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Growth of *Oligoneuriella rhenana* (Imhoff, 1852) (Ephemeroptera: Oligoneuriidae) in Two Rivers with Contrasting Temperatures in NW Italy

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Stefano Fenoglio, Tiziano Bo, Maurizio Battegazzore, and Angelo Morisi (2005) Growth of *Oligoneuriella rhenana* (Imhoff, 1852) (Ephemeroptera: Oligoneuriidae) in two rivers with contrasting temperatures in NW Italy. *Zoological Studies* **44**(2): 271-274. Growth of *Oligoneuriella rhenana* (Imhoff, 1852) nymphs (Ephemeroptera: Oligoneuriidae) were studied in 2 rivers in Piemonte, northwestern Italy. The study was performed during the period of occurrence of the preimaginal stages, and 17 samplings were carried out from Apr. to July 2004. A significant difference in the size increase between the populations inhabiting the 2 streams was detected. We agree with the opinion that dissimilar thermal regimes of the 2 rivers may be the most important factor giving rise to this difference in growth. http://www.sinica.edu.tw/zool/zoolstud/44.2/271.pdf

Key words: Growth, Ephemeroptera, *Oligoneuriella rhenana*.

Environmental and biological variabilities in time and space and changes in community are basic characteristics of lotic systems (Poff and Ward 1990). Stream communities change in composition and density according to seasonal variations, so that some taxa, lacking in a period, can become the dominant component of the total benthic biomass only few weeks later (Murphy and Giller 2000) and play a role of the greatest importance in supporting the food chain of the river ecosystem.

Food availability, primary production and allochtonous organic material input, hydrological status, photoperiod, and temperature are among the most important factors driving the temporal variability in benthic macroinvertebrate coenoses.

It is well known that some species show an explosive growth rate in terms of numerical presence and mass increase (Peràn et al. 1999), thanks to certain temporary advantageous environmental conditions. It has long been known that some mayflies, such as *Ephoron album* for example, completes their life cycle in a few months, with impressive growth rates in the preimaginal stages (Britt 1962).

Another example is represented by the stoneflies of the genus *Brachyptera* Newport, 1849: in Appenninic and subalpine streams, nymphs of this genus are generally absent until early winter, when they suddenly appear and rapidly increase both in numerical abundance and in individual dimensions (Fenoglio et al. 2002). *Brachyptera* species are shredders that feed on autumn-shed leaves, and they use this resource for rapid growth.

In this study, we investigated growth of the mayfly *Oligoneuriella rhenana* (Imhoff 1852), another insect whose aquatic nymphs are characterized by fast growth and short duration of occurrence in streams.

The family Oligoneuriidae is represented in Europe by 2 genera: *Oligoneuriella* Ulmer, 1924 and *Oligoneurisca* Lestage, 1938; 4 species

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belonging to the 1st genus are known, but only *O. rhenana*, a taxon with a large central-southern European range, has reported from the Italian inland waters (Belfiore 1994). In Piemonte the species is reported only from the lower course of some tributaries of the south side of the Po, but it otherwise seems to be almost completely absent from this great river.

The nymphs of *O. rhenana*, typically litophilous, are usually present in rivers with fast-flowing waters and cobble or rocky substrata; they possess a characteristic sub-triangular head and the inner margin of the femur and tibia of the fore legs possesses a double row of long setae. Hence, on the basis of their trophic role, they ecologically belong to the functional feeding group of filterers (Engblom 1996).

Adults are short-lived (Belfiore 2003), and are active after twilight on hot summertime evenings (after July). It is well known that nymphs of *O. rhenana* are present in streams only for a very short period, generally from late Apr. to early summer (Belfiore 1983 and pers. obs.), and during these few months nymphs show an explosive growth rate, with impressive size increase.

We hypothesized that this period is very favorable for filterers, owing to increased amounts of fine particulate organic matter (FPOM) connected to the higher water volumes flowing in the rivers as a consequence of snow melt and rains.

The aim of this study was to analyze and compare the growth of *Oligoneuriella* nymphs in 2 NW Italian rivers, characterized by different temperature regimes.

Fig. 1. Piemonte (NW Italy) with sampling stations (B, Bistagno Bormida River; C, Cherasco, Stura River).

MATERIALS AND METHODS

The Stura di Demonte and Bormida Rivers are located on the southern Piemonte, NW Italy (Fig. 1) and both are tributaries of the Tanaro River, but they show a great environmental diversity: the 1st one is a typical alpine watercourse, with a source at an elevation of 1996 m and a nivo-pluvial hydrological regime, while the Bormida is an Apenninic river, with a pluvial regime and a spring

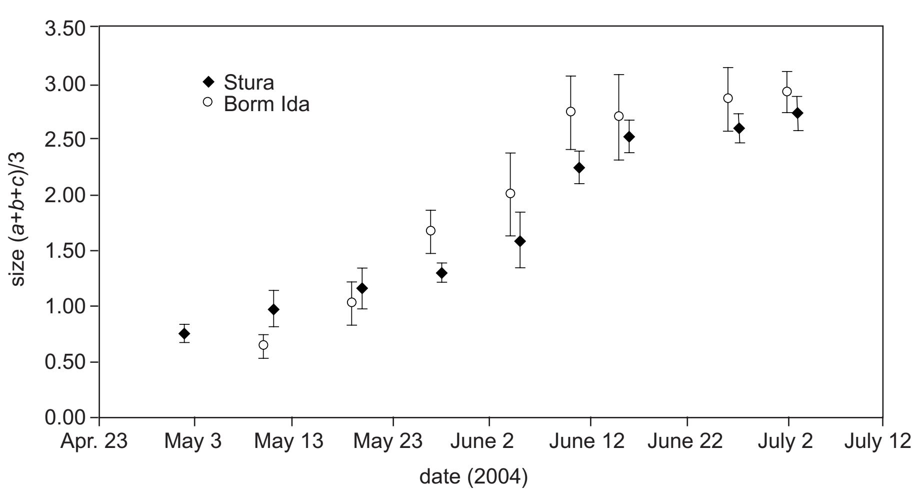

Fig. 2. Growth (mean and SD) of *O. rhenana* nymphs in the Bormida and Stura Rivers. The size was calculated as the mean of the 3 measurements taken from each individual as described in "Methods".

at 700 m in elevation. The sampling stations were placed near Bistagno (AL) (UTM coordinates X=450177, Y=4944898, elevation 158 m.) on the Bormida and near Cherasco (CN) (UTM coordinates X=410862, Y=4945264, elevation 248 m.) on the Stura di Demonte.

Immature stages of *O. rhenana* were collected from the time they appeared (May 2004) until their emergence as adults (July 2004) in the 2 sampled sites; nymphs were collected on 9 dates (2, 10, 20, and 27 May; 04, 10, 17, and 26 June; and 02 July) with a 250-μm-mesh net, and on each occasion, a large number of individuals were found. From these samples, we randomly selected at least 30 individuals/date/site. The nymphs were stored in 75% ethanol and later measured in the laboratory with an ocular micrometer mounted on a Nikon SMZ1500 stereomicroscope (to an accuracy of 0.01 mm).

The following 3 measures were taken from each individual (Fig. 2): *a*) head capsule width, *b*) pronotal length and *c*) total thorax length (including the pterotecae). For statistical analysis, in addition to these 3 parameters, we considered a mean value, calculated as follow: $d=(a+b+c)/3$.

Thermic regimes of the 2 stations where rather different. Considering the mean daily temperatures, higher temperatures were detected in the Bormida (mean, 21.69 ± 5.2°C; range, 11.4~29.1°C), than in the Stura (mean, 15.61 ± 5.1°C; range, 5.4~22.9°C).

RESULTS

In total, 510 nymphs of *O. rhenana* were measured; 30 individuals were randomly selected from the total amount collected on each date, 9 samples in the Stura and 8 in the Bormida. No nymphs were found at Bistagno on the 1st sampling date (02 May).

After 2 mo, nymphs had increased their head width (291.7%) and pronotal length (307.7%) by almost 3-fold and their thorax length (390.3%) by almost 4-fold. We noticed a faster growth in the Bormida population: nymphs appeared earlier and were initially larger in the Stura River, but those in the Bormida rapidly overcame them, having reached dimensions 4.8% larger in head width, 18.1% larger in pronotum length, and 9.0% larger in total thorax length by the end of the sampling period (Fig. 2).

Mean values are reported in tables 1-3 for head width, pronotum length, and total thorax length, respectively, while fig. 2 shows the growth in the *d* value.

Table 1. Head width (*a*), mean ± SD (to an accuracy of 0.01 mm)

Date	Stura	Bormida	*F*	*p*
02 May 2004	1.02 ± 0.17	-	-	-
10 May	1.32 ± 0.23	0.60 ± 0.18	177.11	0.000***
20 May	1.54 ± 0.35	1.53 ± 0.24	0.014	0.91^{ns}
27 May	1.71 ± 0.19	2.24 ± 0.23	97.04	0.000***
04 June	2.26 ± 0.27	2.45 ± 0.36	5.36	0.024*
10 June	2.49 ± 0.21	2.94 ± 0.33	50.63	0.000***
17 June	2.84 ± 0.16	2.96 ± 0.35	2.67	0.11^{ns}
26 June	2.86 ± 0.16	3.04 ± 0.20	15.32	0.000***
02 July	2.89 ± 0.20	3.03 ± 0.18	8.09	0.006*

ANOVA; * $p < 0.05$; ** $p < 0.005$; *** $p < 0.001$; ns, non-significant.

Table 2. Pronotum length (*b*), mean ± SD (to an accuracy of 0.01 mm)

Date	Stura	Bormida	*F*	*p*
02 May 2004	0.28 ± 0.08	-	-	-
10 May	0.33 ± 0.08	0.29 ± 0.05	7.23	0.009**
20 May	0.44 ± 0.10	0.38 ± 0.11	4.23	0.044*
27 May	0.49 ± 0.09	0.60 ± 0.08	24.54	0.000***
04 June	0.53 ± 0.17	0.74 ± 0.16	22.15	0.000***
10 June	0.61 ± 0.04	0.90 ± 0.13	136.52	0.000***
17 June	0.63 ± 0.08	0.89 ± 0.11	103.86	0.000***
26 June	0.76 ± 0.05	0.93 ± 0.09	87.63	0.000***
02 July	0.83 ± 0.12	0.99 ± 0.09	31.53	0.000***

ANOVA; * $p < 0.05$; ** $p < 0.005$; *** $p < 0.001$; ns, non-significant.

Table 3. Thorax length (*c*), mean ± SD (to an accuracy of 0.01 mm)

Date	Stura	Bormida	*F*	*p*
02 May 2004	0.99 ± 0.09	-	-	-
10 May	1.31 ± 0.27	1.08 ± 0.24	12.38	0.001***
20 May	1.55 ± 0.27	1.20 ± 0.33	19.92	0.000**
27 May	1.75 ± 0.15	2.20 ± 0.34	45.82	0.000***
04 June	2.03 ± 0.59	2.88 ± 0.67	26.47	0.000***
10 June	3.69 ± 0.38	4.41 ± 0.74	22.10	0.000***
17 June	4.19 ± 0.33	4.31 ± 0.79	0.60	0.44^{ns}
26 June	4.23 ± 0.36	4.66 ± 0.67	9.14	0.004**
02 July	4.51 ± 0.41	4.81 ± 0.37	8.64	0.005**

ANOVA; * $p < 0.05$; ** $p < 0.005$; *** $p < 0.001$; ns, non-significant.

DISCUSSION

Growth of aquatic organisms is often temperature dependent, since higher temperatures enhance feeding activity and digestion rate (Allan 1995). In a pioneering study, Sweeney (1978) revealed that development rate of both eggs and nymphs of *Isonychia bicolor* (Ephemeroptera: Isonychiidae) were positively correlated with higher environmental temperatures. At present, it is well known that water temperature has a strong influence on the growth rate of some mayfly nymphs (Humpesch 1981). In an elegant experiment, Huryn (1996) measured in situ growth rates of a species of Leptophlebiidae by enclosing groups of nymphs and natural stream substrata in growth chambers. Results showed that temperature explained most of the variation among nymphs growth rates in the 2 streams examined. In the Italian Alps, Erba et al. (2003) recently demonstrated that thermal characteristics seem to be the major factor responsible for the observed differences in the life cycle patterns of different species of Baetidae.

Growth of *O*. *rhenana* nymphs appeared to occur faster in the Bormida, where water temperatures are higher, than in the Stura di Demonte River. Even if other factors such as food quantity and quality were also partially responsible for the detected differences, we suppose that higher temperatures would strongly influence bioenergetics and development, and play a main role in fostering faster growth in the Bormida population of this mayfly.

Studies of the growth of hemimetabolous aquatic insects are attracting increasing interest for their zoological and ecological importance (Sweeney et al. 1986, Friberg and Jacobsen 1999); apart from autoecological data, they can provide useful information which better describe the trophic capacity and functional organization of stream reaches.

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