

The effect of temperature on intraspecific variation in egg biology and nymphal size in the stonefly *Capnia atra* (Plecoptera)

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ABSTRACT

Adults of the univoltine stonefly, *Capnia atra* Morton, were collected from a lowland river at the margin of the species' Scandinavian distribution, a subalpine lake in the mountains of southern Norway and an alpine lake in the coastal area of northern Norway. Eggs were incubated in the laboratory under constant water temperatures at 4° C intervals from 4° to 28° C. For the three populations, there was a common relationship, linear on logarithmic scales, between egg incubation period (Y days) and water temperature (T° C) in the range 4-24° C, expressed by the regression equation: $Y = 185 T^{-0.93}$ ($r^2 = 0.902$, $P < 0.0001$). No hatching occurred at 28° C. No diapause was observed.

Egg volume, and subsequent first instar size, differed significantly between populations; those from the more central populations having larger eggs and first instar nymphs than the marginal lowland population. However, all populations retained most of the same degree of variation, but in different proportions. Egg incubation temperature also had a significant, non-linear, effect on first instar size; the largest nymphs hatched from eggs reared at 8° C and the smallest at 20° and 24° C.

The implications of the results for life cycle regulation in this species, which is univoltine throughout its range, are discussed. The results indicate that certain predications of the thermal equilibrium hypothesis with regard to optimal temperature regimes (Sweeney & Vannote 1978) are already apparent in the egg stage of *Capnia atra*. Non-optimal temperatures may induce a shift in the allocation of energy between growth and tissue development, resulting in smaller eggs.

The full paper is published in the *Journal of Animal Ecology* (1984, 53 : 161-169).

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Biogeography and associations of winter stoneflies in southern Québec (Plecoptera)

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ABSTRACT

Twenty-four species of winter stonefly (8 Taeniopterygidae and 16 Capniidae) inhabit southern Québec. An analysis of their geographical distributions indicates four faunal elements: 6 ubiquitous species occurring over most of the northeastern part of the continent, 4 boreal species, 4 Appalachian species, and 10 species originating from the Mississippi Valley. Except perhaps for *Capnia vernalis* and *C. manitoba*, most seem to have survived the glaciations in eastern refugia and have migrated back into Québec along the slopes of the Appalachians. Characteristic species associations can be recognized. In small slow and eutrophic streams of the upper St. Lawrence Valley and the lower Ottawa Valley, *Allocaupnia granulata* and *A. vivipara* predominate; in the small spring-fed streams of the same area, small populations of *A. recta* can develop. In highland water courses, a clear zonation is established: headwater streams usually harbour no species; in small streams, capniids, particularly *A. illinoensis*, *Paracapnia angulata* and the ubiquitous *A. pygmaea*, dominate; in larger streams, more capniids are added, such as *A. minima*, *A. pechumani*, and *P. opis*, together with the taeniopterygid *T. burksi*; in rivers taeniopterygids abound (*T. nivalis*, *T. parvula*, and *Oemopteryx glacialis*), while the capniids become rarer, except *A. minima* and *A. pygmaea*. In large lowland rivers, only *A. minima* and *O. glacialis* still survive. On the North Shore of the St. Lawrence, boreal elements, such as *C. vernalis*, *Utacapnia labradora* and *Taenionema atlanticum*, are added or substituted in mid-sized streams, while in the Eastern Townships, this is true of the Appalachian species *A. maria*, *A. rickeri* and *T. maura*.

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Sensilla on the antennae of the stonefly nymph, *Paragnetina media* (Walker) (Plecoptera)

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ABSTRACT

Several reviews on the insect sensilla have shown a complete lack of information on the antennal sense organs of stoneflies (Slifer 1970; Mc Iver 1975; Altner & Prillinger 1980; Zacharuk 1980; Rupprecht (1969) and Slifer (1979) have provided some information on the sensilla of *Allopcapnia recta* and *Perla marginata* respectively.

Light and electron microscopic examination the antennae of the *Paragnetina media* nymph revealed a variety of sensilla. Tactile hairs of varying sizes are distributed on all parts of the antenna. Chemoreceptor pegs of different forms (uniporous, thick- and thin-walled) are concentrated on the pedicel and the middle segments of the flagellum. Coeloconic chemoreceptors are minute pegs set in a small cavity in the antennal cuticle. They are present on the middle and distal segments of the flagellum. The campaniform sense organs are mainly located on the pedicel. Methylene blue injections showed that each chemosensillum and campaniform sensillum in innervated by a single bipolar neuron. Conical structures, consisting of 13-20 hair sensilla, project perpendicularly from the distal end of each segment of the flagellum. There is no prior description of these hairs forming conical structure, but their ultrastructure is much like that of taste hairs of blowfly.

A careful ultrastructure study will establish the morphological basis necessary for our future physiological and behavioural experiments, which in turn will provide a better understanding of the roles played by antennal sense organs in the behaviour of nymphs in the stream. A detailed account of these sensilla will be published elsewhere.

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Egg development, nymphal growth and distribution of Fennoscandian stoneflies (Plecoptera)

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ABSTRACT

Several stonefly species have a marked distribution in Fennoscandia and in genera containing several species there are often clear differences in distribution. Studies of the life cycle of single species have therefore been carried out in order to explain some of the differences seen in distribution. So far we have studied egg development in 25 species and nymphal growth in 21 species of the Fennoscandian stonefly fauna, which totals 40 species. We have already published several papers and a number are in preparation.

Beside *C. bifrons* which is ovoviviparous, the studies show that two main groups of egg incubation period are apparent: winter eggs with a long incubation period and whose development appears to be independent of temperature, and summer eggs whose development in nearly all species is greatly influenced by temperature. However, there are also some intermediates such as the eggs of *Leuctra fusca* and *Leuctra digitata*, which hatch over a long time period on account of low winter temperatures.

Nymphal growth can be similarly categorized. There are species with winter growth which are little influenced by temperature, such as *Capnia atra* and summer growing species which are greatly influenced by temperature, such as *N. arctica*. Again intermediate types exist.

A number of species are confined to a one year life cycle, and some of these tackle different environmental conditions by establishing local populations with different growth rate characteristics such as *Leuctra hippopus*. Other species have the ability to switch between one and two-year life cycles.

Distributional trends in the Fennoscandian stonefly fauna compared to type of life cycle indicate distributions dependent on the species' ability to evolve a special life cycle strategy, such as seen in the genus *Nemoura* in Fennoscandia.

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The Plecoptera of the river Fulda : faunistics, longitudinal zonation and changes during the last 30 years

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ABSTRACT

A census of Plecoptera was made at 21 stations along the entire length (220 km) of the river Fulda (Germany) from April to October 1981.

More than 6 500 specimen of 39 species have been collected. Results are compared to those obtained by Illies (1953) and Zwick (1969). All investigators have recorded more or less the same total number of species. Comparison of distribution and abundance of individual species reveals, however, that some species have obviously undergone changes during the last three decades. Species like *Brachyptera monilicornis* (Pictet, 1841), *Taeniopteryx schoenemundi* (Merens, 1923), *Perla burmeisteriana* Claassen, 1936, *Perla marginata* (Panzer, 1799), which have once been dominant in the hyporhithron of the Fulda, have today disappeared.

Distribution of species suggest distinction of three zones only : epirhithron, combined meta- and hyporhithron, and the potamon. The distinction of meta- and hyporhithron as proposed by Illies cannot be confirmed now.

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Contribution to the knowledge of the Plecoptera of Galicia (NW Iberian Peninsula)

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ABSTRACT

We have recently initiated a study of the stoneflies of Galicia as a contribution to the taxonomical, biological and ecological knowledge of these insects in the Iberian Peninsula, an area with a high endemic fauna.

The area shows a clear predominance of acid waters. We have chosen 34 localities situated at different altitudes below 1 500 m. In all of them we sampled by catching individuals in different stages of development and evaluating at the same time a number of physico-chemical parameters which play an important role in the distribution of these organisms. The taxonomical and biological aspects have been studied in collaboration with Dr. Berthélemy.

The most interesting results obtained so far can be summarized as follow :

— The discovery of the first instars of *Capnionemura libera* Navás, *Leuctra maroccana* Aubert and *Protonemura globosa* Berthélemy & Terra.

— The recording of the mating call of *Perla madritensis* Rambur.

— The determination of the distribution and the flight period of 22 species in the basin of the river Tambre, an area of low altitude with an oceanic climate, and the analysis of the ecological preferences of the larvae of the stoneflies from the river Tambre in relation to the main factors of distribution (Membiela P. & Martínez-Ansemil E., in press).

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