CURRENT KNOWLEDGE OF MAYFLY RESEARCH IN EUROPE (EPHEMEROPTERA)

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ABSTRACT

The current status of mayfly research in Europe and North Africa (West Palaearctic area) is briefly reviewed and focused on three main topics: systematics, faunistics, and current research areas.

INTRODUCTION

It is obvious that Ephemeroptera have been studied for a long time in Europe. The pioneer work by Linnaeus (1758) is the root of our actual binomial nomenclature, and was mainly based on European animals and plants. He recognized eleven mayfly species placed in the single genus *Ephemera* within the Neuroptera. Things changed considerably during the 19th century, with the works of Pictet (1843) and, especially, Eaton (1882-1888). The number of European mayfly species continuously increased during the first half of the 20th century, with works such as those of Bengtsson, Esben-Petersen, Klapálek, Mikulski, Schönemund, and Ulmer. After World War II, other scientists (such as Grandi, Jacob, Kimmins, Landa, Macan, Müller-Liebenau, Puthz, Soldán, Sowa, and Thomas, among many others) published major works on European mayflies.

In this small review, only subjects relating directly to mayfly research, i.e. systematics, faunistics, autecology, as well as anatomy, physiology and behaviour will be discussed. Hydrobiological themes involving mayflies as a part of the benthic community will not be treated.

SYSTEMATICS

In the first edition of the "Limnofauna Europaea", Illies (1967) mentioned approximately 200 species (excluding non European Mediterranean countries). In the second edition, Puthz (1978) recorded about 220 species.

Trends in Research in Ephemeroptera and Plecoptera
Edited by E. Dominguez, Kluwer Academic/Plenum Publishers, 2001

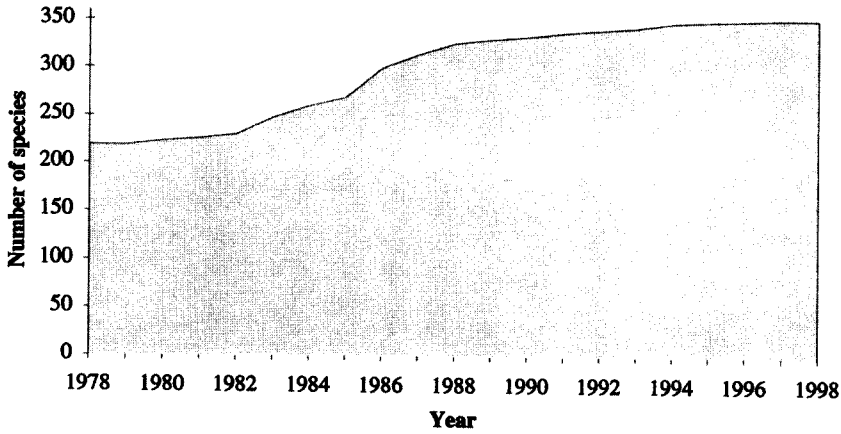

Fig. 1. Evolution of the number of mayfly species in the West Palaearctic from 1978 until 1998.

Figure 1 illustrates the evolution of the number of European mayfly species between 1978 and 1998. A little more than 350 species are actually known, i.e. that during the last 20 years, our taxonomic knowledge increased by 60%. As the shape of the curve indicates (Fig. 1) most of these new taxa were described between 1982 and 1988, with the maximum peak reached in 1986 when the descriptions of 31 new species were published. Since the beginning of the 1990's, less than half a dozen new species have been described each year. Two reasons can be put forward: first, because the European fauna is now pretty well known; second, because systematic activities obey a strange cycle in which periods of "low activity" (i.e., periods with low description rates) follow periods of "high activity" (i.e., with high description rates). The next years will tell us which is the right one.

Speaking about the evolution of mayfly species number in general is a little bit gross since taxa are not involved in the same manner. On one hand, the last European species described in the genus *Ephemera*, among the six actually known, was *E. hellenica* by Demoulin in 1955. On the other hand, the number of species in Baetidae and *Rhithrogena* drastically increased during the last twenty years (fig. 2). The European Baetidae actually reach ca. 80 species (+ 43% since 1978) whereas the heptageniid genus *Rhithrogena* has ca. 75 species (+ 180% since 1978!). The main works on these taxa were those of Alba-Tercedor, Belfiore, Soldán, Sowa, and Thomas.

FAUNISTICS

For literature references used in this chapter, consult the list established by Sartori and Landolt (1999) or Landolt and Sartori, this volume.

From a faunistic point of view, there are important discrepancies among West Palaearctic countries. I will split West Palaearctic countries in four categories with respect to the degree of knowledge in their mayfly fauna (alphabetically listed):

1) Countries with well known mayfly fauna, i.e., for which at least 95% of the supposed fauna is recorded: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Ireland, Luxembourg, Netherlands, Norway, Poland, Slovakia, Sweden, Switzerland, United Kingdom.

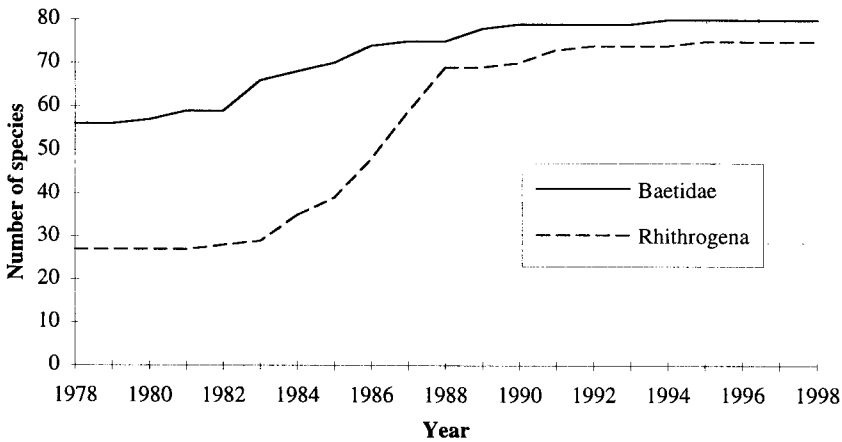

Fig. 2. Evolution of the number of species within the family Baetidae and the genus *Rhithrogena* from 1978 until 1998.

2) Countries with numerous mayfly records, but in which some geographic areas or some taxonomic groups lack recent data: Algeria, Germany, Hungary, Israel, Italy, Macedonia, Morocco, Portugal, Romania, Slovenia, Spain, Tunisia.

3) Countries with only some mayfly records, for which no actual checklists are available: Croatia, Estonia, Greece, Latvia, Lebanon, Lithuania, Syria, Turkey.

4) Countries poorly known, with some isolated records or frankly "terra incognita" concerning mayflies: Albania, Belorussia, Bosnia, Egypt, Libya, Moldovia, Montenegro, Serbia, Ukraine.

These categories perhaps are roughly made, but they highlight places where much has to be done: the Balkans, the former USSR states, as well as the Eastern Mediterranean area. The advancement of the mayfly knowledge in these areas will certainly also lead to the discovery of new species, and thus, will also increase the systematic count in Europe.

Countries mentioned in category 1, as well as some of category 2, have been analyzed further, in order to see if the notion of "well known mayfly fauna" had some realistic basis. In other words, would it be possible to extrapolate the expected number of mayfly species to be found in such countries?

Figure 3 shows the relationship between the number of known species and the size of the investigated country. As it can be seen, there is a semi-logarithmic relationship between the variables. But it is clearly different between Central - South and North European countries. Latitude, climate, landscape homogeneity and insularity are responsible for these differences. Netherlands lies somewhat in-between, whereas Austria is the country with the highest diversity, considering the country size. Italy, Germany and Spain lies below the regression curve, suggesting that additional species could be found.

OTHER FIELDS INVESTIGATED

The anatomy of mayflies has been relatively poorly studied in Europe, except for the pioneer works by Marta Grandi. More recently, researches led by Landa and Soldán (1985) on the anatomy of mayfly larvae with its phylogenetic implications have to be mentioned. The

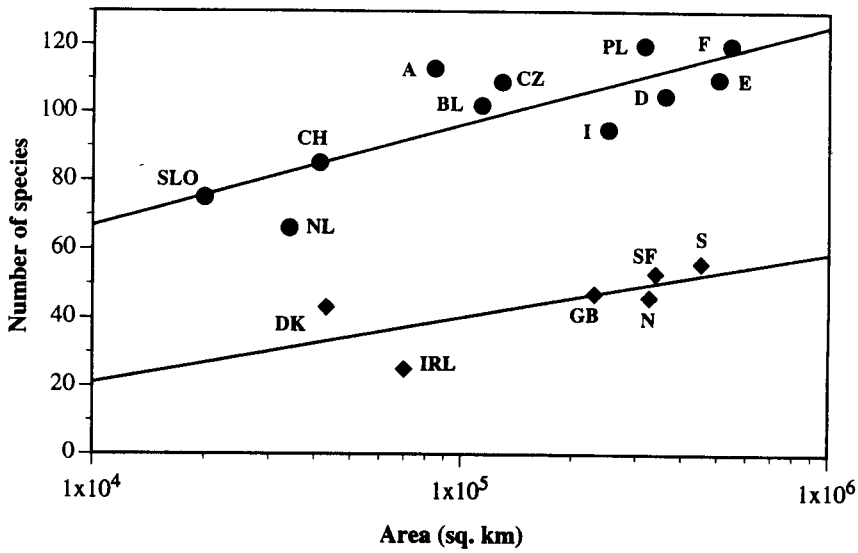

Fig. 3. Relationship between area of the country and the number of mayfly species actually known. Upper curve: Central and South European countries (regression coefficient $r^2 = 0.66$; $p<0.001$); lower curve North European countries (regression coefficient $r^2 = 0.53$; $p<0.005$). A: Austria, BL: Bulgaria, CH: Switzerland, CZ: former Czechoslovakia, D: Germany, DK: Denmark, E: Spain, F: France, GB: Great Britain, I: Italy, IRL: Ireland, N: Norway, NL: Netherland, PL: Poland, S: Sweden, SLO: Slovenia, SF: Finland. (Redrawn from Sartori and Landolt, 1999, courtesy of the Centre Suisse de Cartographie de la Faune, Neuchatel).

study of the ultrastructural organization in mayflies is almost entirely the property of Elda Gaino, with numerous works on egg chorionic structure, as well as ovarioles, fat body, and sensilla, for instance. Functional morphology, especially of the mouthparts, is the domain of Austrian and German scientists, with works such as those of Elpers, Schönemann, Staniczek, and Strenger. Autecological studies have received considerable attention since the pioneer work by Degrange (1960), leading to numerous researches, involving life cycle strategies, such as those of Brittain, Elliott, Humpesch, and Macan.

CURRENT RESEARCH AREAS

A compilation of available literature for three years is presented in fig. 4. Faunistic and ecological studies are the dominant fields investigated. Applied aspects involving mayflies, such as biomonitoring, and human impacts on the environment are still underrepresented compared to other areas (e.g. North America). Autecological studies, mainly life histories, need to be encouraged since we lack data on a great number of species.

Thanks to the increased knowledge in systematics, more and more scientists each year are working on mayflies, leading to the diversification of the investigated themes.

NEW RESEARCH AREAS

Mayflies constitute a unique and fascinating material for basic research such as behavioural ecology. The study of particular cases can shed new light on our understanding of general biological processes. Surprisingly, little has been done in this field. Some recent

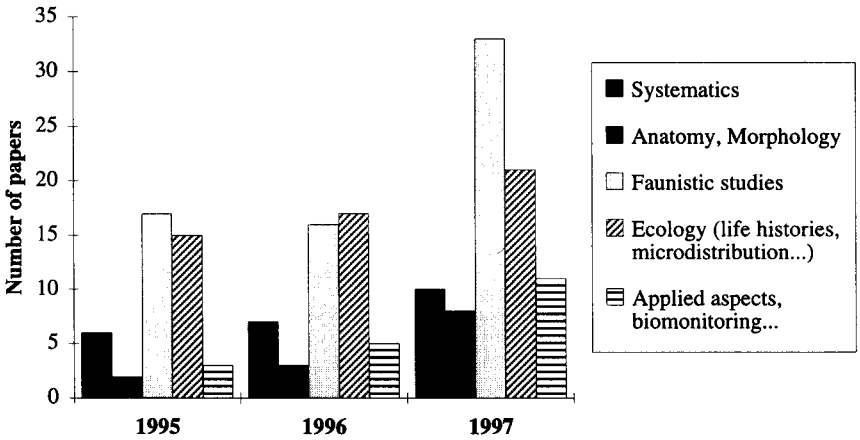

Fig. 4. Mayfly research main topics in Europe during three years (1995-1997). Source: NABS current and selected bibliographies on benthic biology.

attempts have proven that mayfly study can bring some answers of interest to all biologists: mating behaviour and competition (e.g., Flecker et al., 1988; Allan and Flecker, 1989; Harker, 1992), effect of parasites on physiology and predation (Vance, 1996; Vance and Peckarsky, 1997), asphalt as a trap for polarization-sensitive aquatic insects (Kriska et al., 1998), or flightlessness as a response to predator removal (Ruffieux et al., 1998). These studies have to be encouraged since they contribute to making mayflies better known to the scientific community, as well as to the public.

Surprisingly, new molecular techniques (e.g. DNA sequences) are still not used in mayfly research, despite their important contribution to systematics, phylogeny, and biogeography (Landolt, 1991). This field will certainly be developed all over the world in the next years.

CONCLUSIONS

Mayfly knowledge in Europe has increased considerably during the last ten years. On a systematic and faunistic point of view, more information is needed from eastern and southeastern Europe. This situation will be improved only when economic and political stability again occur. We need autecological data on numerous mayfly species. This basic research is a necessary condition to understanding which factors affect populations in order to protect them. Then, the use of mayflies in applied aspects of hydrobiology will be more efficient.

ACKNOWLEDGMENTS

I sincerely thank all the colleagues who help me in providing numerous unpublished data or information used in this paper. Special thanks to Javier Alba-Tercedor (Granada) who pushed me to complete an earlier draft for publication, and to Jean-Luc Gattolliat for helpful comments. Despite all this help, I am solely responsible for errors that could still occur.

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