

FAUNISTIC, TAXONOMIC, AND BIOGEOGRAPHICAL
STUDIES OF EPHEMEROPTERA FROM SOUTHERN ITALY

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ABSTRACT

Italian Ephemeroptera are still poorly known from faunistic and taxonomic points of view. Southern regions, however, have been investigated more in recent years, than other parts of Italy.

This work presents a survey of studies on Ephemeroptera from Southern Italy, carried out from 1986 at the Zoology Department of Naples University. Main taxonomic problems and faunistic data are discussed, and preliminary accounts on accessory studies are presented: experiments on reproductive Isolation between related species, and a tentative approach to the problem of "regionalization" of river basins, based on distribution of Ephemeroptera.

INTRODUCTION

Since 1986 a group of researchers at the Department of Zoology of Naples University has been studying Ephemeroptera from Southern Italy with the aim of clarifying the taxonomic status and distribution of Italian mayflies. This paper gives the first account of the methods and some results. There are two kinds of problems in the study of Ephemeroptera from a taxonomic point of view: "historical" problems, due to bad definition of types, many of which are badly preserved, lost, poorly described, or not designated at all, or a taxonomy based on adult stages, which are rarely available in large numbers from different populations and have fewer characters useful for diagnosis than larval stages. The second kind of problem concerns the interpretation of variability, which is generally low between individuals caught in the same locality at the same time, but very high when more populations are taken into account.

We conduct the study at three levels. The first level is a study of "morphological types" within the area under study (unidirectional view) with the aid of geographic distribution data. The second level focuses on the species definition in Ephemeroptera by studying reproductive Isolation, genetic relationships and biogeographic events. Finally, comparisons with material from other countries and nomenclatural studies will be carried out to produce a

relatively stable picture of Italian mayfly fauna (pluridirectional view).

THE STUDY AREA

Material considered in first level studies comes from Central and Southern Italy. Regions Involved are Latium, Abruzzo, Molise, Campania, Apulia, Basilicata, Calabria, Sicily, Sardinia and Corsica. The latter region was included for the obvious faunistic affinities with Sardinia.

Southern Italy is generally a poorly known area from the entomological point of view, but mayflies, after recent studies (Belfiore, 1987a; 1987b; 1988a; 1988b; 1988c; 1990; Belfiore and Gaino, 1988; Belfiore and D'Antonio, 1990) are today better known from southern regions than other parts of Italy.

METHODS

1. Morphology. Morphological analysis has concentrated on the characters of the larvae. When possible, a large amount of material from different biotopes was examined.

2. Chorology and biogeography. Collections were made mainly with the aim of filling in gaps, choosing as geographic units the "primary areas" discussed below. The biogeographic study, which is still at an early stage. Is not based on faunistic data from administrative or general geographic units but on a division of river basins into districts, called "primary areas" (Audisio et al., 1988), delimited "a priori" by the following criteria:

- a) Size: basins of rivers 50-200 km long with independent estuaries to the sea were considered single primary areas;
- b) Hydrology: very long rivers were divided into several areas with reference to major tributaries;
- c) Geology: small rivers were aggregated on the basis of proximity, geomorphological and geological resemblance.

The whole of Italy was divided in this way into 99 "primary areas." The present study takes into account 47 areas (52-99: Fig. 1); faunistic data were preliminarily elaborated with agglomerative methods (e.g.: Baroni Urbani & Buser Similarity Index (Baroni Urbani & Buser, 1976) and WPGMA cluster analysis (Sneath and Sokal, 1973)) and divisive methods (Lance and Williams, 1968; Kikkawa and Pearse, 1969). The main purpose of this kind of analysis is a regionalization based on faunistic affinities, using geographic units significant for aquatic organisms.

3. Other approaches. Genetic compatibility between closely related species of the genus *Electrogena* was studied experimentally by induced copulations (Huff and McCafferty, 1975; Belfiore 1988d) and by morphological examination of hybrids.

We have recently added studies with electrophoretic methods, for obtaining further data on taxonomic status and relationships between problematic species.

RESULTS

1. Taxonomy.

1.1. New Species. Since 1986, when the articulated study on Southern Italy began, the following new species were described:

- a) *Rhithrogena nuragica* Belf. (Belfiore, 1987a). Endemic to Sardinia.
- b) *Ecdyonurus cortensis* Belf. (Belfiore, 1988a). Endemic to Corsica.
- c) *Choroterpes borbonica* Belf. (Belfiore, 1988c). Distributed in western Southern Italy and in Sicily.
- d) *Pseudocentropilum calabrum* Belf. and D'Ant. (Belfiore & D'Antonio, 1990). Endemic to Calabria.
- e) *Rhithrogena johannis* Belf. (Belfiore, 1990). Distributed from Calabria to Sicily.

1.2. Problematic taxa.

A) The genus *Ecdyonurus*. Notwithstanding recent revisions (Jacob & Braasch, 1984; Hefti *et al*, 1987; 1988; Hefti and Tomka, 1988), most of the problems concerning the species in the genus *Ecdyonurus* are as yet unsolved. The first question concerns the division of the genus into two large groups: the *helveticus* group and the *venosus* group. A recent work (Belfiore, 1987b) focuses on some useful characters for distinguishing larvae of the two groups. These characters have proved to be valid for Italy, and may be applicable elsewhere.

At least two taxa are included under the name *Ecdyonurus* gr. *helveticus* In Table 1: the former widely distributed and abundant in Southern Italy, the second rare and localized.

The main problem with the *venosus* group concerns the type-species of the genus, *E. venosus* (Fabricius, 1775). This species was described from Danish material as *Ephemera venosa* but no *Ecdyonurus* species was ever been found in Denmark (Jensen, in *litt.*); very possibly *Ephemera venosa* Fabr. is *Heptagenia longicauda* (Steph.). A designation of a neotype by the International Commission of Zoological Nomenclature is therefore needed. In Table 1, under the name *Ecdyonurus* gr. *venosus* some taxa are included, which differ from the *E. venosus* of European authors mainly in shape of larval fore femur bristles (not pointed). Within the Italian species, there is an important problem with *Ecdyonurus ruffoi* Grandi. This species was named by Grandi (1953) *Ecdyonurus ruffii* for Prof. S. Ruffo. The original spelling of the species name is incorrect and must be emended according to Article 32 of International Code of Zoological Nomenclature (Univ. of California Press, 1985).

This species is very poorly known: the type was not designated and no specimen is in the Grandi collection which can be designated lectotype. We did not find this species near Verona, which can be assumed as the type locality. The synonymy with *E. wautieri* Fontaine, proposed by Puthz (1975), based on a presumed comparison by Grandi, is still open to question. There are two species, *E. corsicus* Esben-Petersen, and *E. cortensis* Belfiore, in Sardinia and Corsica, which share somewhat intermediate characters be-

tween *helveticus* and *venosus* groups (Belfiore, 1987b; 1988a).

B) The genus *Rhithrogena*. Geographic variation is very wide among *Rhithrogena* species and relevant studies on species definition are much in need. The group classification of Zurwerra *et al.* (1987), which includes most species in two groups has little heuristic value: the group rank concept is a very informal one which is useful to specialists mainly for communication purposes. The former divisions into several groups provide a better account of differences and similarities in morphology.

a) *R. diaphana* group. Two species in Central Italy, *R. adrianae* Belfiore, and a possibly new species, formerly identified as *R. diaphana*, both with very localized distribution.

b) *R. hybrida* group. In Central Italy *R. reatina* Sowa and Belfiore, and *R. sibillina* Metzler *et al.*, are very closely related. They could be the same species.

c) *R. fiorii* group. To this group, named *hercynia* by Sartori, could be referred other species from Southern Italy in addition to *R. fiorii* Grandl.

d) *R. alpestris* group. The group is represented in Southern Italy and in Sicily by only one species, *R. johannis* Belfiore. Very probably species of this group are absent in Central Italy, as they seem to be distributed only in the Alps (most species). Southern Italy (*R. johannis*) and Corsica (*R. eatoni* Esb.-Pet.).

e) *R. semicolorata* group. Specimens from Italy show great variability and intermediate forms: this could confirm the synonymies proposed by Zurwerra *et al.* (1987). All representatives of this group in Southern Italy would belong therefore to *R. semicolorata* (Curtis).

f) *R. insularis* group. To this group belong only the two species from Sardinia and Corsica, *R. nuragica* Belfiore and *R. insularis* Esb.-Pet., characterized from chorion features different from all other species of the genus. Electrophoretic studies currently in progress can help to determine if these two species are really distinct.

C) The genus *Electrogena*. We have examined larvae from Sicily whose characters are somewhat intermediate between *E. grandiae* Belfiore and *E. lateralis* (Curtis). More comprehensive studies are needed to solve the problems of species characterization within this genus. In Corsica and Sardinia possibly only *E. fallax* (Hagen) is referable with certainty to *Electrogena*. *E. zebrata* (Hagen) must be considered *incertae sedis*, until the taxonomic relationships between genera allied to *Electrogena* [*Afronurus*, *Nixe*, etc.] have been cleared up.

D) Centropilum and related genera. This heterogeneous complex has been debated by several authors. A revision is needed for a more satisfactory classification of genera. For the moment we attribute to *Pseudocentropilum* the species previously referred to the *pennulatum* group of the genus *Centropilum*.

We found two species in Southern Italy (*Pseudocentropilum calabrum* Belf. and D'Ant., from Calabria and P. sp. 1 from Campania and Sicily) which have monolamellar gills. The presence of a second lamella on gills can

no longer be considered a valid character for the separation of *Pseudocentropilum* from other genera (i.e.; *Procloeon*). Also the *simile* group of the genus *Cloeon* is very problematic: we found considerable variability in gill shape between individuals even from the same population.

4.2. Chorology and Biogeography. Table 1 lists species found in Southern Italy with their distributions into primary areas.

2.1. New faunistic data. *Caenis pusilla* Nav. was found throughout western Southern Italy, to Sicily. The finding of a *Caenis* species very close to *C. strugaensis* Ikon. in Northern Sardinia is very surprising. Further study are necessary for ascertaining the status of this species, considering the fact that *C. strugaensis* was previously known from Yugoslavia and Greece (Korfu).

2.2. Biogeography. The heterogeneous numbers of species found in primary areas of Southern Italy are evidence of the lack of faunistic knowledge. Notwithstanding the incomplete data we carried out some preliminary analysis with agglomerative methods. The dendrogram (Fig. 2) shows that Corsica and Sardinia are not only closely related but also distinct from other regions. There is some affinity between Cilento (a wide promontory on the coast of Campania, primary area 74) and Sicily. A first attempt with divisive methods, which are much affected by gaps in knowledge, did not yield interpretable results.

3. Experiments on genetic compatibility. Belfiore (1988d) pointed out the genetic compatibility between *Electrogena lateralis* and *E. grandiae*: the hybrid young larvae shared intermediate characters between parental species. Unfortunately the rearing of the larvae to adult stage was impossible till now, possibly because of nutritional problems. Recent unpublished experiments demonstrate the experimental interfecundity between *Electrogena grandiae* and *E. fallax*. Crossbreedings between *Electrogena zebrata* and continental species were unsuccessful.

CONCLUSIONS

Territorial delimitation and different methodological approaches in the taxonomic study of Ephemeroptera seem to be a good strategy for the clarification of taxonomic status and relationships between species of Italian mayflies. Some persistent difficulties remain from nomenclatural and taxonomic instability. Accurate studies on geographical variability and a thorough review of related species are necessary before naming a new taxon. Larval stages can offer a better material for this kind of study. On the other hand, more efforts have to be dedicated to the definition of species as biological entities in Ephemeroptera using data from reproductive biology, ecology and ethology.

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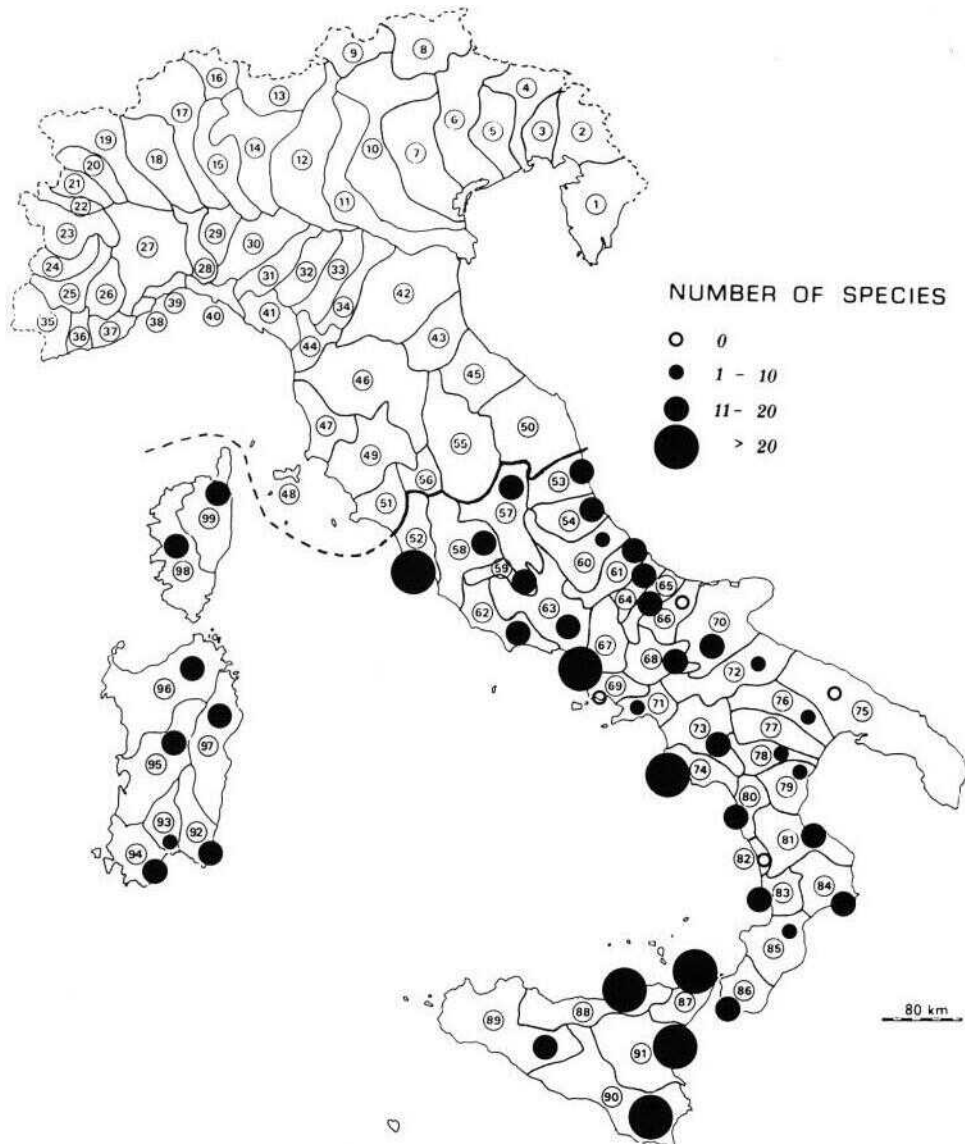


Fig. 1. Number of species collected in the "primary areas" of Southern Italy.

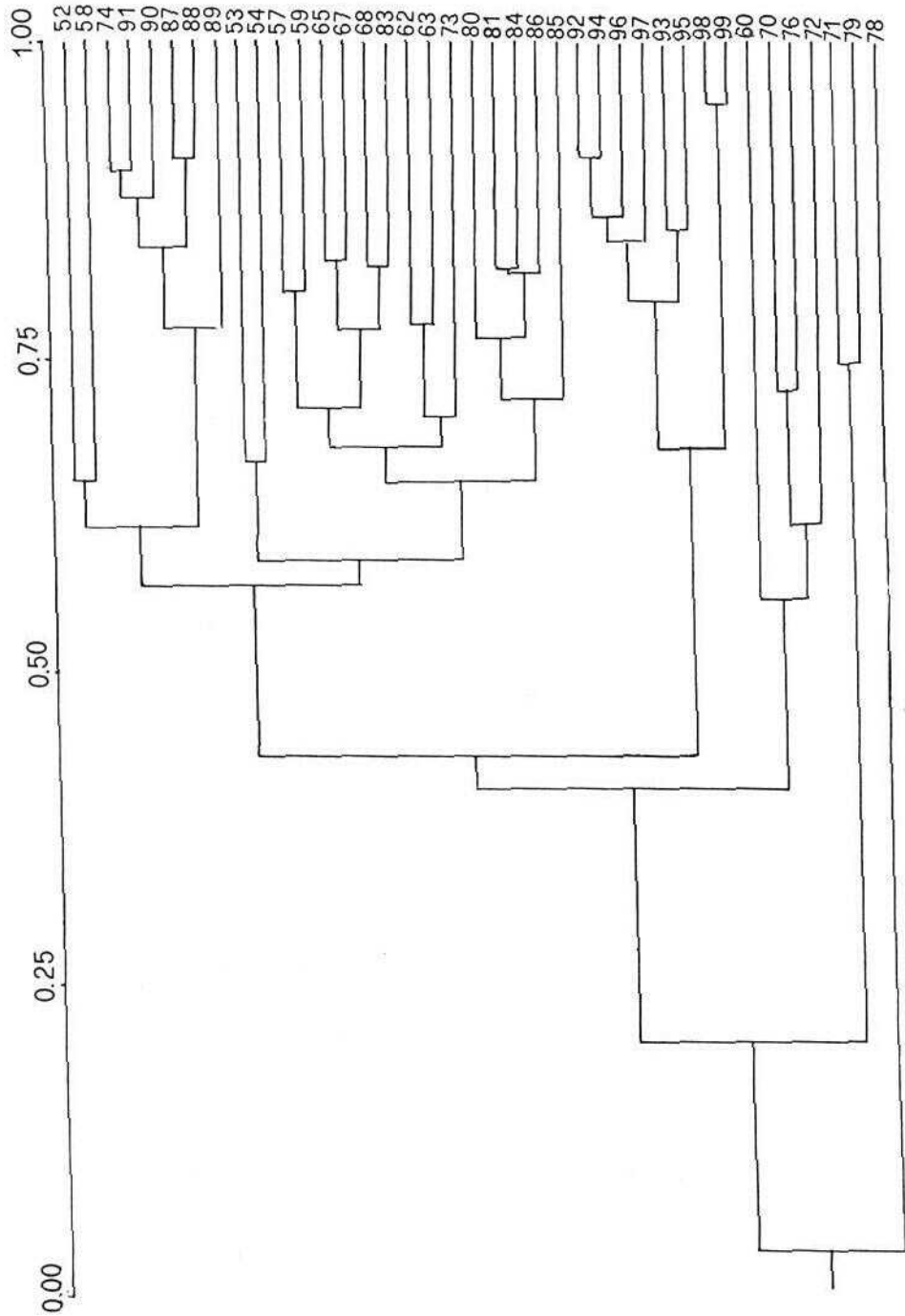


Fig. 2. Dendrogram of similarity of "primary areas" 52-99 as resulting from WPGMA cluster analysis on Baroni Urbani & Buser Similarity Indexes.