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Ecological and morphological notes on *Notopygus bicarinatus* (Hymenoptera: Ichneumonidae)

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ABSTRACT: *Notopygus bicarinatus* Teunissen, 1953 is parasitoid of web-spinning sawflies of the genus *Cephalcia*. This species was found near Větrný Jeníkov. The first record from Bohemia including *Cephalcia lariciphila* as a new additional host. *N. bicarinatus* oviposit into the larvae of *C. lariciphila* when borrowing in soil in the late May. The infestation of *Cephalcia* prepupae is not high and varied within the range of 3.5–6.1% during test period 2003–2005.

Keywords: Bohemia; *Cephalcia lariciphila*; Czech Republic; ecology; morphometry; new host; new record; *Notopygus bicarinatus*

Notopygus bicarinatus Teunissen, 1953 is a Palearctic species, in Europe known from Austria (Jahn 1978), Finland, Germany, the Netherlands (Yu et al. 2005), Italy (Scaramozzino 2009) and Poland (Kaźmierczak 2004). In the Czech Republic, Kaněčka (1993) reported this species from three localities in Moravia: the Beskids – near Velké Karlovice (1,000 m a.s.l.) and the Českomoravská vysočina Highlands – near Kněžice (630 m a.s.l.) and Třešť (650 m a.s.l.).

The literature provides little information on the biology of this species. The only host species known until now is *Cephalcia abietis* (Linnaeus, 1758) (Jahn 1978; Kaněčka 1993; Kasparyan 2002). The flight period extens from the second half of July to mid-August (Kaněčka 1993).

The composition of parasitoids was also studied (Holuša 2011) In this work, we describe (*i*) the morphometry of *N. bicarinatus*, (*ii*) details of its finding, and (*iii*) the parasitization level of *C. lariciphila*.

MATERIAL AND METHODS

The research was carried out near the Bohemian village of Větrný Jeníkov at Peklo Hill (699 m a.s.l., 49°28'8.385"N, 15°29'44.369"E), during an outbreak of *Cephalcia lariciphila* (Wachtl 1898) in the central part of the Czech Republic, which was the in period 2000 to 2004). The larch trees (*Larix decidua* Mill.) used for the study represented the monospecies patches (about 50 m apart) within a spruce (*Picea abies* [(L.) Karst.]) stand. The vegetation zone is the *Abieti-fagetum oligotrophicum* association (Plíva 1991). The climate of the area is moderately warm and dry (Culek et al. 1996). The nearest weather station is at Přibyslav (15°45'45"E, 49°34'58"N; 530 m a.s.l.). According to station data for 1955 to 2001, (*i*) the annual mean temperature was 6.8°C, (*ii*) mean temperature during the May–September growing season was 12.8°C, (*iii*) mean annual total precipitation was 691.2 mm, and (*iv*) mean sum of precipitation during the growing season was 442.6 mm.

Five soil plots of 0.5 × 0.5 m were sampled in each of eight groups of larches (diameter of larch groups is about 50 m) in 2003, only three plots in 2004 to 2005. The plots were located beneath the trees' canopy, along a contour line, at intervals of 5–10 m. Leaf and forest litter (ca to the depth of 15 cm) was dug away and removed at these sites, followed by

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the upper layer of soil (Ah horizon to a depth of 5 cm). The samples were sifted through a coarse sieve with 10 × 10 mm openings. The sampling was conducted during 6–17 April 2003 (P. Baňař lgt.), 7–17 October 2003 (R. Volf lgt.), 2 April 2004 (P. Baňař lgt.), and 3 April 2005 (J. Holuša lgt).

Cocoons was stuck on *C. lariciphila* prepupae from which only the head capsule and rolled skin remained. Cocoons were placed into Petri dishes with forest litter, covered with monofilament mesh and regularly moistened until the adults emerged (at a temperature of 20°C and 16 h of daylight). All material was collected by the Forestry and Game Management Research Institute and determinate by J. Šedivý (material from 2003) and K. Holý (material from 2004–2005).

Measuring of the size of adults (length of body – form head to end of metasoma, length of the fore wing) was carried out using a stereomicroscope with an accuracy of 0.1 mm and measuring of the cocoons' size (length, width, distance of the emergence hole from the top) was carried out with an accuracy of 0.25 mm.

Tests for normality and the Mann-Whitney U test were performed in the programme STATISTICA Vers. 8.0.

The nomenclature is based on Fauna Europaea (Taeger, Blank 2009; Zwakhals 2009).

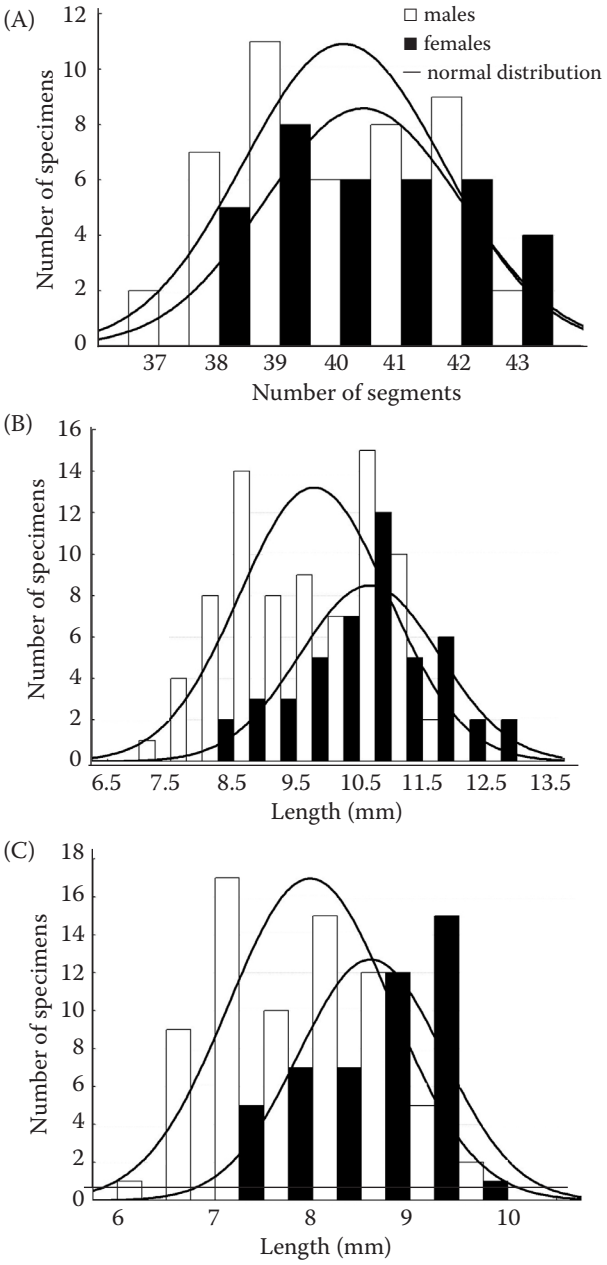

Fig. 1. Numbers of antennal flagellomeres (A), body lengths (B) and lengths of the fore wings (C) of the emerged *Notopygus bicarinatus*

RESULTS

Within May 2003, there emerged in total 89 individuals of the ichneumon wasps *N. bicarinatus*. The infestation in spring 2003 varied based on individual study areas within the range of 1.5–5.2%. In autumn tests, 121 individuals of *N. bicarinatus* emerged, and infestation varied between 3.2 and 11.3%. In spring 2004, 45 adults emerged and infestation varied within the range of 2.8–3.5%. In

Fig. 2. *N. bicarinatus* female (up); empty cocoon (down)

spring 2005, 27 adults emerged. Average parasitization rate of *C. lariciphila* prepupae by *N. bicarinatus* was in individual periods 3.3% (spring 2003), 6.1% (autumn 2003), 3.4% (spring 2004) and 5.5% (spring 2005). Females of *N. bicarinatus* oviposited into larvae of *C. lariciphila* while borrowing into the soil in late May. In test, no hyperparazitoid emerged from *N. bicarinatus* cocoons.

The number of antennal flagellomeres in both sexes of *N. bicarinatus* does not differ, thus in males ($N = 45$), ranging from 37 to 43, and in females ($N = 35$), 38 to 43 ($z = -0.61$; $P > 0.10$) (Fig. 1). Body length in males is a little shorter (7.4 to 11.9 mm) than in females (8.1–12.8 mm) ($z = -3.72$; $P < 0.001$) (Fig. 1), similarly the length of the fore wing in males (6.4–9.8 mm) is shorter than in females (7.1 to 9.8 mm) ($z = -3.88$; $P < 0.001$) (Fig. 1). The fore wings have brown pterostigma with variable yellow basal part (Fig. 2), in males often with yellow spot with variable dark centre occupying one third to one half of the spot area.

The cocoon is smooth, gray-black, attached to the remnants of the host in fallen larch litter. The shape is oblong elipsoidal, widest in the middle, narrowing toward the opposite ends. The male cocoons ($N = 33$) are smaller (9–12.5 mm) than that of females ($N = 12$) (11–13 mm) ($z = -3.55$; $P < 0.001$) (Fig. 3). The width of cocoons at the widest point in males is 3–4.5 mm, which is significantly smaller than in females (4 to 4.5 mm) ($z = -2.06$; $P < 0.05$) (Fig. 3).

The emergence hole is situated laterally at the top of the cocoon. The position of the emergence hole varies from the top of the cocoon to 1 mm from the top, but it always points to the side (Fig. 2). The emergence hole of the males is closer to the top, whereas in females the edge of the emergence hole starts further from the edge. The difference, however, is not statistically significant ($z = -1.77$; $P > 0.01$). Diameter of the emergence hole is 1.5 to 3 mm, of oval shape with fringy margins.

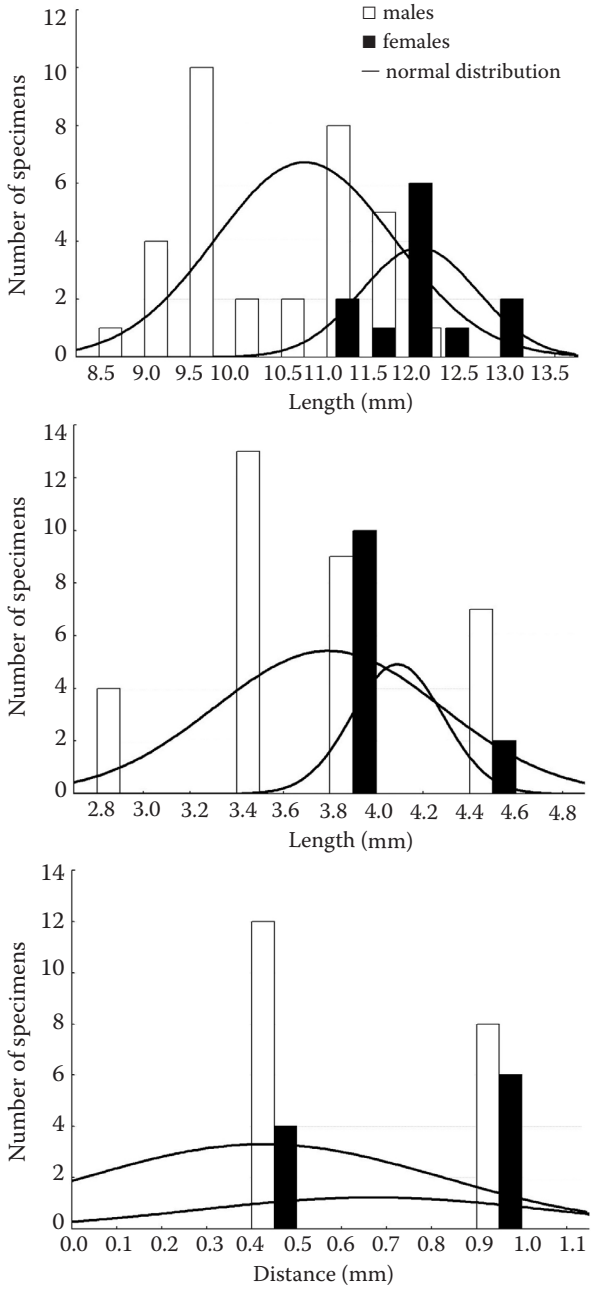

Fig. 3. Length (left) and width (middle) of the cocoon and distance of the emergence hole from the top of the cocoon (right) of *Notopygus bicarinatus*

DISCUSSION

N. bicarinatus is a widely distributed Palearctic species. The first record of its occurrence in the Czech Republic was published by Kaněčka (1993), who collected this species in emergence traps on three Moravian localities together with *C. abietis*. The find of this species near Větrný Jeníkov is the first record for Bohemia. The altitude of the locality is fully consistent with the altitudes of the Moravian localities (Kaněčka 1993).

The number of antennal flagellomeres in males of *N. bicarinatus* as found (i.e. 37–43 flagellomeres) differs slightly from that of Teunissen (1953) (i.e. 39–42). In females, Teunissen (1953) mentioned 40–44 flagellomeres and Kasparyan (1981) 39–44, the latter of which almost agrees with number of 38–42 flagellomeres in our test. Besides in some specimens the significant asymmetry based on the single surplus flagellomera between right and left antenna was also found. Finally no significant difference in the number of antennal flagellomeres in males and females was found, as well.

The body length in males varies from 7.4–11.9 mm, in females from 8.1 to 12.8 mm. The length of the fore wing in males varied from 6.4 to 9.8 mm, in females

from 7.1 to 9.8 mm. The body length of *N. bicarinatus* corresponds partly with data published by Teunissen (1953) (9–13 mm) and Kasparyan (1981) (8–13 mm) although they do not distinguished sexes.

The colour of pterostigma agrees with Teunissen's (1953) original description, but wholly disagrees with monochromatic yellow pterostigma as mentioned by Kasparyan (2002).

The male cocoon is 9–12.5 mm long and 3–4.5 mm wide, the female cocoon is 11–13 mm long and 4 to 4.5 mm wide. On average, female cocoons are slightly larger than are those of males, which corresponds to the females' larger body size and greater length of the fore wing compared with males.

C. abietis (Jahn 1978; Kaněčka 1993; Kasparyan 2002) was the only so far known host species of *N. bicarinatus*. *C. lariciphila* is a new additional host for this parasitoid. Flight period of *N. bicarinatus* depends on the host life cycle. Since the larval development of *C. lariciphila* is completed by the end of May (Holuša 2011), explicitly flight period of *N. bicarinatus* corresponds to this period. In opposite, the larval development of *C. abietis* is accomplished later in period from June to August (Pschorn-Walcher 1982), and therefore Kaněčka (1993) did not detect its appearance until the summer months.

A low rate of parasitization corresponds to the findings of Jahn (1978) and Kaněčka (1993), who found that *N. bicarinatus* might not be a significant regulator of the abundance of the related pest species *C. abietis*. Preliminary results suggest that parasitization and mortality during eclosion do not affect the population dynamics of *C. lariciphila*. Population dynamics most probably are affected primarily by such specialized predators as insectivores and possibly nematodes (Holuša, Turčáni 2007).

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