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NORSK ENTOMOLOGISK FORENING

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STYRET

Collembola and Acari in DDT-and Aldrin-Treated Agricultural Soils in Norway

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Raffensperger, E. M. 1969. Collembola and Acari in DDT- and Aldrin-Treated Agricultural Soils in Norway. *Norsk ent. Tidsskr. 16,* 65-69.

The effect of residues of DDT and aldrin upon Collembola and Acari populations in two types of agricultural soil was investigated. A heavy loam used for apple production in western Norway, and light sandy soils used for vegetable production in southeastern Norway were tested for DDT and aldrin-dieldrin residues respectively. Acari and Collembola were counted. Insecticide residues were found to be relatively light. The arthropod population levels appeared to depend more upon the qualities of the soil resulting from cultivation practices than upon insecticidal residues.

Norway now prohibits the agricultural use of DDT and aldrin, along with certain other persistent chlorinated hydrocarbon insecticides. Residues of these chemicals occur in agricultural soils, and they may have an effect upon populations of arthropods in the soil. Several studies of soil residues (Lichtenstein & Schultz 1961) and arthropod populations (Bund 1965) have been reported. Observations of insecticide residues and arthropod populations were made upon samples taken from carefully controlled plots upon which insecticides were applied under the strictest supervision. Little has been published on arthropod populations in soils subjected to long and intensive commercial agricultural use, including the regular application of insecticides by farmers at presumably recommended rates.

In this study populations of soil Acari and Collembola were counted and notes on other insects were gathered from the soil of an apple orchard in which DDT had been used regularly for 15 years, but in which, according to the grower, no DDT had been used for the three seasons previous to sampling. The soil was analysed chemically to determine the concentration of DDT residues.

Similar counts of arthropods were conducted upon soils used for more than 10 consecutive years in the commercial production of vegetables, primarily carrots and onions. In this latter case aldrin, instead of DDT, was the chlorinated hydrocarbon insecticide of interest, and again appropriate chemical analyses to determine soil residues were conducted.

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METHODS

DDT in an orchard soil

Soil for this portion of the study was taken from a mature apple orchard of mixed varieties on the steeply sloping eastern shore of Sörfjorden, Ullensvang, at an altitude of ca. 30 m. The soil was a heavy loam on which orchard grass was the dominant surface cover. It is evident that in an orchard, distribution of soil residues of insecticides applied to the tree as a spray treatment is not likely to be uniform, and therefore three points were chosen for sampling at which three different levels of residues might be expected. The first, a normal residue point, was chosen midway between two trees and about 2.5 m outside of the canopy of each. The second, a high residue point, was chosen just beneath the drip-line of a tree canopy. The third sampling point was within a nearby unused portion of the orchard, which was said by the grower never to have been treated with insecticides. The point from which the untreated samples were taken had also been exempted from the usual mowing and from the application of fertilizers used elsewhere in the orchard.

Each sampling point was first cleared of grass and loose, dry surface debris. A sharp spade was used to cut a 1000-cm^3 sample from the top 5 cm of soil. A second sample was taken between the depths of 5 and 10 cm, and a third between 15 and 20 cm below the surface. The soil was moist enough to allow samples to be lifted into plastic bags and transported to the laboratory without crumbling.

Each sample was then placed in a Tullgren funnel (Kevan 1962) and air-dried under a 40-watt incandescent electric light bulb for 7 days. Arthropods descending through the funnel were captured in 50 percent ethyl alcohol for identification and counting. After 7 days the soil, now well dried and no longer yielding arthropods, was returned to plastic bags and stored in a cool, dark room until chemical analyses were conducted.

A repetition of this experiment was begun one week after the first. Samples were taken within 1 m of the collecting points for the first replicate.

Aldrin in vegetable soils

The use of aldrin for treating seeds against attack by soil insects has been a common practice among vegetable farmers in Norway for many years, but the total amount of insecticide used for the purpose is quite small considering the area treated. The insecticide is applied as a seed dressing, and is not spread generally over the soil or the foliage of the crop. Lower levels of residue than those in fruit orchards were therefore anticipated, and because of plowing and cultivation, a more uniform distribution of aldrin was expected.

Samples for this portion of the study were taken at two points in southeastern Norway. The first was on a light sandy soil near Stavern, Vestfold. The grower had planted carrots on the land for more than 10 consecutive years prior to the study.

Soil in which a normal residue of aldrin was anticipated was taken from a field which was planted with treated seeds only when the grower felt, for reasons not explained, that insect attacks might be heavy. Treatments were reported to have been applied only about one year in three. For soil in which higher residues were anticipated, samples were taken from a field where the toxicant had been applied to the seed every year. The third sampling point lay at the edge of the grower's kitchen garden, and was said never to have been treated with aldrin. The untreated sample was noted to contain a much higher content of decaying plant material than the soil of the two previous sampling points.

Soil samples were taken at three depths as before, and the samples were handled in identical fashion to those of orchard soils described above.

The second series of samples taken for the aldrin study were gathered on Jelöy near Moss, Östfold. This was also a light sand quite similar to the soil at Stavern. Here carrot crops were alternated with onion plantings, and only the onion seed was treated with aldrin. In the area where normal residues were expected, carrots had been the last crop planted, and therefore no aldrin had been used during the year of sampling. Aldrin-treated onion seed had been used during the year in the area where heavier residues were expected. As before, the samples of untreated soil had to be taken from an area where cultivation practices differed considerably from those in treated areas. In this case rhubarb had been grown on the soil for at least eight years, and there had been heavy applications of manure. Weeds were controlled with a black plastic film mulch.

In anticipation of the expected change of aldrin to dieldrin with aging in the soil, chemical analyses were conducted for both aldrin and dieldrin.

RESULTS AND DISCUSSION

DDT

Soil residues of DDT (Table I) followed rather closely the distribution anticipated by the sampling pattern. Even after three years DDT remained most highly concentrated in the surface layer of soil, and lower residues occurred as depth increased. An earlier study by Stenersen & Friestad (in press) agrees with the observation that most of the DDT residues in orchard soils remains near the surface. The highest residues were found beneath the dripline of the trees, as anticipated.

The sensitivity of the technique for detecting DDT residues was limited to amounts of the toxicant of 0.05 mg/kg of the air-dried soil. Small amounts of DDT were detected in the upper layers of soil in the untreated areas, probably as a result of wind drift of droplets at the time of application and/or as a result of transport by surface movement of water during periods of heavy precipitation.

Total numbers of Acari and Collembola seemed to be unrelated to the presence of DDT. The numbers of Collembola in relation to the numbers of Acari, however, varied somewhat more consistently. In general the higher ratios of Collembola were found where DDT residues were highest, while Acari oc-

Table I. DDT residues, Acari and Collembola from an apple orchard soil in Ullensvang in western Norway

Date	Residue expected	Depth of sample (cm)	DDT residue (mg/kg soil)	Per 1000 cm^3 soil		Totals
				Acari	Collembola	
2/8/68	normal	0-5	3.9	530	397	927
		5-10	0.91	13	10	23
		15-20	0.13	4	1	5
	high	0-5	16.1	281	123	404
		5-10	4.2	39	48	87
		15-20	0.23	11	10	21
	untreated	0-5	0.21	374	46	420
		5-10	0.05	23	11	34
		15-20	0.05	7	3	10
19/8/68	normal	0-5	2.6	155	274	429
		5-10	0.66	27	16	43
		15-20	0.27	9	2	11
	high	0-5	10.0	291	259	550
		5-10	2.0	75	24	99
		15-20	0.93	10	4	14
	untreated	0-5	0.40	538	40	578
		5-10	0.09	19	5	24
		15-20	0.05	6	2	8

curred in higher ratios where DDT residues were low. This observation is consistent with the results of the studies by Bund (1965) and Karg (1967).

Insects from 6 other orders, as well as Symphyla and Diplopoda, were also observed in arthropod samples. Only a few specimens of each occurred, and these so widely scattered as to be negligible in comparison with the numbers of Collembola and Acari.

Aldrin

The quantity of aldrin introduced into soils by the method of seed treatment is very small, and the toxicant could be detected only in trace amounts. Dieldrin, to which aldrin is converted by aging, is the form in which the material accumulates in soil. Small but measurable residues of dieldrin were detected (Table II). The sensitivity of dieldrin analysis was 0.03 mg/kg of air-dried soil.

There is little consistant evidence of the stratification of residues in the upper layers of soil as observed in the case of DDT in the orchard study. This can be attributed to the fact that the vegetable fields were plowed and cultivated each year, while the orchard soil was subjected to no such mixing.

Populations of Collembola and Acari were very low in both the normal and high residue areas, but this may be the result, in large measure, of the almost complete absence of decaying organic material upon which the most numerous arthropods feed. There is no apparent relationship between numbers of arthropods and the residues of dieldrin in treated areas. Arthropods were more numerous in soil samples from untreated areas, where cultivation had been infrequent and where plant debris had accumulated for several years.

In addition to Acari and Collembola, insects of five additional orders, Diplopoda and Sym-

Table II. Dieldrin* residues, Acari and Collembola from vegetable field soils in southeastern Norway

Date and locality	Residue expected	Depth of sample (cm)	Dieldrin residue (mg/kg soil)	Per 1000 cm^3 soil		Totals
				Acari	Collembola	
9/10/68	normal	0-5	0.39	10	6	16
Jelöy		5-10	0.35	50	1	51
		15-20	0.38	4	6	10
	high	0-5	0.48	0	5	5
		5-10	0.49	0	6	6
		15-20	0.45	10	1	11
	untreated	0-5	0.03	82	5	87
		5-10	0.05	131	113	244
		15-20	0.03	13	97	110
18/9/68	normal	0-5	0.14	1	1	2
Stavern		5-10	0.10	0	3	3
		15-20	0.08	0	0	0
	high	0-5	0.19	5	12	17
		5-10	0.14	0	19	19
		15-20	0.11	2	13	15
	untreated	0-5	0.03	216	150	266
		5-10	0.03	2	8	10
		15-20	0.03	2	1	3

*Aldrin was present only in trace amounts. The residues appear essentially as dieldrin phyla were observed in small numbers. Among the insects were several specimens of Protura, a group seldom reported in Norwegian insect surveys.

CONCLUSIONS

Detectable residues of DDT and dieldrin were found in soil areas subjected to regular commercial agricultural use. The proportion of Acari in relation to Collembola among arthropods recovered from the samples seemed to vary somewhat with DDT residues, the Acari being more severely limited by this insecticide. Sample sizes were too small to show such differences, if they occurred, where dieldrin residues were found.

Cultural use of the soil and the accumulation of decaying organic material were much more important than insecticide residues in determining the size of arthropod populations. The commercial use of the two insecticides DDT and aldrin has resulted in quite modest residues, and these appear to have had little effect upon total numbers of arthropods.

ACKNOWLEDGEMENTS

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The Occurrence and Flight Periods of Bombyces and Noctuoidea (Lepidoptera) in Siljan, South-Norway, Based on Light Trap Catches

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Bakke, A., Nesfeldt, A. & Stendalen, A. H. 1969. The occurrence and flight periods of Bombyces and Noctuoidea (Lepidoptera) in Siljan, South Norway, based on light trap catches. *Norsk ent. Tidsskr.* 16, 71-75.

Catching by means of a light trap continued every night in spring and parts of the summer in 1964 and 1965, and more occasionally in 1966-68, at a locality in Siljan, South Norway. The capture periods and abundances are given for several species. The number of Bombyces listed for the geographical division increased from 17 to 35 species and the number of Noctuoidea from 73 to 135 species.

The geographical distribution of Bombyces and Noctuoidea in Norway is described in the *Catalogue of the Lepidoptera of Norway* (Opheim 1958,1962). In this catalogue Norway is separated into 37 bio-geographical divisions according to a proposal by Strand (1943). A species is noted from a division if records have been published, or if a specimen from the division is kept in museum or private collections. In some areas several lepidopterologists have made extensive collections whereas the fauna in other areas is relatively unknown.

The county of Telemark, the coastal as well as the mountainous part, belongs to the less investigated divisions of South Norway. Of those estimated to live in the coastal division, only 50 per cent of Bombyces and 40 per cent of Noctuoidea have actually been found (Opheim 1958, 1962). In this area the Norwegian Forest Research Institute established a field station for studies of bark beetles in 1964 and 1965. In order to contribute to our knowledge of the geographical distribution and flight of nocturnal Lepidoptera in the area, a light trap was in function during most of the seasons, and trapping continued until 1968.

The nomenclature of the species is according to Opheim (1958, 1962).

INVESTIGATED AREA

The field station was established at Vannebu in the northern part of Siljan, Telemark in South Norway (59° 21′ N., 9° 40′ E.) at an altitude of 260 m. The northern part of Siljan consists of a valley running north and south surrounded by mountains up to an elevation of about 400-600 m. The mountains and valley sides are covered with forests, mainly Norway spruce *(Picea abies)* and Scots pine *(Pinus sylvestris)*. The coniferous forests are interspersed with birch *(Betula odorata)*, various species of *Salix*, aspen *(Populus tremula)*, European mountain ash *(Sorbus aucuparia)* and alder *(Alnus incana)*. *Maple (Acer platanoides)*, ash *(Fraxinus excelsior)* and European bird cherry *(Prunus padus)* are sparsely distributed whereas lime *(Tilia cordata)* and oak *(Quercus)* do not grow there. The light trap was placed on the ground at the bottom of the valley where the forest bordered on old grass land.

METHODS

The light trap was built according to the model by Robinson & Robinson (1950) with a mercury vapour lamp, Philips HP 80 W. The lamp was put on at sunset every night in 1964 from 9 April to 24 June and in 1965 from 5 April to 26 July. Apart from these dates the lamp was put on less regularly during the period 1964-68. Tetrachlorethane was added to the container to anesthetize the moths. Every morning the trap was emptied and the specimens of Bombyces and Noctuoidea were identified and counted.

The temperature was recorded continuously during the periods by a thermograph in a Linke screen in an open area 400 m from the trap.

RESULTS

Total capture of species and individuals during the period

The capture of moths varied considerably

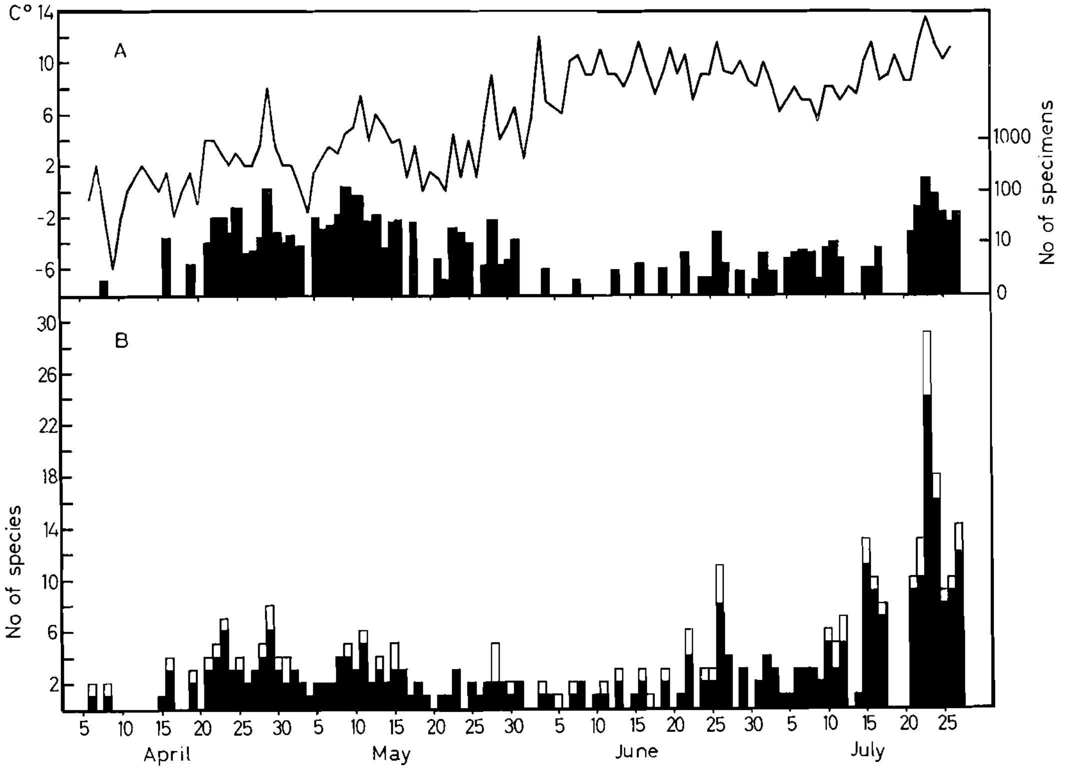

Fig. 1. Capture of Bombyces and Noctuoidea in 1965. A. Number of Noctuoidea specimens trapped every night in 1965 and the air temperature at midnight (00.01 hrs). B. Number of Bombyces (white columns) and Noctuoidea (black columns) trapped every night in 1965.

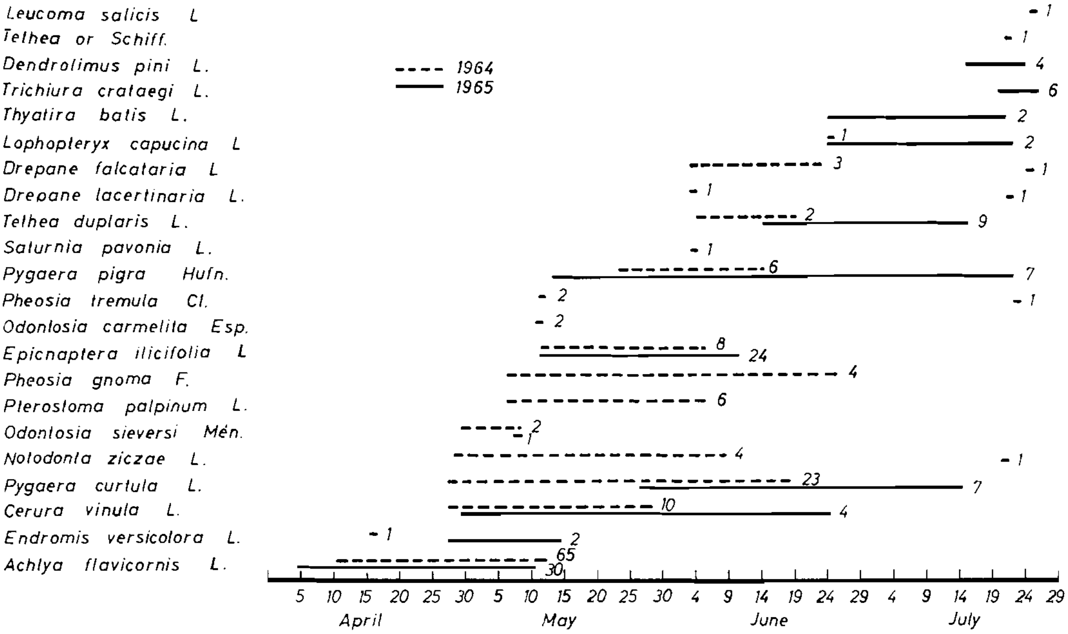

Fig. 2. The period from the first to the last capture of every species of Bombyces in Siljan in 1964 and 1965. The figures give the total number of trapped individuals. In 1964 trapping took place only until 24 June.

during the period of investigation. The number of specimens of Noctuoidea in 1965 (Fig. 1 A) was high from the middle of April to the last part of May. In June and in the first part of July, very few moths were captured whereas the capture increased in the last part of July. The same trend can be seen in the diagram of the number of species (Fig. 1 B), but the number of species is rather small in the spring period compared to the last part of July.

Capture period of each species

The snowlayer on northern slopes and on shady sites was more than one meter thick when the lamp was lit those two years. Nevertheless, moths were trapped on the first nights even when the temperature was close to 0°C. *Lithophane ingrica, Xylina vetusta,* and *Achlya flavicornis* were found earlier than 10 April (Figs. 2 and 3). The figures give the species and number of individuals found during the capture period.

Records made beyond the period of continuous trapping

During the late summer and autumn of 1964 and 1965 and in 1966-68 a light trap was put on more occasionally. Some catches were also made by nets at daytime. In addition to those listed in Figs. 2 and 3, the following species were recorded:

Bombyces: *Notodonta dromedarius* L., *Ptilophora plumigera* Esp., *Poecilocampa populi* L., *Orgyia antiqua* L., *Dasychira fascelina* L., Noctuoidea: *Euxoa obelisca* Schiff., *Agrotis ypsilon* Rott., *A. segetum* Schiff., *A. exclamationis* L., *Epipsila grisescens* F., *Chersotis cuprea* Schiff., *Spaelotis ravida* Schiff., *Diarsia dahlii* Hb., *Amathes baja* Schiff., *A. c-nigrum* L., *Ammoconia caecimacula* Schiff., *Noctua pronuba* L., *N. fimbriata* Schreb., *Mamestra thalassina* Hufn., *M. suasa* Schiff., *M. oleracea* L., *Heliophobus reticulata Vill., Tholera popularis* F., *Anarta myrtilli* L., *A. cordigera* Thnbg., *Orthosia stabilis* Schiff., *O. gracilis*

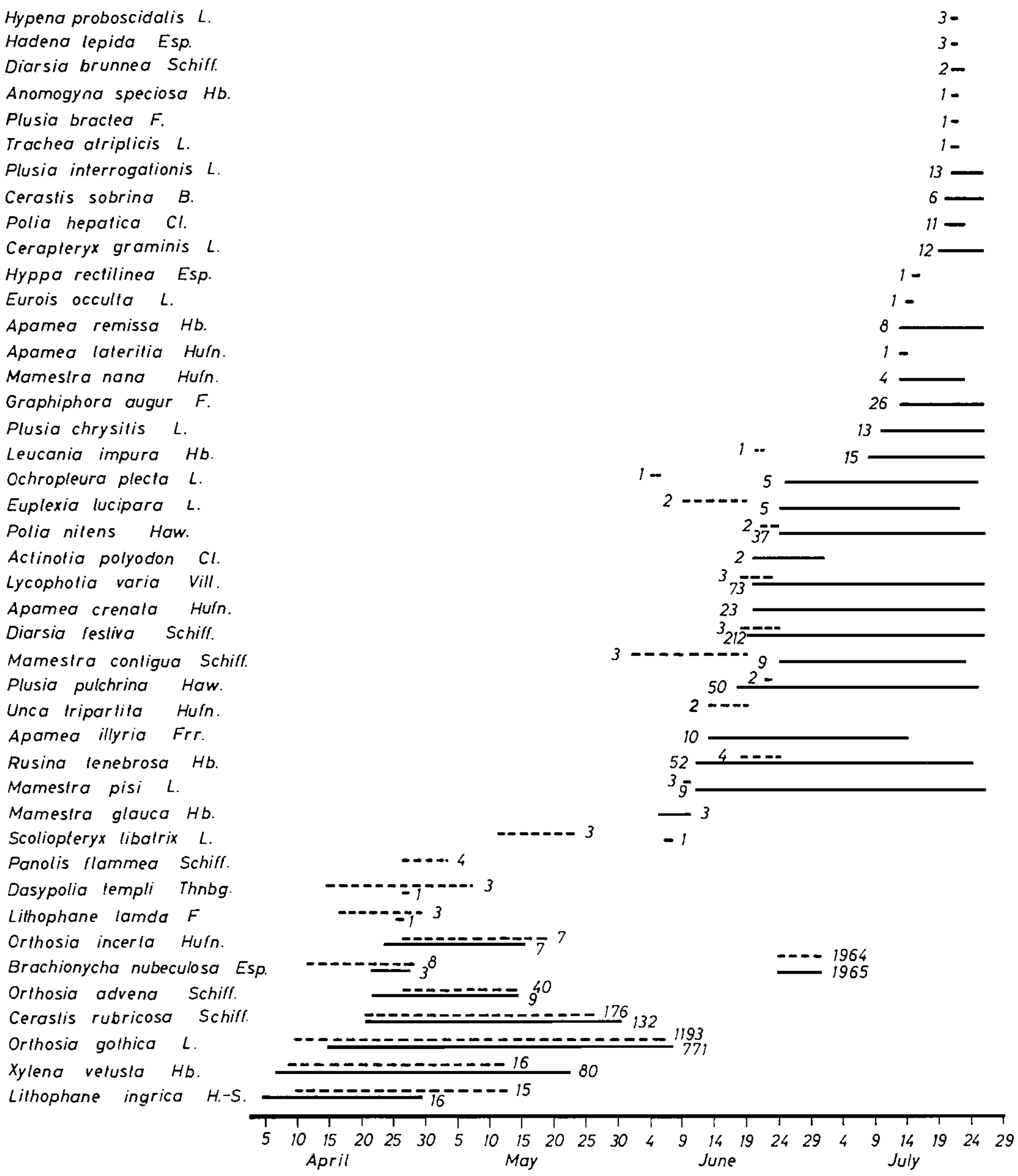

Fig. 3. The period from the first to the last capture of every species of Noctuoidea in Siljan in 1964 and 1965. The figures give the total number of trapped individuals. In 1964 the trapping took place only until 24 June.

Schiff., *Leucania comma* L., *Calophasia lunula* Hufn., *Bombycia viminalis F.*, *Lithomoia solidaginis* Hb., *Lithophane furcifera* Hufn., *Allophyes oxyacantae* L., *Calotaenia celsia* L., *Eumichtis satura* Shiff., *Antitype gemmea* Tr., *A. chi* L., *Eupsilia transversa* Hufn., *Conistra vaccinii* L., *Agrochola lota* Cl., *A. macilenta* Hb., *A. circellaris* Hufn., *A. helvola* L., *A.*

litura L., *Cirrhia lutea* Ström, *C. icteritia* Hufn., *Amphipyra tragopoginis* L., *Apamea monoglypha* Hufn., *A. secalis* L., *A. rubrirena* Tr., *Celaena haworthii* Curt., *Hydraecia oculea* L., *Gortyna micacea* Esp., *Z. subtusa* F., *Cosmia trapezina* L., *Enargia paleacea* Esp., *Nycteola degenerana* Hb., *Euclidimera mi* Cl., *Ectypa glyphica* L., *Plusia iota* L., *P. gamma* L., *Polychrysia moneta F.*, *Lygephila pastinum* Tr.

DISCUSSION

In April and May there is a distinct correlation between the number of moths captured and the midnight air temperature (Fig. 1 A). In nights with high temperatures the capture was highest. When temperature was below 0°C, no moths were trapped, but 1-2°C were enough to give flight conditions for some species.

The number of individuals captured in spring shows few species compared to the capture in late July (Fig. 1). *Orthosia gothica* and *Cerastis rubricosa* were the most common species in spring both years (Fig. 3).

For most of the species the number of individuals is too small to give a complete picture of the flight period. For those which occurred in large numbers there was good correspondence with the flight period in 1964 and 1965 (Figs. 2 and 3).

In the coastal division of Telemark, 17 species of Bombyces were listed by Opheim (1958). Nine of these were found in Siljan. Most of the other 8 species are southern species which belong to the warmer coastal areas with oak forests. In addition to those 9 species, 18 new species of Bombyces can be listed for the division, and the total number of known species increases to 35.

Opheim (1962) has listed 73 species of Noctuoidea from the coastal division of Telemark. 41 of these were trapped in Siljan. In addition, 62 new species were found. Opheim (1962) has estimated the number of species of Noctuoidea in the coastal division of Telemark to be approximately 200, and for the mountainous interior division to be approximately 175. Siljan belongs to the coastal division, but is situated in the northern part, and Vannebu is only 16 km from the borderline of the mountainous division. Even though this investigation has increased the number of species listed for the coastal division by 85 per cent, only about 65 per cent of the species estimated for the division are recorded.

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Atomariinae (Col., Cryptophagidae) from Jordan and Cyprus, with the Description of a New Species

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Johnson, C. 1969. Atomariinae (Col., Cryptophagidae) from Jordan and Cyprus, with the description of a new species. *Norsk ent. Tidsskr. 16,* 77-80. *Ephistemus exiguus* Erichson, *Atomaria atricapilla* Stephens and *A. atripennis* Reitter are recorded from Jordan, whilst a new species, *A. semusta* sp. n., is described on material from Jordan and Cyprus. A lectotype of *A. atripennis* is also designated, and the species discussed.

During 1958-59, Mr. J. Klapperich collected twenty specimens of Atomariinae in various parts of Jordan, and these specimens were made available to the writer for study. Of the four species represented, one is new to science. This same new species was also discovered amongst some material belonging to the National Museum of Natural History, Prague, these specimens, four in number, originating from Cyprus. The present paper is concerned with all this material.

SPECIES REPRESENTED

Atomaria (Anchicera) atripennis Reitter

Atomaria atripennis Reitter (1887, Best.-Tab. 16, p. 42-43).

Jordan: East Jordan, Amman, 800 m, 25.3.1958, 1 ♂; same locality but 13.4.1958, 1 ♀.

Reitter (1887) described this species from Syria in a footnote to his 'Bestimmungstabellen', and indicated that it came into the group of species in which he included *scutellaris* Motschulsky, although he compared the species with *nigripennis* (Kugelann).

No original material of this species is to be found in Reitter's main collection of *Atomaria,* which is conserved in the Hungarian National Museum, Budapest. However, in the collection of Grouvelle (deposited in the Muséum National d'Histoire Naturelle, Paris), to whom a large and fairly complete collection of Reitter's Cryptophagidae went, there is a single specimen with the following labels: 'Syrien, Haifa, Reitter' (printed), '*A. atripennis* m. Syrien' (written in Reitter's hand), three printed labels '204', 'Coll. Reitter' and 'Type' (these latter two without doubt added by Grouvelle, as Reitter's own collection lacks them), and a label '*atripennis* Reitt., Syr.', apparently in Grouvelle's handwriting. This specimen, a female, is herewith designated as the lectotype of *atripennis* Reitter, and has been so labelled by the present writer.

It is not an easy matter to decide on the

Table I. A comparison between *A. scutellaris* Motschulsky and *A. semusta* sp. n.

scutellaris	*semusta* sp. n.
Length 1.55 - 1.75 mm.	Length 1.4 - 1.66 mm.
Pronotal puncturation coarser and closer, the punctures about half a diameter apart from their lateral neighbours on an average; side margin of pronotum usually strongly angled near the middle.	Pronotal puncturation a little finer and sparser, the punctures about 1-2 diameters apart from their lateral neighbours on an average; side margin of pronotum usually more rounded near the middle.
Elytral puncturation slightly coarser and closer, the punctures about 1-$1^{1}/_{2}$ diameters apart from their lateral neighbours on an average; shagreenation slightly weaker.	Elytral puncturation slightly finer and less close, the punctures $1^{1}/_{2}$-2 diameters apart from their lateral neighbours on an average; shagreenation slightly stronger.
Male genitalia (Fig. 1): length of median lobe 0.37-0.4mm; penis about as long as the basal piece; apex of penis strongly extended. Length of paramere plate 0.37-0.42 mm; apex with the granules very close, mainly situated on the disc; ventrally-produced sides of paramere plate broader, with 10-13 setae, the anterior 2-5 shorter and tooth-like.	*Male genitalia* (Fig. 2): length of median lobe 0.29-0.32 mm; penis shorter than the basal piece; apex of penis not or feebly extended. Length of paramere plate 0.32-0.34 mm; apex with the granules more evenly distributed, and less close; ventrally-produced sides of paramere plate narrower, with 6-8 setae of approximately equal development.
Female spermatheca (Fig. 3): apical and basal regions subequal in length.	*Female spermatheca* (Fig. 4): apical region much shorter than basal region.

actual status of *atripennis* at present. Both the lectotype and the Amman female are identical in all respects, both structurally and in colour — head and pronotum red, elytra black — but they do not come in the section of the genus which Reitter indicated. In fact they are extremely closely allied to the variable *rubricollis* Brisout. They differ from this species only (as far as the writer can judge) in having the pubescence much shorter, i.e. it is about half the length of that in *rubricollis,* and in the wings being fully developed as opposed to being rudimentary in the west European form of Brisout's species. The Amman male has the antennae and body-form a little longer than in the female, and the colour is predominantly yellowish (probably due to slight immaturity), but the writer has little doubt that it really is an *atripennis* male, as the males of many species are frequently longer and narrower than in the female, and with the antennae more elongate. The genitalia of this male, however, appear to be identical with that organ in *rubricollis*. It seems desirable to the writer that more material in this group, from a wide geographical area, ought to be studied before judgement can be passed on the status of *atripennis*.

Atomaria (Anchicera) atricapilla Stephens

Atomaria atricapilla Stephens (1830, p. 66), Reitter (1887, Best. -Tab. 16, p. 45), Sjöberg 1947, p. 100, 119).

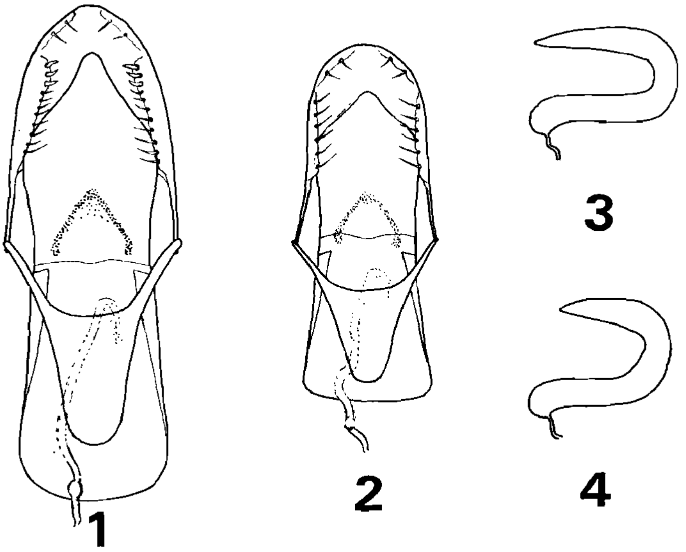
Jordan: Jordantal, Jericho, 250 m u.M., 10.2.1958, 1 ♀.

This specimen is rather more parallel-sided, depressed and somewhat duller than is usually the case with *atricapilla,* but the spermatheca is identical.

Atomaria (Anchicera) semusta sp. n.

Identical with *scutellaris* Motschulsky in

Figs. 1-4. Genitalia of *Atomaria (Anchicera)* spp.: 1. *A. scutellaris* Motschulsky, aedeagus; 2. *A. semusta* sp. n., aedeagus; 3. *A. scutellaris,* spermatheca; 4. *A. semusta* sp. n., spermatheca.



shape, colour and antennal structure. The differences between the two species are brought out in the tabular comparison above (Table I).

Holotype ♂ - *Jordan:* East Jordan, Jordantal, Arda Road, 600 m, 8.3.1958, leg. J. Klapperich.

Paratypes. - *Jordan:* same data as holotype, 6 ♂♂ 1 ♀; East Jordan, Zerkatal b. Romana, 300 m, 7.1.1958, 1 ♀; same locality but 100 m, 8.1.1958, 1 ♂; East Jordan, Amman, 800 m, 25.3.1958, 1 ♀; East Jordan, Homer, N. Amman, 600 m, 26.4.1959, 1 ♂ 1 ♀; Jordantal, Jericho, 250 m. u.M., 10.2.1958, 1 ♂; same locality but 200 m u.M., 31.3.1959, 1 ♀.
Cyprus: no precise locality, 3 ♂♂ 1 ♀.

Holotype and nine paratypes in the Hungarian National Museum, Budapest; six paratypes in the Manchester Museum; three paratypes in the National Museum of Natural History, Prague.

A large number of '*scutellaris*' were re-examined by the writer in the light of the discovery of *semusta* sp. n., but no further specimens were found. The examined *scutellaris* originate from the following countries and islands: England (Scilly Isles), France, Spain, Canary Islands (Gomera, Gran Canaria, Lanzarote, Palma, Tenerife), the Madeiras (Madeira, Porto Santo), Morocco, Algeria, Tunisia, Sardinia, Corsica, Gibraltar, Malta, Greece, Crete, Elba, and Syria. It will be seen from this that with the exception of the Syrian record (based on a male), *scutellaris* is primarily an Atlantic and west Mediterranean species.

Ephistemus exiguus Erichson

Epistemus exiguus Erichson (1846, p. 403), Reitter (1887, Best.-Tab. 16, p. 55).

Jordan: East Jordan, Amman, 800 m, 25.3.1958, 1 ♀; Jordantal, Jericho, 200 m u.M., 31.3.1959, 1 ♀.

ACKNOWLEDGEMENTS

For the loan of material, the writer is indebted to the following colleagues: Dr. Z. Kaszab, Hungarian National Museum, Budapest; Dr. J. Jelínek, National Museum of Natural History, Prague; and Mme A. Bons, Muséum National d'Histoire Naturelle, Paris.

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Extremely Low Supercooling Point in Eggs of *Zeiraphera diniana* (Guénée) (Lepidoptera: Tortricidae)

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Bakke, A. 1969. Extremely low supercooling point in eggs of *Zeiraphera diniana* (Guénée) (Lepidoptera: Tortricidae). *Norsk ent. Tidsskr. 16,* 81-83. Outbreaks of *Zeiraphera diniana* are reported from areas with some of the lowest minimum winter temperatures recorded in South Norway. The eggs which overwinter on the upper branches of pine trees are directly exposed to these low temperatures. The average supercooling point in eggs collected in November was –46.5° C and in February –51.3° C. These extremely low supercooling points indicate how the species can survive the winter.

In summer 1968 outbreaks of *Zeiraphera diniana* (Guénée) were reported on Scots Pine *(Pinus sylvestris L.)* from several areas in the northern mountain region of South Norway. The most severe attacks occurred at Dombås in the northern part of Gudbrandsdalen and Os at Tolga in the northern part of Österdalen, and in areas around Lake Femunden. Only forests at an altitude from 500-600 m to the timber line at 900 m were attacked.

In these areas some of the lowest winter temperatures in South Norway are recorded. At the Norwegian Meteorological Institute's weather stations, situated in the areas Röros, Tynset and Dombås, minimum temperatures between –35°C and –40°C and even lower, are common in winter (Bruun 1967).

The eggs of *Zeiraphera diniana* overwinter beneath bark scales on the upper branches of the pine, directly exposed to the air temperature. It is therefore of great interest to study their cold-hardiness.

Only a few insects are able to survive freezing (Salt 1961) and in most species the avoidance of freezing by supercooling is of vital importance. According to Asahina (1966) no freezing-tolerant insect eggs are known so far. Thus the ability to supercool determines their lowest temperature survival limit.

MATERIAL AND METHODS

Branches of pine with eggs were collected from the upper part of the trees in October 1968 at Tolga and in January 1969 at Dombås. They were stored under outdoor conditions at Ås until the days when the freezing experiments took place. Eggs collected in October were tested in November and those collected in January were tested in February.

The measuring of supercooling points was carried out according to the method described by Robinson (1928) and further developed and used by many others (Green 1962, Sömme 1964). The eggs were placed in a test tube, close to a thermocouple made of 40-gauge copper-constatan wire, and kept in a fixed position by vaseline. The thermocouple was connected to a continuously recording potentiometer, and the tube placed inside two larger tubes of various sizes. The tubes with eggs and thermocouple were put into isopropanol cooled to about —60°C by dry ice. The cooling rate was 2—3°C per minute. Determinations of average supercooling points were based on 20 eggs.

RESULTS

The average supercooling point of eggs tested in November was —46.5°C ± 0.7° and in February —51.3°C ± 0.8°. The last figures give twice the standard error of the mean. There is a significant difference between the results obtained in November and in February. This indicates that an acclimatization to low temperature took place in the eggs during the winter period, increasing their degree of cold-hardiness.

The eggs collected on the branches had a different colour. Some were light brown, others were dark violet. Only the light brown coloured eggs are included in this material. The supercooling points of 6 dark violet eggs varied from —26°C to —28°C. They were probably dead or disturbed in one way or another.

DISCUSSION

The supercooling points found in eggs of *Zeiraphera diniana* are extremely low. In Canada, Sömme (1964) found the average supercooling point to be —44.6°C in eggs of the geometrid *Alsophila pometana* (Harris) and —41.9°C in eggs of the aphid *Pterocomma smithia* (Monell). In larvae of the gall midge *Thabdophaga globora* Felt., it was found to be —49.1°C and in larvae of the chalcid *Eurytoma giganteea* Walsh., —49.2°C. Eggs of the European red mite *Panonychus ulmi* (Koch) from cold areas in Canada supercooled to —37°C (MacPhee 1961) and in Norway to —33°C (Sömme 1965b). In the literature no information could be found as to insects having an average supercooling point below —50°C.

A depression of the supercooling point during the winter period has been described for many insects. The degree of depression found in *Zeiraphera diniana* seems to correspond to results obtained in other insects. Green (1952) found a depression of about 6°C in larvae of *Rhyacionia buoliana* (Schiff.) in Canada from November to March, and Sömme (1965a) found about the same degree of depression in overwintering larvae of *Laspeyresia strobilella* (L.) and *Hyponomeuta evonymellus* (L.) and in eggs of *Acrolita naevana* (Hb.) from October-November to January-February.

The eggs were not taken care of for further studies after the freezing treatment was finished. Studies in Switzerland (Bassand 1965) have shown that an embryonic diapause in the eggs suppresses development for several months, so the present study does not clarify whether the eggs are freezing-susceptible or not. However, so far as is known (Asahina 1966), freezing-resistance has only been found in larval and pupal stages of insects. There is, therefore, reason to conclude that the extremely low supercooling point in eggs of *Zeiraphera diniana* indicates how this species can survive the conditions it encounters in Norway.

ACKNOWLEDGEMENTS

I am grateful to Dr. Lauritz Sömme for critical examination of the manuscript and to Mr. Torfinn Sæther for technical assistance.

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Sisyra dalii McLachlan (Neuroptera, Planipennia) i Norge

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Solem, J. O. 1969. *Sisyra dalii* McLachlan (Neuroptera, Planipennia) i Norge. *Norsk ent. Tidsskr. 16,* 85-86.

Sisyra dalii McLachlan is reported found at Berby, Halden, Östfold county. One male was collected on 8 August 1968 by sweeping the deciduous vegetation along a stream. *S. dalii* has only been found once before in Norway.

I et materiale av nettvinger fra sommeren 1968, ble ett eksemplar, en hann, bestemt til *Sisyra dalii* McLachlan. Eksemplaret ble tatt den 8. august 1968 ved håving av vegetasjonen langs et stille parti av Berbyelva ved Berby, Halden, Østfold. Solem (1969) har gitt en beskrivelse av vegetasjonen langs og i elva, og i tillegg kan nevnes at akkurat ved det stille partiet i elva der *S. dalii* ble fanget er det et sterkt innslag av varmekjære løvtrær langs breddene.

I Norge er *S. dalii* fra før bare kjent fra Ryfylke (Tjeder 1946), der en hann ble funnet i Skjeveland av F. Jensen den 29. juni 1936. Ifølge Tjeder (1938, 1940, 1953) er det også i Sverige gjort få funn av arten, og alle lokalitetene ligger i Sør-Sverige (Halland, Småland og Blekinge). Funnene i Sverige er gjort i juni og juli. Imagines av *S. dalii* er i Danmark fanget i slutten av juli (Esben-Petersen 1929). Fra Finland rapporterer Meinander (1962) at *S. dalii* ennå ikke er påvist der. *S. dalii* som er utbredt over hele Europa regnes for å være sjelden. Den blir ikke funnet ofte og som oftest er det bare enkelte individer som blir tatt ved innsamlinger (Zeleny 1962), men Tjeder (1953) oppgir at mange individer ble samlet ved Rødeby, Lyckebyån, Blekinge 8. juli 1949.

De fleste neuropterene er terrestriske former, men familiene Osmylidae og Sisyridae har aquatiske larver (Illies 1967). *S. dalii* er derfor en av de få neuropter-artene her i landet hvis larver lever i ferskvann. Ifølge Killington (1936) lever larvene som parasitter på ferskvannssvamp og forpuppingen foregår på land.

S. dalii skiller seg fra den mere vanlige *S. fuscata* ved at den er lysere brun og ved at tverr-ribbene og marginalforkenes basis i forvingene er mørkebrune og sterkt iøynefallende.

Disse mørke partiene gjør at forvingene til *S. dalii* virker flekkete, mens *S. fuscata* har jevnt mørkebrune forvinger.

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Mottatt 18. mars 1969

Distribution of *Rhyacionia buoliana* (Denis & Schiffermüller) and *R. pinicolana* (Doubledoy) (Lep. Tortricidae) in the Nordic Countries

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Bakke, A. 1969. Distribution of *Rhyacionia buoliana* (Denis & Schiffermüller) and *R. pinicolana* (Doubledoy) (Lep., Tortricidae) in the Nordic countries. *Norsk ent. Tidsskr. 16,* 87-89.

Materials in museums and other collections indicate that *Rhyacionia buoliana* has a limited range towards the north in Nordic countries. Only in the southwestern parts of Finland is it found north of 60° N lat. The range of *R. pinicolana* is approximately the same, but in Finland it is recorded up to 63° N lat.

Rhyacionia buoliana has played an important role as a pest of pine in Europe (Schröder 1966, p. 384). In 1914 the species was first reported in North America and has become a serious pest of pine plantation in the northeastern United States and southeastern Canada (Pointing and Miller 1967). The larvae live on several species of pine and when they feed within the terminal buds and shoots, they may cause serious injury to the main stem.

Examination of the Norwegian materials in museum collections (Bakke 1958), showed the species in several cases to be confused with the related species, *Rhyacionia pinicolana.* In 1958 specimens of *R. buoliana* from only four localities in Norway were available.

In connection with the cooperation between forest entomologists in Denmark, Finland, Norway and Sweden, I was assigned to study the materials of both species in museums and other collections in the Nordic countries and describe the distributions in these countries. Meanwhile Schröder (1966) has delineated their distribution in Europe including the Nordic countries.

MATERIALS

Information on records was obtained from the following collections:

Denmark Zoological Museum, University of Copenhagen. Royal Veterinary and Agricultural College, Copenhagen. Collections of several Danish lepidopterologists.

Finland Institute for Agricultural and Forest Zoology, University of Helsinki. Zoological Museum, University of Helsinki.

Norway Zoological Museum, University of Oslo. Zoological Museum, University of Ber-

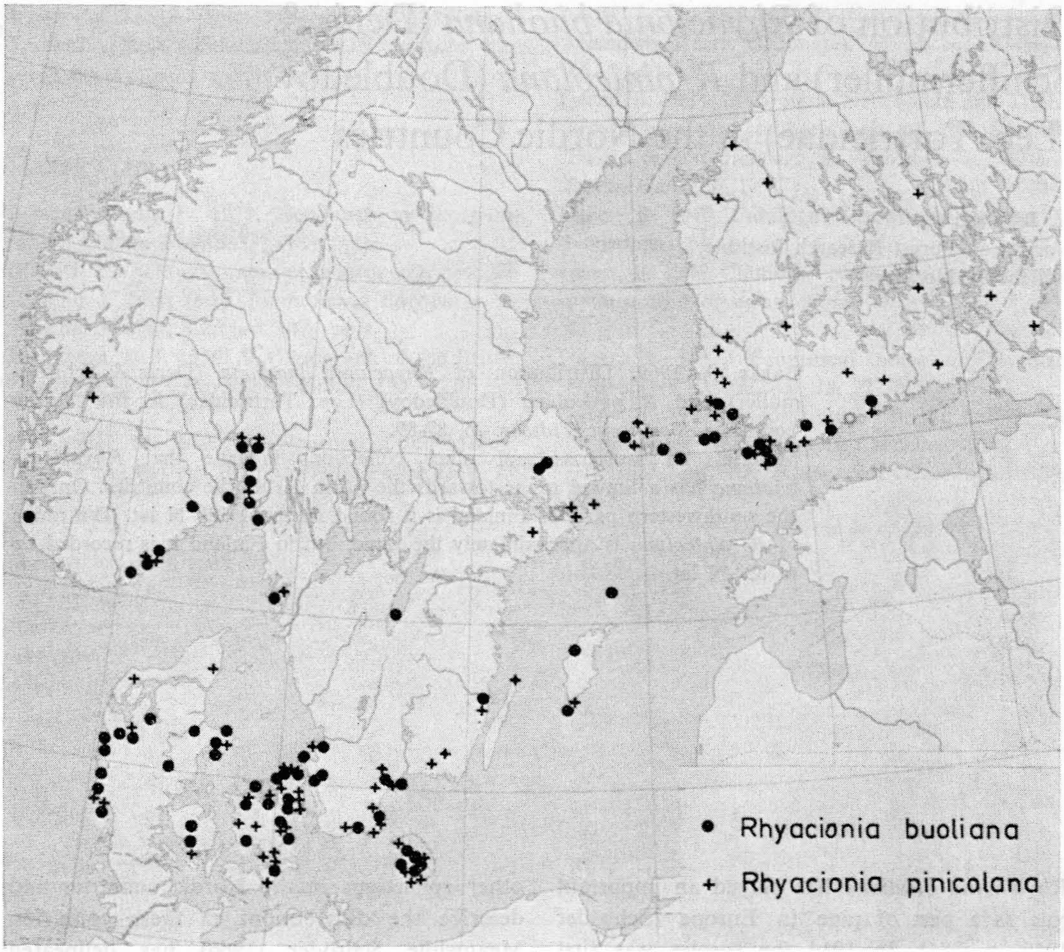

Fig. 1. Records of *Rhyacionia buoliana* and *R. pinicolana* in the Nordic countries.

gen. Norwegian Forest Research Institute, Vollebekk.

Sweden Museum of Natural History, Stockholm. Zoological Institute, University of Lund. Department of Forest Entomology, Royal College of Forestry, Stockholm.

All specimens from Norwegian collections and from Zool. Mus., Univ. of Helsinki, have been examined by the author. From the other collections only a list of records has been sent to me with the information that the specimens have been identified recently by well qualified taxonomists.

RESULTS

Rhyacionia buoliana has a limited distribution towards the north (Fig. 1). In Norway it only occurs along the south coast from the county of Rogaland and around the Oslofjord. In Sweden it is found in southern areas where heavy damage has been done (Butovitsch 1936). There are no records north of 60° N latitude. The distribution in Finland is limited to the coastal districts in the southwest. In Denmark it is recorded all over the country.

Rhyacionia pinicolana. The records from

Norway and Sweden indicate that the range of *R. pinicolana* is approximately the same as that of *R. buoliana* (Fig. 1). The Finnish records indicate a distinct difference in range. *R. pinicolana* is found up to 63°N lat., in coastal districts even further north. In Denmark it is recorded all over the country.

DISCUSSION

The records show that *R. buoliana* is found only in southern parts of the Nordic countries. As a forest pest the species is, therefore, of limited geographical importance to Norway and Finland. The southern parts of Sweden and Denmark are, however, within its range. In these areas it must be considered a dangerous forest insect.

Very few observations have been made on the exology of *R. pinicolana* and its significance as a forest insect is hardly known.

In Canada investigations have been carried out to study factors which may influence the northern range of *R. buoliana*. The half-grown larvae overwinter in buds and are exposed to sub-zero winter temperatures. Green (1962) studied the cold-hardiness of the hibernating larvae, using a supercooling-point technique. He found that larvae in buds above the snow cover, regardless of acclimation level, cannot tolerate temperatures below –30°C. In Ontario, Canada, the northern limit of its continuous distribution coincides closely with the –29°C minimum winter isotherm (Pointing & Miller 1967). Corresponding isotherms are not available for the Nordic countries, but records of minimum winter temperatures (Bruun 1967) within and north of the range of *R. buoliana* in Norway indicate a good correspondance with the Canadian observations.

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Fecundity, Aphid Consumption and Survival of the Aphid Predator *Adalia bipunctata* L. (Col., Coccinellidae)

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Ellingsen, Inger-Johanne, 1960. Fecundity, Aphid Consumption and Survival of the Aphid Predator *Adalia bipunctata* L. (Col., Coccinellidae). *Norsk ent. Tidsskr. 16,* 91-95.

In the laboratory, *Adalia bipunctata* had a rate of increase of 335 imagines per female. At 18°C, the life cycle was completed in 36.6 days; the oviposition period was 3 months. Aphid consumption per larva (measured at 18°C, feeding ad libitum) during the larval period was 188; during 3 months an egglaying pair consumed 3096 aphids. Survival was greatly influenced by temperature. Starved larvae lived almost twice as long when they could cannibalize an egg compared to those fed on water only. Honey slightly prolonged larval survival, whereas imagines had almost normal longevity when offered honey.

In Norway, three aphid predators, *Coccinella septempunctata* L., (Col., Coccinellidae), *Chrysopa carnea* Stephens (Neur., Chrysopidae), and *Syrphus ribesii* L., (Dipt., Syrphidae) have been studied by Sundby (1966, 1967, 1968). The present experiments concern a fourth common aphid predator, *Adalia bipunctata* L. (Col., Coccinellidae) that has not previously been studied in Norway.

Among the attributes of an effective natural enemy (Doutt & DeBach 1964), I have studied in the laboratory (i) rate of increase (including fecundity and developmental period); (ii) theoretical number of aphids consumed by larvae and imagines during one summer; (iii) ability to survive unfavourable periods (i.e. duration of survival without aphid food).

MATERIAL AND METHODS

All material was collected as overwintered imagines at the end of May 1967 and 1968 at Vollebekk, Ås, southern Norway.

Oviposition experiments were carried out in small glass jars covered with cloth gauze. There was one male and one female in each jar. Eggs were isolated, and soon after hatching the larvae for feeding and survival experiments were placed separately in petri-dishes to prevent cannibalism. To secure sufficient humidity, the bottoms of glass jars and petri-dishes were covered with filter papers that were moistened once a day. The peach aphid *Myzus persicae* (Sulzer) was used as prey both for larvae and imagines. The number of aphids

Table I. Characteristics of reproduction of *A. bipunctata*

(a) Data from 12 pairs kept at about 22 °C

	mean ± S. E.
Fecundity (number of eggs per female)	1466 ± 124
Egg development (in days)	3.39 ± 0.01
Number of larvae per female	456 ± 44
Hatching per cent	31.7 ± 6.2
Oviposition period (in days)	89 ± 8.8
Longevity (in days) of males	72 ± 2.6
Longevity (in days) of females	135 ± 3.2

(b) Data from 8 pairs kept at 18 °C of 8–28 °C. Observation period 87 days

Egg-batches per female	mean	43.5
	range	14–82
Number of eggs per batch	mean	15.4
	range	2–43
Infertile eggs		37.0%
Fertile eggs cannibalized		3.4%
Fertile eggs unhatched		7.1%

consumed was checked and a new supply given at the same time every day. Imagines also received honey on the moistened cloth. The aphids were reared in the laboratory on swedes (*Brassica napus napobrassica* (L). Rchb.). Experiments were carried out at room temperature (about 22°C) and in incubators with constant or varying temperature conditions (Ellingsen 1969).

RESULTS AND DISCUSSION

Rate of increase

Twelve egglaying pairs were kept for observation from time of collection until they died. Data on oviposition and longevity are summarized in Table Ia. It is shown that *A. bipunctata* has a high fecundity and a long oviposition period. The values resemble those of El Hariri (1966), but lie above earlier records cited by El Hariri (1966). The total proportion of hatched eggs was low, 31.7 per

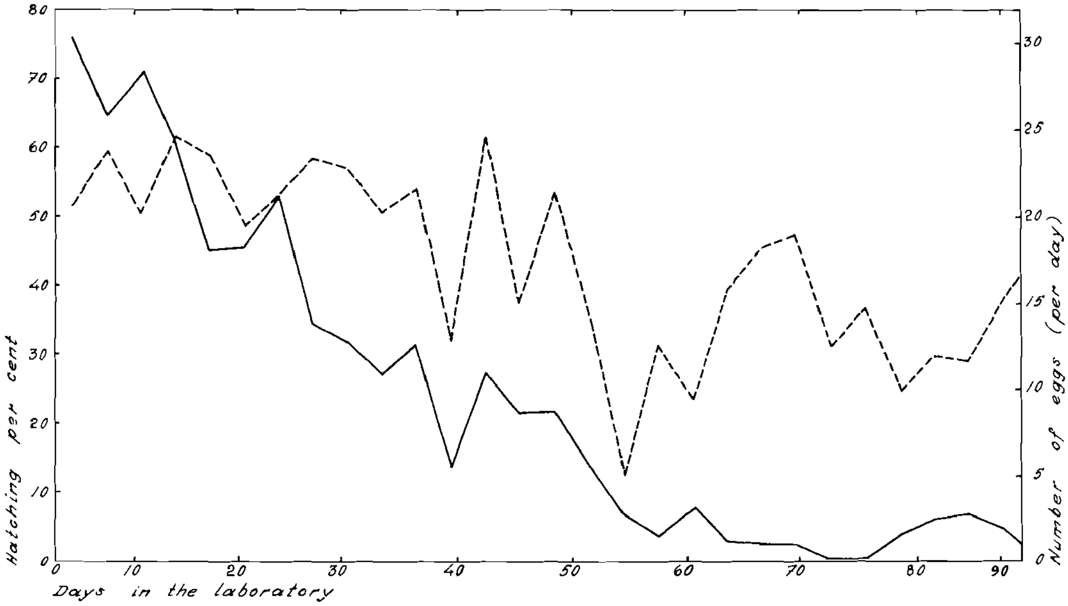

Fig. 1. Changes in hatching per cent and egg-production during 90 days (30th May-30th August) of *A. bipunctata* at room temperature 22°C. --- the daily oviposition is calculated as a mean of 12 females in three-day periods, four days where a sunday comes in between. —— the hatching per cent is calculated as a mean in the same periods.

cent. Changes in hatching during the first 90 days, together with daily oviposition, are shown in Fig. 1. The decline in fertility seems to coincide with the aging and death of males. Hodek (1967), however, states that for most cocconellid species, one copulation is enough to give the female permanent fertility. In the present study copulations were observed quite frequently, and El Hariri (1966) found that in a twice-daily inspection during the whole experiment lasting for 130 days, males were seen to mate 3 to 22 times each (average 9-12 times each).

In order to examine more closely the eggs from which no larvae were obtained, new oviposition experiments were carried out with 8 pairs collected outdoors. Four pairs were kept at 18°C and four pairs at 8°-28°. Since no differences in results were obtained, the data from both temperature conditions are put together in Table Ib. The proportions of infertile eggs, and fertile eggs cannibalized or unhatched are given. The number of fertile cannibalized eggs (recognized by a black residue of the larval skin) depends on how long the batches go without removal of hatched active larvae; my experiments were inspected once daily. Number of egg-batches and number of eggs per batch were also studied (Table Ib). The cannibalistic behaviour of newly hatched larvae is shown in Fig. 2. The egg-batch was 6 days old, and infertile and fertile eggs can be distinguished as the latter appear grey. The last oviposition series had a higher proportion of hatched eggs, 52.5 per cent, than the series reported in Table Ia. At the beginning of the oviposition period the hatching per cent is high (Fig. 1), therefore Jöhnssen (1930) could report 94.6 per cent (395-674 eggs observed) and Banks (1956) 83.4 per cent (of 186 eggs). Infertile eggs increase in numbers towards the end of the period. In the present study, 37.0 per cent infertile eggs were found. Banks (1956) found only 4.8 per cent, and 12.4 per cent were cannibalized by earlier hatched larvae.

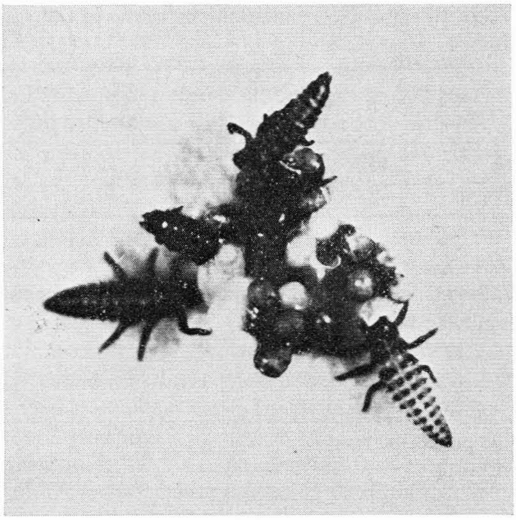

Fig. 2. A six days-old egg-batch of *A. bipunctata* cannibalized by newly hatched larvae.

Mortality during larval and pupal stages is presented in Table II. First larval instar and pupae were most vulnerable.

Rate of increase of *A. bipunctata* during one summer in the present laboratory experiments was 335 imagines per female (i.e. 456 larvae per female with 28.6 per cent mortality in larval and pupal stages, assuming that there is only one generation a year at our latitude). At 18°C the life cycle was completed in 36.6 days. Imagines reared in the laboratory had

Table II. Mortality in larval and pupal stages of *A. bipunctata*. Based on 197 newly emerged larvae

	1st larval	2nd larval	3rd larval	4th larval	pupal
Number dying in stage	37	7	12	6	20
Mortality rate per cent of those alive at beginning of stage	18.8	4.9	7.9	4.3	14.7

Table III. Aphid consumption per larvae in the various larval stages of *A. bipunctata*. Food supply was ad libitum

Temp.	N	1st instar mean ± S. E.	2nd instar mean ± S. E.	3rd instar mean ± S. E.	4th instar mean ± S. E.	total mean ± S. E.
18°	40	12 ± 0.7	19 ± 1.1	42 ± 4.2	118 ± 9.7	188 ± 13.7
28°	29	13 ± 1.0	20 ± 1.2	38 ± 3.3	97 ± 2.4	168 ± 14.1

Table IV. Aphid consumption per egg-producing pair or male of *A. bipunctata* kept at 18° and 8–28°. Food supply ad libitum

	N	per day mean	range	total in 90 days
Egg-producing pair	8	34.4	30.8–39.4	3096
Male	6	12.7	11.2–22.2	1143

a preoviposition period of 8.0 days; and, as reported by Ellingsen (1969), egg-, larval-, and pupal development are completed in 28.6 days.

The question about number of generations during the summer is not clear. I have found pupae late in September, but this can be explained by the long oviposition period of the overwintered generation. Jöhnssen (1930) reports two generations at Cologne in especially hot summers. In the present study four generations were reared during the winter at 18° and 18 hours light per day, and no symptoms of diapause were observed. Mortality in all stages increased with each generation.

Aphid consumption

Both larvae and imagines of *A. bipunctata* are aphid predators. Data on the number of aphids that were eaten are summarized in Tables III and IV. Larvae consumed the greatest number at the lower temperatures because the greedy 4th larval stage lasted longer (also reported by Jöhnssen 1930). This tendency may also be responsible for differing pupal weights that were 144 ± 51 mg at 15°C and 128 ± 8.8 mg at 28°C. Daily voracity increased with temperature. The egg-producing female consumed more aphids than the male, as the consumption of egg-laying pairs is more than twice that of the male (Table IV).

The number of aphids consumed during one summer (one generation a year) is, according to my experiments, 188 aphids per larva, and 3096 per egg-producing pair.

Survival without aphid food

Survival of newly hatched larvae and imagines kept without aphids is shown in Table V. Ability to survive was greatly influenced by temperature; the great difference between 6°C and 18°C indicates that periods of cool temperatures may prolong survival of larvae. Consumption of one egg almost doubled the survival period, compared to the survival of larvae fed only on water (the egg was in some

Table V. Survival (in days) of *A. bipunctata*
(a) Newly emerged larvae

Temp.	food offered	N	mean ± S. E.
6°	water only	30	13.9 ± 0.5
18°	water only	53	2.9 ± 0.1
18°	water ± honey	56	3.7 ± 0.1
18°	water + 1 egg	53	4.8 ± 0.1

(b) Newly emerged imagines. Experiments at 8–28°

food offered	N	mean ± S. E.
water only	42	6.04 ± 0.01
water + honey	16	54.6 ± 12.8

cases from the coccinellid *Propylea quattuordecimpunctata* (L.), which has eggs of the same size as *A. bipunctata).* Cannibalism of the egg-batches was very common; its biological value seems clear, as the prolonged survival gives the larvae more time to search for prey. Cannibalism does not have the same value for imagines, because their flying ability gives them a much greater range. Honey slightly prolonged survival of larvae. Imagines given honey lived almost as long as those fed on aphids, but no eggs were produced. According to Hagen (1962) extra floral nectary secretions are commonly fed upon by many coccinellds. These types of food offer energy sources, but are probably nutritionally deficient for egg production.

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Surveys of Parasites of *Hylemya brassicae* (Bouché), and *H. floralis* (Fallén) (Diptera, Muscidae) in Norway

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Sundby, R. A. & Taksdal, G. 1969. Surveys of parasites of *Hylemya brassicae* (Bouché) and *H. floralis* (Fallén) (Diptera, Muscidae) in Norway. *Norsk ent. Tidsskr. 16,* 97-106.

The parasitation of 18924 puparia of *Hylemya floralis* (Fallén) and *H. brassicae* (Bouché) collected in 130 samples between 1963 and 1966 was investigated. *H. floralis* was the dominating *Hylemya* species. Wide variation in parasitation frequencies occurred. *Cothonaspis rapae* (Westw.) comprised 81.6 and 81.3 % of the parasitation of *H. floralis* and *H. brassicae* respectively, while *Aleochara bilineata* Gyll. made up 11.9 and 12.6 %, and *Phygadeuon trichops* Thoms. 6.5 and 6.1 %. *H. brassicae* was generally more parasitised than *H. floralis,* the difference being statistically significant in 1964. In the laboratory the peak emergence of *C. rapae* always occurred before that of *H. floralis.* Parasitation decreased with increasing northern latitude. Insecticide applications against *H. floralis* and *H. brassicae* generally suppressed parasitation, lindane applications less so than other compounds. Suppression of parasitation was not evident after sprayings against leaf pests or after seed dressing with lindane against flea beetles.

The two main species of *Hylemya* on cruciferous crops in Norway are *H. brassicae* (Bouché) and *H. floralis* (Fallén). A number of crops are attacked by these species, and several studies concerning their biology and chemical control have been carried out (e.g. Lein 1955, Rygg 1962, Taksdal 1963).

As part of a biological control program in Canada, a survey of parasites of *Hylemya* spp. in Europe was carried out, and several species of parasites were recorded from Norway as well as from other countries (Wishart et al. 1957). More information about the distribution and frequency of the parasites was required, however, to evaluate the possibility of biological control, and the influence of the parasites in the natural control of the brassica root flies. Part of the work was carried out as a cooperative investigation in Scandinavia. This publication covers the Norwegian material.

MATERIAL AND METHODS

The collection of the material was organised by the Norwegian Plant Protection Institute, Division of Entomology. Instructions for collecting pupae and inquiry forms for each sample were distributed to the agricultural and horticultural advisory service, schools, and research stations. Most samples were collected by staff members in these institutions. The collectors furnished information on location, date of collecting, kind of crop, use of insecticides during the growing season, severity of the root fly attacks, soil type, altitude etc. The pupae were collected in the autumn (from September to December) when pupation was completed. The samples do not only represent, therefore, the early pupating specimens at each locality.

On arrival at the laboratory of the Zoological Institute, the species were separated simultaneously with the counting of the parasitised puparia. Each sample was placed in a petri dish kept at 21° ± 1 C. The humidity varied with an average of 50 per cent RH. The emerged hosts and parasites were removed and recorded each day. Once a month the total material was examined to observe the development of the parasites. After emergence, the remaining puparia were dissected and examined. The frequencies of parasitation were estimated on the basis of numbers of emerged specimens of parasites and hosts with the addition of numbers of puparia where condition of parasitation could be identified with certainty by dissection. Pupae which died of unknown causes were not included in the estimates.

The investigation was carried out from 1963 to 1966. The material consisted of 4976 pupae in 1963, 5748 pupae in 1964, 5739 pupae in 1965, and 2461 pupae in 1966.

FREQUENCIES OF *H. BRASSICAE* AND *H. FLORALIS*

H. floralis is generally the most abundant and destructive brassica root fly species in Norway, especially in swedes (Rygg 1962). The relative abundance of the two species may vary, however, from year to year in the different districts (Lein 1955). This was also the case during the present investigation. In 1963 *H. floralis* was highly dominating, and the investigation was restricted to this species in 1963.

The percentage of *H. floralis* in the different parts of the country is seen in Table I. The percentage of *H. floralis* of the total material was 52 in 1964, 97 in 1965, and 80 in 1966. Even when great variation was found between the different years, the average for the three years was about the same for the various parts of the country.

Wishart et al. (1957) reported that samples collected early in the season consisted almost entirely of *H. brassicae*, while late collections consisted of *H. floralis*. This is not surprising since *H. brassicae* pupates early and has a partial second generation as far north as 63.5° (Rygg 1962), while *H. floralis* is monovoltine and pupates later. In the present investigation all samples were collected from 10 September to 10 December. Time of collecting has probably not, therefore, biased the results in favour of any of the species. Even if other factors, e.g. kind of crop and soil type, may have an influence on the result, the variation in Table I is believed to be mainly due to a real variation in the relative abundance of the two species. This is also in agreement with observations in Finland, where the percentage of *H. floralis* over a number of years varied from 53 to 85 (Kanervo 1954).

Table I. Per cent *H. floralis* of *Hylemya* puparia from different parts of Norway in 1964, 1965, and 1966.

	1964	1965	1966	Average
Östlandet (South-east)	45.8	97.6	85.2	76.2
Sörlandet (South)	65.1	63.7	87.1	72.0
Vestlandet (West)	60.2	97.5	79.5	79.1
Tröndelag (Middle)	37.4	100	89.7	75.7
Nord-Norge (North)	60.4	98.5	69.7	76.2
Average	52.0	97.0	80.0	

In addition to the two species mentioned, a few *H. platura* (Meig.) were found in the material.

FREQUENCIES OF PARASITES

The numbers of puparia and emerged parasites from the two host species at the different localities are seen in Table II. The per cent parasitation refers to the pupae, while the numbers of parasites comprise the emerged specimens. The parasitation frequency varied, both from place to place, and from year to year. The lowest frequencies of the parasites seemed to appear either when a large proportion of the puparia were collected from fields where insecticides had been heavily applied, as for *H. floralis* in 1964, or when much of the

Table II. Per cent parasitation and numbers of parasites reared from puparia of *H. floralis* and *H. brassicae* from different counties 1963 – 1966

	1963					1964									
	H. floralis					*H. floralis*					*H. brassicae*				
County	Number of Puparia	Parasitation %	*Cothonaspis rapae*	*Aleochara bilineata*	*Phygadeuon trichops*	Number of Puparia	Parasitation %	*Cothonaspis rapae*	*Aleochara bilineata*	*Phygadeuon trichops*	Number of Puparia	Parasitation %	*Cothonaspis rapae*	*Aleochara bilineata*	*Phygadeuon trichops*
Östfold						360	16.1	4			471	18.8	8		
Akershus						39	5.1	2	1		37	2.7	1		
Hedmark						233	42.2	12	4	14	210	30.2	47	2	1
Oppland	897	41.1	302	6	3	242	8.0	13	1		275	34.2	78	17	12
Buskerud															
Vestfold						173	9.2	2	3		269	4.5	8		
Telemark						16	12.5				29	44.8	13		
Aust-Agder	675	47.3	103	64	22	362	28.9	31	5	1	193	25.8	11	8	2
Rogaland	619	23.2	80	41	4	311	4.4	1			147	19.3	5		
Sogn og Fjordane	141	10.8	13		1	27	29.6			2	62	35.4	15		
N. Tröndelag	855	20.6	107	14	12	249	11.1	13			416	8.1	23	1	
Nordland	572	2.2		2	12	626	4.1			2	82	1.7		2	
Troms	235	1.3		3		337	9.1	20	5	1	582	9.4	21		1
Finnmark	92	1.1			1										
Total	4 086	25.4	605	130	55	2 975	13.6	98	19	20	2 773	20.6	230	30	16

Continued

Table II. Continued

	1965										1966									
	H. floralis					*H. brassicae*					*H. floralis*					*H. brassicae*				
County	Number of Puparia	Parasitation %	*Cothonaspis rapae*	*Aleochara bilineata*	*Phygadeuon trichops*	Number of Puparia	Parasitation %	*Cothonaspis rapae*	*Aleochara bilineata*	*Phygadeuon trichpos*	Number of Puparia	Parasitation %	*Cothonaspis rapae*	*Aleochara bilineata*	*Phygadeuon trichops*	Number of Puparia	Parasitation %	*Cothonaspis rapae*	*Aleochara bilineata*	*Phygadeuon trichops*
Östfold	2466	11.3	102	15		40	33.3													
Akershus	161	6.8	7			6	33.3													
Hedmark	264	33.0	32	1	4	2	50.0	1			526	17.5	52	2	3	105	13.8	7		1
Oppland	356	26.1	61	9	6	22	12.5	1		2	127	16.5	21			7	0.0			
Buskerud	412	26.2	52	1	1	11	0.0													
Vestfold																				
Telemark	285	8.3	5	2		17	0.0													
Aust-Agder	79	22.1	3			45	44.4	2			97	23.7	20			12	0.0			
Rogaland																				
Sogn og Fjordane	262	14.1	6			9	0.0				52	15.9	3			15	0.0			
N. Tröndelag	481	21.9	81	1	7	3	0.0				478	25.1	82		1	55	33.8	11	9	
Nordland	450	16.0	9			8	16.7				373	7.7	9	3		29	24.4			
Troms	295	0.0				3	0.0				293	9.5	8		3	261	0.0			
Finnmark																				
Total	5511	16.0	358	29	18	166	24.1	4		2	1946	16.5	195	5	7	484	8.3	18	9	1

Table III. The total number of the three main parasites having emerged from *H. floralis* and *H. brassicae* 1963–66

County	*H. floralis*			*H. brassicae*		
	Cothonaspis	*Aleochara*	*Phygadeuon*	*Cothonaspis*	*Aleochara*	*Phygadeuon*
Östfold	106	15	0	8	0	0
Akershus	9	1	0	1	0	0
Hedmark	96	7	21	55	2	2
Oppland	397	16	9	79	17	14
Buskerud	52	1	1	0	0	0
Vestfold	2	3	0	8	0	0
Telemark	5	2	0	13	0	0
Aust-Agder	157	69	23	13	8	2
Rogaland	81	41	4	5	0	0
Sogn og Fjordane	22	0	3	15	0	0
N. Tröndelag	283	15	20	34	10	0
Nordland	18	5	14	0	2	0
Troms	28	8	4	21	0	1
Finnmark	0	0	1	0	0	0
Total	1256	183	100	252	39	19
	(81.6 %)	(11.9 %)	(6.5 %)	(81.3 %)	(12.6 %)	(6.1 %

material was collected in Northern Norway, as for both species in 1966.

Close agreement appeared in percentages of different parasites emerging from the two host species (Table III). *Cothonaspis rapae* (Westw.) (Hym., Cynipidae) was the most numerous parasite comprising 81.6, and 81.3 per cent of the parasitation of *H. floralis* and *H. brassicae* respectively. In the same order *Aleochara bilineata* Gyll. (Col., Staphylinidae) made up 11.9 and 12.6 per cent, and *Phygadeuon trichops* Thoms. (Hym., Ichneumonidae) 6.5, and 6.1 per cent of the total numbers of emerged parasites.

Only these three species were found to be major parasites. A few other species were recorded, but were not found to be of any importance and are not mentioned in the Tables. The recorded species are the same as found in Norway earlier (Wishart et al. 1957).

PARASITATION AND HOST SPECIES

In the majority of localities where both species were found, *H. brassicae* was more parasitised than *H. floralis*. But only in 1964 the two host species occurred in comparable frequencies from a number of localities which allowed a statistical treatment of the data. In 16 localities where no insecticides against the root flies were applied, the average per cent parasitation of *H. brassicae* was 23.5 (range 2.8-72.4 per cent), and of *H. floralis* 11.0 (range 0.0-25.9 per cent). Tested by Student's t-test, the difference was significant at the 5 per cent level.

Cothonaspis rapae attacks the early larval stages of *Hylemya* spp. and emerges from the puparia (Wishart & Monteith 1954). In the laboratory *C. rapae* may start to emerge as early as 9 weeks before the first specimen of *H. floralis*, but this period varied. The mass bulk of *C. rapae*, however, always emerged before the mass bulk of *H. floralis* (Fig. 1). This applies to the material set up in the laboratory soon after collection in the field. Parasitation by *C. rapae* was found in all counties except Finnmark, but the material included only one small sample (92 puparia) from this county.

Aleochara bilineata was not found in Sogn og Fjordane, western Norway, or Finnmark, but was present although scarce in localities in all

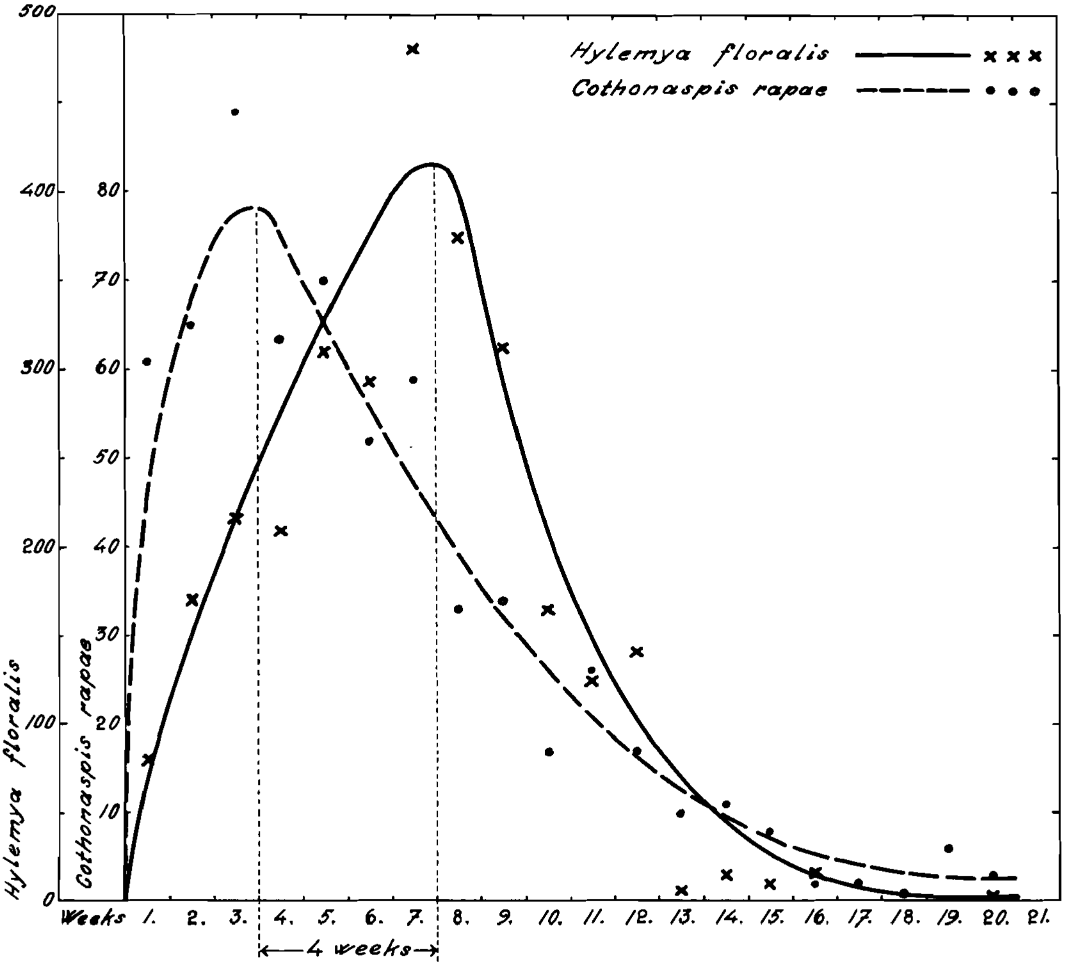

Fig. 1. The sequence of the emergence of *H. floralis* and *C. rapae* in the laboratory.

other investigated counties (Table II). *A. bilineata* places the eggs in the soil, and the larva gnaws an entrance hole into the puparium. According to Colhoun (1953) *A. bilineata* can attack the puparia during all the time they spend in the soil. Fewer beetles may be expected, therefore, in the early collected samples. The localities were situated from latitude 58 to 70. It is consequently difficult to compare the collecting dates for the total material, even for one separate year. Most of the collecting, however, was done rather late in the fall. The number of this species in the present material is lower than that found in 1950-54 (Wishart et al. 1957), but the locality used then is represented in the present material for only one year.

Phygadeuon trichops was present in small numbers only. Monteith (1956) indicates that it has other preferred hosts, and only occasionally attacks *Hylemya* spp. According to Monteith (1956), the egg is deposited on the pupa within the host puparium. It is not mentioned if older pupae are attacked or not, but it is likely that early collected samples have fewer wasps. *P. trichops* has previously been found in Norway, Switzerland and Scotland (Wishart et al. 1957). In the present investigation it was found in 10 out of 14 counties (Table II), but not from all localities in each of the 10 counties.

PARASITATION AND LATITUDE

The results revealed a tendency of decreasing parasitation with increasing latitudes. All samples (65) of *H. floralis* from fields not treated with insecticides against *Hylemya* spp. were used in an analysis of this relationship.

A number of factors other than insecticides may reduce parasitation. The 65 samples represent, therefore, widely variable parasitation frequencies within each degree of latitude. The potentiality of parasitation is illustrated by the maximum per cent parasitation observed at each latitude:

lat.	58	59	60	61	63	64	65	66	67	68	60	70
max. % par.	98	67	60	92	34	11	0	14	30	3	26	0

All 65 samples were included in a linear regression analysis. The coefficient of regression (—2.38) and coefficient of correlation (—0.357) between per cent parasitation and latitude were both statistically significant at the 1 per cent level. 13 per cent of the variation in the parasitation data were explained by the relationship with latitude given in the equation in Fig. 2.

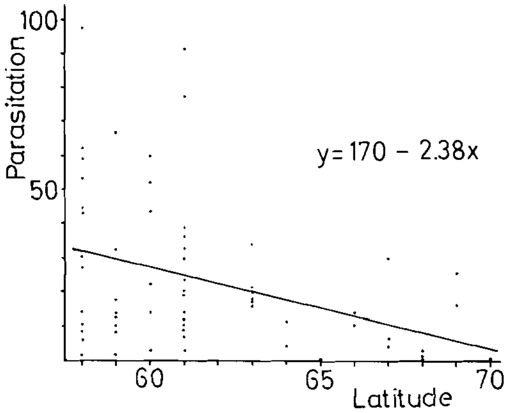

Fig. 2. The relationship between latitude and per cent parasitation of *H. floralis*.

PARASITATION AND CHEMICAL TREATMENT

As seen in Table IV, different insecticides were applied in fields included in the survey. The Table shows wide variation in the frequency of parasites. This cannot be attributed to the chemical treatments alone since parasitation may be influenced by the soil type, the kind of crop, by surrounding vegetation, the climate, and by possible chemical treatment in previous years. To obtain more reliable results on the effects of insecticides on parasitation, investigations should be carried out through several years

Table IV. Parasitation compared to different chemical treatments for the total material

	H. floralis		*H. brassicae*	
Treatment	Parasitation %	Number of pupae	Parasitation %	Number of pupae
Untreated	17.1	4150	11.4	721
aldrin, seed dressing	7.1	42	7.5	67
lindane, seed dressing	28.3	3116	26.2	590
aldrin	5.7	1261	7.7	379
chlordane	9.4	497	15.1	261
DDT	23.8	192	19.5	208
dieldrin	23.0	272	4.2	120
lindane	28.3	1355	14.1	273
diazinon	7.4	690	4.9	102
parathion	33.3	150	24.9	150
phorate	14.7	117	16.1	140
trichloronate	11.0	990	33.3	3

Table V. Parasitation of *Hylemya* sp. in swedes after different chemical treatments at 3 localities

Locality and treatment	Formulation	act. ingr. kg per hectare	Parasitation %	Numbers of puparia
Hå, 1963				
Untreated			30.4	66
aldrin	gran.	10.0	0.0	103
phorate	gran.	5.0	6.8	32
Rygge 1964				
Untreated			16.6	181
diazinon	gran.	5.0	4.5	157
lindane	em. conc.	1.0	27.3	201
phorate	gran.	5.0	19.3	114
trichloronate	gran.	5.0	15.3	111
Moss 1965				
Untreated			17.7	215
diazinon	gran.	5.0	6.5	214
diazinon	gran.	2.5	8.1	210
trichloronate	gran.	5.0	6.6	167
trichloronate	gran.	3.75	8.6	198
trichloronate	gran.	2.5	9.0	188

at the same localities. The data indicate, however, that some chemical treatments may be carried out with little or no reduction in the parasitation of the brassica root flies. Treatments against other pests besides *Hylemya* spp. probably have the least detrimental effect on parasitation, such as sprayings with e.g. parathion against lepidopterous pests on the leaves, or lindane seed dressings against flea beetles. In some cases dressings with higher dosages of lindane and soil drenching with lindane emulsions were followed by fairly high percentages of parasitation. Aldrin and chlordane, however, which were used in soil drenches apparently suppressed parasitation.

The effects of different insecticides on parasitation are more easily compared when several treatments are carried out in the same locality. In three cases *Hylemya* pupae were collected from field experiments. The results are given in Table V. In Hå 1963 and Moss 1965 all treatments reduced the parasitation compared with those untreated. In Moss decreasing dosages of diazinon and trichloronate were followed by increased parasitation. In Rygge 1964, however, only diazinon resulted in a clear reduction of the parasitation, while phorate and trichloronate showed little effect and lindane apparently increased the parasitation.

DISCUSSION

The parasitic species found on *H. floralis* and *H. brassicae* during the present investigation are the same as found in other studies. That *C. rapae* is the most important parasite is also in agreement with observations from England (Miles 1956) and Denmark (Jörgensen 1966), while *A. bilineata* was most numerous in Canada (Wishart 1957), and *C. rapae* and *A. bilineata* occurred in similar frequencies in the Netherlands (Wilkes & Wishart 1953). *C. rapae* is an endoparasite, whereas *A. bilineata* feeds externally on the pupae. Larvae of the two species may be found on the same host, and may compete with each other. According to Wishart & Monteith (1954), *Aleochara* sp. is always the survivor in this competition. In the localities examined, therefore, little if any competition between these two species seems to occur.

Since high parasitation of *H. floralis* by *C. rapae* occurs only where *H. brassicae* is present, Wishart et al. (1957) maintain that *C. rapae* needs *H. brassicae* as a host in the spring and that a second generation will appear at a time when they can attack large numbers of *H. floralis*. The result in the present investigation that *C. rapae* in the laboratory had the peak emergence before *H. floralis* may support this idea. Makarenko (1965) found, however, that *C. rapae* developing in *H. brassicae* had two generations a year, and those parasitising *H. floralis* had one, in both cases like its hosts. Under field conditions in the Leningrad area, the bulk of *C. rapae* emerged when the majority of the host populations were in the early larval instars regardless of whether the host population was *H. brassicae* or *H. floralis*. The second generation of *C. rapae* adults developing from *H. brassicae* appeared almost at the same time as those developing in *H. floralis*, and thereby increased the possibility of parasitation of *H. floralis* (Makarenko 1965).

Because of the ability of *C. rapae* to synchronise its life cycle to that of its hosts, the differences in parasitation of *H. brassicae* and *H. floralis* have probably other causes than the differences in their life cycles. One reason for lower parasitation in *H. floralis* may be that its larvae live deeper in the soil. Thus Makarenko (1968) found that *H. brassicae* had the highest number of pupae at the soil depth where maximum parasitation occurred, while the highest number of *H. floralis* pupae were found below this depth.

It is generally accepted that parasites may act as a regulating or density-governing factor in the population dynamics of their host species. The apparent reduction of parasitism with increasing latitudes in the present material is thus in agreement with the view of many authors that the influence of regulating processes diminishes with increasing severity of disturbing processes, such as increasing adversity of climatic conditions (e.g. Nicholson 1958, Huffaker & Messenger 1964, Richards & Southwood 1968). Winter temperatures are often lower in eastern parts of southern Norway than in the parts of northern Norway where puparia were collected. Reduced parasitism is probably not, therefore, caused by low winter temperatures. This view is also supported by the conclusion of Makarenko (1968) that *C. rapae* is more cold-hardy during hibernation than its hosts. More importance is ascribed, therefore, to the shorter growing seasons, and lower summer temperatures in northern Norway.

Some chemical treatments clearly reduce parasitation. This is in agreement with Read (1960) and Jörgensen (1966). The present results further indicate, however, that some kinds of insecticide applications against other pests of cruciferous crops may occur with little harm on the interaction between the *Hylemya* spp. and its parasites.

The apparent increase in parasitation after use of lindane (Table V) cannot be explained satisfactorily. One possibility is that lindane reduces the *Hylemya* populations more heavily than it does the parasite populations, thus leaving a higher parasitation pressure on the surviving *Hylemya* larvae. This hypothesis needs, however, further investigation, as do other aspects of the relationship between insecticide applications and parasitation of the brassica root flies.

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Mannitol and Glycerol in Overwintering Aphid Eggs

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Abstract: Sömme, L. 1969. Mannitol and glycerol in overwintering aphid eggs. *Norsk ent. Tidsskr. 16,* 107-111.
Mannitol and glycerol were identified from eggs of *Hyalopterus pruni* (Geoff.) by thin-layer and paper chromatography. Glycerol was also present in eggs of *Aphis pomi* De Geer and *Rhopalosiphum padi* L., while no mannitol could be detected. The content of glycerol in *H. pruni* and *A. pomi* eggs increased during the fall, and decreased in the spring. A similar pattern was found for mannitol in *H. pruni.* High glycerol content in mid-winter corresponded to low supercooling points in all species. The high content of mannitol suggests that this substance is also of importance for the cold-hardiness of *H. pruni* eggs.

Sugar alcohols play an important part in insect coldhardiness by increasing the ability to supercool, and thus to avoid the lethal effects of freezing. As reviewed by Asahina (1966) a number of overwintering insects contain large amounts of glycerol, and some insects accumulate both sorbitol and glycerol (Chino 1960, Salt 1961, Sömme 1967). In overwintering eggs of the fruit tree red spider mite, *Panonychys ulmi* (Koch), and pupae of the large white butterfly, *Pieris brassicae* (L.), only sorbitol is present (Sömme 1965, 1967). Analysis of eggs of a black willow aphid, *Pterocomma smithia* (Monell), and the fall cankerworm, *Alsophila pometaria* (Harris), indicated the presence of small quantities of mannitol (Sömme 1964). This last polyhydric alcohol appeared to be of minor importance to cold-hardiness in the species where it was present.

With the severe winter climate under Norwegian conditions a high degree of cold-hardiness is of vital importance to species overwintering in exposed situations. The present study was carried out to investigate the ability to supercool, and the content of polyhydric alcohols in some species of aphids of economic importance.

MATERIAL AND METHODS

Eggs of the green apple aphid, *Aphis pomi* De Geer, and mealy plum aphid, *Hyalopterus pruni* (Geoff.), were collected from twigs of apple and plum respectively. The identity of the eggs were secured by isolating egg-laying females on the twigs in the fall. After the eggs were deposited, the twigs were cut off and stored at 2°C, and saturated humidity in the laboratory. Eggs of the bird-cherry aphid *Rhopalosiphum padi* (L.), were collected from bird-cherry *(Prunus padus)*. All samples of aphid eggs used in the present study originated from Ås, Akershus.

Supercooling points were measured by a copper-constantan thermocouple connected to a recording potentiometer. To keep the eggs in contact with the thermocouple, this was covered by a thin layer of Vaseline.

Samples containing 100 to 200 eggs were extracted and prepared for analysis as described by Sömme (1964). Quantitative measurements of mannitol and glycerol were made from paper chromatograms (Sömme 1964), developed according to Metzenburg and Mitchell (1954). This method does not give a complete separation of mannitol, which may overlap with various hexoses and other sugar alcohols. Since none of these appeared to be present in large quantities, the spots on the chromatograms were taken for mannitol. It is possible, however, that quantitative figures given for mannitol are slightly higher than the true content.

Qualitative identification of mannitol, glycerol and trehalose were carried out by thin-layer and paper chromatography. Solvent systems described by Smith (1958) and Lewis & Smith (1967) were used. Thin-layer chromatograms were developed with silver nitrate (Lewis & Smith 1967), and paper chromatograms according to Metzenburg & Mitchell (1954). The distance travelled by glucose was used as a reference in all cases. This distance was set to 100, and the relative distance (R_g-values) calculated for the other substances. Figures given in Table I are averages of two to eight runs in each system.

For thin-layer chromatography the following combinations of plates and solvent systems were used. I Kieselgur G, Kieselgel G (3:2) plates; iso-propanol: ethyl acetate: water (83:11:6, v/v). II. Kieselgur G, sodium phosphate buffer (pH 5.0) plates; n-butanol:acetone: phosphate buffer (4:5:1, v/v). III. Kieselgel G, 0.1 N boric acid plates; A. Ethyl methyl ketone: acetic acid: methanol (3:1:1, v/v), B. Benzene: acetic acid: methanol (1:1:3, v/v), and C. n-butanol: acetone:water (4:5:1, v/v).

Descending paper chromatograms were run on Whatman No. 1 paper in the following solvent systems. I. n-butanol:pyridine:water (2:2:1, v/v). II. iso-propanol:n-butanol: water (7:1:2, v/v). III. ethyl acetate: pyridine:water (14:5:1, v/v).

RESULTS

R_g-values of various sugars and sugar alcohols are given in Table I, together with values of spots from egg extracts. The extracts gave several spots, of which some corresponded to mannitol, glycerol and trehalose. Some of the other spots may be di- or polysaccharides, while the identity of spots with higher R_g-values than glycerol remains unclear. Judged by the size and intensity of the spots, mannitol (when present) and glycerol dominated in quantity.

Extracts of *H. pruni* eggs gave spots corresponding to mannitol, glycerol, and trehalose (Fig. 1). In the other species no mannitol could be detected, whereas glycerol and trehalose were present. *A. pomi* and *R. padi* also gave spots corresponding to glucose, but these substances did not appear to be present in large quantities in *H. pruni*.

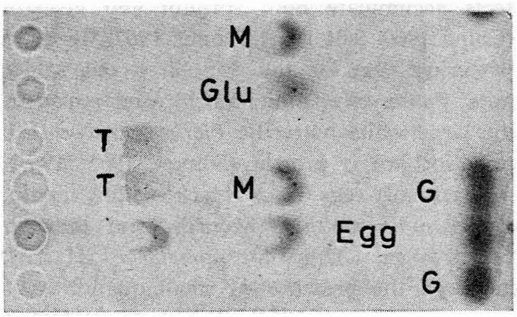

Fig. 1. Thin-layer chromatogram (syst. II) of *H. pruni* egg extract, and of mannitol (M), glucose (Glu) trehalose (T) and glycerol (G).

Table I. Rg-values on paper and thin-layer chromatograms of aphid egg extracts and various sugars and sugar alcohols[1]

	Thin-layer					Paper		
Substance	I[2]	II	III A	III B	III C	I[2]	II	III
Erythrose	87	188	–	89	34	–	–	–
Arabinose	99	125	119	99	105	–	–	–
Xylose	118	158	121	105	89	–	–	–
Ribose	73	159	–	93	45	–	–	–
Glucose	100	100	100	100	100	100	100	100
Galactose	86	72	83	93	62	90	85	85
Mannose	100	124	84	97	81	–	–	–
Fructose	90	118	69	92	32	108	110	137
Sorbose	98	126	56	82	17	103	102	130
Sucrose	79	84	75	94	113	–	–	–
Trehalose	57	41	57	98	92	–	56	–
Raffinose	24	12	28	77	38	–	–	–
Glycerol	114	176	148	104	161	135	187	175
Dulcitol	51	88	38	76	7	90	104	76
Mannitol	66	100	56	82	18	96	110	90
Sorbitol	48	90	39	72	7	90	100	86
Glyceraldehyde	124	200	169	110	166	–	–	–
Dihydroxyacetone	117	195	184	109	172	–	–	–
H. pruni	21	45t	54m, t	–	19m	97m	44	90m
	37	100m	148g	–	38	136g	60t	175g
	65m	176g	164	–	90t	–	106m	–
	116g	187	184	–	159g	–	190g	–
	130	–	–	–	227	–	–	–
	140	–	–	–	–	–	–	–
A. pomi	20	23	58t	84t	40	–	–	–
	51t	42t	97	100g	90t	–	–	–
	98	101	149g	125	102	–	–	–
	114g	174g	201	–	162g	–	–	–
	133	205	247	–	269	–	–	–
	140	–	–	–	296	–	–	–
R. padi	20	23	58t	85t	45	–	–	–
	54t	42t	143g	99g	91t	–	–	–
	97	99	245	124	160g	–	–	–
	115g	178g	–	–	307	–	–	–
	136	–	–	–	–	–	–	–

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[1] Spots from egg extracts corresponding to mannitol, glycerol and trehalose are indicated by m, g and t respectively.

[2] Solvent systems.

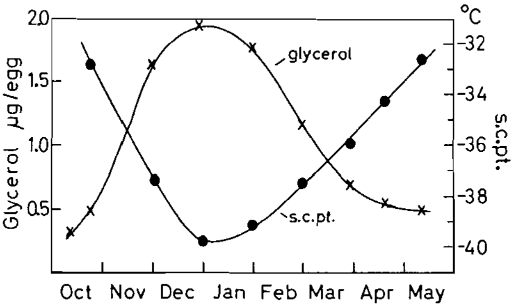

Fig. 2. Seasonal changes in glycerol content and supercooling points in eggs of *A. pomi*.

Seasonal changes in content of glycerol and in supercooling points in eggs of *A. pomi* are shown in Fig. 2 Data are given in µg glycerol per egg; the average weight of one egg being 21 µg. The results are typical for insects that accumulate glycerol, with low values in the fall and spring, and a peak in mid-winter. Supercooling points decreased with increasing glycerol content in the fall, and increased with decreasing glycerol content in the spring.

A similar tendency was found in eggs of *H. pruni*, although less data are available (Table II). The content of mannitol appeared to follow a pattern similar to that of glycerol. A content of 0.5 µg corresponds to more than 2 percent of the egg weight, which averaged 22 µg.

For *R. padi*, measurements were carried out only in February. At this time the eggs had supercooling points in the same order of size as those of eggs of the other species. The content of glycerol also corresponded to that found in *A. pomi* and *H. pruni*.

DISCUSSION

The results indicate that accumulation of glycerol is common in aphid eggs overwintering in places where they are exposed to extreme, low temperatures. In *H. pruni* eggs the high content of mannitol will probably contribute significantly to the lowering of supercooling points. A concentration of mannitol of this size has not previously ben reported, although its presence in other insect eggs has been suggested (Sömme 1964). The source of this sugar alcohol is not known, but since mannose could not be identified from the chromatograms, it is suggested that polysaccharides containing mannose may be present in these insect eggs. In some insects glycogen appears to be the initial source of glycerol and sorbitol (Chino 1960), and similar mechanisms for the formation of mannitol seem to be possible.

The similarities in supercooling points of the three species suggests that this order of size is necessary for survival. The figures correspond to temperature recordings from Ås, which may be as low as between −30° and −40°C on severe winter days.

Table II. Supercooling points and contents of mannitol and glycerol in eggs of *H. pruni* and *R. padi*

Species	Date	S.c.pt.[1]	Mannitol	Glycerol
			µg/egg	µg/egg
H. pruni	5 Nov. 1968	-34.4±0.58	0.13	0.28
	16 Dec. 1968	-36.8±0.70	0.55	1.22
	22 Dec. 1966		0.45	0.85
	4 Apr. 1967		0.29	0.23
R. padi	20 Febr. 1968	-36.9±0.49	none	0.94

[1] x ± S.E.

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Notes on Norwegian Coniopterygidae (Neuroptera) II

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Greve, Lita 1969. Notes on Norwegian Coniopterygidae (Neuroptera) II. *Norsk ent. Tidsskr.* 16, 113-114.
Conwentzia pineticola is reported new to Norway from Hordaland. New localities from southern Norway are given for *Coniopteryx pygmaea, C. tineiformis, Helicoconis lutea* and *Semidalis aleyrodiformis.*

The article is based on material collected in the years 1967-1969. Unless otherwise stated, the specimens have been collected and determined by the author. In cases where the individual could not be determined to either sex, the word 'specimen' is used. The geographical divisions follow Strand (1943).

CONIOPTERYX PYGMAEA END. 1906

C. pygmaea has previously been reported from Norway only from Vestfold (VE) by Greve (1967).

List of records. Östfold (Ö): Halden, Strupe 5 June 1967 31 ♂♂ 51 ♀♀ on *Pinus silvestris.* VE: Tjöme, Kjære 31 May 1967 1 ♂ 1 specimen on *P. silvestris;* 2 June 1967 4 ♂♂ 3 ♀♀ on *P. silvestris;* Tjöme, Eidene 2 June 1967 5 ♂♂ 1 ♀ on *P. silvestris;* Tjöme 3 June 1967 9 ♂♂ 3 ♀♀ on *P. silvestris,* Tjöme, Kjære 21 June 1969 14 ♀♀ on *P. silvestris* (A. Fjellberg, det. A. Fjellberg). Outer Hordaland (HOy): Fana, Fantoft 13 June 1969 on *P. silvestris;* Bruvik, Eidslandet 28 June 1969 4 ♀♀ on *P. silvestris,* 1 June 1963 3 ♀♀ on *P. silvestris;* Bruvik, Flatekvål 29 June 1969 2 ♂♂ 2 ♀♀ on *Pivea abies.*

C. pygmaea is new to Ö and HOy. The species is known to occur in large numbers (Aspöck & Aspöck 1964). Thus, 82 specimens from one locality near Halden is not surprising.

CONIOPTERYX TINEIFORMIS CURT. 1834

C. tineiformis has been reported from Norway by Schöyen (1887), Tjeder (1943) and Greve (1967).

List of records. Ö: Halden 5 June 1967 1 ♂

on *Sorbus aucuparia.* Outer VestAgder (VAy): Oddernes, Gimlemoen 19 Aug. 1967 1 ♀ (A. Fjellberg).

C. tineiformis is new to both Ö and VAy. There are also several new records from Hordaland which will not be listed here. Judging from these records, the species seems to be very common in western Norway (Greve 1967).

CONWENTZIA PINETICOLA END. 1905

List of records. HOy: Bergen, Botanical Garden 9 May 1969 1 ♂ caught flying (A. Fjellberg); Fana, Myravann 5 June 1969 1 ♀ on *P. abies* (A. Fjellberg); Bruvik, Flatekvål 29 June 1969 2 ♀♀, together with *Coniopteryx pygmaea* on *P. abies.*

C. pineticola is new to Norway. The author has in an earlier paper (Greve 1966) reported a find of a female *Conwentzia* from HOy: Stord, Storsöy. This specimen could not be determined with certainty to either of the two species *C. pineticola* and *C. psociformis.* The male found in Botanical Garden, Bergen 9 May 1969 fits with the description by Zeleny (1961) of *C. pineticola.* The female taken at Myravann had 32 antennal joints and the two females found at Flatekvål had 31 antennal joints each, which also fits with Zeleny's description of *C. pineticola* females. Antennae and legs of all the females were dark brown pigmented.

HELICOCONIS LUTEA WALLENGREN 1871

H. lutea has been reported earlier from outer Troms (TRy) by Tjeder (1943) and VE by Greve (1967).

List of records. VE: Tjöme, Kjære 27 June 1968 1 ♀ on conifers (A. Fjellberg, det. A. Fjellberg). Inner Hordaland (HOi): Eidfjord, Vöringfoss 23 June 1969 1 ♂ (T. Nielsen).

H. lutea is new to HOi.

SEMIDALIS ALEYRODIFORMIS STEPH. 1835

S. aleyrodiformis has been recorded once in Norway from VE (Greve 1966).

List of records. VE: Tjöme, Kjære 21 June 1969 9 ♂♂ on *Quercus,* 2 ♂♂ on *P. silvestris* (near deciduous trees) (A. Fjellberg, det. A. Fjellberg). VAy: Oddernes, Gimlemoen 19 Aug. 1967 1 ♂ (A. Fjellberg).

S. aleyrodi formis is new to VAy.

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Über die nordische Form von *Phytodecta linnaeanus* Schrk. (Col., Chrysomelidae)

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Strand, A. 1969. Über die nordische Form von *Phytodecta linnaeanus* Schrk. (Col., Chrysomelidae). *Norsk ent. Tidsskr. 16,* 115-117.

Der Verfasser weist nach, dass der nordische *Phytodecta linnaeanus* mit *orientalis* sensu Bechyné näher verwandt ist als mit *linnaeanus* sensu Bechyné. Grösseres Material ist notwendig um die Frage ob *orientalis* als eigene Art anzusehen ist entscheiden zu können. Unterdessen ister geneigt *orientalis* als Rasse von *linnaeanus* anzusehen.

Weise (1884) hat *Phytodecta orientalis* als var. von *linnaeanus* Schrank folgendermassen beschrieben: «var. b. *orientalis:* Eadem, sed maculis elytrorum plus minus confluentibus, ad ultimum elytris nigris, limbo basali et laterali rufis».

Bechyné (1947) hat indessen *orientalis* als eigene Art auf Grund folgender Unterschiede ausgeschieden:

LINNAEANUS

Grösse 5, 5-8 mm. Halsschild an der Basis am breitesten, die Seiten vor den Hinterecken nicht, oder schwach, ausgeschweift, die Zwischenräume der Deckflügel des ♂ blank, schwach und sparsam punktiert, unregelmässig gestreift, Deckflügel des ♀ infolge dichter Mikroskulptur matt, Penis in Dorsalansicht verhältnismässig schmaler und im apikalen Teil schwächer eingeengt, der eingeengte Teil verhältnismässig lang und breit, Penis in Lateralansicht breiter.

ORIENTALIS

Grösse 6-6,5 mm. (Ein Exemplar als a. *minutus* Bech. bezeichnet, das ich untersucht habe, ist 5,2 mm). Halsschild vor der Basis am breitesten, Seiten vor den Hinterecken stark ausgeschweift, Deckflügel schwach gerunzelt, dicht und unregelmässig gestreift, in beiden Geschlechtern schwach matt, Penis in Dorsalansicht verhältnismässig breiter, in dem apikalen Teil stärker eingeengt, der eingeengte Teil schmaler und kürzer, Penis in Lateralansicht schmaler.

Im nordischen Käferverzeichnis (Lindroth, 1960) ist *linnaeanus* aus folgenden Gebieten erwähnt:

O.-Fennoskandia: Im nördlichen Teil und in den Gebieten Isthmus karelicus und Savonia australis im Süden.

Schweden: Von Torne lappmark südwärts bis Värmland und Dalarne.

Norwegen: Von O.-Finnmark südwärts bis Aust-Agder.

Die als *linnaeanus* bestimmten, norwegischen Tiere in der Sammlung des zoologischen Museums in Oslo und in meiner eigenen Sammlung, im ganzen 146 Exemplare, sind mit folgendem Resultat revidiert worden:

Die Grösse der Tiere variiert zwischen 5,2 und 6,5 mm.

Die Farbe ist wenig variabel, ein Umstand auf den schon Sparre Schneider (1909, 1911) aufmerksam gemacht hat. *Linnaeanus* wurde (Schrank, 1781) nach Exemplaren mit einfärbigen, roten Deckflügeln und mit einfärbigem oder zweifärbigem Halsschild beschieben. Im norwegischen Material kommen Exemplare mit einfärbigen, roten oder schwarzen Deckflügeln nicht vor, einfärbigen, schwarzen Halsschild haben nur 4 Exemplare, alle aus S.-Norwegen. Die Zahl und Grösse der Flecken der Deckflügel variieren, sehr selten fliessen einige zusammen.

Die Seiten des Halsschildes sind normal vor den Hinterecken ausgezweift. Die Ausschweifung variiert, bisweilen ist sie sehr deutlich, wie sie infolge Bechyné (1947) bei *orientalis* sein soll.

Die Mikroskulptur der Deckflügel beim ♀ ist, besonders im hinteren Teil, meist etwas deutlicher, und die Deckflügel daher etwas matter, als beim ♂, der Unterschied zwischen ♂ und ♀ ist aber viel kleiner als bei *linnaeanus.*

Nach den 16 untersuchten ♂♂ zu urteilen ist die Form des Penis recht konstant (Fig. 1). Sie stimmt mit der Form die Bechyné (1947) für *orientalis* gezeichnet hat, und mit den 4 ♂♂ dieser Art aus Kaukasus, Ural- und Samaragebiet im O.-Russland, die ich untersucht habe (Fig.2), gut überein.

24 Exemplare aus O.-Fennoskandia, die ich auch untersucht habe, stimmen mit den nor-

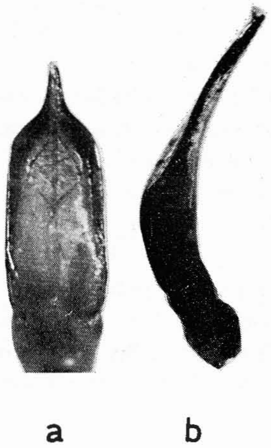

Fig. 1

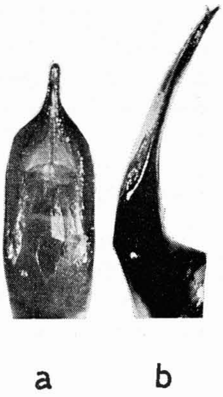

Fig. 2

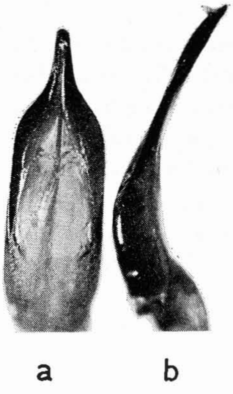

Fig. 3

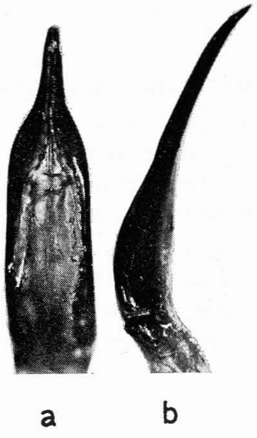

Fig. 4

Fig. 1. *Phytodecta linnaeanus* Schrk. ssp. *orientalis* Weise (*linnaeanus* sensu Lindroth, 1960). Framnes Målselv (A. Strand).

Fig. 2. *Phytodecta linnaeanus* Schrk. ssp. *orientalis* Weise. Katav Ural mer. Mt. Urengai (Dr. Jureček). a: Penis in Dorsalansicht, b: Penis in Lateralansicht. Photo E. Sundt.

Fig. 3. *Phytodecta linnaeanus* Schrk. Ufer der Mulde b. Hohenpriessnitz b. Eilenburg (Dietze).

Fig. 4. *Phytodecta linnaeanus* Schrk. Marbg. St. (Dr. Krauss). a: Penis in Dorsalansicht, b: Penis in Lateralansicht. Photo: E. Sundt.

wegischen überein. Bei einem Exemplar aus Kexholm im Ladoga-Gebiet sind doch der Halsschild und die Deckflügel einfärbig schwarz, der Penis aber ist wie bei den norwegischen Tieren. Palmén (1945) hat den Penis von *linnaeanus* gezeichnet, es handelt sich auch hier um dieselbe Form als die norwegische.

Unzweifelhaft gehört der ganze nordische Bestand zu einer und derselben Form, die eher zu *orientalis* sensu Bechyné als zu *linnaeanus* gerechnet werden muss.

Nach Bechyné (1947) kommt *orientalis* in Kaukasus und O.-Russland vor, während *linnaeanus* von den Karpathen westwärts bis Mont Dore in Frankreich aufgegeben ist.

Von *linnaeanus* sensu Bechyné habe ich 24 Exemplare, davon 14 genitalpräparierte ♂♂, untersucht. Der Penis dieser Art ist von Weise (1886), Bechyné (1947) und Mohr (1966) gezeichnet. Die Zeichnungen Bechynés und Mohrs stimmen mit einigen Tieren aus Thüringen und Eilenburg nahe Leipzig, die ich untersucht habe, überein, vgl. Fig. 3. 7 Exemplare aus München und einigen Lokalitäten in Steiermark weisen jedoch einen ganz anderen Penis auf, vgl. Fig. 4 und die Zeichnung Weises (1886). Es geht aber schon aus den wenigen untersuchten, mitteleuropäischen Exemplaren hervor, dass der Penis recht variabel ist. Unter diesen Exemplaren kommt jedoch keine Penis-Form wie die nordische vor.

Wie erwähnt hat Bechyné (1947) *orientalis* für eine eigene, von *linnaeanus* verschiedene, Art gehalten. Neulich hat er mir als Grund für diese Auffassung mitgeteilt, dass in demselben Gebiet auch normale *linnaeanus* gefunden waren, und dass keine Übergangsform beobachtet wurde. Er fügt aber hinzu, dass das ihm vorliegende Material sehr gering war, und dass die Lokalitätsangaben nicht ganz präzis waren. Er (Bechyné 1947) hat ferner erwähnt, dass Exemplare von *orientalis* aus Ural und Kaukasus den Charakter unstabiler und wenig ausgeprägter subspecies haben.

Eingegangen 18 August 1969

Für eine endgültige Stellungsnahme zur Frage ob *orientalis* als eigene Art anzusehen ist, und wie es sich mit der Rassenfrage verhält, ist grösseres Material, besonders von *orientalis,* aber auch von mitteleuropäischen *linnaeanus* notwendig. Unterdessen bin ich geneigt *orientalis* als Rasse von *linnaeanus* anzusehen.

Für Hilfe mit Material und Auskünften bin ich folgenden Kollegen Dank schuldig: Dr. J. Bechyné, Maracay, Venezuela, Stud.-Direktor K. Ermisch, Leipzig, Professor H. Franz, Wien, Ing. J. Gottwald, Praha, Dr. J. Jelinek, Praha, Professor A. Kofler, Lienz, Konservator A. Lillehammer, Oslo, Professor Carl H. Lindroth, Lund, Dr. K. H. Mohr, Halle (Saale), Magister H. Silfverberg, Helsingfors und Dr. Sten Stockmann, Helsingfors. Ich danke auch meinem Freund E. Sundt, Svartskog, für die Photos.

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Anomaly of the Wing Venation of *Chrysopa albolineata* Killington 1935

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Greve, L. 1969. Anomaly of the wing venation of *Chrysopa albolineata Killington 1935. Norsk Ent. Tidsskr. 16,* 119-120.

A female *Chrysopa albolineata* Kill. with four-sided first intramedian cells in both forewings is described. *C. albolineata* has been found at three localities in south-eastern Norway.

One female *Chrysopa albolineata* Kill. 1929 collected by the author at Årö, Sandar in Vestfold, had four-sided first intramedian cells in both forewings, see Fig. 1. The specimen was netted on deciduous trees on 26 July 1969 together with specimens of *C. carnea* Steph. Another female with normal wing venation was netted on oak at the same place on 25 July.

The shape of the first intramedian cell is used as an important character to separate the genus *Chrysopa* from the genus *Notochrysa (Nathanica)*. However, Killington (1936-1937) remarks on the occasional occurrence of abnormal *Chrysopa* specimens where four-sided cells occur. Ohm (1961) surveyed several species of *Chrysopa,* mostly from northern Germany, when looking for four-sided cells and found these more or less common in several species. In *C. abbreviata Curt.* he found up to 31 % with four-sided cells in one or both wings, while in 33 specimens of *C. albolineata* he found one specimen where one forewing had a four-sided cell.

The present specimen otherwise looks like a normal *C. albolineata* and differs strikingly in colour, bodyform and shape of the pseudomedia from both *Notochrysa fulviceps* Steph. and *N. capitata* Fabr. to which it has been compared.

C. albolineata has twice been reported from Norway, from Akershus and inner Sogn and Fjordane by Tjeder (1944). *New records.* Vestfold: Tjöme, Kjære 24 June 1969 1 ♀ on *Picea abies* coll. A. Fjellberg. Outer Aust-Agder: Holt, Boröy 7 August 1968 1 ♀ leg. A. Fjeldså. All specimens were identified by the author.

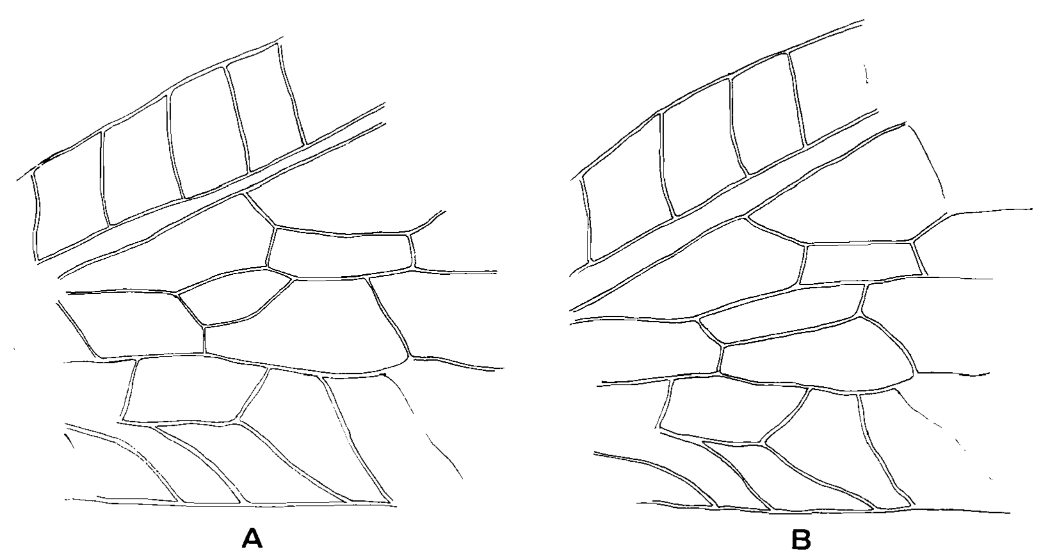

Fig. 1A. Normal wing-venation of *Chrysopa albolineata.* The first intra-median cell is stippled; B. Abnormal foursided cell.

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Effect of Constant and Varying Temperature on Development, Feeding, and Survival of *Adalia bipunctata* L. (Col., Coccinellidae)

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Ellingsen, Inger-Johanne, 1969. Development, Feeding, and Survival of *Adalia bipunctata* L. (Col., Coccinellidae). *Norsk ent. Tidsskr. 16,* 121-125.

The effect of constant and varying temperatures on development, feeding and survival of *Adalia bipunctata* L. was tested. For a varying temperature range of 8-28°C, an incubator was used in which the temperature followed a diurnal cycle with fixed means, maximums, and minimums. Development of the species is possible within most of the range. There was no difference in development of eggs and pupae, and probably not of larvae. Aphid consumption was 10.6 per cent higher at varying temperature, but the difference was not significant. The higher vitality at varying temperature was significant; the survival period of starved larvae increased by 16.7 to 37.8 per cent.

Odum (1959, pp. 105-106) proposed that the stimulating effect of varying temperature, in the temperate zone at least, should be accepted as a well-defined ecological principle, and that special emphasis should be laid on it, since there has been a tendency to conduct experimental work in the laboratory under constant temperature conditions.

The effect of constant and varying temperatures on the rate of development of insects has been extensively investigated, but records of the effect on feeding and survival are few.

Most of these studies may be grouped into classes, according to the method used to vary the temperature: (i) a fraction of the developmental period is spent continuously at one temperature and the remainder at a different constant temperature; (ii) exposure of the insects to two abrupt changes of temperature daily; (iii) a series of artificially constructed patterns in which the temperature varies smoothly and regularly in a theoretical diurnal cycle with fixed means, maximums and minimums; (iv) the most natural approach, by which templates are made from thermographs of natural habitats and used to control incubation temperatures.

An important question is how to summarize the pattern of variable temperature to evaluate its effect on the insect. The mean is an adequate representation of pattern only as long as the temperature remains within the zone in which the rate of development is linearly related to temperature. Therefore, the choice of ranges and the mean temperature is important.

In the present study, experiments were carried out in an incubator that gave smooth consistent cyclical temperature fluctuations.

The pattern was selected to agree as closely as possible with temperatures prevailing in the field at the time of occurrence of the insects. Experiments were also carried out at 7 constant temperatures to study the relationship between development and temperature.

MATERIAL AND METHODS

Material for these experiments was collected at Vollebekk, Ås, southern Norway. Normal mean air temperature at Ås is 14.4°C in June, 16.8° in July, and 15.6°C in August (Meteorologic data for Ås 1967). According to microclimatic measurements in the vegetation (Sundby, unpublished) a range of 8-28°C with mean 18° was chosen in an incubator, where the temperature followed a diurnal cycle with fixed means, maximums, and minimums (the mechanism is discussed by Sundby, unpublished). The incubator had 16 hours of light per day. Experiments at constant temperatures were carried out under the following conditions:

Temperature (°C)	6	9	12	15	18	21	28
Hours of light per day	0	0	0	24	18	0	16

It was not possible to arrange identical light periods at all temperatures. Thermohygrographs showed a range of 50-80 per cent relative humidity.

To avoid individual variations, one pair of *A. bipunctata* was used as the origin of stock culture, except for data on incubation of eggs and survival of larvae, where effect of constant and varying temperature was tested.

The Aphid species used as prey was *Myzus persicae* (Sulzer).

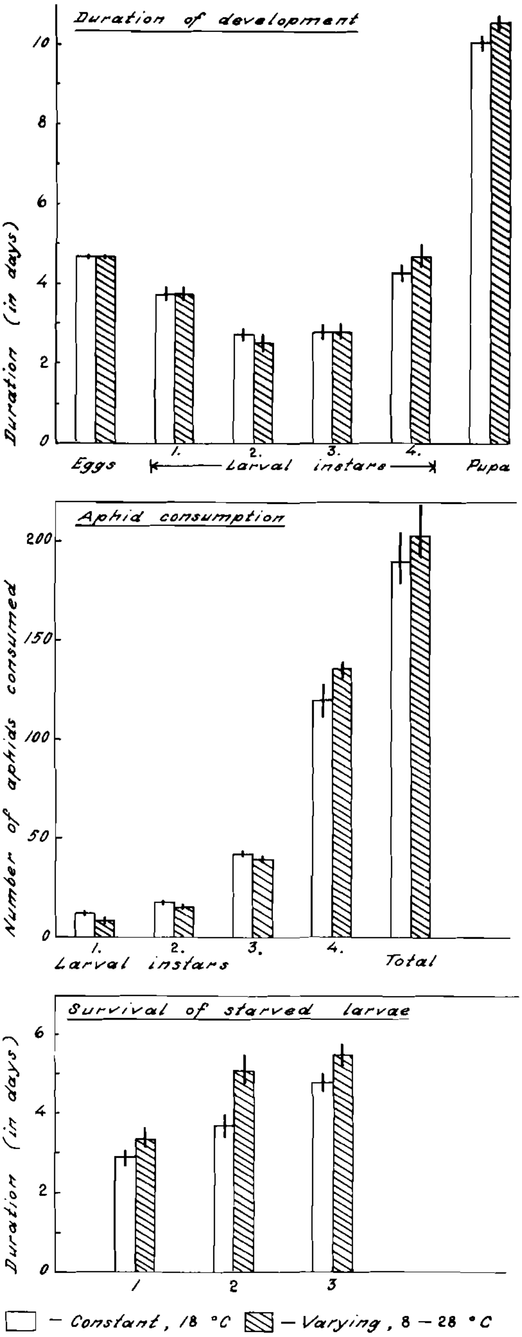

Fig. 1. Effect of constant and varying temperature on *A. bipunctata*. Duration of development. Aphid consumption. Survival of started larvae, (1) offered water only, (2) offered water and honey, (3) offered water and one coccinellid egg. The bars present mean values and ± S. E. is indicated.

RESULTS

Results of experiments at constant and varying temperature are summarized in Table I, and displayed in more detail as histograms in Fig. 1.

The development of larvae seems to be more susceptible to varying temperature than eggs and pupae. Total larval development was sig-

Table I. Effects of constant and varying temperatures on development, aphid consumption and survival of starved larvae in *A. bipunctata*

	Constant 18 °C		Varying 8–28 °C		t-test of
	N	X ± S. E.	N	X ± S. E.	the difference
(*a*) *Duration of development* (*in days*)					
Eggs	1808	5.24 ± 0.01	1038	5.19 ± 0.02	P > 0.05 not sign.
Larvae	54	13.4 ± 0.1	46	14.0 ± 0.1	P < 0.05 sign.
Pupae	40	10.0 ± 0.1	32	10.0 ± 0.1	P > 0.05 not sign.
(*b*) *Number of aphids eaten per larvae*	40	188 ± 13.7	32	208 ± 15.8	P > 0.05 not sign.
(*c*) *Survival* (*in days*) *of newly emerged larvae offered water only*	53	2.9 ± 0.1	46	3.4 ± 0.2	P < 0.05 sign.

nificantly (4.5 per cent) retarded. Fig. 1 reveals in detail, however, that some larval instars were accelerated and some retarded.

Voracity of larvae was increased 10.6 per cent at varying temperature, but it was not statistically significant. Vitality proved to be higher at varying temperature than at constant. Survival of starved larvae was prolonged 16.7 to 37.8 per cent (Fig. 1), and this was statistically significant. Mortality during larval and pupal stages was 28.6 per cent at constant temperature and 22.2 per cent at varying temperature. The highest value of hatched eggs from one female was found at varying temperature.

Experiments on duration of development at 7 different temperatures were performed as an aid towards discussing the difference between constant and varying temperature experiments. Numbers of individuals (N) that completed development at the different temperatures were as follows:

°C	6	9	12	15	18	21	28
N	0	0	0	21	40	12	29

The relationship between temperature and duration of developmental stages is shown in Fig. 2. Standard errors were never greater than 0.3 days, and were most frequently 0.1 days.

Larvae kept at 6 °C were completely inactive and consumed no aphids; at 9°, four (of 36 newly emerged larvae) reached 2nd instar, and one came to 4th instar; at 12°, four (of 31) reached the prepupal stage, but died; at 21°, mortality in larval and pupal stages was 52.0 per cent. All these four series had total darkness.

DISCUSSION

Records of the effect of alternating temperatures from older literature may seem confusing, especially if we do not take into consideration how the temperature range is related to the temperature-development curve. Odum (1959) concludes that it is not certain whether variation in itself is responsible for the accelerating effect, or whether high temperature causes more growth than is balanced by low temperature. Howe (1967) states that there is little evidence in the literature that temperature fluctuations influence the rate of development of eggs. But if varying temperature is represented by a mean, at the lower temperatures the eggs will hatch sooner than expected, in the medial range they will hatch when expected, and at high temperatures the hatching may be delayed.

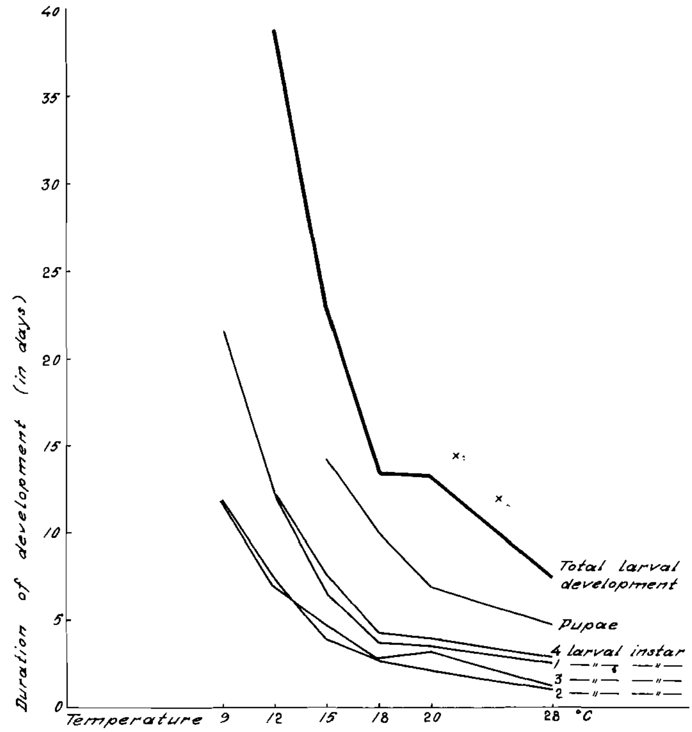

Fig. 2. Duration of developmental stages of *A. bipunctata* at six constant temperatures. Data from Jöhnssen (1930) indicated as x_1 and x_2.

The results of the present study showed no difference in rate of development at constant and varying temperatures, but perhaps a little retardation of larval development at varying temperature.

As seen from Fig. 2, the range 8-28°C is quite suitable for development, but 8° might be too low. The exact threshold for development and optimal temperature cannot be read from the curve.

In addition to temperature change, Hodek (1958) reported that the rate of development and mortality of *Coccinella septempunctata* was affected by the length of the light period. He found 12 per cent retarded development in total darkness, whereas with 24 or 12 hours of light there was little retardation. In Fig. 2 of the present study a correction of values measured in total darkness would have reduced the irregularity at 21°C and given smoother curves.

Duration of development of *A. bipunctata* was reported by Jöhnssen (1930) from Cologne. In Fig. 2, his values are x_1 = 13-16 days larval development at 22-23°C, and x_2 = 12 days at 25°C. These values lie above mine, which may indicate that *A. bipunctata* has been adapted to develop at lower temperatures in our latitude.

As to the effect of varying temperature on feeding, the present experiments may indicate that feeding follows the same pattern as duration of development. Parker (1930) reports that dry weight of food consumed by grasshoppers at alternating temperatures amounts to a 24 per cent reduction from the amount used during the nymphal stage at constant temperature (reduction in length of nymphal stage was 30 per cent). Another possibility is that feeding (like vitality) is stimulated by varying temperature. Sundby (unpublished) found that pupae of *Coccinella septempunc-*

tata were heavier at varying temperatures (same incubator as used for *A. bipunctata).*

The report of Gawande (1966), who fed aphids to *Chilomenes sexmaculata* F.B., is confusing, since feeding rate was stimulated when larvae were kept at low temperature for 8-16 hours, whereas temperature had negative effect on larvae kept for only one hour. For adults the situation was reversed.

For *A. bipunctata,* the larger survival of larvae and lower mortality seem to be the most covincing 'stimulatory effect of variable temperature'. To the author's knowledge this has not previously been described.

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Campylosteira verna Fallén, 1826 (Heteroptera, Tingidae) New to Norway

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Hågvar, S. 1969. *Campylosteira verna* Fallén, 1826 (Heteroptera, Tingidae) new to Norway. *Norsk ent. Tidsskr. 16,* 127-128.

Campylosteira verna Fallén is reported new to Norway. Eight individuals were found in April 1969 at Valler, Bærum, near Oslo.

7 ♀♀ and 1♂ of *Campylosteira verna* Fallén have been collected at Valler, Bærum. The species, which is new to Norway, was found in a dry, south-faced slope at the edge of a mixed forest. Predominating plants are *Melica nutans* L., *Origanum vulgare* L. and *Fragaria vesca* L. The soil is sandy, with many small stones.

The first specimen (1 ♀) was found among old leaves and grass on 4 April 1969. Four days later, seven animals (6 ♀♀ and 1 ♂) were found under a stone in the same place, some meters apart. Obviously these animals had hibernated under the stone, because the snow had melted only a few days earlier. According to Jensen-Haarup (1912), the species can be found in the spring under stones among grass. Southwood & Leston (1959) and Wagner (1967) characterize the habitat of the species as rich

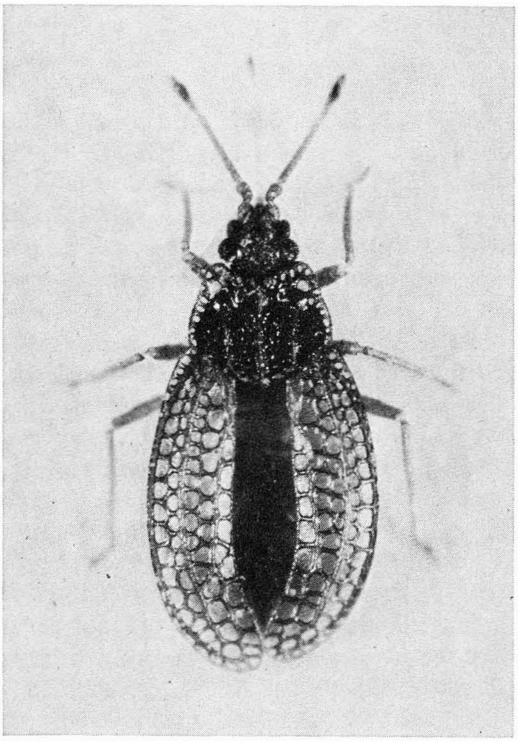

Fig. 1. *Campylosteira verna* Fallén, brachypterous form, × 35. Photo: Johan Basberg, Institutt for anvendt mikroskopi, Blindern, Oslo.

in moss. Mosses are, however, not present in the finding-place in Bærum.

All the collected individuals were brachypterous (Fig. 1). The macropterous form is rare in Denmark (Jensen-Haarup 1912), and has not been found in England (Southwood & Leston 1959).

In Sweden, the species has definitely been found south of Uppland (Ossiannilsson (1947), which is situated at about the same latitude as the Norwegian finding near Oslo.

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Coleoptera in Nests of Tawny Owl *(Strix aluco* L.*)*

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Oslo 3, Norway

Hågvar, S. 1969. Coleoptera in nests of tawny owl *(Strix aluco* L.*)*. *Norsk ent. Tidsskr. 16,* 129-131.

The coleopter fauna of three nests of tawny owl *(Strix aluco* L.*)* is described. All nests contained a large number of Coleoptera. Eleven species were recorded, of which *Carcinops quatuordecimstriata* Steph., *Atheta harwoodi* Williams, *Aleochara albovillosa* Bernh. and *Philonthus parcus* Sharp have previously not been recorded from nests of tawny owl. *P. parcus* has only been found once before in Norway.

Strand (1967a) has described the coleopter fauna in nests of different birds of prey. The Coleoptera in nests of tawny owl have, however, not been investigated in Norway. At Kolsås in Bærum, near Oslo, three big nesting-boxes were occupied by tawny owl in 1969. The boxes (about 60 cm high, about 20 × 20 cm in the bottom, and with a hole 12 cm in diameter) were placed in the middle of high trees. When the youngsters had left the nests, the bottom material was collected. The material consisted mainly of old pellets, feathers, hairs, bones and excrements, and it emitted a strong smell of decay. The material was thoroughly examined, and probably all the living Coleoptera were found. There were a large number of dipter larvae and some coleopter larvae. Specimens of Siphonaptera were found in two of the nests.

Nest No. 1. The wood was rather dense and was predominantly spruce. The nesting-box was placed 7 m high in a spruce, 130 m above sea level. It contained about 4 cm of bottom material. Three eggs were laid, but only two of them hatched. The youngsters left the nest about 7 June, and the nest material was collected 15 June.

Nest No. 2. The wood was mixed and not very dense. The nesting-box was placed 9 m high in a fir, 130 m above sea level. It contained about 5 cm of bottom material. All the four eggs hatched. The youngsters left the nest about 30 May, and the nest material was collected 18 June.

Nest No. 3. The wood was predominantly spruce, and the nesting-tree (a spruce) situated on the hill-side of a small, open valley. The nesting-box was placed 10 m above the ground, at an altitude of 280 m. It contained about 10 cm of bottom material. All the four eggs

Table I. Coleoptera found in three nests of tawny owl (*Strix aluco* L.)

Species	Quantity found in nests Nos. 1	2	3
Trox scaber L.	5	1	
Hister merdarius Hoffm.	3	1	2
Carcinops quatuordecimstriata Steph.	1	9	5
Gnathoncus buyssoni Auzat.	9		4
G. nanus Scriba.		4	3
G. nannetensis Mars.	14	2	2
G. schmidti Reitter		8	12
Atheta nigricornis Thoms.	69	32	11
A. harwoodi Williams	2	20	11
Philonthus parcus Sharp	1		4
Aleochara albovillosa Bernh.			1
Total number	104	77	55

hatched. The youngsters left the nest about 10 June, and the nest material was collected 15 June.

The distance between nest No. 1 and 2 was 1.3 km, between nest No. 2 and 3 1.2 km, and between nest No. 1 and 3 1.0 km.

RESULTS AND DISCUSSION

Table I shows the Coleoptera found. The species composition is very similar in the three nests. Nest No. 1 contained the highest number of individuals. Here only two youngsters had been fed up, and this nest contained the driest bottom material. This nesting-box was also situated lower above the ground than the two other nesting-boxes. In nests No. 2 and 3 parts of the material were very dense and moist, and this medium may have been more difficult for the Coleoptera to dig and hide in. The nest with the smallest number of Coleoptera (No. 3) contained the most dense and moist bottom material. This nesting-box was also situated highest above the ground and at the highest altitude. Nest No. 3 contained, however, a great number of Siphonaptera. In nest No. 1 a few Siphonaptera were found; in nest No. 2 none.

The large number of Coleoptera in the nests may have a connection with very good weather conditions in the preceding period. For more than a week it had been extremely warm, with little or no wind. On such days the flying activity of Coleoptera is especially high. The strong smell from the nest material probably attracted flying Coleoptera.

According to Hicks (1959), *Philonthus parcus* has not previously been found in birds' nests. The species has been found in Norway only once before (Strand 1967 b). The following species are new to nests of tawny owl (Hicks 1959): *Carcinops quatuordecimstriata, Atheta harwoodi, Aleochara albovillosa,* and *Philonthus parcus.*

Among the *Gnathoncus* species, Hicks (1959) has noted *Gnathoncus rotundatus* Kug. as found in nests of tawny owl. Since then, however, the systematics of *Gnathoncus* sp. have been revised. All the four *Gnathoncus*-species in Table I have been found in nests of Tengmalm's owl (*Aegolius funereus* (L.)), and *G.*

buyssoni and *G. nannetensis* in nests of pigmy owl *(Glaucidium passerinum* (L.)) by Strand (1967 a). All the species in Table I, except *Philonthus parcus* and *Aleochara albovillosa* were found by Strand (1967 a) in an investigation of nests of different birds of prey in Norway. All the species, except *Atheta harwoodi, Philonthus parcus* and *Aleochara albovillosa* occured in nests of Tengmalm's owl and/or pigmy owl. *Atheta harwoodi* has, however, been found in nests of owls outside Norway (Hicks 1959).

Gnathoncus nanus, Atheta nigricornis and *Atheta harwoodi* have been found in nests of heron *(Ardea cinerea* L.) in Norway (Fjellberg 1969).

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I am extremely grateful to Dr. Andreas Strand for identifying most of the species; he also checked those that I identified.

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Turnbull and Nicholls' 'Quick Trap' for Acquiring Standing Crop of Evertebrates in High Mountain Grassland Communities

1. Report from the Grazing Project of the Norwegian IBP Committee

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Zoological Museum, University of Bergen

Kauri, H., Moldung, T. & Solhöy, T. 1969. Turnbull and Nicholls' 'quick trap' for acquiring standing crop of evertebrates in high mountain grassland communities. 1. Report from the grazing project of the Norwegian IBP committee. *Norsk ent. Tidsskr. 16,* 133-136.

A trial of Turnbull & Nicholls' quick trap method in a subartic grassland community in Western Norway was made during the summer of 1969. It appeared that after an exact application of the quick trap suction, 84 % of the individuals remained in the vegetation. It was therefore necessary in addition to cut the vegetation and extract the animals in a funnel and perform a second suction in order to collect all individuals. Air velocity in our apparatus was, however, somewhat less than in the one of T. & N.

The quantitative collection of evertebrates in the field cover has so far been filled with difficulties, and the methods have not been satisfactory. Collection in grassland and heathland biotopes is most difficult in the vegetation itself. Methods for sampling in, for instance, soil and foerna are more reliable, since the medium (soil) and the fauna itself are more easy to deal with. When investigating secondary production or determining energy flow in a community, the reliability of the result is dependent on the degree to which the qualitative and quantitative structure can be determined. Turnbull & Nicholls (1966) (further referred to as T. & N) rightly point to the bottleneck which the method of collecting represents.

During the planning for the study of secondary production in high-mountain communities of western Norway, as part of the Norwegian IBP projects, T. & N.'s (l.c.) suction method 'quick trap' was chosen as the main method for quantitative collection. One apparatus was built at the Christian Michelsen Institute of technological research. The apparatus followed the description of the authors, with some smaller modifications. The hoop was made of stainless steel and sharpened at the base. It is thus considerably heavier than was the case with T. & N. and easier to press down in the earth for more effective isolation. As suction pump, a fan, Airflow 64 ES, was used. The electric motor was removed and the fan joined to a petrol driven four stroke Honda engine.

From T. & N.'s paper it can be seen that the quick trap method in comparison with other common methods such as sweep net, Malaise trap, pitfall trap, and vacuum collector, is superior. As far as can be judged, however, no exact test on the effectiveness of the method has been made. As some of the fauna might remain in the vegetation, it was decided to test the apparatus. The collecting was divided into three steps: (1) using suction on the whole vegetation, (2) then cutting down the whole vegetation and placing it later in modified Tullgren funnels and (3) using the suction again on the sample area after the vegetation had been removed.

In the first suction operation it was hoped to take the main part of the fauna, especially the easily mobile component which had not attached itself to the plants or hidden in the leaf bases. The second and third step would show what really remained.

The vegetation forming the habitat (in the sense of biotope) does not entirely consist of non-woody species but contains small amounts of shrubs such as *Dryas octopetala, Salix reticulata* and others. This means that the vegetation cannot be considered as grassland type in the restricted sense (Wiegert & Evans 1957). The biotope also consists of a lower layer of mosses and lichens in scattered patches together with a very thin foerna layer. This definition of the biotope is essential from a zoological viewpoint because of the special nature of the fauna; partly there is an important vertical migration in the vegetation layer, and partly many species react by falling down and hiding in the moss and detritus when disturbed. The delimitation of the plants and soil communities must therefore be at the soil surface, because it is difficult to separate the moss- and lichen community from the upper layer of higher plants.

The material collected in the three operational steps or fractions were placed in specially

Table 1. Number of individuals per 0.5 m^2 on high mountain grassland taken with quick trap at 14h50, 1 July 1969; and extracted in modified Tullgren funnels from the cut vegetation

	1st suction	Cut vegetation	2nd suction	Total
Enchytraeidae	5	59	8	72
Collembola[1]	2347	3655	442 (2)	6444 (2)
Acari	881 (7)	3453 (3)	725 (8)	5059 (18)
Araneae	10	6 (1)	5	21 (1)
Opiliones				
Mitopus morio	2	1	1	4
Thysanoptera	11	23	5	39
Homoptera				
Aphidoidae	85 (6)	5	1	91 (6)
Coccoidea	47 (5)	100 (3)	29 (1)	176 (9)
Cicadoidea	17	–	–	17
Heteroptera	2	–	–	2
Diptera, adult	5 (4)	9 (1)	–	14 (5)
Diptera, larva	–	8	1	9
Lepidoptera, larva	3 (2)	6	– (1)	9 (3)
Coleoptera, larva	–	1	–	1
Hymenoptera, adult	4	2	–	6
Hymenoptera, larva	1	1	1	3
Insecta, larva, pupa	1 (2)	3	2	6 (2)
	3421 (26)	7332 (8)	1220 (12)	11973 (46)

[1] The figures in brackets denote the number of individuals found when sorting the detritus after funnel extraction.

modified Tullgren funnels so that the flying component would also be collected. At the end of the extraction, after 5 days, the material was counted whilst the remaining detritus in the funnels was sorted under binoculars to check any individuals that might remain. The results are listed in Table I.

It can be seen that the fauna consists of a large number of individuals of Collembola and Acari, but this is not surprising for this sub-Arctic area. What is surprising is the large number which was not extracted from the vegetation by the 'quick trap' but collected by cutting the vegetation. Also interesting is the result of the third operational step — using the suction a second time. This includes of course a number of individuals who are naturally found on the soil surface, but also individuals who let themselves fall down during the disturbance of the first two steps. To these must be included especially Coccoidea, but also some Collembola and Acari, and even some Thysanoptera and Araneae.

It can be said that the 'quick trap' is effective for Aphidoidea and Cicadoidea, since they are especially to be found on plants and easy to get at. Only a small portion of Collembola and Acari, 16 per cent and 13 per cent respectively, were taken with the first suction. This suggests that the apparatus is less effective for animals hiding between leaves and in leaf bases etc. That the suction itself is powerful is shown by the appearance of Enchytraeidae which are not usually easy to get at. Twenty-three per cent of the Coccoidea were taken with the first suction, chiefly freeliving forms, mainly Orthezia.

The total percentage obtained in the first step was 28,6 per cent of all animals. The extraction in the funnels was satisfactory, and only 0.45 per cent of total individuals were found on checking the remaining detritus.

Although the quick trap and suction were used as described by the authors in our first operational step, 84.4 per cent of the individuals were left in the sample plot. Velocity of air at full engine speed in the narrow (10 cm = 4 inch) hose in our opparatus was between 22-30 m/sec. T. & N. had a speed somewhat in excess of 45.1 m/sec. (8120 ft/min.) It must be supposed that with a greater air velocity our results would have been better. It is quite clear, however, that an increase of velocity to 45 m/sec would not give a completely satisfactory result. It is also clear that one cannot go on increasing the air velocity because of the delicate organisms, which will be damaged by too great pressures.

T. & N. do not mention the nature of the biotope where the sampling was done. They did, however, limit the height of the vegetation to 8 inches (20 cm) below which the apparatus should be satisfactory. In our case the mean height of the dense vegetation in the area of sampling was not higher than 5-6 cm, with a few straws reaching 10-15 cm.

The number of individuals per square meter is not given in figures by T. & N. By using the diagram (l.c.) an approximate number can be obtained, giving 1800-2000 individuals per square meter. From our results, there are 10,177 individuals per half square meter; from this number, however, 71 enchytraids are to be subtracted as T. & N. only investigated arthropods. Converted to square meters this means 20,000 individuals in our material.

T. & N. do not say where their site was situated. It may be assumed that it was somewhere near Belleville, Ontario — i.e. a little to the north of 44°N, and not much above sea level. Our site is at 60° 19′ N at 1200 meters above sea level, and above the forest limit. It may also be assumed that the Canadian site is on a richer soil than the Norwegian site. This implies that the community which T. & N. investigated would contain larger artropods than ours, as can also be seen from Table I in T. & N., and that the total number of individuals would be somewhat less. However, the total number of individuals per square meter given by T. & N. appears to be a little too small.

In conclusion, it may be said that as long as the effictiveness of the apparatus has not been tested in different plant communities and the selectivity is not known, it will be necessary to make an exact test on each investigation.

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Bokanmeldelser

Hodek, I. 1966. *Ecology of Aphidophagous Insects.* Proceeding of a Symposium held in Liblice near Prague. Dr. W. Junk, The Hague. (360 pp. 78 figs., 12 plates). Price kr. 77,00.

Etter hvert som de uheldige virkninger av de kjemiske bekjempingsmidler er blitt kjent, har behovet for alternative metoder i insektbekjempingen steget. Interessen for biologisk og integrert kontroll har økt over hele verden, og tallrike er de laboratorier som har tatt opp disse metoder som forskningsoppgaver. Kanskje har særlig biologisk kontroll av bladlus vært omfattet med interesse.

Men i alt arbeide med biologisk kontroll er større kunnskap om insektenes økologi av betydning. For å sammenstille en del av den viten en har i dag, ble det i Liblice i nærheten av Praha holdt et symposium i oktober 1965 over aphidophage insekters økologi. Det deltok 84 forskere fra 17 land, og materialet som ble lagt fram under møtet har kommet i bokform. Symposiet omfattet 6 seksjoner:

1. Ernæringsøkologi hvor de aphidophage insekters vertsvalg, de forskjellige bladlus' brukbarhet som næring, mengde næring og virkning av kunstig næring på rovinsektene ble behandlet.
2. Generasjoner og diapause som vesentlig omfatter Coccinellider.
3. Adferd hvor egglegging, vertssøkning, migrasjon og aggregasjon hos de aphidophage insekter blir behandlet, likedan bladlusenes adferd.
4. De forskjellige arters utbredelse, og de forskjellige faktorer som virker inn på denne.
5. De naturlig fiender og bladlusenes populasjonsdynamikk. Her tas effektiviteten av de forskjellige predatorer og parasitter opp til diskusjon. En lang rekke bladlusarter er her tatt med, likedan den intraspesifikke konkurransen hos bladlus.
6. Biologisk og integrert kontroll som behandler forskjellige arter av bladlus, hvor også enkelte fosformidlers virkning på Coccinellider og Chrysopider er tatt med.

Som det framgår av seksjonenes innhold var det et vidt spektrum av dette problemkomplekset som ble behandlet, og bokens verdi øker ytterligere ved oppsummeringen etter hvert kapitel. Boken gir en god oversikt over hvilke emner det arbeides med i dag. For dem som arbeider med aphidophage insekter er boken uunnværlig, men også for dem som ønsker en oversikt over disse emner kan boken anbefales på det beste.

Ragnhild Sundby

Lampel, Gerolf. 1968. *Die Biologie des Blattlaus – Generationswechsels.* VEB Gustav Fischer Verlag, Jena (264 pp., 19 fig. 33 plansjer). Price: DM53,40.

Oversikt over nomenklatur for ulike bladlus morfer, utviklingsmønster og generasjonsveksling er velkommen litteratur.

I en generell del gis historisk oversikt over nomenklatur og symboler som forskjellige forfattere har nyttet for de ulike bladlus morfer. Nomenklaturen er diskutert og munner ut i forslag til mer enhetlig nomenklatur.

Boken gir innføring i de ulike morfers funksjon og plass i bladlusenes livssyklus. Et kapitel om omgivelsenes innvirkning på morf-dannelsen kunne vært mer utførlig.

I en spesiell del er det gitt en kortfattet oversikt over livssyklus innen ulike familier og arter. Familiene er behandlet hver for seg med en generell omtale. Innen hver familie følger eksempler og omtale av enkelte arter. Disse er ledsaget av illustrative plansjer som viser livssyklus og tidsskjema for de ulike faser i syklusen. Tidsangivelser og utviklingsmønster gjelder stort sett mellom-européiske forhold, med små forskyvninger vil de trolig også gjelde norske. Det hadde vært verdifullt om flere økonomisk viktige arter var representert i dette kapitel.

Boken avsluttes med et kapitel som i alfabetisk rekkefølge gir definisjoner på termer brukt til beskrivelse og omtale av bladlusenes biologi.

Særlig verdifullt er det at hvert kapitel er godt dekket med henvisninger til den viktigste litteraturen.

Chr. Stenseth

Johnson, C. G. 1969. *Migration and Dispersal of Insects by Flight.* 763 pp. Methuen, London. Price kr. 150,–.

Migrasjon er eit av dei faguttrykka som er som forundringspakkar, – ein veit ikkje på førehand kva ein forfattar har lagt i dei. Somme held på at migrasjon er ei reise ut og attende til utgangspunktet, i motsetnad til emigrasjon og immigrasjon. Andre reknar migrasjon som eit samleuttrykk som omfattar mange ulike typar av reiser som delar av ein populasjon kan føreta.

Johnson gir termen ei omfattande tyding, i første rekkje basert på kva rolle reisa spelar i arten sin sjanse til spreiing og til å finne høvelege habitatar på nye stader. Kort seir han: «Migrasjon er hovudsakeleg ei overflytting («transference») av ein ny generasjons vaksne frå ein formeiringshabitat til andre».

Migrasjonen har tre stadier. a) Utreise frå den opphavelege habitat. b) Ei flygetid som er tilstrekkeleg langvarig og uforstyrra til at alle fall ein del insekt finn fram til nye formeiringsstader. c) Å finne fram til mikrohabitat og vertorganisme reint lokalt. Boka omhandlar ikkje stadium c), — det blir rekna for å vere eit eige spesialemne. På denne bakgrunnen gir boka eit oversyn over det som er kjent om migrasjon hos insekt. Stoffet er ordna i seks hovuddelar. Etter ein generell del tar forfattaren i to delar for seg migrasjon hos det einskilde individ, og ut frå meir kollektive synsmåtar. I to delar drøftar han ulike døme på migrasjon, først korte og middels lange flyttingar spesielt sett i relasjon til insekta sin livshistorie, og deretter flytting over lange avstandar sett i relasjon til makroklimatiske tilhøve. Siste del handlar om migrasjon og habitatar, — korleis invasjonen i nye habitatar skjer og kva migrasjonen kan ha å seie økologisk sett. Her blir det også drøfta korleis migrasjonen kan påverke populasjonsdynamikken hos insekt.

Johnson har gjennom lang tid deltatt i det omfattande arbeidet om spreiing og migrasjon hos insekt som er utførd ved Rothamsted forsøksstasjon. (Mellom anna blei sugefella der utvikla til eit instrument for kvantitativ måling av insektpopulasjonar i lufta). I boka legg han fram dei synsmåtar på migrasjon som lang tids arbeid med stoffet har gitt han. Sjølv meiner han at dei syn han utviklar i boka gjer det nødvendig med ei revurdering av mange vanlege oppfatningar om migrasjon hos insekt. Han understrekar sterkt at dei store insektmassane som spreiest gjennom lufta ikkje berre er tilfeldige offer for ver og vind. Migrasjonen er derimot eit resultat av ei tilpassing hos insekta. Det er eit vanleg trekk hos mange arter at den første perioden av livet som vaksne er tilpassa til reise mellom ulike formeiringsplassar. I mange høve har dette vore ein evolusjonsmessig nødvendig konsekvens av den korte livslengda insekta har, og den raske omforming som skjer i mange habitatar.

Boka byggjer ikkje berre på arbeidet ved Rothamsted. Litteraturlista fortell litt om kor omfattande Johnsons arbeid er. Den er på 60 sider og inneheld over 1400 referansar.

Gudmund Taksdal

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NORSK ENTOMOLOGISK TIDSSKRIFT

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