

ACTA HYDROBIOL.	23	1	69—76	KRAKÓW 1981
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**Life cycle of *Rhithrogena loyolaea* (Navás)
(Ephemeroptera, Heptageniidae) in the Stream Strążyski
in the Tatra Mts**

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Manuscript submitted June 26, 1980

Abstract — Investigations of the life cycle of *Rhithrogena loyolaea* (Navás) were carried out in the Stream Strążyski in the years 1975—1976 and 1978—1979. This species has a semivoltine life cycle. At least a part of the eggs undergoes a many months long period of quiescence. In favourable conditions a small part of the population probably carries out a univoltine life cycle.

Key words: Entomology, mayflies, life cycle.

1. Introduction

In the territory of the Polish part of the Carpathian Mts the representants of the genus *Rhithrogena* have a univoltine life cycle. *Rhithrogena loyolaea* (Navás) which cannot be classified as an exclusively monocyclic species (Sowa 1975) is an exception. It is a high-montane, digostenothermic species with a disjunctive Carpathian — Alpine — Pyrenees distribution. It is also reported from the East Balkan Mts (Puthz 1978). In the Carpathian Mts it is restricted to the highest parts of the West Carpathian Mts: the Tatra Mts (Zelinka 1953, Sowa 1962, 1975), the Beskid Wysoki Mts and the Gorce Mts (Sowa 1975). In the streams of the Pyrenees and of the Alps this species may reach the altitude of 3000 m (Thomas 1970). The upper limit of its altitudinal

distribution in the Polish Tatra Mts is 1600 m, the lowest 900 m. Periodically it may reach the altitude of 1800 m, this being connected with the occurrence of water at those heights (S o w a 1975). Adult individuals fly from July till the beginning of September. Investigations of the life cycle of *Rhithrogena loyolaea* (N a v á s) were, so far, carried out by L a n d a (1968), and S o w a (1975). Since the results of these two authors differed it has seemed relevant to follow the life cycle of this species once again. Investigations were undertaken twice in the years 1975—1976 (O l e c h o w s k a) and in the years 1978—1979 (D a r o w i c z).

2. Study area

Investigations were carried out in the Stream Strążyski in the West Tatra Mts. Its length is 5.1 km. Down to the valley Hala Strążyska it does not take in any tributaries. Its spring is at an altitude of 1140 m and emerges from a lime stone rubble covering the bottom of the valley. About 200 m from its spring a rapid break in its gradient takes place on a rocky threshold 16.3 m high, forming there a waterfall called Siklawica. Investigation samples were collected at an altitude of 1100 m, 100 m below the waterfall i.e. about 300 m from its spring. The width of the bed at that place is about 3 m, the bottom is covered with stones and gravel, the banks are overgrown with a spruce forest. The distribution of air and water temperature for the two investigation periods is shown in fig. 1.

3. Method

The investigation material derives from two periods: — the first, ranging from 31st January 1975 to 12th February 1976, collected at two week intervals. Samples were always collected from the surface of about 1 m², the collected stones were rinsed over a vessel and its content was then strained through a bolting cloth of 0.3 mm mesh size; and, — the second, ranging from 1st June 1978 to 27th May 1979, collected in summer and autumn at two week intervals, and in winter and spring at one month intervals. Samples of a semiquantitative character were collected from stones and gravel with a standard bottom sampler of side width 22.5 cm, equipped with a net identical as in the former case. The material was preserved in 4 per cent formaline. Fixed nymphs were segregated in 1 mm size intervals, their sizes being measured from the front edge of the head to the back edge of the tenth tergite of the abdomen. In order to simplify the denotation size classes from 1 to 12

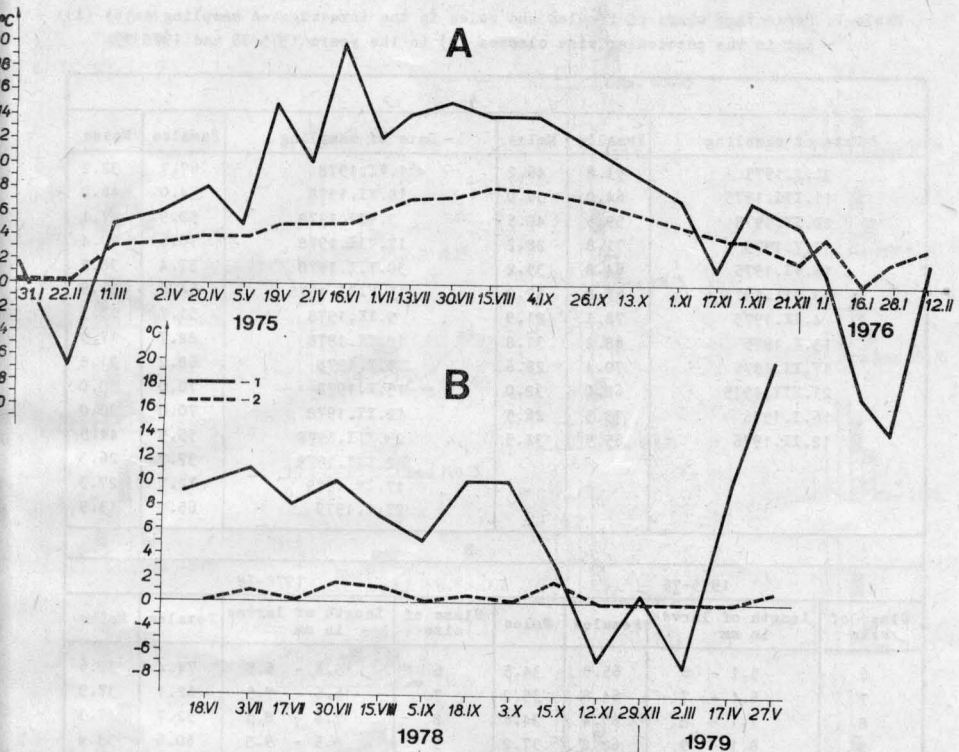


Fig. 1. Temperature of air (1) and water (2) at the station in the years 1975—1976 (A) and 1978—1979 (B)

were adopted. Particular size classes correspond to the respective intervals of the length of nymphs:

- first investigation period: class I — 0 mm to 1 mm
 class II — 1.1 mm to 2 mm, etc.;
- second investigation period: class I — 0.5 mm to 1.5 mm
 class II — 1.6 mm to 2.5 mm, etc.

In order to determine the dates of emergence the appearance and number of nymphs with dark wing pads were recorded. Further, in more grown-out nymphs from 5 mm on sex was recognized and recorded.

4. Results

The total number of the caught specimens was: in the years 1975—1976: 2736 nymphs, in it 951 females (64.6 per cent) and 520 males (35.4 per cent); in the years 1978—1979: 7869 nymphs, in it 434 females (64.5 per cent) and 239 males (35.5 per cent).

As it follows from Table IA, at all periods female nymphs prevailed. The lowest participation of males was recorded at both dates in Sep-

Table I. Percentage share of females and males in the investigated sampling dates (A) and in the particular size classes (B) in the years 1975-76 and 1978-79

A.							
Date of sampling		Females	Males	Date of sampling		Females	Males
31.I.1975		53.8	46.2	1.VI.1978		67.7	32.2
11.III.1975		64.0	36.0	18.VI.1978		54.0	46.0
20.IV.1975		59.5	40.5	3.VII.1978		52.9	47.1
19.V.1975		71.8	28.2	17.VII.1978		70.6	29.4
16.VI.1975		64.8	35.2	30.VII.1978		57.4	38.2
13.VII.1975		67.8	32.2	15.VIII.1978		54.2	31.9
4.IX.1975		78.1	21.9	5.IX.1978		51.7	23.3
13.X.1975		68.2	31.8	18.IX.1978		82.7	17.3
17.XI.1975		70.4	29.6	3.X.1978		68.2	31.8
21.XII.1975		68.0	32.0	15.X.1978		70.0	30.0
16.I.1976		73.5	26.5	12.XI.1978		70.0	30.0
12.II.1976		65.5	34.5	29.XII.1978		55.5	44.5
				2.III.1979		37.7	26.3
				17.IV.1979		72.7	27.3
				27.V.1979		65.1	43.9
B							
1975-76				1978-79			
Class of size	Length of larvae in mm	Females	Males	Class of size	Length of larvae in mm	Females	Males
6	5.1 - 6	65.5	34.5	6	5.6 - 6.5	74.4	32.6
7	6.1 - 7	64.8	35.2	7	6.6 - 7.5	62.1	37.9
8	7.1 - 8	65.4	34.6	8	7.6 - 8.5	52.7	47.3
9	8.1 - 9	62.8	37.2	9	8.6 - 9.5	60.6	39.4
10	9.1 - 10	63.4	36.6	10	9.6 - 10.5	71.4	28.6
11	10.1 - 11	75.0	25.0	11	10.6 - 11.5	96.2	3.8
12	11.1 - 12	77.8	22.2	12	11.6 - 12.5	100.0	-

tember. The highest percentage of males was noted in classes 8 and 9 (1975—1976) and in 9 and 10 (1978—1979); the lowest in the last two classes.

The distribution of nymph size of the investigated species in the univoltine cycle from the years 1975—1976 and 1978—1979 was presented in figs 2 and 3 respectively. In these two seasons emergence started in July and lasted till the beginning of September. The emergence in 1975, earlier by about two weeks, may be connected with the more favourable climatic conditions in that season. It results from the histograms that the rate of nymphs growth is very low during the whole year. Nymphs belonging to classes 11 and 12 were present at the station during the periods both preceding emergence and during it. Nymphs of other classes, including newly hatched ones were recorded from early September till the end of March. This is manifest in the samples from the years 1978—1979. In that investigation period nymphs were also caught from the gravel which proves to be the main habitat of the youngest nymphal stages. From mid June till mid September the presence of two „cohorts" was noticeable, this being concurrent with the time of emergence.

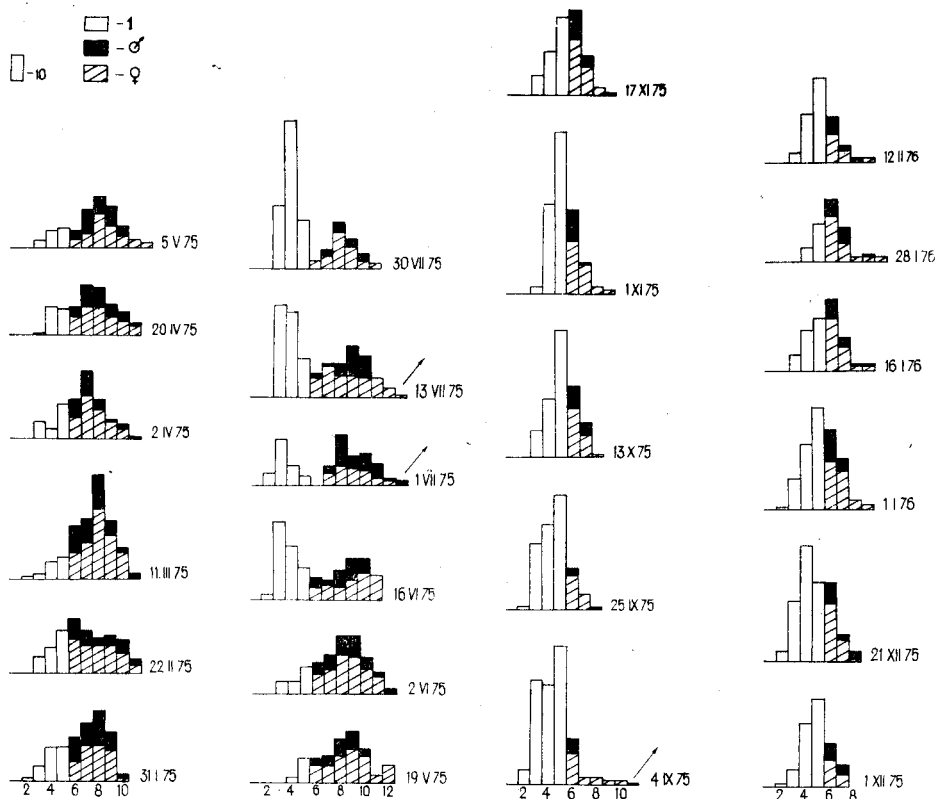


Fig. 2. Distribution of size classes of nymphs of *Rhithrogena loyolae* (N a v á s) in the Stream Strążyski in the years 1978—1979. 1 — sex not determined, ♂ — emergence of subimagines

5. Discussion

L a n d a (1968) classified the investigated species to the group with one generation in a year (monocyclic). Comparing the obtained results this hypothesis cannot be accepted. S o w a (1975) classified *Rhithrogena loyolae* to semicyclic species assuming that, at favourable thermic conditions, a small part of the population can carry out a full life cycle during one year. The present elaboration seems to confirm the hypothesis forwarded by S o w a.

A slow rate of nymphal development and presence of nymphs of various size classes at the station during the whole year prove a semi-voltine cycle. This is also corroborated by the division of nymphs into two „cohorts” distinctly visible in summer time, corresponding to the period of emergence. Insects belonging to one „cohort” emerge in this season, insects belonging to the other one can emerge only in the following year. From the eggs laid in the summer season young nymphs

Number of nymphs

310¹

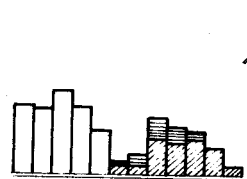
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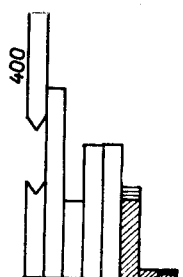
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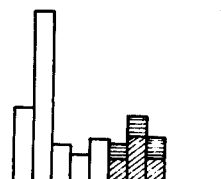
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30.VII.78



15.X.78



27.V.79

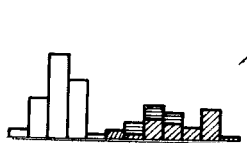
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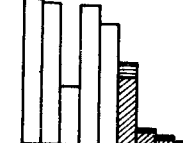
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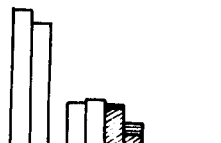
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17.VII.78



3.X.78



17.IV.79

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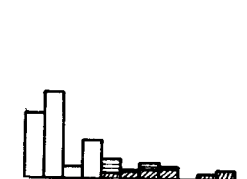
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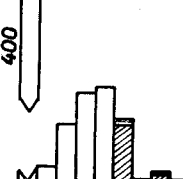
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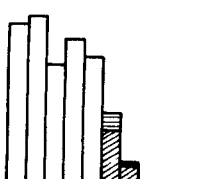
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3.VII.78



18.IX.78



2.III.79

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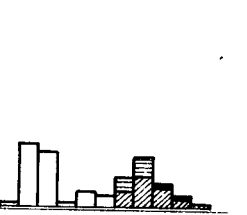
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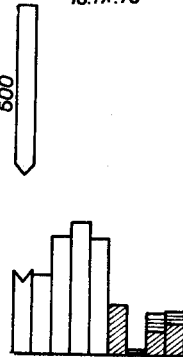
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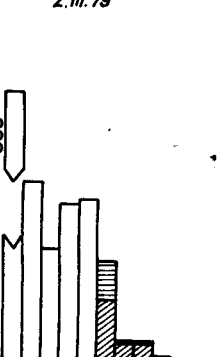
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18.VI.78



5.IX.78



29.XI.78

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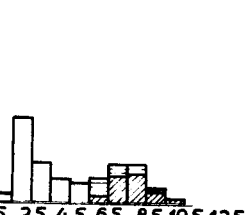
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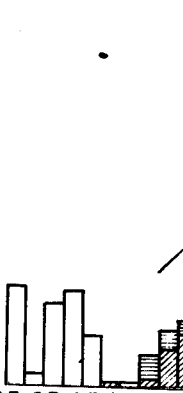
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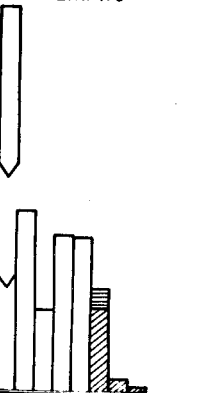
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1.VI.78



15.VIII.78



12.XI.78



hatch successively from September till late spring of the following year. It seems that eggs from which nymphs hatch at the beginning of September develop without a period of quiescence, whereas, eggs from which nymphs hatch during the winter and spring of the following year have a elongated embryonic growth period with a possible few months long period of quiescence. It is possible that a small part of the population which originate from the eggs laid in July and which do not undergo a period of quiescence will be able to carry out a univoltine life cycle. Emergence of adult individuals at the investigation station starts in July. It may be that in the lower sector of the stream, emergence occur somewhat earlier and the females make their compensation flights up the stream. Then eggs laid earliest could originate from the females of another population. This, however, could not be elucidated without the use of special methods for denoting the insects.

Rhithrogena loyolaea (N a v á s) shows flexibility in carrying out the life cycle. This is evidenced, among others, by the differences in the periods of emergence connected with the geographical situation (the Stream Olszowy in the Gorce Mts and the Stream Strążyski in the Tatra Mts), climatic differences, and the difference in the growth rate of nymphs at the same station in the years 1975—1976 and 1978—1979. For a more precise determination of the growth rate of the nymphs, of the length of the quiescence period in the embryonic development of eggs, and of optimal conditions of development this species must be cultivated in laboratory conditions.

Acknowledgement

The author is deeply indebted to Mrs Mariola Darowicz M. Sc. from Zakopane for her kind permission to make use of her materials.

6. Polish summary

Cykl życiowy *Rhithrogena loyolaea* (N a v á s) (Ephemeroptera, Heptageniidae) w Potoku Strążyskim w Tatrach

Badania przeprowadzono w cyklu rocznym dwukrotnie: w latach 1975/1976 i 1978/1979. Próby pobierano zazwyczaj w odstępach dwutygodniowych na stanowisku położonym w górnym odcinku potoku, gdzie ma on dno kamienisto-żwirowe i wodę czystą i bardzo

←
 Fig. 3. Distribution of size classes of nymphs of *Rhithrogena loyolaea* (N a v á s) in the Stream Strążyski in the years 1978—1979. 1. — sex not determined, ♂ — emergence of subimagines

zimną w ciągu całego roku (ryc. 1). Zbierano larwy metodą półilościową stosując standardowy drapacz dna o średnicy oczek 0,3 mm. W obu okresach badań uzyskano zbliżone wyniki. Rozkład milimetrowych klas wielkości (długości) ciała larw w ciągu roku oraz okres wylotu postaci skrzydlatych (od lipca do września) wskazują, że przynajmniej większość populacji ma dwuletni cykl życiowy z długim okresem spoczynku w rozwoju embrionalnym (ryc. 2 i 3). Nie można wykluczyć, że niewielka część populacji może mieć, w sprzyjających warunkach klimatycznych, roczny cykl życiowy. We wszystkich terminach połowu z obu okresów badań przeważały wśród starszych larw okazy samicze. Dotyczy to także poszczególnych klas wielkości; najmniejszy udział samców zaznacza się w dwóch ostatnich klasach (tabela I).

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