies between $H_i = 1.84$ and 2.06. This small variation also comprises the values found by the total season diversity method (Aagaard & Engen, in press) for emergence traps at 5 and 7 m depths.

This means that, on this occasion, the moment diversity and the total season diversity are quite comparable, provided that the moment samples are approximately fully censured (Pielou 1975).

Production estimates of the profundal chironomid community

Estimations of production require data of mortality and growth of each species. Such data are, to a certain degree, available for the *Sticto-chironomus rosenschöldi* and *Procladius barbatus* populations from the profundal of Mål-sjøen. Figs. 20 and 21, which are based on the larvae material captured during the sampling period, indicate that *S. rosenschöldi* takes four years to complete its development in Målsjøen, while the carnivorous species *P. barbatus,* which is of a similar size to *S. rosenschöldi* as a mature larva, only uses one year. The growth data (Jonasson 1972), for *Procladius pectinatus,* which is a sister species of *P. bar-batus* (or conspecific?) from lake Eserom, are

Fig. 21. Growth curves for *Procladius barbatus* (and *Procladius pectinatus,* redrawn after Jonasson (1972)).
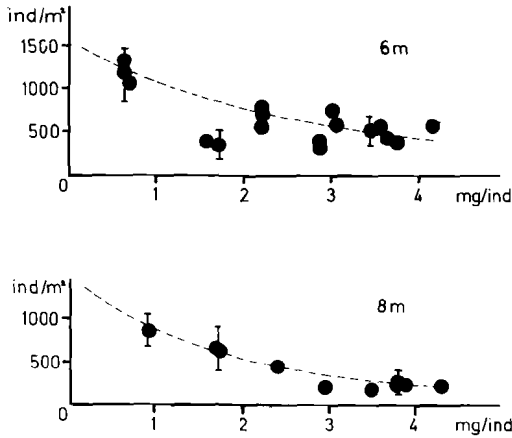
Fig. 22. Allen curves for *Stictochironomus rosenschöldi* based on data from Målsjøen 1970–1971.
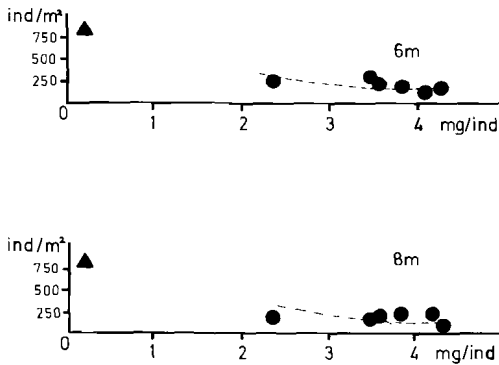
Fig. 23. Allen curves for *Procladius barbatus* based on data from Målsjøen 1970–1971. (▲ = initial number of larvae estimated on basis of egg-numbers found in the females.)

redesigned in Fig. 21 to show the similarity with the results of Målsjøen for *P. barbatus*.

Initial values of *P. barbatus* larvae were calculated from data of egg-number found in emerging females. Mean number of eggs per female was 260 ± SD42. The number of emerging females was ca. 16 ind./m². This gives an egg number of minimum 4000 eggs/m². Assuming 20–25% of the eggs develop (Laville 1971), the number of initial larvae should be ca. 1000 ind./m².

Using the abundance data from the Ekman grab samples, production estimates after the

Allen curve method may be carried out (Figs. 22 and 23).

As shown by Figs. 20 and 21, exact data of the early instars are completely missing. However, as stated by Charles et al. (1974), the production contributions of the smallest larvae are only 2–5% of the annual net production. Further, the variation in the estimated production of the different years was found by Maitland & Hudspith (1974) to be between 16 and 42 g dry weight per m² in the littoral of Loch Leven. Even if the more stable conditions in the profundal of Målsjøen do not give such large variations, it is clear that the production estimates must always be considered as merely indications of what size-group the results will be in.

The annual production estimates of *P. barbatus* and *S. rosenschöldi* are found to be 2.0 and 2.7–3.6 g wet weight per m², respectively. If the production of *Procladius cinereus*, *Procladius signatus*, and *Monodiamesa bathyphila* is considered to be of the same value as for *P. barbatus*, and *Micropsectra insignilobus* (and *Sergentia coracina*) of the same value as for *S. rosenschöldi*, the total chironomid production in the profundal would be 15–20 g wet weight per m². Supposing the dry weight to be 10–20% of the wet weight (Jonasson 1972), the production is in the range of 2–4 g dry weight per m².

Comparing the production estimates of chironomids in oligotrophic lakes (Welch 1976) (0.4–0.5 g dry weight per m²) mesotrophic lakes (2–4 g dry weight per m², Målsjøen) and eutrophic lakes (Jonasson 1972, Potter & Learner 1974) (15–42 g dry weight per m²), there seems to be a factor of 10 between each of these classical types of lakes.

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New records of *Ranatra linearis* L. (Hem., Het.) from Norway, with notes on its biology and distribution

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Hansen, L.-P. & Jacobsen, O. J. 1978. New records of *Ranatra linearis* L. (Hem., Het.) from Norway, with notes on its biology and distribution. *Norw. J. Ent*. Vol. 25, pp. 39–40. Oslo. ISSN 0029-1897.

Two new localities for *Ranatra linearis* L., Vestre Piltjern, Moland in Aust Agder County and Øvre Sjursbråtetjern, Våler in Østfold County, have been recorded. The specimen from Ø. Sjursbråtetjern was studied in an aquarium for eight days and ate two Anisoptera nymphs and one Notonectidae during this period. It made no effort to fly. *R. linearis* is known from 11 localities in Norway, all from the southern part of the country and situated not far from the coast.

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Økland (1977) has given a survey of records of *Ranatra linearis* from Norway, presenting the species from a total of 9 localities in Aust-Agder, Telemark, and Vestfold Counties. This paper presents records of *R. linearis* from two new localities of which one is from Østfold County, a district where the species hitherto has not been observed. In addition some aspects of the biology of *R. linearis* and its distribution in Norway are discussed briefly.

New records

Cand. real. Arne Pedersen in July 1963 made a new record of *R. linearis* in Vestre Piltjern, Moland (UTM: MK 874 841). Previously it has been found in Jovatn and Lille Ribuvatn which are situated close to V. Piltjern (Økland 1977).

In Øvre Sjursbråtetjern, Våler in Østfold (UTM: PL 117 865) a *R. linearis* imago was captured by Lene F. Andreassen on 7 July 1977. This is the first published observation of *R. linearis* from EIS 50 km square no. 20. The specimen had a total body length of 35 mm (64 mm included the breathing tube).

Ø. Sjursbråtetjern has an area of about 15 da and lies 75 m a.s.l. The tarn is typically dystrophic, surrounded mostly by *Sphagnum* mires. In the water *Nuphar luteum*, *Menyanthes trifoliata*, and *Calla palustris* are growing.

A surface water pH as low as 4.8 was measured on the day of observation, and the transparency of the tarn in the middle of July has been measured to about 2 m.

Biological notes

According to Larsén (1936) the wintering imagines die the following July and August, hence imagines observed in summer or autumn are usually specimens hatched the same year. Wintered imagines may easily be separated from recently developed ones by the algae and dirt covering the wings of the former (Larsén 1936). From this it can be stated that the specimen from Ø. Sjurbråtetjern was probably a recently hatched imago.

The specimen was kept in an aquarium with other invertebrates for eight days before it was killed. During this period it ate two Anisoptera nymphs and one Notonectidae, all about 15 mm long. This is in contrast to Wesenberg-Lund (1943), who declared its main food to be animals living on the water surface, and to Chinery (1973), who considered small prey such as *Daphnia* and other small arthropods as most important.

The specimen made no effort to fly during its period in the aquarium.

Discussion

In Norway *R. linearis* seems to live near the northern distribution limit of the species. A probable limiting factor for *R. linearis* in Northern Europe is temperature at the time of egg development. According to Waitzbauer (1974) eggs of *R. linearis* did not survive a decrease in temperature from 17°C to 10°C, and neither a water nor an air temperature of 10°C is uncommon in Southern Norway in the months April–May, when laying of eggs starts in *R. linearis* (Larsén 1936, Waitzbauer 1974). The fact that all Norwegian observations are from localities situated near the coast with relatively early and warm springs, seems to support this theory.

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Kairomone response by the predators *Thanasimus formicarius* and *Thanasimus rufipes* to the synthetic pheromone of *Ips typographus*

ALF BAKKE AND TORSTEIN KVAMME

Spruce logs baited with synthetic pheromone of the bark beetle, *Ips typographus*, and sprayed with lindan, attracted about 17 times more of the clerids *Thanasimus fomicarius* and *T. rufipes* than did logs without pheromone. Both sexes of *Thanasimus* responded to the pheromone. One *Thanasimus* specimen was trapped for approximately every fourth *I. typographus*.

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Predaceous clerids are known to utilize pheromones of their host bark beetles in order to find a habitat infested by its prey. Transspecific chemical messenger, the adaptive benefit of which falls on the recipient rather than the emitter, is termed kairomones (Borden 1977). The first kairomone response by a bark beetle predator was discovered by Wood et al. (1968), who trapped numerous *Enoclerus lecontei* (Wolcott) on field traps baited by the three synthetic pheromone components of *Ips paraconfusus* (Lanier) in California. *E. lecontei* also responds to the pheromone of other bark beetles (Lanier et al. 1972). *Thanasimus dubius* (F.) was trapped on frontalin, a pheromone component of *Dendroctonus frontalis* Zimmermann (Vité & Williamson 1970). *Thanasimus undatulus* (Wolcott) was attracted in numbers to synthetic frontalin used as an attractant for *Dendroctonus psudotsugae* Hopkins and *Dendroctonus rufipennis* (Kirby) in North Western America (Pitman 1973, Kline et al. 1974, Dyer et al. 1975).

The clerids *Thanasimus formicarius* (L.) and *Thanasimus rufipes* (Brahm) are common predators on bark beetles in Europe. Both species occur from early spring on logs of Scots pine newly colonized by the *Tomicus* (=*Blastophagus*) sp. and on logs and trees of Norway spruce under attack by *Ips typographus* (L.) and other scolytids.

Rudinsky et al. (1971) and Svihra (1974) observed that specimens of *T. formicarius* were attracted to spruce logs infested with males of *I. typographus*.

This paper is the first report on response of a predator in Europe to synthetic pheromones of bark beetles.

Material and methods

Field experiments were conducted at Eidskog, county of Hedmark, Norway, in May and June 1977. Newly felled trees of Norway spruce (Picea abies) were cut in 3 m lengths and placed on wooden frames 1.5 m above the ground. Ten replicates, each of four logs, were arranged at the edge of a spruce stand, at approximately 5 m intervals. All logs were sprayed with lindan, at a dose of 2 g a.i. per m^3 bark surface. Every second replicate was baited with two pheromondispensers (Hercon) each containing 41 mg 3-methyl-3-buten-2-ol, 33 mg *cis*-verbenol and 16 mg ipsdienol, which are pheromone components of *I. typographus* (Bakke et al. 1977).

Attracted beetles were trapped in two different traps. One glass barrier trap (Bakke 1975) was placed over each unit of logs and a funnel trap under. The funnel traps consist of an aluminium funnel, 65 cm deep and 80 cm in diameter, with a plastic bottle attached under. The traps were emptied three times a week.

Table I. Mean number and range (in parentheses) of *Thanasimus* sp. trapped at lindane sprayed spruce logs with and without pheromone baits. Five replicates. Eidskog May–June 1977.

		Window traps over the logs	Funnel traps under the logs
Logs baited with pheromone of	*T. formicarius*	2.0 (1–4)	76.4 (48–121)
Ips typographus	*T. rufipes*	1.4 (0–4)	48.0 (31–56)
Logs without pheromone	*T. formicarius*	0.2 (0–1)	5.2 (2–10)
	T. rufipes	0.2 (0–1)	2.0 (0–6)

Results

There is a clear indication that the synthetic pheromone components of *I. typographus* serve as kairomones for *T. formicarius* and *T. rufipes* (Table 1). A total of 677 specimens of *Thanasimus* were trapped during the month of May and June. The pheromone baited logs attracted approximately 17 times more beetles than did the logs without pheromones. The window traps caught rather few beetles compared to the funnel traps. Beetles trapped through the funnel had been in contact with the sprayed logs and dropped down intoxicated by the insecticide. Most of the catches were made in early May, during the first days of the bark beetle flight period. The sex ratio (female-male) of 100 randomly selected beetles of each species was: *T. formicarius* 0.88, *T. rufipes* 1.70.

Traps on pheromone baited logs caught 17 times as many *I. typographus* as did traps on unbaited logs. The response of the predator must be considered high compared to the host. One *Thanasimus* specimen was trapped for approximately every fourth *I. typographus* (Table II).

Discussion

When Wood et al. (1968) trapped numerous clerid *Enoclerus lecontei* in California, they tested the three-component pheromone of *I. paraconfusus*, (ipsenol, ipsdienol and *cis*-verbenol), individually and in combination. The ternary mixture appeared to be the most attractive, but only *cis*-verbenol single failed to elicit a response from the predator. The pheromone of *I. typographus* used in this experiment also consists of three components, methylbutenol, *cis*-verbenol and ispdienol. The experiment was

Table II. Numbers of predators (*Thanasimus*) and the host *Ips typographus* trapped at lindan-sprayed spruce logs, with and without pheromone. Eidskog May–June 1977.

	Logs with pheromone	Logs without pheromone
Thanasimus sp.	639	38
Ips typographus	2514	146
Host/predator	3,9	3,8

not designed for an analysis of the various single components or combination of two of them. Therefore, we cannot exclude the possibility that one or two of the components could have been as attractive as the tripartite pheromone. *Thanasimus* species in North America respond mainly to one single pheromone component, frontalin, which is a major component of several *Dendroctonus* species (Borden 1974).

T. formicarius and *T. rufipes* are also attracted in large numbers to logs of Scots pine infested with *Tomicus piniperda* (L.) (Nuorteva 1956). No pheromone component of *I. typographus* is isolated from *T. piniperda*, and no field response has been observed in *T. piniperda* to pheromones of *I. typographus*. This means that *Thanasimus* must be able to respond to pheromones of various bark beetles or to host tree volatiles. Another explanation could be that races of *Thanasimus* which respond to pheromones of selected prey have developed.

There is a lack of knowledge about the behavioural response mechanisms in kairomone-responding predators. Scanning electron microscope studies of external antennal morphology and electro-physiological experiments are needed for further understanding of the phenomenon.

The effectiveness of bark beetle pheromones as kairomones for the predators causes problems

in the management of integrated control, using pheromones and insecticides. These studies demonstrated response and dead-trapping of one *Thanasimus* for every fourth *I. typographus*, which is a rather high mortality rate for the useful predators.

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Oribatid mites (Acarina) from the Faroe Islands

PETER GJELSTRUP

Four samples collected in moss and lichens growing on trees and stones in 'Vidarlund', Thorshavn, the Faroes, were investigated. 27 species of oribatid mites were found of which 22 are new to the Faroes. A new species, *Danobates insignitus* n.sp., is described. The oribatid species found in the Faroes are generally the same as known from the rest of Europe.

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Oribatid mites in the Faroe Islands were recorded by Sellnick (1908, 1923) and Trägårdh (1931). In all 22 species were found.

From a small material collected by N. Haarløv in 'Vidarlund', Thorshavn, on 10 July 1976, it has now been possible to add 22 more species to the list. These will be treated in greater detail in the following.

Material and methods

The climate of the Faroe Islands is wet and oceanic. There are no natural forests, but during the last century some of the islands have been afforested (spruce pine plantations). In the northern part of Thorshavn there is a plantation covering 2–3 hectares named 'Vidarlund', consisting mostly of coniferous trees of different species and ages. Owing to the humid climate, forest floor and stones, trunks, and twigs are densely covered with lichens and moss; 3 samples were collected from trunks and one sample from a stone. The samples were not taken quantitatively, yet each one of them derives from almost the same area. Hardly any substratum was included in the samples. In the following, 'weight' refers to air-dried weight.

Sample 1: Collected in the lichen *Hypogymnia physodes* (L.) Nyl. on a living mountain pine (*Pinus mugo*) at a height of about 50 cm. Weight: 38 g.

Sample 2: Collected in the moss *Hypnum cupressiforme* Hedw. and *Rhytidiadelphus loreus* (Hedw.) Warnst. from the lowest parts of a decaying mountain pine. Weight: 57 g.

Sample 3: Collected in the moss *Diplophyllum*

albicans (L.) Dum., Phychomitrium polyphyllum (S. M.) Fuerne (oceanic species) and different small *Cladonia* lichens from a stone about 75 cm high between pines and spruce trees. Weight: 57 g.

Sample 4: Collected in *Cladonia squamosa* (Scop.) Hoffm., *Cladonia chlorophaea* (Flöerke ex Sommerf.) Spreng. and other small lichens growing at a height of 25–100 cm on a living and about 6 m tall pine (*P. contorta?*) just beside the stone (sample 3). Weight: 44 g.

The samples were kept in plastic bags and extracted within a week after collection. The samples were extracted after 24 hours in a Tullgren funnel having a final temperature of 40 C°. The extracted mites were stored in 70% alcohol and cleared in lactic acid.

Results

Table 1 shows total number of oribatid mites in the above-mentioned samples. In all, 27 species were found, of which only 5 have previously been recorded from the Faroe Islands. Most of the species and specimens are seen to occur in sample 2 (root collar) and 3 (stone habitat), which are the samples with the highest accumulation of organic material. In the following, comments on habitats and morphology are only given when found necessary.

Liochthonius perpusillus (Berlese, 1910)
Morphology. The interlamellar fields are clearly indicated. However, as other fields have not been mentioned for this species, the fields which could be seen in the Faroe specimens

Table I. List of Oribatid species and their occurrence in four samples of moss and lichens taken 10 July 1976 in 'Vidarlund', Thorshavn

Oribatid species	Samples			
	1	2	3	4
*Liochthonius perpusillus		2	6	
*Camisia segnis			1	
*Camisia sp.			1	
*Platynothrus peltifer		7	4	
Hermannia reticulata	45	29	73	14
Paradamaeus clavipes		1		
Ceratoppia bipilis		16	3	2
*Banksinoma lanceolata		8		
*Carabodes marginatus		16	6	7
*Carabodes minusculus	1		360	2
*Suctobelbella subcornigera		1	3	
*Suctobelbella similis		2	2	1
*Suctobelbella sarekensis			5	
*Suctobelba trigona		2	8	1
*Oppia neerlandica		140	250	5
*Oppia unicarinata		2		
*Oppia ornata		10	50	7
*Phauloppia lucorum			1	
*Chamobates cuspidatus		1		
*Danobates insignitus n.sp.		39	2	11
*Melanozetes mollicomus		1	19	
*Edwardzetes edwardsi			3	
Sphaerozetes piriformis		1	1	
*Eupelops auritus (?)	3			1
Oribatella quadricornuta		1		
*Parachipteria punctata		5		
*Phthiracarus affinis		9	21	1
Total no. of specimens in samples	49	293	819	52
Total no. of species in samples	3	20	20	11

Species marked with * have not previously been recorded from The Faroes.

are shown in Fig. 1. Five small fields are visible between bothridium and lamellar setae, 2 fields are visible on the latero-posterior part of pro-dorsum, 3–4 fields are visible between c_2 and d_1. 2 fields between e_1 and e_2, 4 fields between f_1 and h_3, 4 fields between the f_1 and h_1 setae and 4 fields between the p_1 setae. The specimens are small with a length of about 0.17 mm and a width of about 0.10 mm. Length of the setae is 25–30 μ.

Distribution. Europe, Greenland, North America.

Camisia segnis (Hermann, 1804)

Habitat. According to Grandjean (1936) *C. segnis* is an arboricolous species.

Distribution. Iceland and the rest of Europe, North Africa, North and South America.

Camisia sp.

Morphology. In most ways the *Camisia* specimen from the Faroes corresponds to that of *Camisia foveolata* Hammer, 1955, but deviates from that of *C. foveolata,* especially because the anterior notogastral setae are not barbed, the posterior notogastral setae are only very slightly barbed, and the specimen is only 0.64 mm in length compared to 0.85 mm for foveolata.

Platynothrus peltifer (C. L. Koch, 1839)

Distribution. Iceland and the rest of Europe, Greenland, North America, Asia.

Hermannia reticulata Thorell, 1871

Habitat. In Europe it is mostly found in littoral habitats, in Greenland it is recorded from more dry habitats (Strenzke et al. 1955, and Hammer 1944, 1946). Distribution. *H. reticulata* seems to be a northern species known especially from Northern Europe, Iceland, and Greenland.

Paradamaeus clavipes (Hermann, 1804)

Habitat. According to Grandjean (1936) the main habitats of the species are the bark of trees and old stumps.

Distribution. Iceland and the rest of Europe, North Africa, USSR.

Ceratoppia bipilis (Hermann, 1804)

Habitat. *C. bipilis* occurs in various surroundings: branches and trunks of trees, rocks, litter etc. (Hammen 1952).

Distribution. Europe, North Africa, Greenland, North America, Asia.

Banksinoma lanceolata (Michael, 1888)

Habitat. *B. lanceolata* is usually found in litter and soils, but in Denmark it has been found numerously in moss on an overturned and decaying beech (Gjelstrup in press).

Distribution. Iceland and the rest of Europe, USSR, North America.

Carabodes marginatus (Michael, 1884)

Habitat. *C. marginatus* is usually found singly in acid forest soils (Rajski 1968) and is abundant only on decaying wood (Sellnick & Forsslund 1953).

Distribution. Iceland and the rest of Europe.

Carabodes minusculus Berlese, 1923

Habitat. *C. minusculus* is usually reported from acid forest soils and heath, often in *Cladonia*

lichens in pine forests (Willmann 1931). Travé (1963) found it in rock habitats covered with moss and *Cladonia* species.

Distribution. Europe.

Suctobelbella subcornigera (Forsslund, 1941)
Distribution. Iceland and Northern Europe.

Suctobelbella similis (Forsslund, 1941)
Distribution. Europe.

Suctobelbella sarekensis (Forsslund, 1941)
Distribution. Iceland and Western Europe, North America.

Suctobelba trigona (Michael, 1888)
Distribution. Europe.

Oppia neerlandica (Oudemans, 1900)
Distribution. Europe, USSR.

Oppia unicarinata (Paoli, 1908)
Distribution. Iceland and the rest of Europe, Greenland, North America.

Oppia ornata (Oudemans, 1900)
Habitat. Hammen (1952) found *O. ornata* in litter and in moss in forests, in moss on trees and walls etc. Travé (1963) found it especially in rock habitats and less on trees.

Distribution. Iceland and the rest of Europe, Greenland, USSR, North America.

Phauloppia lućorum (C. L. Koch, 1841)
Habitat. According to Strenzke (1952), *P. lucorum* is a characteristic species in moss and lichens on trees, walls, roofs etc.

Distribution. Europe.

Chamobates cuspidatus (Michael, 1884)
Distribution. Iceland and the rest of Europe, Greenland, USSR, North America.

Danobates, n. gen.
The lamellae are rather laterally placed on prodorsum without transgressing the sideborder of prodorsum. The lamellae are broad in the posterior part and more narrow in the anterior part; they converge anteriorly and bend off against each other. Cuspis or translamella are not present. The rostral setae come from the inside of the tutorium. The lamellar setae come from the anterior parts of the lamellae. The interlamellar setae are situated very close to the anterior part of hysterosoma. The sensilli are
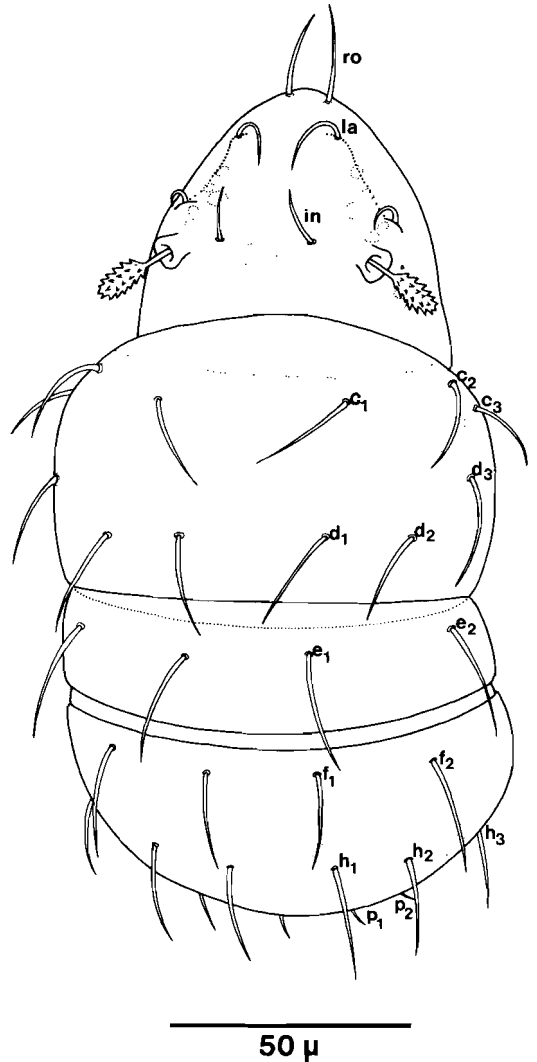
Fig. 1. *Liochthonius perpusillus*. Dorsal side. ro = rostral seta, la = lamellar seta, in = interlamellar seta c_1 c_2 c_3d_1 etc. = setae on notogaster.

50 µ

broad and somewhat flat. Laterally bothridium has a keel–like excrescence which for the greatest part is covered by the pteromorpha. On each side the notogaster has 10 extremely small setae, 4 areae porosa, 4 lyrifissuri, and one gland. Anteriorly the hysterosoma is convex. The pteromorphae are well-developed and bend downward. They are immobile. Other general features are: Tutorium and pedotectum I well-developed. Tutorium has a free point. Pedotectum II and III are smaller with protruding
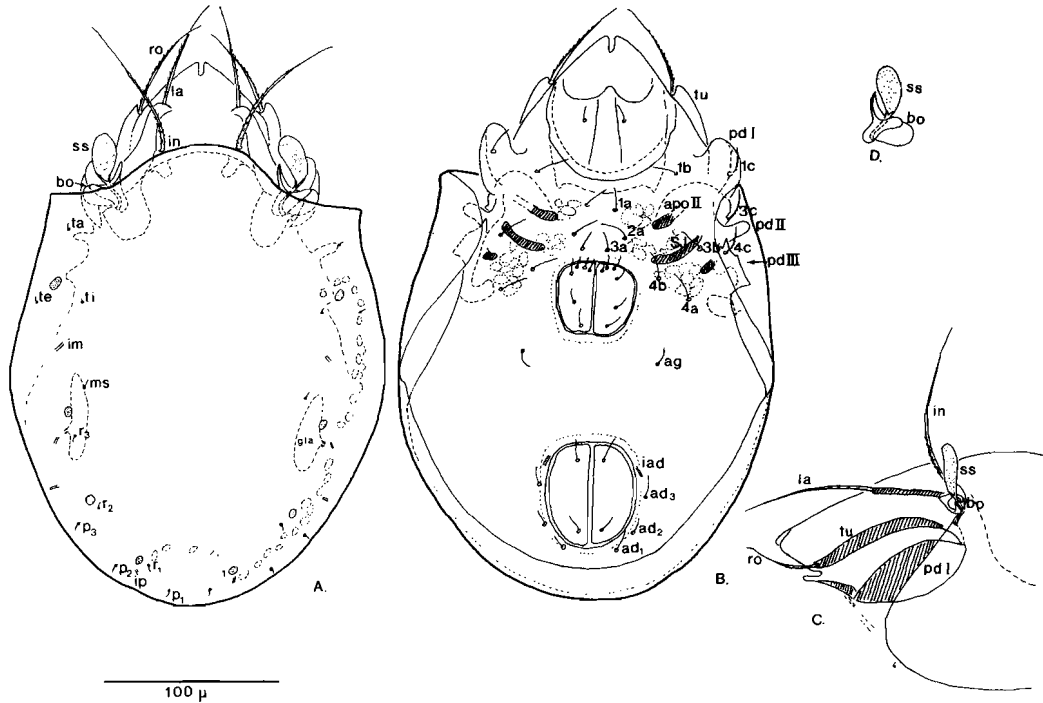
Fig. 2. *Danobates insignitus* n. sp. A: dorsal side. B: ventral side. C: lateral side. D: bothridium and sensillus. ro = rostral seta, la = lamellar seta, in = interlamellar seta, bo = bothridium, ss = sensillus, ta, te, ti, ms, r_1, r_2, r_3, p_1, p_2, p_3 = setae on notogaster, iad, im and ip = lyrifissuri, tu = tutotorium, pd I, II, III = pedotectum I, II, III, 1a, 1b, 1c, 2a etc. = epimeral setae, apo II and SJ = apodemata II and SJ, ag = aggenital setae, ad_1, ad_2, ad_3 = adanal setae.

points. Apodemata II and SJ are distinct. Apodemata III is very small and Apodemata IV is not visible at all. The formula for the epimeral setae is 3-1-3-3. The formula for the genito-anal setae is 6-1-2-3, with the lyrifissur iad anterior to ad_3. The legs all have 3 claws, the middle one being the most powerful.

Danobates insignitus, n. sp.

52 specimens were found in 'Vidarlund', Thorshavn, The Faroe Islands. Length: 0.31–0.33 mm. width: 0.21 mm.

Holotype and 30 paratypes: Zoologisk Museum, Copenhagen.

Only features not mentioned above will be mentioned here. Rostrum with incision. The rostral setae unilaterally barbed, bend downward and inward almost meeting each other anteriorly to rostrum. The lamellar setae are unilaterally barbed.

The sensillus are rather flat and oval, bending upwards and inwards. The interlamellar setae are versatilely barbed and have a length of about one third of the length of the mite. The epimeral setae are rather long and the most lateral ones are barbed.

Colour is light- to slightly dark-brown. On the dark specimens a lot of maculae can be seen on notogaster as well as in the epimeral region (on notogaster only shown in the right part of the drawing), but on light-brown specimens these maculae are rather difficult to see.

Danobates insignitus is shown in Fig. 2.

Danobates seems to be closely related to *Ocesobates* Aoki, 1965, but especially the position of the lamellae, the lack of cuspis, and the presence of small setae on notogaster make it different from *Ocesobates*.

Melanozetes mollicomus (C. L. Koch, 1939)

Distribution. Europe.

Edwardzetes edwardsi (Nicolet, 1855)

Distribution. Iceland and the rest of Europe, Greenland, but seems to be rare.

Sphaerozetes piriformis (Nicolet, 1855)

Distribution. Iceland and the rest of Europe.

Eupelops auritus (?) (C. L. Koch, 1840)

Habitat. In moss, especially on trees (Willmann 1931).

Distribution. Europe, North America.

Oribatella quadricornuta (Michael, 1884)

Distribution. Europe.

Parachipteria punctata (Nicolet, 1855)

Morphology. The tectopedia I do not meet each other but leave a space between their tips. The notogastral setae, except the two anterior ones on each side, are rather small.

Habitat. Strenzke (1952) mentioned *P. punctata* as a characteristic species of dry forest floors, but often found it numerous in moss on decaying wood.

Distribution. Europe.

Phthiracarus affinis (Hull, 1914)

Distribution. Europe.

Discussion

In sample 1 the dominance of *Hermannia reticulata* is obvious. In literature, *H. reticulata* is reported as a northern species which, in Europe, is usually found in littoral habitats (Strenzke et al. 1955), and in Greenland it is recorded from dry soil habitats (Hammer 1944, 1946). So far it has not been recorded from lichens on trees – which may periodically be very dry but certainly not in the Faroe Islands. *Eupelops auritus,* which is known to occur in trunk habitats (Willmann 1931), constitutes 3 of the 49 specimens in the sample. The species composition as a whole seems to indicate a rather specialized habitat in clear contrast to the species of the habitat of sample 2, in which many representatives of both trunk and forest floor occur.

In sample 2 the species *Paradamaeus clavipes, Ceratoppia bipilis, Oppia ornata,* and *Parachipteria punctata* are known to occur on trees, and the species *Banksinoma lanceolata* and *Carabodes marginatus* on decaying wood (Grandjean 1936, Sellnick & Forsslund 1953, Travé 1963, Gjelstrup in press). However, the most dominating species are soil inhabitants: *O. neerlandica* and *H. reticulata* (Hammer 1944,

1946, Hammen 1952, Strenzke et al. 1955). 39 specimens of the new species *Danobates insignitus* were found in this sample.

In sample 3 the species composition is also very complex and very similar to that of sample 2, but it deviates from sample 2 especially because *Carabodes minusculus* is very abundant; this, however, is in good accordance with Travé (1963), who found it in rock habitats covered with moss and *Cladonia* species. Elsewhere *C. minusculus* is reported from acid forest floors and heath – often in *Cladonia* lichens in pine forests Willmann (1931). The presence of *Oppia ornata* may not be quite accidental, in that Travé (1963) has found it abundant together with *Zygoribatula exilis* in high accumulations of suspended soils on rocks in shaded underwood. But again the influence of the soil inhabitants *Oppia neerlandica* and *Hermannia reticulata* is obvious. Only 2 specimens of *Danobates insignitus* were found in this sample.

In sample 4 the representation of species is only half that seen in sample 2, and – with the exception of *Eupelops auritus* and *Carabodes minusculus* – the species are the same as those in sample 2. However, especially *Oppia neerlandica* is less dominating; this may be because sample 4 was collected much further up a stem than sample 2. 11 specimens of *Danobates insignitus* were found in this sample.

From a statistical point of view the material does not allow further conclusions, but it seems as if the oribatid fauna in trunk habitats is poorer than in habitats at root collar (sample 2) or rock habitats (sample 3).

Of the 27 species found in 'Vidarlund', 25 are known from Europe, 13 from Iceland, 10 from North America, and 8 from Greenland. Of the species recorded by Sellnick (1908, 1923) and Trägårdh (1931), 14 are known from Europe, 8 from Iceland, 6 from North America, and 5 from Greenland.

Before 1975 *Tritia färöensis* Sellnick, 1923 and *Oppia krygeri* (Trägårdh, 1931) were thought to be endemic to the Faroe Islands. One of these species, *Tritia färöensis,* has now been recorded from Surtsey (Lindroth et al. 1975). However, a new species *Danobates insignitus* has now been found in the islands.

One species, *Mucronothrus nasalis* (Willmann, 1929), is known from cold and wet habitats all over the world (Hammer 1965). Thus the oribatid fauna of the Faroe Islands

seems to be very closely related to the fauna in the rest of Europe (39 of the 44 species are recorded from Europe), whereas its relationship to the fauna known from Iceland, North America and Greenland is much more distant. The samples from 'Vidarlund' have resulted in a much better insight into the oribatid fauna of the Faroe Islands, especially because the many very small soil inhabitants, as for instance the *Suctobelbella* and *Oppia* species, known from the rest of Europe, are also seen to occur in the Faroes, as might be expected. What is remarkable about the samples is that *Hermannia reticulata* and *Oppia neerlandica* are as abundant as can be seen in Table I. Remarkable also is the occurrence of the species *Danobates insignitus* with 52 specimens.

It cannot be excluded that some of the species found in 'Vidarlund' have occasionally been imported to this plantation because many of the trees have been imported direct from nurseries in Denmark. The fact that 22 out of 27 species found in 'Vidarlund' are new to the Faroe Islands supports the supposition that many more species could be found in the Faroes.

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Notes on the cold-hardiness of prostigmate mites from Vestfjella, Dronning Maud Land

LAURITZ SØMME

The prostigmate mites *Eupodes tottanfjella, Nanorchestes bifurcata,* and *Nanorchestes brekkerista* were collected in Vestfjella (73° to 74°S), Dronning Maud Land, Antarctica. All species were found in habitats with sufficient moisture for the growth of lichens and moss, but *E. tottanfjella* was most numerous where seepage of melt water occurred around breeding colonies of snow petrels. On sunny days, temperatures higher than 16°C were recorded at sites where the mites were living, while long periods of sub-zero temperatures occurred on cloudy days. Most specimens of *E. totanfjella* and of the *Nanorchestes* spp. had supercooling points between −20° and −30°C, but did not survive freezing at these temperatures.

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Vestfjella is a north-east to south-west mountain range situated between 73° to 74°S and 13° to 15°W. It consists of a series of isolated peaks and nunataks rising from the surrounding glaciers. Most of the peaks reach an elevation of 300 to 800 m a.s.l., some of them rising more than 200 m above the surface of the ice field (Hjelle & Winsnes 1971).

During the Norwegian Antarctic Expedition 1976/77 one of the landing parties visited Vestfjella in Dronning Maud Land from 18 January to 15 February. For the first three weeks a camp was maintained in the central parts of these mountains, and during this period some observations were made on the ecology and cold-hardiness of prostigmate mites. This is the first account of arthropods from these mountains, and their detailed faunistics will be given in a separate paper (Sømme, in prep.). Five species of prostigmate mites were collected, but no other terrestrial arthropods were found.

Relatively little information is available on the cold-hardiness of terrestrial arthropods from the Antarctic, and most experiments have been carried out during the austral summer. Even in summer, however, animal survival at very low temperatures has been observed. Of three species of Collembola studied, *Isotoma klovstadi* Carpenter from Northern Victoria Land survived three days at −50°, but all were killed at −60°C (Pryor 1962). According to Janetschek (1967) *Gomphiocephalus hodgsoni* Carpenter from the McMurdo area are killed by temperatures between −20° and −28°C. *Cryptopygus antarcticus* Willem from Signy Island in the maritime Antarctica survived temperatures down to −23° (Tilbrook 1970). Regarding the Acari, Dalenius & Wilson (1957) found that the oribatid mite *Maudheimia wilsoni* survived at −35° for three days, but was killed at −70°C. For the prostigmate mites *Stereotydeus mollis* Womersley & Strandtmann and *Nanorchestes antarcticus* Strandtmann, collected during the summer in the McMurdo area, the lower lethal temperatures were between −11° and −23°C and between −23° and −41°C, respectively (Fitzsimmons 1971).

The ability of Antarctic terrestrial arthropods to supercool has recently been demonstrated. Block et al. (1978) found that starved specimens of *Cryptopygus antarcticus* and the oribatid mite *Alaskozetes antarcticus* (Michael) from Signy Island may have supercooling points down to −25° to −30°C, and that the ability to supercool is greatly reduced by feeding. *C. antarcticus* from Bouvetøya had supercooling points in the *range of* −24° to −27°C (Sømme 1978).

Habitat

In Vestfjella most of the mountainsides are covered by loose rocks and gravel, and are snow free during the summer. Much of the surface has little or no sand and mineral soil to hold the moisture from melting snow. As a result
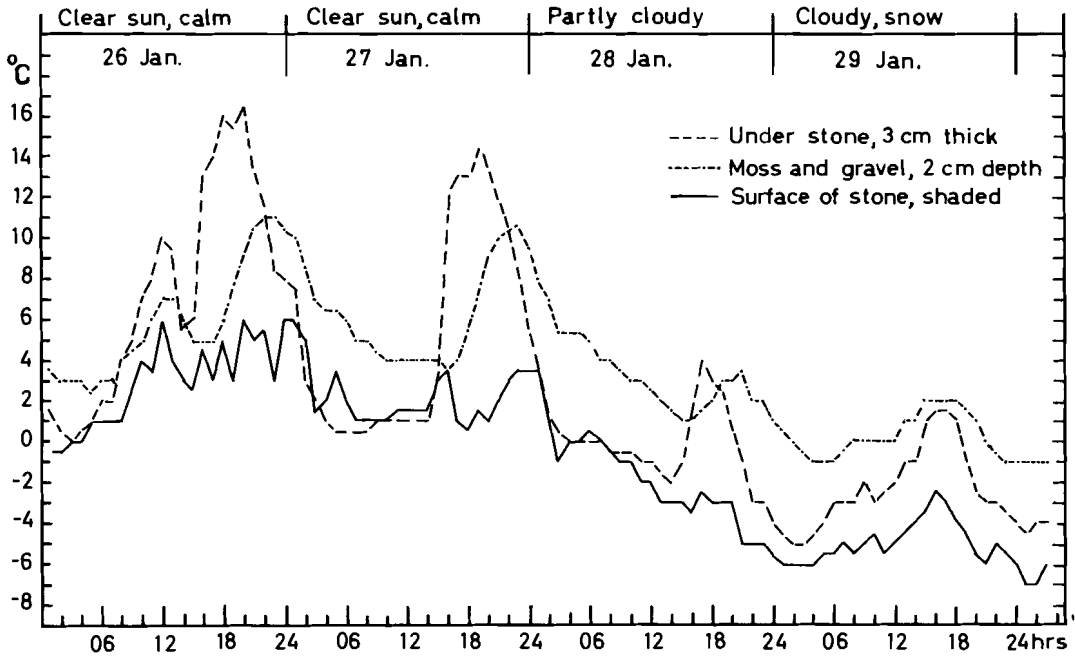
Fig. 1. Hourly temperature records during a four day period at three sites in a mite habitat in Vestfjella.

most of the mountain slopes are extremely dry and unsuitable for terrestrial plant and animal life. Only in a few very small areas, usually in crevices between rocks, is there sufficient moisture from melting snow to support the growth of moss, lichens, and terrestrial algae. *Grimmia* cf. *antarctica* was the most common moss in such crevices, while *Sarconeurum glaciale* was found in one locality. In some places the lichens *Usnea*-sp. and *Umbilicaria*-sp. were abundant in crevices or between loose rocks, separately or in association with mosses. Relatively high moisture content is also found in sand and gravel surrounding the nests of snow petrels (*Pagodroma nivea*). Large patches of the moss *Bryum* cf. *algens* were present, where seepage of melt water occurred in connection with colonies of these birds.

Nanorchestes bifurcatus Strandtmann and *Nanorchestes brekkerista* Strandtmann & Sømme used in the present study were most abundant in habitats with moss and lichens. The two species inhabited the same sites, and were both collected from the underside of small stones. When the rocks were wet after a snowfall, the mites were also found on the surface of stones and lichens.

Eupodes tottanfjella Strandtmann occurred, together with the *Nanorchestes*-sp. but was more abundant in moist gravel close to snow petrel colonies. Wet seepage with the presence of green algae (*Prasiola*-sp.) indicated where specimens of this mite could be found easily. The mites appeared to be very dependent on the right moisture conditions, and were not found among dry stones and gravel. Too wet habitats were also avoided. Under optimal moisture conditions, hundreds of specimens of *E. tottanfjella* could be gathered from the underside of stones, about one dm^2 in size.

A typical habitat was chosen for studies of the temperature conditions under which the mites were living in the middle of the summer. This habitat was situated on the south-west slope of a small nunatak at about 500 m a.s.l. Both moss and lichens were present in the habitat, where a high moisture content was maintained in sand and gravel in crevices between the rocks. Temperatures were measured hourly over a period of two weeks by thermistors connected to a 9 point Grant recorder. As a representative example, the recordings made by three of the thermistors during a four-day period with changing weather are presented in Fig. 1. One of the thermistors

was placed on the surface of the rocks. Although shaded from direct sunlight by aluminium foil, the recordings do not represent the ambient air temperature. The two other thermistors were placed in sites where mites were present; one underneath a stone about 3 cm thick, and the other in sand and gravel covered by a small pad of moss, about 2 cm thick.

Large temperature fluctuations were recorded on sunny days (Fig. 1) when the habitat was heated by the sun in the afternoon. Temperatures as high as 16.5°C were recorded underneath the stone, and 11°C under moss and gravel, markedly higher than on the rock surface. The heat was best maintained under moss. On cloudy days the habitat was less subjected to temperature fluctuations, and freezing temperatures were recorded by all thermistors.

The recordings clearly showed that the mites experience periods of temperatures in their microhabitats that are probably suitable for growth and development. This is in agreement with the conclusions of Janetschek (1967), who made much more detailed microclimatic

Fig. 3. Supercooling point distribution histograms of *Nanorchenstes*-spp. from two localities in Vestfjella. Date of collection and storage time in days at −3°C before supercooling point measurements are given for each sample.

studies in southern Victoria Land. The low temperatures on cloudy days, however, will probably be inhibitive to most biological functions.

Cold-hardiness

Supercooling points were measured in *Eupodes tottanfjella* and *Nanorchestes-spp.*, which were the most common mites of the area. The two species of *Nanorchestes*, *N. brekkerista* and *N. bifurcata*, could not be separated under field conditions, and from later examinations of fixed specimens it appeared that a mixture of the two species had been used.

Both *Eupodes* and *Nanorchestes* are less than 0.5 mm in length, but in spite of their small volume, their supercooling points could be measured with fine copper-constantan thermo-
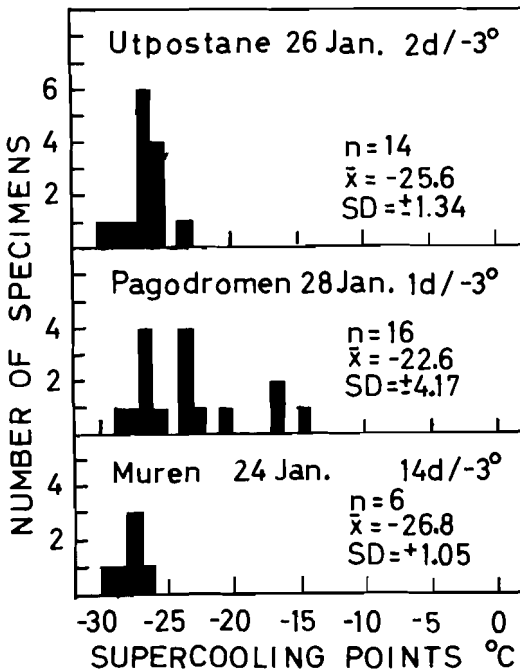

Fig. 2. Supercooling point distribution histograms of *Eupodes tottanfjella* from three localities in Vestfjella. Date of collection and storage time in days at −3°C before supercooling point measurements are given for each sample.
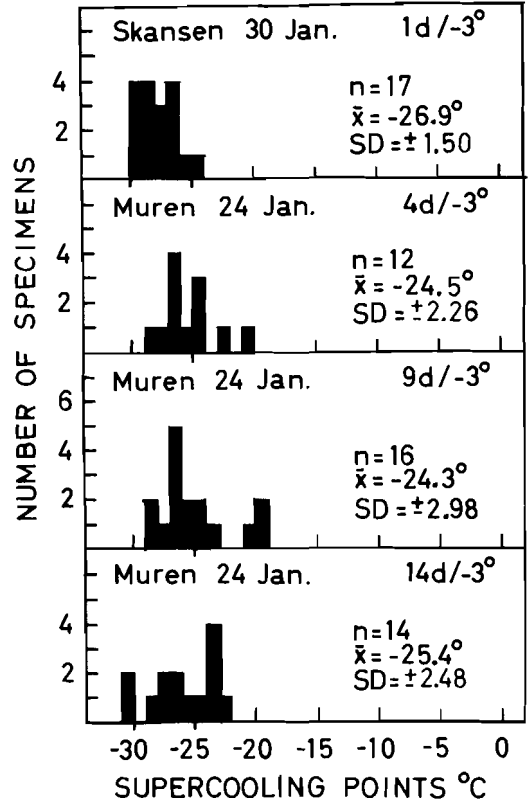
couples connected to a one-point, battery-operated, Grant recorder. After the mites had been attached with petroleum jelly, the thermocouples were placed in two plastic tubes, one outside the other. The tubes were lowered into a cooling mixture made from finely crushed $CaCl_2 \cdot 6H_2O$ and pulverized dry snow. The temperature of the cooling mixture was around $-40°C$. A cooling rate of $1°$ to $2°C$ per minute could be maintained by regulating the depth to which the tubes containing the thermocouples were lowered into the mixture.

Supercooling point distribution histograms for *E. tottanfjella* from three localities in Vestfjella are presented in Fig. 2. In all samples a large proportion of the mites had supercooling points below $-25°C$, but the average supercooling point of mites from Pagodromen was significantly higher than those from Utpostane and Muren. Although the mites from Muren were stored for two weeks at about $-3°$, their supercooling points were not significantly different at the 5% level from those of specimens from Utpostane.

Results of supercooling point measurements in *Nanorchestes*-ssp. collected at the nunataks Skansen and Muren, are presented in Fig. 3. Of the mites from Muren about one third were identified to *N. brekkerista* and two thirds to *N. bifurcata*. There was a slight tendency for a lowering of the supercooling points after two weeks at $-3°$, but the difference is not significant at the 5% level. The supercooling points of the mites from Skansen, however, are significantly lower than all samples from Muren. About half the mites from Skansen were *N. brekkerista* and the other half *N. bifurcata*.

Examinations of the mites after they were frozen at temperatures in the range of their supercooling points, revealed no sign of life. It appears that these species are not tolerant to freezing at these temperatures.

Discussion

As pointed out in the introduction, several species of Antarctic terrestrial arthropods can survive relatively low temperatures even in the summer (Dalenius & Wilson 1958, Fitzsimons 1971, Janetschek 1967, Pryor 1962, Tilbrook 1970). The results of the present study show that prostigmate mites collected during the summer in Vestfjella also have a high degree of

cold-hardiness, expressed as low supercooling points. In this respect they differ remarkably from alpine Collembola and oribatid mites from Norway, where summer supercooling points are often higher than $-10°C$ (Sømme & Conradi-Larsen 1977). The effect of gut content on supercooling has been pointed out by several authors (Powell 1976, Salt 1966, Sømme 1976), and the high supercooling points of these species were explained by the presence of nucleating agents in the gut.

While terrestrial arthropods from Norwegian mountains are not subjected to low sub-zero temperatures during the summer, the prostigmate mites in Vestfjella are. The temperatures recorded in their habitat (Fig. 1) show that the mites may experience whole days of temperatures above $0°C$, but also long periods of freezing temperatures when the sky is cloudy. On one of the days shown in Fig. 1, the temperature declined to $-5°C$ at one of the sites inhabited by mites. In mid-February, after the microclimatical recordings were discontinued, air temperatures down to $-18°$ were measured in the camp. It is reasonable to assume that the mites may be subjected to lower temperatures than those measured. At least at the end of the summer they must be prepared to survive quite low temperatures, perhaps between $-10°$ and $-20°C$.

The mites are thus faced with the problem of being able to feed and to have a high ability to supercool at the same time. A closer examination of their feeding habits and gut content may explain this paradox. At present it can only be assumed that the food is consumed in such a way that coarse particles or other substances likely to cause nucleation are avoided.

Another problem which remains to be solved is how the mites increase their cold-hardiness to survive winter conditions on inland Antarctic nunataks. Acclimation at about $-3°$ for two weeks apparently had little or no effect on the supercooling points of the specimens used in the present study, but it is expected that longer periods of acclimation would have resulted in increased ability to supercool. Although the greatest care was taken, attempts to bring mites back to Norway for further experiments were unsuccessful, and only a few specimens survived the long transport. The high mortality was probably due to difficulties in maintaining the correct moisture conditions. This is usually no problem with collembolans and oribatid mites,

which would have been more suitable for experimental work on adaptation to low temperatures. Unfortunately specimens of these groups were not encountered during the present expedition to Vestfjella.

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Sampling of soil microarthropods from coniferous forest podzol

HANS PETTER LEINAAS

Microarthropods were extracted from soil samples by a Macfadyen high gradient apparatus and effects of different treatments during the complete sampling procedure were studied. The number of animals killed during sampling was reduced by making the inner diameter of the corer larger than the diameter of the cutting edge (37 mm vs. 36 mm). A corer constructed for sampling soil through snow in the winter is briefly described. Apterygota and Acarina were extracted from raw humus. The efficiency was found to be highly dependent on the extraction speed (i.e. the heat regime of the apparatus). Storage of soil samples for up to a month at +2 to +3°C did not cause any significant mortality, but the representation of the youngest size classes may alter. Therefore, the effect of storage is dependent on the reproductive state of the population.

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From podzols, soil living microarthropods are best extracted by dynamic methods (funnel type), which are more efficient and less time consuming than flotation (Healey 1971). However, the sampling procedure is far from 100 per cent efficient (Tanaka 1970, Marshall 1972, Takeda 1973, Tamura 1976). To improve efficiency and to elucidate errors, the effects of sample treatment were studied.

Numerous variations of extractors have been constructed, and several authors have compared different types (Macfadyen 1961, Murphy 1962, Valpas 1969, Edwards & Fletcher 1971, Marshall 1972, Huhta 1972, Lasebikan 1975). The apparatus used in this work, a high gradient canister extractor (Macfadyen 1961), is regarded as the most suitable for ecological research (Healey 1971, Marshall 1972). However, the efficiency of the heat regime (i.e. extraction speed) of the apparatus has not been tested, although Macfadyen (1961) found variation in the efficiency of his small funnel extractor with air conditioning, depending on the heat regime.

Collection and preparation of soil samples for extraction are critical steps in the procedure, often killing a significant number of animals (Murphy 1962, Healey 1971). Only living animals are extracted by dynamic methods. Therefore, the handling of soil samples affects sampling efficiency.

This work was conducted prior to an investigation of Collembola and Protura, but Acarina were

also included in two of the tests. Primarily the paper deals with soil living eu- and hemiedaphic species. Technical problems are less severe when collecting surface-dwelling, epedaphic species. Surface animals are less prone to injury due to soil compression, and even a simple Tullgren funnel probably gives high extraction efficiency. However, larger soil samples are usually required to obtain a representative picture of these species inasmuch as they are often quite active and have relatively low population densities. In the first two tests carried out (the extraction and the storage test) both the corer and the extractor were designed for soil samples of 32.2 cm² in surface area. Later this was changed to 10.2 cm² samples. Soil samples for each test were collected within small, homogeneous plots and randomly divided into the different treatment series. The differences were tested by Students t-test. As recommended by Abrahamsen & Strand (1970), the values were not transformed to obtain normality.

The design of the corer

On unfrozen soil it is recommended to use the split corer described by Macfadyen (1961), with the interior consisting of bakelite cylinders designed to be put directly in the extraction apparatus (Fig. 1). This reduces the disturbance of the soil samples after collecting. The friction
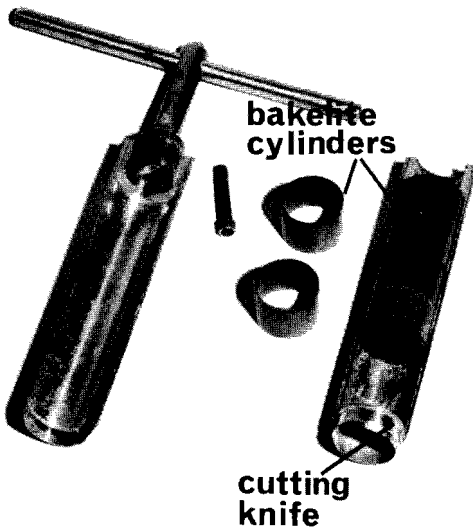
Fig. 1. A split corer for collecting soil samples shown in dismantled state. The diameter of the cutting knife and the bakelite cylinders are 36 mm and 37 mm respectively, and the cylinders are 3 cm wide.

The difference found between the two sampling series at the uppermost 3 cm was not significant. However, it showed the same tendency as the 3–6 cm layer. Therefore, it is reasonable to believe that friction in the 37 mm corer also had a negative effect in the 0–3 cm layer. In addition to less severe pressure near the surface, the structure of raw humus can explain the relatively small effect. Being elastic and very porous it offers few obstacles for the passage of animals out of the soil.

When taking samples from frozen soil the corer has to be driven into the substrate using a sledge hammer. A split corer is unsuitable for such rough treatment, so a simple cylinder of stainless steel was used. Frozen soil can easily be handled without causing any disturbance. Fig. 2 shows a sampling tool made for collecting soil samples through the snow. The sample corer is attached to a metre length of steel pipe by two set screws. The right part of the figure shows the condition when the corer is driven into the, frozen soil. To prevent wedging of the screws by the stroke, they are not in contact with the corer in this situation. When the corer is pulled up (left part of figure), the force is transferred from the pipe via the screws. Then the sampling tool is dismantled and the soil sample taken from the corer. The tool saves the very time-consuming work of digging through the snow for each sample to be taken, which also disturbs the soil surface. It is important to avoid digging, especially when samples are taken close to each other several times during the winter. In addition, the microarthropods being in the snow can be studied by taking care of the snow core from the steel pipe.

between soil samples and the corer is minimised by making the inner diameter of the cylinders (37 mm) larger than that of the cutting edge (36 mm). The importance of this construction was tested by also using a cutting knife (Fig. 1) with 37 mm diameter. With each knife twenty samples were taken. By dividing them into 3 cm layers the raw humus and the mineral soil were separated. Two extractions were performed, one for the raw humus and one for the mineral soil. The number of Collembola and Acarina extracted are given in Table I (only a few Protura were found). Both animal groups gave similar results. The 36 mm corer yielded most animals, but only in the 3–6 cm layer were the differences significant. When taking samples the pressure from friction is transmitted downwards so the effect will be more severe deeper down in the soil. Many animals are killed by the compression. Furthermore, the mineral soil is plastic, and pores that are closed during sampling will remain so afterwards. So a number of animals might have been trapped inside the samples as they are not able to dig their way out (Haarløv 1960). The 36 mm corer gave 2.2 times greater numbers of both Collembola and Acarina at the 3–6 cm depth in spite of the 5.6 per cent larger area covered by the 37 mm corer.

Table I. Number of Collembola and Acarina obtained by using a corer with cutting edge of diameter 36 mm and 37 mm respectively. Both corers had an inner diameter of 37 mm. $\bar{X}$ = mean of 20 soil cores. SD = standard deviation.

	0–3 cm depth				3–6 cm depth			
	Coll.		Acarina		Coll.		Acarina	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
36 mm diam.	177	92	190	56	20	17	49	43
37 mm diam.	140	76	170	59	9	8	22	14
Difference	37		20		11*		27*	

* = difference significant at 1 % level.

Effect of heat regime on the efficiency of the high-gradient extractor

The extractor was designed for 40 cores. Heating was achieved by a heating coil controlled by a variac transformer giving a gradual increase in temperature during the extraction. The coil was arranged so as to provide uniform heating in the apparatus. A 1 mm mesh sieve supported the soil core above the collecting dishes containing 50 per cent solution of picric acid. The cooling water had a temperature of 7°C.

It is generally assumed that the efficiency depends on the temperature and moisture gradients through the samples (Healey 1971). The steepness of these gradients is determined by the heating and the thermal properties of the soil (Macfadyen 1968). It is important to ensure that high temperatures do not injure the animals. In the literature very different values are given for the heat regime. Macfadyen (1961) and Healey (1971) recommended that the temperature on the upper, heated surface should not exceed 30–40°C until the last few hours of extraction. Block (1966) and Edwards & Fletcher (1971) heated their samples up to 120°C on the upper surface at the end of the extraction.

Three series, each consisting of 30 samples of raw humus, were exposed to different extraction conditions. The material was analysed for mites, collemboles, and proturans. The fastest extraction was carried out as described by Block (1966), while the heating in the slowest (exceeding 50°C) was a little stronger than that recommended by Healey (1971). The temperature was monitored by thermocouples on the heated, upper and the cooled, lower surfaces and in the centre of soil cores during the three extractions. Because of uniform heating, measurements from only one core for each extraction are illustrated in Fig. 3. Each extraction was continued until no further animals emerged from the samples. The fastest extraction lasted for three days, the intermediate for five days, and the slowest for eight days. The last extraction was not controlled between the day 5 and the day 8 so the exact duration is not stated.

The result of the test was unambiguous (Table II). Extraction with the intermediate heat regime was significantly the most efficient for all three animal groups. Clearly both too fast and too slow extraction are harmful to microarthropods.
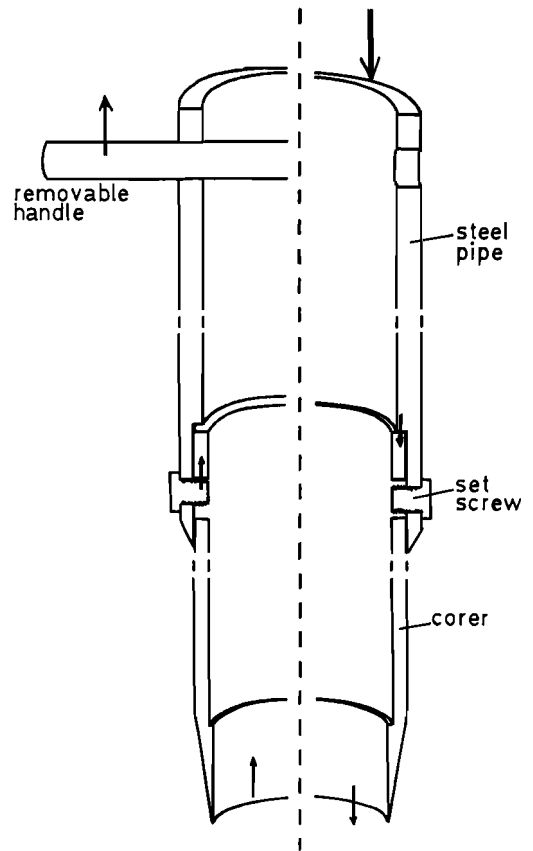
Fig. 2. Longitudinal section of a sampling tool for use in winter with snow cover and frozen soil. The samples are driven down (right part of figure), and pulled up again (left part). Arrows mark the force transfer via different parts of the sampler.

In the fastest extraction many animals appeared to be killed before emerging from the samples. This effect was by far the most drastic on the sluggish and very sensitive proturans. Collemboles, the most active of the animals, were least affected. The slowest extraction regime also gave relatively poor results. An analogous situation was found by Macfadyen (1961) in his study of the small funnel extractor with air conditioning. Two factors may reduce the efficiency of this extraction:

(1) The relatively slight microclimatic gradients through the samples may impede the orientation of the animals in their efforts to escape.

(2) A too mild heating and drying of the soil could cause the animals to congregate at the base of the samples without immediately drop-
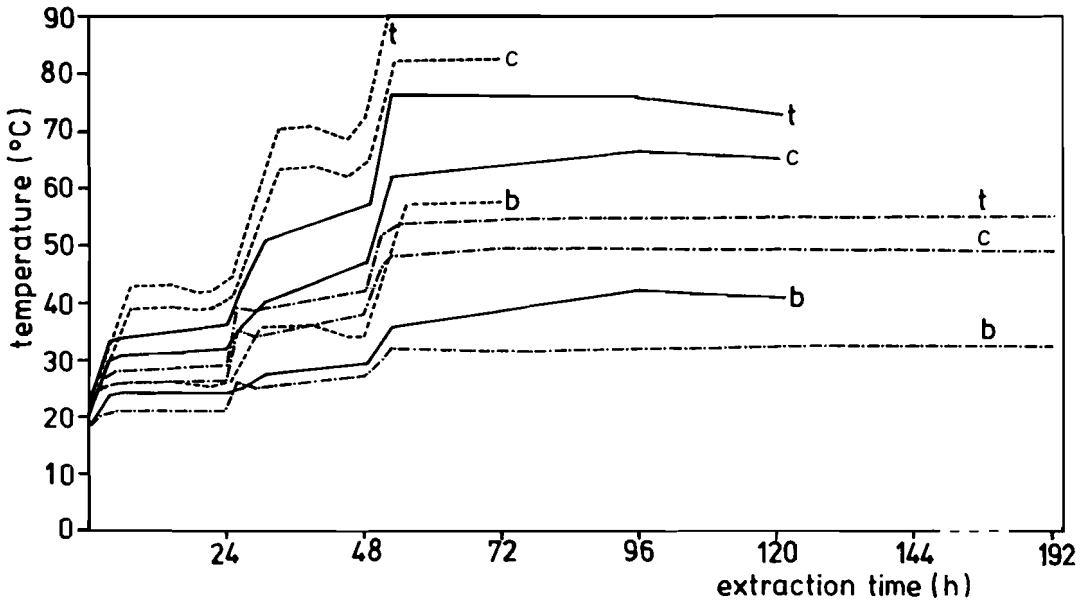
Fig. 3. The heat regime during three different extractions with the high gradient apparatus. Temperatures were recorded at the top, (t), in the centre (c) and in the base (b) of raw humus samples of 3 cm thickness. The potentiometer used did not record temperature above 90°C.

————— = fast extraction
————— = intermediate extraction speed
—·—·—·—·— = slow extraction.

ping into the picric acid. Such a concentration of animals may result in increased mortality, e.g. due to predation or to unfavourable conditions. Fairly similar conditions were obtained by holding all animals extracted from soil in one culture chamber. The Protura disappeared rapidly – within a few days. This supports the low number of Protura from the slowest extraction.

The five-day extraction which was found to be the most suitable in the present experiment is considerably more drastic than that recom-

mended by Healey (1971). It is reasonable that raw humus with its high heat insolating properties requires greater heating than many other soils. The main conclusion of this test is the great influence that variation in heating has on the extraction efficiency. However, the result of the three extractions should not be transferred uncritically to investigations in other areas. Optimum heating is assumed to depend both on the thermal properties of the soil and on the temperature to which the animals are adapted.

Table II. Number of Collembola, Protura and Acarina collected by three extraction speeds in the high gradient apparatus. $\bar{X}$ = mean of 30 soil cores. SD = standard deviation. $\bar{X}\%$ = the mean number as a percentage of what was extracted with the intermediate extraction speed.

	Collembola			Protura			Acarina		
	$\bar{X}$	SD	$\bar{X}\%$	$\bar{X}$	SD	$\bar{X}\%$	$\bar{X}$	SD	$\bar{X}\%$
Intermediate extraction speed	363	87	100	100	42	100	1 040	300	100
Fastest extraction	288	64	79**	22	16	22**	604	177	58**
Slowest extraction	262	95	72**	32	18	32**	802	345	77*

*, ** = significantly different from the result of the intermediate extraction speed at 2% and 0.1% level respectively.
speed at 2% and 0.1% level respectively.

Table III. Storage of soil samples before extraction – effect on Collembola and Protura. X̄ = number of animals exstracted, mean of 40 soil cores. SD = standard deviation.

	Collembola		Protura	
	X̄	SD	X̄	SD
No storage	385	157	38	39
16 days storage	409	178	36	35
29 days storage	338	136	33	36

No significant differences between the three treatments.

Fig. 4. Comparison of the body length distribution of three Collembola species extracted immediately after collecting (A) and after 29 days storage of the soil samples at +2 to +3°C (B).

Therefore, it would be desirable to carry out similar tests for different soil types and climatic conditions.

Storage of soil samples

It may be necessary to store soil samples for some time before they are extracted. Edwards & Fletcher (1971) concluded that samples could be stored for a week at 5°C without causing any notable change in the numbers of animals obtained. Their material indicated that the number of Collembola was little affected by 28 days storage. A similar test with Collembola and Protura was carried out in the present study. Soil samples, 40 in each series, were extracted immediately after collecting, after 16 days and after 29 days of storage, respectively. The samples were stored between +2 and +3°C. Table III shows the result of each extraction. No significant differences were found.

The body size structure of a population is an important parameter in population dynamics studies, and it is also necessary when interpreting density indexes of Collembola (Leinaas 1975). Storage of soil samples, therefore, should not result in any serious change in the body size structure of the animals. In the present study this was analysed by comparing the unstored and the 29 days stored material of three common Collembola species (Fig. 4). The species represented different reproduction patterns (Leinaas 1975) to prevent the analysis being seriously affected by physiological conditions related to specific stages in the life cycle or to reproductive activity. There was a tendency for the mean value of the size distribution to be displaced a little towards larger animals in the material stored for 29 days. A certain amount of growth

did occur. However, when considering *Friesea mirabilis* (Tullberg) and *Isotomiella minor* (Schäffer), this effect was so small that it had little practical importance. *Folsomia quadrioculata* (Tullberg) showed a more distinct change, particularly in the representation of the smallest size groups. Many young individuals in the unstored material indicated high reproductive activity. This was less obvious after 29 days storage of soil samples.

In investigations concerning population dynamics, long time storage of samples before extraction should be avoided in periods with high reproduction (egg hatch). During other seasons as well as in studies not concerned with life cycles the soil samples may be stored for a month at +2 to +3°C without seriously changing the picture of the apterygote community. The effect of longer storage has not been studied as it seems to have little practical interest. Soil samples collected when the earth is frozen should be stored just below 0°C. These samples often contain so much ice that, when melted, they become thoroughly wet giving unfavourable conditions for the animals. To prevent this, thawing should take place just prior to extraction.

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Bokanmeldelser

Glenn B. Wiggins, 1977. *Larvae of the North American Caddisfly Genera (Trichoptera).* Illustrated by Anker Odum. 401 sider, 142 plansjer. University of Toronto Press, Toronto and Buffalo. $ 25,–.

Boken er først og fremst en referansebok og bestemmelsebok. Den inneholder bestemmelsesnøkler til familier og slekter. I introduksjonskapitlet bør en spesielt legge merke til avsnittet om hvordan bruke nøklene, for her ligger en del avgrensninger i bruken, da det er siste larvestadium som er brukt ved beskrivelsene og utarbeidelse av bestemmelsesnøklene.

Deretter følger et kapittel om klassifikasjon og phylogeni. Kapitlet er kortfattet, greit og oversiktlig. I neste kapittel tar Wiggins for seg biologiske betraktninger som opprinnelige lokaliteter (habitater), de mange ulike lokaliteter vårfluer lever i idag, respirasjon, føde, husbygging og livssykluser. Det er en generell innføring i de forskjellige tema, men de blir sett på fra – og satt i en evolusjonssammenheng. At temaene er satt i en utviklingssammenheng gjør avsnittene mye mer interessante å lese enn om bare de nakne fakta var betraktet.

Den morfologiske innføringen er meget oversiktlig både i tekst og figurer, og det er heldigvis rikelig med illustrasjoner. De forskjellige detaljer har fullt navn på figurerne, og forfatteren har unngått forkortelser på figurene med forklaring i figurteksten, noe som er en stor fordel når mange detaljer skal forklares. At mange detaljer er vist med figur, styrker en entydig kommunikasjon mellom leser og forfatter. Dette øker selvfølgelig anvendeligheten av boken. Den generelle innføringen avsluttes med et kapittel om innsamlingsteknikk, å få sikre assosiasjoner larve – puppe – imago, og konservering. Da denne boken for det meste bygger på materiale innsamlet og behandlet av forfatteren selv, er det mange praktiske tips og gode idéer å finne.

Den systematiske delen starter med en bestemmelsesnøkkel til de 18 Nord-Amerikanske vårfluefamilier. Deretter har boken en streng oppbygging. Hver familie blir omtalt med utbredelse, generelle morfologiske karakterer, noe økologi og eventuelt artenes klassifisering innen familien. Videre følger bestemmelsesnøkkel til slekt og så en karakteristikk av hver slekt som omfatter utbredelse og arter, morfologi, hus, biologi og merknader. Dette strenge mønster forenkler og gjør oppstillingen oversiktlig. Også denne delen er rikt illustrert, noe som letter bruken av den i forhold til eldre litteratur. Siden forfatteren virkelig har studert alt materiale som beskrives og mye mer, og alle tegninger er originale, er mange nye diagnostiske karakterer brukt. Siden de fleste beskrivelser bygger på sikre assosiasjoner mellom larve – puppe – imago er karakterene tillitsvekkende. Det er også mere eksakte karakterer som brukes enn i tidligere litteratur.

Eldre klassifisering av vårfluer bygde i alt vesentlig på det voksne stadiet, men den moderne klassifisering tar også hensyn til larvenes morfologi. Dette letter selvsagt utarbeidelsen for bestemmelsestabeller for larver.

Hele boken bærer preg av å bygge på et solid bakgrunns-

materiale som er grundig bearbeidet. Det er meget betryggende å vite at forfatteren har et stort antall sikre assosiasjoner larve – imago å bygge på når han gir sine beskrivelser av slektene. Mye av arbeidet virker så enkelt og greit, og dette skyldes nok det store bakgrunnsmaterialet.

Denne boken har vært etterlengtet i USA og Canada, og det er blitt en god bok. Teksten er klar og presis og illustrasjonene en nytelse med klare detaljer. Selv om mesteparten av slektene er fremmende for vår fauna, er det likevel mellom 40 og 50 slekter vi har felles med Nord-Amerika. Boken er derfor også meget å anbefale for norske ferskvannszoologer.

John O. Solem

Ole Lomholdt, 1975–1976. The Sphecidae (Hymenoptera) of Fennoscandia and Denmark. *Fauna Ent. Scand. 4,* part 1 and 2, 452 pp., 464 Figs. Scandinavian Science Press, Klampenborg, Danmark. Pris d.kr. 158,– (abonnement d.kr. 110,60).

Graveveps, Sphecidae, hører til broddvepsene (Hymenoptera Aculeata) og er en formrik familie. De fleste artene bygger sine reir i jorda, i trær eller hule plantestengler men noen overtar tunneler etter treborende biller eller er parasitter. Gravevepsene er stort sett rovdyr, de samler forråd av insekter eller andre leddyr til sine larver. Fangsten består hos de fleste artene av en eneste slekt familie eller orden. En art holder seg t.eks. til en sikade slekt, en annan fanger bare snutebiller, bladlus eller edderkopper. Endel arter er mindre nøye med hva de jakter på og sleper såvel individer av ulike insektgrupper som andre leddyr till reiret.

Det er igrunnen merkelig at insekter med så fascinerende adferd som gravevepsene har vært så lite påaktet blandt Skandinavias entomologer. En vesentlig grunn må være mangelen på bestemmelseslitteratur. Desto gledeligere er det at vi nå har fått en omfattende monografi i *Fauna Ent. Scand.,* et solid grunnlag for videre studier.

De innledende kapitler gir en generell innføring i gravevepsenes morfologi, biologi med klassifisering av reirtyper, økologiske særtrekk, mm. Derpå følger zoogeografiske betraktninger av den nordiske gravevepsfauna'n basert på utbredelsen av de 171 artene som hittil er registrert. I kapitlet "Phylogeny and evolution" viser forfatteren god innsikt i fylogenetisk systematisk metodikk. Her diskuteres fylogenetisk utvikling innen Sphecidae. Det nære slektskap mellom denne familien og den mere spesialiserte bi-familien Apidae (s.lat.) belyses ved karakterer som er plesiomorfe hos gravevepsene og apomorfe hos biene. Larvesystematikken er den største bøygen for praktisk talt alle insektgrupper. Det er derfor særlig fortjenestefullt og nyttig at forfatteren etter en generell morfologisk beskrivel-

se av gravevepsens larver har våget seg på en bestemmelsestabell til de nordiske slektene såsant deres larver er kjent.

Den vesentlige del av monografien, dvs. 359 sider, er bestemmelsestabeller over imagines med inngående beskrivelse av hver arts morfologi, reirbygging, valg av rov, eventuelle predatorer. Utbredelsen angis detaljert for de nordiske land og mer generelt for verden forøvrig. Arbeidet avsluttes med utbredelsesoversikter hvor det som vanlig går frem at Norge er dårligere undersøkt enn nabolandene. Bestemmelsestabellene er prøvet på flere arter og fungerer utmerket ikke minst takket være gode, instruktive illustrasjoner. Endel mindre feil er naturligvis ikke til å unngå. I beskrivelsen av *Ammophila sabulosa* på s. 76 t.eks. er tergit 1 og 2 blitt svarte hvor de skal være rødgule. Uoverensstemmelser mellom tekst i særlig første del og listene i del to tyder på at det er kommet til endel materiale som bare er tatt med i listene. T.eks. er antall norske arter i tabell 1, s. 26 oppgitt til 94 mens det er listet 105 arter. *Psenulus pallipes* er på s. 200 ikke tatt i Norge men korrekt oppført for Østfold s. 432. At antall arter avtar mot nord og nordvest i Fennoscandia er vel kjent for de fleste dyregrupper så tendensen er riktig i Fig. 12, men isoporene vil vel få en noe annen form når fauna'n er bedre undersøkt, iall fall for Norges vedkommende. Denne figur mangler forresten endel kommentarer. I det avmerkede område for Bv, TEi, AAi, og VAi er det tatt helholdsvis 9, 2, 0, og 2 arter, tilsammen 9 arter ifølge utbredelselistene. Området for HOi er avgrenset for seg for der er registrert 37 arter! Ved bedre inventeringer vil dette område udvides med SFi hvor det utvilsomt forekommer flere enn de hittil registrerte 22 arter. Såvel indre Hordaland, som Sogn & Fjordane har et utpreget kontinentalt klima med varme tørre somre hvilket forklarer en rikere graveps-fauna. Ennvidere bør vel faunainndelingen i Fig. 13, s. 28 delvis korrigeres. I det sentrale område av Sør-Norge er t.eks. de frodige områder med kontinentalt sommerklima som dominerer Os og Bø slått sammen med fjellområdene Hardangervidda–Jotubheimen (TEi, Bv.On) til område 5. Jeg kan heller ikke være med på at vestgrensen for område nr. 6 følger riksgrensen mellom Sverige og Norge hvor denne deler fjellkjeden på langs.

Det norske materiale forfatteren har hatt til disposisjon består vesentlig, kanskje helt, av tilfeldige innsamlinger. Ovennevnte kommentarer fremhever behovet for bedre undersøkelser av faunaen. La oss håper at det grunnleggende arbeide forfatteren har gitt oss vil stimulere såvel amatører som fagentomologer til studiet av gravevepsene. Vi har fått ett ypperlig hjelpemiddel som med sitt engelske språk vil rekke langt utover Nordens grenser og som her anbefales på det beste.

Astrid Løken

å ajourføre en bok, som omfatter hele fagområdet entomologi, kan man knapt forestille seg. Det publiseres idag over 8000 artikler i entomologi i året, og bare å få med en brøkdel av nye resultater har vært et problem for forfatterne. I boken har de foretatt utallige store og små forandringer og korreksjoner, helt eller delvis omskrevet kapitler, og i det hele søkt å inkorporere mest mulig av den viten som har kommet til i disse årene.

Den 10de utgaven er delt på to bind, hvorav det første er en introduksjon i insektenes morfologi, fysiologi og utvikling. Utallige referanser til nyere litteratur viser det arbeidet som er nedlagt i å gjøre denne delen av læreboken up to date. Den generelle delen gir en fyldesgjørende oversikt over ytre og indre morfologi, men den går kanskje ikke så langt i dybden når det gjelder fysiologi og biokjemi. I så måte kan den ikke konkurrere med mer spesielle bøker på området.

Det andre bindet er det største, og omhandler klassifikasjon og biologi. Det er særlig dette bindet som gjør Imms' lærebok til et enestående verk. Her er en komplett oversikt over insektenes ordner og familier samlet mellom to permer. Med så omfattende innhold blir det rimeligvis begrenset plass for hver enkelt familie, men leseren har her et oppslagsverk som gjør det mulig å gå videre. Omtalen av hver orden begynner med en beskrivelse av karakteristiske trekk ved gruppens morfologi og biologi.

Når det gjelder den taksonomiske inndeling har forfatterne valgt en konservativ linje. Denne er begrunnet med referanser til relevant litteratur, og ofte henvises også til litteratur som beskriver en annen inndeling. En vesentlig forandring fra forrige utgave er at bestemmelsestabellene til familier er sløyfet. Dette skyldes at det blir mer og mer vanskelig å lage slike tabeller, ettersom spesialistene reviderer sin oppfatning av antall og omfang av familier innen hver orden. Viktigere enn tabeller er den korte og konsise beskrivelse av karakteristiske egenskaper, som innleder omtalen av hver enkelt familie.

De gamle, typiske strektegningene fra tidligere utgaver av Imms' er beholdt, men det er også kommet til en rekke nye illustrasjoner hentet fra senere litteratur. Figurene virker kanskje litt gammeldagse når man tenker på all moderne teknikk, men viser med all tydelighet at enkle tegninger kan ha like stor pedagogisk verdi.

Det fins neppe noen annen generell lærebok som er så innholdsrik, og i revidert utgave vil Imms' fortsatt være et standardverk. Bøkene kan anbefales, ikke bare for biblioteker ved skoler og universiteter, men også til alle biologer som gjerne vil ha en lett tilgjengelig kilde for informasjon om insekter for hånden.

Boken foreligger som "Science paperbacks", og har med sitt store omfang en meget rimelig pris. Den kan også fåes med stive permer, men faller da noe dyrere.

Lauritz Sømme

O. W. Richards & R. G. Davies. 1977. *Imms' general textbook of entomology. Tenth edition. Vol. 1. Structure, physiology and development, Vol. 2. Classification and biology.* 1354 pp. Chapman & Hall Ltd., London. Pris Vol. 1 £ 5.95, Vol. 2 £ 15.00.

Imms' lærebok i entomologi er en klassiker, og det må konstateres med glede at den ennu en gang foreligger i ny og revidert utgave. Boken utkom første gang i 1925, og ble etter forfatterens død revidert av O. W. Richards og R. G. Davies i 1957. De to samme forfatterne er nå etter tyve år også ansvarlig for en ny og omfattende revisjon. Hvilken kjempeoppgave det må være

Det 17. Nordiske Entomologmøte
Bergen 2.–4. august 1977

Det 17. Nordiske Entomologmøte ble holdt i Bergen 2.–4. august 1977, et år forsinket for å unngå kollisjon med den internasjonale entomologkongressen i Washington i 1976. Innbydere til møtet var Norsk Entomologisk Forening, Entomologisk Klubb i Bergen og Zoologisk Museum, Universitetet i Bergen. Hovedkomitéens medlemmer var førstekonservator dr. Astrid Løken (leder), universitetsstipendiat Arne Fjellberg (sekretær), førsteamanuensis Lita Greve Jensen (leder av finanskomitéen), professor emeritus dr. Hans Kauri, førstelektor Gudmund Taksdal, samt leder av Norsk Entomologisk Forening, amanuensis Karl-Erik Zachariassen. Ekskursjonskomitéen besto av Arne Fjellberg og vitenskapelig assistent Torstein Solhøy.

Tidlig høsten 1976 ble det sendt ut en orientering om tidspunktet for møtet, emner for symposier og forslag til ekskursjoner med anmodning om preliminær påmelding og tittel på eventuelle foredrag. Reaksjonen var gledelig positiv. Møtet ble avviklet med et tett program og gjenspeiler den økende entomologiske aktivitet i Norden. Det ble holdt ialt 59 foredrag, mot henholdsvis 23 (Oslo), 35 (Lund), 26 (Helsingfors) og 31 (Århus) på de 4 foregående nordiske entomologmøtene.

Antall møtedeltakere var ialt 116 fordelt på 18 fra Danmark, 17 fra Finland, 33 fra Sverige og 48 fra Norge.

Åpningsmøtet ble holdt i Studentsentret. Møtevirksomheten var ellers henlagt til universitetets auditorier på Sydneshaugen og Zoologisk Museum. Foredragene ble stort sett avviklet i to parallelle rekker. Ekskursjonen 5.–7. august gikk til indre Hardanger og Hardangervidda.

Hovedkomitéen er takknemlig for den støtte Universitetet i Bergen på forskjellig måte ydet møtet. Økonomisk støtte, dels i form av annonser, er ennvidere med takk tatt imot fra: Bankene i Bergen, Bayer Kjemi A/S, A/S Edv. Bjørnrud, Norske Felleskjøp, Hansa Bryggeri, Kristian Jebsens Rederi A/S, Det Kgl. Kirke- og Undervisningsdepartement, Clara Lachmanns Fond, Det Kgl. Landbruksdepartement, Landås Apotek, Letterstedska Föreningen, J Ludwig

Mowinckels Rederi A/S, Nansenfondet, Norges Landbruksvitenskapelige Forskningsråd, Norges Almenvitenskapelige Forskningsråd, A/S Plantevern-Kjemi, Rieber & Søn v/ Toro Næringsmiddelindustri, Wernøe & Gulbrandsen A/S.

Program

Mandag 1. august.
Arrangørene inviterte til uformell sammenkomst på Zoologisk Museum (110 deltakere).

Tirsdag 2. august.
Åpningsmøte i Studentsentrets store auditorium. Etterat hovedkomitéens leder Astrid Løken hadde ønsket velkommen ble ordet gitt til universitetets rektor professor dr. Arne-Johan Henrichsen. Han uttrykte sin glede over at Nordens entomologer hadde funnet veien til Universitetet i Bergen og nevnte bl.a. hvilken betydning møtet ville ha for det entomologiske miljø som her var under utvikling.

Representanter fra de øvrige lands entomologiske foreninger overbragte så sine hilsener: Fra Entomologisk Forening, København ved Niels Haarløv; fra Entomologiska Föreningen i Helsingfors ved Harry Krogerus; fra Suomen Hyönteistieteellinen Seura, Helsinki ved Antti Pekkarinen; fra Entomologiska Sällskapet i Lund ved Carl H. Lindroth; fra Entomologiska Föreningen i Uppland ved Jan-Erik Bergh.

Professor dr. Edvard Sylvén ble valgt til møtets president.

Åpningsforedraget ble holdt av docent Christer Wiklund: "Värdväxtstrategier hos oligofaga fjärilar." Det var ledsaget av fremragende fargeslides.

Kl. 12 ønsket Bergen by ved sin ordfører Eilert Eilertsen deltakerne velkommen i Håkonshallen.

Om ettermiddagen startet så foredragene i symposiene for *arktisk/alpin entomologi, anvendt entomologi,* og *limnisk entomologi.*

Kvelden var fri. En del deltakere med familie var på Fana Folklore.
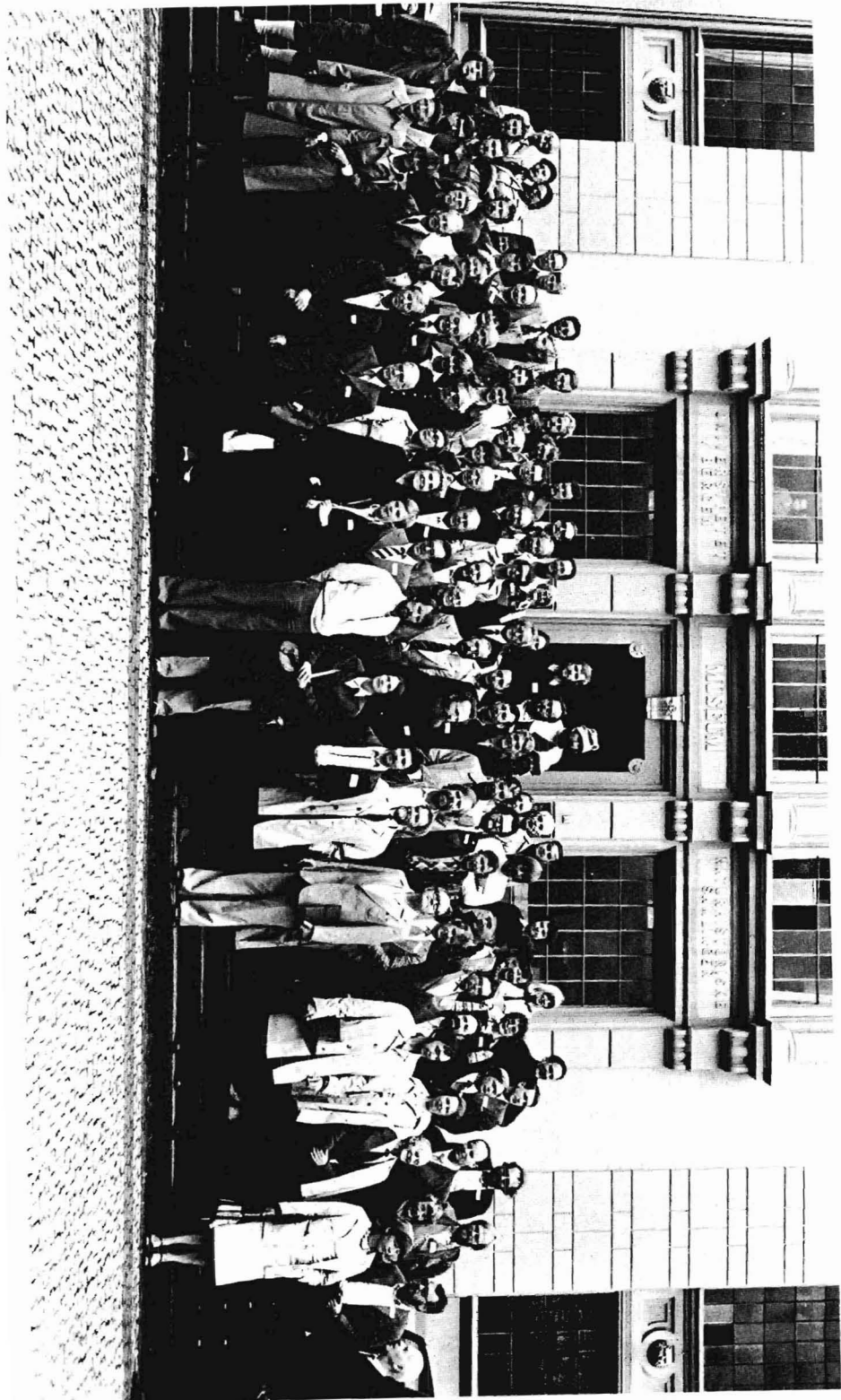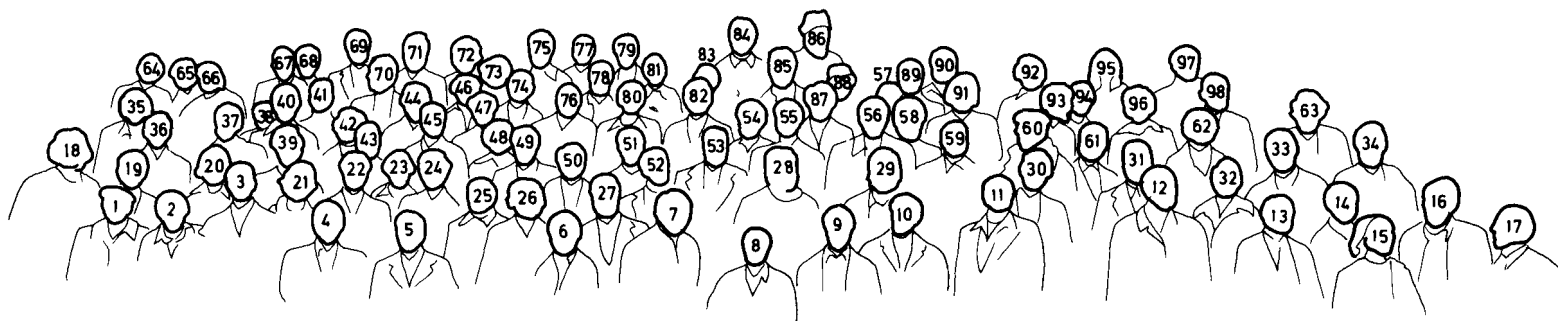
1. Lars Brundin
2. Brita Sylvén
3. Edvard Sylvén
4. Christian Stenseth
5. Osmo Heikinheimo
6. Heikki Nuorteva
7. Trond Hofsvang
8. Eline Hågvar
9. Karl-Erik Zachariassen
10. Jørgen Jørgensen
11. Harry Krogerus
12. Ole Sæther
13. Per Brinck
14. Ragnhild Sundby
15. Carita Brinck
16. Sven-Axel Bengtson
17. Hans Kauri
18. Torstein Kvamme
19. Niels P. Kristensen
20. Sigurd Bakke
21. Astrid Løken
22. Jac. Fjelddalen
23. Ingegerd Cederholm
24. Lennart Cederholm
25. Helene Tambs-Lyche

26. Dagny Brundin
27. Matti Nuorteva
28. Ole Lomholdt
29. Jens Bøcher
30. Lauritz Sømme
31. Gudmund Taksdal
32. Sirkka-Liisa Nuorteva
33. Pekka Nuorteva
34. Arne Fjellberg
35. Arild Fjeldså
36. Tor Bjørnulf Lund
37. Leif Aarvik
38. Elsa Svensson
39. Inger Fjelddalen
40. Gøran Nordlander
41. Ingvar Svensson
42. Marianne Lindroth
43. Carl H. Lindroth
44. Dag Langfjæran
45. Reidar Mehl
46. Lita Greve Jensen
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48. Marit Mehl
49. Søren Ludvig Tuxen
50. Alf Bakke

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87. Torgeir Edland
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89. Svante Ekholm
90. Günter Wohlfeil
91. Søren Achim Nielsen
92. Christer Wiklund
93. Bo Långstrøm
94. Berith Långstrøm
95. Anna Sjölander
96. Elna-Brit Ehnstrøm
97. Uno Ljungberg
98. Bengt Ehnstrøm

Onsdag 3. august.

Dagens program var tett belagt med foredrags-emner i følgende symposier: *anvendt entomo-logi, taxonomi, naturvern og miljøproblemer,* og *arktisk/alpin entomologi.*

Om formiddagen var familiedeltakerne på sightseeing med buss bl.a. til "Gamle Bergen", hvor det ble holdt kort konsert med komposisjo-ner av Grieg, og til Trollhaugen (Edvard Griegs hjem), hvoretter det var lunsj på "Bryggen Trac-teursted".

Torsdag 4. august.

Morgenens program omfattet spesielle fore-drag og foredrag i symposiet for *Lepidopterologi.*

Plenumsmøte. Avslutningsmøtet ble ledet av møtets president Edvard Sylvén. Det ble beslut-tet å sende telegrafiske hilsner til phil. dr. Wol-ther Hellén, Helsingfors, professor emeritus Es-ko Kangas, dr. phil. Niels Wollf, København og dr. h.c. Andreas Strand, Oslo.

Dr. phil. Søren L. Tuxen holdt et inspirerende avslutningsforedrag: "Tropiske proturer og kon-tinentenes bevegelser."

Deretter ga docent M. Meinander en oriente-ring om: "Den entomologiska publiseringsverk-samhetens struktur i Norden." Under den et-terfølgende diskusjon kom Norwegian Journal of Entomology og dets usikre fremtid i fokus. Nor-ges Almenvitenskapelige Forskningsråd vil kon-sentrere sin støtte til nordiske tidsskrifter inklu-sive et nytt nordisk økologisk tidsskrift. Rådets årlige bevilgninger til trykking av nasjonale tidsskrifter, som f.eks. Norwegian Journal of Entomology, vil derfor snart opphøre. Følgende resolusjon, fremsatt av K.-E. Zachariassen ble enstemmig vedtatt:

Med anledning av pågående strävanden att etablera gemensamma nordiska biologiska tids-skrifter, vill vi understryka vikten av kunskapen av regionala förhållanden inom biologien. Dici-pliner som till exempel faunistikk, fenologi, nä-ringsbiologi og tillämpad entomologi är till sin natur till stor del knutna till begränsade geogra-fiska områden. Forskningsresultatet inom dessa dicipliner är av mycket stor betydelse regionalt sett. De regionalt insamlade data utgör för många syntetiska arbeten av stor prinsipielt inte-resse som inte skulle kunne utföras utan tillgång till ett omfattande primärmaterial. Vi vill därför framhålla nödvendigheten av att det också finns publiseringsmöjligheter för stoff av denne natur.

Lennart Cederholm ga en oversikt over: "An-vändandet av kartkoordinater för lägesangivel-

ser", utarbeidet av Lars Österdahl og ham selv og fremholdt fordelen av kvadratisk rutenett. Ebbe Schmidt Nielsen talte om "Danske fauna-kort med UTM koordinater". Under diskusjo-nen gikk det frem at det var vanskelig å bli enige om et felles kartkoordinatsystem for de nordiske land. Det synes som stadig flere går over til UTM koordinater som i økende grad brukes in-ternasjonalt.

Avslutningsbanketten ble holdt i Grand Café's selskapslokaler (94 deltakere). Her innbød pre-sidenten, Edvard Sylvén til det 18. Nordiske En-tomologmøte i Stockholm 1979. Utpå kvelden kom det telegrafiske hilsener fra Andreas Strand, Oslo og fra Mia Økland, Oslo.

Ekskursjoner

Under møtet ble det arrangert endel kortere eks-kursjoner til løvskog og lynghei i Bergen omland. Lysfangst utover kvelden var særlig aktuelt for lepidopterologene.

Hovedekskursjonen startet fredag morgen 5. august og kjørte Hatvik–Mundheim–Nordheim-sund–Ulvik. Øsende regnvær ødela muligheter for å samle insekter, de utvalgte edelløvskog lo-kaliteter måtte med sorg passeres, og man kom tidligere til hoteller i Ulvik enn beregnet.

Lørdag 6. august var været fra morgenen av noe bedre. Bussen kjørte deltakerne opp i høydedraget mellom Ulvik og Granvin. Alt etter spesialitet, viet man sin tid til biotoper i barskog, løvskog og det frodige kalkområde i sydøsthel-lingen ned mot Ulvik. Etter lunsj gikk turen langs fjorden innover til Osa og oppover anleggs-veien tilfjells. Her ble det botaniske utbytte langt bedre enn det entomologiske idet regnværet igjen satte inn. Deltakerne fikk allike-vel inntrykk av Vestlandets topografi med for-revne fjellformasjoner og en variasjon av bioto-per fra havoverflaten bratt opp til alpine områ-der.

Søndag 7. august opprant med sol, så under turen Bremnes–Måbødalen–Hardangervid-da–Geilo ble det faglige utbytte bedre enn dage-ne før, selv om det var noe kjølig for rik insekt-fangst. Vøringsfossen ble beskuet og det ble samlet i det øvre bjerkebeltet nær Maurset. Lengste opphold ble gjort nær Dyranut nær 1300 moh, hvor forekomst av fyllit preger den alpine vegetasjonen. Her ute i det fri ble også lunsjen inntatt og professor Kauri holdt en orientering om vidda's forhistorie, dets naturhistoriske verdi og litt om de undersøkelser som i de senere år

har vært utført i regi av det Internasjonale Biologiske Program. Før vi dro videre takket Sylvén Fjellberg og Solhøy for vel organisert ekskursjon og for at de iallfall tryllet frem solen denne siste dagen. Endel av deltakerne forlot nå ekskursjonen, noen for å gå på fottur innover vidda. De øvrige fortsatte til Geilo hvor ekskursjonen ble avsluttet i god tid til å rekke toget såvel til Oslo som til Bergen.

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Foredrag

Sammendrag av de fleste foredragene er gjengitt på de følgende sider. Foredragene er ordnet etter det symposium de hørte med til. Dessuten ble det holdt følgende foredrag i symposiene:

Johan Andersen: Påvisning av to underkjølingspunkter hos *Bembidion*-sp. (Col., Carabidae).

Alf Bakke: Kjemisk kommunikasjon hos nordiske barkbiller av slekten *Ips*.

Leif Lyneborg: Hvad fortæller de hidtil udgivne bind av Fauna Ent. Scand. om inventeringen av den fennoscandiske og danske insektfauna.

Lennart Cederholm: Den svenske geometridundersökningen – en lägesrapport.

Jan Löfquist: Rörelseaktivitetsmätning hos insekter.

Astrid Løken

I. Arktisk/alpin entomologi

The entomology of Antarctica, with special reference to Dronning Maud Land

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According to Gressitt (1967) about 130 species of terrestrial arthropods are found in Antarctica proper, and a few have been added in later years. Antarctica in this sense includes the antarctic continent with adjacent islands south of 60°S, as well as the South Sandwich Islands and Bouvetøya, which have an antarctic climate. Acarina are represented with about 70 species, and of insects there are 19 known species of Collembola, 40 Mallophaga, 4 Anoplura, 1 Siphonaptera, and 2 Diptera.

Of the free-living terrestrial arthropods, 27 species of Prostigmata have been found on the continent itself. Seven species are known from the Antarctic Peninsula, 12 from the area around the Ross Sea, and 4 from East Antarctica (Gressitt 1967). In Dronning Maud Land 4 species of prostigmate mites were collected by British Antarctic Survey personnel (Bowra et al. 1964), and 3 of the species had not previously been described. During the Norwegian Antarctic Expedition 1970–71, 5 species of prostigmate mites were collected in Sverdrupfjella, and 4 of them were new (Strandtmann & Sømme 1977). Five species were collected by the author in Vestfjella during the Norwegian Antarctic Expedition 1976–77. So far a total of 10 species of prostigmate mites are recorded from Dronning Maud Land.

The Cryptostigmata are only represented by 7 species on the continent, of which 4 are found on the Antarctic Peninsula, and 1 in East Antarctica (Gressitt 1967). During the Maudheim Expedition 1950–52 a new species was found at Borgmassivet, Dronning Maud Land, and described as *Maudheimia wilsoni* (Dalenius & Wilson 1958). Another orbatid mite found in Sverdrupfjella in 1971 also appears to represent a new species, but has not yet been described. Cryptostigmata were not recorded from Heimefrontfjella or Vestfjella.

Collembola are represented by 13 species on the antarctic continent. Three of them are found on the Antarctic Peninsula, 1 in East Antarctica, and 10 in the area around the Ross Sea (Wise 1967). A previously undescribed species was collected in Sverdrupfjella during the Norwegian Antarctic Expedition 1970–71, and this is at present the only record of collembolans from Dronning Maud Land.

The fauna of free-living terrestrial arthropods on the antarctic continent includes a large number of endemic species; 25 Prostigmata, 3 Cryptostigmata, and 10 Collembola. This indicates that many species may be relics from earlier periods with warmer climates. Invasion, in recent times, by wind or bird-transportation is also possible (Gressitt 1967), but the predominant wind directions and risk of dessication make it fairly unlikely. The distribution of species in Antarctica is limited by the dry climate and the lack of soil and vegetation necessary to maintain humidity. Mites and collembolans of the antarctic continent must tolerate very low temperatures all year round, but the physiology of their cold-tolerance is poorly investigated.

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Biology and ecology of the arctic-alpine bug, *Nysius groenlandicus* (Zett.) (Het., Lygaeidae in Greenland)

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Nysius groenlandicus has a wide arctic-alpine distribution, extending from Greenland and Iceland through the mountains of Scandinavia and Eastern Europe to Central Asia. Despite its presence in Greenland it seems to be absent from North America, including Arctic Canada.

Nysius groenlandicus is the only true arctic representative of the Heteroptera. It is found everywhere in Greenland, even along the Polar Sea. However, in humid coastal areas the species is infrequent and found exclusively in scattered, well drained patches with a southern exposure, whereas in inland areas with a continental climate the frequency is high (commonly exceeding 100/m^2) and its occurrence more continuous.

This pattern of distribution reflects the pronounced thermophily and xerophily of the species. Both nymphs and adults prefer a temperature of about 34°C, but the nymphal instars are more xerophilous and resistant to drought than are adults.

In Greenland *Nysius groenlandicus* is univoltine and winters in the diapausing egg-stage. As a rule the nymphs hatch in June and the adults appear in July, oviposition taking place in August. There are nevertheless great local and regional differences, especially from the coast inland; along this gradient the phenological development is accelerated. In coastal areas the very changeable climate and the varying amount of snow during winter have a pronounced effect on the populations of *Nysius groenlandicus,* which during unfavourable seasons may be completely exterminated from localities where snow accumulates.

The species is a polyphagous seed-feeder, but it prefers some seeds to others, and some are apparently unsuitable. The small nymphs seek their food mainly on the soil surface (in moss, litter etc.) while larger nymphs and the adults, chiefly the females, frequently climb the vegetation to feed on ripening seeds and also on nectar. A peculiar cyclical change has been demonstrated in the number of bugs visiting the capitula of some species of Compositae.

The eggs are generally laid in litter etc. on the soil surface, and it has been demonstrated that there is a tendency to oviposit on or in the vicinity of food items. This habit may offer an explanation of the ubiquity of the species in Greenland. It has been established that the eggs are frequently deposited on 'parachute' fruits and seeds which are still attached to the plants, so the eggs may be dispersed by the wind, attached to the airborne seeds.

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Betydningen af insektbesøg i nogle grønlandske blomster

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I sommeren 1976 blev indledt et team work i Grønland med det formål at udarbejde et 're-produktions-budget' for udvalgte populationer af et mindre antal arktiske blomsterplanter. Forskergruppen udgøres af T. W. Bøcher, Jens Bøcher, Ole Mattson, Marianne Philipp, S. R. J. Woodell, og feltarbejdet udføres med Københavns Universitets arktiske station i Godhavn som basis.

Arbejdets hovedsigte er en vurdering af, om disse plantearters tilsyneladende kapacitet for kønnet forplantning bliver udnyttet, samt hvor ofte frø-produktionen er et resultat af krydsbe-

frugtning. Problemstillingen er specielt relevant i et arktisk område, hvor en relativt stor del af blomsterplanterne er apomikter, og hvor forskellige former for vegetativ forplantning forekommer så hyppigt.

Tidligere forskere (Warming, Hagerup) har understreget den arktiske planteverdens høje grad af uafhængighed af insekt-pollination, men mere recente undersøgelser (Hocking, Kevan) har vist, at effektiv insektbestøvning kan eksistere i et højarktisk område, og at visse plantearter dér er afhængige af insektbesøg for maximal frøsætning.

I foredraget præsenteres projektet, de udvalgte plantearter (*Pedicularis lanata, Ranunculus nivalis, Dryas integrifolia, Silene acaulis, Chamaenerion latifolium*) samt de foreløbige resultater af det entomologiske arbejde.

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emptied in the autumn. In all species, glycerol was accumulated in the body fluid during the autumn and winter, which resulted in a further increase in supercooling ability. Most specimens could be supercooled to temperatures between $-40°$ and $-30°C$ in the middle of the winter. In the spring a decrease in glycerol content and new feeding activity greatly reduced their ability to supercool.

Specimens that are enclosed by ice are probably exposed to periods of oxygen deficiency during the winter. In the laboratory all species survived several weeks of anoxia at $0°C$, some specimens more than three months. During anaerobiosis lactate was accumulated in *T. wahlgreni* and *C. labyrinthicus*.

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Cold-hardiness and anaerobiosis in collembolans and mites from windswept mountain ridges

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Several species of Collembola and Acarina overwinter in plant litter and soil of windswept mountain ridges above tree level. Under these conditions they are exposed to very low temperatures, and may be surrounded by ice, which is formed by melting snow or rain on mild days in the autumn. Cold-hardiness and anaerobiosis were investigated in the collembolan *Tetracanthella wahlgreni* and the two orbatid mites *Calyptozetes sarekensis* and *Carabodes layrinthicus* from windswept mountain ridges 1200 m a.s.l. at Finse, Hardangervidda, South Norway (Sømme & Conradi-Larsen 1977a, b).

All species were found to be freeze susceptible, and dependent on supercooling to survive low winter temperatures. Large seasonal variations in ability to supercool were demonstrated in all species. The presence of food in the gut greatly reduced their ability to supercool, which increased substantially when the gut was

Biotopvalg hos mosemidd (Oribatei) i arktiske og alpine områder på Svalbard, Island, Færøyene og i Norge

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Innleggets hovedvekt legges på biotopvalg i et område på Hardangervidda, Norge (1220–1320 m.o.h.). For fortrinnsvis de tørrere biotoper gjøres en sammenlikning mellom de i tittelen nevnte områder.

De viktigste euryøke arter på Hardangervidda, som også er abundante utenom i ekstrembiotoper, er *Tectocepheus velatus* og *Oribatula tibialis*. Vanlige i en forholdsvis vid rang av biotoper er: *Edwardzetes edwardsi, Eupelops plicatus, Platynothrus peltifer, Phthiracarus piger, Oppia subpectinata* og *Oppia nova*.

Grupperes biotopene langs en fuktighetsgradient, finnes 1–5 arter i de ekstremt våte og

3–5 arter i de ekstremt tørre. Størst artsantall finnes ved 'middels' jordfuktighet, d.v.s. urte/gress – eng med flekker av vierkratt. Diversiteten av Oribatei følger til et visst mon diversiteten til de høyere planter.

En sammenlikning av noen alpine lavheier innen Norden viser at der er et visst fellesskap, med forekomst av de ofte dominante arter som *T. velatus, Carabodes labyrinthicus* og *Calyptozetes sarekensis*. Artsantallet veksler mellom 15 og 30, avhengig bl.a. av råhumusens tykkelse. Et lavheisamfunn i Nord-Finland domineres dessuten av de mer nordlige arter som *Carabodes subarcticus* og *Autogneta trägårdhi*, som mangler på Hardangervidda og Island. Den høyarktiske, men forholdsvis tørre strandtundra på Svalbard har få arter (6–8) med en blanding av rent arktiske og europeiske arter.

En sammenlikning mellom faunaen i lavvegetasjon på stein og fjellknauser viser et lavt artsantall (1–7) med slektene *Ameronothrus, Calyptozetes, Zygoribatula, Phauloppia* og *Carabodes,* både i arktiske og alpine områder.

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Oljespill ved Svalbard. Mulige effekter på strandområdenes invertebratliv

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De arktiske områders mulige utnyttelse i oljeproduksjonssammenheng blir stadig mere aktuell. Samtidig er de biologiske konsekvenser av ukontrollerte utslipp og framføring av rørledninger lite kjent. På denne bakgrunn startet det norske MAB-prosjekt opp et simulert oljespill ved Ny Ålesund, Svalbard. 10 l. råolje pr. m² ble helt ut i 25 m² felter i et belte fra sjøen og innover land. Som et eksempel på effekten av råolje på invertebratlivet i fjæra, ble Collembola-samfunnet studert, i et plantesamfunn karakterisert av *C. ursina.* I løpet av tre dager, fra utslipp til prøvetaking, ble hele Collembola-samfunnet både kvantitativt og kvalitativt ødelagt. Abundansen falt fra ca. 165 000 til ca. 100

individer pr. m², og av de 13 artene var det bare en tilbake. I løpet av sommersesongen ble området rekolonisert av enkeltindivider (< 500/m²) av alle de fire dominerende arter i dette Collembola-samfunnet.

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Energetics in *Pardosa palustris* L. (Arach., Aranea) at Hardangervidda

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The investigations were carried out in 1972 during the Norwegian IBP.

In the field, density and life cycle were investigated. In the laboratory, energy metabolism and production of faeces, excreta, and silk, were quantified. Consumption was measured at all instars. Using microbomb calorimetry, calorific content was determined for the parameters.

– Life cycle and abundance: The investigated population of *P. palustris* hibernates three times before adult age. Abundance is low: 8.4 ind. m^{-2} for 1. instar, 0.4 m^{-2} for adults.
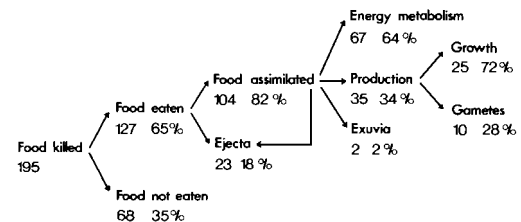
Fig. 1. Annual energy budget of *P. palustris* at a dry meadow site at Stigstuv on Hardangervidda in cal m^{-2} year^{-1}. Values are estimated from the population parameters in 1972.

Table 1. Tropic indices for the population of *P. palustris* at Stigstuv, Hardangervidda

1. Assimilation/consumption	0.82
2. Production/assimilation	0.34
3. Production/consumption, ecological efficiency	0.28
4. Production/food killed, trophic efficiency	0.18

– Energy metabolism (20°C): $R = 9.168 \ W^{0.75}$ 10^{-3} (R = cal. animal^{-1} day^{-1}, W = animal dry weight in mgs).

– Faeces, excreta, silk: $FUS = \dfrac{67.04}{1.14^w} \ 10^{-3}$ cal. mg dw^{-1} day^{-1}.

From the above data an annual energy budget was calculated for the population based on the population parameters in 1972 (Fig. 1 and Table I).

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II. Naturvern og miljøproblemer

De naturliga ekosystemen och människan

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Ekosystemet är en fundamental biologisk enhet, som har många dimensioner och är dynamisk: den drivs genom en serie processer, där energin är bränslet.

Eftersom de levande organismerna utgör en central del av ekosystemen, begränsas dynamiken i dessa inte till fysikaliska förlopp. Strukturellt tillpassas organismerna miljön. Ekologiskt anpassas de till variationen i miljön. I systemet byggs successivt in allt mera information om denna variation och dess amplitud. Denna information syftar dels till att förlägga alla processer, alla funktioner optimalt i tid och rum, dels att undvika störningar utifrån som kan äventyra populationernas fortbestånd. Ju längre denna anpassning fortgått desto mera information har införlivats med systemet. Och desto friare står systemet från störande påverkningar av den omgivande miljön.

De tropiska regnskogarna anses utgöra ekosystem med enastående diversitet, stabilitet och mognad. Som motsats nämns ofta de tempererade regionernas ekosystem, som är föga diversa, instabila och omogna.

Uppfattningen har varit att ökad diversitet ger ökad stabilitet. Härav följer då att en miljö, där de fysikaliska faktorernas variationer kan förutses, är gynnsam för utveckling av diversa och komplexa system. En miljö som karakteriseras av störningar som inte kan förutses ger ett robust men enkelt och föga diverst biologiskt system.

Är då denna prediktabilitet större i de tropiska skogarna än i de tempererade zonernas motsvarande ekosystem. Svaret är ja.

Energetiskt är konsumtionen i de nordliga ekosystemen hög: under hög termodynamisk kostnad byggs stora delar av ekosystemen upp varje år med relativt liten vinst i biomassa. Orsaken är de våldsamma årstidsvariationerna. Cybernetiskt kan man säga att organismerna i den starkt varierande nordliga miljön programmerats bristfälligt för att möta irrationella störningar. I tropikernas fuktskogar är den uppbyggda biomassan väldig i förhållande till energiförbrukningen i systemet. Organismerna i dessa ekosystem är långt programmerade för att utnyttja miljöns resurser.

En enkel lista på de väsentliga skillnaderna mellan dessa båda ekosystemtyper ger följande på populationsnivå:

I motsats till flertalet arter i likartade nordliga ekosystem – arterna i regnskogarna:

1. har låg reproduktionspotential,
2. är kortlivade med inga eller korta perioder i vilstadium,
3. har låg spridningsförmåga,
4. har snäva nicher.
5. har stark specialisering till habitat eller byte,
6. är som regel individfattiga.

Regnskogarna likt många andra tropiska ekosystem utmärkes vidare av att:

1. artantalet är betydande,
2. resursutnyttjandet som regel gått mycket långt. Genom ekologisk eller fyletisk species packing har rader av arter kilats in mellan arterna i den primära uppsättningen av taxa.
3. I nordliga, mindre komplexa system har vi som regel bara en art av varje artgrupp (ofta släkte) i ett och samma ekosystem (Monards princip). I tropiska komplexa system har vi däremot mängder av närbesläktade arter.
4. Antalet växtätare (fytofager) är både absolut och i relation till antalet karnivorer (rovdjur) stort.

Åtskilliga av dessa skillnader formar gradienter, successiva övergångar från polerna mot ekvatorn – eller från norr mot söder. Arternas arealstorlek förändras med latituden.

Ökad species packing (arttäthet) medför på samma sätt mot tropikerna minskad nichbredd

och intensivare utnyttjande av tillgängliga resurser, särskilt födan.

Vi har inte en mosaikartad blandning av skilda ekosystem; vi har serier av gradienter. Påverkan på något ställe i gradienten behöver inte innebära annan väsentlig förändring än att det drabbade systemet förflyttas längs gradienten.

Det myckna talet om stabilitet och mognadsgrad hos ekosystemen är förrädiskt. Inget ekosystem är det andra likt. De är ständigt föremål för förändringar och fluktuationer.

Att komponenter/organismer i ett ekosystem därvid ersättes, att de dör ut, är naturligt i de komplexa ekosystemen lika väl som i de enkla.

Hur påverkar då människan ekosystemen?

Medan den ökade arttäthet som species packing medför, successivt minskar nichbredd och ökar resursutnyttjandet, innebär människans ingrepp ett bortfall av arter, en ökning av nichbredden. Just denna ecological release är ett karakteristikum för människostörda miljöer.

Vilka olika system har föreslagits för värdering av natur i syfte att bevara den åt kommande generationer? De kan indelas efter flera olika principer. Vi kan ha etiska, sociala/pedagogiska, produktionsbiologiska och vetenskapliga skäl för att skydda och bevara ett stycke natur.

Vi måste då inledningsvis bestämma vad som har värde för oss i naturen. Det är intressant att följa naturskyddets utveckling från kravet på skydd åt utrotningshotade arter till dagens krav på skydd åt funktionsdugliga och produktiva ekosystem.

I en rad länder tillämpas ecological planning. Tyvärr har ordet ekologi här missbrukats. Vad som sker är att man inrycker data om landskapet och naturmiljön i planeringen. Men det har inget med ekosystemens struktur och funktion att göra. Ekologiskt sett är insamlingen av data grund och ytlig.

Dennis Owen har för några år sedan föreslagit att man fastställer hur ofta en besökare har möjlighet att uppleva det som anses vara det sociala värdet. Tyvärr sker detta oftare i artificiella reservat än i fria naturen.

Det sociala intresset kan också tillgodoses genom att man utnyttjar Delphi-metoden.

Mot bakgrunden av att människans inverkan på ekosystemen i varje fall i första fasen innebär en utarmning av artbeståndet, har artrikedom och artdiversitet fått stor betydelse för reservatsbildning.

Artantal och diversitet är enkla uttryck för ett systems biotiska värde. De kan sedan relateras till andra faktorer. Senanayake och medarbetare har helt nyligen (1977) infört arealen. Ekologiskt har dessa siffror föga intresse: de ger en falsk uppfattning om arternas relation till miljön.

Alla dessa metoder tar hänsyn till den ögonblickliga situationen. Man tycks utgå från att när väl ett reservat är etablerat, blir det bestående för all framtid. Detta är mot naturens lagar. Utdöendet är naturligt, och ju mindre området är, desto lättare sker det. Senanayakes metod kan bli ödesdiger, eftersom den premierar och prioriterar små områden med högt antal skyddsvärda arter. Har man nödvändiga basdata är det säkerligen klokt att i likhet med Terborgh utnyttja MacArthurs och Diamonds extinktions- och turn over-beräkningar för begränsade bestånd och räkna fram hur stor yta som behövs för att ett reservat inte successivt ska utarmas.

Tyvärr måste man konstatera att publicerade metoder för att värdera skyddsvärda ekosystem eller delar därav inte bara är ekologiskt föga relevanta utan därtill matematiskt föga sofistikerade. Här finns ett viktigt fält för nytänkande.

Genom det moderna skogsbruket hotade insektsarter

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Det moderna skogsbruket i Sverige har orsakat att största delen av de mer ursprungliga skogsbestånden ersatts med kulturskogar. En kraftig utarmning av många faunaelement har blivit följden. Av ursprungliga urskogsartade barrskogar finns endast ca 2 promille kvar i skyddad form. Dessa är främst belägna i norra delen av landet.

En arbetsgrupp vid Skogshögskolan i Stockholm och Uppsala har under några år genomfört en kartering av de av det moderna skogsbruket hotade växt- och djurarterna. Rörande de ryggradslösa djuren har de landlevande gastropoderna, symfyler och pauropoder samt vissa grupper av insekter varit aktuella objekt. Av insekter har ca 190 arter bedömts som starkt

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hotade. För var och en av dessa arter har ett kort utskrivits. Dessa har varit utformade med uppläggning som använts i IUCN:s Red data book. Korten har upptagit dels hotkategorier (7 st), utbredning och status, ekologi, varav hotet består, rekommenderade åtgärder för att behålla och gynna arten samt referenser. Arbetet har utförts i samverkan med specialister på aktuella grupper inom landet.

Av de hotade insektarterna utgör coleoptererna den största gruppen med ca 130 arter. Mer än 80% av dessa är knutna till lövträd och omkring 90% av dessa förekommer endast i träd av mycket grova dimensioner med gammal död ved. Bland hemiptererna är även många av de hotade arterna knutna till gammal död skog. Bland lepidoptererna möter man andra hotbilder. Hos de flesta arterna inom denna grupp är ej gamla urskogsliknande bestånd ett nödvändigt krav. Näringsväxter i form av sällsynta, till skogsmark bundna örter kan göra att ett påtagligt hot uppkommer genom avverkningar i ett bestånd och den åtföljande förändringen av florasammansättningen. En mycket begränsad geografisk utbredning av många insektsarter förstärker ofta risken för hot genom skogliga åtgärder, liksom en varierande möjlighet till ett aktivt uppsökande av passande biotoper i omgivningen.

Meningen med detta arbete är att intresset för skydd av för hotade insektsarter aktuella skogsbiotoper skall ökas hos naturvårdande myndigheter. Ett stegrat intresse har redan märkts även från naturvårdande myndigheter på länsplan i Sverige rörande denna problematik.

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Perspektiv på vernearbeidet for de hvirvelløse dyregrupper

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De hvirvelløse dyrearter utgjør ca. 93% av alle kjente dyrearter i verden. Insektene alene representerer ca. 70% av alle dyrearter. I de fleste økosystemer spiller evertebratene hovedrollen blant dyrene i systemets energiomsetning. Svært mye av menneskets økologiske erkjennelse, som vi i dag mere enn noen gang trenger for å forvalte naturen riktig, har vokst fram ved studier av hvirvelløse dyr. Likevel har det zoologiske vernearbeidet til idag vært konsentrert nesten utelukkende om vertebrater. Forfatteren har forsøkt å sette opp en samlet, systematisk oversikt over de vernemotiver som kan anføres for evertebrater. En slik oversikt burde kunne lette planleggingen av registreringsarbeider, og den måtte også kunne brukes i arbeidet for å skape økt forståelse for vernetiltak på evertebratfronten hos myndighetene. I konsentrert form ser oversikten slik ut:

Vernemotiv 1. Bevare mangfold av arter og dyresamfunn generelt

Begrunnelse: I. Økologisk: *Mangfold gir økosystemene stabilitet og motstandsevne.* II., Etisk: *Mennesket har ikke uten videre rett til å utrydde andre arter.* III. Ren*é* menneskelige interesser: *Arter kan når som helst vise seg å være av verdi for mennesket.* (Eksempler: Biologisk bekjempelse, indikatorarter, anvendt økologisk og genetisk forskning, produksjon av stoffer mennesket har interesse av, estetisk' verdi, naturopplevelse).

Tiltak: I. Sikre mangfold ved å opprette *verneområder:* a) Bevare kjente områder med sjeldne arter/dyresamfunn (utvelgelse på rene evertebrat-zoologiske kriterier). b) Generelt bevare naturtyper det er knapphet på (utvelgelse på f.eks. geologiske/botaniske kriterier, gjerne med støtte i flyfotos). Særlig haster det med å sikre visse naturtyper i *urørt* tilstand (f.eks. visse skogstyper, myrtyper, strandtyper). Dyregeografiske hensyn må trekkes inn. II. Sikre mangfold av arter og dyresamfunn også *utenfor* verneområdene gjennom økt kunnskap om evertebraters toleranse overfor ulike typer naturinngrep. Dette forutsetter a) referanseområder (f.eks. urørt natur), b) konsekvensforskning (følge skadevirkningene på evertebratfaunaen i forskjellige faser av ulike naturinngrep). Dette gir grunnlag for å utføre nødvendige naturinngrep på en mest mulig skånsom måte, og for overvåking. III. I visse tilfelle kan forbud mot innsamling ha mening, dersom beskatning av mennesket antas å være en begrensende faktor for arten.

Vernemotiv 2. Vitenskapelige formål

Begrunnelse: *Innen mange forskningsgrener (f.eks. økologi, dyregeografi, fysiologi, evolusjonslære) spiller evertebratene en betydelig rolle for belysning av grunnleggende problemer.*

Tiltak: Utvelgelse av verneområder, motivert ut fra forskningsbehovet innen forskjellige vitenskapsgrener. Eksempler: Lokaliteter som er særlig godt egnet til bestemte typer økologiske undersøkelser (suksesjon, energetikk, konkurranse, populasjonsdynamikk), områder der ulike faunaelementer støter sammen (dyregeografi), miljøer der artene viser tilpasninger til ekstreme betingelser (fysiologi).

Vernemotiv 3. Pedagogiske formål

Begrunnelse: *Evertebrater er f.eks. egnet til å belyse viktige grunnprinsipper i økologien, økologiske arbeidsmetoder og til undervisning i systematikk.*

Tiltak: Sikring av egnete ekskursjons- og kursområder, slik at alle læresteder på alle nivåer har minst ett slikt område tilgjengelig. To viktige hovedtyper områder: I. Artsrike lokaliteter egnet for studier i systematikk. II. Lokaliteter der evertebratfaunaen kan belyse økologiske prinsipper og økologisk arbeidsmetodikk (gjerne stor variasjon av ulike habitater).

Sluttbemerkninger

I dette arbeidet kan man tenke seg nordisk samarbeid på flere felter, men kanskje særlig i arbeidet med å finne egnete inventeringsteknikker, slik at lokaliteter som oppfyller ulike vernemotiver virkelig kan bli identifisert på en systematisk måte. På kort sikt må en legge vekt på å få registrert samfunn av evertebrater som av ulike årsaker er truet. På lengre sikt burde statlige organer ta seg av det løpende arbeid med registrering og vern av evertebrater. For å oppnå at disse hensyn kan bli vurdert på like linje med det vernearbeidet som er etablert for vertebrater, er det viktig at zoologer i ulike sammenhenger argumenterer for behovet for vernetiltak også på evertebrat-siden.

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Bioaccumulation of mercury in sarcosaprophagous insects

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In studies on the bioaccumulation of biocides, predatory vertebrates are generally considered to be at the top of the animal food chain. But sarcosaprophagous insects are even higher up the food chain. Their role in the processes of bioaccumulation has not been studied much.

Our study group has investigated the bioaccumulation of mercury from fish and other vertebrates in sarcosaprophagous flies. By feeding dead vertebrates with variable mercury contents to calliphorine fly larvae, we detected a linear correlation between the mercury content in the food and the content in the emerging fly larvae. The mean bioaccumulation coefficient for 72 fly samples was 4.3. (The determination of mercury content was performed by neutron activation analysis from fresh vertebrate tissues and from dry fly imagines. The dry-weight results from flies were calculated by dividing fresh weights by 3.8.)

Fly imagines collected with fish bait from the mercury contaminated area of Hämeenkyrö had only 0.18 ppm mercury in their bodies (fresh weight, 13 samples) and those from the uncontaminated Bromarv area had 0.08 ppm (13 samples). These values correspond to mercury contents in the food of less than 0.05 ppm and are astonishingly low (the mercury content of fishes in Hämeenkyrö varies between 0.3 and 6.9 ppm, in Bromarv between 0.02 and 0.68).

The low mercury contamination of the free-living flies was explained by laboratory experiments. We observed that flies held after their emergence on a sugar diet excreted mercury from their bodies very effectively. The biological half-life for mercury in them was only 2 days (in man it is about 2 months, Fig. 1). The mercury excretion continued for about one week. The flies had practically eliminated the mercury when they reached the age at which they start to eat proteins and to develop eggs in their ovaries. Thus they were able to avoid mercury contamination of the sensitive eggs.

ppm Hg
in the fly

Phormia terraenovae

from seal liver with 36.0 ppm Hg •-----•

from pike flesh with 0.7 ppm Hg •————•
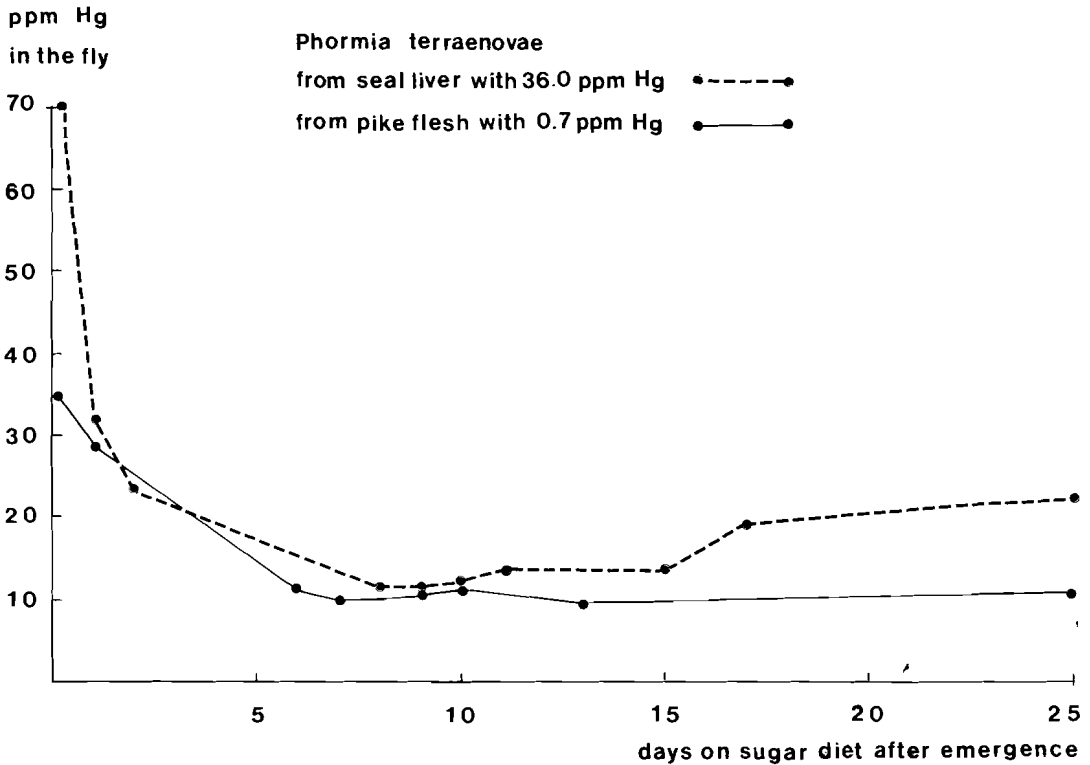
Fig. 1. Decrease of the mercury content in *Phormia terraenovae* (*R. -D.*) on sugar diet. The mercury contents of flies are given on dry-weight basis.

We fed heavily mercury-contaminated (38.9 ppm) dry imagines of the fly *Lucilia illustris* (*Meig.*) to imagines of the mealworm (*Tenebrio molitor L.*). In 4 months the mercury content of the mealworm imagines rose up to 201–243 ppm (dry weight) and they died after progressive leg paralysis. The controls received dry *Lucilia illustris* imagines with a mercury content of 0.19 ppm. They were in good condition, and had only 0.37–2.57 ppm Hg in their bodies when the ordinary experimental animals died.

When we fed (in Petri dishes) 35–40 living mercury-contaminated fly larvae to the staphylinid beetle *Creophilus maxillosus L.*, we observed the following series of mercury bioaccumulation (ppm Hg, fresh weight):

fish	blowfly larva	staphylinid beetle
0.7	2.0	6.9
2.7	6.3	17.5

In one of our experimental rearings of blowflies on a pike from Hämeenkyrö (with 2.7 ppm Hg in the flesh), we obtained, unintentionally, numerous small flies of the sphaerocerid *Limosina empirica* (Hutton). These had obviously developed on dead blowfly larvae. The imagines of *L. empirica* had in their bodies 22.3–40.3 ppm mercury (fresh weight), whereas the imagines of the four blowfly species in the same rearing container had only 13.3–14.6 ppm mercury.

Udledning af husholdningsspildevand i ferskvand og masseudvikling af mitter (Dipt., Ceratopogonidae, *Culicoides*)

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En række slægter inden for familien Ceratopogonidae har medicinsk og/eller veterinær betydning. I Danmark er det udelukkende slægten *Culicoides* Latr., der tiltrækker sig opmærksomhed; hidtil er ca. 25 *Culicoides*-arter påvist her, men endnu flere må forventes.

De trådformede 5–6 mm lange larver er semiakvatiske og er især knyttet til mudder eller meget våd jord med højt indhold af organisk materiale, til kompost, etc. Mittearterne har ofte veldefinerede substratkrav, således at der i et bestemt miljø kan være etableret et specifikt mittesamfund med karakteristisk artssammensætning. Således vil vegetationsløse mudderflader tilført kogødning og ajle ofte være domineret af *C. nubeculosus*.

Nyere undersøgelser i Danmark har vist, at kraftig tilledning af husholdningsspildevand, etc., til lavvandede moseområder med ringe afløbsmuligheder eller til visse vandløb kan skabe ideelle, ynglemuligheder for mitte-arter knyttet til vegetationsløse mudderflader. Ved længere tids kraftig tilledning af husholdningsspildevand dannes der mudderflader, hvor larver af visse mittearter – især af *C. nubeculosus* – kan forekomme i stort tal. I et moseområde på Langeland har tilledning gennem 25–30 år af urenset husholdningsspildevand, mejerispildevand og ajle bevirket akkumulering af meget betydelige slambanker, hvor larver af *C. nubeculosus* optræder i tætheder på op til 10.000 m⁻². Årligt klækkes millioner af *C. nubeculosus* fra denne recipient. Også på andre forurenede ferskvandslokaliteter er der registreret mittelarver. I Østjylland blev der således i 1976–77 undersøgt ca. 100 vandløbslokaliteter, repræsenterende en gradient fra praktisk talt uforurenet til overordentligt stærkt forurenede vandløb. Mittelarver forekom ved alle forureningsgrader, men artsfordeling og individtæthed varierede i relation til forureningsgrad, strømforhold og vandløbets almene karakter. Afgørende var nemlig mulighederne for akkumulering af mudderbanker i bredzonen – mittelarvernes vigtigste tilholdssted i forurenede vandløb. I slamaflejringer i en af de stærkt forurenede åers bredzone kunne larver af *C. nubeculosus* lokalt påvises i tætheder på op til 250.000 m⁻².

De nævnte undersøgelser viser, at der ved spildevandsudledning er skabt eminente ynglemuligheder for visse mittearter på en række danske lokaliteter og utvivlsomt har forureningen i disse år lagt grunden til lokal mitteplage og muligvis til deraf følgende sanitære problemer.

Græssende kvæg og heste udsættes ofte for kraftige mitteangreb, men når spildevandsudledning bevirker masseklækning af *C. nubeculosus* antager angrebene uhyre dimensioner. På marker nær den stærkt forurenede mose på Langeland er registreret angreb af en størrelsesorden på mindst 10.000 *C. nubeculosus* pr. ko pr. nat; i dette område trænger *C. nubeculosus* endog ind i stalden og angriber køer og svin.

Mittestikkenes betydning ligger givet især i den direkte irritative effekt, der kan skabe betydelig uro i en kvægflok; i ekstreme tilfælde vil kvægets trivsel og sundhedstilstand utvivlsomt nedsættes. Som følge af mittebid kan heste udvikle allergisk dermatose (Queeensland itch); sådanne tilfælde er netop registreret i Danmark (Hesselholt & Agger 1977). Imidlertid bør *Culicoides*-arternes potentielle rolle som spredere af arbovirus, bakterier, blodparasitiske protozoer og filarier ligeledes tages i betragtning (Nielsen & Christensen 1975). Generelt indgår mitteplage således i et veterinær-entomologisk problemkompleks og det er især af denne grund betænkeligt, at visse former for spildevandsudledning direkte kan føre til etablering af velegnede ynglesteder for insekter af potentiel sanitær og økonomisk betydning.

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Anvendelse av samfunns-parametre ved registrering av verneverdige biotoper

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Etter oppdrag fra Miljøverndepartementet, ble det i 1974 utført innsamlinger av markskiktets evertebrater i 36 skogsbiotoper i Vest-Norge. Av disse var 22 varmekjær lauvskog og 14 furu, eik eller blandingsskog.

Formålet var å finne fram til verneverdige biotoper ved å analysere artssammensetning, diversitet, dominans og abundans hos noen av de innsamlede evertebratgrupper. For en slik analyse ble valgt Gastropoda som representant for evertebrater med gjennomgående svak spredningsevne og forholdsvis mange stenotope arter, og Araneae som en gruppe med stor spredningskapasitet og forholdsvis flere eurytope arter. Biotopenes kulturpåvirkning ble forsøkt analysert ved innslaget av Myriapoda (se Meidells foredrag).

For gastropodene ser de viktigste skiller mellom edellauvskog (A) og furu-, eik-, blandingsskog (B) slik ut: Artsantall, A: 12–25, B: 3–10, diversitetsindeks, A: 1,6–2,7, B: 0,8–1,9, N pr. prøve, A: 19–699, B: 4–60. A inneholder noen ganger de stenotope, sjeldne arter (*Ena obscura, Acanthinula aculeata, Vertigo alpestris*) og omtrent alltid de såkalte karakterarter (*Carychium tridentatum, Vertigo pusilla, Columella edentula, Cochlodina laminata, Aegopinella pura*) som alle mangler i B. Tilsvarende tall for edderkopper er: Artsantall: A: 3–13, B: 4–23, diversitetsindeks, A: 0,7–2,4, B: 1,3–2,7, N pr. prøve, A: 1–18, B: 1–64. Ingen arter kan karakteriseres som sjeldne, stenotope, men som karakterarter ble funnet *Diplocephalus latifrons, Microneta viaria, Monocephalus castaneipes*. Det ble påvist en klar negativ sammenheng mellom diversitet og abundans av gastropoder og edderkopper.

Skillet mellom de rikeste edellauvskoger (A_I), som antagelig utgjør de eldste suksesjoner, og de mindre rike, yngre suksesjoner (A_{II}) er bl.a. for gastropodene: Artsantall: A_I: 23–25, A_{II}: 15–21, diversitetsindeks, A_I: 2,4–2,7, A_{II}: 2,1–2,5. A_I med i alle fall 2 av de 3 stenotope, sjeldne arter, disse mangler i A_{II}. A_I med høyere innhold av karakterarter og lavere innhold av eurytope arter enn A_{II}. Gruppen A_I ble foreslått som mest verneverdige.

De antropochore arters betydning for vurdering av grad av menneskets påvirkning i naturlige samfunn

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Foredraget er basert på undersøkelser av edelløvskogsområder på Vestlandet, med det formål å finne verneverdige biotoper (Hauge, Meidell & Solhøy 1975). Undersøkelsen var utført etter oppdrag fra Miljøverndepartementet, Landsplan for verneverdige naturområder/forekomster.

Vi satte oss som mål å finne naturlige samfunn med høy artsdiversitet. Med naturlige sammfunn menes her samfunn der menneskenes påvirkning ikke er en dominerende faktor. En økende grad av påvirkning gir en minkende grad av naturlig samfunn. Det prosentvise innslag av anthropochore arter regnes her som målestokk for denne påvirkningen.

Kriterier for vurdering av anthropochori kontra naturlig utbredelse er diskutert av Lindroth (1957). Naturlig utbredte arter som synes begunstiget av et synantropt levesett (hemerofile arter, Lohmander (1953)) har stor sannsynlighet for å vise anthropochori lokalt. Slike arter bør en ikke regne med i prosenten nevnt ovenfor. Valg av indikatorgruppe i relasjon til biotopen er viktig. Grupper med et lavt egenspredningspotensial har ofte et relativt stort innslag av anthropochore arter, spesielt i yngre suksessjoner.

Et godt kjennskap til gruppenes økologiske krav samt geografiske utbredelse er nødvendig.

Vårt utgangspunkt var biotoptypen (edelløvskog) og indikatorgruppen måtte velges blant de aktuelle grupper som var ventet fra denne. Ved å benytte standardisert metodikk kunne resultatene fra flere biotoper sammenlignes.

Artsdiversitetsberegninger ble foretatt på skallsnegl- og edderkoppmaterialet. Slike bereg-
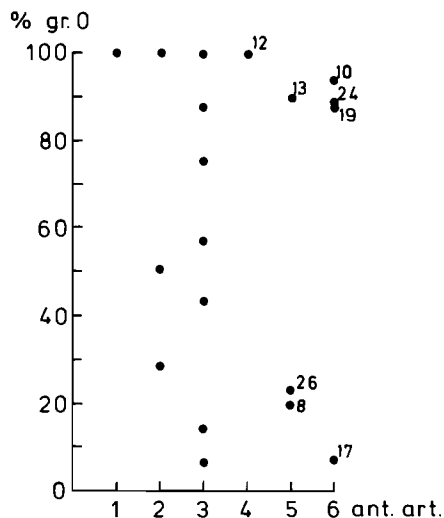
Fig. 1. Forholdet mellom det prosentvise innslag av naturlig utbredte arter (gr. 0) og antallet arter fra 19 lokaliteter.

mellom det totale antall arter og prosent individer av naturlig utbredte arter er fremstilt i Fig. 1.

Lokalitetene 10, 24, 19, 13, 12 er de som viser de største artsantall diplopoder sammen med prosentvis mange naturlig utbredte arter.

Et høyt artsantall sammen med fravær av anthropochore arter er her nyttet som et utvelgelseskriterium. Vår hypotese om en høy grad av naturlig samfunn vil ved et slikt utvelgelseskriterium maksimalt eksponeres for falsifikasjon, et meget viktig moment i en vitenskapelig teori (Popper 1965).

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ninger kunne ikke utføres på myriapodmaterialet. Dette ble istedet brukt til å vurdere graden av naturlig samfunn.

Blant myriapodene er de ekte tusenbeinene den gruppe som best passer de kriteriene gitt ovenfor for en indikatorgruppe.

Skjønnsmessig kan graden av menneskenes påvirkning av en biotop vurderes (hypotetiseres). Vi ønsket å finne en metodikk for å teste en slik vurdering.

11 arter diplopoder ble funnet, hvorav 5 naturlig utbredt, 3(4) anthropochore og 3(2) opprinnelig anthropochore men nå nærmest naturlig utbredt (Tabell I). En sammenligning

Tabell I. De 11 diplopodartene som ble funnet, fordelt på grupper etter antatt opprinnelse. Gruppe 0: Naturlig utbredte arter. 1: Nær naturlig utbredelse, men av anthropochor opprinnelse, 2: Anthropochore arter.

DIPLOPODA	Gruppe: 0	1	2
Polyxenus lagurus (L)	×		
Brachydesmus superus Latzel		×	
Polydesmus denticulatus C. L. Koch	×		
P. inconstans Latzel		×	
Proteroiulus fuscus (Am Stein)	×		
Choneiulus palmatus Nemec			×
Archiboreoiulus pallidus (Brade-Birks)			×
Blaniulus guttulatus (Bosc)			×
Cylindroiulus silvarum (Meinert)	×		
C. nitidus (Verhoeff)		×(?)	×(?)
Schizophyllum sabulosum (L)	×		

III. Taxonomi

Phylogenetic methodology in hexapod high-level systematics: Results and perspectives

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The phylogenetic (or cladistic) methodology as originally formulated by W. Hennig has gained increasingly wide acceptance among biosystematists in recent years. The principal feature of this methodology is the demand that any taxon must fulfill the criterion of monophyly in a strict sense, i.e., it must comprise *all* descendants of its stem species. Application of phylogenetic methodology in biosystematics has led to different kinds of innovations which together profoundly modify high-level hexapod classification (Hennig 1969, Kristensen 1975):

(1). *Abandonment of para-/polyphyletic taxa (i.e., groups not containing all descendants of the stem species) with concomitant splitting of these into a number of monophyletic units.* Many major entities of classical hexapod systematics are now being recognized as para-/polyphyletic and are consequently rejected as taxa in formal phylogenetic classification. Well-known examples include, e.g., Apterygota, Palaeoptera, Exopterygota, Mallophaga, Hemiptera-Homoptera, Hymenoptera-Symphyta, Diptera-Nematocera, Lepidoptera-Monotrysia.

(2). *Downgrading in rank of taxa which owe a traditional high rank to pronounced autapotypic features, but which are phylogenetically merely subordinate members of other currently recognized taxa.* Thus the Isoptera is at most equivalent with the Blattodea, generally considered a suborder within the Dictuoptera (spelling according to Kevan (1977)), (and even perhaps only a subgroup within the Blattodea); the entire Hydradephaga may deserve a rank not higher than as a subtribe within the Carabidae-Trachypachini (see e.g. Burmeister 1976);

and the Pupipara is apparently merely a family-group within the calyptrate fly superfamily Glossinoidea (Hennig 1973). Several similar cases could be cited.

(3). *Decisive allocations of taxa in cases where traditional analyses based on plesiomorphic as well as apomorphic character states have yielded ambiguous results.* An instructive case is the Zeugloptera, which is known to share several features with the Trichoptera and others with the Lepidoptera-Glossata; the position of the group therefore long remained controversial. However, the Trichoptera/Zeugloptera similarities could all be revealed as symplesiomorphis, whereas the Zeugloptera/Glossata similarities include an impressive array of apomorphies and the Zeugloptera may therefore straightforwardly be included in the Lepidoptera.

(4). *Rejections of previous allocations of taxa because the similarities upon which these allocations have been based are revealed as symplesiomorphies.* Such cases are, e.g., very frequent with fossils (such as numerous palaeozoic 'cockroaches' and mesozoic 'scorpion-flies') and application of phylogenetic methodology has therefore been devastating for many concepts of traditional palaeoentomology. This probably lies behind the occasional misunderstanding that phylogenetic systematists disregard fossil evidence altogether.

Much further research remains to be done on the higher classification of hexapods. Among the research themes which seem to be of particular general interest, two shall be singled out. One is the tracing of the evolutionary events in taxa, the constituent subgroups of which exhibit a clear 'additive typogenesis', exemplified by the lowest Lepidoptera and the 'true fly' lineage within the Diptera. The other is the search for the closest relative(s) of pronouncedly autapotypic taxa as a prerequisite for meaningful hypotheses concerning the processes involved in the radical niche shifts: Are all biting and sucking lice together only a subordinate group within the Psocoptera? Are the Siphonaptera really the sister group of the Mecoptera as a whole?

Are the Strepsiptera beetles after all? Or should they be removed from the Endopterygota altogether?

The construction and presentation of the 'argumentation schemes' of phylogenetic systematics, i.e., 'trees' bearing arrays of apomorphies defining each monophyletic entity, should invite attempts to interpret the individual apomorphies functionally. The ultimate impact of phylogenetic methodology on high-level hexapod systematics depends on the success of these attempts, i.e., whether they can generate new, falsifiable hypotheses, concerning the major events in the evolution of the class.

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Kladistisk-taxonomiske metoder anvendt til belysning af de semiakvatiske Hemipters slægtskabsforhold og klassifikation

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Analyser af kladistiske slægtskabsforhold er en nødvendig del af studiet af en dyregruppes fylogeni og historiske biogeografi. Hvorledes kladistisk slægtskab afspejles i en klassifikation er mere kontroversielt.

Kladistisk analyse er baseret på tre hovedprincipper:

A) Stamformer er hypotetiske

B) Fylogenier kan beskrives som sekvenser af dichotome forgreninger

C) Kladistisk slægtskab begrundes ved fælles, afledte karakterer (synapomorfier).

Med disse principper som grundlag udvikles en række kladistisktaxonomiske metoder med eksempler fra en undersøgelse af de semiakvatiske Hemipterers fylogeni, biogeografi og klassifikation.

Karakteranalysen ordner homologe karakterer i transformationsserier. Såvidt muligt bestemmes polariteten af sådanne serier (fra plesiomorfe til apomorfe karakterer). Kompatibilitetsanalysen bestemmer graden of overensstemmelse mellem forskellige transformationsserier og et prokladogram kan konstrueres. Det endelige kladogram fastlægges ud fra principperne om parsimoni, kompatibilitet og sandsynligheden for parallel udvikling og konvergens.

Et kladogram kan tranformeres til en klassifikation ved hjælp af subordinationskriteriet, det fyletiske sekvenseringskriterium, eller begge.

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Fylogenetisk og taksonomisk verdi av hungenitalia innen chironomider og andre Nematocera

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De ytre hungenitalia er et kompleks med hovedkomponentene bestående av antatte telopoditter (gonostyli) og mulige enditter (gonapofyser) plasert på gonocoxitter av segmentene VIII og IX. I Diptera omgir de reduserte 8de gonapofyser de omvendte 9de gonapofyser som også kan være reduserte eller manglende. Utviklingen innen forskjellige dipter-familier er diskutert og en teoretisk stammor illustrert. De 8de gonapofyser er i grunnformen enkle og velutviklede, de er delt i to hovedlapper bare innen chironomider og bare innen slekter av underfamiliene Diamesinae, Prodiamesinae, Orthocladiinae og Chironominae. De samme underfamiliene er også de eneste diptere som stundom har en

apodem-lobus og hvor tergitt IX stundom er delt i to børstebærende forhøyninger. Gonocoxitt IX baerer en gonostylus bare i Sciaridae og i chironomidae-underfamilien Telmatogetoninae, og muligens i noen Nymphomyiidae. Gonocoxitt IX er smeltet sammen med tergitt IX dannende en gonotergitt IX i Tanypodinae, Aphroteniinae og Podonominae. Telmatogetoninae er de eneste diptere hvor seminalkapsler mangler og hele spermatekaldukten tjener som oppbevarings-organ. En teoretisk stammor for chironomider er illustrert og berettigelse for bruken av ene-stående insides parallellisme vist. På grunnlag av synapomorfier tilstede innen hungenitaliene er det vist at slekten *Buchonomyia* danner søstergruppen til Diamesinae + Prodiamesinae + Orthocladiinae + Chironominae og fortjener en ny underfamilie, Buchomyiinae.

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Genetisk enzymatisk polymorfism hos steklar (särskilt apider): dess förekomst och användbarhet inom taxonomin

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Organismernas struktur bestäms gener, som består av DNA. Mutationer, d.v.s. förändringar i DNA-strukturen kan förorsaka förändringar i den elektriska laddningen hos proteinmolekyler-na. Under slutet av 1960-talet började man använda i populationsgenetiken gelelektrofores-tekniken, med vars hjälp man kan konstatera dessa förändringar. Teoretiskt har man dock räknat ut, att c:a 40% av den genotypiska variationen kan härmed konstateras. Metodens fördelar är bl.a., att den är relativt enkel och att man kan skilja både homozygota och hetero-zygota genotyper.

Andelen av polymorfa loci har konstaterats vara i medeltal drygt 50% och andelen hetero-zygota genotyper per locus i medeltal 15% hos 32 diplodiploida arter (Selander 1976). Vi har undersökt enzymatisk variation hos följande

Table I. Enzymatisk variation hos steklar

	N of species	N of loci	Prop. of polym.loci	Heterozyg. per locus
Haplodiploid species:				
Our results	15	15	0.105	0.015
Lester (1975), Snyder (1974),				
Metcalf&al. (1975)	16	16	0.170	0.041
Diplodiploid species:				
Selander (1976)	32	21	0.530	0.150

stekelarter: *Apis mellifera* L., 6 *Bombus*-arter, *Macrobis labiata* F., *Colletes succincta* L., 4 *Andrena*-arter, *Mimesa equestris* F. och *Pontania vesicator* Bremi, som är haplodiploida djur. Variationen syns vara mycket klart mindre hos haplodiploida än diploida arter (Table I).

Man har redan ganska länge antagit, att den genetiska variationen hos steklar är liten. Gener, som är skadliga i homozygot form försvinner lätt, då de inte kan förekomma i heterozygot form hos hanarna och några allmänna selektions-modeller leder till samma resultat. Man har också antagit, att den låga variationen hos sociala steklar förorsakas av stabiliteten hos livsmiljön. Då variationen dock förefaller vara liten också hos icke sociala steklar, kan den sociala livsformen högst vara en delförklaring och det är tydligt, att haplodiploidin är den grundläggande orsaken till den låga variationen.

Hos sociala insekter är populationens effektiva storlek ganska liten och inavel är allmän. Hos parasitsteklar förekommer inavel också allmänt. Då mängden recessiva skadliga alleler är liten, kan inavel vara fördelaktig.

Å andra sidan förekommer fenotypisk poly-morfism rikligt hos steklar. Det verkar dock som om variationsmönster hos de undersökta enzymerna inte har samband med färgvaria-tionen. Variationen är liten och t.o.m. närbe-släktade arter är likadana beträffande de under-sökta enzymerna och detta begränsar metodens användbarhet inom hymenoptertaxonomin. Inom andra djurgrupper har metoden också utnyttjats för arttaxonomi och t.ex. några nya *Drosophila*-arter har upptäckts med hjälp av enzymvaria-tionen.

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Tabell II. Längden av några delar hos stormhattens (*Aconitum septentrionale*) blomma i Karelen och Skandinavien. n = antal mätta blommor (inom parentes mätta individer), L = längden och W = bredden av blommans pip (corolla) och N = längden av nektarblad.

	Karelen	Skandinavien	P(t-test.)
n	121 (60)	99 (45)	
L	22.9 ± 2.11	23.5 ± 1.50	< 0.020
W	7.7 ± 0.63	6.7 ± 0.64	< 0.001
L/W	3.0 ± 0.31	3.5 ± 0.37	< 0.001
N	22.2 ± 1.99	22.5 ± 1.54	< 0.200
N/W	2.9 ± 0.33	3.4 ± 0.37	< 0.001

Mundelarnas längdvariation hos *Bombus consobrinus* i Fennoskandien: ett exempel på anpassning till näringsväxten (*Aconitum septentrionale*)

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Bombus consobrinus Dahlbom är en långtungad humleart, som är specialiserad för att samla näring i blommorna av nordiska stormhatten (*Aconitum septentrionale* Koelle). I Skandinavien är stormhatten vida utbredd, men i Finland förekommer den endast i det sydöstra hörnet av landet, i Karelen. Längden av sugsnabeln har konstaterats att vara större hos skandinaviska humleindivider än hos karelska och det finns inga skillnader hos längden av andra kroppsdelar, som har mätts (Tabell I). Blommorna av stormhatten är i samma mån betydligt smalare och något längre i Skandinavien (Tabell II).

Längden av sugsnabeln är olika hos olika humlearter och det råder en klar korrelation mellan längden av artens sugsnabel och näringsblommans pip (corolla). Man kan antaga, att sugsnabeln av *B. consobrinus* har adapterats olika enligt blommans storlek i Skandinavien resp. Karelen.

Tabell I. Längden av vingens radialcell (storleksindex) och relativa längder av olika delar hos *Bombus consobrinus*-arbetarna i Karelen och Skandinavien. Ra = längden av radialcellen, Oc = avstånd mellan ögonen, Ch = höjden av huvudet, Cw = bredden av huvudet, Sc = längden av antennskaftet, Pr = längden av prementum, La = längden av labialpalpens basalsegment och Gl = längden av glossa.

	Karelen			Skandinavien			
	X	SD	n	X	SD	n	P(t-test.)
Ra	3.31 ± 0.306 mm		47	3.44 ± 0.235 mm		31	< 0.100
Oc/Ra	0.64 ± 0.032		43	0.63 ± 0.018		28	< 0.400
Ch/Ra	1.26 ± 0.045		45	1.25 ± 0.033		29	< 0.400
Cw/Ra	0.76 ± 0.030		44	0.77 ± 0.022		28	< 0.200
Sc/Ra	0.58 ± 0.022		43	0.57 ± 0.015		26	< 0.400
Pr/Ra	1.14 ± 0.033		47	1.14 ± 0.038		28	> 0.500
La/Ra	2.09 ± 0.089		47	2.18 ± 0.060		28	*< 0.001*
Gl/Ra	3.17 ± 0.110		47	3.47 ± 0.133		28	*< 0.001*

Presentation av den nya nordiska skalbaggskatalogen

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Den nya nordiska skalbaggskatalogen (Enumeratio Coleopterorum Fennoscandiae et Daniae, under arbete) uppvisar talrika avvikelser från tidigare nordiska kataloger i både systematiskt och nomenklatoriskt hänseende. Storsystematiken följer huvudsakligen Crowson, och i de enskilda familjerna har likaså gjorts större eller mindre omställningar.

Skalbaggarnas namn har i många fall förändrats. Förutom sådana förändringar som bygger på rent systematiska grunder finns också ett antal fall där förändringen är en direkt följd av nomenklaturreglerna. Några släktnamn har flyttats över på andra släkten beroende på att släktets typart tidigare varit fel tolkad. Prioritetslagen har också lett till att många gamla välkända namn blivit ersatta av nya. Slutligen finns ett antal fall där tidigare använda namn visat sig vara yngre homonymer och har måst ersättas.

Entomologins alltmer internationella inriktning såväl i Norden som i andra länder ställer högre krav än tidigare på begreppens allmängiltighet. Att överallt använda samma namn om samma djur är ett steg i denna riktning.

IV. Anvendt entomologi

Snyltevepsen *Encarsia formosa* for bekjempelse av veksthusmellus (*Trialeurodes vaporariorum*) på veksthusplanter

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Snyltevepsen *Encarsia formosa* stikker sine egg i larvene til veksthusmellus (*Trialeurodes vaporariorum*). Egglegging i mellusens 3. og 4. larvestadium gir vellykket parasittering. Egglegging i 1. og 2. larvestadium dreper også vertlarven, men vanligvis uten å gi opphav til ny snylteveps. Melluslarver kan også bli drept av den voksne snyltevepsens næringsopptak. Best bekjempelse av veksthusmellus oppnås når det er jevn bestand av snylteveps og mellus allerede fra samspillets begynnelse.

Ved Statens plantevern har det vært utført forsøk med bruk av *E. formosa* til bekjempelse av veksthusmellus på tomat og agurk. Snyltevepsen ble introdusert som pupper i veksthus med naturlige angrep av veksthusmellus. Det ble introdusert 1,25–6 snylteveps pr. plante fordelt på 2–3 introduksjoner med 14 dagers mellomrom.

Av 6 forsøk i tomat ga 5 vellykket bekjempelse uten økonomisk skade på plantene. Mislykket bekjempelse skyldtes trolig for sterkt mellus angrep ved forsøkets start og for lite snylteveps utsatt. Generelt var det tendens til avtagende parasittering i slutten av forsøksperioden i september.

Av 5 forsøk i agurk ga ett vellykket bekjempelse. Årsak til dårlig bekjempelse kan delvis tilskrives at det samtidig ble foretatt kjemisk bekjempelse av trips. Større formeringsevne hos veksthusmellus på agurk enn tomat kan også være medvirkende årsak til dårligere virkning av snyltevepsen på agurk enn på tomat.

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Parasitoids of the frit fly, *Oscinella frit* (L.) on oats

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The parasitic hymenoptera attacking larvae and pupae of the frit fly have previously been the subject of research in England, Germany, the U.S.S.R., and North America. The number of species names referred to in the literature are considerable, but the list of parasitoid species will be much reduced when misidentifications, older synonyms, and parasitoids of other hosts on the same plant are eliminated.

A study of the frit fly parasitoids in an oat field was carried out at Solna, outside Stockholm, in 1976. The first summer generation in the tillers was parasitized by 9 species of parasitic hymenoptera (Table 1) and the total parasitism reached about 40%. The second summer generation in the panicles nearly completely escape from being parasitized. Instead, the main part of the parasitoids migrate to the surrounding grasslands where all three

Table 1. Parasitoids reared from the first summer generation of
0. frit in oat shoots (Solna, 1976). IL = internal larval para-
sitoid, IP = internal pupal parasitoid, EP = external pupal
parasitoid. The percentage of each species is given. The total
number of reared parasitoids = 1677.

Cynipoidea: Eucoilidae:		%
Rhoptromeris heptoma (Hartig, 1840)[1]	IL	17
Ganaspis mundata Förster, 1869[2]	IL	1
Hexacola hexatoma (Hartig, 1841)	IL	5
Chalcidoidea: Pteromalidae:		
Spalangia fuscipes Nees, 1834	EP	0,2
Cyrtogaster vulgaris Walker, 1833	IP	3
Halticoptera circulus (Walker, 1833)	IL	46
Callitula bicolor Spinola, 1811	EP	12
Trichomalus nanus (Walker, 1836)	IL	17
Proctotrupoidea: Diapriidae:		
Loxotropa tritoma (Thomson, 1858)	EP	1

[1] R. heptoma is exhaustively described and synonyms are
listed in: Nordlander, G. (in press). Studies on Eucoilidae
(Hym.: Cynipoidea) II. Revision of the genus Rhoptromeris
Förster, 1869 with reference to north-western European
species. Ent. Scand.
[2] No host is previously recorded for G. mundata.

generations of the frit fly larvae develop in the
stems of the grasses.

Generally the same species have occurred in
the previous European studies and the domi-
nating species seem to be Halticoptera circulus,
Rhoptromeris heptoma, and Trichomalus nanus.
These are all internal larval parasitoids while
the pupal parasitoids are mostly of minor im-
portance. The latter are also generally more
polyphagous.

The frequently heavy parasitism of the first
summer generation has no effect on the damage
of the oat plants caused by the frit fly larvae,
because they develop to the pupal stage before
they are killed by the parasitoid larva. The
parasitism, however, means a reduction of the
frit fly population, which will give rise to the
second summer generation in the panicles. This
reduction will have a direct effect if the flies
ovipositing in the spikelets mainly come from the
same oat field.

The ovipositing of the frit fly on the oat
tillers is over in the beginning of June, though
the secondary shoots are also attacked later. The
parasitoids, however, appear in the oat
field throughout June and in the beginning of
July when frit fly larvae and pupae are available
for oviposition. A pesticide treatment during this
time, e.g. against thrips or aphids, could thus
affect the frit fly parasitoids but not the frit fly
itself. The number of flies of the first summer

generation would then increase, which would
lead to an increased number of eggs laid in the
spikelets and consequently an increased damage
to the grains. In the future the effects on the
parasitoids of those pesticides, which could be
used in oats during this period, should therefore
be tested. Together the many parasitoid species
which attack the frit fly certainly play an im-
portant role in the natural control of this species
and must be preserved.

Effect of parasitism by Ephedrus cerasicola Starý on Myzus persicae (Sulzer), studied in small glasshouses during 1976 and 1977

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In 1976, two small glasshouses, each with about
20 paprika plants, were used in the experiments.
Three viviparous females of Myzus persicae
(Sulzer) were introduced on each plant 1 June.
No parasites were released in one of the houses,
where the aphid population increased exponen-
tially ($y = 1.481 \cdot e^{0.291x}$) (Fig. 1) and the plants
collapsed by the middle of July.

A total of 360 females and 360 males of newly
emerged Ephedrus cerasicola Starý were in-
troduced in the other house by means of six
introductions between 4 June and 7 July. The
parasites were expressed by cumulative number
of mummies. They apparently kept the aphid
density below damage threshold and exter-
minated the aphid population within 2 months
(Fig. 2). The maximum aphid density recorded
was 50 times lower than the maximum density
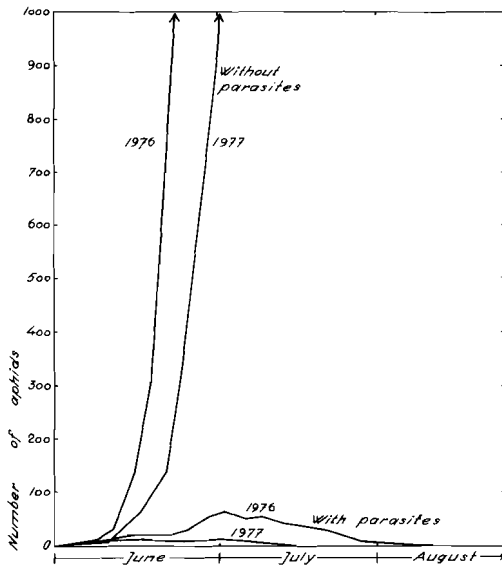
Fig. 1. Average sum of *M. persicae* on 3 marked leaves from each plant in the 2 glasshouses.
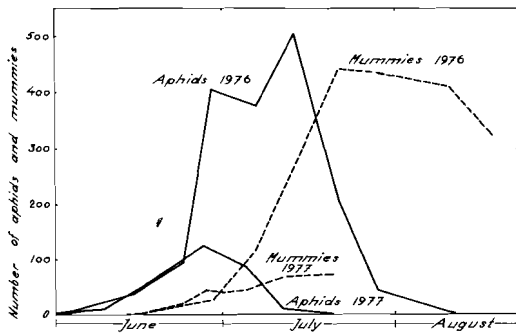
Fig. 2. Average number of *M. persicae* and mummies of *E. cerasicola* (cumulative) per plant.

was less than in 1976: 1 aphid per plant. Even such reduced parasite/aphid ratio controlled the aphid population.

Results from 1976 and 1977 are compared in Figs. 1 and 2. Description of the counting methods is given by Hofsvang & Hågvar (1978).

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in the house without parasites. This experiment from 1976 is described by Hofsvang & Hågvar (1978).

Apparently, continuous oviposition by parasites is important to control aphid population growth. Considering the temperature in the greenhouses, this implies that a minimum of three introductions are necessary, one each 7th day before the F_1 generation of the parasites emerges. Accordingly, a similar experiment was started on 1 June 1977, with parasite introductions on 1, 8, and 16 June, and only 20 females and 20 males each time. The number of introduced aphids, at the start of the experiment,

Bekjempelse av rød furubarveps med virus under et masseangrep ved Tingvoll i Vest-Norge i 1974

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Sommeren 1973 opptrådte rød furubarveps i et kraftig masseangrep over et 300 ha stort skogområde i Meisingset ved Tingvoll på Nord-Møre. Stikkprøver samme høst viste lav parasitteringsgrad og høy klekkeprosent av imagines. På det tidspunkt var forutsetningene tilstede for et nytt angrep i 1974.

En befaring i området i mai 1974 viste at et meget sterkt angrep igjen var under utvikling. Etter inngående vurderinger, uttrykte representanter for skogoppsynet ønsket om at en bekjempelse burde utføres for å forsøke å hindre nye skader og mulige angrep følgende år.

Fordi ca. 85 % av arealet besto av eldre produksjonsskog, med trehøyder opptil ca. 20 m, måtte bekjempelsen foregå fra luften. Da det i Norge ikke er tillatt å spre kjemiske insektmidler fra fly eller helikopter, ble det i dette tilfellet aktuelt å bruke virus. Helikopter med sprøyteutstyr var tilgjengelig.

På grunn av flere omstendigheter kom ikke bekjempelsen i gang før 10. juni, ca. 3 uker etter klekking. På dette tidspunkt var 8 % av larvene i 3. stadium, 89 % i 2. stadium og 3 % i 1. stadium.

Virusmengden til 300 ha ble anskaffet fra Kemira Oy i Finland. Den anbefalte viruskonsentrasjon på 8×10^9 polyederpartikler pr. ha ble

brukt. Anvendt væskemengde var 50 l/ha. Det ble ikke tilsatt klebe- eller spredemidler. Helikopterets kapasitet var 200 liter væske pr. tur. Total flytid var ca. 13 timer, og samlede kostnader for bekjempelsen beløp seg til ca. kr. 140 pr. ha.

Kvistprøver med larvekolonier ble samlet før og etter sprøyting. I laboratoriet begynte sykdomssymptomene å vise seg etter 7 dager, og i løpet av de 4 følgende dager døde praktisk talt alle larvene i prøvene som var tatt etter sprøyting.

I felten viste også sykdomssymptomene seg etter 7 dager, men det meste av larvepopulasjonen var død først ved månedsskiftet juni/juli.

Bekjempelsen var effektiv i den forstand at storparten av larvepopulasjonen ble drept. På grunn av det sene sprøytetidspunktet rakk imidlertid larvene å gjøre betydelig skade før populasjonen brøt sammen.

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Tabel I. Skader forårsaget af knoporme efter behandling med kapselvirus, parathion og uden behandling (Ubehandlet = 100). (Hvert tal gennomsnit af mindst 3 gentagelser). Rødbeder, Lammefjord. 1975.

| | Brogaard | | Stubberup-holm | | Inger-byvej |
	Net-huse	Åben	Net-huse	Åben	Åben
Dybe gnav/m²					
Ubehandlet	100	100	100	100	100
Parathion	55	71	49	80	–
Kapselvirus	26	28	21	30	27
Dybe gnav/kg					
Ubehandlet	100	100	100	100	100
Parathion	50	85	50	86	–
Kapselvirus	20	35	23	30	20

Foreløbige resultater fra forsøg på bekæmpelse af knoporme (larver af *Agrotis segetum* Schiff.) med kapselvirus

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Forsøgene blev udført på afgrøder af rødbeder og gulerødder i Lammefjorden (NV-Sjælland) i 1975 og 1976. Som forsøgsdyr anvendtes dels larver af *A. segetum* fra æg frembragt i laboratoriekulturer og senere udsatte i bestemt antal i nethuse, dels den naturligt forekommende population af larver i åbne forsøgsflader.

Afgrøderne blev sprøjtet med kapselvirus opformeret i laboratoriekulturer af knoporme. Kapselviruset blev påført planterne fortyndet med vand v.hj.a. en håndsprøjteflaske. Larverne indtager kapselviruset med føden og dør efter 2–3 ugers forløb.

Resultaterne fra 7 blokforsøg viste at behandling med kapselvirus reducerede knoporme-skaderne på afgrøderne væsentligt. I nethusene var reduktionen 75–80% sammenlignet med ubehandlede afgrøder, mens reduktionen på åbne arealer lå på 65–80%. Tilsvarende reduktioner af larvernes antal kunne påvises. Virkningen af kapselvirus var betydelig bedre end virkningen af en parathion behandling (Tabel I).

Det kunne yderligere vises, at kapselviruset reducerede knopormeskaderne året efter sprøjtningen, samt at viruset var blevet spredt til tilstødende parceller.

Igangværende laboratorieforsøg indicerer, at kapselvirus fra *A. segetum* dræber denne art og andre arter tilhørende slægten *Agrotis*, mens andre uglearter (*Mamestra brassicae, Spodoptera frugiperda*) og spinderarter (*Lymantria dispar, L. monacha*) ikke synes at påvirkes.

Beregninger af omkostningerne ved opformering af kapselvirus i laboratoriekulturer af *A. segetum* tyder på, at bekæmpelse af knoporme med kapselvirus ikke vil være dyrere end den nuværende bekæmpelse med parathion.

De igangværende undersøgelser og forsøg fortsættes i 1977–78, dels ved afprøvninger af kapselvirus i andre afgrøder (kartofler, frøbedsplanter af skovtræer), dels ved en række forsøg på at inficere andre sommerfuglearter med *A. segetum* kapselvirus.

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Lopper hos danske hunde og katte

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Foranlediget af den stærke stigning siden omkring 1970 af loppeangreb på hunde og katte i Danmark har vi, i samarbejde med H. Mourier fra Statens Skadedyrlaboratorium, påbegyndt en kombineret zoologisk-epidemiologisk undersøgelse af fænomenet.

Ctenocephalides felis var den absolut hyppigst forekommende loppeart på katte. Kun i to tilfælde noteredes andre arter, nemlig henholdsvis *C. canis* og *Archaeopsylla erinacei*.

Den på hund dominerende loppeart var ligedes *C. felis*, men på en del hunde fandtes dog også *C. canis* enten i ren- eller blandingsinfektioner. I et fåtal af tilfælde var hunde angrebet af *A. erinacei* eller *Pulex irritans*.

Der noteredes en tendens til, at hunde fra provinsen eller landet havde relativt mange infektioner med *C. canis*, mens det i København var *C. felis*, der forekom talrigest. Årstidsmæssigt indsamledes forholdsvis flest lopper i august–oktober. Kønsratio var $2♀♀:1♂$.

Nærmere diskussion af disse resultater findes i nedenstående arbejder.

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hjelp av metoden "distance to the nearest neighbour". Stammen ble inndelt horisontalt i seksjoner, og i sju av de åtte seksjonene ble det funnet signifikant avvik fra tilfeldig fordeling i retning av regulær (uniform) fordeling av innboringshullene i barken.

Uniforme fordelinger, som er relativt sjeldne fenomener i dyreriket, kan bety a) at ressursene er uniformt fordelte, eller b) at dyra har en territorial oppførsel.

Tre faktorer som kan forklare det regulære angrepsmønsteret, blir diskutert: Barkstrukturen, repellerende feromoner og akustiske signaler.

Siden denne barkbillearten gjerne angriper i barksprekkene, skulle angrepsmønsteret snarere bli klumpet enn regulært.

Det er foreløpig ukjent om *T. piniperda* produserer repellerende feromoner, men uansett så er det usannsynlig at slike feromoner aleine kan bevirke en så høy grad av regularitet i angrepsfordelingen. Feromonene, som må kunne virke over noen få cm's avstand, er trolig bare effektive over barkoverflaten og kan dessuten bli påvirket av vind, temperatur og fuktighet.

Akustiske signaler er etter alt å dømme et mye bedre kommunikasjonssystem mellom insekter inne i og utenpå barken. Et stort antall barkbillearter har stridulasjonsorganer, og studier av amerikanske arter har vist at ulike arter og kjønn produserer med disse organene spesifikke signaler forbundet med stress, rivalisering og tiltrekning.

T. piniperda er monogam, og hunnene angriper først. Det er ikke påvist lyd fra hunnene, men derimot fra hannene som raskt innfinner seg ved hunnenes angrepshull. Forsvarer barkbillen sitt territorium ved hjelp av lyd?

Angrepsmønsteret hos barkbillen *Tomicus piniperda* L. (Col., Scolytidae)

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Angrepsmønsteret på en stående furustamme, som var sterkt angrepet av *Tomicus* (=*Blastophagus*) *piniperda*, ble undersøkt statistisk ved

Kålgallmygg (*Contarinia nasturtii* Kieff.). Klekke- og svermetider

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Kålgallmygg er første gang omtalt som skadedyr i Norge av W. M. Schøyen i 1910 etter angrep på kål, Tøyen, Oslo. Den er senere påvist i alle Østlandsfylkene.

Statens plantevern, Zoologisk avdeling gjennomførte i årene 1973–76 undersøkelser vedrørende kålgallmygg, spesielt over klekke- og svermetider. Undersøkelsene er utført i kålrot.

Materiale og metoder

Klekking av kålgallmygg ble registrert ved hjelp av konisk/sylindriske bur satt ut i midten av mai over larver og kokonger, samlet foregående høst, og over angrepne planter i veksttiden. Ved hjelp av ulike såtider og isolasjonsbur, fikk en i veksttiden planter som var utsatt for egglegging innen visse tidsgrenser.

Data for sverming er basert på fangst i vannfeller. Til dette ble brukt gule plastfat, 30 cm diameter og 8 cm høye. Fellene ble plassert i to høyder, på bakken og i 50 cm høyde. De ble tømt 3 ganger pr. uke.

Resultater

I det overvintrede materiale inntraff de første klekkinger alle år i uken 28. mai–3. juni. Unntatt i 1973 klekte imidlertid svært få gallmygg før den 10. juni og maksimal klekking inntraff stort sett i tiden 15.–25. juni. Klekkingen pågikk til ca. 10. juli. Et lite antall gallmygg klekte først efter to overvintringer.

Det var ingen forskjell i klekketider mellom bur hvor det var lagt h.h.v. larver eller kokonger foregående høst. De første imagines av sommergenerasjonen klekket i dagene 16.–20. juli, og med maksimal klekking 10–15 dager senere. I klekkebur satt ut over kålrotplanter som ikke hadde vært utsatt for egglegging før 15–20. juli klekket ingen gallmygg samme år. Klekkeundersøkelsene viser i hovedsak at kålgallmygg i Ås har to generasjoner pr. år, men utelukker ikke at det kan forekomme en ubetydelig 3. generasjon.

Fangstresultatene fra vannfellene stemmer stort sett godt overens med resultatene fra klekkeundersøkelsene både m.h.p. begynnende og maksimal opptreden. Den viktigste forskjell er om høsten hvor det ble tatt kålgallmygg i vannfellene, opptil 3–4 uker senere enn i klekkeburene. Antall gallmygg i vannfellene disse ukene var imidlertid lavt.

Prosenten av hanner var vesentlig høgere blant kålgallmygg i vannfellene enn i klekkeburene. Innen vannfeller var prosenten av hanner størst i de høye fellene.

Om vinbärsknoppmalens (Kessleria rufella (Tgstr.)) (Lep., Yponomeutidae) livshistoria och betydelse som skadegörare

OSMO HEIKINHEIMO

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Larver har anträffats utom på svarta, också på röda vinbär (Ribes petraeum).

De fullvuxna malarna flyger i Södra Finland från ca. 25. juni under de följande 4 veckorna. Kläckning skedde i försök mellan 16.–30. juni. Hanar börjar flyga under lugna kvällar omkring kl 20 och flygningen fortfar i 4 timmar. Ljusfångstmaterial innehöll endast 1% honor. Hanarnas livstid var i medeltal 13.1 dygn, honornas 16.8 dygn, maximalt 32 och 42 dygn. Honorna kopulerade 7 dygn efter kläckning. Kopulering började sent på kvällen och fortgick ända till morgonen. Äggläggning började 2 veckor efter parning och fortsatte 2–3 veckor. Äggantalet varierade från 12 till 20 per hona. Ca. 20% av äggen lades på övre, resten på undre sidan av bladet, vid en nerv eller i en nervvinkel, mestadels 1 ägg per blad. Ägget är 0.50–0.62 mm långt, 0.29–0.30 mm brett, ovalt, litet tillplattat, med en spalt omkring, ljusgrönt, ytan full av små gropar. De första larverna kläcktes 30. juli i insektarium. Kläckningen fortgick i 4 veckor. Den unga larven har svart huvud och nacksköld. Kroppen är ljust grönaktig med några ljusa relativt korta hår. Som fullvuxen är larven ca. 10 mm lång, gulgrön till ljusgrön med gråaktigt huvud och tre litet mörkare rygglinjer. Larven söker sig strax efter kläckningen till närmaste knopp i bladvecket och börjar gnaga sig in i knoppen genom ett hål lyftande de avgnagda fjällbitarna åt sidan. Hålet avstänges efter några dagar genom att de inre fjällen växer hastigare än de yttre. Redan på hösten äter den unga larven en del av blom- och bladanslagen inne i knoppe. Larven övervintrar i 1. eller 2. larvstadiet. Under våren fortsättes ätandet, och rester av dessa anslag förstöres. Larven äter sig nu ut ur sin övervintringsknopp genom ett hål och flyttar in i en annan under tiden öppnad knopp genom dess topp, och äter där av blad- och klasskaft. Larven fortsätter ofta sin skadegörelse ännu på en tredje knopp med att äta små hål på unga blad, vilka med exkrementer och silktråd yppar

larvens tillvaro. Larvskadan avviker från skadan av *Incurvaria capitella* (Cl.) också i det att exkrementerna inte kommer fram från övervintringsknoppen och att larven inte gnagar kärndelen av knoppbasen. Larverna blir fullvuxna då vinbärsbuskarna börjar blomma. Då flyttar de ner till marken, där de förpuppar sig under avfall i en dubbel vitaktig vävning, vilkens inre del är spolformig och båda ändarna öppna.

Arten har uppträtt skadegörande på *Ribes nigrum* i Österbotten kring Uleåborg och Karleby samt på några andra lokaler i Södra och Mellersta Finland. Knoppantalet med övervintrande larver har i några fall beräknats utgöra över 10% av alla undersökta vinterknoppar. Det största relativa antalet knoppar med larv har varit 20%. I detta fall uppskattades skördeskadan till 50%. Tröskelvärden för ekonomisk bekämpning uppskattades vara ca. 1% knoppar med larv. Behandlingarna med bekämpningsmedel kan tänkas rikta sig mot knoppsflyttande larver i början av maj eller mot fullvuxna malar i månadsskiftet juni–juli. Övervintrande larver tål inte varmvattenbehandling av vintersticklingar (+45°C, 15 min.).

Faunagranśking i ein frukthage på Austlandet

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Frå 1973 til 1975 blei faunaen granska i eple, plomme og pære i Sem, Asker, omlag 20 km vest for Oslo. Frukthagen var sprøyta på tradisjonell måte til og med 1972. I forsøksåra var det ingen bruk av skadedyrmiddel. Siktemålet var å studere endringar i ulike dyregrupper i fråvær av skadedyrmiddel. Dette kan vise kva skadedyr som då gjer seg gjeldande, og kva nyttedyr ein må ta sikte på å verne i integrerte rådgjerder.

Hovudsakeleg blei Steiners bankemetode nytta, noko støtta av kvistprøvar om våren og visuelle observasjonar i veksttida. Materialet blei sortert med særleg vekt på å skilje mellom planteetarar, predatorar og parasittar. Dei fleste

gruppene er heilt eller delvis sortert til art. I eple og pære blei frukt tatt ved hausting og sortert etter skade.

Størst vekt blei lagt på arbeidet i eple, der materialet omfattar omlag 35000 insekt og edderkoppdyr (Baeschlin & Taksdal 1977). Thysanoptera var mest talrik, med høge tal alt første året. For Auchenorrhyncha, og særleg for Aphidoidea, var det sterkt minkande fangst for kvart år. Frå 1973 til 1974 var det ein drastisk auke i Psyllidae, der *Psylla mali* gjorde utslaget. Larvetalet av Lepidoptera var lågt, men med gradvis stiging over akseptabelt nivå for yrkesdyrking. Blant predatorane var det særleg sterk auke i Heteroptera, medan det stort sett var låge tal og ingen klare årsvariasjonar innanfor Araneae, Coccinellidae og Neuroptera. Det var også lite snylteveps, men bankemetoden egnar seg ikkje for gransking av denne gruppa. Av *Panonychus ulmi* og rovmidd var det låge tal alle tre år.

Fruktsorteringane i eple viste skadar over toleransegrensene, og med tydeleg sterkare skade i Gravenstein enn i Ingrid Marie.

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Frostmålarar som skadedyrproblem i frukthagar

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Fleire frostmålararter er viktige skadedyr i frukthagane i Norge. Skadelegaste arta er *Operophtera brumata* L., som i visse distrikt i Vest-Norge har herjing med 10–12 års mellomrom. Under siste storherjing (1965–68) blei det også registrert snaugnaging av *Operophtera fagata* Scharf., *Agriopis aurantiaria* Hb. og *Erannis defoliaria* Cl. i fleire usprøyta frukthagar (Edland 1976).

Under herjingsperiodane blir ofte eit stort tal

unge frostmålarlarver spreidde med vind frå lauvskog til frukthagane (Edland 1971) og dette kan gjere det turvande med fleire sprøytingar før og omkring blomstring. Mellom herjingsperiodane er derimot angrepa særs svake, og fruktdyrkarane kan då i enkelte år utelate all sprøyting mot gnagande skadedyr om våren og føresommaren (Edland 1975).

Klekkeforsøka viser at parasittane *Cyzenis albicans* Fall. og *Lypha dubia* Fall. (Dipt. Tachinidae), og *Agrypon flaveolatum* Grav. (Hym. Ichneumonidae) var svært talrike mot slutten av siste herjingsperiode. Dette tyder på at desse spelar ei viktig rolle i populasjonssvingningane til *O. brumata*, men kan ikkje åleine vere årsak til at populasjonen braut så drastisk saman.

I dei siste åra har populasjonstettleiken til frostmålarane, særleg av *O. brumata* vore sterkt stigande, og i 1977 var det herjing enkelte stader i Hardanger. Forsøk med lysfeller sidan 1973 har vist at det er god samanheng mellom talet av fanga frostmålarhannar om hausten og styrken på larveangrepet følgjande vår (Edland 1977). I 5 lysfeller på forskjellige lokalitetar i Ullensvang blei det i 1973 fanga ialt 13 *O. brumata*. Fangsten auka dei følgjande åra til 279 i 1976. Angrepsstyrken på ulike lauvtre blir fastsett ved hjelp av Steiners bankemetode (33 greiner pr. prøve). I 1974 varierte larvetalet på t.d. eple mellom O og 72 pr. prøve, medan variasjonen i 1977 var frå 10 til 1404 larver pr. prøve. Dette tyder på at lysfeller kan vere ein praktisk metodikk for utarbeiding a v prognosar om angrepsfare av frostmålarar, og eit nyttig hjelpemiddel ved integrerte rådgjerder.

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Kontaktytor inom tillämpad entomologi mellan naturvetenskapliga institutioner i Sverige

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För högskoleundervisning och forskning i tillämpad entomologi svarar numera i Sverige väsentligen lantbruksuniversitetets institution för växt- och skogsskydd. Av betydelse ur tillämpat entomologisk synpunkt är emellertid även delar av den verksamhet, som bedrivs vid vissa andra naturvetenskapliga institutioner.

Naturhistoriska museer

Taxonomiskt utredningsarbete ingår som ett led i många tillämpat entomologiska undersökningar. En värdefull tillgång bl a i detta sammanhang är insektssamlingarna vid de naturhistoriska museerna (Stockholm, Lund, Göteborg, Uppsala). Bestämningslitteraturen bygger till stor del på museisamlingarna och även härutinnan är de alltså till stor nytta exempelvis för utövare av tillämpad entomologi.

Anledning finns här framhålla att det borde bli rutin att till respektive naturhistoriska museer överlämna ett antal väl konserverade eller preparerade exemplar ur de sändningar eller kollekt av predatorer eller parasitoider, som utnyttjas i bekämpningsprojekt. Taxonomiskt är de arter, som kommit till användning i olika länder, inte alltid tillfredsställande kända. Beläggexemplar för ev framtida taxonomiska utredningar borde därför finnas tillgängliga. Med fog kan misstänkas att negativa resultat vid vissa i utlandet utförda försök rörande biologisk bekämpning med predatorer eller parasitoider bottnar i felbestämning av ursprungsmaterialet.

Till gagn bl.a. ur tillämpat entomologisk synpunkt är också den zootaxonomiska servicecentral, som sedan 1977 är knuten till riksmuseet i Stockholm. Uppsortering av fångstmaterial och identifieringsservice är viktiga arbetsuppgifter för centralen. Bland entomologiskt material, som av institutioner eller enskilda forskare insänts till och bearbetats vid centralen, kan nämnas håvnings- och ljusfällefångster, Collembola i jordprov, Hymenoptera Parasitica och Carabidae.

Specialistbefattningar för taxonomer

Naturvetenskapliga forskningsrådet har inrättat flera för taxonomer avsedda befattningar, av vilka f.n. tre innehas av entomologer, specialister på respektive Diptera Nematocera, Diptera Brachycera och Hymenoptera Parasitica. Förutom att bedriva forskning åligger det specialisterna att svara för bestämningsservice. Även här finns alltså för forskare inom t.ex. tillämpad entomologi möjlighet få hjälp med identifiering av vissa insekter.

Universitetsinstitutioner utanför lantbruksuniversitetet

Av principiell betydelse även för tillämpad entomologi är i många fall den ekologiska forskning, som bedrivs vid de zoologiska universitetsinstitutionerna. Detta gäller t.ex. för vissa av de studier, som under senare år utförts inom ramen för storprojektet "Barrskogslandskapets ekologi". Insekternas relationer till vissa signalsubstanser, ett intressant tema också ur tillämpad synpunkt, studeras sedan många år vid en till Uppsala universitet knuten ekologisk station på Öland. En kurs i insektspatologi, dvs i ett ämne av grundläggande betydelse för mikrobiologisk bekämpning, har årligen sedan 1972 hållits vid zoologiska institutionen i Uppsala. Undervisning och forskning i insektspatologi, delvis med tillämpade aspekter, bedrivs sedan många år vid zoologiska institutionen i Lund. Insektspatologisk forskning ingår också i arbetsprogrammet vid mikrobiologiska institutionen i Stockholm.

Kan en bättre samordning etableras?

Som utgångspunkt för en diskussion i denna fråga lämpar sig en rapport, som Nordisk Råds utvalg for biologisk bekjemping av skadedjur (NUBBS) framlagt (Sundby et al. 1976).

Som NUBBS framhåller bör forskningsinsatsen beröra flera av de metoder, som ryms inom begreppet biologisk bekämpning i vidsträckt bemärkelse. Bland dessa skall här särskilt framhållas nyttjande av attrahenter, repellenter och resistenta växtsorter. NUBBS förordar att forskargrupper etableras för t.ex. insektsfysiologi, insektsetologi och insektspatologi men framlägger ingen mera konkret plan för samordning av dessa gruppers verksamhet.

Självfallet är relationerna mellan skadeinsekt och värd- eller näringsväxter av stort intresse. Vilken eller vilka växter som prefereras är en i många fall otillräckligt belyst fråga liksom också reproduktionskapaciteten, tillväxthastigheten och överlevnadsgraden på olika växter. Även om många undersökningar på detta område redan genomförts, t.ex. beträffande bladlöss, synes fortsatta forskningsinsatser på detta fält vara angelägna. Eftersom sådana studier är tidsödande kan det tänkas bli svårt för yrkesentomologerna på det tillämpade området att medhinna alla önskvärda undersökningsmoment. Till stor fördel vore då ett vidgat samarbete med insektsekologer vid de zoologiska universitetsinstitutionerna, där vissa frågor skulle kunna penetreras av zoologi-studerande som ett led i deras utbildning.

Det är känt att tillgodogörandet av näringen hos bladlöss delvis kan vara beroende av mikrobiella symbionter (Auclair 1969). Därför kan det finnas skäl hos t.ex. skadeinsekter undersöka tarmflorans sammansättning och relationer till insektens nyttjande av näring. Bl.a. i Sverige finns tillgång på insektspatologer, som kan tänkas vara intresserade av att initiera sådana studier.

I samband med näringsrelationerna är betydelsen av sekundära substanser i växterna för insektens styrning till eller från och för dess utveckling på eller i växten en grundväsentlig fråga, som kräver ingående uppmärksamhet, inte minst ur biokemisk synpunkt. Specialister med kapacitet att utföra forskning på detta område är verksamma i Sverige vid olika universitetsinstitutioner.

Förhoppningsvis skulle undersökningar baserade på ovan antydda riktlinjer avslöja "svaga länkar" i insektens livsföring, vilka ev. skulle kunna utnyttjas för bekämpning. Särskilt om undersökningsobjektet är en skadeinsekt inom trädgård eller jordbruk, t.ex. persikbladlusen, glasvingade ängsstriten eller skidgallmyggan, är det också tänkbart att resultat av direkt betydelse för resistensförädlingen skulle kunna erhållas. Om t.ex. en viss sekundär substans i växten visar sig vara av avgörande positiv betydelse för insektens utveckling skulle kanske urval med syftet att nedbringa förekomsten av denna substans i växten bli ett framgångsrikt led i förädlingsarbetet. Motsatsen, nämligen urval för att öka förekomsten av någon substans med hämmande inverkan på insektens utveckling är naturligtvis också en möjlighet, som inte bör förbises.

En integration av flera forskningsområden associerade med biologisk bekämpning i vidsträckt bemärkelse, förslagsvis på sätt ovan anförts, är önskvärd. Det finns alltså anledning uttrycka förhoppningen att ett integrerat projekt inom den biologiska bekämpningens ram under medverkan av ett flertal institutioner kan förverkligas.

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Koordinering af international forskning vedrørende skadedyrbekæmpelse

JØRGEN JØRGENSEN

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Internationalt samarbejde på plantebeskyttelsesområdet har været praktiseret i meget lang tid, men en egentlig koordinering over større regioner kom først i stand på baggrund af en international konvention vedtaget i 1951 på initiativ af De Forenede Nationer (UN) gennem denne organisations Food and Agriculture Organization (FAO). Initiativet fik straks stor tilslutning fra mange europæiske lande, som forpligtede sig til at gennemføre nærmere præciserede foranstaltninger til hindring af spredning af plantesygdomme og skadedyr indenfor planteavlen. Til at effektuere dette arbejde oprettedes samme år i Paris et kontor for The European Plant Protection Organization (EPPO) omkring hvilken 35 lande i Europa og tilgrænsende lande i Afrika og Asien nu slutter op. Jac. Fjelddalen har givet en udmærket oversigt over internationalt samarbejde bl.a. i EPPO.

Den kemiske bekæmpelse har givet anledning til en række sundhedsmæssige problemer, som søges løst bl.a. gennem The World Health Organization (WHO). Spørgsmål om pesticidernes akutte giftighed, persistens og grænserne for tolerable rester i konsumprodukter har her været genstand for drøftelse, og på en del områder har de enkelte lande rettet sig efter internationale vedtagelser, men en egentlig fælles lovgivning har der endnu ikke kunnet opnås enighed om.

Indenfor Norden er der gennem de såkaldte Giftnævn sket en væsentlig koordinering af sundhedsmæssige regler for brug af pesticider, og vedrørende pesticidernes effektivitet har der i mere end 25 år været afholdt årlige bekæmpelsesmiddelkonferencer i nordisk regi.

Desuden er der indenfor Nordiske Jordbrugsforskeres Forening (NJF) udført et betydeligt koordinerende arbejde i arbejdsgrupper, symposier og kongresser både vedrørende biologiske undersøgelser og bekæmpelsesforanstaltninger.

Alternative bekæmpelsesmetoder er kommet i rampelyset gennem de sidste 10–15 år. Siden midten af 1950-erne har der eksisteret: Organisation Internationale de Lutte Biologique (OILB), som især har beskæftiget sig med biologisk og integreret bekæmpelse indenfor frugtavl. OILB har siden 1956 udgivet tidsskriftet Entomophaga. De nordiske lande har kun været med som observatører ved symposier etc. i dette arbejde.

I 1971 dannedes en global organisation: International Organisation for Biological Control (IOBC), som har til formål at koordinere arbejdet over landegrænserne. Som et eksempel kan nævnes, at denne organisation viderefører den identifikationsservice, som påbegyndtes af OILB i 1960-erne, især med henblik på artsbestemmelse af parasitter (snyltehvepse) og til dels prædatorer. Et andet vigtigt område er forskning indenfor regionale områder ved hjælp af arbejdsgrupper. Den vestpalæarktiske sektion (WPRS), som dækker Vesteuropa, har oprettet en række sådanne grupper.

Desværre har det for Danmarks vedkommende hidtil været svært at skaffe de fornødne penge (3000 schweizer-franc årligt) til at være med i dette arbejde. Danske forskere har dog i flere år deltaget i nogle arbejdsgruppers virke.

På nævnte forskningsområde blev der i 1968 taget et initiativ af "Nordforsk", som førte til visse begrænsede aktiviteter og nydannelser indenfor biologisk bekæmpelse i Norden, men der savnedes en tilstrækkelig fast organisation af samarbejdet, og det var svært at skaffe midler til såvel planlægning som til ny forskning.

En henvendelse til Nordisk Råd resulterede i nedsættelse af et udvalg til bedømmelse af forudsætningerne og behovet for et nærmere nordisk samarbejde på området. I 1976 forelå en omfattende rapport fra dette udvalg, som peger på en række områder, hvor det er både ønskeligt og nødvendigt med en bedre koordinering, dels på nordisk plan, dels på bredere internationalt plan.

Det kan være nyttigt at opdele forskningen i niveauer, som i følgende opstilling i stigende grad er afhængig af lokale forhold, og derfor i forskellig grad lader sig udføre i internationalt regi:

1. Basal forskning (international)
2. Målforskning (regional)
3. Praktisk udnyttelse (lokal)

Især på de 2 førstnævnte områder bør den internationale koordinering intensiveres allerede i planlægningsfasen.

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Nya arbetsområden i tillämpad entomologi

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I ideligen omväxlande miljöförändringar har idkarna av tillämpad entomologi alltid nya problem att kämpa med. Arbetsfältet är för stort, och kanske därför har några nya tillämpningar att ta nytta av insekter hamnat i icke-entomologernas händer.

Åt människor, för vilka naturen har blivit främmande, säljes stora skalbaggar till leksaker eller älsklingsdjur. I några storstäder har denna försäljning nått enorma dimensioner.

För akvariefiskar, älsklingsdjur och kycklingar tillverkar man redan nu mat av insekter som massproduktion.

Åt fritidsfiskare säljes odlade fluglarver till bete i stor skala.

Användandet av insekter också som människonäring öppnar i framtiden nya möjligheter att lösa den svåra proteinkrisen i världen.

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Ekonomisk betydelse av bladlus i stråsäd i Sverige

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Bladlöss är sedan gammalt kända som svåra skadegörare i stråsäd. Undersökningar över deras ekonomiska betydelse har emellertid först bedrivits under senare år. Sådana undersökningar är av största betydelse inom det tillämpade växtskyddet och syftar bl.a. till att få fram bekämpningströsklar, som anger vid vilka angreppsnivåer en bekämpning bör sättas in.

Metodik och arter

Undersökningarna har varit koncentrerade till Skåne (det sydligaste landskapet) och främst syftat till att belysa bladlössens populationsutveckling samt inverkan på beståndet och skörden såväl kvantitativt som kvalitativt. Till grund för bestämning av en bekämpningströskel måste ligga fältförsök, men därjämte har utförts s.k. ramförsök med bladlustäta burar.

Den avgjort viktigaste arten i Sverige är havrebladlusen (*Rhopalosiphum padi* L.), som övervintrar på hägg (*Prunus padus*). På stråsäden utvecklar havrebladlusen sig talrikast på havre och korn, men i samband med svåra massangrepp kan den uppträda talrikt också på vete, främst vårvete. Populationsutvecklingen är starkt beroende av grödans utvecklingsstadium, naturliga fiender och väderleken. Vanligtvis kulminerar populationsutvecklingen någon vecka efter axgången, då populationen snabbt bryter samman. Sammanbrottet kan dock ske såväl tidigare som senare. Tillsammans med havrebladlusen förekommer alltid fast i mindre antal sädesbladlusen (*Macrosiphum (Sitobion) avenae* F.) och den grönstrimmiga gräsbladlusen

100

(*Metopolophium dirhodum* Walk.). Särskilt sädesbladlusen har en senare utvecklingsrytm än havrebladlusen och kan enstaka år uppträda talrikt i axen ända fram till mjölkmognad på främst vete.

Sidoeffekter

Bladlössens näringssugning leder till en utarmning av plantan med en sämre matning av kärnorna som följd. Skadorna kan emellertid allvarligt förvärras genom att bladlössen samtidigt sprider rödsotvirus. Virusspridningen i försöken har kontrollerats genom testning av bladlöss och graderingar. Andra samtidigt uppträdande skadedjur som bekämpningen kan ha haft effekt mot har också särskilt kontrollerats.

Resultat

Olika lagbundna samband har belysts med regressionsanalys. Stora bladlusangrepp leder till stora skördeförluster utom att rödsotvirus finns med i bilden. Då bladlusangreppet uppgår till 100 bladlöss eller mer per strå kan skörde-

förlusten uppgå till 1 dt per ha och dygn. Kvalitetsegenskaperna (rymdvikt, växttråd, protein inkl. aminosyresammansättning, grobarhet m.m.) påverkas i större omfattning först vid mycket stora skador på grödan. Som bekämpningströskel rekommenderas 20–30 bladlöss i genomsnitt per strå. Ett angrepp vilket som mest når upp till denna storlek och inte bekämpas medför i genomsnitt en skördeförlust på 2–3 dt/ha. Det motsvarar ungefär kostnaden för bekämpningen.

Under flertalet år är havrebladlusen av ringa eller ingen ekonomisk betydelse. Svåra massangrepp har under 1970-talet hittills förekommit under 1973 och 1976. Under sådana år kan bekämpningsbehovet anta väldiga proportioner, vilket självfallet kan väcka olika populationsdynamiska och omgivningshygieniska frågeställningar. Hittills har den kommersiella bekämpningen fungerat mycket dåligt och inte alls utförts i den omfattning som varit ekonomiskt motiverat. Följden har blivit stora skördeförluster.

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V. Lepidopterologi

Storfjärilarnas utbrednings-inventering i Norden och i Alaska

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Sedan gammalt har man gjort fjärilinventeringar med hänsyn till utbredning i de s.k. natur-historiska provinserna av länderna i Norden. Man kan blott nämna namn som Tengström, Lampa, Nordström, Haanshus, Grönblom osv. Även åtskilliga lokalfaunor har publicerats. Vid skiftet av 1940- och 1950-talet beslöt prof. K. J. Valle och dr Frithiof Nordström att publi-cera en noggrannare utbredningsinventering av Fennoskandiens dagfjärilar, som utkom 1955. Magne Opheim stod för de norska uppgifterna. Materialet insamlades med frågeformulär och utgavs i form av en prickkarta för varje art. Prof. Valle avled 1956. Då man beslöt att fortsätta arbetet med att omfatta även andra fjärilgrupper, "ärvde" undertecknad det finska redaktörsskapet. Materialet insamlades igen med frågeformulär: svärmarnas och spinnarnas ut-bredningsatlas blev färdig 1961 och nattflynas, som innehöll även utbredningen i Danmark som Svend Kaaber stod för, 1969. Mätaredelen med Per Douwes som Nordströms efterträdare ligger f.n. under arbete.

I Alaska har man också gjort utbrednings-inventering närmast av dagfjärilar och arctiider under ledning av dr K. W. Philip, trots att ingen sammanfattning ännu har publicerats. Förutom att varje sommar själv med sina medhjälpare göra väl planerade exkursioner till valda lokaler i olika håll av staten, har han även årligen en mängd volontärsamlare i statens alla delar, och dessa förses med nödvändiga tillbehör och information. Under sensommaren och hösten får han sedan tillbaka det samlade materialet. Inventeringsschemat heter Alaska Lepidoptera Survey (ALS), som understöds av Institute of Arctic Biology i University of Alaska. Andra fjärilgrupper samlas även, men skickas direkt till Smithsonian Institution, Washington D.C. Undertecknad deltog exkursionen av året 1974 till norra sluttningen av västra Brooks Range och blev bekant med ALS:s fältarbete.

Jämförelsen mellan Norden och Alaska visar att fjärilfaunan omfattar både arter, som är gemensamma, i flesta fall cirkumpolära, upp-trädande som underarter i utbredningsområdets skilda delar, och arter som är antingen enbart europeiska (arktisk-alpina) eller amerikansk-sibiriska (i de flesta fall förekommande på båda sidorna av Beringssundet). Härtill kommer naturligtvis i båda fallen sydligare element som jag här förbigår. Till arternas antal medverkar även det faktum att i motsats till den totala ned-isningen av Norra Europa under istiden blev ganska stora områden i Alaska isfria.

Inventeringen i Norden har varit ganska kvantitativ, och de årliga förändringarna i ut-bredningsbilden är ganska små. Både Norden och Alaska ligger ungefär mellan samma bredd-grader; klimatet skiljer sig däremot betydligt, och framförallt är Alaska mycket glesare bebott, befolkningen och vägnätet utgör endast en bråk-del av de motsvarande hos oss. Naturligtvis är även fjärilforskarnas antal mycket mindre. Där-för förekommer det större extensioner av ut-bredningsområden nästan varje år, och då och då dyker det t.o.m. upp en för vetenskapen ny fjärilart.

Industri- och kustmelanism hos släktet *Oligia* (Lep., Noctuidae) i Finland

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I Finland har livsmiljön i städerna förvandlats starkt på grund av luftföroreningar, men den är inte heller på landsbygden den samma som förut. Detta påvisas av s.k. bioindikatorer, av vilka industrimelanismen hos *Oligia*-nattflyn har använts först under de senaste åren.

Den allmännare av två arter, *O. latruncula,* började enligt gammalt museeimaterial bli melanistisk i Helsingfors redan omkring sekelskiftet. Sedan 1950-talet förekommer ett visst antal melanistiska individ också överallt på landsbygden, och detta kan bero på luftföroreningar som kommer från Mellaneuropa.

Förekomsten av mörka former hos den andra arten, *O. strigilis,* har upptäckts mycket senare. Denna melanism är fortfarande begränsad till topografiskt och genetiskt isolerade öar.

En ny aspekt är, att det finns melanism hos *O. latruncula* också i den icke förorenade skärgården, dvs. det är fråga om s.k. kustmelanism.

Feromonfångst som metod för faunistiska undersökningar

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Undersökningarna med olika feromonpreparat av några på fruktträd uppträdande skadliga fjärilarter visar, att dessa feromonpreparat attraherar utom de egentliga ifrågavarande insektarterna också vissa andra arter, som inte behöver vara närbesläktade med de förstnämnda.

Så har år 1975 och 1976 följande arter attraherats av Codlemone[(R)] – ett feromonpreparat för äppelvecklare: *Cydia pomonella* (L.) (1402 ex.), *Pammene rhediella* (Cl.) (356), *P. populana* (F.) (135), *Hedya nubiferana* (Haw.) (112), *Celypha* spp. (10) och *Eucosma campoliliana* (Den. & Schiff.) (3). Alla dessa exemplar var hanar. Dessutom fick vi i fällorna slumpvis mer eller mindre tillfälliga arter, både hanar och honor. Talrikaste av dem var de allmännaste på fångstplats uppträdande arterna, i dessa fall *Phyllonorycter blancardellus* (F.), *Gelechia rhombella* (Den. & Schiff.) och *Argyresthia arcella* (F.). Samma arter uppträdde talrika också i kontrollfällorna utan feromon.

Funemone[(R)] – ett feromonpreparat för plommonvecklare – lockade utaom *Cydia funebana* (Tr.) (620 ex.) också *Cydia tenebrosana* (Dup.) (103), *Celypha* spp. (18), *Xestia baja* (Den. & Schiff.) + *sexstrigata* (Haw.) (10), *Hedya pruniana* (Hübn.) (9), *Apotomis semifasciana* (Haw.) (8), *Pammene rhediella* (Cl.) (7), *P. fasciana* (L.) (5), *P. insulana* (Guen.) (3), *Hedya salicella* (L.) (2) och *Cydia gallicana* (Guen.) (1).

Ett feromonpreparat för *Archips podanus* (Scop.) lockade utom den egentliga arten (642 ex.), också *Aspilapteryx tringipennella* (Zell.) (261), *Colocasia coryli* (L.) (8), *Hysterosia sodaliana* (Haw.) (8) och *Acompsia cinerella* (Cl.) (6).

Dessa är exempel på artspectra, som olika feromonpreparat kan ha. I praktiken är det betydelsefullt, huruvida en odlare, som kontrollerar sina fällor själv för att bestämma bekämpningsbehovet och -tiden för en viss skadlig art, kan skilja den ekonomiskt viktiga arten från andra likartade arter, t.ex. *Cydia funebrana* från *C. tenebrosana* och vissa *Pammene*-arter. Ur faunistisk synvinkel utgör feromonfångst en ny enkel metod att klarlägga vissa sällsynta arters lokala uppträdande och flygperiod. I många fall är dessa arter sådana, för vilka det tidigare inte funnits någon effektiv fångstmetod. Med samma princip, men i många fall med mycket mera besvär, skulle man kunna klarlägga många micro- och macrolepidopterers uppträdande genom att använda flera levande honor tillsammans som feromonemitter i fällorna.

Lepidopterous species recorded on fruit crops in Norway

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Since 1962 a great number of lepidopterous eggs and larvae have been collected from fruit trees, berry bushes, and strawberries in southern Norway. Most of them were reared to the adult stage for identification. About 100 species have been reared. These are listed in Table 1.

Species. Table 1 includes only those species reared by the author and does not give a complete picture of the Lepidoptera from orchards. Several species, especially of microlepidopterans, are probably lacking. *Zeuzera pyrina* L (Cossidae) and *Blastodacna atra* Haw. (Momphidae) have sometimes occurred as pests in our fruit orchards, and *Lampronia quadrimaculella* Hoefn. (Incurvariidae) as a pest on *Ribes* in Northern Norway (Schøyen & Jørstad, 1956). In the area of Kristiansand *Acronicta psi* L (Noctuidae) has occurred plentifully on apple and plums (Berggren 1970). None of these species are included in this study. *Adoxyphyes orana* Fr. (Tortricidae), a most harmful orchard pest in some European countries, has been caught several times in pheromon and light traps in Eastern Norway, but so far it has never been recorded feeding on fruit trees in our country.

The names used in the list follow those of Karsholt & Schmidt Nielsen (1976).

Host plants. The larvae were collected from many different plants, with the majority from apple. In Table I fruit trees are given as host plants when a species has been recorded from at least three of the four hosts: apple, pear, plum, and cherry, and Ribes when it is recorded from both red currant, black currant, and gooseberry. Many of the listed species have been reared from other cultivated and wild plants, but these have not been included in the list.

Frequency. An approximate estimate of the frequency is given; 1) rare: when the species occurred in one or a few of the orchards, 2) occasional: when it occurred in 10–50%, and 3) common: when it was recorded from more than 50% of the orchards.

Abundance. The number of each species often varied greatly from one year to another

Table I. Hostplants, frequency and abundance of lepidopterous species recorded from fruit and berry orchards in Southern Norway.
Figures for frequency and abundance are explained in the text. An asterisk indicates that outbreak with defoliation has been observed.

FAMILY/species	Hostplants	Frequency	Abundance
NYMPHALIDAE			
Polygonia c-album L.	red currant black currant	1	1–3*
SPHINGIDAE			
Smerinthus ocellata L.	apple	1	1
NOTODONTIDAE			
Ptilodon capucina L.	apple	1	1
DILOBIDAE			
Diloba caeruleocephala L.	fruit trees	1	1
LYMANTRIIDAE			
Orgyia antiqua L.	apple black currant	1	1–2
NOCTUIDAE			
Noctua pronuba L.	fruit trees, Ribes, strawberry	1	1
Xestia c-nigrum L.	strawberry	1	1
Xestia baja Den. & Schiff.	strawberry	1	1
Naenia typica L.	strawberry	1	1–2
Lacanobia oleracea L.	fruit trees, Ribes	2	1–2
Ceramica pisi L.	strawberry	1	1
Orthosia gothica L.	fruit trees, strawberry	3	1
Orthosia stabilis Den. & Schiff.	fruit trees	2	1
Orthosia incerta Hufn.	fruit trees	3	1
Lithophane socia Hufn.	fruit trees	2	1
Xylena vestusta Hb.	fruit trees	1	1
Allophyes oxyacanthae L.	fruit trees	2	1
Eupsilia transversa Hufn.	fruit trees, Ribes, raspberry	3	2–3*
Conistra vaccinii L.	fruit trees	3	1–2
Agrochola litura L.	apple	1	1
Parastichtis suspecta Hb.	apple	1	1
Amphipyra pyramidea L.	apple	1	1
Cosmia trapezina L.	fruit trees	2	1–3
Apamea monoglypha Hufn.	strawberry	1	1
Apamea crenata Hufn.	strawberry	1	1
Hydraecia micacea Esp.	strawberry	2	1–2
GEOMETRIDAE			
Alsophila aescularia Den. & Schiff.	fruit trees, Ribes	2	1–3*
Chloroclysta siterata Hufn.	fruit trees	3	1
Chloroclysta miata L.	fruit trees	3	1
Epirrita dilutata Schiff.	fruit trees	1	1
Epirrita autumnata Bkh.	fruit trees	1	1
Operophtera fagata Scharf.	fruit trees	1	1–3*
Operophtera brumata L.	fruit trees, Ribes, raspberry	3	1–3*
Chloroclystis rectangulata L.	fruit trees	2	2–3
Chloroclystis debiliata Hb.	apple, pear	1	2
Abraxas grossulariata L.	Ribes	1	1–3*

FAMILY/species	Hostplants	Fre-quency	Abun-dance
Itame wauaria L.	Ribes	2	1–3*
Opisthograptis luteolata L.	fruit trees	1	1
Selenia dentaria F.	plum	1	1
Odontopera bidentata Cl.	fruit trees	1	1
Crocallis elingularia L.	fruit trees	1	1
Colotois pennaria L.	fruit trees	1	1
Apocheima pilosaria Den. & Schiff.	fruit trees	2	1
Lycia hirtaria Cl.	fruit trees	1	1
Biston betularia L.	fruit trees	1	1
Agriopis aurantiaria Esp.	fruit trees, Ribes	2	1–3*
Agriopis marginaria F.	fruit trees	1	1
Erannis defoliaria Cl.	fruit trees, Ribes	2	1–3*
Campaea margaritata L.	fruit trees	1	1
ARCTIIDAE			
Arctia caja L.	apple, red currant	1	1–3*
SESIIDAE			
Penniseta hylaeiformis Lasp.	raspberry	1	1
Synanthedon tipulaeformis Cl.	red currant, black currant	1	1
COSSIDAE			
Cossus cossus L.	fruit trees	1	1
PYRALIDAE			
Zophodia convolutella Hb.	red currant black currant	2	1–3
TORTRICIDAE			
Pandemis corylana F.	fruit trees	1	1
Pandemis cerasana Hb.	fruit trees, Ribes	3	1
Pandemis cinnamomeana TR (?)	apple, pear	1	1
Pandemis heparana Den & Schiff.	fruit trees, Ribes	3	1
Archips podana Scop.	fruit trees	2	1–2
Archips xylosteana L.	fruit trees, Ribes	2	1–2
Archips rosana L.	fruit trees, Ribes	3	1–3
Ptycholoma lecheana L.	fruit trees	1	1
Lozotaenia forsterana F.	strawberry	1	1–2
Cnephasia stephensiana Doubl.	black currant	1	1
Cnephasia interjectana Haw.	fruit trees, strawberry	1	1–2
Exapata congelatella Cl.	fruit trees, Ribes	2	1–3
Croesia holmiana L.	fruit trees	1	1
Acleris comariana Zell.	strawberry	1	1–3
Acleris rhombana Den. & Schiff.	fruit trees	2	1–2
Acleris variegana Den. & Schiff.	fruit trees	1	1
Olethreutes lacunana Den. & Schiff.	strawberry	1	1–3
Hedya nubiferana Haw.	fruit trees Ribes	3	1–2
Rhopobota unipunctana Haw.	apple pear	3	2–3

FAMILY/species	Hostplants	Fre-quency	Abun-dance
Epinotia cruciana L.	apple, raspberry	1	1
Spilonota ocellana Den. & Schiff.	fruit trees	2	1–2
Enarmonia formosana Scop.	fruit trees	2	1–3
Pammene rhediella Cl.	apple pear	2	1–2
Cydia pomonella L.	apple pear	2	1–3
Cydia funebrana Tr.	plum	1	1–3
GLYPHIPTERIGIDAE			
Eutromula pariana Cl.	apple	1	1–3*
OECOPHORIDAE			
Diurnea phryganella Hb.	apple	1	1
GELECHIIDAE			
Recurvaria leucatella Cl.	apple	1	1
Gelechia rhombella Den. & Schiff.	apple	2	1–2
GRACILLARIIDAE			
Callisto denticulella Thnbg.	apple	2	1–2
Phyllonorycter blancardella F.	apple	3	1–3'
Pyllonorycter sp.	plum	2	1
LYONETHIIDAE			
Leucoptera scitella Zell.	apple, pear	1	1
Lyonethia clerkella L.	fruit trees	3	1–3
YPONOMEUTIDAE			
Argyresthia ivella Haw.	apple	2	1–2
Argyresthia arcella F.	apple	3	1–3'
Argyresthia pruniella Cl.	cherry, plum	2	1–3
Argyresthia conjugella Zell.	apple	3	1–3
Yponomeuta malinellus Zell.	apple	2	1–2
Ypsolopha asperella L.	apple	1	1
Ypsolopha paranthesella L.	apple	2	1
Ypsolopha horridella Tr.	apple	2	1
COLEOPHORIDAE			
Coleophora serratella L.	apple	1	1
INCURVARIIDAE			
Lampronia rubiella Bjerk	raspberry	1	1–2
Lampronia capitella Cl.	red currant	1	1
NEPTICULIDAE			
Trifurcula pulverosella Stain	apple	1	1–3

and between different districts. An approximate estimate of the abundance is indicated: 1) slight: when the species were scarce, 2) moderate: when a high number was recorded, and 3) high: when the species was very numerous in an orchard.

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Kartlegging av sommerfugler og øyenstikkere i Norge

KAARE AAGAARD

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Ved Museet i Trondheim er det, i samråd med Norsk Lepidopterologisk Selskab, opprettet et senter for innsamling av utbredelsesdata for (stor-) sommerfugler og øyenstikkere. Data kan sendes inn på ferdigtrykte feltkort eller artskort. Arbeidet ble startet som et norsk delprosjekt innen European Invertebrate Survey i 1973 og der er til nå kommet inn data fra ca. 90 samlere, for det meste amatører.

Ved siden av to rettledninger har senteret utgitt et foreløpig prikkart over norske dag-sommerfugler (1976) og et UTM kartverk med 50 km ruter over vann-nymfer (1977).

Senteret i Trondheim tar i første rekke sikte på å samle inn data fra amatører og "biprosjekt". Arbeidsfeltet vil derfor neppe kunne utvides til å omfatte stort mer enn Lepidoptera, Odonata, Orthoptera og enkelte ferskvannsinsekter.

Arbeidet i Trondheim skjer i nær kontakt med den norske representanten i EIS komité, Dosent Jan Økland, som forøvrig, ved siden av en rekke andre ferskvannsarter, driver kartlegging av ferskvannstegene *Nepa* og *Ranatra*.

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VI. Limnisk entomologi

Dynamik och energetik hos en larvpopulation av *Potamophylax cingulatus* (Trichoptera) i en bäck

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I den undersökta bäcken hade *Potamophylax cingulatus* (Steph.) en generation per år. Larver kläcktes från ägg i oktober varefter de passerade fem stadier före förpuppningen, vilken skedde under senare hälften av juli följande år. I oktober var larvtätheten 67 ind/m², medan antalet puppor endast var 4 st/m². Endast en imago kläcktes per m², dvs 1–2% av antalet larver i stadium I. "Naturlig mortalitet" orsakade den största förlusten. (83%). Förlust pga drift svarade för 7%, medan predation (fågel–fisk) orsakade en lika stor förlust.

En artificiell eliminering av puppor i bäckens övre del (1.6 km) visade, att immigrerande honor var ansvariga för ca hälften av rekryteringen till larvpopulationen. Den låga larvtätheten medförde att antalet överlevande larver kraftigt ökade.

Drift av larver var störst under tiden april tom juni. Driften medförde stora ansamlingar av larver på platser lämpliga för förpuppning. Generellt sett var de driftande larverna mindre än de, vilka samtidigt togs i bottenprover. Dock var förhållandet omvänt under den kraftiga vår–sommar driften. Driften berodde på flera faktorer t.ex. strömningsresistens, populationstäthet, födobehov och en aggregationstendens innan förpuppningen. Larvernas uppströmsvandring var mycket liten (ca 1%) jämfört med antalet driftande förbi en punkt under ett år.

Tillväxthastigheten var låg under vintern, och steg kraftigt under våren. I juli var energiinnehållet per individ ca 150 cal, varefter det sjönk. Energiinnehållet per gram torrvikt varierade mellan 3900 och 4600 cal under livscykeln. Tillväxten var mycket avhängig födans kvalitet. Larver uppfödda på allöv under tre månader vägde vid förpuppningen dubbelt så mycket som de, vilka ätit boklöv. Den totala produktionen var ca 4500 cal/m²/år av vilken 3830 cal var kroppsvävnad, 160 cal exuvier och 530 cal producerades i form av sekret vid husbyggandet. Den ekologiska effektiviteten (predationsuttag/konsumtion av bytet) var störst i maj–juni (0.8%) beroende på fågelpredation (kråka) under denna tid. Födokedjeeffektiviteten (byte till predator/föda tillgänglig till byte) varierade mellan 0.02–0.16%. Utnyttjandeeffektiviteten (energi konsumerad av larverna/energi tillgänglig till larverna) varierade mellan 1% (höst) och 22% (mars).

Fødens kvalitative betydning for veksten til *Baetis rhodani* Pikt. (Ephemeroptera)

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Fra august 1970 til mars 1973 ble føde, fødens kvalitet med hensyn på protein, fett og carbohydrater undersøkt både i felten og eksperimentelt i laboratoriet for *Baetis rhodani*. Feltundersøkelsene ble foretatt i Arnestadbekken i Vestby ca. 1 mil NW for Moss.

Temperaturen og vannføringen i bekken er vist på fig. 1. Føde og vekstforhold i bekken er vist i tabell I.

Ved eksperimentene ble det brukt 4 forskjellige temperaturer, 3 kvantitative føderegimer og 48 forskjellige kombinasjoner av kvalitative føderegimer. Disse sammen med feltundersøkelsen ga som resultat følgende:

1. Temperaturer mellom 1°C og 15°C synes ikke direkte å ha nevneverdig innflytelse på
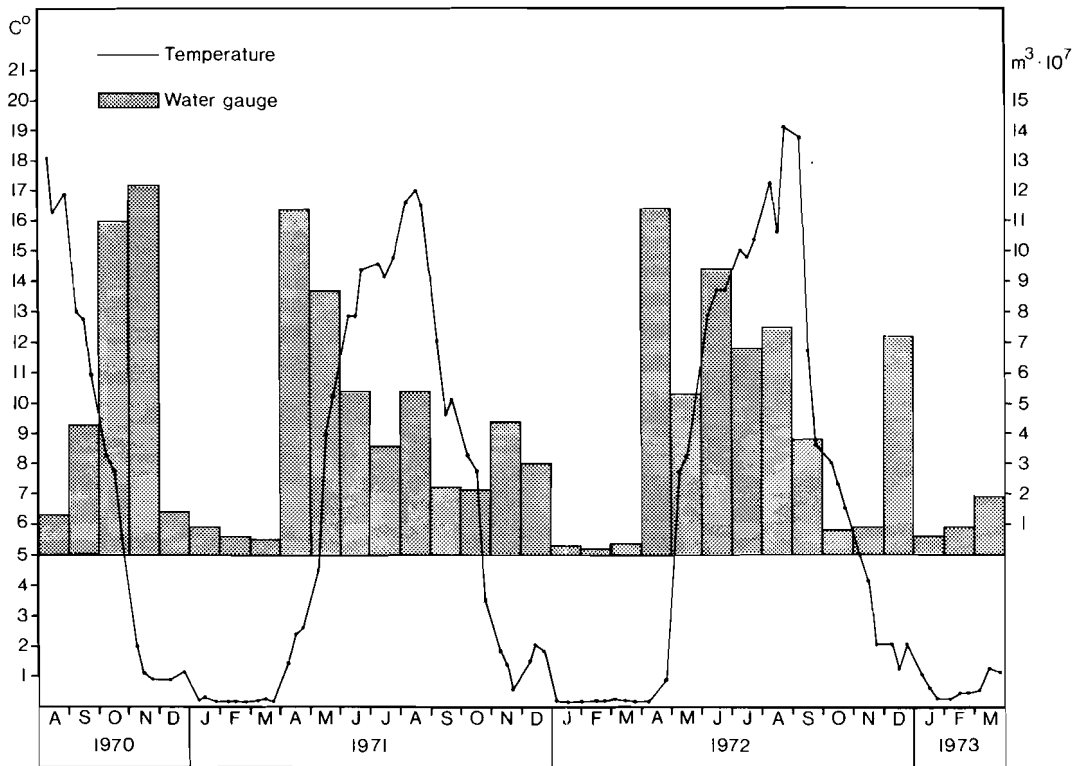
C°

—— Temperature

▓▓▓ Water gauge

m³·10⁷

| A S O N D | J F M A M J J A S O N D | J F M A M J J A S O N D | J F M |
| 1970 | 1971 | 1972 | 1973 |

Fig. 1. Månedlig vannføring og middeltemperaturen som 10 dagers middel i undersøkelsesperioden.

Tabell I. Total mengde føde som g m⁻² askefri tørrvekt, fødens innhold av protein, fett og carbohydrat i %, og veksten til larvene i mm ± standard feil.

Dato	Føde og vekst i elva					Dato	Føde og vekst i elva				
	Tørrvekt g m⁻²	Protein %	Fett %	Carbo- hydrat %	Vekst mm pr. 30 d.		Tørrvekt g m⁻²	Protein %	Fett %	Carbo- hydrat %	Vekst mm pr. 30 d.
A	238,6 ± 28,7	9,7	0,8	89,5	2,6 ± 0,4	J	271,7 ± 47,6	3,5	0,3	96,2	—
S	194,8 ± 36,4	8,1	0,9	91,0	1,7 ± 0,2	F	378,5 ± 58,8	3,8	0,6	93,6	—
O	147,1 ± 19,4	6,2	0,6	93,2	1,5 ± 0,3	M	386,4 ± 76,3	5,0	1,0	94,0	0,1 ± 0,1
N (1970)	164,8 ± 27,8	4,5	0,5	95,0	—	A	385,0 ± 29,6	5,8	0,9	93,3	0,6 ± 0,2
D	217,9 ± 52,3	4,1	0,2	95,7	—	M	371,0 ± 52,6	6,7	1,2	92,1	1,8 ± 0,3
						J	154,7 ± 40,0	8,2	1,4	90,4	2,1 ± 0,4
J	158,5 ± 52,6	3,2	0,2	96,6	—	J (1972)	398,2 ± 48,6	9,4	0,9	89,7	3,0 ± 0,3
F	271,6 ± 31,4	4,9	0,1	95,0	—	A	372,4 ± 76,5	8,5	0,7	90,8	2,6 ± 0,2
M	382,4 ± 42,6	5,2	0,4	94,4	—	S	261,5 ± 32,2	8,3	0,8	90,9	1,4 ± 0,3
A	379,0 ± 68,7	6,3	1,1	92,6	1,1 ± 0,3	O	150,0 ± 46,1	6,5	0,5	93,0	0,2 ± 0,1
M	363,0 ± 44,5	7,4	1,3	91,3	1,2 ± 0,2	N	149,2 ± 58,3	5,3	0,3	94,4	0,1 ± 0,1
J (1971)	284,0 ± 38,7	9,5	0,9	89,6	2,3 ± 0,3	D	158,8 ± 57,1	4,7	0,1	95,2	—
J	275,5 ± 64,8	10,2	1,1	88,7	3,0 ± 0,4						
A	265,4 ± 52,7	10,4	0,7	88,9	2,4 ± 0,2	J (1973)	273,8 ± 36,2	4,3	0,4	95,3	—
S	151,9 ± 64,9	8,2	0,9	90,9	1,1 ± 0,2	F	391,5 ± 53,6	4,9	0,6	94,5	—
O	152,5 ± 75,0	7,4	0,6	92,0	1,0 ± 0,1	M	390,0 ± 84,5	4,1	0,8	95,1	—
N	163,0 ± 34,2	3,9	0,5	93,6	—						
D	264,8 ± 56,3	4,2	0,3	95,5	—						

veksten til larvene. Temperaturen synes derimot å ha stor betydning indirekte ved at den påvirker mikroorganismenes kondisjoneringshastighet av organisk materiale.

2. Hvis proteininnholdet i føden kommer under 5% (askefri tørrvekt) stopper veksten opp og dødeligheten øker sterkt om temperaturen er høy.

3. Fettinnholdet synes bare å ha betydning for siste larvestadium som tar føde til seg. Kommer innholdet under 1% mislykkes klekkingen i høy grad.

4. Total mengde føde bør holdes over $150\,\mathrm{g\,m^{-2}}$ (askefri tørrvekt) i laboratorieforsøk, da veksten ellers går ned og dødeligheten øker.

The macrobenthos of the River Tourujoki and its tributaries (Central Finland). 1. Plecoptera, Ephemeroptera and Trichoptera

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In the qualitative analyses of macrofauna made during the spring and summer of 1975 at 87 lotic localities in the small partly polluted river system of Tourujoki (Central Finland), 14 species of Plecoptera, 21 species of Ephemeroptera, and at least 42 species of Trichoptera were recorded. The species new to the faunal and floral province of northern Tavastia (Tb) numbered 24. Especially interesting faunistically were the finds of *Amphinemura standfussi, A. sulcicollis,* and *Protonemura meyeri,* which have been considered to have a clearly northern or northern and eastern distribution in Finland, and the new finds of *Silo pallipes* and *Notibodia ciliaris* which are relatively southern species in Finland. The analyses of the occurrence of the species of these insect groups showed that there exists clear differences in the composition of the fauna in the different parts of the river system. The poorest fauna (only occasional finds of two species) was observed in the eutrophic and acidotropic parts of the river system, where the pH of the water owing to waste waters from a paper mill sank below a value of 4 during the summer. Relatively few species were found also in slowly flowing mesotrophic small rivers, where the water and bottoms contain plenty of clay particles, while the fauna was richer both in oligotrophic and mesotrophic brooks and even in eutrophicated swiftly flowing river habitats, where the water contained plenty of nutrients (mean content of tot. P 160 mg/m³). Especially the rich occurrence of mayflies in this eutrophicated river type is worth noting, since the group has often been considered to include mainly clean water species. Also many net-spinning and free-living predaceous caddis-larvae were found abundantly in this particular river type, which may be in connection with an unusually rich supply of food particles and organisms.

Flygaktivitetens dygnsrytmik hos några Trichopter-arter i norra Sverige

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Undersökningen utfördes 1970–73 vid Ricklea fältstation, Umeå och Messaure ekologiska station, Jokkmokk med hjälp av en sugfälla, som automatiskt växlade fångstburk var annan timme.

Fångsterna anses representera arternas dygnsaktivitet.

Dygnsaktiviteten för 19 arter visas med figurer. Alla arter var väl synkroniserade. Aktivitetstoppen hos de olika arterna visar en jämn övergång från Philopotamus montanus, som var aktiv kl 06–22 till Psychomyia pusilla, som flög kl 22–08.

Ingen time-nisch segregation mellan närbesläktade arter hittades.

Dygnsaktiviteten hos könen var något olika hos några arter; vanligen var hanarna mest aktiva under artens aktivitetstopp eller strax efter.

Andelen hanar i fångsterna minskade under flygperioden.

Rhyacophila nubila var mest aktiv kl 22–24 i början av flygperioden, men den förskjöts till kl 18–20 i september, beroende på ändrade ljusförhållanden under sommaren. I oktober försköts aktiviteten till dygnets ljusa del på grund av alltför låg nattemperatur. En liknande, men mindre markerad förskjutning, visar även Apatania stigmatella vid Abisko.

på riskor överväger nematocererna. Oligofaga arter har påträffats bara bland svampmyggorna (Mycetophilidae). Specialicerade är *Exechia pseudocincta* och *Mycetophila blanda* vilka nästan enbart förekommer på Lactarius deliciosus-gruppen, *Exechia nigroscutellata* som i finskt material kläckts bara från *Lactarius torminosus* samt *Exechia contaminata* som bara erhållits från *Lactarius necator* och *L. trivialis*. Några svampmyggor synes preferera russulaceer i allmänhet. Den synnerligen polyfaga i svampar av olika grupp synnerligen vanliga *Mycetophila fungorum* förekommer sällan i riskor, möjligen på grund av förekomst av skarp mjölksaft. Bland brachycererna har phoriderna ej ännu bestämts till art (*Megaselia* spp.) men är tydligen viktiga skadegörare på *Lactarius rufus*. Vanliga som larv i riskor är *Pegomya geniculata*, *Pegohylemyia silvatica* (Anthomyiidae) samt *Suillia atricornis* (Heleomyzidae), alla tre polyfaga fungivorer.

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with literature data on development time. Basis for the analysis was 25°C. Assuming an inverse relationship between energy metabolism and development time the following ratios were calculated: (a): O_2-consumption in *H. aculeatus* (O_2-consumption in *T. simplex*)$^{-1}$; (b): (Development time in H. aculeatus)$^{-1}$ (Development time in *T. simplex*).

For the different models (a) had the value 0.53 to 0.61, whereas (b) = 0.49. This indicates that the differences in energy metabolism in the imagines of the two species reflect genetically fixed differences expressed throughout their life cycles.

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Oxygen consumption in Thysanoptera: *Haplothrips aculeatus* Fabr. and *Taeniothrips simplex* (Mor)

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Energy metabolism was measured in the Thysanoptera species *Haplothrips aculeatus* Fabr. and *Taeniothrips simplex* (Mor.) at 10° and 20°C using cartesian diver microrespirometry. Animals were sampled from rye grains (*H. aculeatus*) and *Gladiolus sp.* (*T. simplex*) in the vicinity of the Institute of Ecology (PAN) near Warsaw. Regression equations for O_2-consumption (R = μl O_2 animal^{-1} hr^{-1}; W = dw in μg):

	10°C	20°C
H. aculeatus:	R = 0.158 $W^{0.79}$	R = 1.576 $W^{0.46}$
T. simplex:	R = 0.449 $W^{0.74}$	R = 1.627 $W^{0.66}$

Four different models of energy metabolism were calculated for the species: linear, exponential, logarithmic, and from the Krogh-Jørgensen equation. These models were applied when comparing data from the present study

Oxygen consumption in Collembola from two different forest biotopes

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The investigation was carried out at the Institute of Ecology, Polish Academy of Sciences in Warsaw, summer 1975.

Using cartesian diver microrespirometry, oxygen uptake was measured in three collembola species at 20°C. From dry pine forest: *Lepidocyrthus lanuginosus* (Gmel.). *Schoettella inermis* (Tullb.); from wet *Alnus* forest/swamp: *L. lanuginosus*, *Onychiurus armatus* (Tullb.). Acclimation period at the experimental temperature was one week.

Regression equations for O_2-consumption are presented in Table I.

L. lanuginosus from wet *Alnus* forest has significantly higher O_2-consumption than the others. Animals from the pine forest seem to have a higher regression coefficient. With the exception of *L. lanuginosus* from wet forest, the results are not significantly different, and a common regression line may be calculated:

$$R = 0.330 \ W^{0.71}$$

Table I. Regression equations for O_2-consumption ($R = \mu l\ O_2$ animal^{-1} hr^{-1}; $W = $ dw in μg).

Species	Biotope	Regr.equations
L. lanuginosus	Wet forest	$R = 0.527\ W^{0.64}$
L. lanuginosus	Dry forest	$R = 0.290\ W^{0.76}$
O. armatus	Wet forest	$R = 0.312\ W^{0.71}$
S. inermis	Dry forest	$R = 0.325\ W^{0.76}$

L. lanuginosus, the only species found in both biotopes, does not seem to adjust its metabolism to the experimental temperature in the same way as the others. The shady alder forest has a lower average temperature than the open pine forest. Using the Krogh-Jørgensen curve and 20°C as basis for comparison one finds that *L. lanuginosus* from wet forest seems to be acclimatized to temperatures 4°C lower than individuals from the pine forest. This is approximately the difference in average temperature for the two biotopes.

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i den soleksponerte sanden. Dyrenes opphold i den soleksponerte overflaten hadde derfor trolig karakteren av utfall, hvis varighet er begrenset oppad av de muligheter dyrenes varmekapasitet gir for å forsinke kroppstemperaturens stigning mot omgivelsestemperaturen.

Andre arbeider har vist at enkelte ørkeninsekter kan senke sin kropps temperatur med flere grader i forhold til omgivelsestemperaturen ved evaporativt varmetap. En slik mulighet synes lite sannsynlig i dette tilfelle, både på grunn av dyrenes lille størrelse (4–6 mm lange) og på grunn av at de nok må føre en streng vannhusholdning i disse tørre omgivelsene. Den høye temperaturen gir imidlertid en høy metabolisme, noe som også vil føre til en høy metabolsk vannproduksjon. Dette kunne tenkes å representere en vannkilde de kunne dra nytte av for evaporativt varmetap. Et enkelt overslag, basert på maksimal metabolisme i 10 timer og minimal varmeovergang fra omgivelsene (5 cal/m²·time· ·grad) ved en temperaturdifferanse på 5°C, gir imidlertid en faktor på ca. 10 000 mellom det mulige evaporative varmetap p.g.a. metabolsk vann og varmeovergangen fra omgivelsene. En permanent redusert kroppstemperatur p.g.a. evaporativt varmetap er dermed utelukket. Det er imidlertid en mulighet for at det kunne bety noe i kritiske perioder av kort varighet.

Aktivitet ved høye temperaturer hos afrikanske ørkentenebrionider

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Tenebrionider av slekten *Zophosis* er aktive om dagen på sol-eksponert bakke i afrikanske halvørken og savanne-områder, der overflatetemperaturen kan gå opp til +60°C. Billene stanser hyppig i skyggen av stener, kvister o.l., der temperaturen ligger på +48–+50°C.

Forsøk i laboratoriet viste at dyrene i nær vannmettet atmosfære (91% r.h.) tålte +50°C, men døde ved +53°C. Dette tyder på at dyrene i naturen er aktive ved omgivelsestemperaturer som ligger over deres toleranse-grense. Billenes hyppige opphold i skyggen er derfor trolig nødvendige for at de skal unngå overopphetning

Conceivable effects by atmospheric electricity on insect activity with description of a method of recording spontaneous flight activity in large insects

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The paper deals with a) the presentation of a complex of environmental factors seldom discussed by Scandinavian biologists, b) information on a method of measuring spontaneous take-off activity in locusts, probably modifiable for use with other insects.

Investigations of atmospheric electricity in

connection with biometeorological problems
usually concern the following factors, 1) the
quasi-stationary electric field, 2) the atmospheric
ion balance, 3) the atmosphere's electromagnetic
field. These factors are described by, for
example, Reiter (1960). Insect activity in relation
to parametric variations in atmospheric electri-
city have been studied by, among others,
Helson & Penman (1970) and Warnke (1973).

Weather fronts and other atmospheric condi-
tions with substantial convection cause low fre-
quency electromagnetic fields (VLF = Very low
Frequency). Reports in the literature mention in-
creased activity of locusts, *Schistocerca gre-
garia* (Forsk.) during 'disturbed' weather. This
has led me to propose the hypothesis that VLF
is one of the factors that influence the take-off
activity of these insects. *Schistocerca* is known
to be carried by strong winds into a convergence
area with favourable conditions for breeding.
If the VLF activity increases the take-off activ-
ity, there is also an increased possibility for
the locusts to reach the area of convergence,
a reaction of this kind thus having a positive
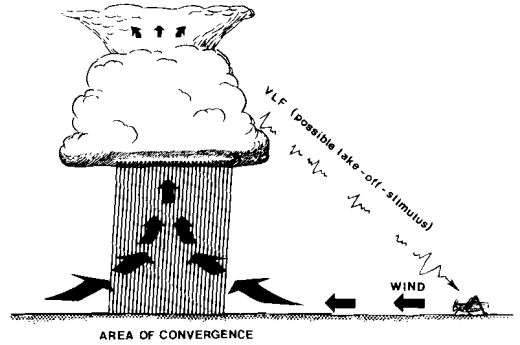selection value (Fig. 1). A method of measuring

Fig. 1. Outline of the hypothesis presented.

the take-off activity of locusts – *Locusta migra-
toria* (R. & F.), *S. gregaria* – has been developed
at the Dept. of Entomology, University of
Uppsala, and should also be modifiable to suit
other, larger, insect species. A cage (2 × 0.7 × 0.8
m) is equipped with eight parallel beams of light
at a height of 0.3 m above the floor. The beams
coincide with 8 photocells. A laser beam is used
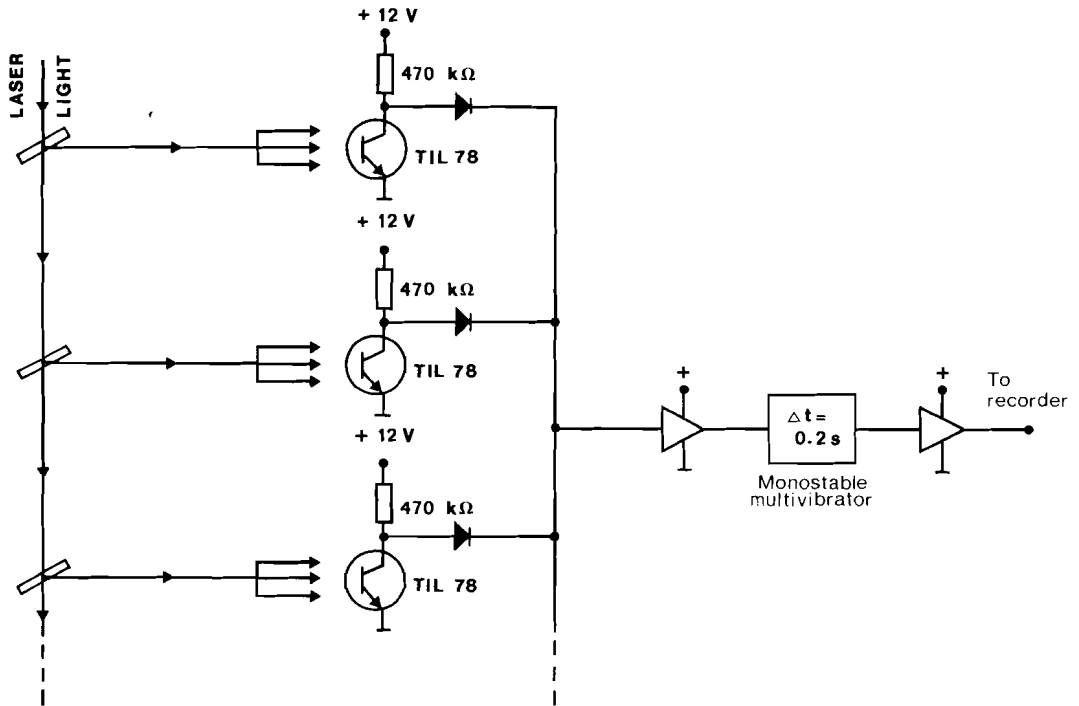to obtain a concentrated light source, the beam

Fig. 2. Electronic circuit diagram.

being divided into eight parallel beams by microscopic slides (Fig. 2). The method is a good means of measuring take-off activity, but requires precision in adjusting the beams and a vibration-free environment.

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Comments on some disease-causing Arthropods in Sweden. Studies on repellents

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Arthropod disseminated diseases are a threat when hygienic conditions deteriorate. Well known arthropod disease constellations are e.g. lice – typhus, mosquitoes – tularemia and malaria, ticks – RSSE, gadflies – tularemia, fleas – plague, mites – scabies, flies – various enteric diseases.

Among possible methods to control the spread of such diseases is obviously to use arthropod repellents.

Some plants are known, or suspected, to interfere with arthropods. We have, therefore, in addition to our work on the synthesis of repellents, prepared and tested some plant extracts for their arthropods repelling activity. Hydrophilic (ethanol) and lipophilic (toluene) extracts were prepared from the plants enumerated in Table 1. The extracts were screened for their activity by a test on humans using the yellow fever mosquito (Aedes aegypti). The results given in Table 1 show the number of piercing mosquitoes – the lower the score the more effective was the extract. A score of zero was

Table 1. Screening of plant extracts

	Number of piercing mosquitoes					
	ethanol extr.			Toluene extr.		
	Before	Test period	After	Before	Test period	After
FANEROGAMES						
Angiospermae						
Compositae						
ET Achillea millefolium	5	0	0	4	0	3
ET Matricaria chamomilla	7	0	7	9	0	9
E Matricaria inodora	4	0	4	8	1	6
ET Tanacetum vulgare	2	0	5	4	0	6
ET Artemisia absinthium	4	0	0	6	0	7
T Artemisia vulgaris	6	1	5	7	0	4
Curcurbitaceae						
ET Cucumis sativus	5	0	3	3	0	4
Solanaceae						
T Solanum tuberosum	20	13	13	4	0	4
T Solanum lycopersicum	10	2	15	3	0	4
Labiatae						
ET Rosmarinus officinalis	6	0	7	3	0	4
Ericaceae						
ET Ledum palustre	9	0	5	6	0	5
Gruinales						
Tropaeolum majus	6	1	7	4	1	4
Rosaceae						
Sorbus aucuparia	10	6	10	4	3	5
E Prunus padus	2	0	3	5	5	7
Umbelliferae						
Petroselinum hortense	4	3	3	4	1	3
Rhamnaceae						
Rhamnus frangula	9	1	10	6	1	5
Urticaceae						
Urtica dioica	6	3	7	3	1	3
Cannabinaceae						
ET Humulus lupulus	6	0	4	5	0	5
Betulaceae						
T Betula alba	3	1	5	7	0	4
Myricaceae						
ET Myrica gale	6	0	5	8	0	7
Liliaceae						
T Allium cepa	7	6	6	8	0	5
Gymnospermae						
Coniferae						
T Pinus silvestris	8	2	6	5	0	4
ET Picea excelsa	5	0	4	4	0	4
ET Juniperus communis	4	0	3	7	0	4

	Number of piercing mosquitoes		
	Before	Test period	After
Pyrethrum	5	0	5
N,N-diethyl-m-toluamide,DEET	10	0	11
703	10	0	6
Paraffin oil	8	0	4

considered to indicate a true repelling activity. The test period was preceded and followed by control periods. For comparison some known repellents were also tested. It can be seen from Table 1 (marked ET) that the ethanol extract as well as the toluene extract from eleven plants caused zero piercing. In two cases (marked E) ethanol but not toluene extracts gave no piercing while the reverse was true in six cases (marked T).

Further work on plant extracts is in progress.

Tropiske proturer og kontinenternes bevægelser

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De store skridt fremad inden for naturvidenskaberne synes at blive taget med 100 års mellemrum og gerne i århundredets midte. Ved midten af 1600-tallet blev grunden lagt til den moderne fysiologi såvelsom til den historiske geologi. I 1758 kom dyrenes og planternes systematik ind i det faste skema, der muliggjorde alle senere undersøgelser over dem. I 1859 skabte Darwin med evolutionslæren og selektionsteorien et vendepunkt inden for al naturvidenskab og forøvrigt også i andre videnskaber. Og i 1960 kom et lille skrift af amerikaneren Henry H. Hess, som gav stødet til en renæssance for den gamle wegenerske kontinentalforskydningsteori i form af teorien om oceanbundsspredning og pladetektonik. Denne teori i forbindelse med en radioaktiv bedømmelse

af geologiske epokers alder er nu så vel begrundet, at jeg bygger på den i nogle betragtninger over proturernes evolution og spredning.

Udgangspunktet var en studie over de brasilianske proturer, hvoraf bl.a. een art er udbredt og almindelig i Nord-Brasilien og Columbia samt i Vest-Afrika fra Nigeria til Angola, og ellers ukendt. Da det sidste berøringspunkt mellem Brasilien og Vestafrika ved Pernambuco-Gabon blev afbrudt i Senon for 90 millioner år siden, er det nærliggende at give denne art – *Delamarentulus tristani* (Silv.) – en alder på 100 millioner år. Proturerne er cladistisk en søstergruppe til Collembola, som er kendt fra Mellem Devon, og må altså være mindst 400 millioner år gamle. At deres evolution er meget langsom, fremgår af deres store ensartethed, og at deres spredning er meget langsom fremgår bl.a. af, at deres ofte tydeligt afgrænsede udbredelsesområder som regel ikke er eksistensøkologisk betinget.

En på synapomorfier bygget fylogeni for de 37 kendte protur-slægter kan ikke laves endnu; men de tre familier Eosentomidae, Protentomidae og Acerentomidae såvel som enkelte slægters fylogeni er cladistisk sikker, og for de øvrige kan man bygge på udviklingslinier, trends. Hvis man sætter disse i forbindelse med den geologiske udvikling får man de skemaer, der er gengivet i tabellerne.

Meget skematisk fremstillet tænker man sig, at kontinenterne i Trias, for 200 mill. år siden, var samlet i Pangæa. Tyve mill. år senere, i Jura, var adskillelsen mellem et nordligt superkontinent, Laurasia, og et sydligt, Gondwana, i fuld gang. Ved Kridttidens begyndelse for 135 mill. år siden, begyndte adskillelsen mellem Afrika og Sydamerika, der sluttede for 90 mill. år siden. Forbindelsen med Antarktis kan dog have varet ved. Indien brød løs fra Antarktis for 100 mill. år siden og dannede Himalya for 45 mill. år siden. Da brød også Australien løs; New Zealand tidligere. Endelig skiltes Amerika, Grønland og Norge for 80–60 mill. år siden, afsluttet i Eocæn for 47 mill. år siden.

Af de brasilianske proturer er den allerede omtalte *Delamarentulus* (kun een art) fundet i Vest-Afrikas og det nordlige Sydamerikas regnskove, men desuden almindeligt i Columbias Andesbjerge i páramo'en i 3500 m's højde. Det samme, bortset fra Vestafrika, gælder *Eosentomon curupira*. En anden brasiliansk art, *Gracilentulus kenyanus*, er fundet i Øst-Afrika, Mauritius, Sydindien. En tredje, *Eosentomon*

(Eosentomidae)	Amer. N.f. Mexico	Europa	Afrika N.f. Sahara	Asien-Kina	Japan	Sydøst-Asien	Syd-Amerika	Afrika S.f. Sahara	Indien	Australien	Melanesien
Eosentomon											
Isoentomon											
Antelientomon											
Anisentomon											
(Protentomidae)											
Hesperentomon											
Fujientomon											
Hinomotentomon											
Huhentomon											
Sinentomon											
Protentomon											
Proturentomon											
Condesllum											

Laurasia — Gondwana

Signaturforklaring:
- Mange arter i mange fund
- Mange arter i få fund
- Få arter (2-3) i mange fund
- Få arter i få fund
- En enkelt art i mange fund
- En enkelt art i få fund
- En enkelt art i et enkelt fund

(Acerentomidae)	Amer. N.f. Mexico	Europa	Afrika N.f. Sahara	Asien-Kina	Japan	Sydøst-Asien	Syd-Amerika	Afrika S.f. Sahara	Indien	Australien	Melanesien
Acerentulus											
Australentulus											
Brasilidia											
Amerentulus											
Acerentomon											
Gracilentulus											
Brasilentulus											
Delamarentulus											
Chosonentulus											
Baculentulus											
Berberentulus											
Silvestridia											
Bolivaridia											
Tuxenidia											
Acerella											
Proacerella											
Tuxenentulue											
Vesiculentomon											
Filientomon											
Verrucoentomon											
Imadateiella											
Nosekiella											
Yamatentomon											
Nipponentomon											

Laurasia — Gondwana

wygodzinskyi, er derimod fundet almindelig i Melanesien, og en fjerde, *Brasilidia tropica,* er meget nær beslægtet med den australske slægt *Australentulus* – for blot at give nogle eksempler.

Tabellerne viser udviklingen fra den pangæiske underorden Eosentomoidea med slægter i det yderste Laurasia, over Protentomidae med de primitiveste slægter i Laurasia, hvor de specialiserede sig i nyere og nyeste tid, og andre i Gondwanaland, til familien Acerentomidae. Inden for denne familie udviklede en række slægter sig i Laurasia ved specialisering af karakterer (munddele, lemmer etc.) til den rent europæiske *Acerentomon* og den japansk-nordamerikanske *Nipponentomon* som højdepunkter, medens andre slægter i Gondwanaland især udviklede sig ved reduktion af karakterer. Tabellerne viser de forskellige udviklingslinier og deres forekomst.

Det hele skema er endu kun et, omend ganske smukt korthus; det er mit håb, at igangværende undersøgelser over proturernes udbredelse ikke vil vælte det.

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