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The invertebrate fauna of the streams in Øvre Heimdalen

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The lotic communities in Øvre Heimdalen were completely dominated by insects. The species distribution of stoneflies (Plecoptera), mayflies (Ephemeroptera) and caddisflies (Trichoptera) is given together with autecological notes on the Plecoptera and certain other major species. The species distribution of these groups, especially the Plecoptera, was clearly related to the deciduous vegetation along the streams. There was a reduction in species parallel to a reduction in *Salix* vegetation.
The main inlet stream to the lake, Øvre Heimdalsvatn, the outlet and the outlet stream had different faunal compositions. The inlet fauna consisted to a large extent of winter growing species, mainly detritus feeders, while the outlet and outlet stream had a fauna dominated by summer growing species, several of which were filter feeders.

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Introduction

The macrofauna of streams is important in the breakdown of large fragments from the terrestrial vegetation into smaller particles (Cummins 1974). In Øvre Heimdalen these particles are in turn carried into the lake and utilized as food by many lake organisms (Larsson and Tangen 1975). Filter feeding organisms such as certain caddisflies, blackflies and bivalve molluscs filter organic particles carried out of the lake. Dendy (1944) showed that stream animals were continously washed into a lake. We must suppose that this also occurs in Øvre Heimdalsvatn. The main inlet stream and the outlet stream are nursery areas for young trout (Lien 1978) and the invertebrate fauna of these streams is the most important food for the trout during a 2–3 yr period (Lien 1978). Therefore a study was made of the fauna of these streams.

Three insect groups in the area were chosen for special study: Ephemeroptera, Plecoptera and Trichoptera. They are fairly easy to handle taxonomically, constitute a significant part of the fauna, are widely distributed and represent the four main feeding functions in running water (detritus feeders, grazers, filter feeders and predators). Many of the species do not strictly belong to one of the functional groups, but to a greater or lesser extent take other types of food. Nevertheless, in most cases one can assign them to the group where they obtain their main food.

The streams in the area (Fig. 1) are quite different in size, water flow and length. Streams 1, 3, 4 and 5 rise high up in the mid-alpine vegetation belt, run through the low-alpine and into the subalpine (Figs 2, 3 and 4). Streams 7, 8 and 9 are small and temporary and situated solely in the low-alpine belt.

Methods

The sampling method was a kicking technique, used earlier by workers such as Kershaw et al. (1968), Frost et al. (1971) and Lillehammer (1974). At each station the substratum was disturbed by kicking for a 3 min period while a net (mesh 450 μm) was placed downstream. The net contents were then sorted and placed in 3% formalin. The streams were sampled at least three times during the ice free period, mainly from June to September.

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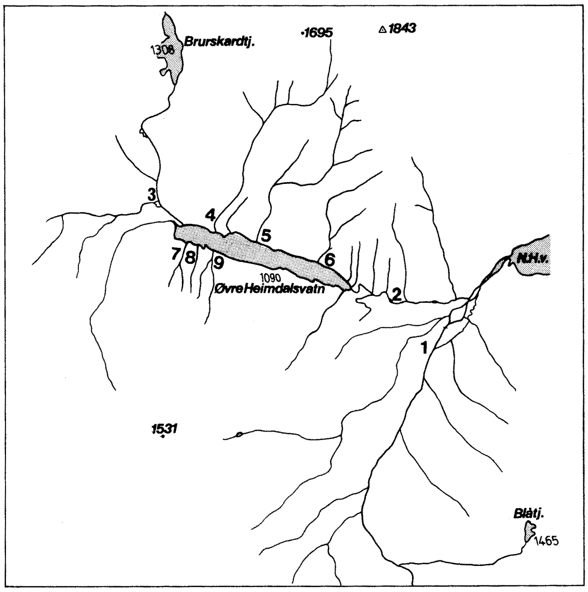

Fig. 1. Sketch of the lake Øvre Heimdalsvatn and the streams investigated (1–9). (Adapted from Lillehammer 1974).

The fauna of the tributary streams

Fauna registration in the tributary streams clearly showed the same trend for Plecoptera (Tab. 1), Ephemeroptera (Tab. 2) and Trichoptera (Tab. 3). In the mid-alpine belt at 1300–1500 m a.s.l. and where dwarf willow (*Salix* spp.) vegetation is absent, only a few species occur, while in the subalpine belt there are 46 species in the three taxa. In the Plecoptera, which are mainly represented by detritus feeders and predators there were 20 species in the subalpine where the willow vegetation is dense along the streams, but only 4 species in the mid-alpine belt (Tab. 1). The reduction was by far the greatest among the detritus feeders, from 15 to 2

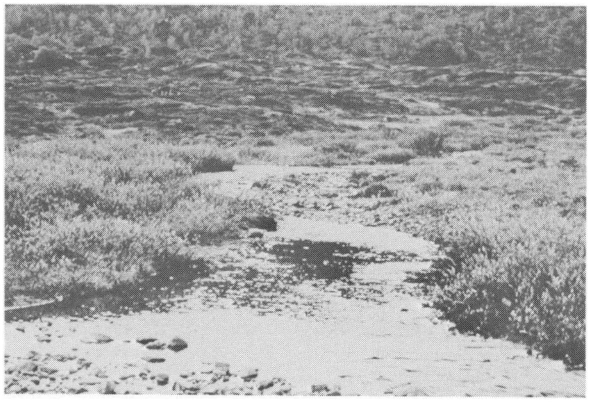

Fig. 3. The stream (3) near the lake in the subalpine vegetation belt at about 1100 m a.s.l. fringed by dense vegetation of small willow bushes.

species. Data on feeding is taken from Brinck (1949), Hynes (1941) and Lillehammer's studies (unpubl.) of 13 of the 15 detritivore species.

The Ephemeroptera, detritus feeders and grazers, were represented by 13 species, but only four have been commonly taken in the mid-alpine (Tab. 2).

The Trichoptera represented all the four feeding functions and the trend in their distribution was the same as for Plecoptera (Tab. 3). Only two of the five species in the mid-alpine are detritus feeders or grazers compared with 9 out of 13 in the subalpine.

Thus changes took place in species distribution which were paralleled by changes in terrestrial vegetation.

The faunal composition of the main inlet and the outlet stream of Øvre Heimdalsvatn

Larsson and Tangen (1975) have shown that the inlet streams carry large amounts of larger organic particles

Fig. 2. The stream (1) Flybekken in the mid-alpine vegetation belt at about 1400 m a.s.l. (From Lillehammer 1974).

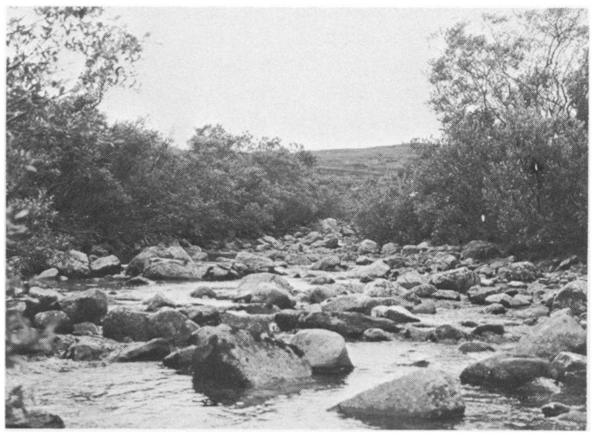

Fig. 4. The stream (1) Flybekken, in the subalpine vegetation belt at 1080 m a.s.l. The stream is fringed by dense vegetation of tall willows.

Tab. 1. The Plecoptera recorded from streams in different vegetation belts in Øvre Heimdalen (from Lillehammer 1974).

	Sub-Alpine	Low-Alpine	Mid-Alpine
Isoperla grammatica (Poda)	×		
Dinocras cephalotes (Curtis)	×		
Taeniopteryx nebulosa (L.)	×		
Amphinemura sulcicollis (Stephens)	×		
Nemoura avicularis Morton	×		
Capnopsis schilleri (Rostock)	×		
Leuctra digitata (Kempny)	×		
Leuctra fusca (L.)	×		
Leuctra hippopus (L.)	×		
Diura nanseni Kempny)	×	×	
Brachyptera risi (Morton)	×	×	
Nemoura cinerea (Retzius)	×	×	
Nemurella picteti Klapálek	×	×	
Protonemura meyeri (Pictet)	×	×	
Capnia bifrons (Newman)	×	×	
Leuctra nigra (Olivier)	×	×	
Arcynopteryx compacta (McLachland)	×	×	×
Isoperla obscura (Zetterstedt)	×	×	×
Amphinemura standfussi (Ris)	×	×	×
Capnia atra Morton	×	×	×
Number of species	20	11	4

into the lake, while the particles carried out of the lake are mainly much smaller. The influence of this upon the fauna of the inlet and outlet was studied.

The fauna in the inlet, the outlet itself and the outlet stream 900 m from the lake was dominated by insects; Ephemeroptera, Plecoptera, Trichoptera and Diptera (Chironomidae and Simuliidae) (Tabs 4, 5). However, in the outlet other groups such as bivalva (*Pisidium* spp.) could be numerous.

The highest densities were recorded in the outlet, followed by the outlet stream. This was largely due to the high numbers of chironomids and the filter feeders (mainly *Pisidium* and net-spinning Trichoptera) in the outlet and the outlet stream.

The filter feeding black flies (Simuliidae) were most numerous in the inlet stream and less common in the outlet.

The number of species in each biotope was also different. Among the stoneflies, 15 species were taken in the inlet area compared with 8 in the outlet and 7 in the outlet stream. The Trichoptera were represented by three species in each biotope, and the Ephemeroptera by four species in the inlet stream, three in the outlet and five in the outlet stream. The total number of species from these three groups in the three biotopes was therefore 22, 14 and 14 respectively. Thus the highest number of species was in the inlet.

Tab. 2. The Ephemeroptera recorded from streams in different vegetation belts in Øvre Heimdalen.

	Sub-Alpine	Mid-Alpine
Ameletus inopinatus Eaton	×	×
Siphlonurus lacustris Eaton	×	
Baëtis fuscatus (L.)	×	
Baëtis lapponicus (Bengtsson)	×	×
Baëtis macani Kimmins	×	×
Baëtis rhodani (Pictet)	×	×
Baëtis scambus Eaton	×	
Baëtis subalpinus Bengtsson	×	
Baëtis vernus Curtis	×	
Heptagenia sp.	×	
Leptophlebia marginata (L.)	×	
Leptophlebia vespertina (L.)	×	
Ephemerella aurivilli Eaton	×	
Number of species	13	4

Tab. 3. The Trichoptera recorded in streams from different vegetation belts in Øvre Heimdalen. The two *Potamophylax* species have only been identified as imagines.

	Sub-Alpine	Mid-Alpine
Rhyacophila nubila (Zetterstedt)	×	×
Philopotamus montanus (Donovan)	×	×
Polycentropus flavomaculatus (Pictet)	×	×
Plectrocnemia conspersa (Curtis)	×	
Parapatania stigmatella (Zetterstedt)	×	
Limnephilus flavicornis (Fabricius)	×	
Limnephilus nigriceps (Zetterstedt)	×	
Limnephilus sp.	×	×
Potamophylax cingulatus (Stephens)	×	
Potamophylax latipennis (Curtis)	×	
Halesus radiatus (Curtis)	×	
Chaetopteryx villosa (Fabricius)	×	×
Oxyethira sp.	×	
Number of species	13	5

Tab. 4. The total number of specimens from each taxa, recorded in the inlet, outlet and outlet stream during June, July and August 1971.

	Inlet stream	Outlet	Outlet stream	Total
Oligochaeta	16	22	5	43
Gammarus	–	10	–	10
Hydracarina	42	161	38	242
Plecoptera	99	169	225	493
Ephemeroptera	253	126	289	604
Trichoptera	17	354	77	448
Coleoptera	–	1	5	6
Chironomidae	281	716	449	1446
Tipulidae	19	4	3	26
Simuliidae	208	24	69	301
Other Diptera	8	–	–	8
Hirudinea	–	–	1	1
Mollusca	–	425	62	487
Hydrozoa	–	10		10
Total no.	943	2022	1223	4125

Tab. 5. The frequency composition (%) of stonefly species in the inlet, outlet, and outlet stream biotopes.

	Inlet stream	Outlet	Outlet stream
Capnia atra	17	0	0
Capnia bifrons	18	0	0
Leuctra digitata	12	0	0
Leuctra fusca	6	5	8
Leuctra hippopus	4	7	12
Leuctra nigra	3	0	0
Amphinemura sulcicollis	2	40	70
Amphinemura standfussi	6	1	2
Protonemura meyeri	8	0	4
Nemoura cinerea	3	0	1
Taeniopteryx nebulosa	0	13	0
Brachyptera risi	7	0	0
Isoperla grammatica	0	16	2
Isoperla obscura	2	10	0
Diura bicaudata	1	8	0
Diura nanseni	11	0	0
Dinocras cephalotes	0	0	1

Autecological notes on common species

Among the Plecoptera the Capniidae, *Capnia atra* and *C. bifrons* were most common in the inlet streams (Tab. 6), although *Leuctra digitata* and *Diura nanseni* were also numerous. The outlet and outlet stream were dominated by *Amphinemura sulcicollis*. In the outlet *Isoperla grammatica, I. obscura* and *Taeniopteryx nebulosa* were also numerous, and in the outlet stream *Leuctra fusca* and *L. hippopus*.

C. atra and *C. bifrons* emerge in the first part of June, two months later than in the low altitude locality of Sæterbekken, near Oslo (Lillehammer 1974). Most growth takes place while the streams are covered by ice. On hatching the nymphs of *C. atra* are 0.7–0.8 mm long and between 6 and 9 mm when fully-grown. Nymphs of *C. bifrons* are about 0.8 mm long at hatching and from 6 to 11 mm when fully-grown. Both species are detritus feeders, mainly consuming leaf fragments. *C. atra* is widely distributed in Norway, while *C. bifrons,* a southern immigrant, has only a scattered distribution and is absent from western Norway and the most northern parts of the country (Lillehammer 1974). In Øvre Heimdalen *C. bifrons* was recorded in the low-alpine belt at about 1200 m a.s.l., the most extreme climatic habitat found for this species in Norway. In the inlet streams the bottom consisted of gravel and small stones, a substratum which *C. bifrons* seems to prefer (Lillehammer 1975).

D. nanseni, the most common carnivorous stonefly in southern Norway (Lillehammer 1974) was believed to partly have a two year life cycle in Lappland, Sweden (Ulstrand 1968b). Field studies in different areas in Norway and laboratory studies have shown that the species has a two year cycle. The first winter is spent in egg diapause, with hatching in the spring (Lillehammer 1976). Growth takes place during the summer and winter, from 0.8–0.9 mm at hatching in the spring to 10–15 mm as a full-grown nymph a year later. In Øvre Heimdalen, they emerged in the latter part of June and the first part of July. The nymphs consumed on all kinds of invertebrates.

L. digitata is a detritivore and in Øvre Heimdalen it was not taken above the *Salix* vegetation. It has an egg incubation period of 50–60 d, hatching in October at 0.7–0.8 mm long. Growth is slow during the winter and the main growth occurs during June, July and August. Fully grown nymphs are 5.5–9 mm. Emergence takes place in August. The species has not been recorded in the lake or in the outlet.

L. fusca, which had its main growth in Øvre Heimdalen during June, July and part of August, emerged from the end of July until the beginning of October (Lillehammer 1975), an extremely long emergence period. On hatching the nymphs are 0.7–0.8 mm long, while the

Tab. 6. The frequency composition (%) of caddisfly species and of mayfly species in the inlet, outlet, and outlet stream.

	Inlet stream	Outlet	Outlet stream
Trichoptera			
Rhyacophila nubila	59	0.5	2
Plectrocnemia conspersa	31	0	0
Polycentropus flavomaculatus	0	99	90
Limnephilus spp.	10	0.5	8
Ephemeroptera			
Baëtis rhodani	66	86	17
Baëtis lapponicus	10	0	0
Baëtis scambus	0	0	16
Baëtis spp.	15	0	5
Ameletus inopinatus	9	11	56
Leptophlebia marginata	0	3	6

fully-grown nymphs are 6–8 mm long. The species feeds on detritus.

L. hippopus emerged between the first half of June and the last half of July. Its growth mainly occurred while the streams were ice covered. In the outlet stream this is the only common spring emerging plecopteran. On hatching it is 0.7–0.8 mm long, and when fully grown the nymphs are 5–9 mm long. It feeds on detritus.

A. sulcicollis is a detritus feeder and emerges during the latter part of June and during July, almost coincident with emergence in the lowland locality (200 m a.s.l.) of Sæterbekken, near Oslo (Lillehammer unpubl.). According to Hynes (1961) *A. sulcicollis* is abundant where the stones are covered by vegetation and especially in the outlet stream the stones were covered by algae and aquatic mosses. On hatching the nymphs were about 0.7 mm long, while the fully grown nymphs had a body length of 5–7 mm.

I. obscura and *I. grammatica* are omnivorous (Brinck 1949). They probably have a one year life cycle, but there seems to be evidence that they may sometimes take two years. *I. grammatica* emerged during July, while *I. obscura* emerged at the end of July and during the whole of August. On hatching the nymphs of both species are 0.8–0.9 mm long and when fully grown are between 8.5 and 12 mm long.

T. nebulosa, a detritivore in Heimdalen, emerged during April and May while the lake and streams were still ice covered, but when the outlet was open (Brittain 1977). In Øvre Heimdalen this species seemed to prefer stones covered by aquatic mosses. Growth mainly occurred in August, September and October. *T. nebulosa* was the only numerous early spring emerging species in the outlet fauna and extensive bird predation took place (Lien pers. comm.).

The ephemeropteran dominating both in the outlet and inlet stream, *Baëtis rhodani,* has a one year life cycle in Lappland (Ulfstrand 1968b). Brittain (1978) also states that the species has a one year life cycle in Øvre Heimdal, emerging in late June and the first half of July. Growth takes place throughout the winter and spring. The other common species in the inlet stream, *Baëtis lapponicus* is a typical "summer" species, growing rapidly during June and July.

The ephemeropteran fauna of the inlet stream and the outlet was dominated by one species of the family Baëtidae, *B. rhodani* while in the outlet stream one species from the family Siphlonuridae, *Ameletus inopinatus* was dominant (Tab. 7).

A. inopinatus is univoltine in Heimdalen (Brittain 1978). It has its growth during winter (Larsen 1968, Ulfstrand 1968a, Brittain 1978). The main emergence took place in late June and early July.

The trichopteran fauna of the inlet stream was dominated by one carnivorous species *Rhyacophila nubila,* but *Plectrocnemia conspersa* and *Limnophilus* spp. were also common. The outlet and outlet stream was dominated by the net-spinning *Polycentropus flavomaculatus* (Tab. 7). The larvae of *R. nubila* are carnivorous. The life cycle is uncertain, but Ulfstrand (1968a) found the population very heterogeneous in Lappland, Sweden and considered it had a two year cycle. However, studies made by Fjellheim (1976) and Karlström (1976) indicates that *R. nubila* has a one year life cycle both in western Norway and in northern Sweden. In Øvre Heimdalen *R. nubila* emerged from a heterogeneous larval population from late July to the middle of September.

P. flavomaculatus filters the water for organic particles, insect larvae and other invertebrates. Ulfstrand (1968b) found that *P. flavomaculatus* mainly had a two year life cycle in Lappland, Sweden. Its main growth in Øvre Heimdalen appeared to be during June and July with emergence in late July and during August.

Both the inlet and outlet simuliid fauna was dominated by *Eusimulium vernum* (Macquart) while *Simulium orantum* Meigen, *S. tuberosum* (Lundstrøm) and *S. nitidifrons* Edwards were also numerous in the inlet. *E. vernum* is one of the most common species in Norwegian streams and rivers. It may have two generations per year (Raastad 1974).

Conclusions

The lotic communities in Øvre Heimdalen were dominated by insects. The same situation seems generally true of streams in northern Scandinavia (cf. Lillehammer 1966, Ulfstrand 1968b).

The considerable differences in distribution among the aquatic insects in relation to the vegetation belts clearly seems to be linked to food availability (Lillehammer 1974). Above the *Salix* vegetation only a few species from each taxon occurred. When *Salix* vegetation occurred along the streams, a larger number of species in different genera were present. Differences in temperatures as well as substratum also certainly influence the distribution of Plecoptera. Studies in Sæterbekken (Lillehammer 1974) indicated that the amount of food available, at least locally, is more important for the occurrence of Plecoptera than substratum. In the Ephemeroptera temperature may be equally important in determining species distribution at different altitudes (Brittain 1974).

Differences exist in the presence of detritivores and filter feeders between the inlet and outlet. The fauna of the inlet streams consisted to a greater extent of detritivores, while the outlet fauna was dominated by filter feeders. The outlet stream, 900 m below the outlet, had a faunal composition between that of the inlet stream and the outlet.

The dominance of filter feeders in outlets has been discussed by several authors, such as Knöpp (1952), Müller (1954) and Illies (1956). However, the dominance of faunal elements varied. Knöpp (1952) and Illies (1956) described outflows dominated by simuliids, while Müller (1954) shows that outflow from a north

Swedish lake was dominated by net spinning Trichoptera. This might arise from differences in the cover of aquatic vegetation, which according to Carlsson (1967) has a negative effect on simuliids. The amount of small particles in the outflow water also seems to be a regulating factor for the abundance of simuliids (Carlsson et al. 1977).

In the lake outflow in north Sweden described by Müller (1954) *Neureclipsis bimaculata* occurred in slow flowing water in the outflow area of the lake to be replaced by *Hydropsyche* sp. when the current increased. When the current decreased *Neureclipsis* occurred again. In Heimdalen none of these species were present, and *P. flavomaculatus* occupied all three habitats. In addition, *P. flavomaculatus* was also a dominant species in the exposed zone of the lake (Lillehammer 1978).

Differences between the inlet and outlet can also be seen in species composition, growth period and emergence. The plecopteran fauna in the inlet stream consisted to a large extent of winter growing and early emerging species such as *C. atra* and *C. bifrons,* while the outlet was dominated by summer and autumn growing species such as *A. sulcicollis* and *T. nebulosa.* The reason for this might be that the main food source in the inlet streams is leaves from trees and bushes which fall into the streams during the autumn providing the basis for winter production. The dominant trichopteran in the outlet, *P. flavomaculatus,* also had its main growth during the summer, and a late emergence. *P. flavomaculatus* and the bivalve, *Pisidium* spp., are both filter feeders and therefore depend to a greater extent upon what is produced in the lake during the summer.

Naturally there are exceptions. Examples are the mayflies *A. inopinatus* and *B. lapponicus.* The former, common in the outlet stream, has its main growth while the lake and streams are ice covered, while *B. lapponicus* in the main inlet stream is a typical "summer' species.

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References

Brinck, P. 1949. Studies on Swedish stoneflies (Plecoptera). – Opusc. ent. Suppl. 11: 1–250.

Brittain, J. E. 1974. Studies on the lentic Ephemeroptera and Plecoptera of Southern Norway. – Norsk ent. Tidsskr. 21: 135–154.

– 1977. The effect of temperature on the egg incubation period of *Taeniopteryx nebulosa* (Plecoptera). – Oikos 29: 302–305.

– 1978. The Ephemeroptera of Øvre Heimdalsvatn. – Holarct. Ecol. 1: 239–254.

Carlsson, G. 1967. Environmental factors influencing blackfly populations. – Bull. Wld Hlth Org. 37: 139–150.

Carlsson, M., Nilsson, L. M., Svensson, Bj., Ulfstrand, S. and Wotton, R. S. 1977. Lacustrine seston and other factors influencing the blackflies (Diptera: Simuliidae) inhabiting lake outlets in Swedish Lapland. – Oikos 29: 229–238.

Cummins, K. W. 1974. Structure and function of stream ecosystems. – Bioscience 24: 631–641.

Dendy, J. S. 1944. The fate of animals in stream drift when carried into lakes. – Ecol. Monogr. 14: 344–357.

Fjellheim, A. 1976. Livssyklus, produksjon og drift hos *Rhyacophila nubila* (Zett.) (Trichoptera) i Oselven, Hordaland. – Unpubl. thesis, Univ. Bergen.

Frost, S., Huni, A. and Kershaw, W. E. 1971. Evaluation of a kicking technique for sampling stream bottom fauna. – Can. J. Zool. 49: 167–173.

Hynes, H. B. N. 1941. The taxonomy and ecology of the nymphs of British Plecoptera with notes on adults and eggs. – Trans. R. ent. Soc. Lond. 91: 459–557.

– 1961. The invertebrate fauna of a Welsh mountain stream. – Arch. Hydrobiol. 57: 344–488.

Illies, J. 1956. Seeausfluss-Biozönosen Lappländischer Waldbäcke. – Ent. Tidskr. 77: 138–153.

Karlström, U. 1976. Notes on the life cycle of *Rhyacophila nubila* Zett. (Trichoptera) in a North Swedish river. – Ent. Tidskr. 97: 39–42.

Kershaw, W. E., Williams, T. R., Frost, S., Matchett, R. E., Mills, M. L. and Johnson, R. D. 1968. The selective control by *Simulium* larvae by particulate insecticides and its significance in river management. – Trans. R. Eoc. trop. Med. Hyg. 62: 35–40.

Knöpp, H. 1952. Studien zur Statik und zur Dynamik der Biozönosen eines Teichausflusses. – Arch. Hydrobiol. 46: 15–102.

Larsen, R. 1968. The life cycle of Ephemeroptera in the lower part of Aurland River in Sogn and Fjordane, West Norway. – Norsk ent. Tidsskr. 15: 17–59.

Larsson, P. and Tangen, K. 1975. The input and significance of particulate terrestrial organic carbon in a subalpine fresh water ecosystem. – In: Wielgolaski, F. E. (ed.), Fennoscandian tundra ecosystems. Part 1. Ecol. Stud. 16. Springer, Berlin. pp. 351–359.

Lien, L. 1978. The energy budget of the brown trout population of Øvre Heimdalsvatn. – Holarct. Ecol. 1: 279–300.

Lillehammer, A. 1966. Bottom fauna investigation in a Norwegian river. The influence of ecological factors. – Nytt Mag. Zool. 13: 10–29.

– 1974. Norwegian stoneflies, II. Distribution and relationship to the environment. – Norsk ent. Tidsskr. 21: 195–250.

– 1975. Norwegian stoneflies, III. Field studies of factors important to the distribution. – Norw. J. Ent. 22: 71–80.

– 1976. Norwegian stoneflies, V. Variations in morphological characters compared to differences in ecological factors. – Norw. J. Ent. 23: 161–172.

– 1978. The Trichoptera of Øvre Heimdalsvatn. – Holarct. Ecol. 1: 255–260.

Müller, K. 1954. Faunistisch-ökologische Untersuchungen in nordswedische Waldbäche. – Rep. Inst. Freshwat. Res. Drottningholm 36: 148–162.

Raastad, J. 1974. Systematikk og populasjonsøkologi hos fennoskandiske knottarter (Diptera, Simuliidae). – Unpubl. thesis Univ. Oslo.

Ulfstrand, S. 1968a. Life cycles of benthic insects in Lapland streams (Ephemeroptera, Plecoptera, Trichoptera, Diptera Simuliidae). – Oikos 19: 167–190.

– 1968b. Benthic animal communities in Lapland streams. A field study with particular reference to Ephemeroptera, Plecoptera, Trichoptera and Diptera Simuliidae. – Oikos Suppl. 10: 1–120.