

Impact of the parasitic wasp *Nasonia* spp. (Walker, 1836) Hymenoptera: Pteromalidae) on populations of bird blowflies *Protocalliphora* spp. Hough, 1899 (Diptera: Calliphoridae)

Abstract

In this work we focused on the prevalence of infection of *Nasonia* spp.¹ in pupae of *Protocalliphora* spp. collected from nests (n=160) of different avian hosts from different sites in Slovakia. Our research was focused on the impact of this parasitoid wasp on bird blowflies under natural conditions. We studied its occurrence, which was 83.125% of all nests where bird blowflies were present. The consequent mortality of host populations was 61.087% with the number of wasps localized in individual pupa estimated on almost 23. The aim of this work was to show that parasitoid wasp *Nasonia* spp. significantly affects populations of *Protocalliphora* spp. under natural conditions and that they have important role in regulation of population of bird blowflies.

Keywords: *Nasonia* spp., *Protocalliphora* spp., pupae, parasitoid wasp, Slovakia

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Jan Jamriska,^{1,2} Terezia Lucenicova²

¹Tierklinik Zistersdorf, Austria

²Wildlife Rescue and Rehabilitation Center, Slovakia

Correspondence: Jan Jamriska, Wildlife Rescue and Rehabilitation Center—Into the Wild/Navrat do divociny, Borinka 199, 90032 Borinka, Slovakia, Email jan.jamriska5@gmail.com

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Introduction

The immature stages of a large number of blowflies are parasitized by parasitic wasps with local or cosmopolitan distribution.²⁻⁴ Several species parasitize pupae of bird blowflies by penetrating the host pupae. One such group of parasitic wasps, are solitary or gregarious ectophagous parasitoids from the Pteromalidae family. The most commonly world-wide distributed is *Nasonia vitripennis*. Its life cycle is well established because it has been widely used in genetic and field studies^{5,6} and pupal parasitoids have attracted a lot of attention because of their potential control of house and stable flies in farms.¹ A female parasite with matured eggs drills through the host pupae with her ovipositor laying eggs externally on the pupa and injects a substance, to narcotize or kill the host. The female feeds on haemolymph from the host tissues. The parasite larvae feed throughout the three instars, and then pupate, and the adult's enclose approximately 24 hours before biting one or more holes and emerging from the host pupa. The same emergence hole is used by successive emerges, and the males usually emerge before the females.⁶⁻⁸ The females do not drill pupae which have an emergence hole of a fly or parasites, otherwise it drills without laying eggs if the host is not pupated or is dead or contains late instars parasite larvae or adults.⁷ Temperature and humidity are important factors in the survival of the wasp, and in unsuitable conditions for further development the third instar can be diapaused. Previously there has been little information about the parasitization of bird blowflies under natural conditions. Eshuis van der Voet⁹ recorded that 48.8 % of *Protocalliphora* spp. pupae were infested by this parasitic wasp in *Parus major* nests in Holland, while in the USA, 20.1 % of these species pupae found to be parasitized by the same wasp.² The parasitization of *N. vitripennis* reported by Peters⁴ was 42.1% in *Protocalliphora azurea* (*cele meno*) pupae and 15.8% in *Protocalliphora falcozi* (*cele meno*) pupae.

Material and methods

We collected 2300 specimens of pupae from 160 bird nests infected by *Protocalliphora* spp. from western Slovakia during the 2011-2014

season. These nests were collected after nestlings fledged, carefully examined, and pupae were reared, observed under a stereomicroscope and then divided into groups. At first, there was a group that contained pupae specimens where *Protocalliphora* spp. flies emerged and no parasitoids were found. The second one consisted of specimens which were parasitized by parasitoid wasps. Presence of parasitoids was determined by exit holes and enclosed pupae were dissected and inspected for wasps. All stages of parasitic wasp if present were counted. These results were statistically analyzed, and compared to accessible records. The parasitic wasp was identified according to Bouček's¹⁰ taxonomic key. Some parasitized pupae were kept under laboratory conditions, (T=26°C, humidity 65%) until wasps emerged to identify how many adult specimens were able to develop and emerge from one particular puparium.

Results

During the seasons 2011–2014, 160 bird nests parasitized by bird blowflies were collected from western Slovakia, whereas 83.125% (133) of these nests, were predated with parasitoid wasp *Nasonia* spp. 2300 pupae specimens were reared from all these nests (133). Only 38.913 % (895) of adult flies emerged from nests where *Nasonia* spp. was found. The rest of pupae 61.087 % (1405) were predated by parasitoid wasp (872) or did not develop from other differing reasons (533). Therefore the mortality rate of *Protocalliphora* spp. pupae directly caused by *Nasonia* spp. was estimated on 37.913 % and causes such as temperature or environmental factors resulted in a further 23.174 % cases. We also recorded the number of parasitoid wasps in one pupa. 50 pupae were held under laboratory conditions to let the wasps develop and emerge. Almost 40% of selected puparia were predated by parasitoid wasps. The average number of adult *Nasonia* specimens emerging from one pupa was 22.7±9.1 while the min=14 and the max=49 specimens.

Discussion

Numerous parasitoid species attack more than one host species,

and in many cases, these hosts vary in suitability for the parasitoid development.^{11,12} The most common polyphagous pupal parasite *N. vitripennis* is found in North America, together with two other pteromalids *N. giraulti* and *N. longicornis*.¹¹ *N. vitripennis* is a generalist and parasitizes a wide range of fly hosts, including blowflies, flesh flies and houseflies.¹¹ Other rarer parasitoid wasps recorded from *Protocalliphora* spp. puparia, include those from the near arctic region; namely pteromalid *Morodora armata*,¹³ pteromalid *Dibrachys cavus*¹ and encyrtid *Tachinaephagus zealandicus*.¹⁴ Additionally, the pteromalid *Muscidifurax raptor*¹⁵ was recorded in the bird nests containing *Protocalliphora* spp. but definite association with it was not established.^{2,3} The most important parasitic wasp which attacks the pupae of bird blowflies in Europe is *N. vitripennis*.^{4,16,17} In contrast to much laboratory research on this species there is only little known about its biology under natural conditions. The clutch number in *Protocalliphora* pupae is ranging from 4 to 24 wasps per host.¹⁸ Draber¹⁷ reported that in 7 puparia 140 adults of *Nasonia* spp. were found (min=11 and max=44 specimens). Our research showed that the average number of adult *Nasonia* specimens emerging from one pupa was almost 23, and this is consistent with King and Skinners' reports. *Nasonia* females probably regulate the number of eggs laid during one period and supernumerary larvae are eliminated by starvation. Eshuis van der Voet⁹ recorded 48.8 % of *Protocalliphora* pupae infested by this parasitic wasp in *Parus major* nests in Holland, while in the USA, 20.1 % of these species pupae found to be parasitized by the same wasp.² The parasitization of *Nasonia vitripennis* reported by Peters⁴ was 42.1% in *Protocalliphora azurea* puparia and 15.8% in *Protocalliphora falcozi* puparia. In this study we found that parasitism of *Protocalliphora* spp. pupae, directly attributable to *Nasonia* spp. occurred in 37.913 % of birds nests where this parasitoid wasp was present. Additionally, 83.125% of the total nests found, were subject to parasitoid predation. It seems that parasitoid wasp *Nasonia* spp. plays an important role in regulation of population of bird blowflies in birds nests and only 38.913 % adult flies emerge from pupae present in nests. Also specific host ecology can be something that plays its role in parasitoid predation.

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Conflicts of interest

Authors declare that there is no conflicts of interest.

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