Notes on the nymphal biology of *Nemoura mortoni* Ris 1902 (Plecoptera, Nemouridae) in a high altitude stream (Trentino, Italian Alps)

Notas sobre la biología ninfal de *Nemoura mortoni* Ris 1902 (Plecoptera, Nemouridae) en un arroyo de alta montaña (Trento, Alpes italianos)

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SUMMARY

Some biological aspects of a *Nemoura mortoni* population inhabiting a high mountain Alpine stream (Stelvio National Park, Trentino, Italy) are studied. This population presents an univoltine slow seasonal life cycle, with nymphal hatching occurring in spring, a relatively faster growth in summer, slower growth during winter, and emergence in spring. The analysis of gut contents shows that this species behaves mainly as gatherer-collector, feeding mainly on detritus, but, in a lower proportion, can act as shredder, ingesting plant pieces. Diatoms are also present in its diet.

RESUMEN

Se estudian algunos aspectos de la biología de una población de *Nemoura mortoni* que habita en un arroyo alpino de alta montaña (Parque Nacional Stelvio, Trento, Italia). Esta población presenta un ciclo de vida univoltino estacional lento, con eclosión ninfal en primavera, un crecimiento relativamente más rápido en verano y más lento en invierno, y emergencia en primavera. El análisis de

los contenidos digestivos muestra que esta especie se comporta principalmente como colectora de depósito, alimentándose principalmente de detrito, aunque, en menor medida, puede actuar como fragmentadora, ingiriendo fragmentos vegetales. Las diatomeas forman también parte de su dieta.

INTRODUCTION

Knowledge about the life cycles and other aspects of the biology of many macroinvertebrate species are very important to evaluate the effects of environmental stress, especially in the last decade (Raddum & Fjellheim, 1993; Fjellheim & Raddum, 2008). Stoneflies are very sensitive macroinvertebrates and changes in their life histories can be used as indicators. Temperature is one of the most important factors influencing the phenology of stonefly species. In fact, it regulates egg development period and hatching, nymphal growth and development, and adult emergence and flight period (Sweeney, 1984).

The genus *Nemoura* Latreille, 1796 includes around 175 species, 55 of them present in Europe (Fochetti & Tierno de Figueroa, 2006, 2008a), living in different aquatic habitats, mainly in streams and rivers but also in lakes. In Italy, *Nemoura* counts 17 species, 13 of which are typical of Alpine and Pre-Alpine areas (Fochetti & Tierno de Figueroa, 2008b). *Nemoura mortoni* (Ris, 1902) is one of the most abundant species in the Alps. In Italy, this species presents an altitudinal range comprised between 200 and 2300 m a.s.l. and a spring flight period, from April to June or early July, (Consiglio, 1980; Fochetti & Tierno de Figueroa, 2008b), but there is no data on its life cycle and feeding habits.

Thus, the aim of this work is to increase the knowledge about the ecology of this species in a high mountain cold habitat, the altitudinal limit of the distribution of this species in Italy.

Some *Nemoura* species, with univoltine life cycles in low altitude and/or middle latitude areas, present longer cycles in colder areas, while other species can complete their life cycles in these areas in only one year despite the unfavorable conditions (Lillehammer, 1986, 1988). Also, the growth rates can vary in relation to temperature or remain approximately constant along the year, although it is usually accepted that growth is slow and gradual at low temperatures (Lillehammer, 1986). In relation to this, we would like to remark the importance of studies on life cycles and other aspects of stonefly biology at species or population level, given that it is not possible to infer this information from the general patterns obtained from some other species or populations that, living in different conditions, may behave in a different way. The same fact happens in relation to the feeding behavior,

being especially interesting to know if there are dietary particularities in a population inhabiting a very high and cold stream.

MATERIAL AND METHODS

Nymphs were collected in a stream (Larcher stream) of Noce Bianco watershed in De la Mare Valley (Stelvio National Park, Trentino, NE Italy, 46°N, 10°E), located at 2270 m a.s.l. The stream substrate was composed mainly by cobbles and the typology of the sampling site was rithral.

The macroinvertebrate community was sampled from May 2002 to December 2004 using the kick sampling method, and collected specimens were preserved in 75% ethanol in the field. Stonefly specimens were identified in the laboratory to the species level. Harsh environmental conditions made impossible to carry out sampling from January to the end of April. Thus, nymphs of *N. mortoni* were collected in a total of 11 sampling, extended from May to December. Due to the scarcity of sampling where the species was present, we used data from all the period (2002-2004) to study the life cycle of the species. Measurements of the pronotum width (usually employed as a good indicative measure of growth) of *N. mortoni* nymphs were taken with a microscope equipped with an ocular micrometer. To study the life cycle, FiSAT II software (Gayanilo *et al*., 2002) was used.

Nymphs were later used to assess food consumption. The gut contents were analysed following the transparency method proposed by Bello & Cabrera (1999) and previously employed in aquatic insect feeding studies (Tierno de Figueroa & Sánchez-Ortega, 2000; Derka *et al.,* 2004; Fenoglio *et al.,* 2008) with slight variations: each nymph was introduced in a vial with Herwig´s liquid for 19 hours at 65ºC, and afterwards, cleared individuals were collocated on a slide glass with a cover glass on. An Olympus microscope was used for identifying the different components of the gut contents and the percentages that they occupied in the guts were quantified. Statistical analyses were performed with Statistica 7.1 (StatSoft, 2005). Mean, standard deviation and maximum and minimun values were calculated.

RESULTS AND DISCUSSION

A total of 61 nymphs of *N. mortoni* were collected and measured from high altitude sampling station. Figure 1 shows the life cycle of *N. mortoni* in the studied stream. This species presents a univoltine life cycle that can be catalogued as “Slow Seasonal Life Cycle” according to Hynes (1970).

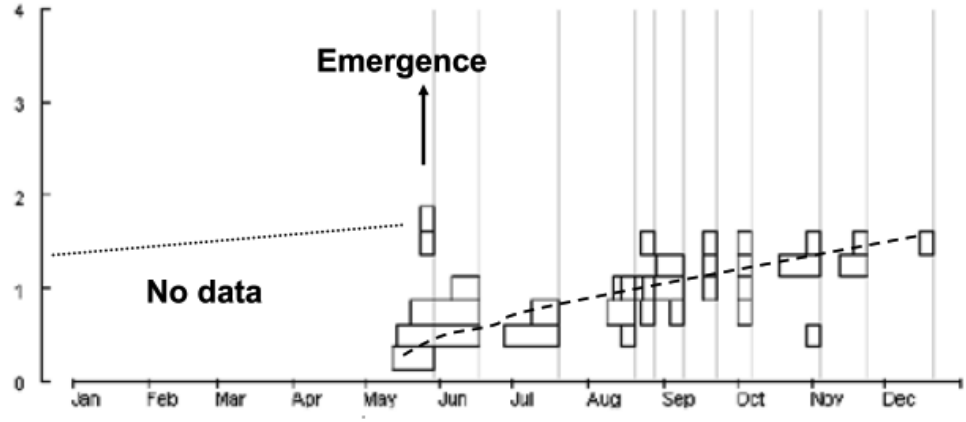

Fig. 1.—Life cycle of *N. mortoni* at the studied stream. Emergence arrow corresponds to the presence of completely mature nymphs. Y-axis represents pronotum width in mm.
Fig. 1.—Ciclo de vida de *N. mortoni* en el arroyo estudiado. La flecha de emergencia se corresponde a la presencia de ninfas completamente maduras. El eje Y representa la anchura del pronoto en mm.

The presence of earlier nymphal stadium in May suggests that egg hatching begins in late spring. Our data point out that *N. mortoni* shows a relative fast growth during summer and a slightly slower growth rate in autumn and, specially, in winter. Thus, in December, nymphs present small and medium-size wing pads and they have a total size almost similar to mature nymphs, showing that there is not a notable growth during the winter period. In May, the presence of big nymphs with completely developed wing pads (and one individual in which the epiproct pieces were already clearly observed when transparented) would mean that the adult emergence must occur in this period, but also the presence of smaller nymph in the same period suggests that some adults must have emerged, at least, in the previous month. Thus, we can suppose a spring flight period for this species in the study area that coincides with that usually indicated for this species in other parts of Italy (Consiglio, 1980; Fochetti & Tierno de Figueroa, 2008b). This life cycle of *N. mortoni* in the studied area is very similar, in phenology and duration, to the one described for a population of *N. avicularis* Morton, 1894 in a North Wales lake (Brittain, 1973). Future studies in other lower areas in the same latitude will let us confirm if, in high altitude glacial stream, the harsh environmental conditions induce a slowing growth or if the observed life cycle for this species is similar at different altitudes.

The analysis of the gut contents (Table I) shows that the studied population of *N. mortoni* behaves mainly as gatherer-collector and, in a lower proportion,

Table I.—Absolute and relative percentages of gut contents of *N. mortoni* nymphs.
Tabla I.—Porcentajes absoluto y relativos de los contenidos digestivos de las ninfas de *N. mortoni*.

	N	Mean	Min.	Max.	S.D.
% Absolute	61	22.84	0	95	23.33
% Detritus	47	64.26	0	100	39.33
% Plant fragments	47	23.40	0	100	38.38
% Algae (mainly Diatoms)	47	11.11	0	85	23.44
% Spores	47	0.94	0	20	2.97
% Pollen	47	0.11	0	5	0.73
% Diptera	47	0.19	0	9	1.31

as shredder (*sensu* Cummins & Merrit, 1996). Thus, the main component found in the gut contents is detritus, that comprises 2/3 of the ingested food, followed by plant fragments and algae, mainly Diatoms. Other components, including spores, pollen grains and a Diptera larva, or part of it (the two last items only found in one individual) were probably ingested accidentally. Comparing the diet of the *N. mortoni* studied population with the one described for other *Nemoura* species, we detected some differences between them. Although, all studied *Nemoura* are phytophagous-detritivorous [as pointed for Nemouridae in general (Hynes, 1976)], some of them act almost exclusively as gatherer-collectors, while others act, in different rates, as scrappers and/or shredders (e.g. Brittain, 1973; Bird & Kaushik, 1985; Azzouz & Sánchez-Ortega, 2000; López-Rodríguez & Tierno de Figueroa, 2005).

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