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LIFE CYCLE OF *DINOCRAS CEPHALOTES* (CURTIS, 1827) IN CENTRAL ITALY (PLECOPTERA, PERLIDAE)

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Summary: Life cycle of the stonefly *Dinocras cephalotes* (Curtis, 1827) was studied in the medium and high course of the river Aniene (Lazio, Central Italy). According to the results, the life cycle in the study area seems to last three years (merovoltine) and seems to show a maximum growth (increase in size of average specimens) in spring-summer. Our results confirm that life cycle of *D. cephalotes* is clearly influenced by latitude and by the related joint parameters (temperature, day lenght, etc.). First instars individuals found in different periods (March-October) suggest: 1) the presence of two different cohorts with life cycle of different lenght or, alternatively, 2) the existence of an autumm-winter diapause.

Key words: Stoneflies, *Dinocras cephalotes*, life cycle, Central Italy.

Ciclo de vida de *Dinocras cephalotes* (Curtis, 1827) en Italia Central (Plecoptera, Perlidae)

Resumen: Se estudia el ciclo de vida de *Dinocras cephalotes* en el curso medio y alto del río Aniene (Lazio, Italia central). De acuerdo con los resultados, el ciclo de vida en el área de estudio parece durar tres años (merovoltino) y parece mostrar un máximo de crecimiento en primavera-verano. Nuestros resultados confirman que el ciclo de vida de *D. cephalotes* está claramente influenciado por la latitud y factores relacionados (temperatura, fotoperíodo, etc.). La presencia de individuos de los primeros estadíos en diferentes períodos (marzo-octubre) sugiere: 1) la presencia de dos cohortes diferentes con un ciclo de vida de diferente duración o, alternativamente, 2) la existencia de una diapausa otoñal-invernal.

Palabras clave: plecópteros, *Dinocras cephalotes*, ciclo de vida, Italia Central.

Introduction

The stonefly *Dinocras cephalotes* (Curtis, 1827) is a carnivorous species of the family Perlidae and is the most widely distributed European species of the family (ILLIES, 1978; LILLEHAMMER, 1988). It is widespread in central and western parts of Europe from the extreme South (37°N; SANCHEZ-ORTEGA & ALBA-TERCEDOR 1991) to the extreme North (70°N; LILLEHAMMER, 1988). High temperature requirements to start egg development (LILLEHAMMER, 1987) limit its occurrence farther North.

The nymph occurs chiefly in rivers and streams with a stable, stony bed (HYNES, 1977), fast running water and can be found under most of the large stones throughout the day. *D. cephalotes* is one of the few stonefly species with a life cycle longer than two years (BRINCK, 1949; HYNES, 1941). It is known that the adults emergence occur after two, three or more years, usually in spring or in early summer. The males are short winged and unable to fly and the adults survive only few days (HYNES, 1941; AUBERT, 1959; ZWICK, 1980). The study of the life cycle of *D. cephalotes* has been carried out by several authors with different results depending mainly by latitude: HYNES (1941) described a three years cycle in England, like FRUTIGER (1987) in Switzerland, and SANCHEZ-ORTEGA & ALBA-TERCEDOR (1991) in Spain, while in Northern Norway, HURU (1987) found a life cycle that may reach four or five years.

Such kind of researches have rarely been carried out in Italy. In fact, while are relatively well known taxonomy and sistematics of the Italian stoneflies, very few studies have dealt with the life cycle of these insects.

The present work was conducted with the aim to study the life cycle of *D. cephalotes* in a typical Apenninic Italian water course. The comprehension of this aspect of its biology can also shed light on the genetic intra and interpopulational structuring, since interesting phenomena of genetic diversity have been discovered in *D. cephalotes* (FOCHETTI *et al*., 2001; KETMAIER *et al*., 2001).

Material and Methods

The study was carried out in the river Aniene (Lazio, Central Italy), that rises at 1600 m.a.s.l. in the Monti Simbruini and flows into the river Tevere after 119 Km. Particularly four sampling points were selected on the main : Vicovaro (308 m), Madonna della Pace (390 m), Subiaco (408 m) and Trevi (821 m).

Eight samplings (representing seven months) were carried out from December 1994 to October 1995 (8-XII-1994; 2-III-1995; 24-V-1995; 29-VI-1995; 16-VII-1995; 1, 8-VIII-1995; 31-X-1995). The spring-summer months were over-represented because they represent the growth period in *D. cephalotes* according to FRUTIGER (1987) and also include the emergence and oviposition periods, supporting a valuable information on the life cycle of this species.

The nymphs were collected with a net with mesh size of 0.5 mm. The samples were preserved in 70% alcohol and

examined in laboratory under a steromicroscope. A total of 209 specimens were studied. The total length and the pronotum width were measured in all the nymphs by means of a micrometric ocular.

To draw the figures, size intervals of 0.05 cm and 0.2 cm were used respectively for pronotum width and total length. The statistical analyses were conducted with the program Statistica for Windows-1993.

Results and Discussion

The results are shown in the figs. 1. and 2., where pronotum width and total length are respectively represented. According to bibliography (HYNES; 1941; FRUTIGER, 1987), the hatchlings of this species are 0.9 mm long, while the nymphs reach a body length of 23.4 mm (female) and 16.6 mm (male). In general the incubation period lasts 70-80 days at 12°C to 35 days at 25°C (LILLEHAMMER, 1987). Also, it has been pointed out that during the course of their development the body proportions do not change to any great extent (FRUTIGER, 1987). Our results agree with this statement (pronotum width vs. total length; $r= 0.96$; $p< 0.05$; $N= 209$). Thus, both total length and pronotum width can be used indistinctly to infer data on the life cycle.

From the figures 1. and 2. we can infer a three year cycle for the total development of the individuals. The first intars individuals are found in October; they hatch from eggs deposited in summer. Individuals of intermediate instars are found throughout all the studied period, while big size nymphs are found in March-June. They prelude to the spring-summer emergence (in fact, the flight period of *D. cephalotes* in Central Italy spands from the end of May to the beginning of July). Although we could not distinguish nymph sex, since the size of early instars are very similar for both sexes, errors which may occur are negligible (FRUTIGER, 1987). In the last instars, the sexual dimorphism is so great that does not create a problem. Nevertheless, the existence of a strong sexual dimorphism makes difficult the clear distinction among the intermediate instars, overlapping two different cohorts in which great females of a year could be overlapped with males from the next one.

According to the figures (figs. 1-2), the species life cycle in the study area seems to show a maximum growth in spring-summer. A few nymphs have reached the last nymph instar (and consequently, the end of the growth) at the beginning of autumn (figs. 1-2), but the emergence does not occurr until the next spring. A clear increase of population size is observed during the spring-summer period (figs. 1-2), supporting the hypothesis that there is no growth in the cold months.

The existence of first instar individuals in October and in March could indicate that a few eggs hatch the same summer that are oviposited while others hatch the next spring, supporting the theory by HARPER (1973) that large perlids may have two different hatching periods, and consequently indicate the existence of two nymph cohorts that develop cycles with different duration, since the emergence is synchronous (SÁNCHEZ-ORTEGA & ALBA-TERCEDOR, 1991). ZWICK (1996) proposed that the dormant eggs can remain vital for a long time and may form a "seed bank". Another possible explanation is that there is no growth during the autumn-winter period, as previously proposed by FRUTIGER (1987). The same author (FRUTIGER, 1987) suggests that most individuals spend winter by diapausing and hatch only in the early spring of the following year. This difference in embryogenesis may be affected by environmental causes or by genetic variability within the population, as pointed out by FRUTIGER (1996). In our study the low number of individuals collected in December makes impossible to conclude which of the two hypothesis can apply to our case.

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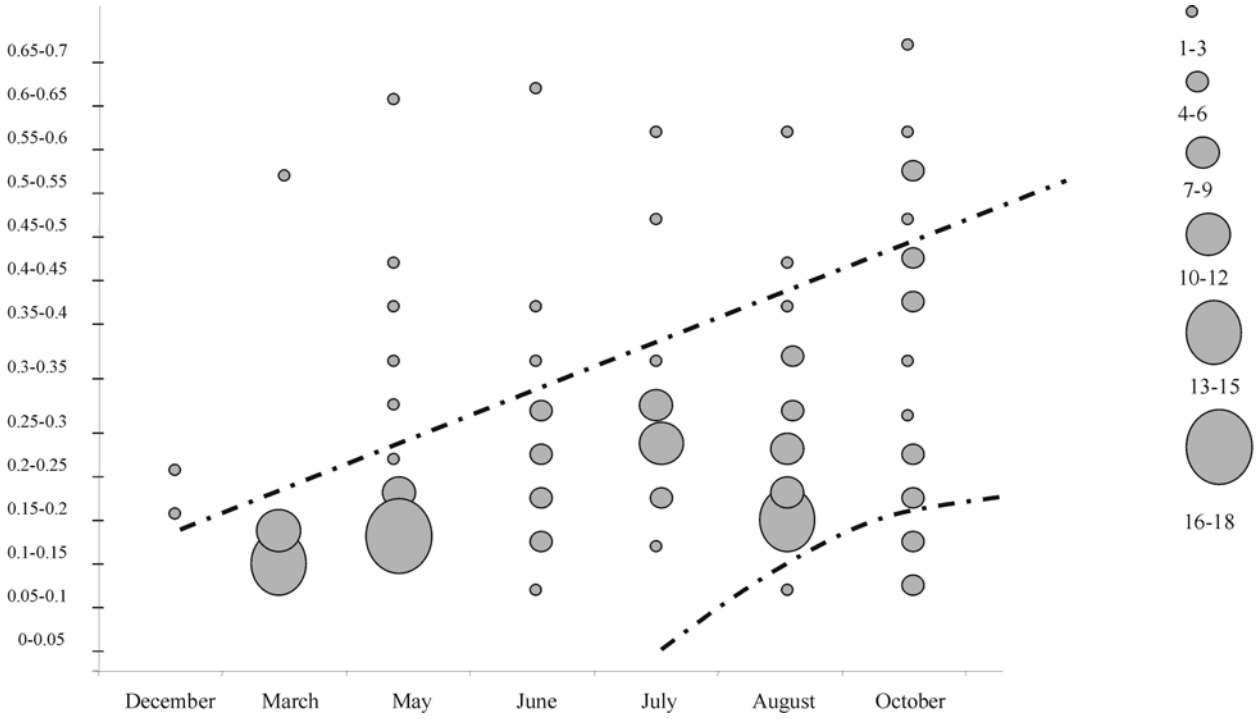

Fig. 1. Life cycle of *D. cephalotes*; vertical axis: pronotum width (cm), horizontal axis: sampling months.

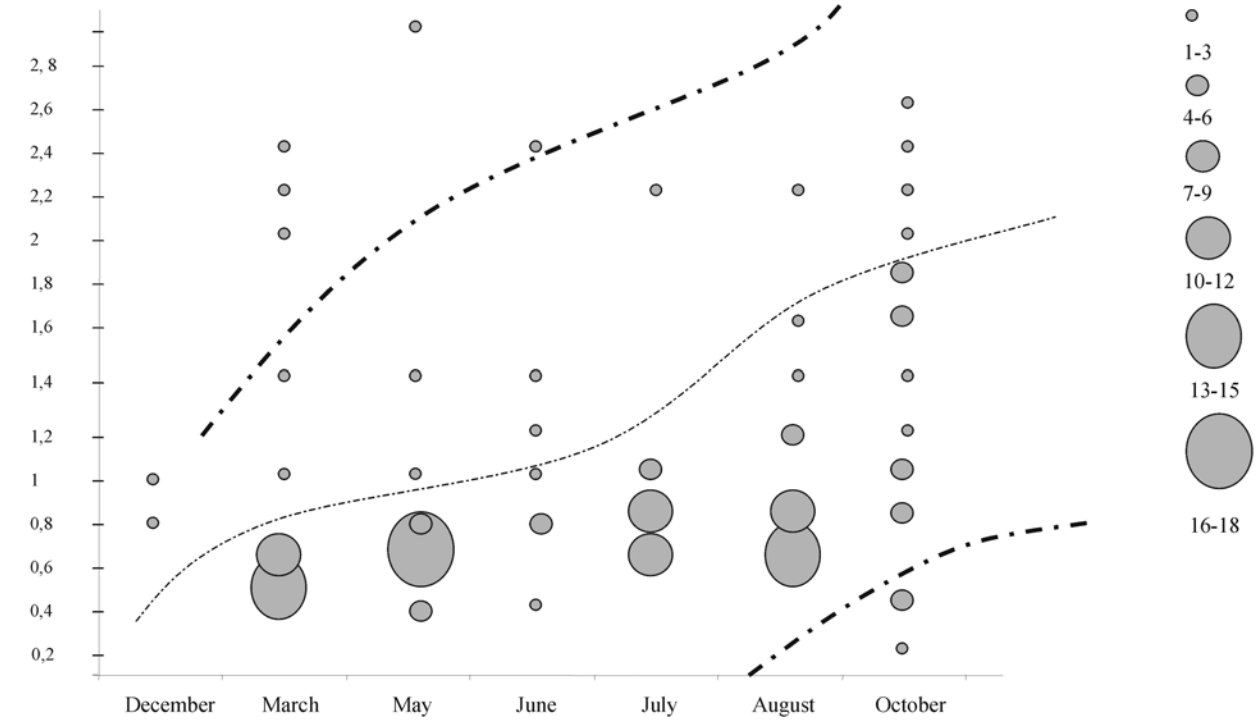

Fig. 2. Life cycle of *D. cephalotes*; vertical axis: total length (cm), horizontal axis: sampling months.

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