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THE LIFE CYCLE AND NYMPHAL FEEDING OF *CAPNIONEURA PETITPIERREAE* AUBERT, 1961 (PLECOPTERA, CAPNIIDAE)

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ABSTRACT

The life cycle and nymphal feeding of *Capnioneura petitpierreae* Aubert in a temporary stream in the Southern Iberian Peninsula was studied. This collector-gatherer species had a univoltine life cycle with fast growth. In fact, nymphs are only present during five months, from November to March, showing remarkable size variation in all months. The life cycle is compared with that of other Plecoptera from temporary streams and with other species of Capniidae.

Keywords: Plecoptera, stonefly, nymphal biology, temporary stream, Spain

INTRODUCTION

Feeding habits and growth of nymphs are often highly variable among Plecoptera, even within the same genus or family, depending on environmental conditions. Thus, trophic and developmental ecology of stonefly nymphs cannot always be inferred from general patterns at higher taxonomic levels (Stewart & Stark 1993). Studies of these topics are not very numerous, and they are particularly scarce in the European and North African Mediterranean area, especially in temporary streams from Southern Europe. These streams present a pronounced seasonality (summers with low or no water flow) that highly conditions the life cycle strategies of the species living in them.

In stoneflies, only the life cycle and sometimes feeding habits of a few species have been studied in temporary waters (e.g. Agüero-Pelegrín & Ferreras-Romero 2002; López-Rodríguez & Tierno de Figueroa 2005, 2006). Thus more studies are needed to enhance our understanding of the Plecoptera nymphal adaptations to this particular habitat. Because no studies exist on life cycle and nymphal feeding in Capniidae from European Mediterranean temporary waters, our objective is to elucidate these aspects of the *Capnioneura petitpierreae* Aubert biology. This species is only present in some streams from the Southern Iberian Peninsula (Cádiz and Málaga provinces) and from northern Africa (Tierno de Figueroa et al. 2003). Limited biological data are available on the flight period of Spanish populations (Tierno et al. 1996) and nymphal feeding of a population from Morocco (Azzouz & Sánchez-Ortega 2000).

MATERIALS AND METHODS

Nymphs were collected in Bolaje stream, a tributary of the Genal River, in the Serranía de Ronda (Málaga, Spain), U.T.M. coordinates 30SUF085545, 680 m. The study stream has a temporary water regime with low flow during July and August when only a few pools remain. Monthly samples were taken from February 2006 to January 2007, but no nymphs were taken from April through October.

Collections were made using a kick net with mesh size of 300 μm and specimens were preserved in 70% ethanol. Water temperature, measured during each sample period, varied between 8 and 13.5° C.

Growth data were obtained by measuring pronotal width and outer, right hind femoral length. Measurements were made using an ocular micrometer on an Olympus binocular microscope at 30-40x magnification. In the study of nymphal feeding, 200 individuals (40 per sample period) were randomly selected. Gut contents were analyzed using the methodology of Bello & Cabrera (1999) as modified by, for example, Tierno de Figueroa & Sánchez-Ortega (1999, 2000), Derka et al. (2004) and López-Rodríguez & Tierno de Figueroa (2006). Nymphs were placed in a vial with Herwitg's solution (a variation of Hoyer's media) and maintained in an oven at 65° C for 24 hours. Afterwards, cleared individuals were collocated on a glass slide and studied with an Olympus microscope at 40x magnification to estimate absolute content percentage (measured as percentage of occupied area), and at 400x magnification to estimate relative content percentage of each component.

A Kolmogorov-Smirnov normality test was used to evaluate distribution of life cycle data. Non-parametric tests were used due to the non-normality of data. Spearman R correlations between femur length and pronotum width were established to represent nymphal growth. For feeding data we determined mean, standard deviation, minimum and maximum, median and quartile range for each component in the diet.

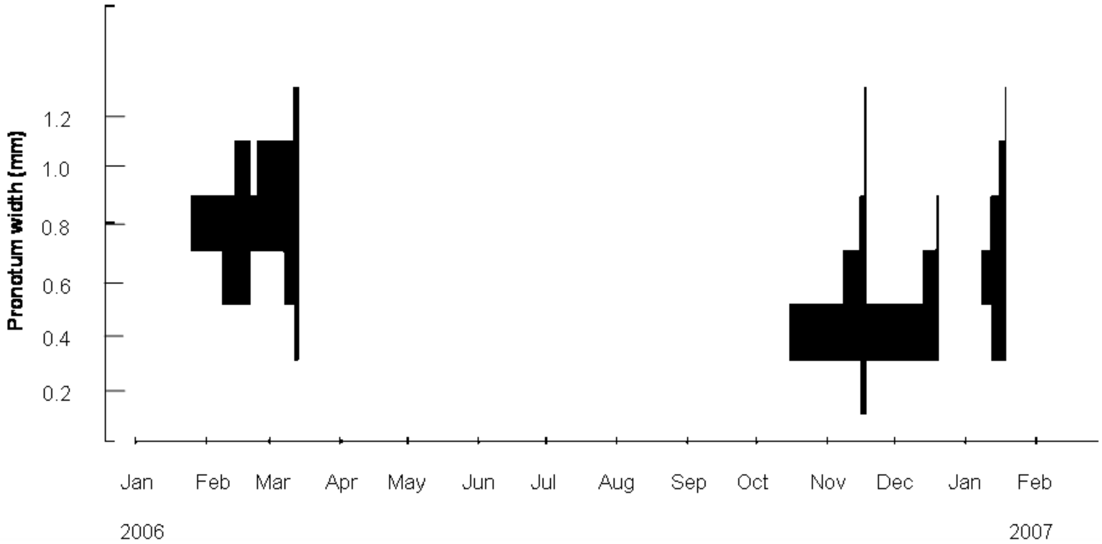

Fig. 1. Life cycle of *Capnioneura petitpierreae*. Box width is proportional to the number of nymphs.

RESULTS AND DISCUSSION

A total of 412 *C. petitpierreae* nymphs were collected from February to March 2006 and from November 2006 to January 2007. Pronotal width and femoral length were highly correlated ($R = 0.96$; $p < 0.05$), consequently only pronotal width was used for construction of graphs (Figs. 1-2). The data indicate nymphal growth extends over five months, with egg hatching beginning in October, after a probable spring-summer diapause. The remarkably high size variability (reflecting asynchronous growth) for a given sample date is typical of reports for other aquatic insect populations in temporary water (Dieterich & Anderson 1995). Most full grown nymphs were found in February-March samples but a few were found in each sample which probably accounts for the extended flight period reported for this species in this area (Tierno et al. 1996). Thus, *C. petitpierreae* shows a univoltine life cycle typical for most Capniidae (Hynes 1976; Stewart & Stark 1993), and following Hynes (1970) it would be classified as a fast seasonal species due to the short developmental period and extended diapause.

The life cycle of *C. petitpierreae* is similar to that

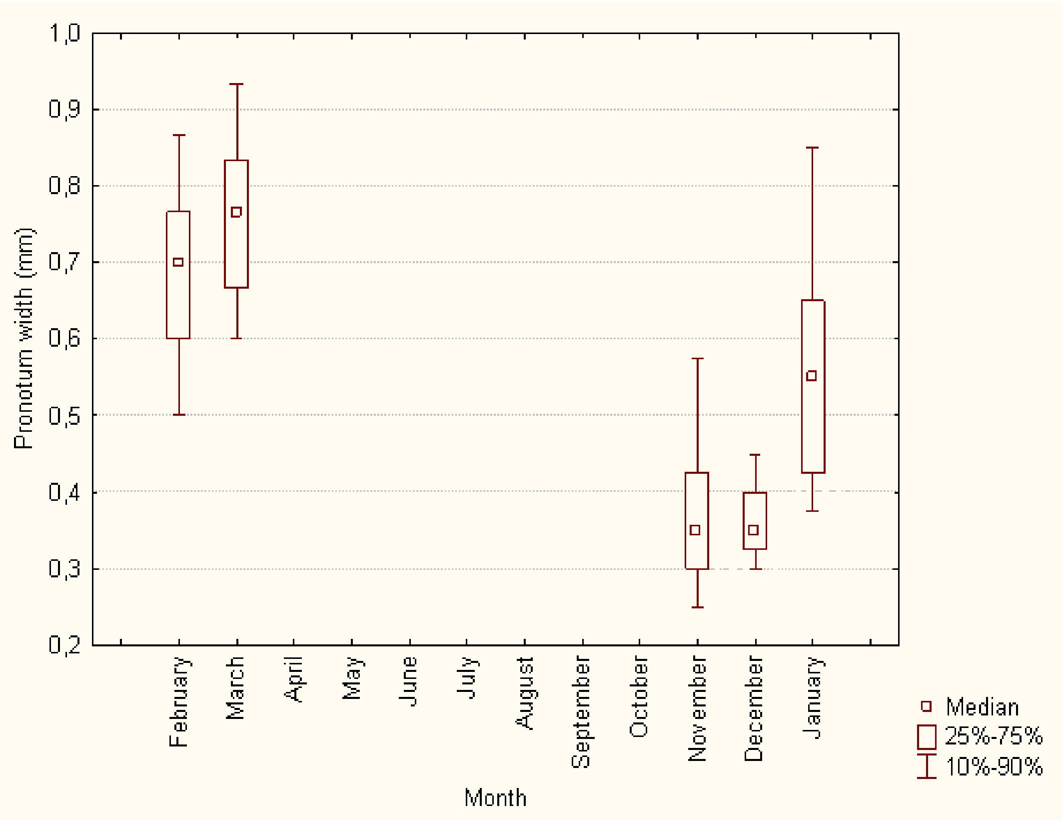

Fig. 2. Box plots representing *Capnioneura petitpierreae* life cycle.

reported for other univoltine species from temporary waters, such as *Rhabdiopteryx christinae* Theischinger and *Nemoura lacustris* Pictet (López-Rodríguez & Tierno de Figueroa 2005, 2006), but it is also similar to that of other *Capnioneura* species found in permanent waters of southern Spain (Sánchez-Ortega & Alba-Tercedor 1990). *Capnioneura mitis* Despax, for example, occurs in permanent streams but shows a univoltine fast cycle with extended flight period (Sánchez-Ortega & Alba-Tercedor 1990; Tierno de Figueroa et al. 2001). However, this does not appear to be a general pattern for all *Capnioneura* species because *C. brachyptera* Despax is known to have a two year life cycle with slow growth in the first year followed by more rapid growth in the second summer (Lavandier 1975).

	Valid N	Mean	Std.Dev.	Minimum	Maximum	Median	Quartile Range
% abs	200	31.79	26.56	0	90	30	46
% detritus	151	67.23	28.20	5	100	70	45
% diatoms	151	20.26	25.31	0	95	8	30
% hyphae	151	5.42	12.03	0	80	1	5
% spores	151	6.46	14.37	0	85	1	4
% phyllidia	151	0.02	0.24	0	3	0	0
% pollen	151	0.22	0.54	0	3	0	0

Table 1. Gut content composition of *Capnioneura petitpierreae* nymphs.

Regarding feeding habits, 151 of 200 individuals examined for diet had gut content (Table 1), and based on the gut composition, this population of *C. petitpierreae* can be considered as a gatherer-collector (feeding mainly on detritus and, to a lesser extent, on diatoms). Other Capniidae are often listed as shredder species (e.g. Tachet et al. 2000), or as shredders and collectors (e.g. Hynes 1976) and the Morocco population of this species studied by Azouzz & Sánchez-Ortega (2000) had a slightly higher quantity of CPOM than was found in our study. This suggests, as does many other studies, that multiple studies on multiple species and multiple populations within species are necessary to gain a more complete understanding of aquatic insect feeding and life cycle adaptations. No general patterns can be applied to particular species living in streams with different biotic and abiotic conditions. The Capniidae, in particular exhibit great diversity in different aspects of life history (e.g. oviparity vs ovoviviparity; lotic vs lentic habitat; univoltinism vs semivoltinism, etc.) showing it is a very heterogenous group.

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