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LIFE HISTORY OF *AMELETUS LONGULUS* SINICHENKOVA, 1981 (EPHEMEROPTERA: AMELETIDAE) IN A SMALL STREAM IN VICINITY OF VLADIVOSTOK

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Summary. The data on distribution and life history of *Ameletus longulus* Sinichenkova, 1981 (Ephemeroptera: Ameletidae) are given. This univoltine species overwinters in the nymphal stage. Eggs development is direct. Incubation of eggs lasts for about one month. Hatching of eggs takes place from May to July. The larval growth continues for about 320 days without winter diapause. Flying of imago is prolonged and takes from mid April to the beginning of June.

Key words: Ephemeroptera, mayflies, *Ameletus longulus,* life history, Russian Far East.

Е. А. Горовая. Жизненный цикл *Ameletus longulus* Sinichenkova, 1981 (Ephemeroptera: Ameletidae) в условиях малого водотока в окрестностях Владивостока // Дальневосточный энтомолог. 2018. N 353. С. 17-23.

Резюме. Приводятся сведения о распространении и жизненном цикле *Ameletus longulus* Sinichenkova, 1981 (Ephemeroptera: Ameletidae). *Ameletus longulus* является унивольтинным зимующим в нимфальной стадии видом. Развитие яиц прямое. Инкубационный период занимает около одного месяца. Отрождение личинок с мая по июль. Рост личинок без зимней диапаузы и продолжается около 320 дней. Вылет имаго растянутый и наблюдается со второй половины апреля по первые числа июня.

INTRODUCTION

Mayfly *Ameletus longulus* Sinichenkova, 1981 can be considered as endemic to the Russian Far East (Sinichenkova & Tshernova, 1976; Sinichenkova, 1981; Tiunova, 2013). This species was erroneously synonymized with *Ameletus costalis* (Matsumura, 1931) by Kluge (2007), and resurrected as valid species by Tiunova (2013). *Ameletus longulus* was also recorded from Primorsky krai and Amur River basin as *A. costalis* (Tiunova, 2005; Tiunova & Potikha, 2005) and *Ameletus* gr. *cedrensis* (Tiunova & Gorovaya, 2011; Tiunova & Korotenko, 2008). Here the distribution of *A. longulus* in the Russian Far East is clarified based on the collection the Laboratory of Freshwater Hydrobiology of Federal Scientific Center of Biodiversity FEB RAS (Vladivostok) and the materials collected by author (Fig. 1). Present paper devoted to some peculiarities of *A. longulus* biology in vicinities of Vladivostok City.

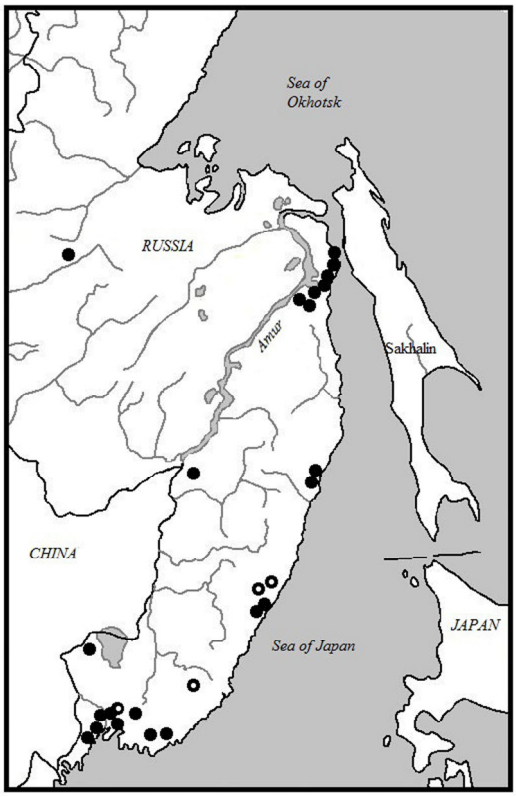

Fig. 1. The map of the distribution of the *Ameletus longulus* in the Russian Far East (● – by material examined, ○ – by published data).

MATERIALS AND METHODS

Larval samples for study of the life history were collected from a spring which flows into the east of the Muravyov-Amursky Peninsula through the territory of the Rybachii village (near Vladivostok, Primorsky krai). This spring originates from the southeastern slopes of one of highest points of Vladivostok of Vargin Mount (458m) and runs into the Ussuri Bay of the Sea of Japan. The length of the spring is about 3.8 km. The first 2/3 of this length run through the forest and the 1/3 runs through the village on open places. Spring alimentation comes from numerous wellsprings, subsoil waters and it is pluvial as well. The depth of the spring outside floods periods varies from 0.1 to 0.4 m, but there is one manmade cavity about 1.2 m deep near the Rybachii village. The most full-flowing spring is in May and June and after typhoons and others extreme natural events. The flow velocity is about 0.1–0.5 m/sec in spring time and in autumn, 0.1 m/sec in winter and 0.4–1.5 m/sec in summer. According to Levanidov's (1969) classification this spring has a moderate cold-water thermal regime with recorded temperature from 0.2°C to 20.1°C. The spring bottom has different mesh-size distribution. It has large rock, small petrosal or sandy substrate. Also it can be covered by warp or moss.

Fig. 2. The sampling site on the Rybachii village spring.

Numerous natural and anthropogenic factors cause frequent and quick changes in the type of substrates and surfaces covered by the substrates. This is also true for the changes in water flow velocity during the year and ice coverage in winter.

The spring of Rybachii village is subjected to a drastic anthropogenic load, however it is characterised by a significant abundance of aquatic insects. There are larvae of about 16 species of mayflies (Tiunova & Gorovaya, 2017), 15 species of stoneflies (Teslenko, 2017), caddis flies, chironomids, black flies, dragon flies and also amphipods and flat worms in the spring.

The mayfly samples were collected at a location on the border between "forest" and "open" parts of the spring in the areas with different kinds of substrate and variform currents (Fig. 2). The larvae of *A. longulus* were collected with a kicking net with gauze No. 23 at two week intervals from the end of October 2015 to the beginning of October 2016. During a freeze-up (from end of November to beginning of December 2015 and from the first day of January to middle of March 2016) the samples were gathered through a man made ice-hole on a riffle. There were collected 233 specimens of *A. longulus.* The samples were preserved initially in 96% ethanol and after definition (as defined by Sinichenkova (1981) and Tiunova (2013)) 75% ethanol was used. Identification of larvae and imago was done by rearing in natural and managed conditions. As a growth characteristic length of the larvae body was used and all larvae of *A. longulus* were measured with 0.1mm precision under the ocular micrometer of an MBS-10 binocular. The previous researches showed that the width of head capsule for the *Ameletus* genus is not indicative (Gorovaya, 2017). As an age criterion of mayfly's larvae it was proposed to consider incipiency and development of wings pads and change of their location in relation to abdominal tergites (Plescot, 1958; Jop, 1981). The *A. longulus* larvae has wings pads which reach the posterior margin of the first tergite and overgrow it only at the latest stages of the development. Due to this reason an age plan proposed by I. Levanidova and L. Rubanenkova (1965) was used in this work.

RESULTS AND DISCUSSION

Currently the distribution of *A. longulus* is limited to streams of Primorsky krai and eastern parts of Khabarovsky krai and of Amurskaya oblast (Fig. 1).

A. longulus larvae belong to ecological group of psychrorhitrophile – they are cold rithral zone lovers (Tiunova, 2005) and inhabit quiet sites of streams with fast current and prefer petrosal and pebble bottom. Being collectors-gatherers and good swimmers *A. longulus* larvae try to stay near water front on big stones from the surface of which they collect small parts of fine particulate organic matter.

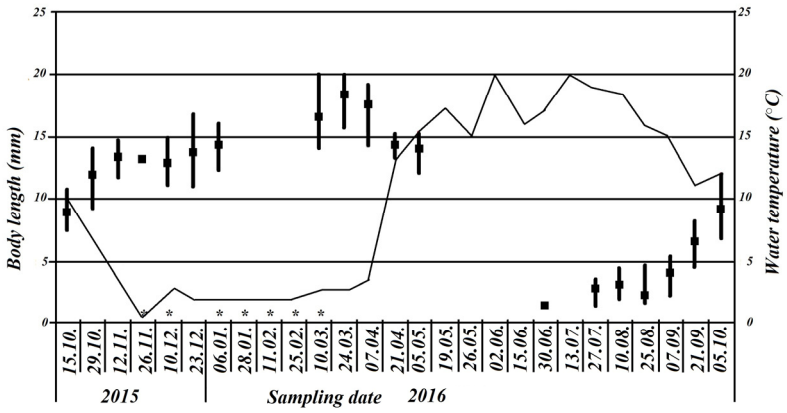

Fig. 3. Dynamics of water temperature and body length range of *Ameletus longulus* in the spring of Rybachii village in 2015–2016 (* – ice coverage).

Calendar dates of imago's emergence in different geographical parts of the Russian Far East have small differences. In Primorsky krai subimago and imago were noticed near the streams since the first days of June. In the more northern region (Nikolaevsky region of Khabarovsky krai) they were registered at the end of June. It allowed identifying a flying period as the early-summer one (June–July) (Gorovaya, 2014). During of our research collection in the spring of Rybachii village the first sporadic larvae's skins after the metamorphosis

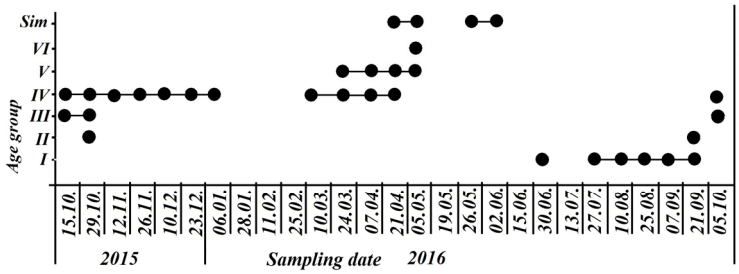

Fig. 4. The age structure of the *Ameletus longulus* population in the spring of Rybachii village in 2015–2016 (*Sim* – subimago).

to subimago were found on the 21 April 2016 at the water temperature 13.3°C. By that time flying of all large specimens with body length about 19–20 mm already took place and samples taken after the 21 April 2016 contained *A. longulus* larvae with body length less than 15.2 mm. These medium-sized specimens conducted the active emergence of subimago which was noticed at this spring from the 26 May 2016 to the 2 June 2016 (the water temperature 15–20°C). Samples collected on 15 June 2016 did not contain the larvae of *A. longulus*.

Figs. 5–10. Gradations the pads of wings of the different age groups of *Ameletus longulus* larvae: 5 – I; 6 – II; 7 – III; 8 – IV; 9 – V; 10 – VI.

Thus the process of flight of *A. longulus* was prolonged and lasted from the second part of April to the first days of June. Emergence of subimago from Rybachii village spring was in day-time (12 p.m. – 2 p.m.) from large stones and pebbles mainly in sunny weather. The process of molting from subimago to imago in managed conditions occurred in 30 hours in the evening time.

The first tiny nymphs of *A. longulus* with body length of 1.2–1.4 mm were collected in the spring of Rybachii village at the end of June (Fig. 3). By the end of July the body length of these larvae was about 1.9–3.4 mm. However the single small nymphs (1.4–1.5 mm) were also present in the spring until the end of August, 2016. It is assumed that the eggs development is direct and the incubation in the water with temperature from 15°C to 20°C lasts for about one month. The process of eggs hatching in the spring took place since the end of May through July. However the great bulk of larvae appeared at close time-frame. As a result, during the whole period of development the population of *A. longulus* constituted a certain growth group. All individuals of this group at one moment of time had similar size characteristics.

The active larvae growth processes were observed during the all larvae time. The presence of larvae molting skins in the samples collected on the 11 February 2016 as well as insignificant changes in dimensions of the larvae bodies which were found after the ice clearance, indicates that the processes of growth and development of *A. longulus* did not stop during under-ice period at the temperature of about 2^0C.

During the first months after hatching only increasing of larvae's body length took place (age group I, Figs. 4, 5). The pads of fore wings started to appear in the larvae (age group II, Fig. 6) when the body length reached 4.4–8.2 mm at the end of September. The pads of hind wings appeared (age group III, Fig. 7) at the beginning of October. By the middle of November all larvae reached the age group IV (Fig. 8). The process of active growth and development of *A. longulus* was observed till the beginning of winter months. Since the beginning of March there were observed the processes of gestation of larvae, the processes of development of wings pads which determined their transition to age groups V (Fig. 9) and VI (Fig. 10) and subsequent emergence of subimago.

Thus the mayflies *A. longulus* in the small stream on the south of the Russian Far East have the univoltine life cycle and winter in the nymphalinae stage. The larval growth continues about 320 days and does not have winter diapause. The process of flight of *A. longulus* is prolonged and takes place during two months from the second part of April to the first days of June. Eggs development is direct and the incubation lasts for about one month. The process of eggs hatching took place since May through July.

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