BRAUERIA (Lunz am See, Austria) 31: 33-35

Weight and size of Italian Trichoptera fauna

Maria Vittoria DI GIOVANNI, Enzo GORETTI, Umberto CHIAPPAFREDDO & Donatella CECCAGNOLI

Key words: Trichoptera, Italy, body morphological model

Abstract Morphometric characters of 787 adult caddisflies, 419 ♂ and 368 ♀, belonging to 293 taxa of Italian Trichoptera have been observed and measured. The mean size of males is smaller, there are differences in weight and body length of 30.38% and 12.6% respectively, indicating a sexual dimorphism. We could calculate the value of exponent *b* and coefficient *a* of the allometric function $Y=a*X^b$, through the regressions of the relationships between body dimensions. This pointed out, except for head width, that the lengths versus body length relationships show a high degree of isometry among the species, this is particularly true for forewing length (especially in males), which shows the highest correlation degree. The lengths versus weight relationships, indicates that is body length the one which best fits the regression model, with a *b* value very close to 3. As a consequence the variability depends on isometric size variation and not on allometric shape one among the different species. For the adult caddisflies this indicates a constancy of the morphological model in the order Trichoptera.

Introduction

The nature of the relationships between linear body measurements and the biomass of organisms is well documented in literature (WENZEL, MEYER & SCHWOERBEL 1990). In general, the power function $Y=a*X^b$ (allometric equation, HUXLEY 1932) or its linear logarithmic analogue $lnY=lna+b*lnX$, provides a good estimate of weight (Y) in relation to some morphometric variables (X) of the body (SMOCK 1980). Because of its simplicity (also with computerized image analysis systems; BERNARDINI, SOLIMINI & CARCHINI 2000), this method of conversion of linear measures into weight is normally used to estimate biomass instead of direct determination of the dry (or wet) weight of fresh (or preserved) specimens or determination of the biovolume (BENKE et al. 1999).

The aim of the present study is to compare, for adult specimens, the relationships between linear variables and weight in the Trichoptera, and to define the variability of the body morphological model at order level.

This work gives a further information to the yet published in BRAUERIA about studies of Italian Trichopteran biometry (DI GIOVANNI et al., 2001).

Materials and Methods

We examined adult caddisflies from all 19 families of Trichoptera in Italy, including 82 of the 91 known genera, comprising 269 species and 24 subspecies (respectively 71% and 83% of the taxa reported in the literature; CIANFICCONI, 2002). The number of taxa in each family is: Limnephilidae: 86, Rhyacophilidae: 30, Hydroptilidae: 29, Leptoceridae: 25, Psychomyidae: 20, Philopotamidae: 19, Beraeidae: 16, Hydropsychidae: 14, Polycentropodidae: 14, Glossosomatidae: 10, Sericostomatidae: 7, Brachycentridae: 6, Goeridae: 6, Lepidostomatidae: 4, Phryganeidae: 2, Helicopsychidae: 2, Ecnomidae: 1, Thremmatidae: 1 and Odontoceridae: 1.

The 787 specimens (419 ♂ and 368 ♀) are from the "G.P. Moretti Collection" (University of Perugia) and they all present the typical morphometric characters of the populations under study.

Whenever possible, we examined 6 specimens per taxon: 1 ♂ and 1 ♀ from each of northern, central and southern Italy. Because of the limited number of specimens for each species, the results represent only biometric indications and certainly not the variability of any taxon within Italy (DI GIOVANNI et al. 2001).

The following variables were measured (to 0.025 mm) with a dissecting microscope equipped with a micrometric eyepiece: Body, maximum body length; Forewing, maximum forewing length; Metafemur, maximum length parallel to the dorsal margin of the metafemur; Head, maximum head width (including the eyes).

The body weight of the specimens, preserved in 70% ethanol, is expressed as the wet weight in alcohol (to 0.01 mg) to prevent alterations of the specimens themselves. They were quickly weighed with an electronic balance after removal from the preserving liquid and standardized application of blotting paper to prevent different degrees of evaporation of externally adhering fixative (DONALD & PATERSON 1977).

The examined specimens have been preserved in alcohol for at least 10 years (1944-1994), a period of time which we have believed sufficient to standardize the alcohol effects on the caddisflies' biomass (in literature we don't know studies with a so long alcohol preservation time).

Using the regression of the relationships among the various linear body dimensions and the preserved wet weight, it has been possible to estimate (after natural logarithmic transformation of the variables) the value of coefficient *a* and exponent *b* in the power function $Y=a*X^b$. This last one is the formula of the allometric equation as well, as a consequence *a* and *b* become the allometric coefficient and exponent respectively. Conditions of isometry occur only for $b=1$ with both the *X* and *Y* variables uni-dimensional or tri-dimensional, or for $b=3$ with *X* uni-dimensional and *Y* tri-dimensional (body weight or biovolume).

Results

A sexual dimorphism is pointed out by the smaller mean values of the variables in males, in fact there are differences in weight and body length of 30.4% and 12.6% respectively. This is shown in Table 1, where mean values and ranges of the variables measured in the 787 specimens (divided into males and females) of the 293 Italian Trichoptera taxa are reported.

Fig. 1 reports the regression lines of body length, forewing length, metafemur length and head width versus preserved wet weight (after logarithmic transformation of the corresponding power functions).

The regression lines are closest to linearity when body length or forewing length are regressed on weight, with coefficients of determination (R^2) of 0.9558 and 0.9539 respectively. Moreover, for *X* corresponding to body length, the value of *b* is 2.896 and, considering only the male specimens, *b* is 2.9009, i.e. approaching the value of 3. For head width, the regression analysis shows an apparent condition of allometry, with a *b* value of 3.5631 and, for males only, of 3.6033 (Table 2).

Discussion

In the order Trichoptera the relationships between the linear dimensions of various body parts and the preserved wet weight have been estimated by means of the regression lines and their equations: a high degree of isometry was revealed.

An indirect estimate of biomass from linear body measures is very useful for studies about the trophic role of adult caddisflies, even without regard for specific recognition. Our analyses of lengths versus preserved wet weight makes it possible to find regression lines at order level. Body length and forewing length provide the best fit to the regression model.

Among the Italian Trichoptera species the morphological variability depends on isometric size variation and not on allometric shape one, particularly for male specimens.

This is demonstrated by the allometric equation particularly for body length-weight where the value of *b* is very close to 3 ($b = 2.896$). Therefore, these results suggest a constancy of the morphological model at the order level for adult caddisflies.

For the larval stages of Trichoptera, body length-dry mass power functions were found by MEYER (1989) for 403 specimens belonging to 10 taxa from Central Europe and by SMOCK (1980) for 232 larvae of 7 taxa from North America, with *b* values of 2.7946 and 3.12 respectively. Indeed, only one of the taxa examined by Smock belonged to the Limnephilidae, the only family in common with the 7 families considered by MEYER.

These values are rather different, probably because the larval morphological model is more diversified than that of adult specimens, as they can live free, or build different types of cases with different materials, or weave capture nets: all ecological adaptations depending on the species.

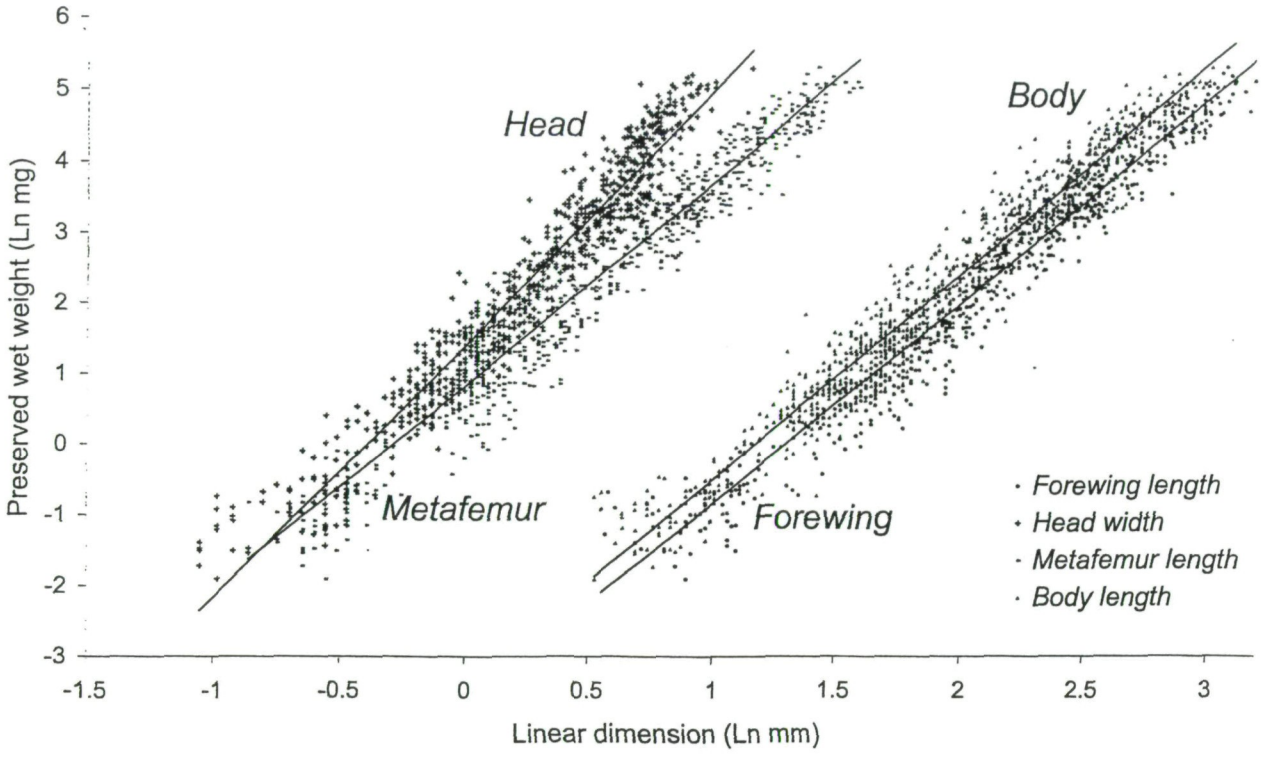


Fig. 1: Regression lines: linear dimensions versus preserved wet weight (logarithmic transformation of the data)

Table 1. Means (±SD) and ranges of the variables measured in adult specimens of 293 Trichoptera taxa

	Preserved wet weight (mg)			Body length (mm)			Forewing length (mm)			Metafemur length (mm)			Head width (mm)		
Sex	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀
Mean	27.73	23.03	33.08	8.25	7.73	8.85	9.60	9.23	10.02	1.94	1.87	2.03	1.42	1.39	1.45
SD	36.22	31.30	40.50	4.24	4.04	4.38	5.07	4.98	5.16	1.02	1.00	1.04	0.56	0.56	0.56
Minimum	0.15	0.15	0.23	1.70	1.70	1.70	1.75	1.78	1.75	0.43	0.43	0.45	0.35	0.35	0.35
Maximum	198.74	198.74	182.33	22.50	21.50	22.50	25.10	25.00	25.10	4.95	4.95	4.90	3.20	3.20	2.75
No.	787	419	368	787	419	368	782	416	366	776	414	362	780	415	365

Table 2. Regression line equations *ln(y)=lna+b*ln(x)* and values of the coefficients of determination

Sex	y = Preseved wet weight (Ln mg); x = Linear dimension (Ln mm)							
	x = Forewing length;	R^2	x = Metafemur length;	R^2	x = Head width;	R^2	x = Body length;	R^2
♀	y = 2.7904x - 3.4854	0.9596	y = 2.7987x + 0.9854	0.9418	y = 3.4822x + 1.5805	0.9468	y = 2.8795x - 3.3412	0.9521
♂	y = 2.8257x - 3.7579	0.9543	y = 2.8825x + 0.7075	0.9443	y = 3.6033x + 1.2371	0.946	y = 2.9009x - 3.4238	0.9576
♀+♂	y = 2.8236x - 3.6616	0.9539	y = 2.8599x + 0.8268	0.9392	y = 3.5631x + 1.3923	0.9383	y = 2.896x - 3.396	0.9558

References

BENKE, A.C., HURYN, A.D., SMOCK, L.A. & WALLACE, J.B.,1999, Length–mass relationships for freshwater macroinvertebrates in North America with particular reference to the Southeastern United States. – J. N. Amer. Benthol. Soc. 18: 308–343.

BERNARDINI, V., SOLIMINI, A.G. & CARCHINI, G., 2000, Application of an image analysis system to the determination of biomass (ash free dry weight) of pond macroinvertebrates. – Hydrobiologia 439: 179–182.

CIANFICCONI F., 2002 - The third list of Italian Trichoptera, 1990-2000, Proc. 10th Int. Symp. Trichoptera. Nova Suppl. Ent. Keltern, 15: 359-358.

DI GIOVANNI, M.V., GORETTI, E., CHIAPPAFREDDO, U. & CECCAGNOLI, D., 2001, Preliminary results on the biometry of Italian Trichoptera fauna. – Braueria 28: 15–18.

DONALD, G.L. & PATERSON, C.G., 1977, Effect of preservation on wet weight biomass of chironomid larvae. – Hydrobiologia 53: 75–80.

HUXLEY, J.S., 1932, *Problems of Relative Growth*. – The Dial Press, New York, 276 pp.

MEYER, E., 1989, The relationship between body length parameters and dry mass in running water invertebrates. – Arch. Hydrobiol. 117: 191–203.

SMOCK, L.A., 1980, Relationships between body size and biomass of aquatic insects. – Freshwat. Biol. 10: 375–383.

WENZEL, F., MEYER, E. & SCHWOERBEL, J., 1990, Morphometry and biomass determination of dominant mayfly larvae (Ephemeroptera) in running water. – Arch. Hydrobiol. 118: 31–46.

Author's address: Dipartimento di Biologia Animale ed Ecologia, Università di Perugia, I-06123 – Perugia, Italia
benthos@unipg.it

Book review.

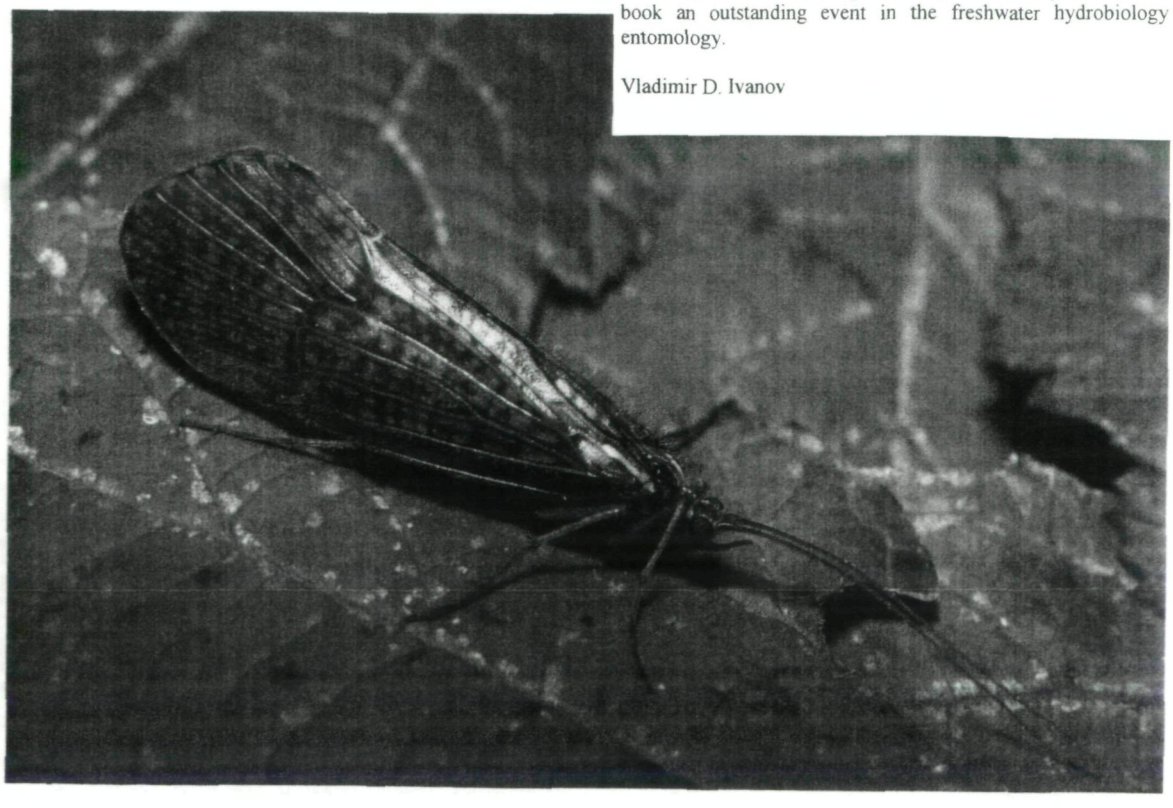
Lydia A. ZHILTSOVA. Stone-flies (Plecoptera). Group Euholognatha. - St. Petersburg, Nauka, 2003. 538 p. [in Russian]

This is a long-awaited book on the Euholognathan stoneflies of Russia and the adjacent countries. The book was originally planned as a part of the "Fauna of the USSR" series. The author, Lidya A. Zhiltsova, began to study Plecoptera in 1953. The manuscript was nearly completed to 1990. The Soviet Union have collapsed soon after; disintegration of the state and economical disrupting prevented the publication of this book. L.A.Zhiltsova had been retired then, and the nearly completed work was not finished. Fortunately, she was able to accomplish the book at the edge of the millennium.

The book covers 218 species of Euholognathan Plecoptera inhabiting the territory of the former Soviet Union (total number of Plecoptera there, including the group Systellognatha, is ca. 350). It is based mainly on the original studies by the author who curates the large (more than 80 000 specimens) Plecoptera collection of the Zoological Institute in St. Petersburg (Russia) and on other materials scattered in the collections in different regions of the former Soviet Union.

The preface to the book describes the scope of the work and the materials involved in the revision, including the type deposition list. It is followed by the species index according to the current system of the order. The next part of the book is the summary of morphology, bionomics, practical importance, zoogeography, and history of Plecoptera taxonomy. The large systematic part includes the thorough descriptions of supraspecies taxa and keys for identification of all inclusive taxa. The family key embrace also families of Systellognatha. Data on morphology and distribution are given to every family and genus. The species keys are concise and provide an adequate help for the determination of both sexes. The species chapters are informative and uniformly styled: the species name is given with the reference to the original description; the profound data on morphology are followed by a comparative section, data on distribution, bionomics, typical habitats, type specimens (place of origin and deposition), and the studied material. The reference list includes 508 entries (mostly before 1990). The book is hard-bound and illustrated by 903 pictures (body parts, total views, distribution maps). It is an excellent manual for the North Palearctic Plecoptera-Euholognatha. The book will be helpful even for those who do not read Russian because of numerous illustrations. The academic level of the issue and wide range of study make the publication of this book an outstanding event in the freshwater hydrobiology and entomology.

Vladimir D. Ivanov



Halesus tessellatus