Phenological data on a parasitic relationship between *Electrogena lateralis* (Curtis, 1834) (Ephemeroptera) and *Symbiocladius rhithrogenae* (Zavrel, 1924) (Chironomidae)

By

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Abstract. As a result of six-year (1993-98) research in the field and under laboratory conditions, we have completed our knowledge about the chironomid species *Symbiocladius rhithrogenae* by examining its life cycle as well as formation and facts of its parasitic relationship. According to our unambiguous conclusion its co-existence with *Electrogena lateralis* is a true parasitism; wich, thus, differs from the relationships formed between a Plumed Gnat larva, *Epoicocladius flavens* (Malloch, 1915) and mayfly larva, *Ephemera danica and Ephemera vulgata*.

Between 1993 and 1998, we studied the life-cycle of a non-biting midge, *Symbiocladius rhithrogenae* from egg-laying to swarm in the field and in the laboratory as well. Larvae of this species, similarly to another non-biting midge breeding in our country, *Epoicocladius flavens,* form relationship with mayfly larvae at a particular stage of their life cycle. *E. flavens* was found in Morgó Creek, Börzsöny Mountains, Hungary (Berczik, 1968) while *S. rhithrogenae* examined by us, is in the determination book of chironomid larvae (Bíró, 1981) without comments on breeding-place.

Similarly to *Epoicocladius flavens* (Cobo, 1987; Coffman & al., 1986; Soldan, 1988; Tokeshi, 1986, 1988), we possess several European data about the spread of *Symbiocladius rhithrogenae* (Coffman & al., 1986; Moubayed, 1991). We carried out field experiments and observations by a creek in Pilis Hills, along Holdvilág Ditch between 1993 and 1998 (Fig. 1 a). The largest width of the creek was 1–1.5 metres, the depth changes during the year between 10–20 cms. The creek had little water in, and it flowed on volcanic stones, mainly andezit and its debris. Alder trees grow along the creek which produce high amounts of plant detritus during the year.

The conductivity expressing the overall salt contents of the creek is about 487 mS/cm; this value is common in small waters flowing into the River Danube. The

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examined stage of the creek needs a considerable quantity of chemical oxygen demand (19 mg/l O_2) as well as iron (0.54 mg/l) and manganese (0.48 mg/l). This high amount of organic material in the autumn samples (23. 09. 1995) probably come from a lot of fallen alder leaves. The aim of our work was to get new information on the life-cycle of *Symbiocladius rhithrogenae* by exploring its living and nonliving environment at a particular-breeding-place as well as to investigate the formation and development of the parasite relationship of this species with *Electrogena lateralis* mayfly larva.

Materials and methods

We carried out field examinations at the Holdvilág Ditch in the Pilis Mountains every two weeks, however, we collected twice a week after the parasited mayfly larvae appeared (from April to June and from August to September). We took hydrochemical samples from the creek on one occasion, 23. September, 1995, and their measurements were performed in the hydrobiological laboratory of Zoological Department EKTF.

We collected *Electrogena lateralis* larvae and eggs of *Symbiocladius rhithrogenae* with tweezers from the surfaces of the stones in the creek. We determined the collected mayfly larvae by examining in the field that parasitism was only formed with larvae larger than 7.5 mm; therefore we merely took samples of larvae larger than about 6 mm. These larvae bred on the lower and lateral surfaces of the stones with diametres of about 20–40 cm.

We found the 1–2 mm sized whitish, jellywise eggs of *Symbiocladius rhithrogenae* (Fig. 1 c), similarly to mayfly larvae on the lower and lateral surfaces of the stones with diametres of about 20-40 cm. Mostly, we only came across one bunch of eggs on one stone, however, occasionally two bunches were to be found as well. The eggs were identified by microscope by one hundred magnification. While testing them, the primary marking feature appeared to be the typical spiral form of the eggs in the egg-mass. As a result of the subsequent laboratory experiments lasting for several months, we also succeeded in raising imagoes of *S. rhithrogenae* (Fig. 1 b) from the eggs collected in the field.

We collected *Electrogena lateralis* larvae from a part of the creek on 100–150 metres investigating branches and stones in the bed simultaneously.

Larvae were taken to the laboratory and the assumed degree of their being parasited was identified by microscope by hundred magnification. The microscope test turned out to be indispensable since in the case of often tiny *Symbiocladius rhithrogenae* larvae flattening to the lower surface of wingbuds completely, it was extremely difficult to determine parasitism unambiguously even by applying a larger magnification.

Results

Electrogena lateralis mayfly species was identified by the book of Studemann & al. (1992). The taxonomic status of the species has been clarified as a result of enzyme-electroforetic examinations (Zurwerra & Tomka, 1985). Formerly the „*lateralis*" group (13 species) was considered to be among *Ecdyonurus* Eaton, 1868 by their features in larval and adult stages, or *Heptagenia* Walsh, 1862. However morphological traits of larvae and imagos attached to genus often did not coincide, thus following gelelectroforetic test results the independent status of „*lateralis*" group was justified.

Symbiocladius rhithrogenae was determined by the keys of Bíró (1981) and Coffman & al. (1986).

Periods of the parasite's and host's life-cycle

We have obtained new informations on the life-cycle of a parasite chironomid species *Symbiocladius rhithrogenae*. This species is bivoltin in Hungarian climate, i.e. it produces two generations annually. Its swarm starts along the Holdvilág Ditch early June, subsequently the first eggs appear in the creek approximately a week later. The larvae appear from the eggs 8–11 days later, in the second half of June, then they abandon the jellylike eggs 1–2 days later. It might be assumed that *S. rhithrogenae* takes 8–11 days for embryonic development. The first mayfly larvae parasited by *S. rhithrogenae* larvae are to be found at the breeding place six weeks later, early August (Fig. 1 d). At first, the low degree of being parasited of *Electrogena lateralis* larvae sized 7.5 mm or more reaches 37% by mid-August, and by the end of the month it might even exceed 59%.

The univoltin *Electrogena lateralis* swarming process lasting from July till September culminates early September also affecting the speed of the swarm of *Symbiocladius rhithrogenae.* The primary reason for this is that *E. lateralis* larvae develop sizeable black wingbud after the last larval moult, which, according to our observation, makes it impossible for *S. rhithrogenae* larvae to penetrate under the mayfly's wingbuds. We were unable to identify parasitism in the case of any mayfly larva that had sizeable black wingbuds before swarm. Considerably many of *E. lateralis* populations larger than 7.5 mm participate in the swarm, therefore the number of parasitable mayfly larvae decreases after the last moult, which hinders increasing percentages of parasitism (Fig. 2). On forming parasite relationship, most *S. rhithrogenae* larvae are 1 mm long, afterwards, as a result of swift growth, they reach 3 mm 1 or 1.5 weeks later before pupation. The fast growth of *S. rhithrogenae* larva under the wingbud of mayfly larva is the most relevant evidence of parasite relationship: namely that chironomid larva feeds from mayfly larva.

The first *Symbiocladius rhithrogenae* adults appear mid-August, subsequently their number increases until mid-September. Imagos having emerged by late September, when the swarm begins. The first eggs appear in the creek late September. The first larvae emerged 9–12 days later. Subsequently, the first mayfly larvae parasited by *S. rhithrogenae* larvae appeared in the second half of April in next year. We found the first imago early May and all imagos came out a month later by early June. The above data show it clearly that the summer cycle merely lasts for 3 months (from mid-June to the second half of September), while the autumn one lasts three times as long, i.e. about nine months (from late September to mid-June). Although there is a marked difference between the cycle-lengths starting from early summer and early autumn, the parasite relationship arises in both cycles 1-1.5 months before the end of the life cycle. Therefore, the approximately five-month-long difference between the two cycles is restricted upon the development of the free living larva. Whereas the *S. rhithrogenae* larvae appearing in June form parasite

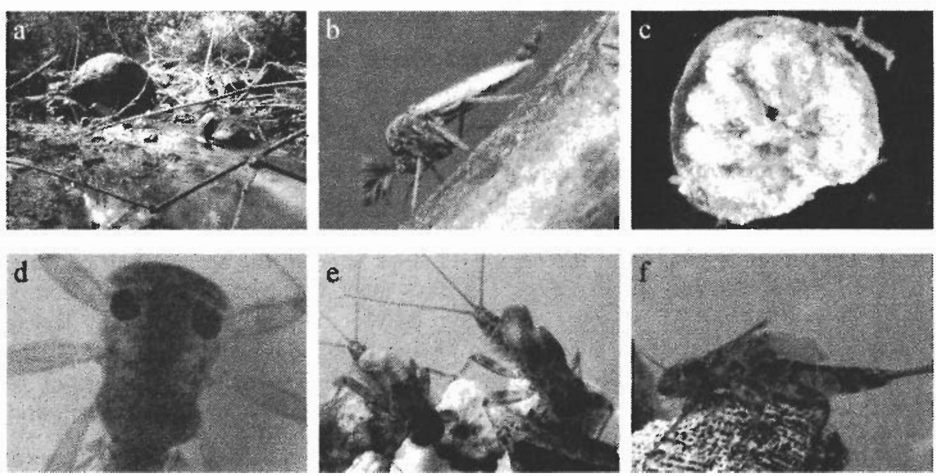

Fig. 1. a: Venue of terrain examinations; b: male *Symbiocladius rhithrogenae* imago; c: eggs of *S. rhithrogenae;* d: *S. rhithrogenae* larva under the mayfly larva's wingbuds; e: *Electrogena lateralis* parasited with *S. rhithrogenae* pupas; f: *E. lateralis* larva after the chironomid imago's release

relationship with mayfly larvae two months later, the larvae appearing in October do this almost seven months later. We assume, the difference is due to the accelerated development of the free *S. rhithrogenae*. Favourable environmental conditions, primarily higher water temperature (about 20–21° C), contribute to the rapid growth of the species

Formation and development of parasitism

The forming parasite relationship between *Symbiocladius rhithrogenae* and *Electrogena lateralis* is a remarkable process: the tiny, about 1–2 mm long slow-moving chironomid larva has to penetrate into the relatively fast-moving mayfly larva, where it will live until the imago comes up to the surface. While collecting, we came across *E. lateralis* larvae several times that already had *S. rhithrogenae* on them, however, they had not got under the mayfly larva's wingbuds yet. The chironomid larva hung on the mayfly larva so firmly that it was hardly possible to remove it with tweezers, either. On forming parasite relationship the chironomid larva crept towards the wingbuds and from one side, either right or left, it drilled itself under the wingbuds (Fig. 1 d). This process lasted 108 minutes on average.

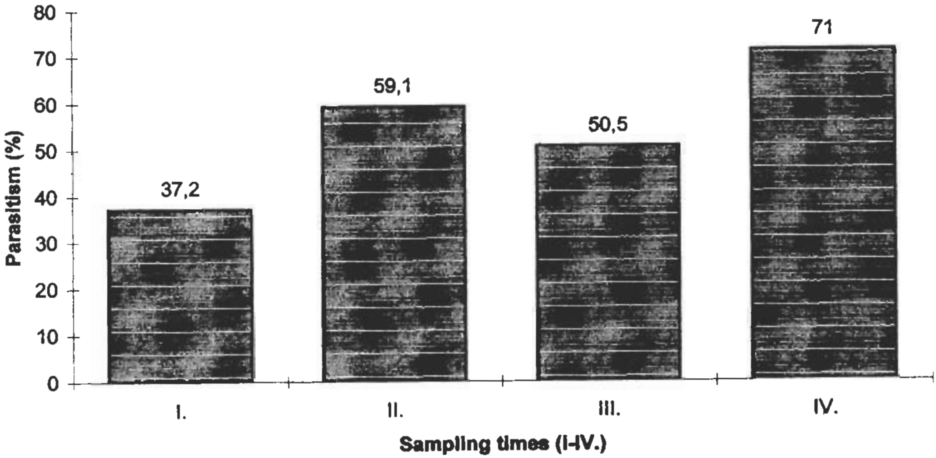

Fig. 2. I-IV sampling times: 19. August, 1998 (I); 25. August, 1998 (II); 31. August, 1998 (III); 10. September, 1998 (IV)

We found different size (1–2 mm) *Symbiocladius rhithrogenae* larvae among those that had got under the mayfly larva's wingbuds, so we drew a conclusions: parasite relationship may form at different larval stages of *S. rhithrogenae*. So, the time necessary for chironomid larva to form a parasite relationship with mayfly larva might extend.

From among the parasited mayfly larvae collected in the field, some (7) lost their larval skin during the microscope test, which resulted in chironomid larva's coming off the mayfly larva together with the lost larval skin of the latter. This chironomid larva had been hiding under the mayfly larva's wingbuds. However, this process did not last long, since the chironomid larva left the lost larval skin withinsome seconds and it crept back to the wingbuds of the mayfly larva just losing its cuticle. The chironomid larva got under the wingbuds again within 45 minutes which is a much shorter time as compared with the first penetration time (108 minutes). We do not have data on the fact to what degree the mayfly larva's losing its larval skin might influence the chironomid imago come out after the pupation of *Symbiocladius rhithrogenae* in the case of the pupas at the bottom. After pupation, the firstly light pupas gradually become darker and darker (Fig. 1 e). The actively moving pupa breaks the cuticle of the wingbuds before appearance, subsequently the chironomid imago emerges.

When comparing parasited and unparasited mayfly larvae, we did not experience any deviation in behaviours; according to our observations, mayfly larvae always survived when *Symbiocladius rhithrogenae* pupas became free (Fig. 1 g).

This proves that this must be a slight degree of parasitism, however, *S. rhithrogenae* larva feeding from mayfly larva, therefore the relationship forming between them has to be considered parasitism.

Summary

As a result of our regular field experiments between 1993–1998, we collected new data on the life-cycle of *Symbiocladius rhithrogenae* by examining its animate and unanimate surroundings. We also examined the formation of parasite relationship of the above species with *Electrogena lateralis* mayfly species: regarding the timespan of the relationship, too. As a result of the parasite relationship between *S. rhithrogenae* and *E. lateralis*, the chironomid species population doubtlessly becomes stronger at the expense of another species of insects; even though, according to our research, in this particular situation, a slight form of parasitism exists that parasited mayfly larvae survive.

Having examined the two species life-cycle overlaps, we assume that research into populations' intereffects, which is sometimes very hard, not only helps us get they more informations on the life-cycles of particular species, but might also contribute to the recognition of significant ecological phenomena.

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