

# First Danish record of *Ptilocolepus granulatus* (Pictet) (Trichoptera, Hydroptilidae)

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The Central European mountain trichopteran, *Ptilocolepus granulatus* (Pictet), is recorded for the first time in Denmark. Surprisingly, the locality is a small rather undisturbed lowland stream, located in moorland in Central Jutland. Larval instars III-V are illustrated. They bear close resemblance to the larval instars of *Palaeagapetus ovatus* Ito & Hatt., another member of the subfamily Ptilocolepinae (Hydroptilidae). Both species undergo hypermetamorphosis, which is also characteristic of the sister group, the Hydroptilinae. The biology and geographical distribution of *P. granulatus* is briefly discussed.

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## Introduction

Danish Trichoptera are rather well known and their distribution, along with that of many other aquatic invertebrates, has during the last decade been clarified by surveys in Danish lotic and lentic waters. According to the latest checklist of NW European Trichoptera (Andersen & Wiberg-Larsen, 1987) only a few as yet unrecorded species can be expected to exist in Denmark and they are most likely to be lowland species inhabiting ponds and lakes. Consequently it was with great surprise that we discovered a new Danish Trichoptera species, *Ptilocolepus granulatus* (Pictet, 1834), which is reputed to be a typical mountain species (e.g. Marshall, 1979), in a Danish lowland stream.

## Description of the locality

The Danish locality in which *P. granulatus* was found is a small first order stream, Skærbæk, located in moorland near Silke-

borg in Central Jutland. The stream is a tributary of the River Salten, which belongs to the River Gudenå system. In contrast to most Danish streams and rivers, which have been channelized, Skærbæk has almost retained its natural shape and meanders through a landscape of sandy hills covered by grasses, heather, crowberry and scattered junipers. *P. granulatus* was found during a study of a 220 m long unshaded section of Skærbæk in 1987. The stream has been described by Iversen et al. (1990). Mean stream width varied between 4.5-5.1 m, mean depth between 0.10-0.15 m and annual mean discharge was 83 l s<sup>-1</sup>. Discharge varied rather little because the stream is mainly fed by ground water.

The stream section studied was dominated by sandy sediment although there were a few riffles with stones and coarse gravel. Macrophytes covered 60-70% of the stream bed throughout the year and overwintering biomass was considerable. The submerse

flora, which constituted about 80% of the average biomass, was dominated by *Myriophyllum alterniflorum* D.C. and *Scapania undulata* (L.) Dum., and the emergent flora by *Carex rostrata* Stokes.

The catchment area is mainly moorland but includes minor agricultural areas and spruce plantations. Consequently the stream water concentration of dissolved inorganic phosphorous was low ( $0\text{--}7 \mu\text{g P l}^{-1}$ ), whereas nitrate concentration was relatively high ( $0.2\text{--}3.6 \text{ mg N l}^{-1}$ ). Average pH was 6.44 and average alkalinity was  $0.12 \text{ mmol l}^{-1}$ . Water temperature in Skærbæk does not normally exceed  $20^\circ\text{C}$  and the mean summer temperature is about  $15^\circ\text{C}$  (Sode, 1983).

### Study of Skærbæk

*Ptilocolepus granulatus* was discovered in Skærbæk in 1987 during an extensive study of four small streams, the main object of which was the elucidation of factors regulating the biological structure of these streams. The study, undertaken by the Freshwater Biological Laboratory of University of Copenhagen and Division of Freshwater Ecology of the National Environmental Research Institute, has been described in detail elsewhere (Iversen et al., 1990).

The benthic invertebrate fauna was sampled on 11 occasions at approximately monthly intervals between January 1987 and March 1988. Stratified random sampling was performed with a transparent plexiglass core (cross sectional area:  $21 \text{ cm}^2$ ), which was pressed 5-10 cm into the sediment. Between 34 and 53 samples were collected on each occasion. After conservation, they were washed through a sieve (mesh size: 0.2 mm) and sorted without magnification. Most of the sampling area was covered by the liverwort *Scapania undulata*, the bottom substrate being coarse gravel, gravel or sand.

Larvae of *P. granulatus* were only found in 6 of the 510 core samples collected during the study. All samples containing *P. granulatus*

were from areas where the dominant macrophyte was *Scapania undulata* (ashfree dry weight (AFDW) of *S. undulata* in the six samples was 95-174 mg i.e. 45-83 g AFDW  $\text{m}^{-2}$  whereas that of other macrophyte species was only 1-19 g AFDW  $\text{m}^{-2}$ ).

A total of 40 larvae were found during the period August to December 1987. Instars could easily be separated according to head capsule width (mean  $\pm$  standard error): 0.27 mm in instar III (1 larva),  $0.37 \text{ mm} \pm 0.01$  mm in instar IV (8 larvae) and  $0.45 \pm 0.01$  mm in instar V (31 larvae). Whereas only about 50% of the larvae found in August were in instar V, all larvae found from September to December were in instar V.

### Morphology of larvae

It is widely accepted, that the genus *Ptilocolepus* belongs to the subfamily Ptilocolepinae of the family Hydroptilidae. An exception is the Atlas of European Trichoptera (Malicky, 1983b), which classifies *Ptilocolepus* among the Glossosomatidae. According to Marshall (1979), the Ptilocolepinae are the most primitive of the hydroptilids and include only two genera, *Ptilocolepus* and *Palaeagapetus*, both confined to the holarctic region.

Ito & Hattori (1986) have shown that *Palaeagapetus ovatus* Ito & Hatt. has 5 larval instars. Instars I-IV have a slender abdomen with one large dorsal sclerotized plate on each of abdominal segments 1-8 and do not construct a larval case. In contrast, instar V lacks sclerotized plates on abdominal segments 1-8 and constructs a purselike case. Instar V also undergoes hypermetamorphosis (abdominal swelling due to the accumulation of food reserves), a phenomenon characteristic of their sister group, the subfamily Hydroptilinae (which, together with the subfamily Ptilocolepinae, makes up til Hydroptilidae).

Previous descriptions of *Ptilocolepus granulatus* have only included final instar larvae (e.g. Thienemann, 1904; Jacquemart & Coineau, 1962). The present investigation revealed, that instars III and IV of *P. granulatus*

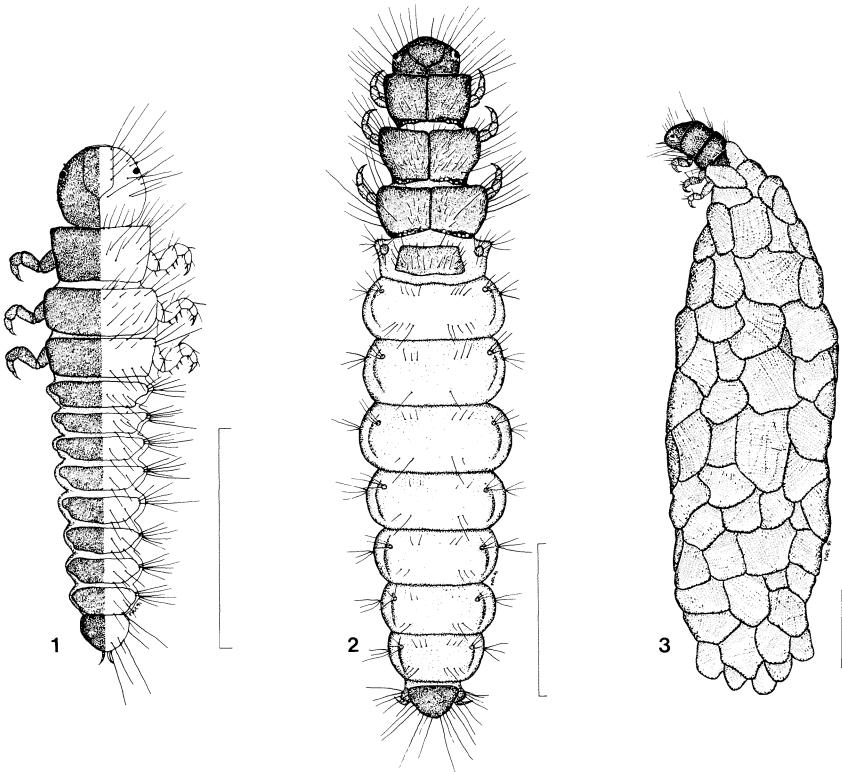


Fig. 1-3. Habitus of larva (dorsal view) and larval case (lateral view) of *Ptilocolepus granulatus*. 1: Instar IV, left half showing deepness of color and right half showing setae; 2: Instar V; 3: Case of instar V. Scales: 1 mm.

*tus* (like instars I-IV of *Palaeagapetus ovatus*) have a slender abdomen with one large sclerotized dorsal plate on each of abdominal segments 1-8 (Fig. 1). A similar abdominal sclerotization is found among instars II-IV of the Hydroptilinae (Wallace et al., 1990). In contrast instar V of *P. granulatus* only have one single dorsal sclerotized plate on abdominal segment 1 (Fig. 2), a feature that distinguish it from larvae of other Danish Trichoptera (including other Hydroptilids), which have abdominal segments 1-8 unsclerotized. Only instar V appear to construct cases. Case length varied between 6.5-7.5 mm in accordance with Thienemann (1904), who found a mean case length of 8 mm, which was shortened to 6-7 mm prior to pupation.

Adults of *P. granulatus* have not yet been found in Skærbæk. However, when found

they should be identified using Malicky (1983b), who provides good illustrations of male and female.

### Biology of larvae

In Skærbæk the *Ptilocolepus* larvae were closely associated with the liverwort *Scapania undulata*. They were only found in samples where *Scapania* was the dominant macrophyte and their purselike cases were made exclusively of *Scapania* leaf fragments (Fig. 3). Information on larval biology and habitat preference of *P. granulatus* is rather limited, although it is known to occur in the krenal and rithral zones (Caspers et al., 1977; Burkhardt, 1987), and in springs, springbrooks and small streams rich in macrophytes (Thienemann, 1904; Tobias & Tobias, 1981). The species thus seems to be restricted to the upper part of watercourses and

mainly occurs at altitudes of 100 to 1600 m a.s.l. (Decamps, 1967, 1968). According to Jacquemart & Coineau (1962), *P. granulatus* is closely associated with fast flowing waters which have a dense growth of *Fontinalis* or liverworts upon which the larvae can live and feed. Thienemann (1904) reported that the larvae were abundant in brooks among dense mats of *Fontinalis antipyretica* Hedw. and *Jungermannia riparia* Taylor, where they built cases by nibbling small pieces off the soft distal parts of *Fontinalis* leaves. According to Lauterborn (cited in Thienemann, 1904), pieces of *S. undulata* leaves can also be used as case building material, as was observed in the present study.

Thus, although mosses or liverworts are clearly preferred, *P. granulatus* larvae do not seem to depend on a single plant species as their source of food and case building material. In contrast, *Palaeagapetus ovatus* feeds exclusively on leaves of the liverwort *Chiloscyphus polyanthos* (L.) Corda, and is not even able to survive on a diet of other liverwort species (Ito & Hattori, 1986).

Although most reports describe the larvae as being truly aquatic, Lauterborn (cited in Thienemann, 1904) also found larvae on sprinkled moss cushions above the water level of brooks.

### Geographical distribution

The discovery of *P. granulatus* in Denmark was rather surprising because the most northerly localities so far reported are near Fulda, Germany, and southern Netherland/northwestern Belgium, both about 500 km south of Skærbæk. Furthermore, the species is usually considered to be restricted to mountain areas of Central and Southern Europe and the Caucasus (Fig. 4).

Thienemann (1950) regarded *P. granulatus* as one of several Trichoptera species, that he considered were associated with glacial fronts. They were thought to require low water temperatures and were supposed to have followed the moving glaciers in accordance with their temperature requirements.

Our knowledge on distribution of European Trichoptera has improved considerably since and according to Malicky (1983a), *P. granulatus* is now considered a typical representative of European mountain stream Trichoptera for which he suggested a new zoogeographical biome type, the dinodal (defined as "aqua turbulenta"). He also suggested that as mountain stream Trichoptera generally have a relatively low temperature requirement they were not forced, at least within certain temperature limits, to migrate over long distances in response to the cooler conditions prevailing during glaciation. Thus, they could have survived Pleistocene glaciations in hilly areas and do not necessarily need to have had refuges. Malicky postulated that present disjunctive distribution of *P. granulatus* reflects successive steps of regression and extension that probably occurred prior to the last of the Pleistocene glaciations.

If this is correct, and if the Danish population of *P. granulatus* is isolated from the Central European mountain populations, then the Danish population can be regarded as a

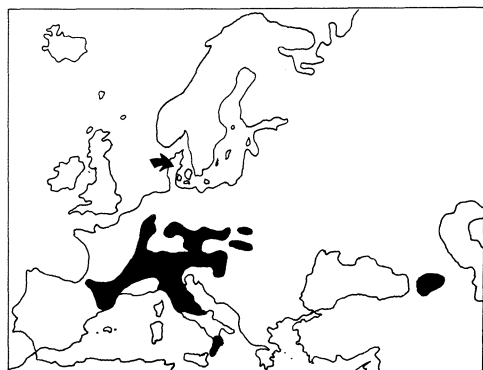


Fig. 4. Known geographical distribution of *Ptilocolepus granulatus*, based on data from Jacquemart & Coineau (1962), W. Tobias (1964), Malicky (1975, 1983a), Caspers et al. (1977), Novak & Obr (1977), Mey et al. (1979), Moretti & Cianficconi (1981), Stroot (1984), D. Tobias (1986), J. Majecki, Poland (in litt., 1988) and A. Uherkovich & S. U. Nogradi, Hungary (presentation at the 6th International Symposium on Trichoptera, Lodz-Zakopane, 1989). Arrow indicates Danish record at Skærbæk.

relict isolated by glaciation. This is supported by the fact that the only known Danish population of *P. granulatus* is located west of the glaciation area that covered eastern Denmark, including eastern Jutland, about 10 000 years ago. The question may never be answered however as *P. granulatus* is undoubtedly rare in presentday Denmark, unpolluted and relatively undisturbed small streams like Skærbæk being few and far apart and dense growths of *Fontinalis* and especially *Scapania undulata* being very rare.

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### Dansk sammendrag

I 1987 blev vårfluen *Ptilocolepus granulatus* (Pictet) fundet for første gang i Danmark. Fundet blev gjort i det lille, stærkt slyngede og næsten uregulerede vandløb Skærbæk. Vandløbet, der er beliggende i hedeklædte bakker ca. 4 km nord for Vrads, er et tilløb til Salten Å i Gudenå-systemet. Vandløbet er grundvandsfødt med en meget ensartet vandføring året rundt. Fundet blev gjort i tilknytning til en større undersøgelse af den biologiske struktur i 4 små vandløb, heriblandt Skærbæk. Undersøgelsen blev udført som et samarbejdsprojekt mellem Danmarks Miljøundersøgelser, Afd. for Ferskvandsøkologi og Københavns Universitet, Ferskvandsbiologisk Laboratorium.

Den undersøgte del af Skærbækken er en 220 m lang ubeskygget strækning med en gennemsnitsbredde på 4,5-5,1 m og en middeldybde på 0,10-0,15 m. Vandløbsbunden bestod overvejende af sand, men der forekom også enkelte stryg med sten og groft grus. Makrofyter, hovedsagelig *Myriophyllum alterniflorum* og levermosset *Scapania undulata*, dækkede 60-70% af vandløbsbun-

den. Oplandet til Skærbækken består hovedsagelig af udyrkede arealer. Vandløbsvandet er svagt surt (gns. pH 6,44), kalkfattigt (gns. alkalinitet 0,12 mmol<sup>-1</sup>) og fattigt på opløst uorganisk fosfor (0-7 µg P l<sup>-1</sup>). Den gennemsnitlige sommertemperatur i Skærbækken er ca. 15°C.

Der blev i alt fundet 40 larver af *P. granulatus* i perioden august-december 1987. Larverne fandtes i kun 6 ud af i alt 510 bundprøver. Prøverne med *P. granulatus* blev alle taget i områder med dominans af *S. undulata*.

Larverne kunne opdeles i stadium III-V på baggrund af hovedkapselbredden. I august var ca. halvdelen af larverne i stadium V, medens samtlige larver havde nået dette sidste stadium i september-december.

De undersøgte stadium III-IV larver havde alle slank bagkrop med én dorsal, sklerotiseret plade på hvert af abdominal segmenterne 1-8 (Fig. 1). Stadium V larver havde alene én dorsal sklerotiseret plade på abdominal segment 1 (Fig. 2). Larvehuse blev kun fundet hos stadium V larver. Husene var udformet som brilléfuteraler og sammensat af små stykker blade af *Scapania* (Fig. 3). *P. granulatus*, der tilhører Ptilocolepinae, en underfamilie af Hydroptilidae, udviser samme hypermetamorfose som medlemmerne af den anden underfamilie, Hydroptilinae (fx. slægterne *Agraylea*, *Hydroptila*, *Oxyethira*). Ved hypermetamorfosen gennemløbes stadium I-IV hurtigt uden væsentlig tilvækst, medens stadium V er det egentlige vækststadium, hvorunder larvens bagkrop svulmer kraftigt op i takt med, at der oplagres næringsstoffer i den.

Tilstedeværelsen af *P. granulatus* i Danmark er overraskende, idet arten hidtil kun er kendt fra små vandløb i Central- og Syd-europas bjergegne samt Kaukasus (Fig. 4). Det hidtil nordligste fund er gjort i henholdsvis Sydholland/Nordvestbelgien og nær Fulda i Tyskland, begge ca. 500 km syd for Skærbæk.

Såfremt de danske *P. granulatus* er isoleerede fra artens centraleuropæiske populationer, kan den måske betragtes som en relict i Danmark, hvor den i så fald har over-

levet den seneste istid. Dette er muligt, idet Skærbæk ligger i det område af Jylland, der forblev isfrit under istiden.

*P. granulatus* er givetvis en sjælden art i Danmark, idet den på baggrund af tilgængelig viden sandsynligvis kræver uforurenede, uregulerede småbække med tæt vækst af mosset *Fontinalis* eller levermosser, der udgør dens føde og husbygningsmateriale. Sådanne levevilkår lader sig desværre vanskeligt opfylde i vore dages danske vandløb.

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