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NORSK ENTOMOLOGISK FORENING

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E. SEM A/S, HALDEN

Some Coleoptera from the outer part of Sogn and Fjordane, western Norway

TROND ANDERSEN & ARNE FJELLBERG

Andersen, T. & Fjellberg, A. 1975. Some Coleoptera from the outer part of Sogn and Fjordane, western Norway. *Norw. J. Ent. 22*, 87–88.

A list of 69 species of Coleoptera new to the outer part of Sogn and Fjordane county is given. *Encephalus complicans* Westw. and *Orchesia micans* Panz. are reported for the first time from the west coast.

Trond Andersen & Arne Fjellberg, Zoological Museum, University of Bergen, N-5014 Bergen-Univ., Norway.

Below is given a list of 69 species of Coleoptera previously not collected from the outer part of Sogn and Fjordane county (Lindroth 1960, Strand 1970). The material comes from a light trap operated by Andersen at Steine in Gulen during 1973 (Andersen 1974 a, 1974 b) and from a collection made by Andersen and Fjellberg in November 1974 at different localities in Gulen (Table I). The material is deposited at Zoological Museum, Bergen.

Records from Steine in Gulen, 29 July to 19 August 1973. Light trap in thicket surrounded by pastures, heaths and moist meadows: *Cychrus caraboides* L., *Loricera pilicornis* F., *Calathus micropterus* Dft., *Catops alpinus* Gyll., *C. coracinus* Kelln., *C. tristis* Panz., *C. watsoni* Spence, *Liodes calcarata* Er., *L. oblonga* Er., *Megarthrus denticollis* Bck., *Anthobium sorbi* Gyll., *Platystethus arenarius* Fourc., *Bolitobius exoletus* Er., *Tachinus proximus* Kr., *Bolitochara lunulata* Payk., *Atheta britanniae* Bernh., *A. lateralis* Mnh., *A. monticola* Th., *A. pertyi* Heer, *Tinotus morion* Gr., *Podistra pilosa* Payk., *Malthodes flavoguttatus* Kies., *M. guttifer* Kies., *M. mysticus* Kies., *Denticollis linearis* L., *Cryptophagus setulosus* Sturm, *Lathridius nodifer* Westw., *Anaspis rufilabris Gyll.*, *Orchesia micans* Panz., *Serica brunnea* L., *Luperus longicornis* F., *Deporaus mannerheimi* Humm., *Polydrosus undatus* F. and *Micrelus ericae* Gyll.

Collected on 20 Nov. 1974: *Notiophilus germinyi* Fauv., *Calluna* heath at Grindevann; *Bembidion bruxellense* Westm., brackish meadow at Eide; *Bradycellus collaris* Payk., *Calluna* heath at Grindevann; *B. similis* Dej., *Calluna* marsh at Iledalselva; *Pterostichus diligens* Sturm, brackish meadow at Eide; *Agonum ericeti* Panz.,*Alnus* wood at Grindevann; *A. fuliginosum* Panz., meadow at river in Fjordsdalen; *Dromius quadrinotatus* Panz., in *Pinus* bark at Iledalselva; *Cercyon analis* Payk., litter in moist, deciduous wood at Eivindvik. *Laccobus minutus* L. and *Chaetraria seminulum* Hbst., brackish meadow at Eide; *Nanoptilium kunzei* Heer, in old horse dung at Grindevann; *Megarthrus sinuatocollis* Lac., litter in moist, deciduous wood at Eivindvik; *Olophrum piceum* Gyll. and *Oxytelus laqueatus* Mrsh., moist meadow at Grindevann; *Lathrobium brunnipes* F. and

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

Locality	UTM reference
Breivik	32VKN966735
Dale	32VKN928615
Dalsøyra	32VKN907617
Eide	32VKN892540
Eivindvik	32VKN878673
Fjordsdalen	32VLN100651
Grindevann	32VKN905585
Halsvik	32VKN883518
Iledalselva, Calluna marsh	32VKN898519
Iledalselva, pine wood	32VKN902522
Rutledal	32VKN945771
Steine	32VKN893535
Svaberget	32VKN917661
Vardefjell	32VLN075658

Philonthus nigrita Gr., *Calluna* marsh at Iledalselva; *Quedius boops* Gr., sup-alpine meadow at Vardefjell; *Q. fuliginosus* Gr., brackish meadow at Eide; *Q nigriceps* Kr., *Pinus* litter at Iledalselva; *Myllaena kraatzi* Sharp, *Calluna* heath at Svaberget; *Encephalus complicans* Westw., litter in moist, deciduous wood at Eivindvik; *Atheta alpestris* Heer, *Calluna* heath at Svaberget; *A. arctica* Th., sub-alpine meadow at Vardefjell; *A. harwoodi* Will., rotten sea-weed at Breivik; *A. oblongiuscula* Sharp, moist deciduous wood at Eivindvik; *Meotica apicalis* Bck., grass tufts and debris by shore at Halsvik; *Oxypoda haemorrhoa* Mnh., old *Formica* hill on marsh at Iledalselva; *O. procerula* Mnh., moist meadows at Grindevann and Fjordsdalen; *Tinotus morion* Gr., litter in *Populus* wood at Rutledal; *Coccinella hieroglyphica* L., *Calluna* marsh at Iledalselva; *Phyllodecta vitellinae* L., in moss on *Populus tremula* at Rutledal and *Brachonyx pineti* Payk., *Pinus* litter at Iledalselva.

In addition, Andersen found *Dianous coerulescens* Gyll. on stones by the river in Dale and *Deporaus betulae* L. at Dalsøyra on 8 May 1973.

Most of the species in the list are common and widely distributed in Norway, but the records of *Encephalus complicans* and *Orchesia micans* are the first from the west coast. The two species *Atheta pertyi* and *A. britanniae* are apparently restricted to the coast from Agder to Møre. The latter was first reported from Norway by Strand (1965).

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Relative response to coloured substrates by ovipositing black-flies (Diptera, Simuliidae). II. Oviposition by *Simulium (Odagmia) ornatum* Meigen

V. I. GOLINI & D. M. DAVIES

Golini, V. I. & Davies, D. M. 1975. Relative response to coloured substrates by ovipositing black-flies (Diptera, Simuliidae). II. Oviposition by *Simulium (Odagmia) ornatum* Meigen. *Norw. J. Ent.* 22, 89-94.

Gravid females of *Simulium ornatum* comprised 98% of 1,994 simuliids trapped on test strips on the Renåa river in the Rendalen region, Norway. Two sets of sticky strips, six coloured and four neutral, were exposed over the black background of the river bed. The flies landed more frequently on green and yellow than on purple, blue, orange, and red strips. They landed also more frequently on white and light-grey than on dark-grey and black strips. The relative attractance among the coloured strips varied inversely with the intensity ratio 325–450 mμ over 450–700 mμ and 450–500 mμ over 500–550 mμ. Among the neutral strips the relative attractance varied directly with reflectance and inversely with the intensity ratio 325–450 mμ over 450–700 mμ, but only up to the 27% relative reflectance level.

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Previous workers have reported that several simuliid species oviposit on vegetation trailing on the surface of streams and rivers (Jobbins-Pomeroy 1916, Wu 1931, Smart 1934, Zahar 1951, Davies & Peterson 1956, Muirhead-Thomson 1956, L. Davies 1957, Carlsson 1962). Additional studies have shown that during oviposition females of *Simulium verecundum* Stone & Jamnback and *Simulium vittatum* Zetterstedt oviposit on certain coloured substrates more frequently than on others (Golini 1970, Golini & Davies 1975). During a cooperative research project on simuliids in the Rendalen region of Norway (Eide et al. 1969), simuliid eggs were found amassed on submerged leaves of willow (*Salix* spp.) along the banks of the Renåa river. Experiments were subsequently made to determine (1) what species of simuliids were ovipositing on these leaves and (2) whether the behavioural response of these simuliids to coloured oviposition substrates was similar to that observed with other simuliid species.

MATERIALS AND METHODS

The general habitat in the Rendalen region, Norway (61°45′N, 11°38′E) was described previously (Golini 1970, Davies et al. 1971). Oviposition experiments were made on the Renåa river, 1 km upstream from the Renådalen seter. The eastern and western slopes of the valley are drained by numerous shallow streams having an average width of 50 cm. During late spring and early summer these tributaries carry much water from snow-melt and rain into the Renåa river. In early summer this river has an average width and depth of about 4 m and 50 cm respectively along its swifter segments. The oviposition site was located approximately 45 m upstream from the remnants of an old wooden dam. The first 40 m of the stream just above the dam consisted of a lacuna about 5 m wide and 1 m deep, which was flanked by marshy terrain abounding in aquatic vegetation, mainly *Typha latifolia* L. and *Sparganium* sp. The next 45 m upstream from the lacuna consisted of a swift section flowing at ca. 45 cm/sec over a black, stony river bed with an average width and depth of 3 m and 45 cm respectively. The banks of this part of the river contained an abundance of shrubby *Salix* spp., predominantly *S. caprea* L. and *S. reticulata* L. The branches and leaves of these plants were often partly submerged in the water current and provided suitable substrate for ovipositing simulids.

Strips of paper towel (25 cm × 2.5 cm) were coated on both sides with vinyl plastic paint so that a series of light colours across the spectrum were produced having relatively similar total luminous reflectances, close to the Munsell intensity notation 7 (for fuller detail see Golini & Davies (1975)). Other strips were painted to produce four neutral (achromatic) shades (black, two greys and white). These strips were floated over the Renåa river where there was a natural black stony bottom. A wooden float supported the strips which floated on the water parallel to each other at 12 cm intervals, each simulating a blade of grass. The float with the six coloured strips was placed on the water adjacent to the north shore, and the one with the four neutral strips along the south shore of the river (Fig. 1). During the 1967 season each strip was coated on both surfaces with Bird-Tanglefoot ® and floated as described previously (Colini & Davies 1975). Strips with gravid simuliids caught on the sticky surfaces were removed almost daily (see dates in Table I) in early afternoon, and replaced with new sticky strips. The order of the strips attached to the two floats was randomized for each test. Trapped adult simuliids were preserved in 70% ethanol, eventually cleaned of Tanglefoot with ethyl acetate and ethanol solution, and identified to species. Similar experiments were repeated at the same site during the 1968 season with non-sticky strips. The spectral reflectances of the test strips were analyzed spectrophotometrically from 325–700 mμ by the Defence Research Board of Canada (Golini & Davies 1975).

Fig. 1. Oviposition strips floating on the water surface of the Renåa river in mid-July 1967. Six coloured strips in front and four neutral strips upstream. The former were moved to the opposite bank before experiments were begun.

OBSERVATIONS AND RESULTS

The site for the oviposition experiments along the Renåa river was selected after several leaves of willow (*Salix* spp.) and cattail (*Typha latifolia* L.) were found covered with large masses of simuliid eggs. These eggs were laid in irregular masses up to 8 layers deep, and thus indicated that many female simuliids were ovipositing in groups along certain sections of the river. Before the experiments were begun, in mid-July 1967, oviposition had already started and it decreased abruptly after the beginning of August. Oviposition was observed to occur mainly before and soon after sunset during clement weather, and gravid simuliids were trapped almost daily on the sticky strips. A total of five simuliid species comprising 1,994 gravid females were trapped in ten tests, and of these, 98% were *Simulium ornatum* Meigen (Table

Table I. Relative Species Abundance of Gravid Female Simuliids Trapped while Landing on Ten Sticky Oviposition Strips Floating on the Renaa river, Rendalen, Norway, during the 1967 Season.

	Number of gravid females											
	July							August				
Simuliid species	17	18	25	26	27	29	31	1	2	9	Total	Percent
Schoenbaueria pusilla Fries	0	0	0	0	1	0	10	1	2	0	14	0.7
Gnus rostratum Lundst.	1	0	1	2	0	0	0	0	2	0	6	0.3
Simulium morsitans Edw.	0	1	0	0	0	0	0	1	0	0	2	0.1
Simulium vulgare Rubtz.	0	0	1	2	2	6	2	0	0	0	13	0.6
Simulium ornatum Mg.	335	212	54	351	357	148	226	200	14	62	1959[a]	98.1
Total number of flies	336	213	56	355	360	154	238	202	16	62	1994	

[a] This includes 945 gravid females from the four neutral strips, and 1014 from the six coloured strips.

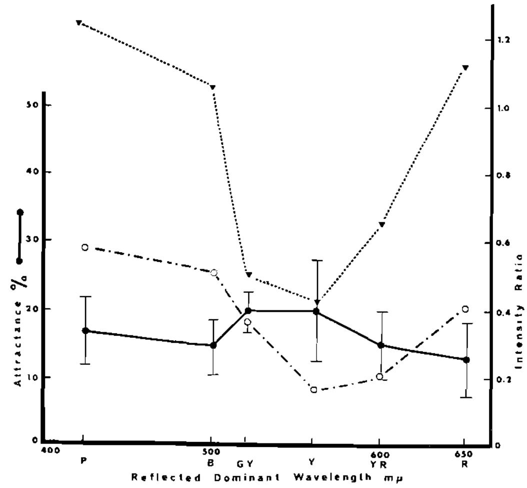

Fig. 2. The relative attractance of oviposition strips (coated with Tanglefoot) to gravid females of *Simulium ornatum*, expressed as the mean percent of the number of gravid females trapped on each sticky strip. (●——●). The standard error of the means (vertical bars) was calculated at 80% confidence limits. The strips were floated over the black, stream-bed background. Two reflectance ratios are shown, namely 325–450 mμ/450–700 mμ (o– – –o) and 450–500 mμ/500–550 mμ (v——v). There were 10 tests involving 1,014 females which were trapped on six coloured strips (P = purple, B = blue, GY = green, Y = yellow, YR = orange, R = red).

I). The average number of mature eggs dissected from 4 gravid *S. ornatum* females was 304 (min. = 172, max. = 570) and the average dimensions of 40 randomly selected mature eggs agreed with those of Smart (1934), namely 0.30 mm × 0.17 mm × 0.16 mm. A total of 1,014 females of this species were caught on the six coloured strips, and the remainder on the four neutral strips. These flies landed most frequently on the green and yellow strips, each of which showed a relative attractance of 20%. The purple, blue, orange and red strips received fewer landings with the relative attractance decreasing to approximately 15% on either side of the green-yellow peak (Fig. 2). With the neutral strips a total of 945 females of *S. ornatum* landed with almost equal frequencies on the white and light-grey strips which showed a relative attractance of about 30%; the dark-grey and black strips received fewer but equal numbers of landings, showing an average relative attractance of 20% (Fig. 3).

Similar experiments were repeated at the same site in 1968 with non-sticky strips. It was hypothesized from previous work (Golini & Davies 1975) that, if simuliids were allowed to oviposit freely on non-sticky strips, their selection of the substrate colours would

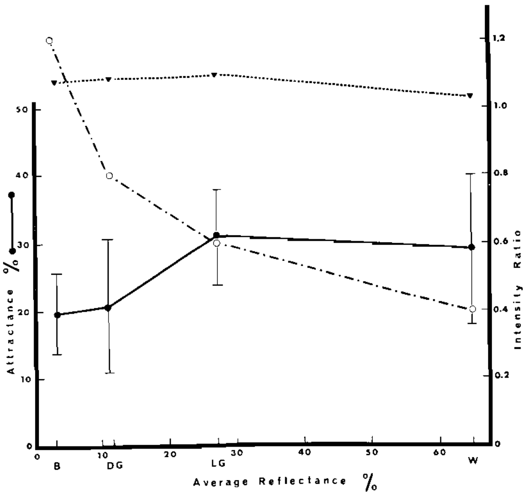

Fig. 3. Conditions and treatment are explained in Fig. 2. There were 10 tests involving 945 gravid females of *S. ornatum* which were trapped on four achromatic, sticky, oviposition strips (B = black, DG = dark-grey, LG = light-grey, W = white).

have resulted in a more definite pattern. However, during this season only few eggs were found on all ten strips, and this made it valueless to compare the relative response to coloured substrates during actual oviposition of *S. ornatum.*

DISCUSSION

Communal oviposition by *S. ornatum* on emergent, aquatic vegetation has been reported previously from Great Britain (Britten 1922, Smart 1934, Zahar 1951, L. Davies 1957). Britten (1922) observed females of *S. ornatum* on 24 May 'busy' ovipositing, together with *S. latipes* Mg., on the leaves of reed-grass, *Phalaris arundinacea* L., floating on water. He observed both species crawling down both surfaces of leaves and occasionally descending from 1.3 to 3.8 cm below the water surface. 'In most cases, both surfaces of leaves were equally thickly coated with the ova, and on many of the leaves several flies had been actually coated with the ova of their companions, and so were unable to escape.' One of these egg masses was estimated to be 7.6 cm long ond 5.1 cm wide and to contain many thousand eggs. Similarly, Smart (1934) observed females of *S. ornatum* ovipositing on both sides of leaves of *Glyceria fluitans* (L.). The eggs were laid with no definite orientation in several layers in a gelatinous matrix. Often adjacent leaves were cemented together by the adhering egg masses. These flies began depositing their eggs just where the leaf broke the water surface in relatively fast-flowing waters. He also found that flies occasionally became trapped and died in their own egg masses.

These reports are similar to observations made on ovipositing *S. ornatum* in Norway. Although, in the present study, flies were observed to lay eggs in similarly large irregular masses on leaves of semi-aquatic plants, they were not observed to crawl down the leaves below the water surface. In addition, the prevalence of ovipositing flies found at certain sites and not other similarly suitable ones is a phenomenon probably related to their communal oviposition habit. L. Davies (1957) found that ovipositing females of *S. ornatum* were active only in the period between sunset and dusk, and observed that females oviposited on *Glyceria* sp. at certain sites and not others. He partly attributed this differential attractiveness of similar ovisites to 'the highly communal oviposition habits of this species' which may be modifed by changing weather factors. In an attempt to quantify the oviposition activity of *S. ornatum*, Davies (1957) trapped ovipositing females weekly in varying numbers from late April to early November. Oviposition peaks were found in mid-May, late June to mid-July, mid-September, and mid-October. In Norway, gravid females of *S. ornatum* were trapped in relative abundance throughout the latter half of July 1967 but numbers decreased sharply after the beginning of August (Table I). The reduced level of oviposition in 1968 was probably the result of a smaller population of *S. ornatum* during this particular season. In fact, fewer females were captured from cows and humans in late June and early July 1968 than in 1967 (Golini 1970). The dry early-spring and an early summer heat wave in 1968 (Davies et al. 1971) were probably the major factors that reduced the survival of *S. ornatum.*

Response to light reflected from neutral strips

In a study of the response of gravid females of *S. verecundum* in Canada, it was found that their landing was affected primarily by the intensity of light reflected from the test strips, but that this was modified by the light intensity reflected from the stream bed, which provided a background for the strips (Golini & Davies 1975). Thus, *S. verecundum* females showed a much greater response to intensity differences among the neutral strips when they were floated over a mid-brown background than over a black background. The results, described above, for the response of *S. ornatum* females in Norway are similar to those for *S. verecundum* females responding to neutral strips over a black background, i.e. that the response to white and light-grey was almost the same, but greater than that to dark-grey and black. Also when using non-sticky strips, on which gravid *S. verecundum* females could oviposit freely, the difference in response to strips reflecting various intensities was much greater than with sticky strips (Golini & Davies 1975). This was attributed to two effects. First, in communal oviposition with limited substrates for oviposition, females may land momentarily one or more times before selecting the strip of preferred luminous reflectance on which to oviposit. Gusty winds may accentuate this behaviour. With sticky strips the fly is trapped on the first landing. Second, the most attractive lighter sticky strips become covered more rapidly with dark bodies of black-flies which makes these strips increasingly less attractive. Therefore, it seems that the weakness in the trend of the response of gravid *S. ornatum* females to the intensity of light reflected from the neutral strips is related both to the dark stream bed and to the fact that the strips were coated with Tanglefoot. Nevertheless, the attractance of the neutral strips to gravid *S. ornatum* females varied directly with their reflectance and inversely with the reflectance ratio of 325–450 mμ over 450–700 mμ, but only up to the 27% relative reflectance level.

The response to reflected light intensities by *S. ornatum* during oviposition was exactly opposite to that shown during the host-seeking phase. Experiments with black and white suction traps baited with equal quantities of CO_2 have shown that *S. ornatum* females were attracted to the black and the white traps in a ratio of 6 to 1 (Golin 1970). L. Davies (1957) reported that this species preferred to land and feed on the shaded (darker) undersurface of cattle.

Response to light reflected from strips of different hues

Gravid females of *S. ornatum* selected green and yellow sticky oviposition strips more frequently than purple and blue or orange and red. Although these differences were statistically insignificant, they were similar to the pattern found with gravid females of *S. verecundum* (Golini & Davies 1975) and of *S. vittatum* (Golini 1970). Similar to the results mentioned above for the neutral strips, the difference in attractance for *S. verecundum* between the coloured strips is much greater with a moderately light background than with a black one (Golini & Daves 1975), and this would probably have been true for *S. ornatum*. Similarly, the secondary effect of lower background reflectance reduced the attractance of green and yellow and increased that of blue and purple. Also with *S. verecundum*, the use of sticky rather than non-sticky strips reduced the differences in attractance between the coloured strips (Golini & Davies 1975), for the reasons mentioned above concerning the neutral strips. The attractance of these coloured strips for *S. ornatum* females was inversely related to the reflectance ratios 325–450 mμ/450–700 mμ and 450–500 mμ/500–550 mμ, as was previously discussed for *S. verecundum* (Golini & Davies 1975).

Thus, as these coloured strips were prepared with the intent of keeping the average reflectance from 325–700 mμ relatively similar, the gravid females of *S. ornatum* appeared to discriminate between the colours, as well as between different intensities, of the light reflected from the oviposition strips. This had previously been found with simuliid species in Canada (Peschken & Thorsteinson 1965, Golini 1970, Golini & Davies 1975).

Although there are as yet no observations, it is highly probable that host-seeking females of *S. ornatum* would select purple, blue and red rather than green, yellow and orange, as has been found for *S. venustum* (Davies 1961, 1972).

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Four Lepidoptera new to Norway

TROND ANDERSEN & ARILD FJELDSÅ

Andersen, T. & Fjeldså, A. 1975. Four Lepidoptera new to Norway. *Norw. J. Ent.* 22, 95–98.

Four species of Lepidoptera new to Norway are reported: *Cilix glaucata* (Scop.) (Drepanidae), *Macrochilo cribrumalis* (Hb.) (Plusiidae), *Bapta bimaculata* (Fabr.) (Geometridae) and *Apoda avellana* (L.) (Heterogenidae). Food plants and distributions are mentioned. *B. bimaculata* has probably colonized the south-eastern parts of Vestfold during the last years.

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Four Macrolepidoptera, new to Norway, were obtained by continuous collecting from early spring to late autumn 1974 in the county of Vestfold.

Cilix glaucata (Scopoli 1763)

Localities: Ve: Moutmarka, Tjøme (UTM: 32VNL802489) 19 May 1974 1 ♂; Mostranda, Tjøme (UTM: 32VNL801497) 22–25 Aug. 1974 1 ♀.

The male was netted just after 23 hrs. among shrubs of *Salix* spp., *Corylus avellana* L. and *Prunus spinosa* L. The female (second generation) was caught in a light-trap one kilometer from the first locality. The Mostranda–Moutmarka area is a wide and open wasteland along a two kilometer long coastline, mainly with dry, partly washed moraines, but also with exposed rock and humid meadows. Low shrubs, some places continuous thickets, are covering sheltered places. The larva is reported to feed on *P. spinosa*, but also on other *Prunus* spp., *Crataegus* and even on *Pyrus* and *Malus* (Edelsten & Fletcher 1961, Nordström et al. 1941).

The distribution includes probably the greater part of the Palaearctic region from Ussuri and Amur to North Africa, also South-Central- and parts of North Europe (Strand 1911). It reaches as far north as Scotland (Clydesdale), Denmark (North East Jutland), Sweden (Skåne, Blekinge, Småland, Öland, Gotland and one isolated locality in Bohuslän), and Polonia (Gdansk) (Edelsten & Fletcher 1961, Hoffmeyer 1960, Nordström et al. 1961). The present record of *C. glaucata* is the northernmost in Europe.

Macrochilo cribrumalis (Hübner 1793)

Localities: Ve: Robergsmyra, Stokke (UTM: 32VNL773679) 11 July 1974 6 ♂♂; Gullkronen, Sem (UTM: 32VNL786726) 19–27 July 1974 2 ♂♂; Borrevann, Borre (UTM: 32VNL818850) 7 July 1974 1 ♂.

A single male was netted at Lake Borrevann an hour after sunset in the wide *Scirpus lacustris* L. zone at the south end of the lake. At Robergsmyra the species apparently occurred commonly in the wettest part of the bog; the dominating vegetation was *Typha latifolia* L., *S. lacustris*, *Carex* spp., and *Cicuta virosa* L. We arrived at sunset, but the species was not observed until midnight. The specimens from Gullkronen were captured in a light-trap situated in a deciduous wood, which once marked the northern boundary of a large fen-land. Remnants of the fen lie some hundred meters to the south of the trap and deep ditches with *Phragmites communis* Trin. and *Scirpus silvaticus* L. still border the wood. The larva feeds on *Carex, Luzula* etc. (Nordström et al. 1941).

M. cribrumalis is locally distributed in Europe (Warren 1913). The range extends north up to SE England, Eastern Denmark, Dalarne and Hälsingland in Sweden, Alandia and Tavastia australis in Finland, and Ingria borealis in USSR (Edelsten & Fletcher 1961, Nordström et al. 1969). The species has not been recorded from the Swedish provinces east of the Oslofjord area.

Bapta bimaculata (Fabricius 1775)

Localities: Ve: Moutmarka, Tjøme (UTM: 32VNL804486) 19 May 1974; Gunnarsrød, Tjøme (UTM: 32VNL813490) 26 May 1974; Mostranda, Tjøme (UTM: 32VNL801497) 20 May–28 June 1974; Treidene, Tjøme (UTM: 32VNL806499) 25 May 1974; Havna, Tjøme (UTM:32VNL812505) 27 June–3 July 1974; Kolabekkilen, Tjøme (UTM:32VNL806514) 26 May, 16 June 1974; Kjære, Tjøme (UTM: 32VNL804527) 17 June 1974; Lindhøy, Tjøme (UTM: 32VNL795542) 17 June 1974; N. Sundene, Tjøme (UTM: 32VNL798596) 21 June 1974; Strengsdalsvann, Nøtterøy (UTM: 32VNL808623) 18 June 1974; Bjønnes, Nøtterøy (UTM: 32VNL815658) 3 June 1974; Magnhildås, Nøtterøy (UTM: 32VNL-799664) 12 June 1974; Bjørnebu, Foynland, Nøtterøy (UTM: 32VNL822677) 14 May 1974; Herstad, Nøtterøy (UTM: 32VNL-804677) 23–25 May 1974; Gjennestadmyra, Stokke (UTM: 32VNL718664) 30 June 1974; Robergsmyra, Stokke (UTM: 32VNL773679) 3 June 1974; Aker, Sem (UTM: 32VNL-763713) 22 May 1974; Gullkronen, Sem (UTM: 32VNL786726) 14 May–8 July 1974; Frodeåsen, Tønsberg (UTM: 32VNL8072) 18 May–12 June 1974; Bastøy, Borre (UTM: 32VNL863843) 9 June–4 July 1974.

The species was caught frequently in all localities, perhaps less commonly at Mostranda. No preference for any particular kind of biotope could be detected. As a matter of fact the species was found in all localities visited in the evening during the month of June, both near bogs, in deciduous woods and on rocky, dry grounds. The flight-activity began in the evening, but occasional specimens were spotted in the daytime resting on the upper side of leaves. At Gullkronen nearly seventy specimens were caught in a light-trap during one night. Totally more than a thousand specimens were obtained. For comparison the corresponding number of *Bapta temerata* (Denis & Schiffermüller 1775) was about thirty. The larva is polyphagous and feeds on various deciduous trees, especially *Prunus* spp. (Hoffmeyer 1966).

B. bimaculata is distributed in Eastern Asia, East, Central and Northern Europe (Prout 1915). It occurs north up to Cumberland in England, North Jutland in Denmark, Västergötland and Närke in Sweden, Tavastia australis and Savonia australis in Finland and near Petrosavodsk in USSR (Edelsten & Fletcher 1961, Hoffmeyer 1966, Kaisila 1962, Nordström 1943, 1953).

Apoda avellana (Linnaeus 1758) (Syn.: *limacodes* (Hufnagel 1766))

Locality: Ve: Mostranda, Tjøme (UTM: 32VNL801497) 14 June 1 ♂, 15 June 1 ♂, 22 June 1 ♂, 23 June 1 ♂, 28 June–3 July 1974 1 ♀.

The first specimen was netted in sunny weather at 04.30 hrs., flying to and fro between the branches of a *Quercus*. The other specimens were caught in a light-trap. The hardwood at the locality consists mainly of *Quercus* and a few scattered specimens of *Populus tremula* L., *Corylus avellana* L., and *Sorbus aucuparia* L. The larva feeds on a number of deciduous trees such as *Fagus, Quercus, Prunus spinosa* L., *Crataegus* etc. (Nordström et al. 1941).

A. avellana is distributed in Europe; the range extends from the Black Sea, Asia Minor and the Mediterranean north up to Worcestershire and Suffolk in England, North Jutland in Denmark, most Swedish provinces south of Bohuslän and Uppland and Ösel in Estonia (Edelsten & Fletcher 1961, Hoffmeyer 1960, Nordström et al. 1961, Seitz 1912).

DISCUSSION

Bapta bimaculata must be regarded as a recent addition to the Norwegian fauna. It is known to have expanded its range (Kaisila 1962) and increased its frequency within its previous range (Lempke 1970) in other parts of Northern and Central Europe. However, its present limits of range in our neighbouring countries seem to have been established for some years. Since contiguous localities have not been investigated continually for the last years, evaluation of its sudden appearance in the SE Vestfold will remain speculative. The species may have spread from other places in Vestfold or from adjacent provinces. It may also have reached Vestfold directly, e.g. via places like the island of Tjøme.

B. bimaculata did not occur on Tjøme or Nøtterøy in 1968–70, since several collectors visited these islands and collected continuously for long periods. Besides, three of the localities mentioned above were worked with light-traps in the flight-period for the species, one of them already in 1968. *B. bimaculata* is a conspicuous species, easily obtainable in light-traps or with a net in the evening. It can hardly escape the attention of collectors for long. Because of the short distances it is reasonable to assume that the species at present occur in Østfold, and perhaps also in outer Telemark.

Macrochilo cribrumalis is probably an overlooked species because of its biotopes. *Cilix glaucata* and *Apoda avellana* are possibly rare and restricted to localities with optimal conditions, as is often the case with marginal populations.

ACKNOWLEDGEMENTS

We are indebted to Dr. S.-A. Bengtson for criticism of the manuscript. We also witsh to thank G. W. Wedel Jarlsberg, Esq., without whose help it would not have been possible to run a light-trap continuously at Gullkronen, Sem.

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Norwegian stoneflies. IV. Laboratory studies on ecological factors influencing distribution

ALBERT LILLEHAMMER

Lillehammer, A. 1975. Norwegian stoneflies. IV. Laboratory studies on ecological factors influencing distribution. *Norw. J. Ent. 22,* 99–108.

This work describes studies of egg incubation period, nymphal growth and emergence and substratum preference of a number of Norwegian stoneflies. In addition the longevity of adult females was recorded. A marked intraspecific variation was visible in the length of the egg incubation period and the length of the nymphal growth period and emergence. A higher temperature than normal during late autumn and early winter shortened the development time, giving rise to early emergence in three species investigated while there were no differences in the photoperiod. The study showed that several stonefly species could go through their life cycle when given only fallen leaves as food. A shortage of food produced a lengthening of the development period and a later emergence in two species investigated. An interaction between the temperature and the amount of food seems to be a major regulating factor in the life cycle of stoneflies and in this way may effect the distribution. Between nymphs of the species *Capnopsis schilleri* and *Leuctra hippopus* there were clear differences in substratum preference.

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The field work on distribution (Lillehammer 1974b) and field studies of factors influencing distribution (Lillehammer 1975) indicated that temperature, food and substratum were among the main factors effecting distribution. This led to a laboratory study of egg, incubation period, nymphal growth, substratum preference of nymphs and adult life span.

Authors such as Miller (1939), Hynes (1941) and Brinck (1949) have discussed the incubation period of stonefly eggs and experimental studies on the egg incubation period of a number of Plecopteran species have been carried out by Khoo (1964a), by Brittain (1971, 1973) on *Nemoura avicularis* and by Harper (1973) on nine North-American species. They all stressed that egg incubation period were affected by temperature.

In this work the first aim was therefore to document intraspecific variation in the incubation period in eggs from the same female and in eggs from different females originating both from the same population and from widely separated populations. In this a representative number of herbivorous species from different families were chosen. Secondly, the length of the incubation period in species reared of the same temperature was compared. Included in these studies were also little known species such as *Nemoura arctica, N. viki* and *Capnopsis schilleri.*

Nymphal growth has been mostly studied in field, but workers such as Khoo (1964a) and Brittain (1971, 1973) have studied some European species and Harper (1973) some North-American species in the laboratory. They stressed that nymphal growth was affected by temperature.

In this work, however, the length of the nymphal growth period and emergence were studied in three species to see if the emergence time was mostly bound to the temperature range as had been indicated by Lillehammer (1975a). The temperature was held as con stant as possible and the nymphs were reared in darkness. The species chosen, *Leuctra hippopus*, *Capnopsis schilleri* and *Capnia atra* have different distributions in Norway (Lillehammer 1974b) and they are all spring emerging species.

Lillehammer (1975a) mentioned also that the amount of food available to the nymphs could influence growth and produce differences in emergence. For a study of this, two species *Leuctra hippopus* and *Nemoura cinerea* were chosen. Both of them occur over the whole country, but they have a quite different distribution at high altitudes. The food of herbivorous nymphs, mainly allochthonous matter, is often scarce at high altitudes (Lillehammer 1974b).

Substratum preference has been studied in the field by several authors including Hynes (1941), Brinck (1949), Ulfstrand (1967, 1968) and Lillehammer (1975), who showed that certain species seemed to have a preference for particular substratum while others seemed to be more indifferent.

In this work two species, *Capnopsis schilleri* and *Leuctra hippopus,* which show considerable differences in their distribution in Norway (Lillehammer 1974b) and in which field studies (Lillehammer 1975a) seemed to indicate differences in substratum preference, were further studied under controlled conditions.

Finally the life span of females was recorded in several species, many of them not studied before.

REARING METHODS

Methods of rearing stoneflies have been described by Khoo (1964a), Bjarnov & Thorup (1970) and Kapoor (1972). Kapoor reared the nymphs in running water, imitating natural conditions, while Bjarnov & Thorup used small glass still water aquaria.

In the present studies the life cycles of several Plecopteran species were studied in still water in glass aquaria placed in refrigerators to control the temperature at a suitable level.

Adults were collected, brought to the laboratory and kept at 10°C in transparent plastic boxes (17 × 11 × 4.7 cm) to which leaves and twigs from *Salix* spps., *Alnus* spps., *Betula* spps. and *Populus tremulus* and small petri dishes (diameter 5.5 cm) containing water taken from the same locality as the adults were added.

After oviposition the petri dishes containing eggs were removed and placed in refrigerators. Development was followed and the number of nymphs hatching each day was noted. After hatching the nymphs were placed in rearing aquaria consisting of petri dishes with a diameter of 20 cm and a height of 3 cm.

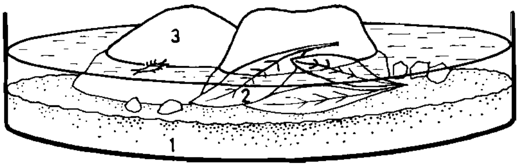

Fig. 1. Rearing aquarium filled with sand, gravel, small stones, leaves and some detritus. 1. fine substratum, sand and gravel. 2. Leaves and small stones on the surface. 3. Stones reaching over the water edge.

The rearing aquaria were partially filled with sand and gravel, small stones, leaves and some detritus (Fig. 1). They were then filled with water taken from the same locality as the adults and allowed to stand for a week before nymphs were introduced, thus permitting the establishment of a microfauna and flora which is believed to keep the aquarium stable during the whole life cycle of the species. The only food given to the nymphs was leaves. The dishes were refilled with fresh water to maintain a constant water level.

Temperature in the rearing refrigerators was usually measured daily. In refrigerator I the mean temperature was 4.04°C (standard deviation 0.7), range 2.5°–6.0°. About 70% of the values were between 3.3 and 4.7°C. In refrigerator II the mean temperature was 8.1°C (standard deviation 0.8), range 6.0°–11.0°C. About 70% of the variation was between 7.3° and 8.9°C. The eggs were kept at 4°C. The nymphs were reared at both 4° and 8°.

The eggs were kept in darkness at low temperatures, which were chosen to compare the species under the same conditions to see if they responded differently to the same stimuli. This gave a basis for a comparison of the length of the incubation period between the species. The eggs were reared at 4°C because this was found to be the best temperature to hold fungal growth at a low level although a low temperature can extend the

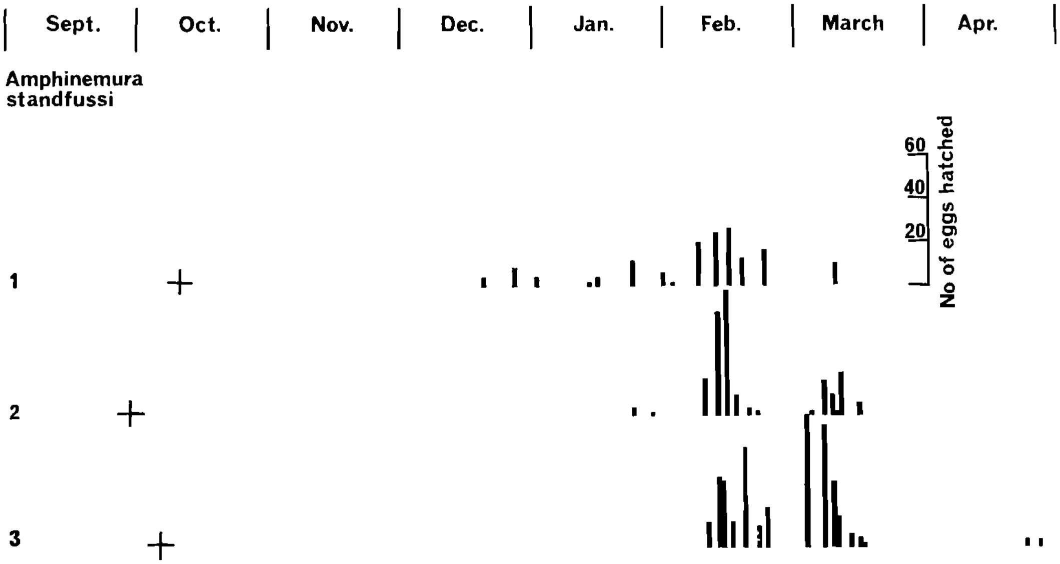

Fig. 2. Oviposition (+), length of the incubation period and hatching of eggs from females of *Amphinemura stadfussi.*

incubation period. In all species the comparison were made between specimens reared in the same temperature regime.

EGG INCUBATION PERIOD

Eggs from three *Amphinemura standfussi* females taken at Øvre Heimdalsvann were reared and showed differences both in the incubation period and the duration of hatching (Fig. 2). The three egg batches from different females had incubation periods varying from 70 to 126 days and a duration of the hatching from 5 to 87 days. However, where the hatching had a long duration the last eggs to hatch had a much longer incubation period. The incubation period of the last eggs of *A. standfussi* to hatch might therefore have a duration of more than 200 days. However, eggs from the three females laid at the beginning of October, had their main hatching period from about 10th February to 10th March, indicating that in general there are less differences.

The northern Nemourids *Nemoura arctica* and *N. viki* together with the umbiquitous *N. cinerea* were all taken as adults near Kautokeino in Finnmark and the eggs showed less variation in incubation period than *A. standfussi* (Fig. 3). Eggs from three females of *N. viki* needed 31, 25 and 48 days before they started hatching. The duration of the hatching period was 4, 6 and 8 days respectively. Eggs from two *N. arctica* females took 36 and 37 days before hatching commenced and the duration of the hatching was 29 and 21 days respectively. Finally, eggs from two females of *N. cinerea* took 40 and 43 days before they began to hatch and the duration of hatching was only 4 and 3 days respectively.

Eggs from two females of *Nemurella picteti,* taken at Halvfjordingsvatn, Odda at about 1000 m a.s.l. in the Middle-Alpine belt, had incubation periods of 52 and 53 days (Fig. 4). The duration of hatching was 8 and 12 days respectively.

The intraspecific variation in incubation period was also studied in *Capnia atra* and *Capnopsis schilleri.* The material consisted of eggs of *Capnia atra* from five localities and two females of *Capnopsis schilleri* from the same locality. Females of *Capnia atra* were taken from different areas to determine whether there were marked differences among them. Two eggs batches laid by different

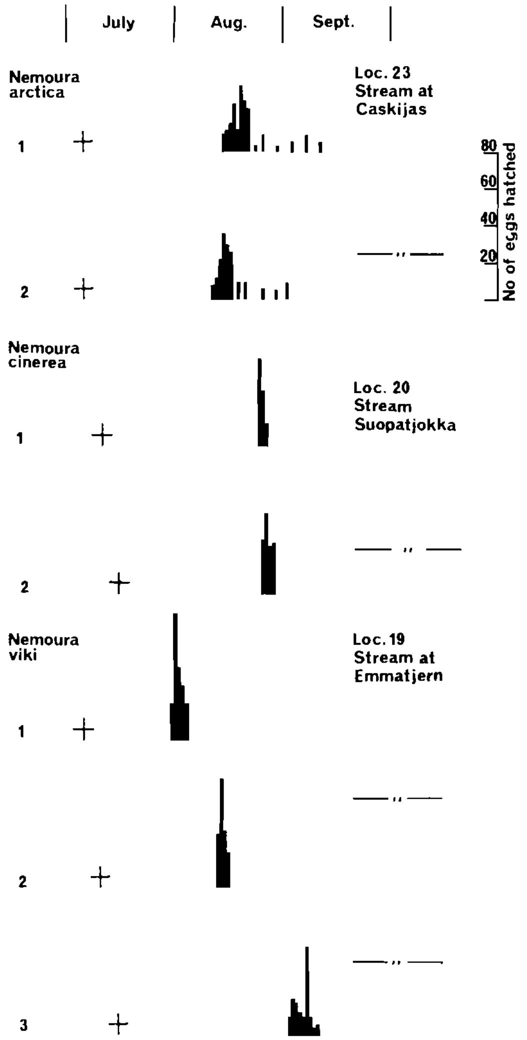

Fig. 3. Oviposition (+), length of the incubation period and hatching of eggs from females of *Nemoura arctica, N. cinerea* and *N. viki.*

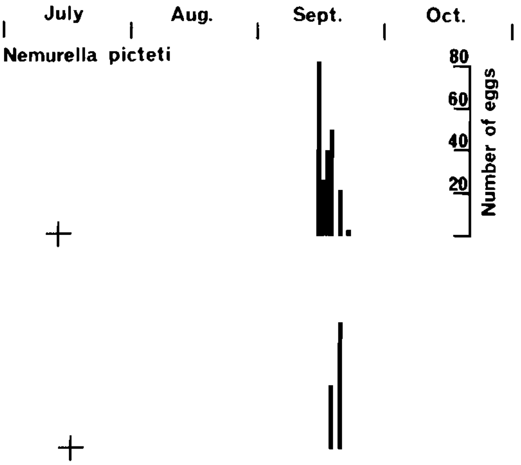

Fig. 4. Oviposition (+), incubation period and hatching of eggs from females of *Nemoura picteti.*

females from Mjøsa were also reared. In the latter case there were differences in the incubation period from 8 to 10 days (Fig. 5). There were variations in the incubation period among the eggs from four localities from 8 to 24 days and the duration of hatching ranged from 5 to 22 days.

The results indicated that there were just as large variations in incubation period between eggs from the same locality as between eggs from such widely different localities as a lowland stream in Bærum (Lomma) at a height of 120–200 m a.s.l. and a Middle-Alpine lake near Finse at 1430 m a.s.l. However, there were large differences in the date when the eggs were laid. The females from Lomma in Bærum laid their eggs on 10th and 15th May, while the female from Finse oviposited on 2nd August. In all eggs from every female the embryo was visible when the eggs were laid.

In *Capnopsis schilleri* the incubation periods were 14 and 23 days, the duration of the hatching being 7 and 4 days respectively (Fig. 6). In this species there were no signs of an embryo when the eggs were laid.

The intraspecific variation in incubation period was also studied in *Leuctra fusca* and *Leuctra hippopus,* the material consisting of eggs from five females of *Leuctra hippopus* from two localities and two *Leuctra fusca* females from different localities. Eggs from three females of *Leuctra hippopus,* taken at Østernbekken, Bærum, had incubation periods of 28, 30 and 40 days and a duration of the hatching of respectively 14, 6 and 5 days (Fig. 7). Eggs from two females of succeeding generations from Isternfoss, one in May 1972 and one in January 1973, had an incubation period of 28 and 43 days and a duration of hatching of 8 and 18 days respectively.

Eggs from the two females of *Leuctra fusca* from Os in Hedmark and Øvre Heimdal had incubation periods of 53 and 63 days

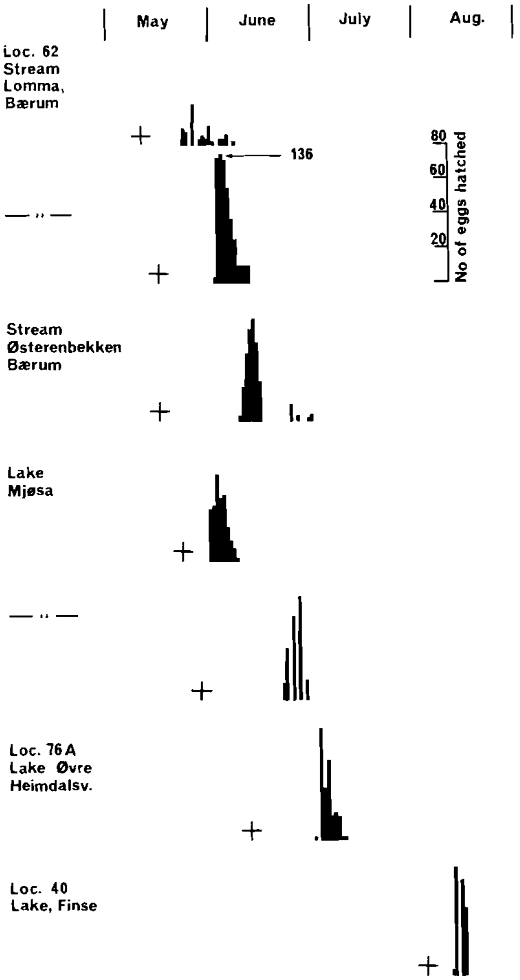

Fig. 5. Oviposition (+), length of the incubation period and hatching of eggs from females of *Capnia atra.*

and a duration of hatching of 16 and 5 days respectively (Fig. 8).

Thus some species showed considerable intraspecific variation in the duration of the incubation period, which was most marked in *Amphinemura standfussi.*

NYMPHAL GROWTH AND EMERGENCE

Temperature

The dependence of nymphal growth on temperature was investigated in three species: *Capnia bifrons, Capnopsis schilleri* and *Leuctra hippopus.*

In the same study the length of the growth period between specimens from two populations of *Leuctra hippopus* was also compared. They originated from females taken at Isternfoss, Hedmark and Østernbekken, Bærum, Akershus and had been shown to be morphologically different (Lillehammer 1974b).

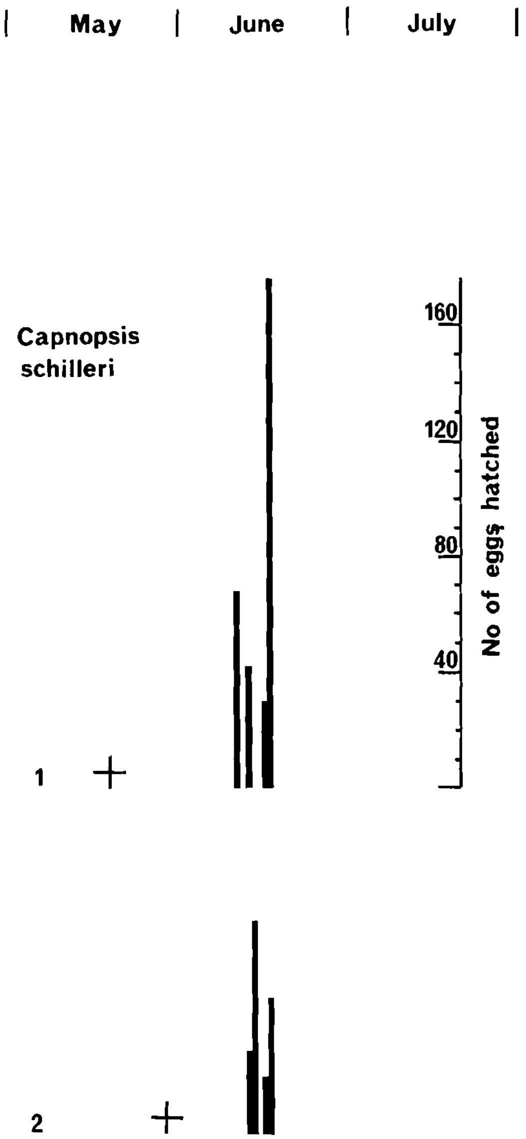

Fig. 6. Oviposition (+), length of the incubation period and hatching of eggs from females of *Capnopsis schilleri.*

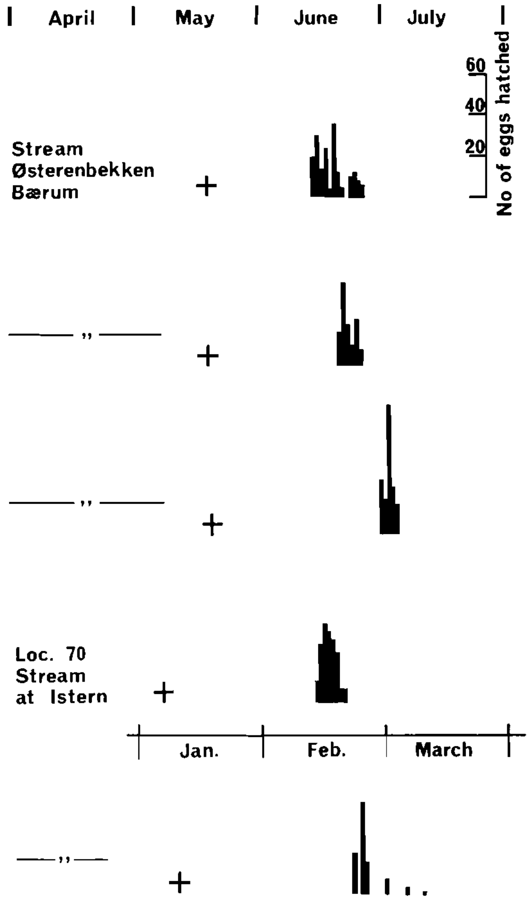

Fig. 7. Oviposition (+), length of the incubation period and hatching of eggs from females of *Leuctra hippopus*.

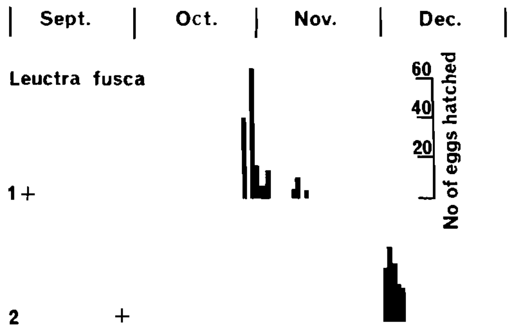

Fig. 8. Oviposition (+), length of the incubation period and hatching of eggs from females of *Leuctra fusca*.

The specimens were kept in refrigerator II at a mean temperature of 8°C and in darkness, enabling one to see whether they grew and emerged normally without variations in photoperiod.

The results are shown in Fig. 9. The relatively low temperature of 8°C during the summer months meant that the nymphs of *C. bifrons* did not enter diapause, but grew rapidly the whole time. During November and December the temperature was 6° to 7°C above the usual field temperature and they emerged at the end of December and the beginning of January in contrast to the normal field emergence during March/April.

Capnopsis schilleri also grew rapidly at 8°C, especially during the months of Novem-

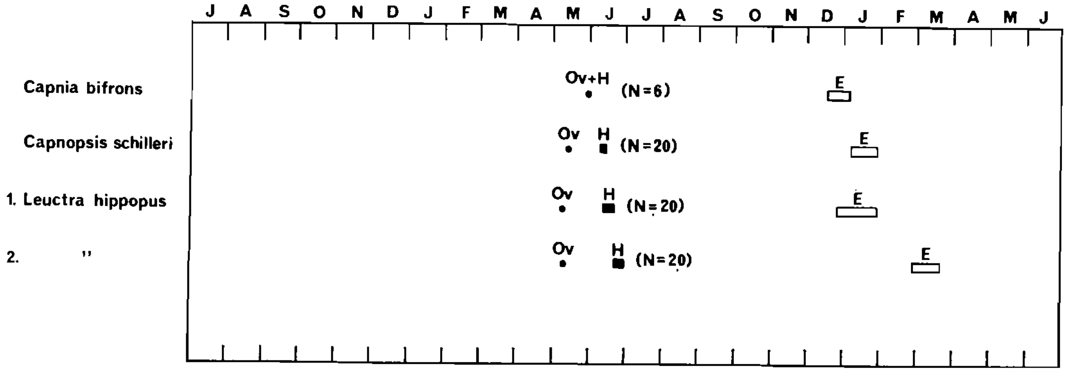

Fig. 9. The growth period and emergence of *Capnia bifrons, Capnopsis schilleri* and *Leuctra hippopus* reared at a temperature of about 8°C with excess food. Ov = oviposition, H = hatching, E = emergence. *Leuctra hippopus,* 1 originates from Isternfoss and 2 from Østernbekken. N = number of specimens reared.

ber and December and emerged in January compared with normal field emergence during May.

Nymphs of *Leuctra hippopus* from the Isternfoss population emerged during December and January while the emergence period in the field is at the end of April and during May. Nymphs from Østernbekken population emerged in February/March which is two months before emergence in the field.

These experiments showed that a high temperature during the autumn and winter months can shorten the growth periods of *C. schilleri* and *L. hippopus* by up to 40%, producing emergence during the middle of the winter. In *C. bifrons* a combination of a low summer temperature, thus avoiding the summer diapause, and a high autumn temperature, shortened the growth period by about 30% and produced emergence during December.

It seems clear that higher temperatures than normal can produce rapid growth and an early emergence in some species, as long as there is sufficient food.

The distribution of *C. bifrons* at high altitudes such as in Øvre Heimdal (Lillehammer 1974b) might depend on a direct development without diapause. The rapid growth observed in *C. bifrons* by Khoo (1964b) during late auaumn and late winter was assumed to be caused by shortening of the photoperiod. The darkness during the growth period of nymphs in this experiment might also influence the growth positively, but since the species are reared in darkness, differences in photoperiod do not seem necessary for development and emergence, neither does a significant increase in the water temperature just before emergence.

In *Leuctra hippopus* differences in the growth period and emergence between specimens from Isternfoss and from Østernbekken were marked, even if they were reared under the same conditions.

Food

Both the egg incubation period and nymphal growth were influenced by temperature. The next question is, therefore, can food shortage lengthen the growth period. To examine this, the species *Nemoura cinerea* and *Leuctra hippopus* were chosen. *Nemoura cinerea* was reared at 4° and *Leuctra hippopus* at 8°C.

Laboratory studies on the food of stonefly nymphs have been carried out by authors such as Hynes (1942), Brinck (1949) and Bjarnov & Thorup (1970).

Nemoura cinerea was reared at 4°C because the species is one of the few herbivorous species which occurs high in the Middle Alpine areas of southern Norway, where the annual mean temperature is low and where there is less allochthonous matter than at lower altitudes (Lillehammer 1974b). In addition, field data of *Nemoura cinerea* which strongly indicated a change from an univoltine to a semivoltine life cycle under certain environmental conditions have been mentioned by Brittain (1974). In both *N. cinerea* and *L. hippopus* 20 nymphs were placed in two aquaria, one with sufficient food and one with only a small amount of food, producing a shortage situation. In both species the nymphs reared with different amount of food originated from the same female.

In both species the nymphs which had enough food developed and emerged at about the normal time, while the nymphs which were reared with a shortage of food had a longer developmental time (Fig. 10). *Nemoura cinerea* changed from one year cycle to a nearly two year cycle and the nymphal period of *L. hippopus* was lengthened by about 30%.

Studies were also made with *Leuctra fusca* on the growth of nymphs given sufficient food and nymphs given only small amounts of food, but reared at the same temperature of 4°C. Unfortunately the experiment was prematurely terminated in July when the nymphs reared with sufficient food were twice the length of those reared with only small amounts of food (Fig. 11) thus clearly demonstrating the importance of food for growth.

SUBSTRATUM PREFERENCE

Hynes (1970) discussed the location of insect larvae and nymphs during different stages of their development period. He also referred to investigations made by Schwoerbel (1961, 1964) which showed that a large part of the young population of benthic insects was present in the hyporheic zone.

To obtain information about the substratum

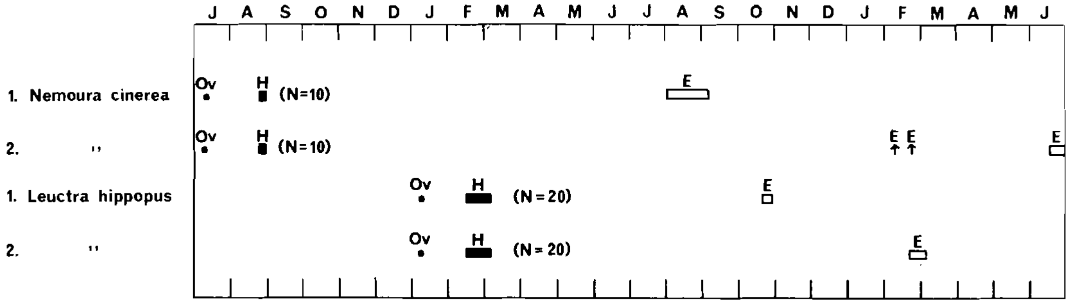

Fig.10. The growth period and the emergence of *Nemoura cinerea* reared at 4°C and given much food (1) and insufficient food (2). *Leuctra hippopus* reared at 8°C and given much food (1) and insufficient food (2). Ov = oviposition, H = hatching, E = emergence. The arrows indicate single specimens emerging. N = number of specimens reared.

preference during different developmental stages, two species with quite different Norwegian distributions were chosen. These were *Leuctra hippopus*, which is one of the most common stoneflies throughout Norway, and *Capnopsis schiller* which in southern Norway is restricted to the eastern parts.

Mature females of both species were taken into the laboratory where they deposited eggs in small petri dishes. The species were followed throughout their life cycle. After hatching the nymphs were placed in a rearing aquarium at 8°C with a layer of fine and coarse sand, gravel, small stones and leaves of *Alnus* spps. and *Salix* spps.. The dishes were controlled at intervals, usually weekly.

During the first few months from May until early August the nymphs of both species remained mainly down in the substratum (Fig. 1.1) and could only be found when the substratum was disturbed. Later the nymphs were largely seen on the top of the substratum (Fig. 1.2). At this stage, however, there were differences between the two species. When disturbed, most of the nymphs of *L. hippopus* hid beneath leaves and stones, while most nymphs of *Capnopsis schilleri* mainly buried themselves down in the substratum with only their cerci visible, seeming to prefer places where the particles in the substratum were fine and where they could most easily bury themselves. During the last few weeks before emergence both species were often seen on the sides of stones which reached above the water surface (Fig. 1.3). They sometimes sat in this position for a long time with their head often at the water's edge. They also sometimes went 'ashore', walked around for some time and then returned to the water.

The experiment showed that the two species inhabited three different levels during different periods of development, and that there were also differences in their behaviour when they were disturbed. The ability to bury in the substratum might explain the high numbers of *C. schilleri* on sand substrata in parts of Sæterbekken and in other streams where fine sand occurs.

ADULT LIFE SPAN

Recording of females present by streams and lakes during a longer period (Lillehammer 1975) provided information about the length of time mature females were present in the same biotope, but did not provide any information on the life span of single specimens. Females were therefore taken and reared in plastic boxes in a refrigerator at temperature of about 10°C. They were kept until they died, which was often after oviposition. The specimens had usually lived for an unknown time as imagines in field before they were taken into the laboratory, so the values listed in Table I are probably inexact minimum values except for those females which emerged in the laboratory. Usually 30–50 specimens of each species were reared, but only the maximum life span is given in Table I. Studies of the life span of the adults of European species have been made by Hynes (1942) and Khoo (1964a) and in Table I the results of Khoo's

Table I. The maximum life span observed in females of 13 species held in the laboratory compared to the observation made by Khoo (1964a). For Leuctra hippopus, 1 and 2 are females from Isternfoss, Engerdal and Østernbekken, Bærum, 3 and 4 are females of the succeeding generation from the same localities.

	Max length of life in females in days (Own observations)	Max length of life in females in days (Khoo's observations)
Diura bicaudata	20	28
D. nanseni	25	
Taeniopteryx nebulosa	39	30
Amphinemura standfussi	56	41
Nemoura arctica	13	
N. avicularis	42	51
N. cinerea	21	37
N. viki	26	
Capnia atra	37	
C. pygmaea	24	
Capnopsis schilleri	27	
Leuctra fusca	35	38
L. hippopus 1	9	
2	33	
3	5	
4	37	63

studies are compared with those from the present study.

Table I shows that it is not uncommon for females to live for one month or more. The longest life span recorded was 56 days for a female of *Amphinemura standfussi*. The shortest adult life span was recorded in *L. hippopus* from Isternfoss, where a female emerged on 4 January 1972 in the laboratory, mated, oviposited and died after the following 5 days.

Three females of *A. standfussi* taken at the same time and place laid their eggs at quite different times and had different life spans even though they were reared under the same conditions. This indicates that they use different times for egg maturation, even if they are the same age. Differences in egg maturation were also observed in two females of *Leuctra hippopus* reared in the laboratory under the same conditions. One female from the Isternfoss population emerged and oviposited within 5 days, while a female from the Østernbekken population took 34 days (Table I).

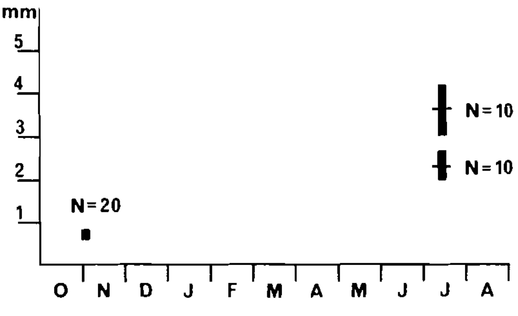

Fig. 11. The growth of *Leuctra fusca*, given excess food, above, and insufficient food, below. N = number of specimens reared.

CONCLUSION

There appeared to be a marked intraspecific variation in the length of the incubation period of several species, also between eggs from the same female. There were also considerable differences between species.

Nymphal growth and emergence seemed greatly dependent on temperature; the growth period of the spring emerging species *Capnia bifrons, Capnopsis schilleri* and *Leuctra hippopus* was shortened by 30–40% using a constant temperature of 8°C during development.

A shortage of food was shown to lengthen the nymphal period in *Nemoura cinerea* and *Leuctra hippopus*, and growth in *L. fusca* seemed to be greatly influenced by the amount of food.

The study showed also that nymphs could complete their life cycle when given only fallen leaves as food.

As the specimens were reared in darkness and under constant temperature, neither differences in photoperiod nor a significant rise in temperature seem to be necessary for emergence.

Studies of substratum preference of *Capnopsis schilleri* and *Leuctra hippopus* nymphs showed they occupied different locations in the substratum during different periods of development. The two species had differences in their preference for fine sand and for gravel in the substratum, which can influence the occurrence of the two species.

The life span of adults varied greatly from species to species, but it was not uncommon that the length was one month or more. The longest life span was recorded for one female *Amphinemura standfussi* with 56 days, the shortest in a female *L. hippopus*, which emerged, mated, laid eggs and died within five days.

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Archistoma polaris n. sp. A new species of Collembola (Isotomidae) from Spitsbergen

ARNE FJELLBERG & NICOLE POINSOT

Fjellberg, A. & Poinsot, N. 1975. *Archisotoma polaris* n. sp. A new species of Collembola (Isotomidae) from Spitsbergen. *Norw. J. Ent. 22*, 109–112.

Archisotoma polaris n. sp. is described from Ny Ålesund and Longyearbyen at W. Spitsbergen (Svalbard), where it occurred on mud-flats with *Puccinellia phryganodes* along shallow bays and lagoons. It is separated from the nearest relatives in shape of maxillary lamellas, size of eyes, and cover of setae on dens. A key for determination of the species group is given. *A. megalops* Bagnall is reported for the first time from Spitsbergen.

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The two first weeks of August 1973 an expedition from Zoological Museum in Bergen (Sven-Axel Bengtson, Arne Fjellberg, and Torstein Solhøy) visited the area around Ny Ålesund on West Spitsbergen for studies of soil fauna. A new species of Collembola was collected along a shallow brackish lagoon at Gluudneset (78°55′N, 12°5′E).

TYPE MATERIAL

Holotype. Female 1.4 mm labelled: 'Svalbard: W. Spitsbergen. Ny Ålesund, 11 VIII. 1973. Gluudneset. Lagoon with *Puccinellia phryganodes*, S.-A. Bengtson, A. Fjellberg & T. Solhøy'. Deposited in alcohol at Zoological Museum, Department of Entomology, Bergen, Norway.

Paratypes. Specimens from the type locality deposited as follows: 63 specimens in alcohol and 10 on slides together with holotype in Bergen, 5 specimens in alcohol at British Museum (Nat. Hist.), Department of Entomology, London, 20 specimens in alcohol and 3 on slides at Laboratory of Animal Ecology, Marseille.

Description

Body size 1.4–1.8 mm, light grey. The index post antennal organ/diam. of nearest ocellus about 2.9. Tibiotarsus without apical spur, claws without teeth. Abdomen V—VI not completely fused, with 3+3 trichobothria (Figs. 1 and 4). Capitulum of maxilla with two subequal teeth (g in Fig. 2), the inner one sometimes rather small. The external ventral lamella (*lve*) is plate-like with several undulating fringes and long cilia along outer edge. The internal ventral lamella (*lvi*) spoon-shaped, slightly ciliated along the edge. The internal median lamella (*lmi*) is shaped like a long, plain tongue with rough surface. The internal dorsal lamella (*ldi*) is hood-shaped with fringed edges, dilated at base. The internal proximal lamella (*lpi*) is fan-shaped with long fringes.

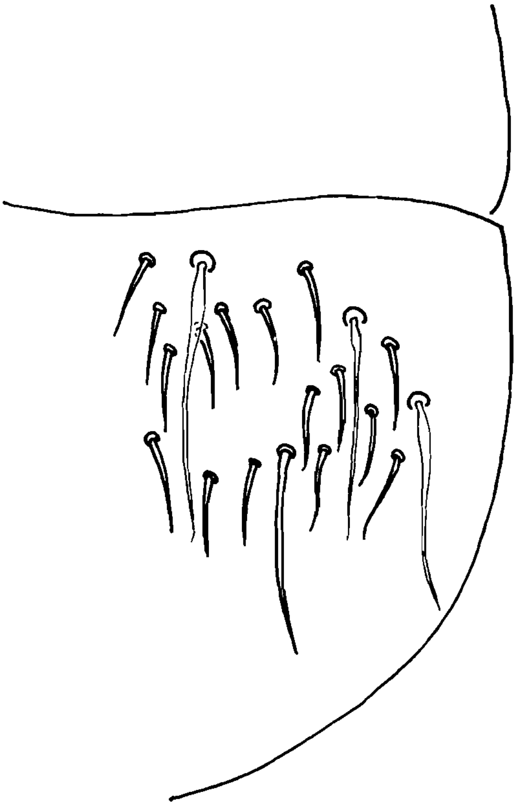

Fig. 1. *Archisotoma polaris* n. sp. Right part of Abd. VI with the three trichobothria.

Affinities

This species belongs to the group of *A. megalops* Bagnall, *A. brucei* (Carpenter), *A. subbrucei* Delamare and *A. pulchella* (Moniez), characterized by the two teeth of the maxillary capitulum. The two maxillary lamellas *lve* and *ldi* are similar to those of *A. brucei* and *A. subbrucei*, *lvi* resembles that of *A. subbrucei*, while *lmi* looks like *ldi* of *A. pulchella*. Concerning the external morphology, we have observed that these four species all have 3+3 trichobothria which contradicts Stach (1947), who stated that 2+2 trichobothria is a generic character for *Archisotoma*.

As the new species can be found within the same area as *A. megalops*, some morphological differences are mentioned here. The eyes of *A. polaris* are smaller (PAO/ocellus = 2.9, of *A. megalops* it is 1.5–1.6) and the ventral side of dens is less hairy (about $^1/_3$ basal part of dens without ventral hairs in *A. polaris*, about $^1/_4$ in *A. megalops*, see Fig. 3). Also Abd. V–VI is less fused than in *A. megalops* (Fig. 4).

According to Altner (1963) and Poinsot (1965) *A. megalops* is separated from other species of *Archisotoma* by the presence of a distinct tooth at the inner edge of the first claw. Specimens from different *A. megalops* populations in Western Norway are highly variable in this character. Individuals with hardly visible inner tooth are frequent and cannot be distinguished from *A. subbrucei* as the maxilla are identical. It is possible that *A. megalops* Bagnall, 1939 and *A. subbrucei* Delamare, 1954 are synonyms.

Ecology

The new species was collected in numbers on fine-grained sediments along a shallow lagoon with brackish, stagnant water. The vegetation was a rather dense cover of *Puccinellia phryganodes* mixed with *Carex ursina*. Many specimens were also seen on the water surface in the lagoon. During a stay at Longyearbyen on 2 Aug. 1973 the species was collected under pieces of board and debris on

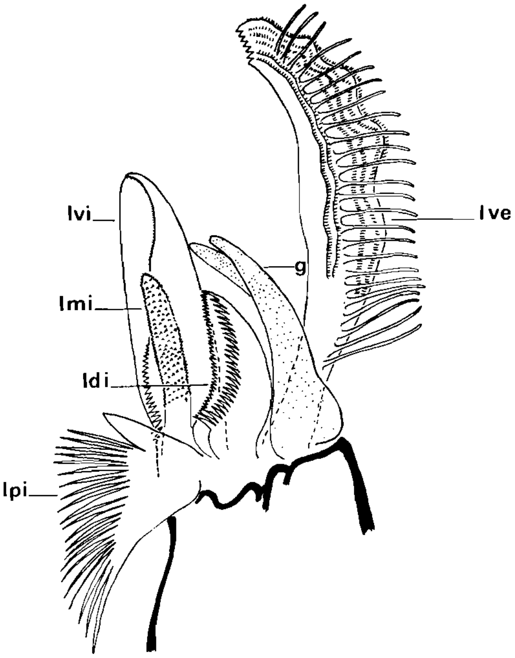

Fig. 2. *Archisotoma polaris* n. sp. Maxilla.

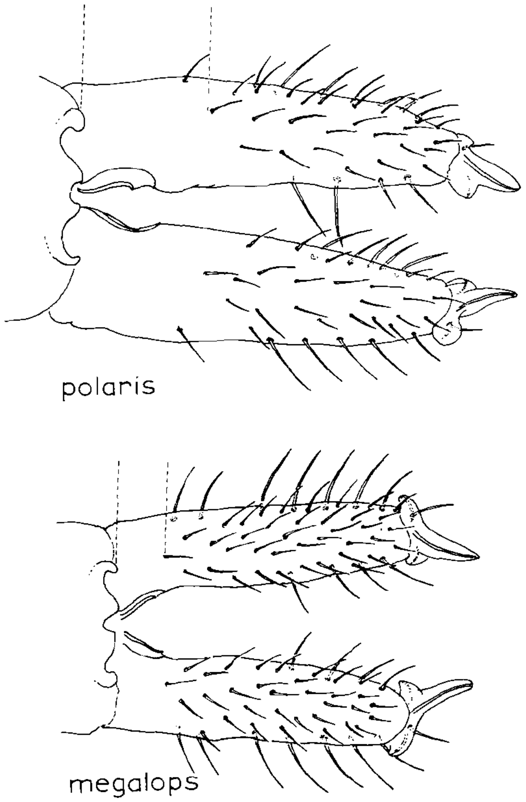

Fig. 3. *Archisotoma polaris* n. sp. and *A. megalops*. Ventral view of dens.

mud-flats with the same vegetation as the Ny Ålesund locality.

On exposed shores with stones and gravel the species was not found. Apparently this was the favoured habitat of *A. besselsi* (Packard). One specimen of *A. megalops* was also collected in coarse gravel at Prins Heinrich Island at Ny Ålesund. This is the first record of this species from Svalbard.

KEY

A key for separation of *Archisotoma* species with bidentate maxillary capitulum is presented (see also Poinsot 1965).

1. Inner edge of first claw with a distinct tooth .... *A. megalops* Bagnall
- Without tooth at inner edge of first claw 2
2. The internal median lamella (*lmi*) of maxilla broad and plate-like with several rows of fringes .... *A. pulchella* (Moniez)
- *lmi* not broad and plate-like 3
3. Internal ventral lamella (*lvi*) plate-like .... *A. brucei* Carpenter
- *lvi* more like a hood or a spoon 4
4. Internal median lamella (*lmi*) hood-shaped .... *A. subbrucei* Delamare
- *lmi* like a tongue .... *A polaris* n. sp.

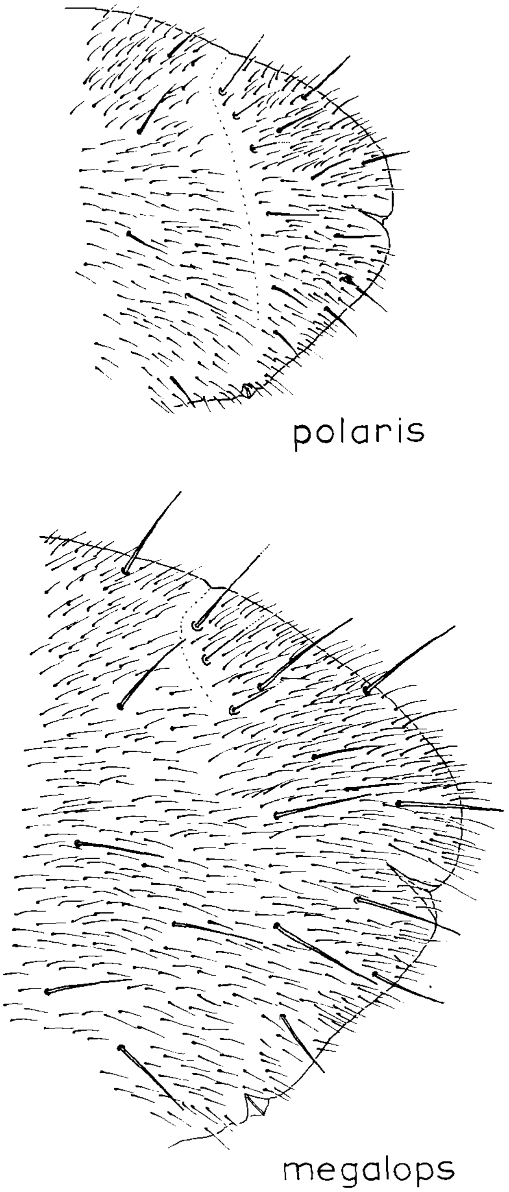

Fig. 4. *Archisotoma polaris* n. sp. and *A. megalops*. Profil of Abd. V–VI.

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Fecundity and oviposition period of *Aphidius platensis* Brèthes (Hym., Aphidiidae) parasitizing *Myzus persicae* Sulz. (Hom., Aphididae) on paprika

TROND HOFSVANG & ELINE BENESTAD HÅGVAR

Hofsvang, T. & Hågvar, E. B. 1975. Fecundity and oviposition period of *Aphidus platensis* Brèthes (Hym., Aphidiidae) parasitizing *Myzus persicae* Sulz. (Hom., Aphididae) on paprika. *Norw. J. Ent.* 22, 113–116.

The daily fecundity of *Aphidius platensis* Brèthes was studied at 21°C with *Myzus persicae* Sulz. as host. The mean total fecundity was 46 mummies per female. 88% of the total number of mummies produced resulted from eggs deposited the two first days after emergence of the female. The total sex ratio of *A. platensis* was 0.87 females/males.

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Aphidus platensis Brèthes is an aphid parasite with a pantropical and subtropical distribution (Starý 1972), although recent investigations have revealed that it also occurs in Europe, i.e. in the Mediterranean area (Starý, pers. comm.). It has been found in Norway but is thought to have been accidentally introduced from abroad (Hofsvang & Hågvar 1975b).

Recently, *A. platensis* has been synonymized with *Aphidius colemani* Vier. by Starý (in press), but owing to the continuity of our papers (Hofsvang & Hågvar 1975b), we use the name *platensis*.

Parts of the biology of *A. platensis*, such as developmental time and adult longevity, have been published elsewhere (Hofsvang & Hågvar 1975b). The present paper deals with fecundity and oviposition period, two important parasite characteristics. The investigations also allow a close comparison with the biology of *Ephedrus cerasicola* Starý, which has been studied previously under the same conditions (Hofsvang & Hågvar 1975a).

MATERIAL AND METHODS

The parasite, *A. platensis*, had been kept for several generations in the laboratory before being used in the experiments. Further information about the collection and rearing in the laboratory are given elsewhere (Hofsvang & Hågvar 1975b). Ten males and ten females of *A. platensis*, all newly emerged, were used in the oviposition experiment. They were released together into a cage and allowed to oviposit an excess of aphids on one paprika plant (*Capsicum annuum* L.). All living parasite specimens were each day transferred to a new cage with a similar aphid-infested paprika plant. In this way the daily fecundity could be calculated. Fecundity was measured as number of mummified aphids resulting from parasitation, but is in the following often referred to as egg production. Mean total or daily fecundity per female was calculated in two ways, either from the original, 10, number of females or from the number of living females each day, i.e. per surviving female.

Further descriptions of the methods have been given previously (Hofsvang & Hågvar 1975a). The temperature was 21°C, the photoperiod 16 hrs, and humidity higher than 70% RH.

RESULTS

The average fecundity of *A. platensis*, calculated by summarizing the daily fecundities, was 46 mummies per female, or 48 mummies per surviving female. Fig. 1 shows the average number of mummies per surviving female per day and the survival of the adult parasites. All the eggs were evidently deposited during the first 5 days after adult emergence. 88% of the eggs were laid during the first two days. Another experiment, which partly failed, was performed in exactly the same way prior to that presented in Fig. 1. Possibly due to the small size of the aphids, only 50 mummies totally were recorded in this experiment. However, the survival of both sexes of the adult parasites was about the same as depicted in Fig. 1. Furthermore, the females in the second experiment laid their eggs during the first 4 days after emergence. 82% of the eggs were deposited the first day.

The relationships between the age of the parents and certain aspects of the development of their progeny are shown in Table I. No clear influence of parental age could be demonstrated. 46.6% of the total number of emerging parasites were females.

The average rate of development, based on the total number of progeny, was also estimated. Mean period from oviposition to mummification of the aphids was 10.5 days (SD = 2.7, n = 447) and from mummification to emergence from the cocoon, 5.1 days (SD = 0.7, n = 368). The mean total developmental period was 15.4 days (SD = 2.5, n = 385). The variation in developmental rate was considerable, e.g. the minimum and maximum values of the total developmental

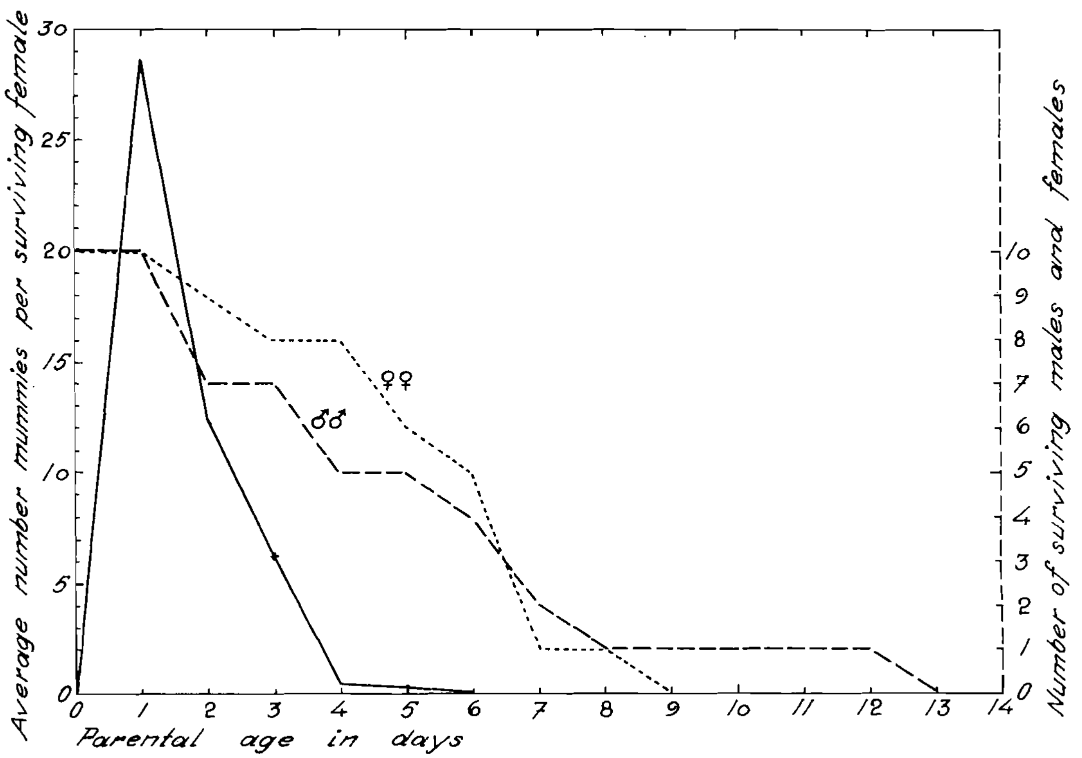

Fig. 1. Daily oviposition pattern (solid line) and survival of males and females (dotted lines) during adult life of *A. platensis* parasitizing *M. persicae* at 21°C.

Table I. Relationship between the age of adult *A. platensis* and the development of the progeny on *M. persicae* at 21°C and 16 hrs photoperiod.

Parental age	Emergence from n mummies		Sex ratio	Average total developmental time	
Days	n	%	♀/♂	Days	n
1	287	84	112/130	15,8	242
2	112	84	41/56	14,6	97
3	51	80	25/15	14,7	41
4	4	75	1/3	12,8	4
5	2	50	0/1	16,0	1
Total	456	83	179/205	15,4	385

period were 11 and 22 days, respectively. The results on developmental time conform very well with those obtained in an earlier investigation, where eggs were deposited during one day by adult *A. platensis* of unknown age (Hofsvang & Hågvar 1975b).

DISCUSSION

In a previous paper, data on rate of development and longevity in *A. platensis* are given (Hofsvang & Hågvar 1975b). Under the same conditions, similar studies have also been carried out on *E. cerasicola* by Hofsvang & Hågvar (1975a). Any information on *E. cerasicola* in the text below refers to this study.

The average fecundity of *A. platensis* on paprika was 46 mummies per female. Under similar conditions, *E. cerasicola* produced 51 mummies. Comparable figures have been found by other authors for several *Aphidius* species, although considerably higher values have been recorded (see Hofsvang & Hågvar 1975a). However, no fecundity data are available for aphidiids in the literature where paprika is used as host plant.

Very few works give an accurate description of the daily egg production pattern in aphidiids. According to Starý (1970), there is a general trend for aphidiids to lay the majority of the eggs the first few days. The oviposition pattern shown in Fig. 1 conforms very well with such a statement. However, *E. cerasicola* had an oviposition period and pattern that were essentially different from that of *A. platensis*. Thus, *E. cerasicola* deposited the eggs throughout a period of at least 13 days, with several peaks, culminating the 7th day. This species also had a higher adult longevity.

Adult *A. platensis* lived considerably longer in small glass jars with honey only, than in the present study with great cages supplied with aphid-infested plants, where energy-demanding activities like flying and oviposition were possible. Thus, average longevity in the two cases were 12.7 days (Hofsvang & Hågvar 1975b) and 5.6 days, respectively. A similar reduction was observed in *E. cerasicola.*

Because eggs deposited by *A. platensis* the first day after emergence resulted in female offspring, mating must take place the first day of adult life. No effect of sperm shortage, which was found in *E. cerasicola,* could be demonstrated.

In the oviposition experiment, 46.6% of the emerging offspring of *A. platensis* were females. Previous experiments on developmental rate at 21°C (Hofsvang & Hågvar 1975b) resulted in 53.2% females from paprika (n = 77) and 56.7% females from pepper (n = 413). In *E. cerasicola,* experiments on developmental rate and oviposition at 21°C gave 25–30% female offspring on paprika. The difference in sex ratio between the species could be inherent, which may have importance for their practical application in pest control. However, the fact that sex ratio is very much dependent on external factors during oviposition must be stressed (Starý 1970), although the experimental conditions were basically the same for the two species.

From the data on fecundity per surviving female, percentage of emergence, and sex ratio, it can be calculated that in the mean, one female of *A. platensis* at 21°C gives rise to 40 adults, of which 19 are females. The corresponding value for *E. cerasicola* was 11 females. The difference is largely due to a lower percentage of adult emergence in *E. cerasicola* together with a lower percentage of female offspring.

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Production of faeces, excreta, and silk in the wolf spider *Pardosa palustris* (L.) (Araneae, Lycosidae) from Hardangervidda, southern Norway

ANDREAS L. STEIGEN

Steigen, A. L. 1975. Production of faeces, excreta, and silk in the wolf spider *Pardosa palustris* (L.) (Araneae, Lycosidae) from Hardangervidda, southern Norway. *Norw. J. Ent.* 22, 117–120.

Estimates of daily production of faeces, excreta, and silk in the wolf spider *Pardosa palustris* (L.), collectively referred to as ejecta (FUS), were calculated from laboratory experiments at 10° and 20°C. Animals were collected for the investigations in the high mountain area of Hardangervidda, southern Norway.

Animals weighing 1 mg dw produced 0.004 and 0.012 mg FUS/mg dw/day at 10° and 20°C, respectively, and animals of 10 mg dw 0.002 and 0.004 mg FUS/mg dw/day at the same temperatures. Percentual weight loss through FUS was highest in large animals at 10° and at 20°C in the smaller animals.

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During investigations in summer 1972 on the energetics of the wolf spider *Pardosa palustris* (L.) (syn.: *Lycosa tarsalis* (Thorell)) at the Norwegian IBP dry meadow site at Stigstuv, Hardangervidda (1225 m a.s.l., 60°18'N, 7°40'E), southern Norway, estimates of daily energy loss through faeces, excreta, and silk production were calculated from feeding experiments carried out in laboratory. Few such data are available for spiders.

MATERIALS AND METHODS

For a description of the study area see Solhøy (1972), French (1974), and Brown & Veum (1974).

Experimental animals were fed adult *Drosophila melanogaster* (Meigen) and to assess daily production of faeces, excreta, and silk they were put into separate containers (10 ml vials) where the bottoms were covered by calibrated thin glass discs. Experiments were carried out at 10°C and 20°C. At 10°C the experiment lasted for 96 hours and at 20°C for 48 hours.

The experimental conditions may have increased the activity of the spiders. This will increase dragline production, and thereby increase the estimate of ejected material. At the end of the experiment, the glass discs were dried for two hours at 105°C, and cooled in an exsiccator prior to weighing.

The animals were weighed before and after the experiments. Spider dry weight was estimated from an equation obtained by weighing spiders from the field alive and after drying for 24 hours at 105°C:

$$y = 0.278x + 0.072$$

$$r = 0.96$$

$$p < 0.001$$

x = live weight of spider, y = estimated dry weight of spider.

Faeces, excreta, and silk products in spiders cannot be separated and are consequently

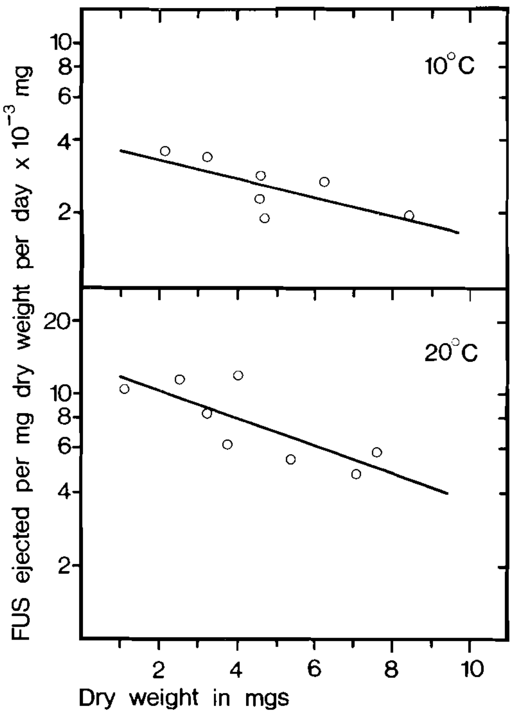

Fig.1. Production of faeces, excreta, and silk (FUS) in *P. palustris* from Hardangervidda. Each dot represents one animal.

referred to as ejecta (FUS). FUS–Q_{10} has been calculated from the formula:

$$Q_{10} = \left(\frac{v_1}{v_2}\right)^{\frac{10}{t_1 - t_2}}$$

(Prosser 1973). v_1, v_2 = velocities of a physiological process at temperatures t_1, t_2.

RESULTS AND DISCUSSION

There are good correlations between ejecta production and estimated dry weights of spiders (Fig. 1). There is also a correlation between dw and weight loss at 20°C (Fig. 2). However, at 10°C there is no such correlation between these variables, and hence the calculated mean is:

$$y = 0.05 \text{ mg dw/day}$$

At 20°C the regression formula has the form

$y = 6.89 \times 10^{-2} (1.31x)$ $r = 0.85$ $p<0.01$
x = dry weight of animal, y = total weight loss per animal per day in mg dry weight.

Table I presents FUS-parameters at the experimental temperatures in individuals weighing 1 and 10 mg dw, respectively.

The results show that small animals have a relatively higher FUS production than larger animals. At 10° animals weighing 1 mg dw lose ten times as much weight during the experiment in relation to total dw than animals of 10 mg dw. At 20° the percentual loss is slightly higher in the larger animals. The weight loss through FUS is five times higher in relation to weight in animals of 10 mg dw than in the smaller animals at 10°C, but at 20°C this has shifted, the smaller animals losing three and a half times as much through FUS. This must be a result of higher increase in energy metabolism in animals of 10 mg dw. The increase in FUS production through the temperature interval 10–20°C is, however,

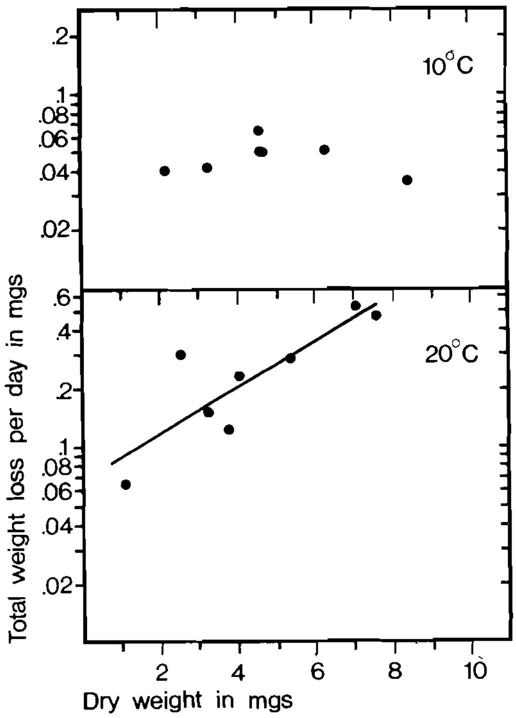

Fig. 2. Total daily weight loss in *P. palustris* during ejecta experiments. At 10°C there is no correlation between dry weight and weight loss, and consequently no regression line can be drawn.

Table I. Ejecta production in P. palustris from Hardangervidda at 10° and 20° C in laboratory.

t°C	Dry weight mgs	mg FUS /day	mg FUS /mg dw/day	FUS as % of dw	Total weight loss /day in mg dw	Total weight loss in % of body dw	% of weight loss through FUS
10° C	1	0.004	0.004	0.4	0.05	5.0	8.0
	10	0.020	0.002	0.2	0.05	0.5	40.0
20° C	1	0.012	0.012	1.2	0.09	9.0	13.3
	10	0.040	0.004	0.04	1.04	10.4	3.8

higher in the smaller animals, their FUS-Q_{10} being 2.0, whereas the value in animals of 10 mg dw is 3.0.

Calorific content of ejecta was 5003 cal/g ejecta dw; i.e. 87% of the calorific content of the *Drosophila* prey. No experiments were carried out to investigate the relationship between hunger and production of ejecta. It is assumed that the production of silk is independent of the degree of hunger, and since a considerable amount of the ejecta component consists of silk the variation in FUS is small. Regression equations of calories lost through ejecta per day (y) and mg dw (x) are given below:

10°C: $n = 7$

$$y = \frac{19.76}{1.09x} \times 10^{-3} \quad r = -0.70 \quad p<0.05$$

20°C: $n = 8$

$$y = \frac{67.04}{1.14x} \times 10^{-3} \quad r = -0.76 \quad p<0.02$$

Few data are available on the production of ejecta in wolf spiders. Van Hook (1971) gives a value for *Pardosa* sp. of 0.01 mg FUS/mg dw/day at 20°C which is close to the values for *P. palustris* at the same temperature. Edgar (1971) neglects energy loss through FUS when calculating the energy budget for *Pardosa lugubris* (Walckenaer). Ejecta will, however, always be registered as a surplus in calculated respiration in an energy budget. Silk production will vary with the species in wolf spiders (Richter 1970), and the amount of faeces will always be low because of the mode of consumption in spiders. Fluids containing enzymes are injected into the prey animals and sucked back as a nutrition broth, containing little waste. The variation in ejecta between species is therefore likely to be caused by specific variation in silk production. Data obtained in web building species cannot be compared to results from wolf spiders because of differences in activity patterns and use of silk.

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Four diplopods new to Norway

BJARNE A. MEIDELL

Meidell, B. A. 1975. Four diplopods new to Norway. *Norw. J. Ent. 22,* 121–122.

Four species of diplopods new to Norway are recorded: *Polymicrodon polydesmoides* (Leach, 1815), *Ophyiulus pilosus* (Newport, 1842) (= *fallax* Meinert, 1868), *Cylindroiulus nitidus* (Verhoeff, 1891) and *Cylindroiulus britannicus* (Verhoeff, 1891). All species are clearly anthropochore of origin in Norway.

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The following four species are reported for the first time from Norway: *Polymicrodon polydesmoides* (Leach, 1815), *Ophyiulus pilosus* (Newport, 1842) (= *fallax* Meinert, 1868), *Cylindroiulus nitidus* (Verhoeff, 1891) and *Cylindroiulus britannicus* (Verhoeff, 1891). Unless otherwise stated, the specimens were collected by the author.

Polymicrodon polydesmoides (Leach, 1815)

P. polydesmoides has been well described by Blower (1958), who also gives a list of synonyms. It is a common species in Great Britain and Ireland. It also occurs in France and as an isolated race, *italicum,* in the Alps and in a cave in Northern Italy.

Norwegian localities: Hordaland; Bergen 7 Aug. 1956, 2 ♀♀ found in a garden (leg. A. Storesund). This is the first report from Scandinavia. According to Jeekel (1970) *Nanogona* Cook, 1895, should be the generic name of polydesmoides, but to my knowledge no decision has yet been made on this problem by the commission.

Besides *P. polydesmoides, P. angustus* Latzel, 1884 and *M. gallicum* (Latzel, 1888) (Meidell 1967, 1968) are found only in the western parts of Norway, and might be classified as having an extreme western distribution in Europe. All three species are clearly anthropochore and synanthrope in their distribution in Norway.

Ophyiulus pilosus (Newport, 1842)

O. pilosus has been described by Schubart (1934) and Blower (1958). Schubart uses the name O. fallax (Meinert), but according to Blower (1958) *O. pilosus* should be used.

O. pilosus has a wide distribution in Europe. It has been introduced to the eastern parts of North America, Newfoundland, Bermuda, New Zealand, Tasmania and India (Schubart 1963).

Lohmander (1957) states that *O. pilosus* in Sweden and Denmark belongs to its north-western European race. He concludes that the Scandinavian distribution is anthropochore and synanthrope.

Norwegian localities: Hordaland, Kvinnherad, Rosendal near Hattebergselv. In 1967: 3 June, 1 ♂ + 4 ♀♀; in 1968: 27 May, 1 ♂ + 1 ♀; 28 May, 4 ♂♂ + 4 ♀♀; 14 Aug., 1

♀; 19 Aug., 1 ♂ + 3 ♀♀. Aust-Agder, Arendal, Bjørnebo, 19 April 1968, 1 ♀ (leg. T. Solhøy. All specimens were found under stones. The distribution of *O. pilosus* in Norway corresponds to the anthropochore/synanthrope distribution elsewhere in Scandinavia.

Cylindroiulus nitidus (Verhoeff, 1891)

C. nitidus has been well described by Schubart (1934). It has a clear western distribution in Central Europe. It is found in both Denmark and Sweden, where it has an anthropochore/synanthrope distribution.

Norwegian localities: Hordaland, Stord, Rommetveit 9 Aug. 1967, 26 ♀♀; 16 July 1968, 1 ♀ + 1 juv.; Kvinnherad, Rosendal; in 1967: 3 June, 1 ♂ + 3 ♀♀; 5 June, 4 ♂♂ + 6 ♀♀; 7 June, 2 ♂♂; 21 June, 2 ♀♀ from under bark, 1 ♂ + 3 ♀♀ from under stones; 26 June, 1 ♂; in 1968: 24 May, 1 ♂ + 2 ♀♀; 26 May, 1 ♀; 27 May, 1 ♂; 28 May, 1 ♂ + 3 ♀♀; 15 Aug., 1 ♂; 19 Aug., 2 ♀♀ + 1 juv.; in 1969: 18 May, 1 ♀; 22 May, 1 ♂ + 11 ♀♀; in 1970: 11 May, 2 ♂♂. Fana, Tveitevannet, in 1967: 15 April, 2 ♂♂; 22 April, 1 ♂; 21 May, 2 ♂♂ + 4 ♀♀; 29 May, 2 ♂♂ + 12 ♀♀; 7 Sept., 1 ♂ + 1 ♀; 19 Oct., 1 ♀; in 1968: 23 May, 8 ♂♂ + 14 ♀♀ + 1 juv.; 17 June, 3 ♂♂ + 2 ♀♀ + 1 juv.; 9 Sept., 1 ♂ + 4 ♀♀; 21 Sept.,10 ♂♂; in 1969: 5 Oct., 5 ♂♂ + 8 ♀♀ + 1 juv.; in 1970: 25 Sept., 8 ♂♂ + 6 ♀♀; Myravann, 26 Sept. 1965, 1 ♀; 18 April 1968, 1 ♂ (leg. R. Larsen); Fantoft, 14 May 1964, 1 ♀; Laksevåg, Alvøen, 28 May 1967, 1 ♀; Loddefjord, 24 Sept. 1967, 2 ♀♀; 3 March 1968, 1 ♀; 4 May 1969, 2 ♀♀, Åsane, Golfbanen, 27 May 1969, 1 ♂ + 4 ♀♀ (leg. T. Solhøy); Os, Lepsøy, 25 May 1967, 1 ♂ + 2 ♀♀; Moldegård, 19 Sept. 1966, 1 ♀ (leg. H. W. Walden); Osterøy, Vikno, 7 Oct. 1974, 27 ♂♂ + 28 ♀♀ + 8 juv.

The finds from Rosendal represent several sub-localities, and *C. nitidus* is an abundant species wherever accumulations of litter occur.

The distribution of *C. nitidus* in Norway is clearly of anthropochore origin, but several of the finds show that the species has reached localities which are only slightly influenced by man.

The list of localities shows that *C. nitidus* has a wide distribution in Hordaland. It is a common speices in Sweden (Lohmander 1957) and Denmark (Enghoff 1974). It might have been previously overlooked in Norway, but there is also the possibility that its introduction to Scandinavia is relatively new.

Cylindroiulus britannicus (Verhoeff, 1891)

C. britannicus has been well described by Blower (1958). It has a synanthropic distribution in the greater parts of Northern Europe. Only in the western parts of its area has it a natural distribution. As a synanthrope/anthropochore species it is known from Madeira, Southern India, South Africa, Newfoundland, Chile, Brazil and New Zealand (Schubart 1963). In Sweden it is found only under clear synantrophic conditions (hothouses, gardens and parks).

Norwegian localities: Hordaland, Kvinnherad, Rosendal near Hattebergselv, in 1968: 24 May, 2 ♀♀ (leg. R. Larsen and J. Fjeldså); 28 May, 6 ♂♂ + 17 ♀♀; in 1969: 22 May, 5 ♂♂ + 8 ♀♀; near Avlsgården, 3 June 1967, 3 ♂♂ + 15 ♀♀; Baroniskogen, 23 Aug. 1971, 1 ♂. Aust-Agder: Tromsøy; Bjellandsvann, 22 March 1967, 1 ♂ + 1 ♀ (leg. T. Solhøy).

C. britannicus is clearly anthropochore of origin in Norway, but the species has made its way to localities not so heavily influenced by man.

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Neuroptera in light-traps at Osterøy, Hordaland

TROND ANDERSEN & LITA GREVE

Andersen, T. & Greve, L. 1975. Neuroptera in light-traps at Osterøy, Hordaland. *Norw. J. Ent.* 22, 123–128.

Thirteen species of Neuroptera were caught in five light-traps operated at Osterøy, Hordaland county, South Norway during 1972 and 1973. Altogether 2368 specimens were trapped.
Sisyra fuscata constitutes 80.3%, and *Sialis lutaria* 10.1% of the material. Of the remaining species only *Micromus paganus* and *Wesmaelius nervosus* occurred in large numbers. Three species, *Megalomus hirtus, Sympherobius fuscescens* and *Conwentzia pineticola* must be considered rare. Flight periods and sex ratio for the four abundant species are discussed.

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The Neuroptera fauna of Norway is still incompletely known. In recent years a more systematic survey of this order has been started by one of the authors (Lita Greve). It was therefore of interest to analyse the material of Neuroptera collected during the years 1972 and 1973 by the other author (Trond Andersen), who carried out field work collecting Trichoptera in light traps on the island of Osterøy, located north of Bergen in Hordaland county. Five traps were operated from early June to November in 1972. Three of the traps, at Revheim, Valestrandsfossen, and Lono were operated from April to November in 1973.

1. Valestrandsfossen, UTM: 32VLN041134. The light-trap was situated on the bank of a small lake. Though cultivated fields extend down to the water edge, the area is fairly urbanized. The vegetation near the trap was composed mainly of *Calamagrostis purpurea* Trin., *Urtica dioica* L., *Angelica silvestris* L. and deciduous trees such as *Betula pubescens* Ehrh and *Alnus glutinosa* L. The dominating growths in the lake are *Equisetum fluviatile* L., *Potamogeton natans* L., and *Nymphaea* spp.

2. Revheim, UTM: 32VLN085131. The light-trap was situated on the bank of Lake Borgevann, approximately 2 m from the waterline. The vegetation in the lake is rather sparse, *Sparganium angustifolium* Michx. and *Nymphaea* sp. are dominating. The trap was placed on a small *Sphagnum* bog with *Myrica gale* L. and *Drosera rotundifolia* L. Further away the shore is dominated by *Carex* sp. and *Comarum palustre* L. Cultivated fields and pastures surround this part of the lake. Trees in the area are mainly *Salix caprea* L., *B. pubescens* and planted *Picea abies* L.

3. Lono, UTM: 32VLN093135. The light-trap was situated near a small stream. The bottom of the stream is covered with rather big stones overgrown with mosses. A little further up, the stream is more lentic, and here *E. fluviatile* and *Callitriche* sp. are growing. Cultivated fields and pastures extend down to the bank where the light-trap was located, the opposite bank is planted with *P. abies*.

4. Herland, UTM: 32VLN105216. The

light-trap was situated on the bank of a stream, which runs through an area with pastures and scattered thickets with *Populus tremula* L., *Corylus avellana* L. and *B. pubescens*. Further away lie extensive pine forests (*Pinus silvestris* L.).

5. Holo, UTM: 32VLN075202. The light-trap was situated near a rather swift little stream. The bottom material consists of big stones covered with mosses. The stream runs through a mixed forest with *P. abies*, *B. pubescens*, *A. glutinosa* and *Prunus padus* L.

The light-traps used were Robinson traps fitted with mercury vapour bulbs (Philips HPL 125 W). In 1972 the insects were killed with trichloroethylene, and later conserved in alcohol. The second year the batches were conserved directly in a container with ethyleneglycol and later transferred to alcohol. The traps were emptied at regular intervals, every fifth day in 1972 and every tenth day in 1973. Some technical faults occurred, mostly in 1973, and we assume that they reduced the total material to some extent.

RESULTS

A total of 2368 specimens belonging to 13 species of Neuroptera caught during 1972 and 1973 (Table I). The material is deposited at Zoological Museum, University of Bergen.

Table I. Species and number of specimens of Neuroptera captured in the light traps.

	Valestrandsfossen				Revheim				Lona				Herland		Holo		Total	
	1972		1973		1972		1973		1972		1973		1972		1972			
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Suborder Planipennia																		
Fam. Chrysopidae																		
Chrysopa *carnea* Stephens, 1836	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2	-
Nineta *vittata* (Wesmael, 1841)	1	-	1	-	-	-	-	2	-	1	-	-	-	-	-	2	2	5
Fam. Hemerobiidae																		
Hemerobius *nitidulus* Fabricius, 1777	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
pini Stephens, 1836	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
simulans Wolker, 1853	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	2
Megalomus *hirtus* (L., 1761)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-
Micromus *paganus* (L., 1767)	23	1	35	5	7	3	12	3	9	-	6	1	6	-	14	1	112	14
Sympherobius *fuscescens* (Wollengren, 1863)	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Wesmaelius *nervosus* (Fabricius, 1793)	2	9	2	5	2	5	3	6	1	5	1	4	4	18	2	11	17	63
Fam. Coniopterygidae																		
Coniopteryx *tineiformis* Curtis, 1834	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1	1
Conwentzia *pineticola* Enderlein. 1905	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-
Fam. Sisyridae																		
Sisyra *fuscata* (Fabricius, 1793)	308	19	137	12	505	380	244	157	47	2	22	5	19	-	38	5	1324	580
Suborder Megaloptera																		
Fam. Sialidae																		
Sialis *lutoria* (L., 1758)	117	1	108	6	4	1	2	-	1	-	-	-	-	-	-	-	232	8

Sisyra fuscata was taken regularly at all stations, but in very varying numbers. The species consttutes 80.3% of the total material. The number of trapped individuals at the three stations operated in 1973 was much lower than in 1972, from 45% to 55% of the numbers trapped the previous year.

The start in 1972, early June, was probably too late to catch the first swarming individuals. In 1973 the first specimens were found in the period 22 May–2 June. The last week of August and the first week of September represent the end of the swarming period. One single individual was trapped as late as 24 Sept.–2 Oct. at Revheim in 1972, but in the fortnight before this, there were none.

In England there are two broods per year, but only some of the larvae from the spring generation emerge as adults in the late summer. Most of the larvae become full-fed in the summer and spend the winter as resting larvae within the pupal cocoon (Kimmins 1962). So far no reports have been given on the complete rearing of the species in the laboratory from egg to adult.

Fig. 1 & Fig. 2 show the swarming period at Revheim and Valestrandsfossen in the years 1972 and 1973. There is no clear indication of two separate breeding periods, but as the numbers are high in the middle of August, we might assume that some of the larvae from the spring generation have become full-fed and pupate in early summer, and emerge in August.

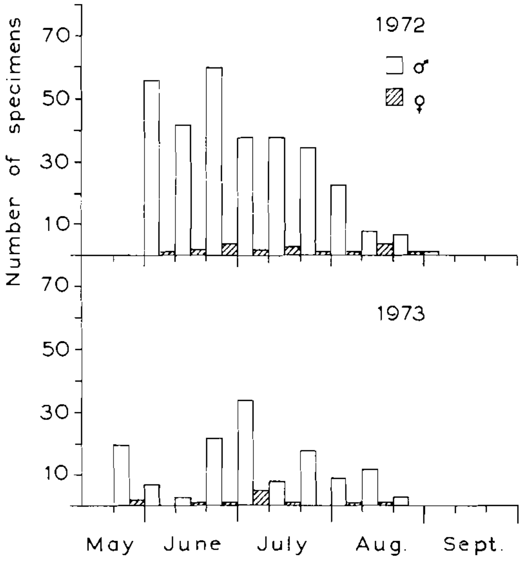

Fig.1. The number of males and females of *Sisyra fuscata* trapped at Valestrandsfossen in 1972 and 1973.

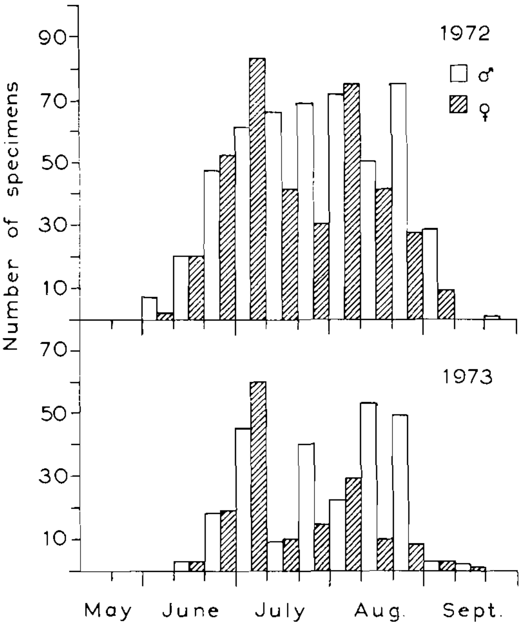

Fig. 2. The number of males and females of *Sisyra fuscata* trapped at Revheim in 1972 and 1973.

S. fuscata is often reported to hide among the vegetation during the daytime. On sunny days, however, large numbers of specimens have been swarming near their localities.

S. fuscata has a wide distribution in Europe (Illies 1967) and has also been found in eastern U.S.A. and Canada (Parfin & Gurney 1956). Tjeder (1945) reports the species from scattered localities in many parts of Norway north to Troms county.

Sialis lutaria was trapped three times at Revheim, and once at Lono. The rest of the material was taken at Valestrandsfossen. The species constitutes 10.1% of the total material. The swarming period started in May and culminated both years in the middle of June (Fig. 3).

S. lutaria has been reported from various localities in southern Norway by Tjeder (1945). Solem (1973) reports that the most intensive flight period is in June and July (no figures or numbers are given for the adults). *S. lutaria* is a common and wide-

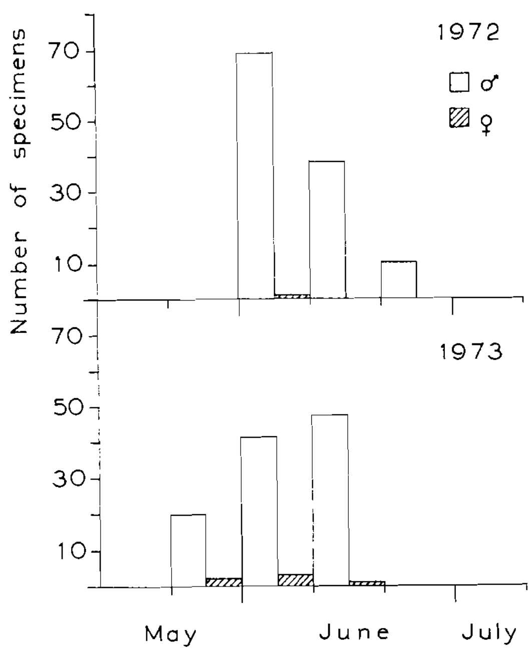

Fig. 3. The number of males and females of *Sialis lutaria* trapped at Valestrandsfossen in 1972 and 1973.

spread species in southern Norway, both in the lowlands and the mountains, but the number of adult specimens caught in the lowlands in July is low, and specimens are rarely found after the first week of this month. In mountain areas in southern Norway, individuals are found in July and as late as first week of August. This indicates a delay in the swarming period. For comparison it can be mentioned that in Switzerland the swarming period lasts from the end of April to approximately 20 May (DuBois & Geigy 1935). In Denmark the swarming period starts at the beginning of May and lasts 7 weeks. After the first week of June few individuals are found (Kaiser 1950). The life-span of adult *S. lutaria*, according to Kaiser (1961), is 10 days at best. There is only one brood per year. In southern Finland swarming starts in late May and extends throughout June (Meinander 1962).

Micromus paganus was trapped regularly at all localities, and constitutes 5.4% of the total material. The earliest and latest date of occurrence was 22 May–2 June and 31 Aug.–4 Sept. *M. paganus* must be considered a common and widespread species in Norway (Tjeder 1945, Greve 1970).

Wesmaelius nervosus was taken at all localities, and constitutes 3.4% of the total material. The flight-period extends from early June to November, but only three specimens were trapped before middle of June. It was found regularly during the months of October and November, and in fact more than half of the material trapped in 1972 was taken from September on and later in the year. The last appearance was 2–18 Nov. Thus the flying period of this species lasts considerably longer than most Hemerobiidae. In England it has been found from late April to late October, and one reckons with at least two broods per year (Killington 1936). *W. nervosus* is very common and widespread in southern Norway (Tjeder 1944).

Hemerobius nitidulus was taken at Herland 4–15 Oct. 1972. The species is not uncommon in the area; the date, however, is surprisingly late in the year.

Hemerobius simulans was trapped at Revheim 22–27 June 1972 and at Holo 4–15 Oct. 1972. Adults are frequently found late in the year and since it also is found early in the spring (Greve 1967), the species might perhaps hibernate as an imago like *Hemerobius stigma.*

Megalomus hirtus was taken at Holo 5–10 Aug. 1972. A total of 25 specimens from 12 localities has so far been reported from Norway (Greve 1970). Since then more material has been found, but the species must still be considered rare in Norway.

Sympherobius fuscescens was taken at Herland 5–10 Aug. 1972. The species was reported from Hordaland by Greve (1967), but it is not common in the area.

Conwentzia pineticola was taken at Herland 4–15 Oct. 1972. Four specimens of *C. pineticola* from three localities have earlier been reported from Norway, all localities in Hordaland county not far from Osterøy (Greve 1969). Like most specimens of the family Coniopterygidae, *C. pineticola* has probably been overlooked so far because of its minute size.

SEX RATIO

The sex ratio for the four species caught in more than fifty specimens ranges from 21%

males in *Wesmaelius nervosus,* 70% males in *Sisyra fuscata,* 89% *Micromus paganus* to 97% males in *Sialis lutaria.* When collected with a sweep-net the sex ratio for *Sialis lutaria* is close to unity (Kaiser 1950). The same is known for Hemerobiidae (Banks 1952), but for Sisyridae the sex ratio has not been studied.

Insects collected in light traps often show an unequal sex ratio. Sex differences in light perception or in phototactic response are possible explanations. Killington (1936) however, reports that in various species of Hemerobiidae and Chrysopidae the sexes are equally attracted to light, but he does not refer to any particular species.

In some species one of the sexes, usually the male, is more active and has a wider range. This has been shown in one species of *Sialis* studied in the laboratory (Pritchard & Leischner 1973). Differences in activity may therefore explain some of the observed differences in sex ratio for *S. lutaria.* The female of *S. lutaria* is larger than the male, particularly in the size of abdomen.

Table I shows a clear difference betwen Revheim and the other stations in the sex ratio for *S. fuscata.* At Revheim the number of females is much larger, viz. 43% females in 1972 and 39% in 1973; at the other stations this percentage varied from 0 to 19%. At Valestrandsfossen there were 6% females in 1972 and 8% females in 1973, at Lono 4% females in 1972 and 19% in 1973. At Lono large sponge colonies (the principal food for *Sisyra* larvae) were growing in shallow waters near the trap site. Emerging adults of both sexes would therefore have very short flying distance to the light-trap. At Revheim we did not find any sponge colonies near the trap, and they must have grown further away. The obtained figures do not support a hypothesis that the females of *S. fuscata* are more inactive or have a shorter range than the males.

DISCUSSION

Since the original intention with the light trapping was to collect Trichoptera, all five traps were situated near fresh water localities. Thus the diversity of the localities was too small to yield a representative collection of Neuroptera from the area. A total of 25 species of Neuroptera are at present known from the island and its neighbouring districts.

Sisyra fuscata and *Sialis lutaria* both have water-dwelling larvae and were to be expected in the catches. They constitute 90.4% of the total material. *Micromus paganus* and *Wesmaelius nervosus* occurred regularly and in fairly large numbers at all stations. They are among the most common species of Neuroptera in Norway, known from both lowland and mountain localities. The remaining nine species constitute only 0.8% of the total material. Three of these species, *Conwentzia pineticola, Megalomus hirtus* and *Sympherobius fuscescens,* are interesting from a faunistical point of view; they belong to species still inadequately known in Norway.

Neuroptera is usually collected with sweep nets, but large samples are often difficult to obtain and in Western Norway the rainy climate often hinders regular sampling. Light-trapping seems therefore to be a successful additional method, indeed very useful for collecting species like *Sisyra fuscata* and *Sialis lutaria.*

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Studies on the behaviour of *Bombus* Latr. species (Hym., Apidae) parasitized by *Sphaerularia bombi* Dufour (Nematoda) in an alpine area

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Lundberg, H. & Svensson, B. G. 1975. Studies on the behaviour of *Bombus* Latr. species (Hym., Apidae) parasitized by *Sphaerularia bombi* Dufour (Nematoda) in an alpine area. *Norw. J. Ent.* 22, 129–134.

At Abisko, northern Sweden, the alpine/supalpine bumble-bee queens of the species *B. alpinus* L., *B. balteatus* Dahlb., and *B. lapponicus* Fabr. were found to be new hosts for the parasitic nematode *Sphaerularia bombi* Dufour. The parasite was also found in five other species in the area. The distribution and dispersal of the parasite are discussed. The parasite caused severe changes in the behaviour of the queens. The nest-seeking, hibernacula-seeking, and foraging activities of healthy and parasitized queens are described and compared. Behaviour and parasitization showed an absolute correlation.

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Sphaerularia bombi Dufour is a parasite on bumble-bee queens, *Bombus* Latr., and has been a subject of several investigations. Studies on the morphology and life history of the nematode have been published by Madel (1966), Hattingen (1956), and Stein & Lohmar (1972). The altered behaviour of the bumble bees was noted by Bols (1939) and Minderhoud (1951), while other aspects of parasitization were reported by Alford (1969a) and Poinar & van der Laan (1972).

Despite these reports, the mode of infestation is uncertain. However, infestation is thought to occur during hibernation (Alford 1969a, Povreau 1964, and Poinar & van der Laan 1972), or in the nest (Schneider 1883, Stein 1956). In the spring, the parasitized queens are unable to initiate colonies and are seen flying till late summer when they die from the effects of the parasite. Throughout the summer their behaviour seems disordered; in particular they repeatedly exhibit inappropriate behaviour such as nest-seeking and hibernacula-seeking activities. When the queen is digging in the soil she deposits the third-stage juvenile nematode through the anus (Poinar & van der Laan 1972). The nematode completes its development, copulates, and the female enters a new host. In our four-year ecological study on bumble bees, this abnormal behaviour was consistently related to bumble-bee queens infested with *Sphaerularia bombi.* The nematode was frequently found during nectar analysis of the honeycrop and on examination of the genitalia. The distribution of the nematode among the alpine bumble-bee species is now reported, and a comparison made between the behaviour pattern found in the infected and healthy bumble bees.

MATERIALS AND METHODS

The present study was carried out June–August 1974 in Abisko, northern Sweden, 68 22°N, 18 47°E. The behaviour of healthy queens was observed in the field along a transect ranging from the sub-alpine (350 m a.s.l.) to middle-alpine belt (1,000 m a.s.l.)

on Mt. Njulla. The behaviour of the parasitized queens was studied in the middle-alpine belt, from where they were mostly collected. For a description of the intensive study area see Hundt (1963).

Nest-seeking behaviour is exhibited in spring when the bumble-bee queens are searching for nesting places, whereas hibernacula-seeking activity is shown in late summer/autumn. The behaviour characteristics of the parasitized queens were observed especially in July, when the parasite is fully developed in the host. To estimate the degree of parasitization, the number of uteri of the parasite in the abdomen of the hosts were counted and the stage of development of the parasite noted. For identification (and for some comparative measurements) of the third-stage nematode, the data from Poinar & van der Laan (1972) were referred to.

Plants visited by the parasitized queens were determined by a qualitative analysis of the pollen content in the crop. The pollen flora by Erdman et al. (1961) was used for the identification.

The nomenclature for the bumble-bee species follows Løken (1973) and for plants, Hultén (1971).

BEHAVIOUR OF HEALTHY QUEENS

B. lapponicus Fabr. is the most frequent species in the area, so our study concentrates on that species. Together with *B. balteatus* Dahlb. and *B. jonellus* K. it is distributed throughout the transect (350 m – 1,000 m a.s.l.). The first queens of *B. lapponicus* are seen in the middle of May. By the end of the month, they are frequently observed exhibiting nest-seeking behaviour. The new queens appear in the third week of July.

The nest-seeking behaviour of *B. lapponicus* in the birchforest (350 m a.s.l.) is easily recognized. The queens fly about half a metre above the ground in a typical and fast zigzag flight. They stop in flight above potential nesting sites, such as the bases of birch trunks and bushes, as well as old vole nests (in tussocks) and small dips in the ground. Nests have usually been found in such sites. When the queens alight on the ground, they rapidly move in and out of holes. Sometimes the bees are seen to hover above a dark object mistaking it for a hole before flying away. Later inspection of these sites usually reveals the presence of a stone or twig, the shape of which may have formed a deceptive image for the bee. The principal stimuli during nest-seeking behaviour are probably visual. Similar observations were made on *B. pratorum* L., *B. jonellus,* and *B. balteatus.*

In the low-alpine belt (600–1,000 m a.s.l.), a somewhat different pattern of nest-seeking flight was observed for *B. aplinus* L., *B. arcticus* K., *B. balteatus,* and *B. lapponicus.* Whereas distances between potential nesting sites were usually short in the birch-forest, the bumble bees in the low-alpine belt were often seen flying long distances at high speeds between sites. Areas in the sub-alpine and low-alpine belt frequented by nest-seeking queens were often associated with the main food resource – *Salix* species (Lundberg unpubl.). The queens alternated between foraging and nest seeking; this was very obvious when the weather changed rapidly between sunny and cloudy.

The hibernacula-seeking behaviour was exhibited by the new queens which appeared in the last week of July. Compared with the large number of queens seen on *Salix* in the spring, very few queens were seen in the autumn. They probably hibernate shortly after mating. The hibernacula-seeking behaviour of the new queens was observed for *B. alpinus, B. balteatus, B. hyperboreus* Schönh., and *B. lapponicus.* They were noted to favour ground which offers sheltering snow in the winter. The queens would fly more directly between suitable sites, wasting little time hovering before inspecting the ground more closely. Definite hibernation was not seen.

BEHAVIOUR OF PARASITIZED QUEENS

Most of the observations on the behaviour of parasitized queens were made between 800 m and 1,000 m a.s.l. Parasitized queens were frequently observed on small wind exposed hillocks partly covered with heath and shrub vegetation. The surrounding areas were covered with grass heath. The description of the behaviour of the parasitized queens con-

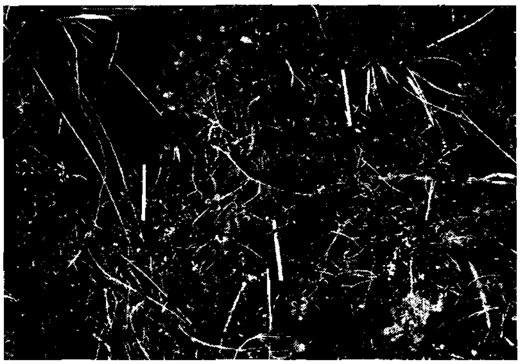

Fig. 1. Holes dug by one parasitized queen of *Bombus lapponicus* Fabr. Matches indicate the holes.

cerns mainly *B. lapponicus,* but similar behaviour was also exhibited by *B. alpinus* and *B. balteatus.* The hillocks seemed very attractive to the queens. In one day, 25 parasitized queens were collected. Few queens were seen on the surrounding grass-heath areas, and those were often flying between adjacent hillocks. The infested queens approached the hillocks in a fast, high, and direct flight. They then descended usually to the base of the hillock and then the queens flew low over the hillock in a flight pattern similar to that of nest-seeking queens or queens searching for forage plants. However, their flight was noted to be unsteady, and during landing they often hit grass stems or twigs of *Betula nana,* and fell to the ground. In flight their abdomen was hanging down and often bent towards one side. The parasitized queens could easily be recognized by their tone pitch. There was no apparent object in their alighting on the ground, and indeed they frequently fell there after colliding with the vegetation while in flight. Their subsequent behaviour seemed totally disorientated. The parasitized queens were observed to start digging like the hibernacula-seeking queens and/or search in holes like the nest-seeking queens. They were observed digging both in sheltered places such as shrub vegetation with a thick layer of litter and in unsheltered places which were wind exposed and had sparse vegetation. During this digging activity they often dug several holes, 1–2 cm deep, close to each other (Fig. 1). Dissection of those queens confirmed that they were all parasitized and contained large numbers of third-stage nematodes. Digging, which is usually associated with hibernating activities in healthy bees, was thus noted among the infected bees in the most unsuitable places, which would never have given protection if the bees had attempted hibernation. Furthermore, the sites where these activities were performed were never used for nest-seeking behaviour by the healthy bees (Fig. 2).

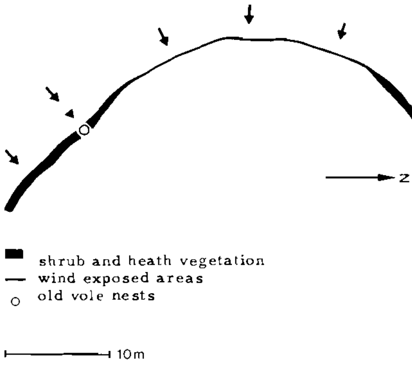

Fig. 2. Comparison of the distribution of places for digging and/or hole-seeking activities on a theoretical alpine hillock for parasitized (arrows), healthy nest-seeking (filled triangles), and hibernacula-seeking (unfilled triangles) *Bombus lapponicus* Fabr. queens.

The infested queens could be observed performing the digging, hole-seeking, and foraging activities in the same habitat.

Pollen-crop analysis was performed to determine plants visited, and consequently areas visited by the parasitized queens, and thereby the dispersal of the parasite. The pollen analyses confirmed a wide vertical range of foraging including different habitats by the same specimen. Birch-wood areas and sub-alpine heaths are characterized by pollen from *Andromeda polifolia, Chamaenerion angustifolium* and species of *Melampyrum* and *Vaccinium,* while pollen from *Astragalus alpinus, Bartsia alpina* and *Geranium silvaticum* indicates visits to sub-alpine meadows. Queens captured in the low and middle-alpine belts (Table I, specimens No. 2, 5, 11, 17, 21, 25) indicate such vertical forage patterns. The pollen analyses also confirmed foraging by the same specimen in different habitats

Table I. Plants visited by parasitized Bombus spp. queens as recorded by pollen crop analysis.

SPECIMEN NUMBER	PARASITIZED BOMBUS SPECIES	DATE	ALTITUDE	ANDROMEDA POLIFOLIA	ARCTOSTAPHYLOS ALPINA	ASTRAGALUS ALPINUS	BARTSIA ALPINA	CAMPANULA UNIFLORA	CASSIOPE SP.	CHAMAENERION ANGUSTIFOLIUM	DIAPENSIA LAPPONICA	GERANIUM SILVATICUM	GENTIANA SP.	GEUM RIVALE	LOISELEURIA PROCUMBENS	MELAMPYRUM SP.	MELANDRIUM RUBRUM	MYOSOTIS SILVATICA	PARNASSIA PALUSTRIS	PYROLA SP.	PHYLLODOCE COERULEA	RANUNCULUS SP.	RHODODENDRON LAPPONICUM	SALIX SP	SOLIDAGO VIRGAUERA	TARAXACUM SP.	VACCINIUM SP.	VIOLA BIFLORA
1	B. ALPINUS	17 July	900			▨																					▨	
2	B. BALTEATUS	13 July	-"-	▨	▨	▨	▨	▨			▨										▨			▨			▨	
3	-"-	13 July	-"-			▨																						
4	-"-	13 July	-"-			▨	▨																▨				▨	
5	-"-	13 July	-"-	▨		▨	▨		▨				▨								▨		▨					
6	-"-	20 July	-"-			▨	▨																				▨	
7	B. HYPNORUM	25 July	700			▨	▨										▨											
8	B. JONELLUS	25 July	-"-			▨																					▨	
9	B. LAPPONICUS	24 June	300	▨		▨																					▨	
10	-"-	5 July	1000			▨																		▨			▨	
11	-"-	13 July	900	▨		▨					▨				▨								▨	▨				
12	-"-	13 July	-"-			▨									▨													
13	-"-	13 July	-"-			▨																▨					▨	
14	-"-	17 July	-"-			▨																						
15	-"-	17 July	-"-			▨																					▨	
16	-"-	17 July	-"-																		▨						▨	
17	-"-	17 July	-"-	▨		▨													▨									
18	-"-	17 July	-"-			▨	▨																					
19	-"-	17 July	-"-			▨																						
20	-"-	17 July	-"-			▨																					▨	▨
21	-"-	17 July	-"-			▨																						
22	-"-	17 July	-"-	▨			▨																				▨	
23	-"-	25 July	650			▨	▨																					
24	-"-	25 July	1000	▨		▨														▨							▨	
25	-"-	25 July	-"-	▨		▨				▨						▨		▨	▨						▨		▨	
26	B. LUCORUM	6 July	350			▨						▨																
27	B. PASCUORUM	31 July	600																▨							▨		
28	B. PRATORUM	4 July	400				▨					▨		▨													▨	▨

within the sub-alpine and middle-alpine regions, where wind-exposed hillocks are represented by pollen from *Diapensia lapponica, Arctostaphylos alpina,* and *Loiseleuria procumbens,* and shrub and heath vegetation by pollen from *Phyllodoce coerulea* and *Cassiope* sp. The most frequently visited plants were *Vaccinium* sp. and *Astragalus alpinus* (Table I), all common and yielding good amounts of nectar and also favoured by the healthy queens (Lundberg 1975). However, pollen from *Campanula uniflora, Myosotis silvatica,* and *Parnassia palustris* was also found in the crops of parasitized queens, (Lundberg, unpubl.). These three plants are highly unfavourable forage plants because of their low nectar yield and widely scattered distribution. All queens had a very low content of nectar in the crop, whereas third-stage nematodes were numerous.

NUMBER OF PARASITES PER HOST

43 queens were collected because their behaviour was suspected to be due to parasitization, and in every instance the suspicion was confirmed. Table II shows the number of parasites recovered from different host species, 14 being the greatest number found in one queen, *B. lapponicus.* The uterus of the nematode was found to be of variable size but could be as long as 3 cm in queens with few nematodes. The number of matured female nematodes in *B. lapponicus* was also variable and seemed to have no correlation with the date of collection. All parasitized queens also contained numerous third-stage nematode juveniles.

Table II. Number of females of *Sphaerularia bombi* found in the abdomen of different *Bombus* species.

Species	Number of queens examined	Number of *S. bombi*	
		range	mean
B. alpinus	1	5	-
B. balteatus	7	1-10	3 57
B hypnorum	1	1	-
B. jonellus	3	1-4	2.66
B. pratorum	2	1-2	1.50
B. lapponicus	28	1-14	2.32
B. pascuorum	1	3	-

DISCUSSION

Sphaerularia bombi has a holarctic distribution, and in Europe the parasite is reported from 14 bumble-bee species, viz. *B. soroeensis* Fabr., *B. lucorum* L., *B. terrestris* L., *B. hypnorum* L., *B. jonellus* K., *B. pratorum* L., *B. lapidarius* L., *B. hortorum* L., *B. humilis* Ill., *B. muscorum* L., *B. pascuorum* Scop., *B. ruderarius* Müll., *B. distinguendus* Mor., and *B. subterraneus* L. (Alford 1969a, Palm 1948, Schneider 1866, Stein & Lohmar 1972). Other parasitized genera are *Psithyrus* Lep. (Palm 1945, Pauvreau 1963) and *Vespa* L. (Schneider 1866). In Sweden, Palm (1945) was the first to recognize the parasite in southern Sweden, and later Fridén (1966) and Hasselroth (1960) reported it further north at latitude 60°. Infestation has not been reported before in alpine or sub-alpine bumble-bee species. In this study we found the parasite in *B. alpinus* L., *B. balteatus* Dahlb. and *B. lapponicus* Fabr., which are new hosts for the parasite, and in *B. lucorum, B. hypnorum, B. jonellus, B. pratorum,* and *B. pascuorum.* The five last-mentioned species were parasitized in central Sweden (Hasselroth 1960). These species are distributed throughout the entire country (Løken 1973) and they are occasionally found in the alpine region, except *B. jonellus.* The occurrence of the parasite in both alpine and sub-alpine species may be explained by the infection of those species which are distributed throughout the country. Thus is seems likely that *Sphaerularia bombi* is distributed all over Fennoscandia. Bols (1939) and Alford (1969a) suggested that species with a wide range of local distribution may act as local vectors; species likely to do so in the study area would be *B. balteatus* and *B. lapponicus,* which have a wide vertical distribution and utilize variable habitats (Svensson & Lundberg, unpubl.). Pollen analysis supports this theory, indicating a vertical flight by the parasitized queens. Thus the parasite will be spread over large areas and the chance for infestation of healthy queens will be increased. The disorientated behaviour of the infested queens was most striking, the net result of which was that they frequently flew unnecessarily long distances and foraged on unfavourable plants – a classic lack of strategy in energy economy. In combination with the debilitating effect of the parasite, this behaviour led to death from starvation.

It has been proposed that the nematode enters a new host during the hibernation of bumble bees. Poinar & van der Laan (1972), Alford (1969b), and Holm (1972) found that suitable hibernation sites for the queens are well-drained slopes with an open vegetation and a rather moist soil texture. This statement is supported in the present study where queens were observed to seek suitable hibernation sites on the sides of hillocks or mountain slopes. Furthermore, the nectar analyses confirmed that the parasitized queens had visited these habitats. Observations on the behaviour of the parasitized queens showed, however, that they are not particularly attracted to the hibernation sites of healthy queens as proposed by Bols (1939) and Cumber (1949). Thus, infested queens were frequently observed digging holes in very exposed places, quite contrary to the selective behaviour of healthy queens (Fig. 2). It is suggested that those holes dug and excavations visited by the infected queens may later be visually attractive for healthy queens when they are searching for a suitable hibernation site.

Poinar & van der Laan (1972) proposed that different species of bumble bees contain morphological races of *Sphaerularia bombi* because of their different hibernation sites. The present study does not support this theory for the following reasons: (1) the dispersal of the parasite by bumble-bee species with an overlapping distribution; (2) the unspecific behaviour of the parasitized queens. As stated by Alford (1969a), it is very difficult to estimate the level of infection betwen host species and bumble-bee populations because the proportion of infested queens apparently rises during the summer (Stein & Lohmar 1972). Differences of degree of parasitization between individual host species may reflect differences in the choice of hibernation site.

In conclusion, we wish to stress our findings that: (1) the behaviour of the parasitized queens seems to be associated with natural nest-seeking, hibernacula-seeking and foraging behaviour. However the behaviour is mixed and disorientated. (2) The flight behaviour and sound production is characteristic. (3) Observations showed an absolute correlation between parasitation and behaviour. (4) The disorientated behaviour seems to favour the dispersal and survival of the parasite.

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Coleoptera in nests of birds of prey

SIGMUND HÅGVAR

Hågvar, S. 1975. Coleoptera in nests of birds of prey. *Norw. J. Ent.* 22, 135–142.

Twenty-two coleopterous species, mainly Staphylinidae and Histeridae, were found in fifteen nests of eight birds of prey. Several of the coleopterous species have not previously been found in nests of one or more of the bird species. Coleoptera in nests of long-eared owl (*Asio otus* (L.)) have not previously been investigated in Norway. It has been commonly assumed that *Philonthus parcus* Sharp has recently invaded northern Europe from the East. The author points out that the species, developing in the nests, may have been overlooked. Several Coleoptera show preferences for certain species of birds of prey, for open nests or nests in hollow trees, for nests in use or abandoned nests. Old nests in use contain the largest number of species. A succession of coleopterous species occurs both in nests which are used year by year and in nests which are left abandoned. Factors creating special ecological conditions in the nests are discussed.

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The coleopterous fauna in nests of several birds of prey in Norway has earlier been investigated by Strand (1967a), in a nest of short-eared owl (*Asio flammeus* Pontopp.) by Strand (1943), and in nests of tawny owl (*Strix aluco* L.) by Hågvar (1969). Evidently, for several species of Coleoptera, nests of birds of prey represent favourable habitats, and the density may be quite high. The purpose of the present paper is to increase our knowledge in this field. Emphasis is laid on the ecological aspects of this fauna.

MATERIAL AND METHODS

The nest material was collected after the youngsters had left the nests. In nesting-boxes all the bottom material was collected, but in open nests only the central part containing pellets, feathers, remnants of prey, and finer twigs was taken, leaving the main structure of the nest untouched. The Coleoptera were sorted out by hand. Most nests contained a large variety of invertebrates. Some of the material collected in addition to the Coleoptera will be published elsewhere. Altogether Coleoptera from fifteen nests were collected, representing eight species of birds of prey. Data about the nests are presented below.

Nest No. 1. Tawny owl (*Strix aluco*). Kolsåsen, Bærum (Ak), 280 m a.s.l. Wood dominated by spruce. Nesting-box 10 m high in a spruce, situated on the hill-side of a small valley. Three youngsters left the nest about 1 June 1971. About 2 l material was collected and examined 11 June.

Nest No. 2. Tawny owl (*Strix aluco*). Kolsåsen, Bærum (Ak), 130 m a.s.l. Dense wood dominated by spruce. Nesting-box 7 m high in a spruce. Two youngsters left the nest about 25 May 1974. Only about 0.5 l material was collected 30 May and examined 2 June. Probably most of the material had fallen out through a small hole in the box.

Nest No. 3. Tawny owl (*Strix aluco*). Kolsåsen, Bærum (Ak), 290 m a.s.l. Rather dense mixed wood dominated by spruce. Nesting-box 3 m high in a spruce. Four youngsters left the nest about 8 May 1973. The bottom material, about 1.8 l, was collected 17 February next year, stored at nearly outdoor temperatures and examined 5 May. The material was very moist.

Nest No. 4. Tengmalm's owl (*Aegolius funereus* L.). Jeppedalen, Gran (Os), 500 m a.s.l. Spruce wood. Nesting-box 5 m high in a scotch pine on a mire with small birches and spruce trees. Five youngsters left the nest about 30 May 1974. About 2.5 l very moist material was collected few days later, stored at about 10°C and examined in late June.

Nest No. 5. Tengmalm's owl (*Aegolius funereus*). Jeppedalen, Gran (Os), 520 m a.s.l. Spruce wood. Nesting-box 6 m high in a birch near a mire. The youngsters (number unknown) left the nest about 20 May 1974. About 2 l of very dry and compressed material was collected roughly ten days later, stored at about 10°C and examined 16 June.

Nest No. 6. Long-eared owl (*Asio otus* (L.)). Near Hurdalssjøen, Hurdal (Ak), 180 m a.s.l. Small spruce wood near agricultural land, in an old nest of magpie (*Pica pica* (L.)) about 12 m high in a 18 m high spruce. The youngsters (at least two) left the nest about 20 June 1974. About 2 l rather dry material was collected 3 August, stored at about 10°C and examined 25 August.

Nest No. 7. Long-eared owl (*Asio otus*). Near Bøn, Eidsvoll (Ak), 180 m a.s.l. Grove dominated by deciduous trees, near agricultural land. An old nest of crow (*Corvus corone cornix* L.) about 10 m high in a 18 m high spruce had been used. Four youngsters left the nest about 10–15 June 1974. About 3 l material was collected 3 August, stored at about 10°C and examined 25 August.

Nest No. 8. Long-eared owl (*Asio otus*). Near Bøn, Eidsvoll (Ak), 185 m a.s.l. Grove dominated by spruce, near agricultural land. An old nest of crow had been occupied about 6 m high in a 9 m high spruce. The nest had probably been used each of the last five years. Four youngsters left the nest about 20 June 1974. About 3 l material was collected 3 August, stored at about 10°C and examined 15–20 August.

Nest No. 9. Osprey (*Pandion haliaëtus* L.). The Coleoptera were taken in a nest at Vegårdshei (AAy) 28 June 1974.

Nest No. 10. Kestrel (*Falco tinnunculus* L.). Near Bøn, Eidsvoll (Ak), 180 m a.s.l. Mixed wood dominated by spruce, and old nest of crow about 19 m high in a 25 m high spruce. Three youngsters left the nest about 1 July 1974. Roughly 1.5 l of rather dry material was collected 3 August and stored at about 10°C for some days before examination.

Nest No. 11. Sparrow hawk (*Accipiter nisus* L.). Valler, Bærum (Ak), 100 m a.s.l. Spruce wood. The nest, situated in a spruce, had been used the same year. A small sample was taken and examined 3 July 1969.

Nest No. 12. Sparrow hawk (*Accipiter nisus*). Valler Bærum (Ak), 100 m a.s.l. Spruce wood. The nest, situated in a spruce, had been used the previous year. A small sample was taken and examined 5 October 1969.

Nest No. 13. Goshawk (*Accipiter gentilis* L.). Near Sogndal (SFi), about 550 m a.s.l. Mixed wood dominated by scotch pine and birch. Nest about 7 m high in a 15 m high pine. The nest had not been used since 1971. One l was collected and examined 31 June 1974.

Nest No. 14. Buzzard (*Buteo buteo* L.). Hurdalen, Eidsvoll (Ak), 175 m a.s.l. Wood dominated by scotch pine and birch. Nest about 15 m high in a 20 m high birch. One youngster, which left the nest about 1 July 1974. The nest was also used the two previous years. 2–3 l material was collected 3 August and stored at about 10°C for some days before examination.

Nest No. 15. Buzzard (*Buteo buteo*). Hurdalen, Eidsvoll (Ak), 185 m a.s.l. Mixed wood dominated by spruce. Nest about 18 m high in a 25 m high spruce. The nest had not been used during three years or more. Very old and large nest, up to 80 cm high, mainly consisting of branches from conifers. About 3 l material was collected 3 August 1974 from the central upper part of the nest, stored at about 10°C and examined 22 August.

RESULTS

Table I lists 22 coleopterous species from five families found in the nests. Most species belong to Staphylinidae and Histeridae. *Microglotta picipennis* is new to the outer part of Aust-Agder (AAy), *Atheta nidicola* and *Coryphium angusticolle* are new to the inner part of Sogn og Fjordane (SFi), and

Table I. The occurrence of Coleoptera in nests of different birds of prey. The following species names have been abbreviated: *Aegolius funereus*, *Pandion haliaëtus*, *Falco tinnunculus*, *Accipiter nisus* and *Accipiter gentilis*.

Bird species	Strix aluco			Aegol. funer.		Asio otus			Pand. hal.	Falc. tinn.	Acc. nis.		Acc. gent.	Buteo buteo	
Nest nr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Silphidae															
Necrophorus vespilloides Hbst.				1											
Staphylinidae															
Coryphium angusticolle Steph.													4		
Philonthus parcus Sharp						5		1						1	
Quedius brevicornis Th.															1
Atheta canescens Sharp						1	1								
A. celata Er.	2						2								
A. harwoodi Will.	3					2	1	2		2					
A. nidicola Johans.								2		1	1	1	5	4	29
A. nigra Kr.								7		1					
A. nigricornis Th.	72		1			5	21	20		14				5	
Microglotta picipennis Gyll.									2		5			2	
Aleochara sanguinea L.							1								
A. sparsa Heer							2								
Histeridae															
Gnathoncus buyssoni Auzat	7				4	2		7							
G. nannetensis Mars.	4	3													
G. nanus Scriba	4					3									
G. schmidti Rtt.	19		4												
Carcinops quatuordecimstriata Steph.	1						2			1				3	
Hister merdarius Hoffm.	4							1							
Cryptophagidae															
Cryptophagus scanicus L.														1	
Atomaria apicalis Er.						2		1						1	
Lathridiidae															
Enicmus nidicola Palm								2					1	2	
NUMBER OF SPECIMENS	116	3	5	1	4	20	30	43	2	19	6	1	10	19	30
NUMBER OF SPECIES	9	1	2	1	1	7	7	9	1	5	2	1	3	8	2

Gnathoncus buyssoni is new to the southern part of Oppland (Os) (Lindroth 1960).

Of the five specimens of *Philonthus parcus* recorded in nest No. 6, four were found as pupae. They hatched after 1–5 days at room temperature.

The small number of Coleoptera from nest No. 2 is mainly due to the small sample. The material from nest No. 3 was collected during winter and contained only two species in the adult stage.

Altogether, material from six nesting-boxes of *Aegolius funereus* was examined. All boxes had been used the same year. In two boxes the material was very dry and strongly compressed, with almost no spaces for the Coleoptera. One of these nests contained no coleopters; the other (No. 5) contained four *Gnathoncus buyssoni*, of which one was dead. All were found in the inner parts of the 'block', where the material was still a little humid. The material from the four other boxes was very moist, and the only Coleoptera found was a dead specimen of *Necrophorus vespilloides* in nest No. 4. Probably beetles were present in all samples, but had died because of ammonia development or oxygen deficiency in the bags, which were rather close. It is almost impossible to pick out small beetles from nest material when they are dead and immobile. The fauna from nest No. 4 must therefore be regarded as incomplete.

The coleopterous fauna in nests of *Asio otus* has not previously been investigated in Norway.

DISCUSSION

A short comment shall be given to each coleopterous species in light of earlier investigations in this field.

Necrophorus vespilloides. Not earlier found in nest of *Aegolius funereus* (Hicks 1959, Strand 1967a). Fjellberg (1969) recorded the species in nest of heron (*Ardea cinerea* L.) in Western Norway.

Coryphium angusticolle. Not previously recorded in nest of *Accipiter gentilis* (Hicks 1959, Strand 1967a).

Philonthus parcus. Not previously found in nests of *Asio otus* and *Buteo buteo* (Hicks 1959, Strand 1967a). The only earlier records from birds' nests are from two nests of *Strix aluco* (Hågvar 1969) and one nest of sand-martin (*Riparia riparia* L.) (Strand 1975) in Norway. In this country the species has been found outside birds' nests only once (Strand 1967b). According to Strand (1975 and pers. comm.), the species has been recorded for the first time in several North European countries during the two last decades, and it is generally believed that the species has newly invaded Europe from East. Obviously the species has an affinity to birds' nests. The pupae found in nest No. 7 show that the species can fulfil its life cycle in nests of birds of prey. The fauna of birds' nests has not been very thoroughly investigated in Europe, so perhaps *P. parcus* has been overlooked. According to Strand (1967b) its morphology is very similar to the common *P. sordidus* Gr. It is therefore also possible that *P. parcus* has been confused with this species. The development of the pupae indicates that *P. parcus* hatches in the last part of August. The records in nests of *Strix aluco* were from the middle of June (Hågvar 1969). This indicates that the species overwinters as imago, and that eggs are laid during spring or early summer. The larvae will then develop when prey remnants and pellets are present in the nest. Cannibalism observed among newly hatched specimens indicate that the species is a predator, taking other invertebrates feeding on prey remnants or other nest material.

Quedius brevicornis. Strand (1967a) has earlier found the species in nest of *Glaucidium passerinum* L. in Norway.

Atheta canescens. Not previously found in nest of *Asio otus* (Hicks 1959). Strand (1967a) found the species in nest of *Aegolius funereus* in Norway.

Atheta celata. This is the first record in nests of *Strix aluco* and *Asio otus* (Hicks 1959). Other Norwegian records from birds' nests are from *Buteo lagopus* Pont. and *Falco tinnunculus* (Strand 1967a), and from *Asio flammeus* (Strand 1943).

Atheta harwoodi. Not previously found in nest of *Asio otus* (Hicks 1959, 1962). The species is obviously a common inhabitant in nests of *Strix aluco* (Hågvar 1969). Also Strand (1967a) recorded it from nest of *Falco tinnunculus.* In addition he mentions it from a nest of *Buteo lagopus*, and Fjellberg (1969) found the species in nests of *Ardea cinerea.*

Atheta nidicola. Not previously found in nest of *Asio otus* (Hicks 1959, 1962). Also Strand (1967a) recorded it from nests of *Falco tinnunculus, Accipiter gentilis* and *Buteo buteo.* He even found it in nest of *Pandion haliaëtus.* In his publication, Strand points out that the species was not found in any of those nests of *Buteo buteo* which were situated in cliffs, but only in corresponding nests in trees. All the nests of *Buteo lagopus* studied by him were placed in cliffs, and despite of a rich coleopterous material recorded, *A. nidicola* was missing also from these nests. Even in the present material, the species was taken only in nests situated free in trees. Nor was the species recorded from nesting-boxes of *Strix aluco* studied earlier (Hågvar 1969). Most birds reported by Hicks (1959) as host for this species have open nests, mainly in trees. The present data indicate that among nests in trees, *A. nidicola* prefers old nests which have not been used for some years, viz. nests No. 13 and 15. The material collected from these nests was dominated by rottening needles and small twigs from conifers. This obviously represents a favourable habitat for the species. Probably *A. nidicola* inhabitats nests of birds of prey in trees continually from the first years of use, through a long series of years, till the nests fall down, becoming especially numerous in abandoned nests.

Atheta nigra. Not previously found in nests of *Asio otus* and *Falco tinnunculus.* Strand (1967a) recorded it from nests of *Buteo buteo* and *B. lagopus.* Hicks (1959, 1962) does not mention the species.

Atheta nigricornis. This is a typical species in nests of birds of prey (Hicks 1959, 1962, Hågvar 1969, Strand 1967a) and dominates the present material. It has not previously been recorded in nests of *Asio otus.* Fjellberg (1969) found it in nests of *Ardea cinerea.* The species occurs both in open nests in trees, in nests situated in cliffs, and in nesting-boxes and hollow trees. Contrary to *A. nidicola, A. nigricornis* seems to prefer nests which are in use. The species was absent from the three abandoned nests No. 12, 13, and 15. Nests containing much decaying prey remnants and pellets, often emitting a strong smell, seem to be favoured, e.g. nest No. 1 and the three nests described by Hågvar (1969). The specimen found in nest No. 3 indicate that the species hibernates as imago or pupa.

Microglotta picipennis. This was the most typical species in nests of hawks, buzzards, and *Pandion haliaëtus* studied by Strand (1967a), often occurring in very large numbers. However, except for one specimen in a nest of *Aegolius funereus,* the species did not occur in owls' nests studied by him. Also in the present material and in Hågvar (1969), the species was absent from owls' nests, both from nests in nesting-boxes and from open nests of *Asio otus* in trees. Hicks (1959) reports the occurrence in a nest of the large Eagle owl (*Bubo bubo* (L.)), which nests on the ground. The bird species reported by him are almost exclusively species with open nests. The preference for open nests is also evident from the present material and that of Strand (1967a).

Aleochara sanguinea. First record in nest of *Asio otus* (Hicks 1959, 1962). Strand (1967a) found it in a nest of *Aegolius funereus.*

Aleochara sparsa. First record in nest of *Asio otus* (Hicks 1959, 1962). Strand (1967a) found it in nest of *Pernis apivorus* L.

Gnathoncus buyssoni. First record in nest of *Asio otus.* The systematics of *Gnathoncus* sp. has been revised since the works referred to by Hicks (1959, 1962). In the present work, the systematics of Hansen (1958) is used. Taken in nests of all three owl species in Table I, and also in nests of *Strix aluco* earlier (Hågvar 1969). Strand (1967a) found it in nests of the two owl species *Aegolius funereus* and *Glaucidium passerinum.* Evidently the species is typical for owls' nests, both in hollow trees, nesting-boxes, and in open nests. Strand even found the species in nests of other birds of prey, so it is not restricted to owls. Two specimens collected 16 June from nest No. 5 copulated when brought together.

Gnathoncus nannetensis. The species is typical for nests of *Strix aluco* (Hågvar 1969). Strand (1967a) found it in nests of the owls *Aegolius funereus* and *Glaucidium passerinum,* and also in nests of *Accipiter gentilis* and *Falco tinnunculus.* The preferences seem to be similar to that of *G. buyssoni.* One pair picked out 2 June from nest No. 2 was in copulation.

Gnathoncus nanus. Not previously taken in nests of *Asio otus.* It has also previously been taken in nests of *Strix aluco* (Hågvar 1969). Strand (1967a) recorded the species from nests of *Aegolius funereus, Buteo buteo,* and *Pandion haliaëtus.* It was found in nests of *Ardea cinerea* by Fjellberg (1969). The preferences are similar to that of the two previous species.

Gnathoncus schmidti. The species is common in nests of *Strix aluco* (Hågvar 1969). Strand (1967a) found it only in nests of *Aegolius funereus.* Both birds are owls nesting in hollow trees or in nesting-boxes, and it seems that *G. schmidti* prefers this habitat. Three living specimens picked out from nest No. 3 indicate that the species overwinters as imago or pupa.

Carcinops quatuordecimstriata. Not previously found in nest of *Asio otus* (Hicks 1959). It is commonly found in nests of *Strix aluco* (Hågvar 1969). Also Strand (1967a) found it in nests of *Falco tinnunculus* and *Buteo buteo.* He even recorded it in other nests: *Pandion haliaëtus, Glaucidium passerinum* and *Aegolius funereus. C. quatuordecim-*

striata evidently occurs in nests of many species of birds of prey, both in open nests and in hollow trees.

Hister merdarius. Not previously recorded in nest of *Asio otus* (Hicks 1959, 1962). It is commonly found, although in small numbers, in nests of *Strix aluco* (Hågvar 1969). Strand (1967a) took it from nests of *Buteo buteo, Glaucidium passerinum,* and *Aegolius funereus.* As in the present study, this was the only species of the genus *Hister* occurring in the nests. The species seems to have a preference for owls' nests, although Hicks (1959) also reports several other bird species.

Cryptophagus scanicus. Besides in nest of *Buteo buteo,* Strand (1967a) recorded it in nests of *Buteo lagopus, Accipiter gentilis,* and *Pernis apivorus,* i.e. only open nests. The majority of records mentioned by Hicks (1959) are also from open nests. There are no records from owls' nests.

Atomaria apicalis. Not previously found in nest of *Asio otus.* Also Strand (1967a) took it in nest of *Buteo buteo.* Fjellberg (1969) collected it from nests of *Ardea cinerea.* All these birds and those cited by Hicks (1959) have open nests.

Enicmus nidicola. First records in nests of *Asio otus* and *Buteo buteo* (Strand 1967a). Besides in nest of *Accipiter gentilis,* Strand (1967a) collected it from nests of *Accipiter nisus, Pernis apivorus,* and *Falco tinnunculus.* Thus, all records are from open nests. In his work, Strand denotes it as a typical species in birds' nests. Hicks (1959, 1962) does not mention the species, but according to Strand (1967a) it has probably been confused with *E. minutus* L.

All coleopterous species listed in Table I have previously been found in nests of birds of prey. The majority are rather common inhabitants of such nests. Among the most typical nest species are *Atheta harwoodi, A. nidicola, A. nigricornis, Microglotta picipennis,* the four *Gnathoncus*-species, *Carcinops quatuordecimstriata,* and *Enicmus nidicola.*

The species composition in nest No. 1 of *Strix aluco* is very similar to that of three nests studied two years earlier (Hågvar 1969). Of the five species recorded in nest No. 10 of *Falco tinnunculus,* four were present in a nest of the same falcon studied by Strand (1967a). Of the nine different Coleoptera taken in the nests of *Buteo buteo* (Nos. 14 and 15), Strand (1967a) recorded six in his studies of nests from the same bird.

The present material together with earlier investigations show that several coleopterous species occurring in nests of birds of prey have special preferences for certain species of birds of prey, for open nests or nests in hollow trees, for nests in use or abandoned nests. Strand (1967a) found that the coleopterous fauna in nests of *Buteo buteo* placed in cliffs differed from that recorded in nests situated in trees.

Evidently a succession of coleopterous species occurs in nests of birds of prey, either in nests which are left abandoned, or in nests which are used year by year and grow larger and larger. In the latter case, older nest material gradually humifies, and the number of niches increases. Fjellberg (1969) mentions this effect in nests of *Ardea cinerea,* the largest number of species being found in old nests which were in use. Also in the present material old nests in use, which probably had been occupied continuously during several years, contained a high number of species (nests No. 6, 7, 8 and 14).

The actual species of Coleoptera must be good flyers, and it is reasonable to assume that they orientate themselves to the nests by their olfactory sense. Nests of *Strix aluco,* emitting a rather strong smell, receive a rich coleopterous fauna already the first year (nest No. 1 and Hågvar 1969).

The two dry samples from nesting-boxes of *Aegolius funereus* show that a certain moisture in the nest material is essential for the Coleoptera. Large, old nests keep humid in the centre even during long periods of drought. Nest No. 13 contained humid material 10–20 cm under the surface, even though the weather had been very warm and dry for several weeks. In this partly humified layer, there was a rich life of invertebrates. Even such typical soil inhabitants as larvae of Tipulidae developed here.

Nests of birds of prey are often used over long periods of years. Ecologically, each nest may be looked at as a small 'universe', containing a special fauna which includes eurytopic as well as stenotopic species. Several coleopterous species belong to this last group. The special conditions offered in this habitat are created mainly by decaying prey remnants and pellets, and, especially in hollow trees, excrements. Even in abandoned nests, it must be anticipated that the more or less humified material is specially rich in nitrogen, phosphorous, and other elements, creating favourable conditions for fungi or other microorganisms, which again can serve as food for invertebrates.

The body heat from the breeding bird and later from the youngsters may obviously create favourable temperature conditions for the invertebrates in the upper part of the nest material. According to R. Nordbakke (pers. comm.), the density of Coleoptera in nests of *Pandion haliaëtus* may be very high on the nest surface just under the youngsters.

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Territorial behaviour in *Heodes virgaureae* L. (Lep., Lycaenidae) with particular reference to visual stimuli

PER DOUWES

Douwes, P. 1975. Territorial behaviour in *Heodes virgaureae* L. (Lep., Lycaenidae) with particular reference to visual stimuli. *Norw. J. Ent.* 22, 143–154.

Males of the butterfly *Heodes virgaureae* fly up at and pursue butterflies, particularly conspecific males. The intraspecific male interaction is part of a territorial behaviour. Males occupy a small area, usually along a sun-exposed forest edge, for a shorter or longer period (up to several days) and defend this area against conspecific males.

In roundabout experiments with rotating dummies it could be demonstrated that size, wing-stroke frequency, and colour, but not shape, are significant stimuli for the approach and pursual response of the *H. virgaureae* male. The flying *H. virgaureae* male has the optimal wing-stroke frequency and the optimal colour for these responses, but the optimal size is 2–3 times that of the butterfly.

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During preliminary studies of the behaviour of *Heodes virgaureae* in 1963 I frequently observed interaction between *H. virgaureae* males and individuals of other species as well as intraspecific male interaction. Sitting males fly up at passing butterflies, follow them, and return to the starting point. It seems as if males defend a territory by chasing away intruding butterflies. These preliminary findings occasioned further investigations to obtain more detailed information on this behaviour.

The aim of the investigation was, then, to answer the following questions: (1) Do the phenomena observed really involve a territorial behaviour, and if so, (2) against which butterflies is the territory defended; (3) at which times of the day and under what conditions does this behaviour occur; (4) which are the topographical characteristics of the territory; (5) how long does a male stay in a territory and (6) which visual stimuli produced by a flying butterfly release the approach and the pursual response of the *H. virgaureae* male?

To answer (1) to (3), the responses of *H. virgaureae* males to flying butterflies were observed at different times of the day and at different air temperatures. For (4) an area was systematically surveyed, when the places where territorial behaviour of *H. virgaureae* males occurred were noted. For (1) and (5) more detailed investigations in two preferred territorial sites were carried out. To answer (6) *H. virgaureae* males were offered dummies simulating different characteristics of a flying butterfly.

The investigations for (1) to (5) were carried out in an area (referred to as the study area) in Östergötland, southern Sweden, described in a previous paper (Douwes 1970) in which the size of the population is dealt with. For detailed information of the study area and of the methods used reference should be made to this paper. The experiments on visual stimuli were performed at two different sites in Scania in southernmost Sweden.

TERRITORIAL BEHAVIOUR

The response of the H. virgaureae male to flying butterflies

Investigations were carried out during 19–29 July 1965 and 13–27 July 1966; in 1965 mainly in and around Loc. A and in 1966 in Loc. B (Fig. 2). From previous investigations (1963–64), Loc. A and the westernmost part of Loc. B. were known to be preferred territorial sites. *H. virgaureae* males were observed for a shorter or longer period. Their behaviour was continuously recorded (in 1966 with a tape recorder) and all butterflies passing within 2 m of the sitting *H. virgaureae* male were specifically identified (in *H. virgaureae* also the sexes were distinguished), or, in the case of very similar butterflies (e.g. blue-coloured blues), groups were recorded. Encounters between the flying male and other butterflies are omitted, e.g. because in most cases it was impossible both to follow the male and to note the butterflies within 2 m from him. On the basis of previous observations, 2 m seemed to be not too great a distance for the male to respond to flying butterflies and, furthermore, this distance was convenient for the purpose of observation.

Weather, particularly insolation and wind, strongly influence upon the activity of butterflies: *H. virgaureae* and many other species rarely fly during cloudy or windy conditions. It follows that territorial behaviour occurs during sunny and calm weather. All observations were made during calm weather and the few observations made during cloudy weather have been excluded from the analysis.

In 1965 the temperature was measured at 17 stations with thermometers 150–160 cm above the ground (Douwes 1970) and in 1966 with a thermocouple 150 cm above the ground in Territory b.

For the analysis, the responses of the males were scored as follows:

0 = no response.
1 = flies up but not towards the passing butterfly.
2 = flies up at the passing butterfly and pursues it up to 1 m.

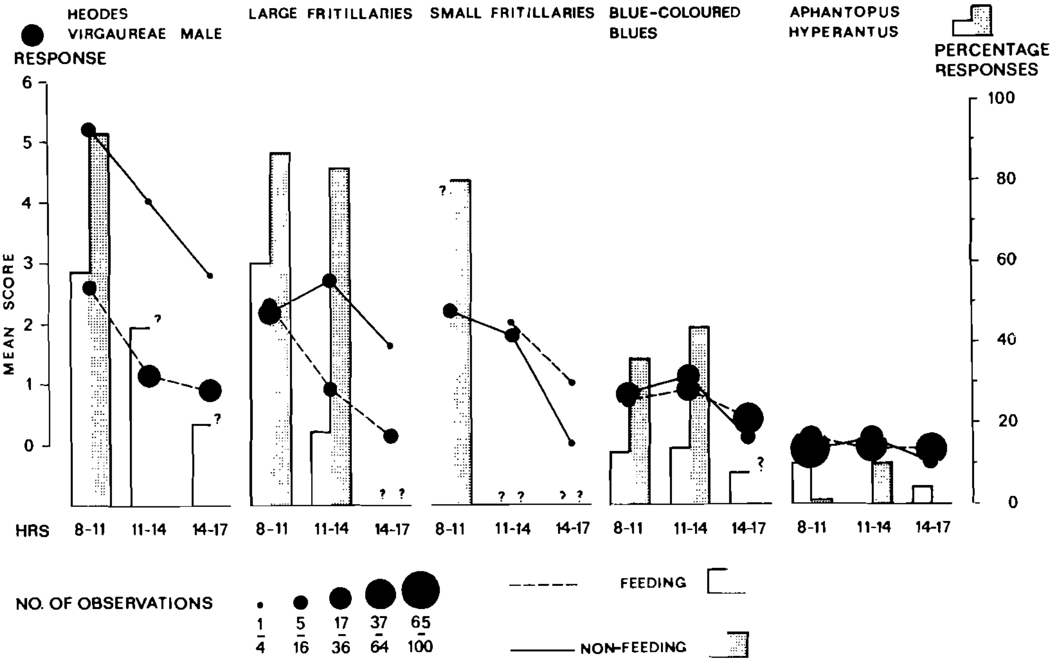

Fig. 1. The responses of sitting *H. virgaureae* males (feeding and non-feeding) to five different kinds of flying butterflies at different times of the day. The response is given as a mean score (see text) and as a percentage of times the male responded on the flying butterfly. A ? shows that no percentage value has been calculated (= less than 10 observations).

3 = as in 2 but pursues up to 2 m.
4 = as in 2 but pursues up to 5 m.
5 = as in 2 but pursues up to 10 m.
6 = as in 2 but pursues more than 10 m.

In all, 753 observations were made in sunny weather; of these 27 were made before 0800 hrs. or after 1700 hrs. and are excluded from the analyses. Five kinds of butterflies occurred in sufficiently large numbers for a more detailed analysis: *Aphantopus hyperantus* (291), *'blue-coloured blues'* (mainly *Plebicula amanda* males) (165), *H. virgaureae* males (109), *'large fritillaries'* (*Fabriciana adippe* and *Mesoacidalia aglaja*) (66), and *'small fritillaries'* (*Brenthis ino* and *Clossiana selene*) (22 observations). The response of the males to these five kinds of butterflies was analysed in relation to whether or not the male was feeding when the butterfly passed, the time of the day, and the air temperature.

The responses to *H. virgaureae* males are shown in Table I. A considerable variation in the response can be related to all three factors. Few data are available for low temperatures and observations made at temperatures below 19°C are excluded from the analysis. The remaining temperature-related variation is small enough to be considered negligible (Table II). The data for the other four kinds of butterflies were treated in the same way and the results for all five are shown in Fig. 1. Two different measures for the response are used, one being the mean-score and the other the percentage of the times the males flew up at the passing butterfly (not calculated for less than 10 observations). Concerning the mean response, clear differences between the five kinds of butterflies were obtained, except between the *'large'* and the *'small fritillaries'*. For comparison, the mean response to some other butterflies are (number of observations in brackets): *'brown-coloured blues'* (18) 0.7, *Coenonympha* spp. (11) 1.1 and *'whites'* (*Pieridae*) (12) 0.3. It is also obvious that non-feeding males reacted more strongly than feeding ones and that there was a decrease in the responses during the course of the day.

A similar picture is shown by the percentage of responses (Fig. 1), but the differences between the kinds of butterflies, particularly between *H. virgaureae* male and the *'fritillaries'*, are less pronounced. This indicates that the *H. virgaureae* male is less specific in the approach response than in the pursual response. The difference in response to *H. virgaureae* males and to other butterflies is still more pronounced in the case of long-distance pursual (>10 m). 31 such interactions were observed and in all but one case two *H. virgaureae* males were involved. There is also a discrepancy between the percentage and the scored responses as to feeding–non-feeding which is entirely due to a curious difference in the responses scored 1 and 2, the 2's being more common for the feeding males.

Table I. The responses scored 0-6 of sitting H. virgaureae males to conspecific males flying closer than 2 m, in relation to temperature, time and feeding behaviour of the sitting male (feeding = F; not feeding = NF).

	temperature °C						
hours	13-15 F NF	16-18 F NF	19-21 F NF	22-24 F NF	25-27 F NF	28-30 F NF	mean
0800 - 1059	0 -	0 0 3	6 6 6	0 2 0 6 0 2 6 6 0 2 6 6 0 6 6 6 1 6 6 6 6	6 4 6 6	- -	3.8
1100 - 1359	- -	0 -	0 2 - 1	0 1 - 0 1 0 1 0 2 0 2 0 2 0 2 1	0 2 2 6 0 2 0 2 0 2 0 2 0 2 1 2 1 2 2 6	0 2 -	1.2
1400 - 1700	- -	- 0 2	- 0	0 0 1 4 0 1 0 1 0 1	0 0 - 0 1 0 1 0 1 0 1 0 2 0 2 0 2 0 2 0 6 0 6	- 6	1.1
mean	0.0	0.8	3.0	2.2	1.6	2.7	

	mean
Feeding (F)	2.2
Not feeding (NF)	5.3

Table II. Statistics of the data from Table 1 in relation to time and feeding behaviour. All observations at lower temperatures than 19° C are excluded.

hours	Feeding		Not feeding	
	n	mean	n	mean
0800 - 1059	12	2.6	16	5.5
1100 - 1359	38	1.3	2	4.0
1400 - 1700	30	0.9	4	2.8

It was also observed that after an interaction the *H. virgaureae* male almost invariably returned alone to the starting point, indicating that the male was confined to a small area and perhaps also indicating that the other individual was chased away.

The territorial sites

In 1964 *H. virgaureae* was observed along an observation route covering the whole study area. The behaviour was noted at the moment it was discovered. Such samples of the population were taken once or twice a day, every day except one, between 10 July and 16 August. From these observations a picture of the distribution and topographical characteristics of the territories in the area could be obtained.

Since each individual could be observed for a short moment only, the chance of observing a territorial interaction was small. However, as shown above in the morning on sunny days, non-feeding males are most likely to be territorial. Thus a male was considered to occupy a territory if he (1) pursued a conspecific male for more than 10 m, or (2) pursued another butterfly for more than 1 m, or (3) was sitting on a leaf some time between 0800 hrs. and 1330 hrs. in sunshine and at a temperature above 18°C. It should be pointed out, however, that when such a butterfly is flushed, as happened during these surveys, it often settles on a leaf and, hence, some of the specimens observed sitting on a leaf might have been non-territorial males.

The results of the surveys are shown in Fig. 2. A striking feature is the concentration of the territories to the edges of the area (more apparent in the field than in Fig. 2). 26 of the 49 observations were made at southerly- or easterly-facing forest edges (sun-exposed in the morning and the middle of the day) bordered by a shrub and/or fern vegetation on which the males sat.

The males in a territory

The results from the investigations in 1965–66 presented above were partly based on observations in two preferred territorial sites, Loc. A (1965) and the western part of Loc. B (1966). These observations are treated separately and in more detail here to demonstrate the defence of the territory as well as the time the males are resident there.

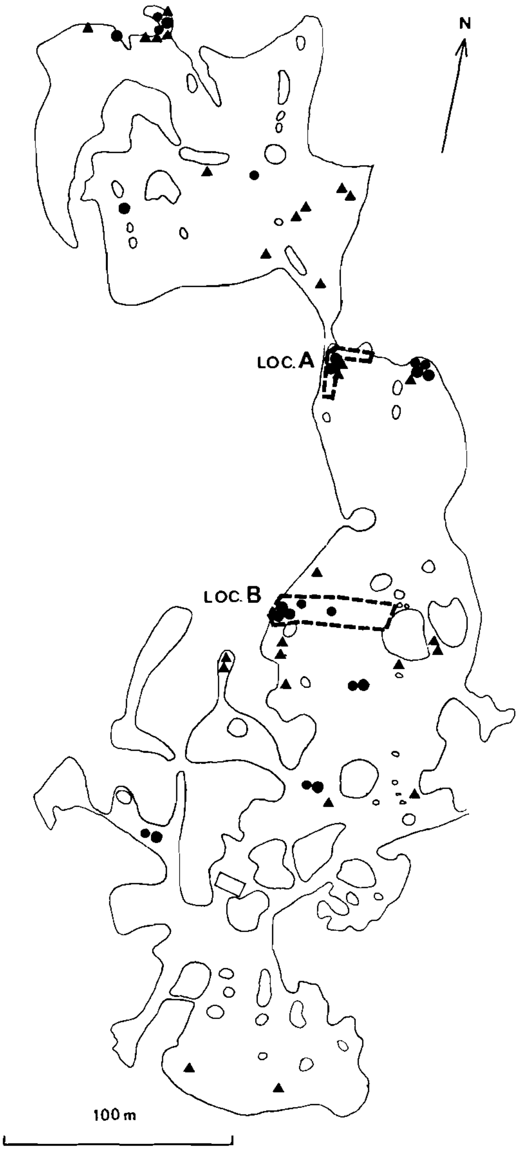

Fig. 2. Territorial behaviour in the study area in 1964. The observations of a *H. virgaureae* male pursuing a conspecific male more than 10 m (large black circle), pursuing another butterfly more than 1 m (small black circle) and a *H. virgaureae* male sitting on a leaf in sunshine in the morning (triangle) in the study area in 1964. Loc. A and B where detailed studies of territorial behaviour were made are also shown. Only the outlines of the study area and of higher bushes and trees are shown.

Loc. A (Figs. 2 and 3), which was studied on 19–23 and 25 July, was a 2–10 m broad

Fig. 3. Loc. A seen from SW.

border of different kinds of bushes, small trees and ferns along an easterly- and a southerly-facing forest edge. This marginal vegetation gradually merged into a meadow with many flowering herbs, and, hence, the area considered to be a *H. virgaureae* male territory had to be arbitrarily delimited: Territory a (= Loc. A).

Loc. B (Fig. 2) comprised a typical territorial site in the western part at the forest edge, where a sharply delimited group of ferns and small trees, approximately 6 m^2 in size, occurred: Territory b (= W part of Loc. B). This perching site was separated by a 5 m broad strip of grass vegetation from the flower-rich field that covered most of Loc. B. Observations were made on 19–23

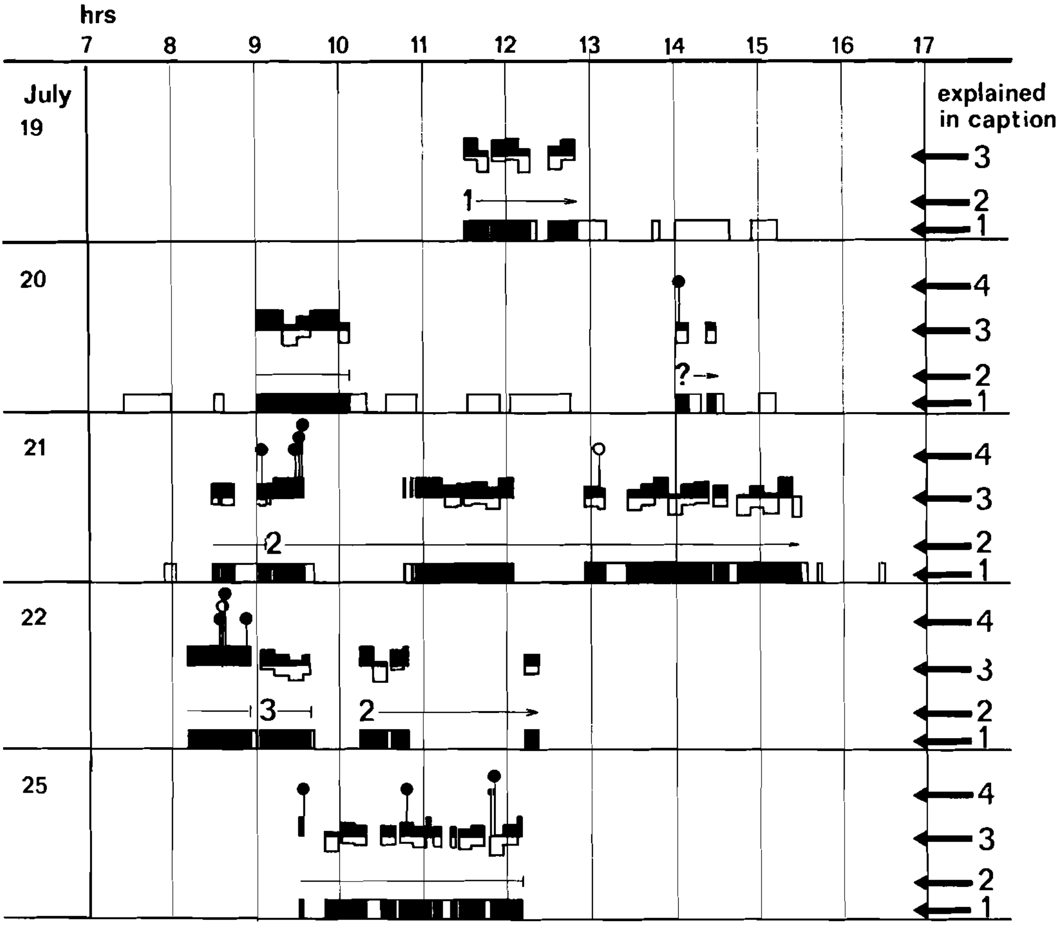

Fig. 4. The observations in Territory a. 1. Male present (black) and male absent (white). 2. The number of one of the marked males; ? = unidentified (unmarked) male. 3. Percentage of visits on leaves (black, above) and on flowers (white, below). 4. Intruding male followed more than 10 m (large solid circle); intruding male followed 1 m (small solid circle) and intruding male not followed (open circle).

Table III. Observations in Territory b in 1966.

Date July	Time observed in min			Territorial male left the territory due to:							
	Male No. 1	Male No. 2	Other males	Persuing a *H. virgaureae* male				Persuing another spec.		Spontaneous flight	
				Terr. ♂ return.	Both ♂♂ return.	Other ♂ return.	No ♂ return.[1]	The ♂ return.	The ♂ did not return[1]	The ♂ return.	The ♂ did not return[1]
19	53	-	8	5	2	-	-	4	-	2	2
20	55	-	4	-	-	1[2]	1	-	-	5	-
21	19	-	26	3	-	-	1	-	-	1	1
22	-	-	10	-	-	-	-	-	-	-	-
23	-	22	-	2	1	-	-	2	-	1	1
Sum	127	22	48	10	3	1	2	6	-	9	4

[1] Within one min. [2] Male No. 1 returned.

July. The territories were observed on sunny and warm days, and Territory b only in the morning. This was because from 13 hrs. onwards the perching site was in the shade. In both localities a number of males were individually marked by the method used in 1964 (Douwes 1970).

Fig. 4 shows the results from the observations in Territory a. Unfortunately few males occurred in and around the territory; this was particularly true for the first two days when male No. 1 was the only one observed until 1400 hrs. on the second day. So apparently this male did not have to defend the territory against other males. Male No. 2 occupied the territory on 21, 22, and 25 July (23–24 July were rainy) and was involved in 9 territorial fights (that I observed) of which he won at least 8. After an interaction at 0930 hrs. on 25 July no male returned within one minute; when, however, the territory was checked 15 min later, the male was back again. Fig. 4 also demonstrates that the frequency of visits to flowers increased towards the afternoon indicating a decrease in the territorial activity as discussed earlier.

In contrast to the investigations in Territory a, Territory b was observed only when a male occurred there; i.e. the group of ferns and small trees was carefully checked and when a male was detected he was observed for about 10 min or until he disappeared. When the male left the territory, I always waited for 1 min to see if he returned. (The male usually returns immediately after an interaction).

The results of these observations are shown in Table III. As in Territory a, Territory b was mainly occupied by two individuals, male No. 1 on 19–21 July and male No. 2 on 23 July, the latter being marked on 22 July. On 13 out of 16 occasions when a conspecific male was pursued, the territorial male returned. In three cases, however, the territorial male returned together with the other male which was immediately chased again. The second time the territorial male returned alone. Once it happened that male No. 1 entered the territory when this was already occupied. After the subsequent territorial interaction male No. 1 returned alone.

So far, the territorial interaction has been described as a pursual flight which might give the impression that the territorial *H. virgaureae* male flies behind the other butterfly all the time. This seems to be true when another species was pursued, but in intraspecific interactions the two males appeared to lead the flight alternately. As Baker (1972) suggests, the territory might be defended by chasing or leading the intruder far enough away for it not be able to find its way back.

Conclusions

From the observations presented above it is evident that *H. virgaureae* males defend a territory against conspecific males.

A typical *H. virgaureae* male territory is situated at a sun-exposed forest edge with a border of shrub or similar vegetation which is used as a perch. The territorial behaviour starts in the morning and continues until midday or the early afternoon, the limits being set in some cases by the shading of the perching site (as in Territory b).

A male occupies the same territory for a couple of days and when he more or less temporarily leaves, other males may take over. Thus, it appears that only a few males in a population are territorial due to their superiority in the competition for the suitable territorial sites, and that the other males only occasionally occupy a territory. It should be pointed out, however, that territorial behaviour also occurs outside these optimal territorial sites. It happens, particularly in the morning, that feeding *H. virgaureae* males attack and pursue conspecific males and return to the same flower, but these males do not stay in that particular area for any length of time.

The male also darts out and may even pursue, usually over a short distance, other species, most probably to determine whether or not it is a conspecific male or female. Of the butterflies studied so far, *'fritillaries'* are the most 'attractive' ones, probably due to their similarity in colour (fulvous) to the *H. virgaureae* male (shining orange) whereas *'whites'* (*Pieridae*) and *Aphantopus hyperantus* (dark-brown) are hardly attacked at all.

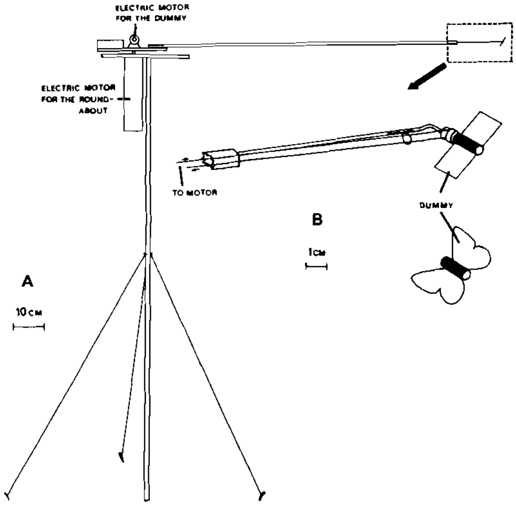

Fig. 5. A. The roundabout used for the tests of visual stimuli. B. The end of the arm of the roundabout and two dummies (the different shapes tested).

VISUAL STIMULI

Methods

The visual characteristics of a flying butterfly are size, shape, wing-stroke frequency, colour, and flying speed. To test the significance of these different characteristics as stimuli for the approach and pursual response of the *H. virgaureae* male, the roundabout method of Magnus (1958) was used. A dummy was placed at the end of a rotating stick which moved with a constant speed of 30 r.p.m. (Fig. 5). The dummy consisted of a central, black paper cylinder with two square-shaped wings constructed from 'Colour-Aid' paper (Geller Artist Materials Inc., New York) (Fig. 5). Two layers of paper were used so that the wings were coloured on both sides. The colour of these papers is given by letters: V = violet, B = blue, G = green, Y = yellow, O = orange and R = red. Thus, for instance, the hues between Y (yellow) and O (orange) are designated YOY, YO and OYO. When followed by a T and a number (e.g. T 3) the hue is less saturated (white added). White, different greys (e.g. GREY 2) and black are also available.

The colour of the *H. virgaureae* male is dominated by a gleaming orange that covers the entire upperside except the body and the outer margins of the wings (which are black). The underside is pale orange and greyish yellow. Different orange hues were tested, OYO being very similar to the upperside colour of the *H. virgaureae* male and YO being rather similar to the upperside colour of the *'fritillaries'* which, however, is somewhat paler and browner. Moreover, BURNT UMBER (dark brown) which resembles the upperside colour of *Aphantopus hyperantus,* YO T 3, WHITE, and GREY 2 (approximately as light as YO) were tested.

The different colours are here characterized as they appear to the human eye, but the butterfly might perceive them differently, since the colour paper reflects more UV-light than do the wings of *H. virgaureae.* This is visible on photos taken with a filter transparent to UV-light (maximum around 360 nm) but not to visible light.

Dummies of different sizes were tested from 2 cm^2 (each wing 1 × 1 cm) to 18 cm^2 and the effect of shape was briefly checked with a dummy with normal shaped wings (Fig. 5).

The dummy was attached to a rotating axis which was driven by an electric motor at the opposite end of the stick (at the axis of the roundabout, Fig. 5). By means of a transmission the rotational velocity of the dummy could be changed, thus different wing stroke frequencies could be imitated. Magnus (1958), who studied *Argynnis paphia* (Nymphalidae), found that a rotating cylinder with transverse black and coloured stripes was superior to the kind of dummy used here. I found, however, in a preliminary study, that *H. virgaureae* males are not attracted to such a cylinder (different sizes were tested).

The experiments were carried out near Torna Hällestad in 1971 (Exp. Nos. 1 and 4–10) and near Vomb in 1972 (Exp. Nos. 2–3), 13 and 24 km respectively WSW of Lund, Scania. In Exp. Nos. 1–3 size was tested, in Exp. No. 3 also shape, in Exp. Nos. 4–8 wing-stroke frequency (rotational velocity), and in Exp. Nos. 9–10 colour. Flight speed was not tested (the roundabout moved with a constant speed). When size, shape, and colour were tested the dummy rotated at a speed of 500 r.p.m., when wing-stroke frequency and colour were tested the dummy was 8 cm^2, and when size, shape, and wing-stroke frequency were tested an orange-coloured dummy (OYO) was used. To influence the experiments as little as possible the roundabout was black-coloured.

In all experiments the different dummies were tested the same number of times, each time for 4.5 min. The sequence of the dummies was random (Exp. No. 1), random within blocks (Exp. Nos. 2, 3, and 5–8), or arranged in a Latin square (Exp. Nos. 4, 9, and 10). The randomized blocks and Latin square designs were used to minimize the error variance due to the variation in the number of males present during the course of the experiment. Moreover, the error variance was reduced by running the tests under as similar conditions as possible, i.e. between 10 and 15 hrs. and in sunshine. All *H. virgaureae* male approaches to the dummy and the distance this was pursued were recorded. It should be pointed out that in these experiments the response of flying males was registered, because it was impossible to arrange any experiments within the male territories.

The results from the experiments are given in Table IV and in Figs. 6–8. For each 4.5 min period the number of approaches and the lengths of the pursuit distances were summed, and the latter sum was divided by the former. From these figures (No. of approaches/4.5 min and distance pursued/approach) the means and the variances were calculated. For the analysis of variance which requires normally distributed data the values were transformed to square roots. In some trials no male approached the dummy, yielding a zero estimate of the distance followed which is not a representative figure. Therefore, in the calculation of the mean distance these trials were excluded. Means calculated in this manner are marked by an open square in Figs. 6 and 7.

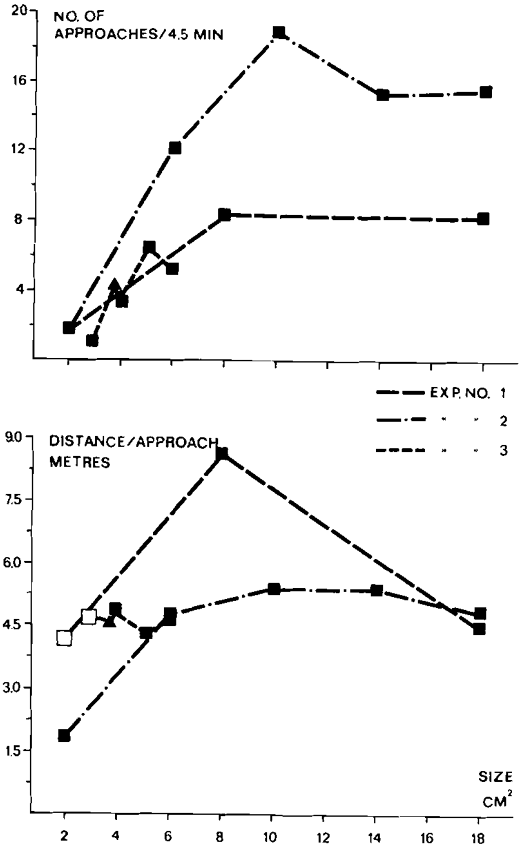

Fig. 6. The responses of *H. virgaureae* males to dummies of different sizes and shapes. The mean number of approaches per 4.5 min (above) and the mean distance pursued per approach (below). Square = dummy with square-shaped wings; triangle = butterfly-shaped dummy. For explanation of open square see text.

It also happened that males approached the dummy when this was already being chased by a male or some other butterfly. Such approaches were excluded from the calculations since I could not decide whether this was a response to the dummy or to the butterfly. By doing so the number of approaches to 'attractive' dummies were slightly underestimated.

The effect of size and shape

The larger the area, up to 8–10 cm^2, the stronger was the response (Table IV, Fig. 6). A further increase in the surface area seems to have a slightly negative effect at least on the pursual response. This result is remarkable in so far that it shows that the maximal stimulus is presented by an area much larger than that of the *H. virgaureae* male (3.5–4 cm^2). This, however, is in accordance with the results obtained by Magnus (1958).

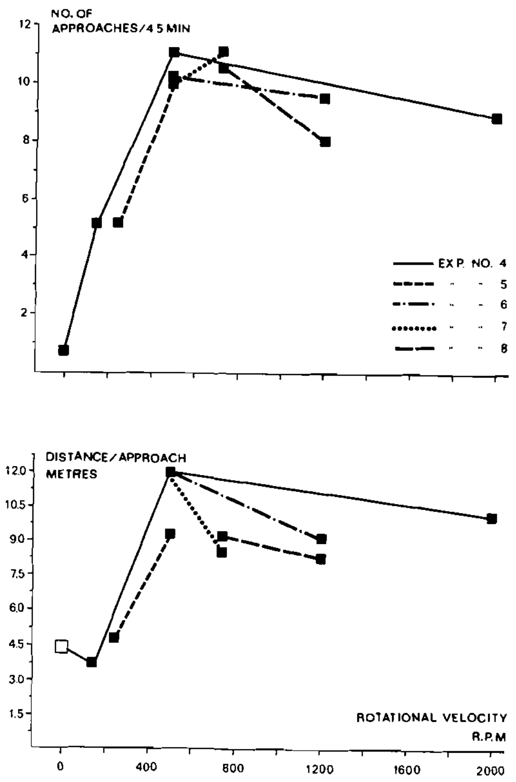

Fig. 7. The responses of *H. virgaureae* males to dummies with different rotational velocities. The mean number of approaches per 4.5 min (above) and the mean distance pursued per approach (below). For explanation of open square see text.

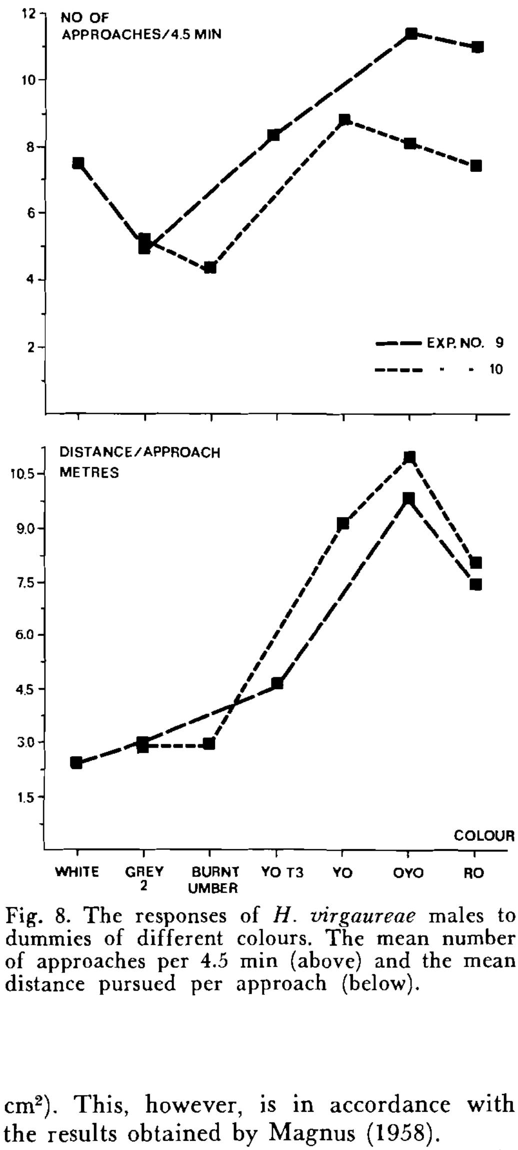

Fig. 8. The responses of *H. virgaureae* males to dummies of different colours. The mean number of approaches per 4.5 min (above) and the mean distance pursued per approach (below).

In previous investigations with immovable dummies I found that the butterfly shape does not release the approach reaction (Douwes, in press). This was confirmed in Exp. No. 3.

The effect of wing-stroke frequency

The same picture is revealed as for size (Table IV, Fig. 7). The strongest response was obtained at 500 r.p.m. By filming flying *H. virgaureae* males in nature (64 frames/sec) the wing-stroke frequency of the butterfly was estimated at 1,000 strokes/min. One stroke (= one up and one down move-

Table IV. Data from the roundabout experiments with H. virgaureae males. Variances and F-ratio estimated and the probability (P) of the latter given. See also Figs. 6 - 8.

Exp. No.	Treatments (Test of)	Variance (degrees of freedom in brackets)					Significance	
		No. of approaches		Distance followed			Approaches	Distance
		Treatments	Error	Treatments	Error			
1	Sizes	0.072 (1)^{1}	0.531 (48)	64.80 (1)^{1}	1.74 (48)	F	0.136	37.2
						P	>0.5	<0.001
2	"	0.082 (4)	0.002 (12)	325.52 (4)	8.83 (12)	F	52.9	36.9
						P	<0.001	<0.001
3	"	0.780 (4)	0.321 (28)	0.04 (4)	1.09 (28)	F	2.43	0.036
	and shapes					P	0.1-0.05	>0.75
4	Velocities	6.451 (3)	0.222 (6)	–^{2}	–^{2}	F	29.1	–^{2}
						P	<0.001	
5	"	2.142 (1)	0.581 (9)	22.17 (1)	2.60 (9)	F	3.68	8.52
						P	0.1-0.05	0.025-0.01
6	"	0.243 (1)	0.377 (20)	12.65 (1)	2.95 (20)	F	0.645	4.28
						P	>0.5	0.1-0.05
7	"	0.308 (1)	0.480 (19)	17.48 (1)	0.79 (19)	F	0.646	22.1
						P	0.5-0.25	<0.001
8	"	0.818 (1)	0.405 (10)	0.78 (1)	2.57 (19)	F	2.02	0.305
						P	0.25-0.1	>0.5
9	Colours	2.075 (4)	0.371 (12)	16.27 (4)	0.31 (12)	F	5.59	52.6
						P	0.01-0.005	<0.001
10	"	1.592 (4)	0.439 (12)	20.85 (4)	1.18 (12)	F	3.62	17.7
						P	0.1-0.05	<0.001

[1] Only the two largest sizes analysed. [2] Data insufficient.

ment) is probably equal to half a rotation of the dummy, since the bright dorsal surface of the wings is certainly a stronger stimulus than the dull ventral surface. Thus the flying *H. virgaureae* male flutters optimally to stimulate conspecific males to approach and pursue him.

The effect of colour

The tendency for a greater variation in the pursual than in the approach response demonstrated above (size, rotational velocity) is more pronounced here (Table IV, Fig. 8). The male approaches different hues of orange without discrimination, but he prefers to pursue objects of his own colour (OYO). Brightness evidently plays a role for the approach but not for the pursual response. Bright objects are probably more easily observed.

Conclusions

The results of the experiments, as demonstrated in Table IV, Figs. 6–8, show that of the four factors tested – size, shape, wingstroke frequency, and colour – all but the shape are significant stimuli for the approach as well as for the pursual response.

DISCUSSION

The males of a number of butterfly species usually stay in a small area for a period of time and dart out at passing objects. As a rule, however, this is obviously a searching for females rather than a defence of a territory (Lederer 1960, Scott 1973, Stride 1957, Tinbergen et al. 1942). A true territorial behaviour has been reported from *Apatura iris* (Joy 1902), nearctic *Oeneis* spp. (Masters & Sorensen 1969), and particularly from *Inachis io* and *Aglais urticae* whose behaviour has been analysed in detail by Baker (1972).

Undoubtedly, the territorial behaviour in the species studied by Baker (1972) is successful in the competition for females. The territories are held along the females' route (at forest edges, hedges etc.). Topographically, the *H. virgaureae* male chooses similar territorial sites, but the purpose is certainly not to find a female, since she is visiting flowers or searching for the larval foodplant to oviposit, activities which occur in the open field a distance from the male territories. The best strategy to search for females would be to fly around and visit flowers as the feeding males do. During the investigations presented above I only once observed a female passing over a male territory, whereas courtship behaviour occurred rather frequently on flowers.

As a matter of fact, the function of the territorial behaviour in *H. virgaureae* is hard to understand. Obviously, it has an effect in the spacing out of the males as indicated by the distribution of the males in the study area at different male densities (Douwes, 1975). The selective advantage might be that the males cover the habitat better in their search for females, thereby increasing the chance for the females to become fertilized.

It seems from Baker (1972) that practically all males were territorial most of the time (during the afternoon). It is obvious that the *H. virgaureae* males differ considerably in their territorial behaviour in the area studied. Far from all males occupy a territory, probably due to a limited supply of suitable territorial sites. For instance, in the locality near Vomb which virtually lacks the properties of a typical territorial site, I never saw a male occupying a territory, despite the fact that the butterfly was abundant and that I spent two summers there.

The roundabout experiments demonstrate that the differences in the response to different butterflies can be largely attributed to differences in visual stimuli. These experiments also show that differences in colour (perhaps also size and rotational velocity) are more important for the pursual than the approach response. This might explain why the *H. virgaureae* male is more particular as to the butterflies he pursues than the ones he approaches. Stride (1957) came to the same conclusion partly on the basis of the results obtained by Tinbergen et al. (1942). In Fig. 1 the butterflies are arranged according to the responses they elicited and this order also expresses their 'attractiveness' due to visual characteristics: *H. virgaureae* male (gleaming orange, high wing-stroke frequency, small), *'large* and *small fritillaries'* (pale, brownish orange with dark markings, low wing-stroke frequency, large or medium sized), *'blue-coloured blues'* (blue and grey, high wing-stroke frequency, small) and *Aphantopus hyperantus* (dark brown, low wing-stroke frequency, medium sized). There is, however, a gap between the pursual response to *H. virgaureae* males and to other butterflies which cannot only be explained by differences in visual stimuli. Some other factor, probably olfactory, is almost certainly involved. It might also be that the *H. virgaureae* males respond to each other.

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Caddis flies (Trichoptera) from Vestfold, south-eastern Norway

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Andersen, T. 1975. Caddis flies (Trichoptera) from Vestfold, south-eastern Norway. *Norw. J. Ent. 22*, 155–162.

A list of 94 species of Trichoptera from Vestfold county, south-eastern Norway, is given. Eight species have not previously been recorded from Norway, viz.: *Orthotrichia costalis* (Curt.), *Hydropsyche contubernalis* McLach., *Ironoquia dubia* (Steph.), *Limnephilus externus* Hag., *L. hirsutus* (Pict.), *L. quadratus* Mart., *Crunoecia irrorata* (Curt.) and *Oecetis furva* (Ramb.), and 77 species are new to the area. The distribution of the species new to Norway is briefly discussed.

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Only few species of Trichoptera have previously been recorded from Vestfold county (Brekke 1946, Økland 1964, Solem 1972). This paper reports on Trichoptera collected in Vestfold during 1974; some specimens caught from 1971 to 1973 are also included. Twenty-seven localities have been visited, Table I. Most of the material was caught in light-traps, but in addition several specimens were taken with nets.

The main aim of the light-trapping in Vestfold in the summer of 1974 was to collect Lepidoptera; most of the traps were therefore situated far from fresh-water localities. However, at Lake Borrevann, a light-trap was placed in the *Phragmites* belt on the south-east shore of the lake. A detailed description of Lake Borrevann is given by Økland (1964). At Lake Gjennestadvann the trap was situated on a *Sphagnum* bog at the south-east end of the lake. Lake Gjennestadvann is a shallow lake, rich in vegetation; the shores are overgrown with *Phragmites communis* Trin. and *Scirpus lacustris* L. At Lake Langvann the trap was placed at a small brook running through a *Sphagnum* bog some 150 m north of the lake. At Sukke the light-trap was situated near a small stream.

The light-traps used were Robinson traps fitted with mercury-vapour bulbs (Philips HPL–N 125W). The insects were killed with trichloroethylene and the caddis flies were later conserved in alcohol. Only the traps at Gullkronen and Mostranda were run continuously all summer; the trapping periods at the other localities varied.

A number of other fresh-water localities have been visited on one or two occasions. In these localities sweep-nets were used to collect caddis flies resting in the vegetation. Many specimens were also netted on the wing.

The collection of adult caddis flies amounts to 7295 specimens belonging to 94 species. I have not identified the Hydroptilidae females. Specimens of all species are deposited at the Zoological Museum, University of Bergen.

The specimens are caught during 1974 if not otherwise stated in the list.

RHYACOPHILIDAE

Rhyacophila fasciata Hagen, 1859 (Syn.: *septentrionis* McLachlan, 1865)
Sukke 13–25 Aug. 1 ♂.

Rhyacophila nubila (Zetterstedt, 1840)
Borrevann; Langvann; Hukstrøm bru; Nøklegård; Osestad; Sukke 6 July–27 Sept. 168 ♂♂ 112 ♀♀.

GLOSSOSOMATIDAE

Agapetus ochripes Curtis, 1834 (Syn.: *comatus* (Pictet, 1834))
Gjennestadvann; Hvåra bru 15–25 July 3 ♂♂ 1 ♀.

HYDROPTILIDAE

Orthotrichia costalis (Curtis, 1834) (Syn.: *tetensii* Kolbe, 1887)
Borrevann 7 July 50 ♂♂ (T. Andersen), 25 July–2 Aug. 42 ♂♂ (A. Fjeldså & T. Andersen), 2 Aug. 1 ♂ (T. Andersen); Åsrumvann 7 July 14 ♂♂ (T. Andersen).

Ithytrichia lamellaris Eaton, 1873
Borrevann; Mostranda; Sukke 20 July–25 Aug. 8 ♂♂.

Oxyethira flavicornis (Pictet, 1834) (Syn.: *costalis* Eaton, 1873)
Borrevann; Gjennestadvann; Osestad; Sukke; Åsrumvann 7 July–13 Sept. 695 ♂♂.

Oxyethira frici Klapalek, 1890
Sukke 13–25 Aug. 2 ♂♂.

Hydroptilia pulchricornis Pictet, 1834
Borrevann 7 July–2 Aug. 101 ♂♂.

Hydroptilia tineoides Dalman, 1819 (Syn.: *femoralis* (Eaton, 1873))
Hvåra bru; Osestad; Sukke 6 July–13 Aug. 5 ♂♂.

PHILOPOTAMIDAE

Wormaldia subnigra McLachlan, 1865
Langvann; Sukke 11 Aug.–9 Sept. 37 ♂♂ 8 ♀♀.

HYDROPSYCHIDAE

Hydropsyche angustipennis (Curtis, 1834)
Gile 3 June 9 ♂♂ 1 ♀.

Hydropsyche contubernalis McLachlan, 1865 (Syn.: *ornatula* auct. nec McLachlan, 1878)
Hukstrøm bru 3 Aug. 1 ♀ (T. Andersen).

POLYCENTROPODIDAE

Plectrocnemia conspersa (Curtis, 1834)
Bergli; Borrevann; Gjennestadvann; Gullkronen; Havna; Herstad (1973); Langvann; Mostranda; Nøklegård; Osestad; Sukke 1 June–12 Sept. 50 ♂♂ 13 ♀♀.

Polycentropus flavomaculatus (Pictet, 1834) (Syn.: *multiguttatus* (Curtis, 1835))
Gran; Sukke 10–25 Aug. 23 ♂♂ 23 ♀♀.

Polycentropus irroratus (Curtis, 1835) (Syn.: *multiguttatus* McLachlan, 1878)
Langvann 9–25 Sept. 1 ♂.

Holocentropus dubius (Rambur, 1842)
Bastøy; Borrevann; Gjennestadvann 9 June–25 July 10 ♂♂ 7 ♀♀.

Holocentropus picicornis (Stephens, 1836)
Borrevann 7–25 July 6 ♂♂ 4 ♀♀.

Cyrnus flavidus McLachlan, 1864
Borrevann; Åsrumvann 15 July–11 Sept. 18 ♂♂.

Cyrnus insolotus McLachlan, 1878
Borrevann; Gjennestadvann; Goksjø 8–25 July 33 ♂♂ 7 ♀♀.

Cyrnus trimaculatus (Curtis, 1834)
Bølevann; Sundbyfoss 3–8 Aug. 11 ♂♂.

PSYCHOMYIIDAE

Psychomyia pusilla (Fabricius, 1781)
Hukstrøm bru 3 Aug. 1 ♀.

Lype phaeopa (Stephens, 1836)
Bølevann; Hvåra bru; Sukke 15 July–11 Aug. 3 ♂♂.

Tinodes waeneri (Linnaeus, 1758)
Borrevann; Sukke 2–25 Aug. 5 ♂♂ 4 ♀♀.

Ecnomus tenellus (Rambur, 1842)
Borrevann; Gjennestadvann; Sundbyfoss; Åsrumvann 7 July–13 Sept. 1705 ♂♂ 118 ♀♀.

PHRYGANEIDAE

Trichostegia minor (Curtis, 1834)
Borrevann; Gullkronen; Moutmarka (1973) 9 July–14 Sept. 16 ♂♂.

Agrypnia varia (Fabricius, 1793)
Borrevann; Fyn (1971); Gjennestadvann; Gullkronen; Kjære (1972); Langvann; Mostranda 4 July–27 Aug. 46 ♂♂ 8 ♀♀.

Phryganea grandis Linnaeus, 1758
Borrevann; Gullkronen 8 July–2 Aug. 4 ♂♂ 1 ♀.

LIMNEPHILIDAE

Ironoquia dubia (Stephens, 1837)
Gjennestadvann 12–25 Sept. 1 ♂ (A. Fjeldså & T. Andersen); Langvann 10–28 Aug. 4 ♂♂ (A. Fjeldså), 25 Sept.–19 Oct. 1 ♂ (A. Fjeldså).

Apatania zonella (Zetterstedt, 1840)
Havna 4–11 Aug. 4 ♀♀.

Limnephilus affinis Curtis, 1834
Borrevann; Gjennestadvann; Gullkronen; Havna; Herstad (1971); Langvann; Løvøya; Mostranda; Moutmarka 20 July–28 Sept. 27 ♂♂ 18 ♀♀.

Limnephilus auricula Curtis, 1834
Borrevann; Gullkronen; Herstad; Langvann; Mostranda 20 July–27 Sept. 151 ♂♂ 13 ♀♀.

Limnephilus binotatus Curtis, 1834 (Syn.: *xanthodes* McLachlan, 1875)
Mostranda 19 May–2 Aug. 30 ♂♂ 8 ♀♀.

Limnephilus borealis (Zetterstedt, 1840)
Borrevann; Gjennestadvann; Hvåra bru; Langvann 15 July–12 Oct. 58 ♂♂ 7 ♀♀.

Limnephilus centralis Curtis, 1834
Borrevann; Gjennestadvann; Gullkronen; Herstad (1971); Langvann; Mostranda; Moutmarka; Strengsdalsvann; Sukke 18 June–10 Oct. 54 ♂♂ 6 ♀♀.

Limnephilus cœnosus Curtis, 1834
Gjennestadvann; Langvann; Mostranda 6 Aug.–9 Nov. 158 ♂♂ 2 ♀♀.

Limnephilus decipiens (Kolenati, 1848)
Borrevann; Gjennestadvann; Langvann; Mostranda; Sundbyfoss 7 Aug.–29 Sept. 251 ♂♂ 20 ♀♀.

Limnephilus elegans Curtis, 1834
Moutmarka 19 June 1 ♂.

Limnephilus externus Hagen, 1861
Langvann 9–25 Sept. 1 ♂ (A. Fjeldså & T. Andersen).

Limnephilus extricatus McLachlan, 1865
Borrevann; Gjennestadvann; Gullkronen; Havna; Langvann; Mostranda; Sukke 26 May–30 Aug. 56 ♂♂ 9 ♀♀.

Limnephilus flavicornis (Fabricius, 1787)
Borrevann; Gjennestadvann; Gullkronen; Havna; Kjære (1972); Mostranda; Moutmarka 22 June–12 Oct. 492 ♂♂ 56 ♀♀.

Limnephilus fuscicornis Rambur, 1842
Sukke 11–13 Aug. 3 ♂♂.

Limnephilus fuscinervis (Zetterstedt, 1840)
Borrevann; Fyn (1972) 13 Aug.–27 Sept. 2 ♂♂ 1 ♀.

Limnephilus germanus McLachlan, 1875
Borrevann 13–27 Sept. 1 ♂.

Limnephilus griseus (Linnaeus, 1758)
Borrevann; Gjennestadvann; Mostranda 19 May–26 Sept. 14 ♂♂ 5 ♀♀.

Limnephilus hirsutus (Pictet, 1834)
Mostranda 20 July–12 Aug. 5 ♂♂ 1 ♀ (A. Fjeldså & T. Andersen).

Limnephilus ignavus McLachlan, 1865
Borrevann; Gjennestadvann; Gullkronen; Herstad (1971); Langvann; Mostranda 7 July–11 Oct. 101 ♂♂ 12 ♀♀.

Limnephilus incisus Curtis, 1834
Borrevann; Moutmarka (1973) 7 July–15 Sept. 4 ♂♂.

Limnephilus lunatus Curtis, 1834
Borrevann; Gjennestadvann; Herstad; Langvann; Sukke 11 Aug.–29 Sept. 36 ♂♂ 23 ♀♀.

Limnephilus luridus Curtis, 1834
Gjennestadvann; Gullkronen; Herstad (1971); Mostranda 19 July–12 Sept. 10 ♂♂ 1 ♀.

Limnephilus marmoratus Curtis, 1834
Borrevann; Gjennestadvann; Herstad; Langvann; Mostranda 2 Aug.–12 Oct. 392 ♂♂ 55 ♀♀.

Limnephilus nigriceps (Zetterstedt, 1840)
Borrevann; Langvann 9–27 Sept. 21 ♂♂ 1 ♀.

Limnephilus picturatus McLachlan, 1875
Borrevann 13–27 Sept. 2 ♂♂ 1 ♀.

Limnephilus politus McLachlan, 1865
Borrevann; Gjennestadvann; Langvann 9–27 Sept. 243 ♂♂ 1 ♀.

Limnephilus quadratus Martynov, 1914
Gjennestadvann 12–25 Sept. 1 ♂ (A. Fjeldså & T. Andersen).

Limnephilus rhombicus (Linnaeus, 1758)
Borrevann; Gjennestadvann; Langvann; Sukke 10 Aug.–25 Sept. 23 ♂♂ 2 ♀♀.

Limnephilus sericeus (Say, 1824) (Syn.: *despectus* Walker, 1852)
Borrevann; Gjennestadvann; Langvann 9–27 Sept. 11 ♂♂ 1 ♀.

Limnephilus sparsus Curtis, 1834
Borrevann; Gjennestadvann; Gullkronen; Havna; Herstad (1971); Langvann; Mostranda; Moutmarka 25 May–1 Nov. 70 ♂♂ 11 ♀♀.

Limnephilus stigma Curtis, 1834
Borrevann; Fyn (1972); Gullkronen; Havna; Kjære (1972); Langvann; Mostranda 20 July–9 Sept. 16 ♂♂ 2 ♀♀.

Limnephilus subcentralis Brauer, 1857
Borrevann; Gjennestadvann; Herstad (1971); Langvann; Mostranda 9 Sept.–12 Oct. 37 ♂♂ 9 ♀♀.

Limnephilus vittatus (Fabricius, 1798)
Borrevann; Mostranda 20 July–9 Nov. 58 ♂♂ 9 ♀♀.

Grammotaulius atomarius (Fabricius, 1793)
Borrevann; Gullkronen; Mostranda 10 May–29 Sept. 15 ♂♂ 6 ♀♀.

Glyphotaelius pellucidus (Retzius, 1783)
Borrevann; Frodeåsen; Gjennestadvann; Gullkronen; Havna; Herstad; Kjære (1972); Langvann; Mostranda; Moutmarka; Sukke 20 May –1 Nov. 115 ♂♂ 15 ♀♀.

Nemotaulius punctatolineatus (Retzius, 1783)
Gjennestadvann 14 July–20 Aug. 3 ♂♂ 4 ♀♀.

Anabolia brevipennis (Curtis, 1834)
Borrevann; Gullkronen; Langvann 11 Aug.–27 Sept. 11 ♂♂.

Anabolia nervosa (Curtis, 1834)
Gjennestadvann; Langvann 9–25 Sept. 11 ♂♂ 2 ♀♀.

Rhadicoleptus alpestris (Kolenati, 1848)
Gjennestadvann; Herstad (1971); Langvann; Mostranda 30 May–9 Sept. 11 ♂♂ 1 ♀.

Potamophylax cingulatus (Stephens, 1837)
Borrevann; Gjennestadvann; Gullkronen; Herstad; Langvann; Osestad; Sukke 6 July–30 Sept. 250 ♂♂ 5 ♀♀.

Potamophylax nigricornis (Pictet, 1834)
Langvann 6–10 Aug. 3 ♂♂.

Halesus radiatus (Curtis, 1834)
Borrevann; Gjennestadvann; Herstad; Langvann 9 Sept.–12 Oct. 264 ♂♂ 40 ♀♀.

Halesus tesselatus (Rambur, 1842)
Borrevann; Gjennestadvann; Langvann; Sukke 11 Aug.–12 Oct. 29 ♂♂ 2 ♀♀.

Stenophylax permistus McLachlan, 1895
Borrevann; Gjennestadvann; Gullkronen; Herstad; Langvann; Mostranda 11 Aug.–19 Oct. 29 ♂♂ 9 ♀♀.

Micropterna lateralis (Stephens, 1837)
Frodeåsen; Gullkronen; Herstad (1973); Mostranda 17 June–30 Aug. 26 ♂♂.

Micropterna sequax McLachlan, 1875
Borrevann; Gjennestadvann; Gullkronen; Havna; Langvann; Mostranda; Moutmarka; Osestad; Sukke 6 July–27 Sept. 64 ♂♂.

Chaetopteryx villosa (Fabricius, 1798)
Lagvann 27 Nov. 5 ♂♂ 2 ♀♀.

LEPIDOSTOMATIDAE

Lepidostoma hirtum (Fabricius, 1781)
Gran; Herstad; Sukke 10 Aug.–23 Sept. 2 ♂♂ 33 ♀♀.

Crunoecia irrorata (Curtis, 1834)
Borrevann 25 July–2 Aug. 4 ♂♂ 2 ♀♀ (A. Fjeldså & T. Andersen).

LEPTOCERIDAE

Athripsodes albifrons (Linnaeus, 1758)
Hukstrøm bru 3 Aug. 1 ♂ 1 ♀.

Athripsodes alboguttatus (Hagen, 1860)
Gran; Sukke 10–25 Aug. 4 ♂♂.

Athripsodes annulicornis (Stephens, 1836)
Hvåra bru; Osestad 6–15 July 3 ♀♀.

Athripsodes aterrimus (Stephens, 1836)
Bårnes; Hvåra bru 15 July–3 Aug. 8 ♂♂ 12 ♀♀.

Athripsodes cinereus (Curtis, 1834)
Bårnes; Hvåra bru; Sukke; Åsrumvann 15 July–25 Aug. 6 ♂♂ 2 ♀♀.

Athripsodes commutatus (Rostock, 1874)
Hukstrøm bru 3 Aug. 2 ♂♂ 1 ♀.

Athripsodes fulvus (Rambur, 1842)
Gjennestadvann 20 July–12 Sept. 2 ♀♀.

Athripsodes senilis (Burmeister, 1839)
Gjennestadvann 30 June–8 July 26 ♂♂ 7 ♀♀.

Mystacides azurea (Linnaeus, 1761)
Borrevann; Bårnes; Hukstrøm bru; Hvåra bru; Langvann 7 July–9 Sept. 5 ♂♂ 3 ♀♀.

Mystacides longicornis (Linnaeus, 1758)
Sundbyfoss; Åsrumvann 15 July–8 Aug. 6 ♂♂ 6 ♀♀.

Tiraenodes bicolor (Curtis, 1834)
Borrevann; Bølevann; Gjennestadvann; Goksjø 7 July–12 Aug. 27 ♂♂ 37 ♀♀.

Triaenodes simulans Tjeder, 1929 (Syn.: *forsslundi* Tjeder, 1941)
Bårnes; Gjennestadvann; Hukstrøm bru; Sukke 3–13 Aug. 3 ♂♂ 5 ♀♀.

Oecetis furva (Rambur, 1842)
Borrevann 7 July 1 ♂ (T. Andersen), 17 July–2 Aug. 15 ♂♂ 4 ♀♀ (A. Fjeldså & T. Andersen); Gjennestadvann 8 July 2 ♂♂ (T. Andersen).

Oecetis lacustris (Pictet, 1834)
Borrevann; Herstad (1973) 7 July–13 Aug. 127 ♂♂ 13 ♀♀.

Oecetis ochracea (Curtis, 1825)
Borrevann; Mostranda 17 July–12 Aug. 4 ♂♂.

Oecetis testacea (Curtis, 1834)
Langvann 9–25 Sept. 1 ♂ 3 ♀♀.

MOLANNIDAE

Molanna angustata Curtis, 1834
Sukke 11–25 Aug. 5 ♂♂.

Molannodes tincta (Zetterstedt, 1840)
Gullkronen 11–19 July 1 ♀.

DISCUSSION

Brekke (1946) recorded only one Trichoptera, *Limnephilus centralis,* from Vestfold. Økland (1964), in his study on the ecology of the shore and bottom fauna of Lake Borrevann, was able to add 18 species, viz.: *Neureclipsis bimaculata, Plectrocnemia conspersa, Polycentropus flavomaculatus, Holocentropus dubius, H. picicornis, Cyrnus trimaculatus, C. flævidus, Tinodes waeneri, Ecnomus tenellus, Trichostegia minor, Limnephilus affinis* (?), *L. flavicornis, L. fuscinervis* (?), *L. rhombicus, Goera pilosa, Lepidostoma hirtum, Triænodes bicolor,* and *Oecetis lacustris.* He also recorded larvae of the genus *Molanna* and of the Hydroptilidae genera *Orthotrichia, Oxyethira, Hydroptilia* and *Agraylea.* Later

Solem (1972) examined the *Agraylea*-larvae and stated that they belong to *A. sexmaculata*, a species until then unknown to Norwegian fauna.

Of these 20 species we failed to find *A. sexmaculata, N. bimaculata* and *G. pilosa.* Apart from *P. conspersa, P. flavomaculatus, H. dubius, H. picicornis, C. trimaculatus, C. flavidus, T. waeneri, E. tenellus, T. minor, L. affinis, L. centralis, L. flavicornis, L. fuscinervis, L. rhombicus, L. hirtum, T. bicolor* and *O. lacustris*, the remaining 77 species recorded here are therefore new to the area. Thus a total of 97 species of caddis flies are at present known from Vestfold. This comprises about 56% of the total of 174 species known from Norway. Most of the species recorded here seem to be common and widespread in Norway, but some are interesting from a faunistic point of view, as they are new to Norwegian fauna, or only recorded once before.

In Norway *Rhyacophila fasciata* is previously only recorded from the inner part of Troms county (Brekke 1946).

Orthotrichia costalis is new to Norwegian fauna. The species was netted in numbers in the vegetation along Lake Borrevann and Lake Åsrumvann. In the light-trap catches at Lake Borrevann during late July four species of Hydroptilidae were found, viz.: *O. costalis, Ithytrichia lamellaris, Oxyethira flavicornis* and *Hydroptilia pulchricornis. O. flavicornis* was the most numerous, but *O. costalis* comprised not less than 5.9% of the Hydroptilidae males caught (n = 713). *O. costalis* is distributed all over Europe (Botosaneanu 1967). It is locally common at lakes in the southern parts of Finland north up to Tavastia borealis and Karelia borealis, and it has been recorded from some Swedish provinces as far north as Dalarna (Forsslund 1953, Forsslund & Tjeder 1942, Nybom 1960).

The only Norwegian record of *Ithytrichia lamellaris* is Vikelva, Trondheim in the inner part of Sør-Trøndelag county (Solem 1970). *Hydroptilia pulchricornis, Cyrnus insolotus,* and *Psychomyia pusilla* were all reported as new to Norwegian fauna from different localities at Halden in Østfold county by Solem (1970).

In Norway *Hydropsyche angustipennis* has previously only been recorded from Østfold county (Brekke 1946). *Hydropsyche contubernalis* is new to the Norwegian fauna. The single female was netted flying close to the water surface of the big River Lågen. The species is distributed in North, West, and Central Europe (Tobias 1972). In Fennoscandia it reaches as far north as Norrbotten in Sweden and Lapponia enontekiensis in Finland (Forsslund & Tjeder 1942, Nybom 1960).

Table 1. Names of the localities. Light-traps were used in localities marked (+).

Locality	Municipality	UTM reference
Bastøy	Borre	32VNL863847
Bergli	Lardal	32VNL526822
Borrevann^{+}	Borre	32VNL820858
Bølevann	Andebu	32VNL579772
Bårnes	Hedrum	32VNL513744
Frodeåsen	Tønsberg	32VNL802724
Fyn^{+}	Tjøme	32VNL833495
Gile	Stokke	32VNL765671
Gjennestadvann^{+}	Stokke	32VNL715668
Goksjø	Sandefjord	32VNL673597
Gran	Andebu	32VNL665776
Gullkronen^{+}	Sem	32VNL786726
Havna^{+}	Tjøme	32VNL812505
Herstad^{+}	Nøtterøy	32VNL803681
Hukstrøm bru	Lardal	32VNL555849
Hvåra bru	Hedrum	32VNL535710
Kjære^{+}	Tjøme	32VNL805529
Langvann^{+}	Ramnes	32VNL683805
Løvøya^{+}	Borre	32VNL818909
Mostranda^{+}	Tjøme	32VNL801497
Moutmarka	Tjøme	32VNL801490
Nøklegård	Andebu	32VNL607735
Osestad^{+}	Hedrum	32VNL540746
Strengsdalsvann	Nøtterøy	32VNL808622
Sukke^{+}	Andebu	32VNL645814
Sundbyfoss	Hof	32VNL642986
Åsrumvann	Hedrum	32VNL610587

Outside Vestfold, *Trichostegia minor* has previously only been recorded from the inner part of Rogaland county (Brekke 1946).

Ironoquia dubia is new to Norwegian fauna. All specimens were caught in light-traps. The species is recorded in most parts of Europe, even though there are considerable gaps in the distribution (Botosaneanu 1967). It is rather common but local at small brooks and ditches in southern and south-western parts of Finland (Nybom 1960). In Sweden the species has been taken in a few provinces north up to Härjedalen (Forsslund 1953, Forsslund & Tjeder 1942).

In Norway *Limnephilus decipiens* has previously only been recorded in the southern part of Opland county (Brekke 1946). Outside Vestfold *Limnephilus fuscinervis* has only been recorded in the eastern part of Buskerud county (Brekke 1946). Solem (1967) recorded *Limnephilus germanus* as new to Norwegian fauna in Lake Jonsvatnet, Trondheim in the inner part of Sør-Trøndelag county.

Limnephilus externus should be considered new to the Norwegian fauna. Wallengren (1891) mentions that Siebke had caught the species in Norway, but that no information about the locality was given, and Brekke (1946) states that before adding the species to the list of Norwegian caddis flies: 'there ought to be made new discoveries with exact information as to where they were made'. The single male of *L. externus* was caught in a light-trap. The species is distributed in the northern Holoarctic south to Wyoming and southern Germany (Schmid 1955). The species is very scarce at rivulets in the southern and south-western parts of Finland (Nybom 1960). In Sweden the species is recorded in Dalarna, Lycksele Lappmark and Lule Lappmark (Forsslund & Tjeder 1942, Tobias 1969).

Limnephilus hirsutus is new to the Norwegian fauna. All specimens were caught in a light-trap. The species is distributed in most parts of Europe north up to England, northern Germany, and Denmark (Botosaneanu 1967, Esben-Petersen 1916). In Sweden the species is only recorded from Gotland and Skåne (Forsslund & Tjeder 1942, Ulfstrand 1969). It is not reported in Finland.

Limnephilus quadratus has previously not been recorded in Norway. The single male was caught in a light-trap. The species is distributed in north-eastern Europe and Siberia (Botosaneanu 1967). In Sweden the species is recorded in some provinces north up to Uppland (Forsslund & Tjeder 1942). It is not reported in Finland.

Brekke (1954) recorded *Grammotaulius atomarius* as new to Norwegian fauna from Edøy, Smøla in the outer part of Møre and Romsdal county. *Anabolia nervosa* is previously only recorded from the eastern part of Buskerud county (Brekke 1946).

Crunoecia irrorata is new to the Norwegian fauna. One female was netted in the vegetation at Lake Borrevann, the other specimens were all caught in the light-trap. The species is distributed in most parts of Europe, except the Balkans (Botosaneanu 1967). In Sweden it is only recorded in Skåne and Dalarna (Forsslund & Tjeder 1942). It is not reported in Finland.

In Norway *Athripsodes albifrons* has previously only been recorded in the outer part of Rogaland county (Brekke 1946). *Triaenodes simulans* was recorded as new to Norwegian fauna by Tobias & Tobias (1971) in Fiskevatn, Sør Varanger in the eastern part of Finnmark county. *Oecetis testacea* has previously only been recorded from Rogaland county (Brekke 1946).

Oecetis furva is new to Norwegian fauna. Two males were netted swarming close to the water surface of Lake Gjennestadvann. At Lake Borrevann one male was netted swarming, the rest were captured in the light-trap. The species is distributed in most parts of Europe (Botosaneanu 1967). It is a southern species in Finland, common at lakes, ponds, and seashore (Nybom 1960). In Sweden the species is recorded in most provinces north up to Dalarna (Forsslund & Tjeder 1942, Forsslund 1953).

Most Limnephilids are nocturnal, long distance flyers, easily obtained in light-traps (Crichton 1960, Ulfstrand 1970). With the position of most of our light-traps in mind it is not surprising that Limnephilidae is the best represented family – 3535 specimens belonging to 47 species. Not less than 31 *Limnephilus* species, of which three are new to Norwegian fauna, were found.

Non-Limnephilids were captured in greater numbers in traps situated near freshwater localities. At Lake Borrevann, for instance, *Oxyethira flavicornis* and *Ecnomus tenellus* dominated in the catches during July.

Without doubt there are several other species of Trichoptera to be recorded in Vestfold, and more collecting is necessary to give a satisfactory picture of the caddis fly fauna in the province.

ACKNOWLEDGEMENTS

I would like to thank Dr. S.-A. Bengtson, Bergen, for criticism of the manuscript. I am also indebted to Dr. B. W. Svenson, Lund, for help with identification. Dr. Svenson has identified the female of *Limnephilus picturatus*, and he has also verified my identifications of *Orthotrichia costalis, Hydropsyche*

contubernalis, Cyrnus insolotus, Psychomyia pusilla, Apatania zonella, Limnephilus hirsutus, Athripsodes annulicornis and *Triaenodes simulans*. Finally I would like to thank cand. mag. A. Fjeldså, Bergen, for help and company during the fieldwork.

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Short Communications

Aurorasommerfuglen (*Anthocaris cardamines*) funnet i indre Troms

JOHAN ANDERSEN

Anthocaris cardamines is reported from the outlet of the river Skakterelva in Dividalen in Troms county, where at least two males were seen 14 July 1973. The species has previously not been observed so far north in Fennoscandia.

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Ved utløpet av Skakterelva i Dividalen i TRi ble det 14. juli 1973 fanget en flygende hann av aurorasommerfuglen *Anthocaris cardamines* L. Ytterligere minst en hann ble observert samme dag. Arten var tidligere kjent nord til Inderøya i NTi (Nordstrøm 1955), mens den i Sverige er funnet nord til Kiruna. Dividalen er altså nordligste funnsted i Fennoscandia.

Sommerfuglene fløy dels på selve elvebredden, dels i skogsglenter. Skogen består av gråor, hegg, bjørk og *Salix*. Vertsplanter for *A. cardamines* oppgis å være ulike arter av korsblomstfamilie. Korsblomster på stedet var Berggull (*Erysimum hieraciifolium*) og stakekarse (*Barbarea stricta*). Førstnevnte planteart er meget vanlig på tørre grusskrenter, som forøvrig er bare.

I Sverige har *A. cardamines* bredt seg mot nord og nordvest i dette århundre (Nordstrøm 1955) og det er sannsynlig at forekomsten i Dividalen er av ny dato. Det er likevel for tidlig å si noe om hvorvidt arten har etablert seg i indre Troms.

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Pyla (*Salebria*) *fusca* Haw. (Lep., Pyralidae) found at Spitsbergen

K. AAGAARD, T. BERGVIK & E. SENDSTAD

Four females of *Pyla fusca* Haw. (Lep., Pyralidae) were found at the G. O. Sars mountain, Spitsbergen, in July 1974.

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According to Kaisila (1973), only one species of the lepidopteran family Pyralidae, *Pempelia dilutella* Hb., has been reported from Spitsbergen. Kaisila (1973) doubts, however, that this report is correct, and suggests that the species might be *Pyla fusca* Haw., a holarctic species.

During an expedition from the Royal Norwegian Society of Sciences and Letters, the Museum, Trondheim, to Spitsbergen, two of

Fig. 1. *Pyla fusca* ♀ from Spitsbergen.

the authors (Bergvik & Sendstad) collected four females of a pyralid moth on the G. O. Sars mountain on 20 July 1974. These specimens turned out to be *Pyla fusca*. The finest specimen is pictured on Fig. 1. The specimens seem to be a little brighter than the European ones, but are not, as the Greenland specimens, larger (Barca 1937).

Pyla fusca is known from Europe, north to Lappland and in North America to Alaska, Labrador, and Greenland (Kaisila 1973). The species is most probably a true inhabitant of Spitsbergen. The locality at G. O. Sars mountain is a southern slope, mostly covered with a dense vegetation of grasses, but the specimens were all collected among rocks where the vegetation was dominated by *Salix polaris* and *Dryas octopetala*. The altitude of the locality is 50 m a.s.l.

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Nye funn av Lepidoptera

C. F. LÜHR

New localities are reported for 14 Lepidoptera from various parts of Norway.

C. F. Lühr, N-2680 Vågåmo.

Anthocharis cardamines L.

Funnet 23. juni 1973 ved Gargia, Alta, Finnmark. Arten ser ut til å bre seg nordover idet Opheim (1958) ikke anfører den som observert nordligere enn Nord-Trøndelag.

Leptidia sinapis L.

Funnet 26. juni 1973 ved Gargia, Alta, Finnmark. I likhet med foregående art ser den også ut til å bre seg nordover. Opheim (1958) anfører at den ikke er fanget nordenfor indre, søndre Nordland. Senere samme år, nemlig 9.–14. juli 1973 også tatt av Mogens Schlüter i «birkeskoven ned til Alta elv. Vi så mest hunner og de var rett friske, mens hannerne var affløjne. Den sås ikke andre steder i dalen» (Schlüter 1974).

Cerura bicuspis Bkh.

Fanget i lysfelle 14. juni 1974 nord for Helgesjøen, øst for Vestmarka, Eidskog, Hedmark.

Leucoma salices L.

Fanget 13. juli 1974 ved Gargia, Alta, Finnmark i et eksemplar. Så flere av arten, men de fløy i høyde med tretoppene og var vanskelige å fange. Ikke tatt mellom indre Sør-Trøndelag og nordlige og østlige deler av Finnmark.

Cerastis sobrina B.

Fanget 9. august 1974 på Groos, Grimstad, Aust-Agder i lysfelle.

Anartomina bohemanni Stgr.

Ifølge Opheinm (1962) er det ingen norske funn av denne arten i dette århundre. Den 6. juli 1970 tok jeg et eksemplar av arten dagflygende i utkanten av en myr oppe på Grønnåsen ved Gargia, Alta, Finnmark. Nordström, Wahlgren & Tullgren (1941, p. 120) skriver: «sällsynt på myrar i tallskog, sitter gärna på stammar och stubbar». Det var ingen nåletrær i nærheten av hvor jeg tok sommerfuglen.

Apamea ophiogramma Esp.

Fanget i lysfelle 13. august 1974 på Groos, Grimstad, Aust-Agder.

Cosymbia albipunctata Hufn.

Opheim (1972) anfører at sommerfuglen ikke er tatt nordenfor indre Sogn og Fjordane, bortsett fra østre del av Finnmark. Jeg fanget den 24. juni 1973 ved Gargia, Alta, Finnmark.

Scopula bisetata Hufn.

Fanget 18. august 1962 ved Fossberg i Lom, Oppland.

Eupithecia goossensiata Mab.

Fanget 6. august 1970 i Søgne, ytre del av Vest-Agder. Ifølge Opheim (1972) kan rapporter om funn av denne arten være tvilsomme. Mitt eksemplar er bestemt av Ingvar Svensson, Kristianstad, Sverige, som skriver (personlig meddelelse): «Eksemplaret var i alla fall en så typisk *E. goossensiata* etter vingform och storlek (spetsig resp. liten) att den bör kallas så, om man lämnar artsberättigandet därhän». Hoffmeyer (1952) holder *E. goossensiata* som egen art selv om man ikke har helt sikre kjennetegn som skiller den fra *E. absinthiata*. *E. goossensiata* skal være forholdsvis enkel å skille ved utseende og farvetone (gråere og tydeligere tegnet enn *E. absinthiata*). Ifølge Juul (1958) fins det overganger mellom de to artene. Han hevder imidlertid at finnestedet er et viktig indisium på hvilken art det dreier seg om, og hvis den er fanget på en lynglokalitet er det temmelig sikkert *E. goossensiata*. Mitt eksemplar fra Søgne ble fanget over lyng.

Eupithecia sobrinata Hb.

Fanget 21. juli 1964 på Finnsnes, Lenvik i ytre Troms.

Horisme tersata Schiff.

Fanget i lysfelle 5. juli 1974 ved Tveitsund, Nissedal, indre Telemark.

Itame brunneata Thnbg.

Fanget 21. juli 1964 ved Innset, Bardu i indre Troms.

Celama confusalis H.S.

Fanget i stort antall 2.–11. mai 1974 på Groos, Grimstad, Aust-Agder.

Mottatt 25. januar 1975

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Elenchus tenuicornis (Kirby, 1815) (Strepsiptera, Elenchidae) new to Norway

TROND ANDERSEN & ARNE FJELLBERG

One male of *Elenchus tenuicornis* (Kirby, 1815) (Strepsiptera, Elenchidae) was caught in a light-trap at Osterøy in western Norway (UTM: 32VLN085131) in July 1973. It is the first record of a leaf-hopper parasitizing Strepsiptera from Norway. Some morphological details of antenna and genital segments are figured.

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One male of *Elenchus tenuicornis* was caught in a light trap at Revheim (UTM: 32VLN085131), Osterøy, in Hordaland county, during 11 to 21 July 1973. The trap was situated on a small *Sphagnum* bog on the bank of a lake. The light trap used was a Robinson trap fitted with a mercury vapour bulb (Philips HPL 125W).

There are only a few records of Strepsiptera published from Norway. Løken (1967) summarizes the observations until then. All previous records are of the family Stylopidae which parasites species of Apoidea (Hymenoptera). The present species *E. tenuicornis* belongs to the family Elenchidae, which parasites several species of Delphacidae (Homoptera).

The systematics of Strepsiptera is problematic, and Lindberg (1949) discussed the possibility that the two species of Elenchidae described from Sweden and Finland, *Elenchinus delphacophilus* Ahlberg, 1925 and

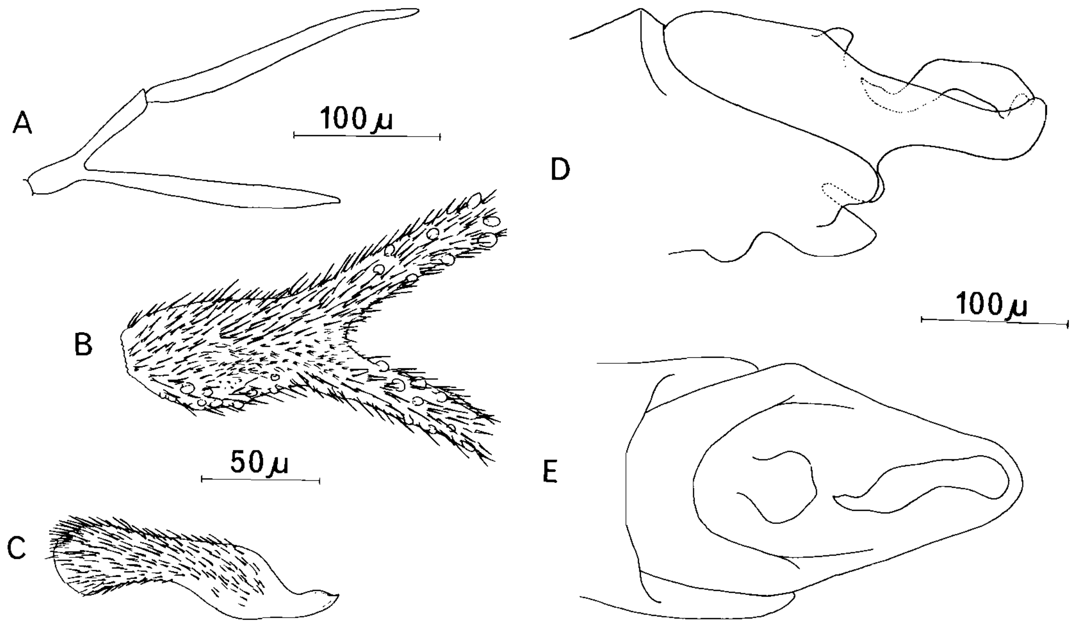

Fig. 1. *Elenchus tenuicornis.* A, antennal segment 3 and 4. B, detail of antennal segment 3. C, male aedagus. D, male genital segment, lateral. E, male genital segment, dorsal.

Elenchinus chlorionae Lindberg, 1939, may be synonyms of *Elenchus tenuicornis*. Kinzelbach (1969) mentions only this species in his survey of Central European Strepsiptera. Our specimen measures 1.04 mm (total length in alcohol) with a wing length of 1.27 mm. The antennae are four jointed with a processus from the third segment. Some morphological features are shown in Fig. 1 A–E.

Males of Strepsiptera have only a few hours free-living period, and the best way of collecting them is by breeding from infested hosts (Lindberg 1939). We know only one other case of Strepsiptera being caught in light traps (Olsson 1971).

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Sympherobius pygmaeus (Rambur, 1842) (Neuroptera, Planipennia) new to Norway

LITA GREVE

Sympherobius pygmaeus (Rambur) (Neuroptera, Planipennia) is reported new to Norway. In May 1975 four males and five females were hatched from oak twigs (*Quercus robur* L.) collected on 24 April 1975 at Frodåsen, near Tønsberg, Vestfold.

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On 24 April 1975, Trond Andersen collected twigs of oak (*Quercus robur* L.) with the intention of hatching *Cynipidae* (Hymenoptera) from galls. The twigs were collected at Frodåsen near Tønsberg, UTM: 32 NL 803723 in Vestfold county. The locality is facing south, and the vegetation consists mainly of oak, with some hazel (*Carylus avellana* L.), rose (*Rosa* sp.), blackthorn (*Pruxnus spirosa* L.) and barberry (*Berberis vulgaris* L.). The ground is of vulcanic origin. From 12 May and the following two or three days a total of four males and five females of *Sympherobius pygmaeus* was hatched from the twigs.

S. pygmaeus has hitherto been recorded from southernmost Finland (Meinander, 1962), southern Sweden north to Upland (Tjeder, 1940, 1953) and Denmark (Esben-Petersen, 1940). Meinander and Esben-Petersen refer to *S. pygmaeus* as very rare. The species is also known from southern England (Killington, 1937). *S. pygmaeus* is nearly always found on oak and prefers warm localities. Including *S. pygmaeus* 60 species of Neuroptera are now recorded from Norway.

ACKNOWLEDGEMENT

I wish to express my gratitude to cand. mag. Trond Andersen for giving me the material.

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Stilbia anomala Hw. verifisert som norsk art (Lep., Noctuidae)

TOR BJØRNULF LUND

Three specimens of *Stilbia anomala* Hw. have been captured on Buøy, Rogaland, confirming its existence as a Norwegian species.

Tor Bjørnulf Lund, Statens oljedirektorat, Postboks 600, N–4001 Stavanger.

Fig. 1. *Stilbia anomala* Hw.

Sommeren 1974 ble det foretatt lysfangst av insekter på Buøy, Stavanger (Ry). Lyskilden var en Osram 150 W, 220 V blandingslyslampe type HQLS 125 W. Det ble ikke benyttet bedøvelsesmiddel av noen art.

Den 8. aug., 12. aug. og 15. aug. ble det tatt i alt tre eksemplarer av *Stilbia anomala* Hw. (Fig. 1). Samtlige eksemplarer satt utenpå fella om morgenen. Alle tre eksemplarene var pene og så ut til å være klekket ganske nylig.

Funnstedet ligger inn mot fastlandet, forholdsvis godt skjermet fra havet. Det ligger i et villastrøk, men 50 m unna finnes naturlig vegetasjon med en del barskog og løvskog. Berggrunnen er overveiende fyllitt. Denne ligger blottet på store deler av øya. Dette passer godt med beskrivelsen av de stedene hvor arten forekommer i Storbritannia: «. . . a local species, but sometimes not uncommon on heaths or in rocky places by the sea» (South 1948).

Arten er tidligere funnet bare en gang i Norge (Nielsen 1968). Dette eksemplaret ble tatt ved Dale i Sandnes, 11 km i luftlinje fra Buøy. Vegetasjon og klimatiske forhold er vidt forskjellig på de to stedene, idet Dale ligger bedre skjermet fra havet.

Utbredelsen er ellers vestlig. Arten er påtruffet i store deler av de britiske øyer og i Irland. South (1948) oppgir den fra Orknøyene, Skottland, England, Wales og Isle of Man. *S. anomala* er videre funnet i Frankrike og i Vest-Tyskland. I Spania finnes den som var. *andalusica* Staud. og i Syrie som var. *syrica* Staud. Larven lever på grasarter.

Tidligere har det ikke med sikkerhet kunnet fastslås om *S. anomala* tilhørte den norske fauna. Eksemplaret fra Sandnes kunne under gunstige værforhold vært vindtransportert fra utbredelsesområdene ved den skotske østkysten eller fra Orknøyene. Klimaobservasjoner fra Stavanger i tiden 5.–15. aug. 1974 viser at både vindretning og -styrke var ugunstig dersom insektene skulle bli blåst over Nordsjøen. Det er derfor lite sannsynlig at eksemplarene skulle være vindtransportert fra Skottland eller Orknøyene. *S. anomala* må tilhøre den norske fauna og funnene til nå tyder på at arten bør kunne finnes flere steder ut mot havet langs sørvestkysten.

De norske eksemplarene er blitt sammenlignet med eksemplarer av *S. anomala* fra British Museum. Eksemplarene fra Stavanger ser ut til å ha en lysere gråtone og være skarpere tegnet enn de britiske. Dette kan skyldes at de norske eksemplarene gjennomgående var friskere, og ytterligere funn må til for å bekrefte om arten danner egen underrase i Norge.

ACKNOWLEDGEMENT

Jeg vil få takke Dr. Arne Nielsen for hjelpen med å bestemme insektene.

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The identity of *Acrotrichis sitkaensis* (Motschulsky) (Col., Ptiliidae)

COLIN JOHNSON

Acrotrichis sitkaensis (Motschulsky, 1845) is shown to be the valid name for *A. fratercula* (Matthews, 1878), based on the type specimen of the former species in the Matthews collection, British Museum (Nat. Hist.).

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Sundt (1968) has recently established *Acrotrichis sitkaensis* (Motschlusky, 1845) as a *nomen dubium.* This was based upon the incomplete original description, and the absence of the beetle from Motschlusky's collection in the Zoological Museum, Moscow, both of which preclude any certain identification of the species. The name *sitkaensis* had previously been given priority over *insularis* (Mäklin, 1852) by Matthews (1872) and subsequent cataloguers. The latter is now well-established as a good species (Sundt 1968).

In the Matthews collection in the British Museum (Nat. Hist.), I have found a specimen which is clearly labelled in Matthews's hand 'Sitkaensis, type from Motschulsky' on a mauve label. Other labels, all printed, are '1309', 'Correctly named. I.B.E.' (= I. B. Ericson), and 'Matthews coll. 1904-120'. The specimen is fortunately a female, which the writer has remounted, after dissecting out the spermatheca. This shows the species to be identical with *fratercula* (Matthews, 1878) sensu Rosskothen 1935, i.e. a paludicole. [It should be pointed out at this point that the recognition of a further European member of the *fratercula* group (Johnson 1975, in press) has considerably simplified the concept of *fratercula* (Matth.)]. Motschulsky (1845) in his original description of ***Ptilium sitkaënse,*** writes that he only possesses a single specimen, so there seems no reason to suppose that the Matthewsian specimen is anything other than this. Accordingly I have labelled it as the holotype.

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Bokanmeldelser

C. D. Michener. 1974. *The Social Behaviour of the Bees. A Comparative Study.* 404 pp. 214 Ill. The Belknap Press of Harvard University Press, Cambridge, Mass. Pris U.S. $25.–.

Humler, (*Bombus*), honningbier (*Apis*), tropiske broddløse honningbier (*Meliponini*) ble lenge betraktet som de eneste sosiale biene. Etter hvert som overfamilien Apoidea's ca 20 tusen arter utforskes trer imidlertid et vidt spektrum av sosial adferd stadig tydeligere frem. En rekke bier som tidligere ble ansett som solitære arter, viser seg å være mer eller mindre sosiale. Fra et evolusjonistisk synspunkt er gradene av sosial organisasjon av særlig interesse fordi arter som sosialt rangerer mellom solitære og høyt spesialiserte samfunnsdannende former er sjeldne eller utdødd hos andre sosiale insekter.

Professor Michener som i årevis har viet sin forskning til bienes systematikk, biologi, etologi, evolusjon m. m., gir i foreliggende bok en systematisk fremstilling av bienes sosiale adferd. Som nødvendig bakgrunnsstoff gis først en generell innføring i bienes biologi og morfologi med særlig henblikk på sosiale funksjoner. Korte kapitler omhandler så deres utviklingshistorie og de sosiale artenes antatte systematiske stilling innen Apoidea, bl. a. illustrert ved instruktivt dendrogram. Bokas første del avsluttes med forklaring av termer vedrørende bol og sosial livsførsel.

Bokas «hjerte», for å bruke forfatterens uttrykk, er annen del som har tittelen «Comparative Social Behaviour». Her gis først en karakteristikk av de ulike nivåer av sosial organisasjon som er funnet hos bier: 1) Aggregasjon av få eller tallrike bol hos solitære bier; 2) ulike stadier av parasociale kolonier (arter med en generasjon imagines, ingen yngelpleie); 3) subsosiale kolonier (arter med en generasjon imagines, yngelpleie); 4) eusosiale kolonier, primitive eller høyt spesialiserte (arter med to generasjoner imagines hvorav den ene, døtrene, er arbeidere.

I etterfølgende kapitler beskrives ved tallrike eksempler artenes individuelle livscyklus, celle- og bolstruktur m. m. på de nevnte sosiale nivåer. Likeledes gis artenes eller bigruppenes sosiale trekk (haploide hanner, arbeidsfordeling, økende produksjon av hunner, kjønns- og kastefordeling, eggleggende arbeidere, foragering, orientering, kommunikasjon, forsvar, etc. etc.) inngående omtale på de sosiale trinn hvor de forekommer. Hvordan evolusjonen, utviklingen av sosial livsførsel, kan ha foregått, er et stadig tilbakevendende tema. I avsluttende kapitel trekkes bolbygging, haploid/diploid genetisk system, yngelpleie, fordeler og mangler ved uproduktive arbeidere, m. m. inn i en dyptpløyende diskusjon om hvordan sosiale arter kan ha oppstått.

I tredje og siste del gis for hver av de grupper bier som er av særlig interesse en mer omfattende oversikt over deres livssyklus, økologi, etc. enten de omtalte trekk har direkte relasjon til sosial adferd eller ikke. Sandbiene (*Halictidae*) har vært gjenstand for intensiv forskning fordi så mange arter viser seg å være sosiale, og fordi familien har representanter på alle sosiale nivåer helt opp til det primitivt eusosiale. Humlene er primitivt eusosiale. På s. 226 påståes forresten at den antakelig fakultativ parasittiske, arktiske kjempehumla (*Bombus hyperboreus* Schønherr) bare samler nektar til tross for at den har samme samleorganer for pollen, dvs. pollenkorg (corbicula) på bakbeina som andre humle-arter. Det er feil. Anmelderen har observert denne sjeldne humle samle pollen. Dessuten finnes bevis i museets samlinger, dvs. individer med pollen i korgene. De siste kapitler omhandler de høyt spesialiserte eusosiale biene, dvs. de dårlig undersøkte broddløse honningbiene og de øvrige honningbiene.

I et appendix er et nomenklatorisk kapitel, en liste med forklaring av termer, en litteraturliste på 20 sider, samt index.

I sine sammenlignende studier og analyser av biartenes sosiale adferd har forfatteren trukket inn, eller referert til, praktisk talt all den viten vi har om bifamilienes liv og levnet. Et imponerende arbeid. Boka er en uunnværlig oppslagsbok for apidologer. De mange uløste problemer forfatteren peker på vil kanskje finne sine løsninger etter hvert som flere av de mange tusen biarter utforskes. Boka anbefales også på det beste til dem som ellers er opptatt av de sosiale insektenes fascinerende livsførsel.

Astrid Løken

M. Fibiger & N. P. Kristensen. 1974. The Sesiidae (Lepidoptera) of Fennoscandia and Denmark. *Fauna ent. Scand. 2,* 91 pp. Scandinavian Science Press, Gadstrup, Danmark. Pris d. kr. 40.–.

Bind 2 av den nye serie Fauna Entomologica Scandinavica omhandler glassvingene (fam. Sesiidae). I overensstemmelse med seriens formål inneholder boken beskrivelser av de arter som er funnet i Fennoscandia og Danmark, bestemmelsestabeller til slekt og art, og en ajourført oversikt over de enkelte arters utbredelse innen området.

Glassvingene er middelstore eller små sommerfugler med smale vinger. Karakteristisk for de fleste artene, og dette gjelder alle nordiske arter, er at bakbingene og store felt i forvingene er gjennomsiktige. Sammen med et slående fargemønster i rødt, gult og hvitt, gir dette en påfallende likhet med veps og andre Hymenoptera. Det synes hevet over enhver tvil at dette er et eksempel på mimicry, og en del arter skal til og med minne om veps i sin adferd.

Familien Sesiidae omfatter i alt nesten 1000 arter, og av disse er 17 funnet Fennoscandia og Danmark. Tolv arter er funnet i Norge. Kjennskapet til artenes utbredelse er relativt dårlig i alle nordiske land og spesielt mangler mange opplysninger fra Norge. Behovet for bedre kjennskap til forekomst og utbredelse av disse insektene, gjør det spesielt verdifullt at vi her har fått en ny bok om gruppen, spesielt tilrettelagt for nordiske forhold.

Boken har innledningsvis en detaljert beskrivelse av glassvingenes morfologi. Derpå følger bestemmelsestabeller og beskrivelser av de enkelte artene. Dette omfatter også en kort oversikt over deres biologi. Selv om de fleste arter kan identifiseres på ytre karakterer, som f. eks. farger og vingenes årer og åpne felt, har boken detaljerte tegninger av alle arters genitalia. Til sammen gir dette muligheter for en sikker identifikasjon, også av eksempler i dårlig forfatning.

Boken er meget rikt illustrert. Strektegninger av genitalia m. m. er laget av K. L. Elsman og G. Lyneborg. Dertil fins et sett med fargeplansjer over imagines tegnet av R. Johansson. Plansjene gir et godt inntrykk av de forskjellige artenes mønster og fargeprakt, men for de mindre artenes vedkommende har trykken blitt litt utydelig og utflytende. Fotografiene av plantemateriale infisert med glassvingelarver burde også vært tydeligere, men vil formodentlig tjene sitt formål. Kvaliteten kunne blitt bedre på et annet papir, men dette er igjen et økonomisk spørsmål.

I alt gir boken inntrykk av grundig gjennomarbeidelse, og fremfor alt vil den være nyttig som bestemmelseslitteratur. En bok som dette burde inspirere til nærmere undersøkelser av glassvingenes forekomst og levevis. I likhet med det første bind, lover den godt for serien Fauna Entomologica Scandinavica, som nå allerede har over 50 bind under forberedelse.

Lauritz Sømme

Milan Chvala, Leif Lyneborg & Joseph Moucha. 1972. *The Horse Flies of Europe (Diptera, Tabanidae).* 499 sider, 8 plansjer. The Entomological Society of Copenhagen, Copenhagen.

Dette store verket er en meget velkommen og nyttig oppstilling av Europas klegg. Hittil har dette vært savnet i en slik oversiktlig form. Denne insektgruppe har stor økonomisk betydning. Som blodsugere og overførere av sykdommer og parasitter kan de volde skader for kreaturholdet, og man må ha kjennskap til dem både av medisinske og veterinærmessige grunner. Fra vitenskapelig synspunkt er interessen kanskje enda større med tanke på de aspekter av parasittisme–halvparasittisme som de ulike taxa representerer, med perspektiv for evolusjonistiske og zoogeografiske problemstillinger.

Boken er ikke en kompilasjon, men en grundig og kritisk bearbeidelse av det enormt store materialet. Forfatterne har ikke bare nøyet seg med å gjennomgå litteraturoppgaver, men har gjennom flittig studium av originalmaterial i ulike museer og samlinger skaffet seg egne erfaringer. Dette høyner bokens verdi. Tabanidene er ikke just den letteste gruppen blant insektene å arbeide med. Takket være en tidligere altfor rundhåndet navngivning har det vært skapt rett så uoversiktlige forhold i kleggens taksonomi.

I bokens allmenne del berettes om den europeiske tabanidforskningens historikk og gis en tabellarisk oversikt over geografisk utbredelse, innsamlings- og kulturteknikk, økonomisk og medisinsk betydning, det voksne individets morfologi, og klassifikasjon. I den systematiske delen gis bestemmelsesnøkler og gjennomgås Europas samtlige 176 arter samt i tillegg 5 hvis forekomst er diskutabel eller sannsynlig. For hver art gis en kort diagnose, en mer utførlig beskrivelse, økologi, flygetid samt utbredelse. Det er klart at behandlingen av enkelte arter i en slik bok må bli mer eller mindre sjablonmessig, men de kritiske artene får en noe fyldigere behandling. Illustrasjonene, tusjtegningene er klare, men ofte kanskje noe for skjematiske. Bestemmelsestabellene er anvendelige, men noen feil forekommer, f. eks. på side 17 der det sies i antitesis til § 10 (9): «Subcallus naked (*borealis*-group)». Dette er feil, det skulle ha stått i foregående antitesis som leder til *montana*-gruppen (med tanke på artene *lurida* og *nitidifrons*). I § 12 karakteriseres antennene hos *arpadi* som «chestnut brown». De er mørkere enn dette, hos de nordlige populasjonene er den terminale delen iblant til og med svart. Sikrere karakteristika å nevne skulle være tredje segmentets kraftige tann og følehornenes silke- eller oljeglans. Men, med tanke på varibiliteten hos tabanidene er sammensetningen av allmenngyldige bestemmelsestabeller ingen lett oppgave.

Det er utmerket at det gis gode beskrivelser av begge Meigens arter *Hybomitra auripila* og *aterrima*, som særlig blant nordiske dipterologer har voldt vanskeligheter. Eldre forfattere har anvendt det korrekte navnet *auripila*. Siden Wahlgrens bestemmelsesbok i serien Svenske insekter kom ut i 1907 har man fulgt hans oppfatning om at *auripila* var å betrakte som en gulhårig variant av *arterrima* (Ringdahl, Frey). Jeg har også selv gjort det på samme måte uten å kontrollere saksforholdet. Arten i Norden synes således å være *auripila*. Men, forekommer også *arterrima*, slik forfatterne angir? Andersson (1975) har nylig tatt opp dette problemet og konstatert det motsatte. Når det gjelder forfatternes art *Hybomitra solstitialis*, står det fremdeles åpent om den ikke tilhører *H. bimaculata* slik Olsufjev foreslår. Man kan slett ikke være enig med forfatternes mening om at underarten *flaviceps* av *H.*

montana bare er «a melanistic variety without taxonomic value». Det er ikke bare fargen som skiller, men også størrelsen, samt at den danner geografisk skilte populasjoner som med overgangsformer er bundet til sydligere populasjoner av nominatrasen.

For å sikre en nødvendig stabilitet i nomenklaturen og forebygge forvirringen, har man i Zoologiske nomenklaturen foreslått det prinsippet at navn som ikke er anvendt i den grunnleggende vitenskapelige litteraturen i 50 år eller mer ansees å være glemte navn, og anvendes ikke.

Denne anbefaling fra Internasjonal Nomenklaturkommisjon har forfatterne ikke villet følge. De har blant annet tatt i bruk *Hybomitra borealis* Fabricius, 1781 = *H. lapponica* Wahlberg, 1848 og *Chrysops viduatus* Fabricius, 1794 = *Ch. pictus* Meigen, 1820.

Bortsett fra disse få anmerkninger skal arbeidets grunnleggende verdi for entomologien og for den praktiske zoologien understrekes. Den er uunnværlig for universitetet, veterinærhøgskoler, landbrukshøgskoler, og over alt hvor man kommer i kontakt med sykdommer og parasitter overført av klegg.

Hans Kauri

Carl H. Lindroth, Hugo Andersson, Högni Bödvarsson & Sigurdur H. Richter. 1973 *Surtsey, Iceland. The Development of a New Fauna, 1963–1970. Terrestrial Invertebrates.* 280 pp. Entomologica Scandinavica, Supplementum 5. Munksgaard, København. Pris d. kr. 140.–.

Øyenes fauna har spilt en betydelig rolle i utviklingen av økologiens idéverden. Darwins observasjoner på Galapagos-øyene hadde avgjørende betydning for evolusjonsteorien. Det indo-pasifiske arkipelaget og dets fauna har betydd meget for tankegangens modning til en ny oppfatning av systematikken, The new systematics. Hutchinson-McArthurs nisjemodell og de perspektiver som har blitt åpnet i sammenhengen for økologien–taksonomien og evolusjonsforskningen, har fått sin viktigste utbygging med øyenes fauna som underlag. Lindroth og hans medarbeideres arbeid må sees på bakgrunn av disse innfallsporter.

I bokens tre deler berettes først om disposisjonen, feltarbeidet, om Surtsey's tilblivelse og utvikling samt innledningsvis over fenomenet – nye øyer. Den andre, spesielle delen omfatter terrestrisk evertebratfauna på Surtsey og i dens baseområde, eller som forfatterne kaller det «Hinterland». Den tredje delen er viet allmenne spørsmål, analysen av Surtsey's og baseområdets fauna, spredningsspørsmål, koloniseringen og rekkevidden og generaliseringsmulighetene av vunne erfaringer fra Surtsey.

Egentlig er det en merkelig og enestående begivenhet, både dette med Surtsey som ny øy og forskningen av dens fauna. Surtsey ble født som på bestilling for at det kunne sette kronen på verket ved avslutningen av en lang og lysende forskningsinnsats. Med dette menes Islands fauna og dets økologi som professor Carl Lindroth har gjort til sin egen og undersøkt gjentagne ganger siden 20-årene. Om jeg sier enestående så er det fordi undersøkelsene startet fra første begynnelse av øyens historie, og at den kom i hendene til den mest kompetente forsker på området. Dertil kom at baseområdet Islands fauna var vel kjent, ikke minst gjennom Lindroths egne tidligere undersøkelser, som ble effektivt komplettert under det aktuelle arbeidets gang.

Det ble et metodisk opplagt og konsekvent gjennomført arbeid som neppe har noen like blant de få undersøkelser som har vært gjort på nydannete vulkanøyer. Resultatene er meget detaljrike. Særskilt spredning, spredningsfaktorer og -muligheter har vært underkastet en grundig analyse og eksperimentell prøving.

Det viste seg at innvandringen til Surtsey for en overveiende del var vindspredning, anemochor. Til år 1970 ble tilsammen 158 arter funnet levende på øyen, samtlige – leddyr. Av disse var 105 (66%) mygg og fluer, de fleste fra Island, en mindre del fra Vestmannaøyene, særskilt den største øyen Heimaey. Det meste av karplanter hadde flytt i land sjøveien. En midd hadde ankommet med drivved og to arter Collembola samt fem midd i en gresstue. Spredning med andre dyr som faktor (zoochor spredning) hadde forekommet gjentagne ganger og gjaldt først og fremst midd som var festet til fluer. Derimot ansees antropochor spredning, ved mennesker, å ha spilt en underordnet rolle. Fjernere migranter, noen få sommerfugler og en aeronautisk edderkopp ble også konstatert.

Når antallet fundne arter således ikke var så lite, viste det seg at ytterst få hadde fått fast fotfeste på Surtsey og etablert permanente populasjoner: de var to Collembola arter, en fjærmygg og en midd. Fattigdommen berodde på savnet av eksistensgrunnlaget, vegetasjonen var ennå ikke blitt utviklet. Resultatet av forskningen er tross dette meget imponerende, først og fremst ved at innvandringsmekanismen er blitt klarlagt så minutiøst. Det ene er å teoretisere over baseområdenes avstand, vinddrift, hydrochor- og zoochor spredning m. m., noe annet er å fremlegge bevis. Forfatterne betoner at tilfellet Surtsey er egenartet, og at resultatene, erfaringene som er oppnådd, ikke uten videre kan overføres til andre øyer. Det er nok sant, men erfaringene skal samles for så smått om senn sammenstilles til et omfattende geografisk-økologisk mønster. Som et bidrag til dette og som et eksempel for etterkommerne kan Lindroths og hans medarbeideres arbeid ikke verdsettes høyt nok.

MacArthur og Wilsons syntese om øyfaunaens økologi bygger på vertebratene, først og fremst fuglene. Surtsey-arbeidet er en høvelig komplement til dette, til tross for at metodikken er en annen. En fortsatt undersøkelse av populasjonenes utvikling på Surtsey skulle kunne gi muligheter til å prøve MacArthurs & Wilsons variable-nisj teori på evertebratene i et nord-temperert klimaområde, der konkurransen som begrensende hovedfaktor i større utstrekning erstattes med abiotiske miljøfaktorer.

Arbeidet er selvskrevet som lesning på høystadiet ved universitetsundervisningen i økologi.

Hans Kauri

D. J. Candy & B. A. Kilby (Eds.). 1975. *Insect Biochemistry and Function.* 314 pp. Chapman and Hall, London. Pris £8.50.

Insekter har aldri tiltrukket biokjemikerens oppmerksomhet i samme grad som mikroorganismer og vertebrater. En stor del av våre biokjemiske kunnskaper bygger på studier av laboratorierotter og E. coli bakterier. Allikevel har også insektenes biokjemi gjort store fremskritt i senere tid. Insektene er egnet til undersøkelser av både generelle og spesielle biokjemiske problemer. I den foreliggende bok er sentrale emner innen insektenes biokjemi tatt opp til behandling. Boken gir ikke en total fremstilling av fagområdet, men søker å gi en utførlig omtale av fire viktige felt.

Det første kapitlet er skrevet av B. Sacktor ved National Institute of Health i Baltimore, og omhandler flygemusklenes bruk av energi. Forskjellige nedbrytningsveier for fett, carbohydrater og aminosyrer gjennomgås, etterfulgt av en redegjørelse hvorledes metabolisme i flygemusklenes mitochondrier reguleres. Stoffomsetningen i disse musklene er uovertruffen i dyreriket forøvrig, og ligger 30 til 50 ganger høyere enn i menneskenes hjerte- og benmuskler. Som forfatteren fremhever er insektenes flygemuskler ideelle studieobjekter når det gjelder katabolske prosesser og biologisk oksydasjon. Mange av resultatene fra insekter har generell gyldighet i dyreriket.

I annet kapittel blir det gjort rede for hvorledes flygemusklene forsynes med brennstoff, og hvorledes dette reguleres. Kapitlet er skrevet av E. Bailey ved Sheffield University, og er en detaljert oversikt om syntese, lagring og transport av fett og karbohydrater i kroppen, så vel som betydningen av aminosyrer som energikilde for flygemuskler. Kapitlets omfang viser at man nå, med unntak av aminosyrene, har meget omfattende detaljerte kunnskaper innen området.

Ekskresjon av nitrogenholdige avfallsprodukter, sett i relasjon til insektenes tilpasning til liv på land, er et interessant tema. Dette behandles i et kapittel av D. G. Cochran ved Virginia Polytechnic Institute. Det har etter hvert blitt klart at insektene produserer et stort antall forskjellige avfallsprodukter. Nyere undersøkelser viser også at urinsyre ikke alltid er det viktigste produkt, men at selv visse terrestriske insekter kan gjøre bruk av det giftige ammonium.

Boken har til sist et kapittel av G. G. Lunt ved University of Bath, hvor det redegjøres for synaptisk overføring i insektenes nervesystem. Det er nå klart at acetylcholin er den viktigste substans i det sentrale nervesystem, mens glutaminsyre er ansvarlig for overføring i synapser mellom muskler og nerver. Den mulige betydning av andre stoffer blir også diskutert.

I alt er dette en meget interessant bok, som viser hvor langt man er kommet på forskjellige områder av insektenes biokjemi. Den er tilstrekkelig rik på detaljer til å kunne tjene som oppslagsbok, samtidig som den vil være nyttig lesning for studenter og andre som er interessert i insektenes fysiologi og biokjemi. Boken kan godt leses uten alt for store kunnskaper i biokjemi, men et visst kjennskap til faget er naturligvis en fordel. Det er interessant å kunne konstatere den økende forskningsinnsats innen insektenes biokjemi. Faget er ikke bare av grunnleggende interesse, men kan få stor betydning innen anvendt entomologi. Kunnskaper om biokjemiske forskjeller mellom insekter og andre former for liv vil være nyttige for utvikling av selektive insektmidler. En velskrevet bok, som denne, vil være kilde til inspirasjon for videre forskning på området.

Lauritz Sømme

P. N. R. Usherwood (ed.). 1975 *Insect Muscle.* 621 pp. Academic Press, London, New York, San Francisco. Pris £14.50.

Ved første blikk kan man kanskje undres over at det kan skrives en så tykk bok bare om insektmuskler. Ved nærmere ettersyn blir man klar over hvor omfattende kunnskaper som etter hvert har samlet seg på dette området. Boken tar for seg insektmusklenes struktur, fysiologi og biokjemi, og har spesiell interesse for entomologer. Men bokens redaktør håper også å kunne vise andre vitenskapsmenn at insektenes muskler er spesielt egnet til studier av prinsipielle strukturelle og fysiologiske egenskaper. En rekke forfattere har bidratt til en utførlig sammenfatning av eldre og nyere viten.

Boken gir ingen anatomisk oversikt over insektenes forskjellige muskler, men innledes med en omtale av musklenes struktur. Kapitlet som er skrevet av H. Y. Elder ved University of Glasgow, viser hvilken enorm betydning elektronmikroskopet har hatt for detaljerte studier av musklenes bygning. Både fotografier og diagrammer er klare og instruktive.

Innledningen etterfølges av en rekke kapitler om mer spesielle sider ved musklenes egenskaper og funksjon. L. H. Finlayson, University of Birmingham, skriver om musklenes utvikling og vekst fra embryonale stadier til voksne insekter, og om deres degenerasjon, f. eks. under puppeutviklingen. Den finere struktur av synapsene mellom nerver og muskler er viet et eget kapittel, skrevet av M. P. Osborn, University of Birmingham. Også dette kapitlet har en rekke glimrende elektronmikroskopiske fotografier. Forfatteren legger stor vekt på å korrelere nervecellenes cytologiske komponenter med deres fysiologiske funksjoner.

Farmakologiske undersøkelser av nerve–muskel synapser er beskrevet av P. N. R. Usherwood og S. G. Cull-Candy, henholdsvis ved University of Nottingham og University of Glasgow. Mens L-glutamat generelt er akseptert som transmittor i stimulerende synapser, mener forfatterne at det nå foreligger gode indikasjoner på at gamma-aminobyturat er transmittorsubstans i inhiberende synapser.

Musklenes elektrofysiologiske egenskaper er behandlet av T. Piek, Universiteit van Amsterdam, deres mekaniske egenskaper og kontraksjon av D. J. Aidley, University of East Anglia, og de fibrillære flygemusklers biofysikk av R. T. Tregear, University of Oxford.

Musklenes metabolisme er rimeligvis viet stor plass, og har et eget kapittel skrevet av B. Crabtree og E. A. Newsholme, University of Oxford. Forfatterne foretar bl. a. en rekke interessante sammenligninger mellom vertebratmuskler, insektmuskler og ander evertebratmuskler, både når det gjelder fysiologiske og biokjemiske funksjoner. Kapitlet er konsentrert skrevet, men gir utmerket oversikt over området, og de spesielle forhold som gjelder for stoffomsetningen i insektenes muskler.

Et kapittel av G. Hoyle, University of Oregon om nervesystemets kontroll av muskelaktiviteter tar for seg det man vet om musklenes innervering, og de mønstre av nerveimpulser som mottas. Forfatteren tar også for seg spørsmålet om hvorledes nerveimpulser oppstår, og de integrerende aktiviteter innen nervesystemet som fører til frigjøring av de rette impulser. Dette vanskelige tema er elegant fremstilt.

Boken avsluttes med et kapittel om de viscerale muskler. Undersøkelser av disse musklenes egenskaper har kommet noe i bakgrunnen sammenlignet med den store interesse for insektenes skjelettale muskler. Forfatteren, T. A. Miller ved University of California, kan allikevel summere opp en ganske omfattende oversikt om de viscerale musklers egenskaper, innervering og farmakologi.

Det er vanskelig å gi en kritisk vurdering av en så omfattende bok som denne. Men det kan ikke være tvil om at man har fått en meget verdifull oppslagsbok, som egentlig spenner over mer enn det tittelen sier. Det er interessant at det på samme tid også utgis en annen bok med hovedvekt på insektmusklenes biokjemi (se anmeldelse ovenfor). Tilsammen viser de to bøkene hvilken enorm innsats det har vært på dette området i senere tid, og hvilken betydning studier av insektenes muskler har for forståelsen av prinsipielle biokjemiske og nevrofysiologiske problemer.

Lauritz Sømme

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