Relative abundance and flight periods of Ephemeroptera, Plecoptera, and Trichoptera in a regulated West Norwegian river

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In a West Norwegian river, where minimum discharge is considerably reduced due to hydroelectric exploitation, the lotic fauna did not show aberrant features. The number of species of Ephemeroptera was 8, of Plecoptera 15, and of Trichoptera 19. The most abundant species of the respective groups were *Baetis rhodani* (Pict.), *Capnia pygmaea* (Zett.), and *Potamophylax cingulatus* (Steph.). Emergence of stoneflies, mayflies, and caddisflies started in April, May, and June, respectively, and from November onwards no imagines were found.

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The fauna of rivers subjected to hydroelectric exploitation has been shown to diverge enormously from similar rivers not affected by exploitation (Ulfstrand et al. 1971). One general feature of many regulated rivers is the heavy fluctuations of discharge. Thus, rivers which for periods may be almost dry suddenly transport large water volumes. The purpose of the present study was to investigate the species composition of some common amphibiotic insect orders (Ephemeroptera, Plecoptera, and Trichoptera) in the 'moderately' disturbed river Ekso. The term 'moderately' here means that maximum discharge equalled, while minimum was only about 1/10 of the discharge present before the regulation, which took place in 1971.

Study area

The river Ekso runs into the sea about 100 km NE of Bergen. The river runs in an east-west direction and is about 42 km long. The altitude at the river's easterly part is about 780 m a.s.l. The present study was performed about 4 km downstream at an impounding reservoir with an altitude of 580 m a.s.l. Here at Ekse (60°15'N, 6°15'E) the width of the river is about 40 m, and the discharge usually ranged between 0.5 and 15 m^3/s (Fig. 1). Apart from mosses, no aquatic macrophyte vegetation was present at the study area. The water temperature is given in Fig. 2, and it can be seen that ice covered the river from November to the middle of April. The study area was situated within the sub-alpine birch woodland belt.

Methods

Relative abundance of the different species of Ephemeroptera and Plecoptera is based on data obtained with bottom and drift samples and from emergence traps, collected from December 1975 through November 1976. The bottom samples were taken by a suction device driven by a vacuum pump. Each month 50 samples spaced out over a distance of about 0.5 km were taken. Each sample covered a surface of 283 cm^2. Drift samples (mesh size 250 μ) were taken at fortnightly intervals throughout the year. Presence of eggs was looked for by direct observation in the field. Nine emergence traps (1 × 0.6 m, height 0.6 m) were placed along the banks. They were usually inspected at fortnightly intervals. Flight periods were also checked by direct observations at regular visits to the study area.

Because of the meagre larval material, flight periods and relative abundance of Trichoptera are mainly based on light trap material. A Robinson trap fitted with a mercury vapour bulb (Philips HP 125 W) was placed about 20 m from

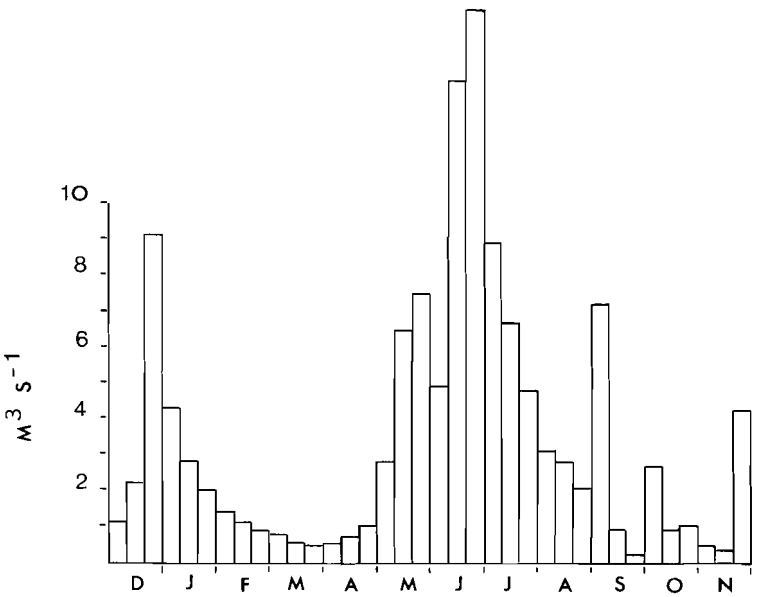


Fig. 1. Average water flow at Ekso in terms of m^3/s per 10-day period from December 1975 through November 1976.

the bank. The trap was run from May to the middle of October and emptied every fifth to fifteenth day.

Ephemeroptera

Of the 44 Ephemeroptera species found in Norway (Brekke 1938, Dalby 1973), eight were collected in the present study, Table I. Only *Ameletus inopinatus* Eat., *Siphlonurus aestivalis* Eat., and *Baetis rhodani* (Pict.) have previously been reported from western Norway (Brittain 1974, Larsen 1968). *B. rhodani* was by far the most dominant species making up more than 90 % of the total Ephemeroptera material; the density of nymphs usually ranged between 100–2000 individuals m^{-2}. Since *Baetis niger* (L.) is known to inhabit slow flowing rivers rich in macrophyte vegetation (Müller-Libenau 1969), the presence of this species was notable.

All species were found in numbers large enough to draw conclusions as to their flight periods (Table I), and egg and nymphal periods could also be distinguished for most species. The first mayfly to emerge during spring was *B. rhodani*, the last one found as imago was *Baetis lapponicus* (Bengts.).

In Ephemeroptera, winter quiescence has been reported as a common phenomenon (Brittain 1974, Macan 1971). In relation to the quiescence period the growth curves of many stream-living insects often show two different basic patterns. Thus Ulfstrand (1968) distin-

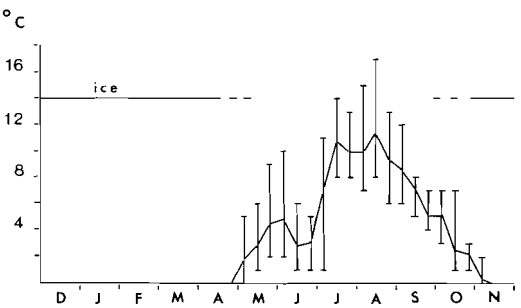
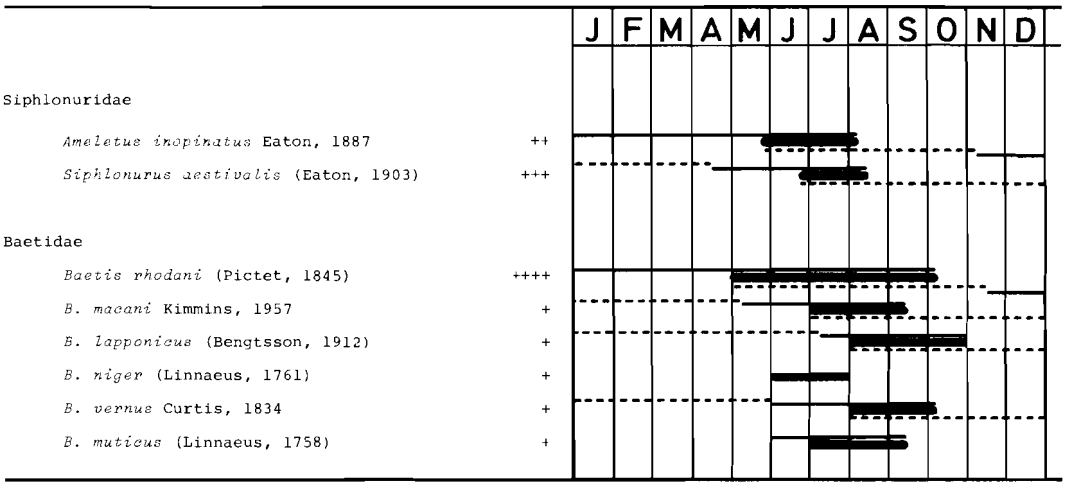


Fig. 2. Maximun, minimum and mean water temperature per 10-day period at Ekso from December 1975 through November 1976. Mean temperature is given as arithmetic mean of maximum and minimum values for each day.

Table I. Relative abundance (+, ++, +++, ++++), flight periods (▬▬), presence of nymphs (———) and eggs (- - - - - - -) of ephemeropteran species at the study area in the Ekso river.



guished between (I) considerable growth commencing shortly after oviposition leading to the presence of more or less large sized nymphs during a long period, and (II) intense growth concentrated to a period preceding emergence.

A winter quiescence was observed also among the mayflies in Ekso. Both *A. inopinatus* and *B. rhodani* were representatives of category no. I of Ulfstrand, while *S. aestivalis, Baetis macani* Kim., *B. lapponicus*, and *B. vernus* Curt. all belonged to category no. II. *Baetis muticus* (L.) seemed to fit category no. II, but low numbers made conclusions dubious.

Plecoptera

Of the 35 Plecoptera species found in Norway (Lillehammer 1974), 15 were collected in this study (Table II). In addition, Steinar Haaland (unpubl.) has collected *Siphonoperla burmeisteri* (Pictet, 1841) about 25 km further downstream. According to Lillehammer (1974), all the species except *Leuctra fusca* (L.) belong to the category 'present in all parts of Norway'. Only two other Plecoptera species, *Isoperla obscura* (Zetterstedt, 1840) and *Dinocras cephalotes* (Curtis, 1827), have been taken in south west Norway (Lillehammer 1974). *Capnia pygmaea* (Zett.) was the most common stonefly species, the nymphal density usually ranging between 100–2500 individuals m^{-2}.

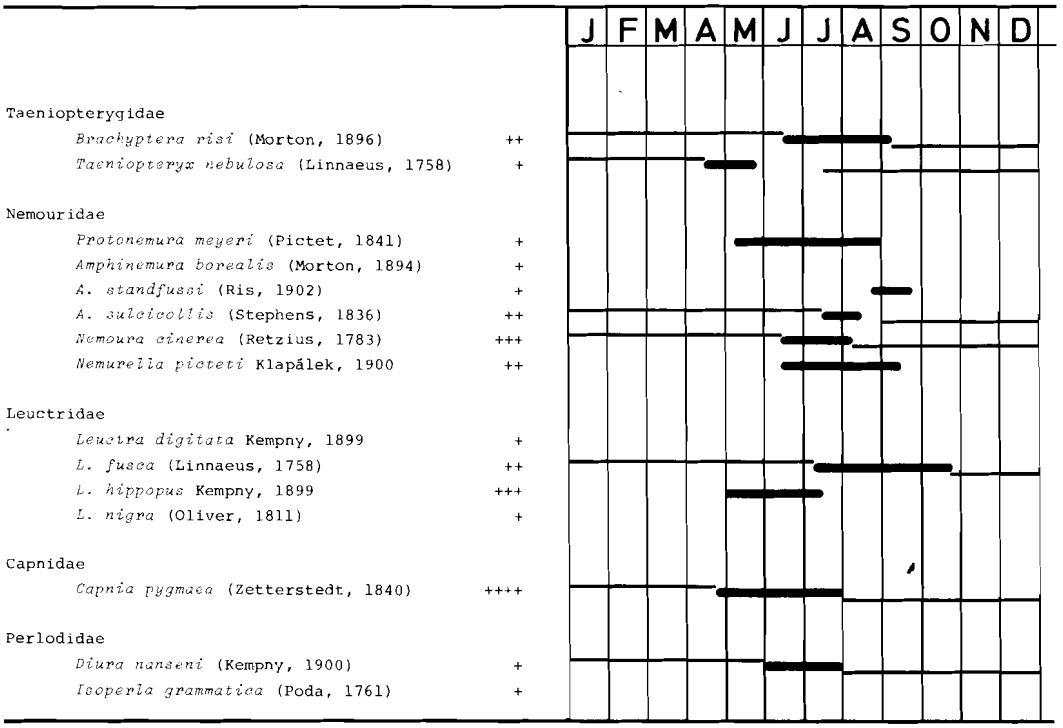
Most species obtained in numbers large enough to draw conclusions as to their flight periods were found as imagines during June and July, Table II. Two species, viz. *Taeniopteryx nebulosa* (L.) and *C. pygmaea,* emerged in April, while *Amphinemura standfussi* (Ris) and *L. fusca* were the only species present as imagines from the middle of September onwards.

Among Plecoptera, winter quiescence, as also observed at Ekso (unpubl.), has been reported in many species (Brinck 1949, Svensson 1966, Ulfstrand 1968). In the present study growth pattern no. I (see Ephemeroptera) was represented by *T. nebulosa* and *Diura nanseni* Kemp., while *Amphinemura standfussi, A. sulcicollis* (Steph.), *Leuctra fusca* and *L. hippopus* (Kemp.) all belonged to category no. II. The growth pattern of the remaining species was either not easily classified or the nymphal material was insufficient for conclusions.

Trichoptera

The information concerning relative abundance and flight periods of Trichoptera, Table III, was primarily based on the light-trap material. A total of 1890 specimens belonging to 25 species were caught in this trap. The Limnephilidae was the dominating family, comprising 77.8 % of the material. Four other families with altogether five

Table II. Relative abundance, flight periods and presence of nymphs of plecopteran species at the study area in the Ekso river. Legends as in Table I.



species were represented. The three dominant species were *Potamophylax cingulatus* (Steph.) (30.7%), *Rhyacophila nubila* (Zett.) (11.4%), and *Rhadicoleptus alpestris* (Kol.) (11.2%). Additional material from the emergence traps yielded 105 specimens belonging to eight species. Limnephilidae comprised 85.7% of this material, the three dominating species being *P. cingulatus* (42.9%), *Halesus radiatus* (Curt.) (19.0%), and *Limnephilus extricatus* McL. (11.4%). The larval density of *P. cingulatus* usually ranged between 0–5 individuals m^{-2}.

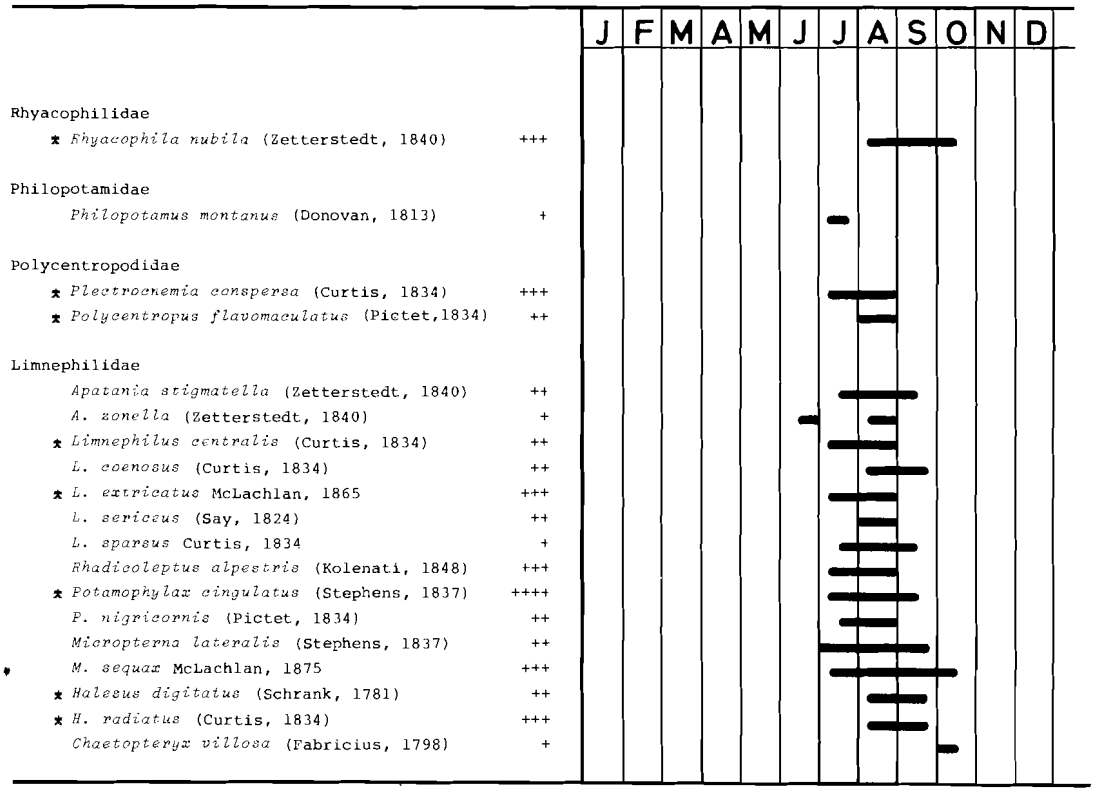
Many caddis flies, especially among the limnephilids, are good flyers. This can make it difficult to decide if a species collected as imago near a special biotope really originates there. In the light-trap material from Ekso, six species, *Limnephilus borealis* (Zetterstedt, 1840), *L. elegans* Curtis, 1834, *L. pantodapus* McLachlan, 1875, *L. rhombicus* (Linnaeus, 1758), *L. stigma* Curtis, 1834, and *Agrypnia obsoleta* (Hagen, 1864) all have larvae which are known to prefer lentic waters, and they are therefore excluded from the table. Of the 172 Trichoptera species so far recorded in Norway (Andersen 1975, Svensson & Tjeder 1975), only 19 species can thus be supposed to inhabit Ekso.

Except for *Limnephilus sericeus* (Say), *Potamophylax nigricornis* (Pict.), and *Haleus digitatus* (Schrk.), all the species listed are common and widespread in western Norway. In Hordaland *H. digitatus* can be found near small brooks especially in the inner part of the province. *L. sericeus* and *P. nigricornis* seem to be rather common in the lower mountain regions in the inner parts of Hordaland, the record of *L. sericeus* being so far the westernmost.

At Ekso, Trichoptera began to fly regularly in the second half of July; one female of *Apatania zonella* (Zett.) was already caught in the last part of June. The light-trap catches were greatest during August, and some species were still flying until the beginning of October. The late and relatively short flight period of *R. nubila* should be noted.

In the Bergen region, this species is one of the

Table III. Relative abundance and flight periods of trichopteran species at the study area in the Ekso river. Legends as in Table I. Species marked with asterix were taken in the emergence traps.



earliest encountered, starting to fly in the middle of May and continuing until November. The species were found in the emergence traps during the same period as they were caught in the light trap; only *L. extricatus* appeared a few days earlier in the emergence traps than in the light trap.

The sex ratio in the light-trap catches was rather uneven, the females constituting only 13.1 % of the total material. Of *R. alpestris* 211 males but no females were caught. More surprising is that the sex ratio also in the emergence traps was rather uneven. The proportion of females here was 27.6 %. *P. cingulatus* showed 24.4 % females (n = 45), *H. radiatus* 25 % (n = 20), and *L. extricatus* 33.3 % females (n = 12). Uneven sex ratio of Limnephilidae species at emergence has previously been reported by Tobias (1967) and by Tobias & Tobias (1971).

Conclusion

Judging from experience and previous surveys, the number of Ephemeroptera species was higher than expected, in Plecoptera the number agreed, and in Trichoptera the number was below the number expected. Thus, our general conclusion is that the moderate disturbance of this river in terms of reduced minimum discharge does not adversely affect the number of species. It should be pointed out that not even in periods of minimum discharge did real lentic conditions evolve at the study area. A small discharge (0.1–0.2 m^3/s) apparently was enough to sustain a considerable number of specimens of the lotic fauna. However, only a couple of years have passed since the regulation took place, and long-term effects can possibly occur in the future.

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References

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

Brekke, R. 1938. The Norwegian mayflies (Ephemeroptera). *Norsk ent. Tidsskr. 5,* 55–73.

Brinck, P. 1949. Studies on Swedish stoneflies (Plecoptera). *Opusc. Ent. Suppl. 11,* 250 pp.

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

Dahlby, R. 1973. A check-list and synonyms of Norwegian species of Ephemeroptera. *Norsk ent. Tidsskr. 20,* 249–252.

Larsen, R. 1968. The life cycle of Ephemeroptera in the lower part of Aurland river in Sogn and Fjordane, western Norway. *Norsk ent. Tidsskr. 15,* 49–59.

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

Macan, T. T. 1961. A key to the nymphs of British species of Ephemeroptera. *Freshwater Biol. Assoc. Scient. Publ. 20,* 68 pp.

Müller-Liebenau, I. 1969. Revision der europäischen Arten der Gattung *Baetis* Leach, 1815 (Insecta, Ephemeroptera). *Gewässer und Abwässer 48/49,* 214 pp.

Svensson, B. W. & Tjeder, B. 1975. Check-list of the Trichoptera of north-western Europe. *Ent. scand. 6,* 261–274.

Svensson, P. O. 1966. Growth of nymphs of stream living stoneflies in northern Sweden. *Oikos 17,* 197–206.

Tobias, W. 1967. Zur schlüpfrhytmik von Köcherfliegen (Trichoptera). *Oikos 18,* 55–75.

Tobias, W. & Tobias, D. 1971. Köcherfliegen und Steinfliegen einiger Gewässer in Sør Varanger (Nord-Norwegen) (Trichoptera, Plecoptera). *Senckenbergiana biol. 52,* 227–245.

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

Ulfstrand, S., Svensson, B., Enckell, P. H., Hagerman, L. & Otto, C. 1971. Benthic insect communities of streams in Stora Sjöfallet National Park, Swedish Lapland. *Ent. scand. 2,* 309–336.

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