ARTICULATA 2020 35: 79–85 **FAUNISTIK**

New data on the biology of Nocaracris bulgaricus (Ebner & Drenowski, 1936) (Orthoptera: Pamphagidae) in mountains of northern Greece and southern Albania

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Abstract

The Bulgarian Stone Grasshopper (Nocaracris bulgaricus) is a threatened species of the South Balkans. The species occurs at medium to high elevations. We studied the life cycle and found that the species overwinters as nymph, its development is slowed down at the second nymphal stage during 6 months in winter and then the development returns to normal speed. We did not notice differences between our breeding at temperate temperatures and in natura at cold temperatures in mountains. We concluded that the nymphs are sheltered by low bushes against snow and low temperatures during winter.

Zusammenfassung

Die Pamphagide *Nocaracris bulgaricus* (Bulgarian Stone Grasshopper) ist eine bedrohte Art des Südbalkans. Die Art kommt in mittleren bis hohen Lagen vor. Wir untersuchten den Lebenszyklus und stellten fest, dass die Art als Larve überwintert, ihre Entwicklung im zweiten Larvenstadium während sechs Monaten im Winter verlangsamt und die Entwicklung dann wieder zu normaler Geschwindigkeit zurückkehrt. Wir stellten keine Unterschiede zwischen unserer Zucht bei gemäßigten Temperaturen und in der Natur in den Bergen bei kalten Temperaturen fest. Wir schlossen daraus, dass die Jungtiere den ganzen Winter über von niedrigen Büschen vor Schnee und negativen Temperaturen geschützt sind.

Introduction

The genus *Nocaracris* includes about forty species mainly distributed in Asia Minor and the Middle East, with only two taxa known in Europe: *Nocaracris istanbul* Ünal, 2016 only known to the Istanbul region in Turkey and a species studied in this paper, and *N. bulgaricus* (Ebner & Drenowski, 1936). This species, formerly placed in the genus *Paranocaracris*, is reported from the southern part of European Turkey, southern Bulgaria, northern Greece up to Albania to the west (Puskas, comm. pers.). In Greece, it occurs in mountainous regions of Epirus, Macedonia and Thessaly (WILLEMSE et al. 2018). The species has been assessed as Endangered (EN) in the IUCN red list (CHOBANOV et al. 2016).

As in many Pamphagidae, *N. bulgaricus* is difficult to detect in the field, as the animals are inconspicuously coloured and not very active, particularly the females. The difference in size between the sexes is remarkable, the females can reach 40 mm, while the males do not exceed 26 mm.

We studied the species in Greece, where it lives in the mountain and subalpine vegetation belts between 1400 and 2300 m above sea level. Usually xero-thermophilous meadows, spotted with bushes (*Buxus sempervirens, Juniperus* sp*.,* etc.) are preferred, but we have noticed that in the areas where cattle grazing pressure is high, the species tends to take refuge in denser vegetation refused by livestock, such as shrubberies and forest edges with scrubs.

The period of emergence of adults generally indicated in the literature is between June and August (HARZ 1975, WILLEMSE et al. 2018), sometimes sooner, in May (ÜNAL 2016).

During several consecutive years, we observed many nymphs in the early stages, sometimes mixed with adults, from the beginning of August and until the end of autumn on several stations located between 1200 and 1900 m elevation in the regions of Epirus and Macedonia in Greece, as well as in the south of Albania (Puskas, comm. pers.). The fact that these stations, located in mountains, are generally covered with snow in winter, has led us to conduct investigations to better understand the development of this species.

Material and methods

Four stations selected for investigation (Figure 1):

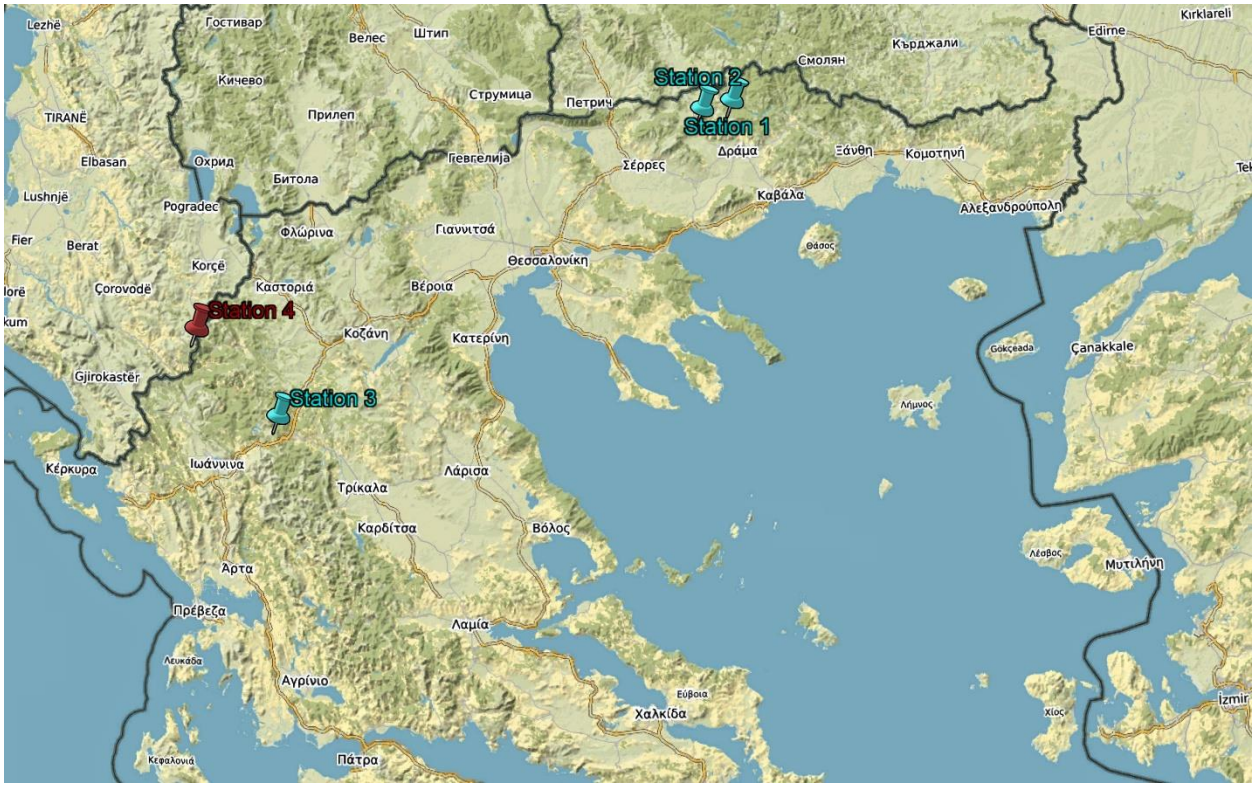

Figure 1: Map of the studied stations.

Station 1: Mt Falakron – Macedonia. Greece. Subalpine meadow, rocky and moderately grazed by cattle, with herbaceous vegetation, sometimes dense in clumps and with some bushes including *Juniperus sp*. N41.300 / E24.077 - 1930 m elevation. Five nymphs (stage 1) have been collected for breeding in the end August 2018.

Station 2: Mt Agios Pavlos – Macedonia, Greece. Rocky meadow with low and dense herbaceous vegetation with some ligneous. N41.264 / E23.886 - 1400 m elevation. Five nymphs (stage 1) have been collected for breeding in the end August 2018.

Station 3 (Figure 2): Katara, Metsovo – Epirus, Greece. Clear and stony *Buxus sempervirens* community, on the edge of a pine forest. N39.802 / E21.199 – 1630 m elevation. Thirteen nymphs in stage 2 collected for breeding by mid-November 2019.

Station 4: Grammos mountains, Kolonjë county– Albania: Pine forest with stream. N40.221 / E20.676 – 1260 m elevation. No nymphs collected in this station, but we note that one male adult and some nymphs have been observed mid-October (G. Puskás, comm. Pers.).

Figure 2: Biotope of *Nocaracris bulgaricus* in Greece: Katara, Metsovo at 1630 m elevation. © Michèle Lemonnier-Darcemont.

Breeding

The nymphs were kept in our laboratory, in a 40 x 40 cm terrarium, with lighting corresponding with the natural day light and regular humidification. The room was heated all the day throughout the winter. The temperature range in the room was from 15 °C at night (at the coldest) to 23 °C during the day (at the warmest).

The diet consisted of wheat bran and plants renewed every two days: grass, cauliflower leaves, various herbaceous plants.

Results

In winter, all individuals are in nymphal stage 2. Their activity is reduced to a minimum, also the feeding is much reduced, but not null. Mainly stems and leaves of fresh grasses and Brassicaceae leaves are particularly appreciated (Figure 3), and occasionally wheat bran. The young nymphs squat on the ground of the terrarium or perch in the branches of *Buxus sempervirens* which were placed in the cage. The nymphs of the last stage and adults prefer to stay close to the ground.

We have had very little mortality. The dissection of the few nymphs who died in stage 2, shortly after their capture in autumn 2019, revealed the presence of larvae of acridophagous dipterans.

We did not observe any growth evolution during the whole winter period. Stage 3 was reached in March, the fourth stage at the end of the same month and the last moult in April (Figure 6).

We analysed the development of a parasitized female with a growth stop in the last stage. The individual was euthanized mid-July and the dissection revealed that its abdominal cavity was almost completely filled with dipteran larvae.

Mating and egg laying took place from May until July at least (Figures 4 and 5); the optimum being observed in June on Mt Falakron, at 1900 m elevation. The nymphs in first stage are observed in August and by the end of August, most of them are in stage 2 for wintering.

Figure 3: Nymph (Stage 2) eating a cauliflower leaf in early December (breeding). © Christian Darcemont.

Figure 4: Mating in early June on Mt Falakron (Greece), at 1930 m elevation. © Michèle Lemonnier-Darcemont.

Figure 5: Egg laying in late May (breeding). © Christian Darcemont.

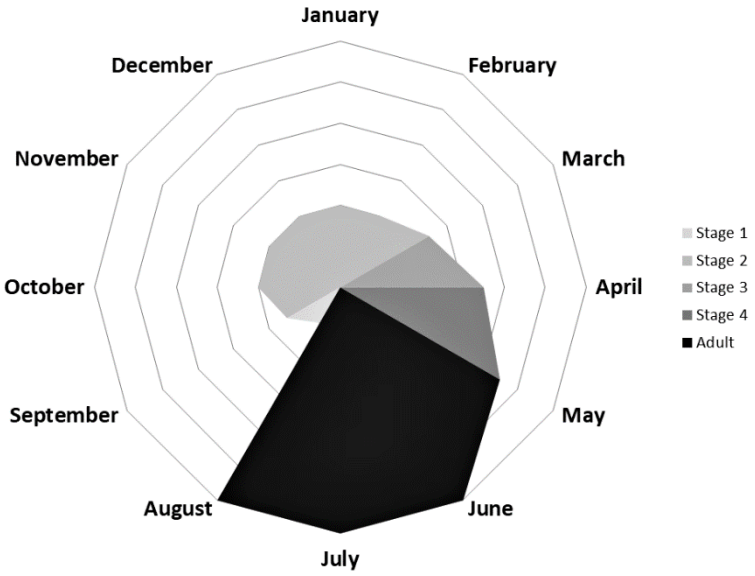

Figure 6:
Phenology graph.

Discussion and conclusion

The Bulgarian Stone Grasshopper (*Nocaracris bulgaricus*) overwinters as nymph (in stage 2). Our comparative observations in breeding and in natura do not show any differences concerning the period of emergence of the adults which is always at the end of May, beginning of June. This shows that temperature is not a determining factor. The mechanism is different and probably determined by internal biological factors and/or the length of the day.

Despite that the life cycle of many Pamphagidae species is not well known, the overwintering as nymphs has already been mentioned in some other species of this family in Europe, such as *Ocnerodes brunneri* in the northeast of Spain in Catalonia, in the Mediterranean area at around 800 m elevation (OLMO-VIDAL 2000) or *Paranocarodes chopardi* in Greece (oriental Macedonia), around 1000 m elevation (ALEXIOU 2017). Nevertheless, our study stations are all located above 1000 m above sea level and up to more than 1900 m elevation, in some mountainous regions which can have long periods of snow cover. In these mountains *Gryllus campestris* can often reach 1700 m elevation in its nymphal state during winter and it is sheltered in a burrow dug by its predecessors.

The preferred biotopes of *Nocaracris bulgaricus* include a relatively large proportion of low bushes (*Juniperus, Buxus*…) and it is likely that this vegetation is a shelter that effectively insulates them from the low temperature and excess humidity, even when they are covered by snow.

Acknowledgements

We would like to express our thanks to Gellért Puskás for the communication of his data from Albania.

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