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Original article

FIRST RECORD OF *LIPOPTENA CERVI* (DIPTERA: HIPPOBOSCIDAE) AMONG GOATS IN BULGARIA

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Summary

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The investigation was conducted on 4,599 goats from eight breeds, naturally infected with ectoparasitic insects. The visit to the farms was paid after the owners alarmed for signs of considerable discomfort and itching among the animals. Two of examined flocks turned out to be infected with *Lipoptena cervi* (Linnaeus 1758*)* from the Hippoboscidae family, order Diptera, also known as deer ked or deer fly. Complete morphological description of detected 34 flies was performed. The total body length of male specimens varied from 2.754 to 3.754 mm, and that of females: from 3.508 to 4.500 mm. This is the first report about this insect species among goats in our country, which confirms the studies reporting expansion of its distribution area. The deer fly spread among this non-specific host incurs risk from emergence of new vector-borne diseases in men and animals.

Key words: deer fly, ectoparasites, morphology

INTRODUCTION

The family Hippoboscidae consists of three subfamilies: Ornithomyinae, Hippoboscinae and Lipopteninae, the latter including 32 species (Dick, 2006). The species of veterinary importance are *Lipoptena capreoli, Lipoptena cervi, Lipoptena depressa, Lipoptena fortisetosa, Lipoptena mazamae* and *Neolipoptena ferrisi* (Gałęcki *et al.*, 2020).

Lipoptena cervi (Linnaeus 1758), also known as deer ked or deer fly, is the most commonly encountered species from this family that attacks deer in Europe (Dehio *et al.*, 2004). The deer ked is encountered all over Europe, in China, North Africa and North America (Skvarla & Machtinger, 2019). During the recent years, an increasing expansion of *L. cervi* has been observed (Lazar *et al.*, 2014; Jaakola *et al.*, 2015*)*. The commonest hosts comprise red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and fallow deer (*Dama dama*). They are important for the spread of *L. cervi*, as deer ked fly nearly 50 m seeking a host (Paakkonen, 2012).

Deer keds attack also other hosts as companion animals (Sokoł & Gałęcki, 2017), European bison (Izdebska, 2001),

mouflons, wild goats (Bianchi *et al.*, 2016), horses and cattle, but does not reproduce on them (Dehio *et al.*, 2004). In laboratory conditions, it feeds on dogs, house mice, moles, monkeys, pigeons and waterfowl. Povolný & Rosický (1955) have outlined the goat (*Capra hircus*) as accidental host in Slovakia. Men could be also infested (Kaunisto *et al.*, 2009; Härkönen *et al.*, 2009). When the insect finds an appropriate host, it settles on it for the rest of its life and gradually loses its wings as a result of burrowing through the haircoat (Andreani *et al.*, 2019). After several days, females lay completely developed larvae that rapidly pupate (Wood, 2010). Adult flying insects leave pupae to find new hosts which takes place between August and October (Hackman *et al.*, 1983). In Europe, the entire biological cycle with the winter diapause takes 270–370 days (Maa & Peterson, 1987). Most commonly, adult insects are detected on hosts in autumn and winter (Kadulski, 1974) with life span of one year.

Being a bloodsucking insect, it causes direct damage to skin, severe alopecia, hyperaemia, multifocal to coalescing and eosinophilic to lymphocytic dermatitis (Madslien *et al.*, 2011), as well as substantial blood loss in the host (Dehio *et al.*, 2004; Wall, 2007; Kaunisto *et al.*, 2009). In infested humans, dermatitis, allergic reaction and allergic rhinoconjunctivitis and even anaphylactic shock may occur consequently to stimulation of host immune response (Dehio *et al.*, 2004; Laukkanen *et al.*, 2005; Härkönen *et al.*, 2009). Bites induce scattered erythematous papules which may persist up to one year and accompanied with pruritus (Gałęcki et al, 2020). Härkönen *et al.* (2009) affirm that the number of people with severe dermatitis caused by *Lipoptena cervi* will continue to grow.

It is known that *L. cervi* transmits zoonotic agents to its hosts, e.g. agents of borreliosis, bartonellosis, anaplasmosis, coxiellosis and trypanosomiasis (Bruin *et al.*, 2015; Buss *et al.*, 2016).

MATERIALS AND METHODS

Animals

The present study was conducted in 34 farms from 29 settlements in 16 districts of Bulgaria.

A total of 4,599 goats from eight breeds, naturally infected with ectoparasite insects were examined. The farms were located in different regions of southern, northern, western, eastern and central parts of the country with various landscape. Our visit to the farms was initiated by the owners that alarmed for signs of considerable discomfort and itching among the animals. During the grazing season, goat flocks were in contact with other herds of domestic and wild ruminants on pastures.

Examination

Examined goats were inspected with magnifying glass for presence of skin lesions as alopecia, flakes, crusts, nodules, and for presence of eggs and adult ectoparasites. Detected insects were individually collected with tweezers and stored in containers with 70^{o} ethanol. All collected insects were transported to the laboratory. After identification, hippoboscids were fixed with entomological pins and stored in entomological boxes. Species identification was done according to morphological features described by Maa (1963), Hutson (1984) and Andreani *et al.* (2019).

According to the morphological description of Maa (1963) *L. cervi* has three pairs short stout legs of various strength and stability, compound eyes and palps of various length. The dorsal part of 2nd pleuron has a slightly narrowed end, the 3rd and 4th pleurons possess two lateral spiracles each of which are much more noticeable dorsally than ventrally. The 5th pleuron is barely seen.

Hutson (1984) recognises the species by the three middle tergitae plates arranged evenly on the abdomen, presence of compound eyes, a postvertex which is much wider than longer, noticeably shorter than the mediovertex, presence of 15–18 laterocentral bristles on the mesonodum; prosternum bristles.

Andreani *et al.* (2019) modified the keys proposed by Maa (1963) with respect to more accurate and certain identification of species. They described the ventral surface of the chest, which has sparse bristles and hairs or densely arranged predominant bristles with only few hairs in other family members, as a considerable difference distinguishing subfamily Lipopteninae from the other members of the family Hippoboscidae. Wings are fully developed and are kept after landing on the host, whereas Lipopteninae flies have dense evenly arranged bristles and their fully developed wings are partially shed after landing on hosts resembling solid semi-cylindrical veinless knobs, halters are present. The eyes are as wide as long, about twice wider than antennae. Male *L. cervi* have evenly arranged 4-6 abdominal tergal plates, whereas females: 4–7.

Microscopic observations and photographs were made on Leica® microscope with photo camera. Seven morphological parameters of collected male and female specimens were measured: head length, head width, thorax length,; thorax width, abdomen length, maximum abdomen width, and total body length. For each of measured parameters, mean value, minimum and maximum values were calculated (STATISTICA 7).

RESULTS

Out of the examined 34 flocks, two were infected with insects, never detected by us before. The flock in the Veliko Tarnovo district consisted of 208 animals, and that in Haskovo district – of 210. In the first flock, 14 infected goats (7%) were found out vs 10 in the other one (5%). The average extent of infestation for both flocks was 5.74%. Infected animals had low rate of infestation (1–2 insects per host) spread over the entire body of goats except for the head and distal part of the legs. Detected insects were identified as *Lipoptena cervi* (Linnaeus 1758) from the family Hippoboscidae of order Diptera, also known as deer fly or deer ked.

The morphological features of this ectoparasite show its good adaptation to parasitic lifestyle: dorsoventrally flattened body, thickened cuticle to bear mechanical loads and a well expressed chaetotaxy. Hairs and bristles increase the cohesion with haircoat of the host. The colour of head, chest and anterior abdomen from dorsal (Fig. 1) and ventral (Fig. 2) sides is brownish-orange, and that of targal plate located on the abdomen and leg – yellow. The head is oval, with compound eyes, proboscis mouthpart, normally concealed in a sheath. The chest is trapezoid, with broken wings to the second segment (Fig. 3). Spiracles of the first and third segments are well visible. Legs are solid and end with 2 curved spurs each (Fig. 4).

The abdomen is oval, with medially located 4–6 tergal plates in males (Fig. 2)

Fig. 1. *L. cervi*, Linnaeus (1758), male, dorsal side. Black arrows – compound eyes; white arrowheads – shed wings; white arrows – tergal plates.

Fig. 2. *L. cervi,* Linnaeus (1758*),* male, ventral side.

Fig. 3. *L. cervi*, Linnaeus (1758), female, dorsal side. Black arrows – compound eyes; white arrowheads – shed wings; white arrows – tergal plates.

Fig. 4. *L. cervi,* Linnaeus (1758*),* female, ventral side.

Table 1. Values of main biometric parameters of the species *L. cervi* (Linnaeus, 1758).

Parameter	Male (n=15)			Female (n=19)		
	Min.	Max.	Mean	Min.	Max.	Mean
Total body length (mm)	2.754	3.756	3.240	3.508	4.500	3.846
Head length (mm)	0.282	0.319	0.304	0.256	0.317	0.284
Thorax length (mm)	0.985	1.296	1.147	1.236	1.445	1.318
Abdomen length (mm)	1.358	2.107	1.800	2.005	2.812	2.301
Head width (mm)	0.919	0.952	0.931	0.921	1.097	0.993
Thorax width (mm)	1.083	1.206	1.119	1.105	1.460	1.190
Maximum abdomen width (mm)	1.408	1.915	1.730	1.020	1.084	1.825

and 4–7 in females (Fig. 4) seen from the dorsal side.

The total body length of males varied from 2.75 to 3.75 mm, and that of females: from 3.5 to 4.5 mm. All additional measurements are summarised and presented in Table 1.

DISCUSSION

The results of our morphometric examinations showed similar values of total body length (TBL) with those reported by Kaunisto *et al.* (2009): 3.5-5 mm regardless of the sex. Acici *et al.* (2012) detected *L. cervi* in roe deer in Turkey observing only five female insects with TBL 4.77–5.22 mm.

Andreani *et al.* (2019) provided evidence for this hippoboscid fly in Toscana having examined three red deer (*C. elaphus*) and two does. They measured total body length and maximum abdomen width in 55 male and 54 female insects. The average total body length of females was 7.40±0.071 mm with abdomen width 3.84 ± 0.038 mm, whereas average total body length and abdomen width of males was 6.71 ± 0.091 mm and 3.92 ± 0.049 mm, respectively. It may be assumed that the reason for notably larger size was the different host and conditions of transportation and storage of insects.

The global warming resulted in shorter diapause and increased deer ked populations during the last years. This is especially pronounced in forest areas. The migration of specific hosts increases the insect's areal and even non-specific sites (cities) may be affected (Gałęcki *et al.*, 2020). The farms where the deer ked was detected by us were located outside settlements in premountainous forested areas in contact with wildlife. The detection of *L. cervi* among goats is likely as it has been already reported in this host in Slovakia (Povolný & Rosický, 1955), whereas Maa (1969) has described the species as present in our country as well.

A specific host is colonised by 9.9 hippoboscids on the average (Szczurek & Kadulski, 2004), despite that Vikøren *et al.* (2008) have reported more than 16,000 in a moose. In our study, the intensity of infection was low (1–2) probably because of the non-specific host (goats).

In Poland, the extent of infestation of fallow deer was 76% and in red deer: 78% (Szczurek & Kadulski, 2004). In goats, a low extent of infestation was found out – 5.74%. Nevertheless, the presence of the parasite on non-specific hosts and the expansion of its distribution area indicate its rapid adaptation to novel environment. This is genetically predetermined in the insects's haplotype (Gałęcki *et al.*, 2020).

The role of the deer ked as a vector of diseases with veterinary and medical importance is not yet fully acknowledged and thus, may be underestimated. There is evidence that louse flies are vectors of dangerous zooanthroponosis agents (Bruin *et al.*, 2015; Buss *et al.* 2016). Therefore, purposeful ecological, epidemiological and genetic research is necessary to reveal the significance of deer keds for the transmission of vector-borne diseases specific to our country.

CONCLUSION

The present report describes the first detection of *L. cervi* on goats in Bulgaria, supporting existing studies about the expansion of its areal. The spread of the deer ked among this non-specific host species incurs a risk for emergence of new vector-borne diseases in men and animals.

REFERENCES

Acici, M., C. Bolukbas, E. Beyhan, G. Pekmezci, A. Gurler & S. Umur, 2012. Ectoparasites on roe deer (*Capreolus capreolus*) in Samsun. *Turkish Journal of Veterinary and Animal Sciences,* **36**, 456–459.

Andreani, A., P. Sacchetti & A. Belcari, 2019. Comparative morphology of the deer ked Lipoptena fortisetosa first recorded from Italy. *Medical and Veterinary Entomology,* **33**, 140–153.

Bianchi, A., M., Salvetti & I. Bertoletti, 2016. Dati preliminari riguardanti i ditteri Ippoboscidi (Diptera: Hippoboscidae), ectoparassiti di ungulati nelle province di Sondrio e Lecco (Italia settentrionale), e osservazioni sulle specie del genere *Lipoptena conosciute* in Europa. *Il Naturalista Valtellinese: Atti del Museo Civico di Storia Naturale di Morbegno,* **27**, 15–36.

Bruin, A., A. D. Leeuwen, S. Jahfari, W. Takken, M. Foldvari, L. Dremmel, H. Sprong & G. Foldvari, 2015. Vertical transmission of *Bartonella schoenbuchensis* in *Lipoptena cervi*. *Parasites & Vectors,* **8**, 176.

Buss, M., L. Case, B. Kearney, C. Coleman & J. D. Henning, 2016. Detection of Lyme disease and Anaplasmosis pathogens via PCR in Pennsylvania deer ked. *Journal of Vector Ecology,* **41**, 292–294.

Dehio, C., U. Sauder & R. Hiestand, 2004. Isolation of *Bartonella schoenbuchensis* from *Lipoptena cervi*, a blood-sucking arthropod causing deer ked dermatitis. *Journal of Clinical Microbiology* **42**, 5320–5323.

Dick, C. W., 2006. Checklist of World Hippoboscidae (Diptera: Hippoboscoidea). Department of Zoology, Field Museum Natural History, Chicago, IL, pp. 1–7.

Gałęcki, R., J. Jaroszewski, X. Xuan & T. Bakuła, 2020. Temporal-microclimatic factors affect the phenology of *Lipoptena fortisetosa* in central European forests. *Animals,* **10**, 2012.

Hackman, W., T. Rantanen & R. Vuojolahti, 1983. Immigration of *Lipoptena cervi* (Diptera, Hippoboscidae) in Finland, with notes on its biology and medical significance. *Neotropical Entomology,* **63**, 53–59.

Härkönen, S., M. Laine, M. Vornanen & T. Reunala, 2009. Deer ked (*Lipoptena cervi*) dermatitis in humans - An increasing nuisance in Finland. *Alces,* **45**, 73–79.

Hutson, A., 1984. Handbooks for the ldentification·of British Insects Keds, flat-flies and bat flies (Hippoboscidae and Nycteribiidae), v.10, part 7.

Izdebska, J. N., 2001. European bison arthropod parasites from closed Polish breeding facilities. *Acta Parasitologica.* **46**. 135–137.

Jaakola, M., M. Ojanen, E. Hurme, M. Mutanen, N. Wahlberg, P. Välimäki & A. Kaitala, 2015. Morphological variation between populations of the expanding ectoparasitic deer ked *Lipoptena cervi* (Diptera: Hippoboscidae) in Fennoscandia.

Biological Journal of the Linnean Society. **116**. 432–448.

Kadulski, S., 1974. The dynamics of infestation of the Cervidae with *Lipoptena cervi* L. (Diptera, Hippoboscidae) on the territory of Poland. *Wiadomosci Parazytologiczne.* **20**. 703–707.

Kaunisto, S., R. Korter, L. Härkönen, S. Härkönen, H. Ylönen & S. Laaksonen, 2009. New bedding site examination-based method to analyse deer ked (*Lipoptena cervi*) infection in cervids. *Parasitology Research,* **104**, 919–925.

Laukkanen A., P. Ruoppi & S. Mäkinen-Kiljunen, 2005. Deer ked-induced occupational allergic rhinoconjunctivitis. *Annals of Allergy, Asthma & Immunology,* **94**, 604–608.

Lazar, M., O. C. Iacob, C. Solcan, S. A. Pasca, R. Lazar, P.C. Boisteanu, 2014. The first report of massive infestation with *Lipoptena cervi* (Diptera: Hippoboscidae) in Roe Deer (*Capreolus capreolus*) in Iasi county, N-E of Romania. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia,* **69**, 293–298.

Maa, T. C., 1963. Gênera and species of Hippoboscidae (Diptera) : Types, synonymy, habitats and natural groupings. *Pacific Insects Monograph,* **6**, 132–138.

Maa, T. C., 1969. A revised checklist and concise host index of Hippoboscidae (Diptera). *Pacific Insects Monograph,* **20**, 261–299.

Maa, T. C. & B. V. Peterson,1987. Hippoboscidae. In: *Manual of Nearctic Diptera*, vol. 2, ed J. F. McAlpine, pp. 1271–1332.

Madslien, K., B., Ytrehus, T. Vikøren, J. Malmsten, K. Isaksen, H. O. Hygen & E. I. Solberg, 2011. Hair-loss epizootic in moose (*Alces alces*) associated with massive deer ked (*Lipoptena cervi*) infestation. *Journal of Wildlife Diseases*, **47**, 893–906.

Paakkonen, T., 2012. Ecophysiology of the Deer Ked (*Lipoptena cervi*) and its Hosts. PhD Thesis, University of Eastern Finland. https://erepo.uef.fi/bitstream/handle/123456789/10833/urn_isbn_978-952-61-0772-1.pdf?sequence=1&isAllowed=y (16 March 2022 date last accessed).

Povolný, D. & B. Rosický, 1955. Faunisticko-bionomický nástin klošovitých (Hippoboscidae, Diptera) z území ČSR. *Zoologické a entomologické listy,* **4**, 5–20.

Skvarla, M. J. & E.T . Machtinger, 2019. Deer keds (Diptera: Hippoboscidae: *Lipoptena* and *Neolipoptena*) in the United States and Canada: New state and county records, pathogen records, and an illustrated key to species. *Journal of Medical Entomology,* **56**, 744–760.

Sokoł, R. & R. Gałęcki, 2017. Prevalence of keds on city dogs in central Poland. *Medical and Veterinary Entomology,* **31**, 114–116.

Szczurek, B. & S. Kadulski, 2004. Ectoparasites on fallow deer, *dama* (L.) in Pomerania, Poland. *Acta Parasitologica,* **49**, 80–86.

Vikøren, T., A. Lillehaug & K. Handeland, 2008. Helseovervakingsprogrammet for Hjortevilt (HOP), Årsrapport for 2006 Og 2007. National Veterinary Institute Report Series, National Veterinary Institute, Oslo.

Wall, R., 2007. Ectoparasites: Future challenges in a changing world. *Veterinary Parasitology,* **148**, 62–74.

Wood, D. M., 2010. Hippoboscidae (louse flies). In: Manual of Central American Diptera, vol. 1, eds B. V. Brown, A. Borkent, J. M. Cumming, D. M. Wood, N. E. Woodley, M. A. Zumbado, NCR Research Press, Otawa, Canada, pp. 1241–1248.

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