

New records of ticks (Acari: Ixodidae) parasitising on bats in Slovakia

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Abstract. New records of ticks of the family Ixodidae (*Ixodes simplex* and *I. vespertilionis*), parasitising on bats in Slovakia, are presented. These records also include evidences of new bat host species for the respective parasites; i.e. *Ixodes simplex* found on *Rhinolophus hipposideros*, *Ixodes vespertilionis* on *Nyctalus noctula*, *Myotis mystacinus*, and *Pipistrellus cf. pygmaeus*. The first record of *Ixodes ricinus* parasitising on a bat (*Rhinolophus euryale*) in Slovakia is also reported.

Ectoparasites, Chiroptera, new records, new host, habitats

Introduction

The hard ticks (Ixodidae Dugès, 1834) are obligatory haematophagous ectoparasites parasitising temporarily or periodically on various taxa of terrestrial vertebrates (Kolonin 2007, 2008). The family is distributed worldwide, occupying various ecological niches (Camicas et al. 1998).

The species *Ixodes vespertilionis* Koch, 1844 and *I. simplex* Neumann, 1906 were included into the zone of bat acarinia of Central Europe by Rosický & Mrciak (1959) and Dusbábek (1972). Several characteristics of this zone are a result of ecological isolation of bats as a host group from other terrestrial vertebrates. Thus, the contacts between bats and hosts from other acarinia zones are considered rare and occurring almost exclusively in bat roosts.

Records of the two ticks on bats (Table 1, 2) were first reported from Slovakia already in the 1960s (Dusbábek 1963, 1972, Černý 1972). Together with recent records of *Ixodes vespertilionis* (Mock et al. 2007, Siuda et al. 2009, Uhrin et al. 2010), they represent rather accidental findings from the southern part of Slovakia and originate almost exclusively from bats examined in caves, as the most inspected habitats. Following seven bat species were reported as the hosts of *Ixodes vespertilionis* from Slovakia; viz. *Rhinolophus ferrumequinum* (Schreber, 1774), *R. euryale* Blasius, 1853, *R. hipposideros* (Borkhausen, 1797), *Myotis myotis* (Borkhausen, 1797), *M. blythii* (Tomes, 1857), *Miniopterus schreibersii* (Kuhl, 1817), and *Plecotus auritus* (Linnaeus, 1758). *Ixodes simplex* was reported only twice from Slovakia, found on *Miniopterus schreibersii* (Dusbábek 1963, Černý 1972).

Table 1. Outline of findings of *Ixodes vespertilionis* Koch, 1844 on individual hosts Slovakia.
 Tab. 1. Prehľad nálezov *Ixodes vespertilionis* Koch, 1844 na jednotlivých hostiteľoch Slovenska.
 Legend / legenda: F – female / samica; M – male / samec; N – nymph / nymfa; L – larva

host species hostiteľ	Dusbábek (1963*, 1972*)	Mock et al. (2007)	Siuda et al. (2009*)	Uhrin et al. (2010)	new records
<i>Rhinolophus ferrumequinum</i>	+	–	–	–	3 F, 13 N, 10 L
<i>Rhinolophus hipposideros</i>	+	–	+	–	12 F, 23 N, 40 L
<i>Rhinolophus euryale</i>	+	–	–	–	2 F, 1 N
<i>Myotis myotis</i>	+	–	–	2 F	1 F, 1 N
<i>Myotis blythii</i>	+	–	–	–	–
<i>Myotis mystacinus</i>	–	–	–	–	2 N
<i>Nyctalus noctula</i>	–	–	–	–	1 N
<i>Miniopterus schreibersii</i>	+	–	–	–	1 N
<i>Plecotus auritus</i>	+	–	–	–	–
<i>Pipistrellus cf. pygmaeus</i>	–	–	–	–	1 L
host unknown / hostiteľ neznámy	–	2–9	–	–	–
Σ No. of hosts / počet hostiteľov	7	–	1	1	8
Σ No. of records / počet nálezov	127	2–9	13	2	111
	12 F, 67 N, 48 L		3 F, 5 M, 2 N, 3 L	2 F	18 F, 42 N, 51 L

* author does not give the exact number of specimens and stages of *Ixodes* recorded on the host

* autor neudáva presný počet a štádiá *Ixodes* nájdených na hostiteľovi

Data on Ixodidae species parasitising on bats in Slovakia still remain rather poor. The published records originate from the traditionally studied karstic regions and from the most common cave bat species known as their hosts. We report here new findings of Ixodidae ticks from bats together with new data on their hosts and habitat types from the territory of Slovakia.

Material and methods

The data were gathered in the period March–October of 2005–2010 in several geographical units of the Western Carpathians (Malé Karpaty Mts – MK, Nitrianska pahorkatina Mts – NP, Považský Inovec Mts – PI, Revúcka vrchovina Mts – RV, Strážovské vrchy Mts – ST, Štiavnické vrchy Mts – SV, Trábeň Mts – T, Košická kotlina Basin – KK, Krupinská planina Plateau – KP, Veporské vrchy Mts – VV; 48° 18' – 48° 47' N, 17° 15' – 20° 59' E; 140–681 m a. s. l., see Fig. 1). Various methods of bat catching were used in different habitats and roosts: (a) nettings at cave entrances – NC, (b) nettings at mine entrances – NA, (c) nettings at or over water bodies – NL, (d) harp-trappings at tree holes – HT, (e) examinations and/or trappings of individuals in attics – A, (f) examinations of individuals in cellars – TE, (g) examinations of individuals in caves – TC. All hosts were sexed and aged using the following categories: adult male (♂ ad), adult female (♀ ad), subadult female (♀ sad), pregnant female (♀ G). Lactating females (♀ L) were identified according to their enlarged nipples and mammary glands. After checking for ectoparasites the bats were released. The collected ticks

Table 2. Outline of findings of *Ixodes simplex* Neumann, 1906 on hosts in Slovakia. For explanation see Table 1
 Tab. 2. Prehľad nálezov *Ixodes simplex* Neumann, 1906 na hostiteľoch Slovenska. Vysvetlivky viz tab. 1

host species / hostiteľ	Dusbábek (1963*)	Černý (1972)	new records
<i>Rhinolophus hipposideros</i>	–	–	1 N
<i>Miniopterus schreibersii</i>	+	1 L	1 N
Σ No. of hosts / počet hostiteľov	1	1	2
Σ No. of records / počet nálezov	+	1 L	2 N

were preserved in 75% alcohol; species were determined using the identification keys by Filippova (1977), Nuttall et al. (1908) and Yamaguti et al. (1971). We identified three stages of the life cycle of ticks: six-legged larva, eight-legged nymph and eight-legged adult; adult ticks were sexed (♂ – male, ♀ – female). The preserved parasites are deposited in collections of the Department of Zoology and Anthropology, University of Constantine the Philosopher in Nitra (DZA) and in the Institute of Zoology, Slovak Academy of Sciences, Bratislava (IZ), both in Slovakia.

The material examined is listed below. All records are complemented with the following data: localisation (site name, orographical unit, coordinates, and altitude) and date of the record, number of recorded parasites with identification of their stage, host species and habitat in the above defined categories.

Results

Ixodes (Pomerantzevella) simplex Neumann, 1906

Records. **Bradlo mine** (RV, 48° 37' 26" N, 20° 11' 41" E, 490 m a. s. l.), 20 June 2009 – 1 nymph from 1 ♂ ad *Miniopterus schreibersii*, NA, IZ; **Rákoš Baňa II mine** (RV, 48° 36' 25" N, 20° 09' 02" E, 454 m a. s. l.), 14 July 2007 – 1 nymph from 1 ♀ L *Rhinolophus hipposideros*, NA, IZ (leg. P. Kaňuch).

Distribution of this species is reported from the Palaearctic, Afrotropical, Oriental and Australian regions (Filippova 1977, Haitlinger & Ruprecht 1985, Walter & Kock 1985, Estrada-Peña et al. 1989, Teng and Jiang 1991, Kolonin 2003, Yamaguti et al. 1971).

Usually only adult females and nymphs are recorded. Males probably feed very rapidly and then quickly hide themselves (Arthur 1956, Yamaguti et al. 1971). Only one record of *Ixodes simplex* [reported as *I. pospelovae* Emčuk, 1955 (Dusbábek 1963)] has been known from Slovakia. Černý (1972) recorded a larva of this species on *Miniopterus schreibersii* collected in the Čertova diera cave in southeastern Slovakia. The new record from the Rákoš Baňa II mine represents a finding on a yet unregistered host in Slovakia (*Rhinolophus hipposideros*). Beaucournu (1967)

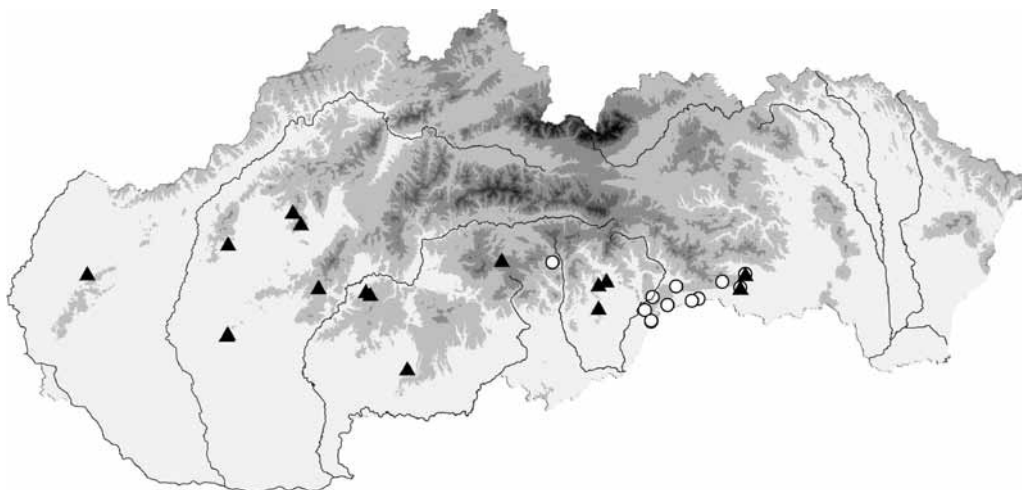


Fig. 1. Map of the records of ticks (Acari: Ixodidae) parasitising bats in Slovakia.

White circles – published records (for references see Table 1, 2), black triangles – new records.

Obr. 1. Mapa názvov kliešťov (Acari: Ixodidae) parazitujúcich na netopieroch na Slovensku.

Biely krúžok – publikované údaje (citácie pozri v Tab. 1, 2), čierny trojuholník – nové údaje.

and Haitlinger & Ruprecht (1985) referred *Miniopterus schreibersii* to be the main host of this tick species. However, several authors reported this tick also from other host taxa, e.g. *Rhinolophus ferrumequinum* from Shanghai, China (Nuttall et al. 1908), *Rhinolophus* sp. from Sudan and *Myotis* sp. from Kashmir (Arthur 1956), *Myotis myotis* from Germany (Walter & Kock 1985) and *Rhinolophus affinis* Horsfield, 1823 from Vietnam (Kolonin 2003). *Ixodes simplex* was also found on *Myotis myotis* in Poland, an area outside the distribution range of its main host, *Miniopterus schreibersii* (Haitlinger & Ruprecht 1985). However, *Rhinolophus hipposideros* is probably an occasional host species and our record may document a transfer of *Ixodes simplex* from *Miniopterus schreibersii* occurring syntopically in the Rákoš Baňa II mine system.

***Ixodes (Eschatocephalus) vespertilionis* Koch, 1844**

Records. Bradlo mine (RV, 48° 37' 26" N, 20° 11' 41" E, 490 m a. s. l.), 15 May 2009 – 1 ♀ from 1 ♂ ad *Rhinolophus hipposideros*, NA, DZA; 20 June 2009 – 1 ♀ from 1 ♀ ad *Rhinolophus euryale*, NA, IZ; **Brložná jaskyňa cave** (ST, 48° 45' 21" N, 18° 26' 32" E, 681 m a. s. l.), 30 March 2009 – 2 nymphs from 1 ♂ ad *Rhinolophus hipposideros*, TC, DZA; **Čabrad' castle ruins** (KP, 48° 14' 38" N, 19° 06' 23" E, 310 m a. s. l.), 23 April 2009 – 1 larva from 1 ♂ ad *Rhinolophus hipposideros*, 2 nymphs from 2 ♀♀ ad *Rhinolophus hipposideros*, and 4 larvae from 3 ♀♀ ad *Rhinolophus hipposideros*, TE, DZA; 28 November 2009 – 1 nymph from 1 ♀ ad *Rhinolophus hipposideros* and 2 larvae on 2 ♂♂ ad *Rhinolophus hipposideros*, TE, DZA; **Chvalovská jaskyňa cave** (RV, 48° 31' 11" N, 20° 9' 29" E, 270 m a. s. l.), 31 July 2009 – 1 ♀ from 1 ♀ ad *Rhinolophus euryale*, NC, IZ; **Jaskyňa pri kaplnke cave** (SV, 48° 31' 22" N, 18° 51' 51" E, 362 m a. s. l.), 8 March 2010 – 1 ♀, 1 nymph, and 1 larva from 3 ♂♂ ad *Rhinolophus hipposideros*, TC, DZA; **Jasov monastery** (KK, 48° 40' 56" N, 20° 58' 01" E, 266 m a. s. l.) 8 May 2010 – 3 nymphs and 1 larva from 1 ? *Rhinolophus ferrumequinum*, 1 larva from 1 ♂ ad *Rhinolophus hipposideros* A, DZA; **Jasovská jaskyňa cave** (KK, 48° 40' 41" N, 20° 58' 32" E, 286 m a. s. l.), 22 April 2009 – 1 ♀, 7 nymphs, 6 larvae on 6 ♂♂ ad *Rhinolophus ferrumequinum*, 1 nymph and 2 larvae from 2 ♀♀ ad *Rhinolophus ferrumequinum*, 9 nymphs and 2 larvae from 7 ♂♂ ad *Rhinolophus hipposideros*, NC, DZA; 14 May 2009 – 1 ♀ and 1 larva from 2 ♂♂ ad *Rhinolophus ferrumequinum*, 14 larvae from 2 ♂♂ ad *Rhinolophus hipposideros*; 7 May 2010 – 1 nymph from 1 ♀ ad *Rhinolophus ferrumequinum*, 1 ♀ and 1 nymph from 1 ♂ ad *Rhinolophus ferrumequinum*, 3 nymphs and 3 larvae from 2 ♂♂ ad *Rhinolophus hipposideros*, 4 nymphs and 2 larvae from 1 ♂ ad *Rhinolophus hipposideros*, NC, DZA; **Jazvečí hrad cave** (T, 48° 31' 23" N, 18° 34' 28" E, 513 m a. s. l.), 8 March 2010 – 2 ♀♀ and 2 larvae from 4 ♂♂ ad *Rhinolophus hipposideros*, TC, DZA; **Kamenistá dolina (Sihla)** (VV, 48° 40' 31" N, 19° 36' 41" E, 841 m a. s. l.), 31 July 2005 – 2 nymphs from 1 ♂ ad *Myotis mystacinus*, NL, IZ, (leg. P. Kaňuch); **Nitra, Sihot' park** (NP, 48° 18' 53" N, 18° 04' 46" E, 140 m a. s. l.), 31 May 2006 – 1 larva from 1 ♀ G *Pipistrellus* cf. *pygmaeus*, NL, IZ; **Nitra, Sihot' park** (NP, 48° 19' 12" N, 18° 05' 07" E, 143 m a. s. l.), 24 June 2007 – 1 nymph from 1 ♂ ad *Nyctalus noctula*, HT, IZ; **Opálená skala cave** (PI, 48° 39' 21" N, 18° 02' 29" E, 474 m a. s. l.), 28 March 2010 – 1 ♀, 1 nymph, and 2 larvae from 1 ♂ ad *Rhinolophus hipposideros*, TC, DZA; **Plavecká jaskyňa cave** (MK, 48° 29' 41" N, 17° 15' 53" E, 245 m a. s. l.), 20 June 2007 – 1 ♀ and 1 nymph from 2 ♀♀ ad *Myotis myotis*, NC, IZ; **Rákoš Baňa mine I** (RV, 48° 36' 21" N, 20° 09' 09" E, 428 m a. s. l.), 21 April 2009 – 1 nymph from 1 ♂ ad *Miniopterus schreibersii*, NA, IZ; 21 June 2009 – 1 nymph from 1 ♂ ad *Rhinolophus euryale*, NA, IZ; **Strieľaná jaskyňa cave** (SV, 48° 30' 42" N, 18° 52' 01" E, 459 m a. s. l.), 8 March 2009 – 4 ♀♀ and 6 larvae from 8 ♂♂ ad *Rhinolophus hipposideros*, TC, DZA; **Vlčia diera cave** (ST, 48° 47' 46" N, 18° 23' 28" E, 547 m a. s. l.), 31 March 2009 – 1 ♀ from 1 ♀ ad *Rhinolophus hipposideros*, 2 ♀♀ from 1 ♂ ad *Rhinolophus hipposideros*, TC, DZA.

Distribution range of this species covers Europe, Africa, Middle East (Arthur 1956, Hoogstraal 1956, Filippova 1977), Southeast Asia, Pacific islands (Wilson 1970), China (Teng & Jiang 1991) and Japan (Yamaguti et al. 1971).

Only larvae, nymphs and females were recorded to parasitise on bats, males are known to occur on cave walls, mainly in crevices (Arthur 1956, Hoogstraal 1956). It is a strict cave-dwelling

species, occurring outside the cave environs only when sucking its host. So, its hosts are usually attacked in the winter period during their hibernation (October–January), when they are roosting in a relatively high abundance (Arthur 1956). This tick attacks a wide range of hosts from the families Rhinolophidae and Vespertilionidae, among them several bat species are frequent cave-dwellers (Dusbábek 1972, Filippova 1977).

Our new records confirm the known host species spectrum (*Rhinolophus ferrumequinum*, *R. hipposideros*, *R. euryale*, *Myotis myotis*, *M. blythii*, *Miniopterus schreibersii*, and *Plecotus auritus*; Table 1). In addition, we evidenced several new host species, viz. *Nyctalus noctula* (Schreber, 1774), *Myotis mystacinus* (Kuhl, 1817), and *Pipistrellus* cf. *pygmaeus*. The findings come from three habitat types (tree holes, cellars, mines), all are first records for *Ixodes vespertilionis*.

The record on the host *Pipistrellus* cf. *pygmaeus* is the first finding on the member of the genus *Pipistrellus* from Slovakia. Differences in parasitisation between the cryptic species of the *Pipistrellus pipistrellus* group [*P. pipistrellus* (Schreber, 1774) and *P. pygmaeus* (Leach, 1825)] have not been identified, but the parasite transfer is possible due to their sympatric and syntopic occurrence (Mayer & von Helversen 2001). Such finding can be expected also for *Pipistrellus nathusii* (Keyserling & Blasius, 1839), which often form associations with other species of the genus (Jahelková 2003, Lučan et al. 2007).

The record of *Ixodes vespertilionis* from *Nyctalus noctula* in a new roost type (tree hole) may be an accidental occurrence caused by a roost switch of this bat; this is also suggested by the results of our intensive survey in this roost type when this parasite was not found. The microclimatic conditions required by this parasite are not known, however, its new host, *Nyctalus noctula*, roosts and/or hibernates mainly in rocky fissures and concrete prefab houses (e.g., Gaisler et al. 1979, Cefuch & Kaňuch 2005).

Myotis mystacinus uses caves for hibernation (Gerell 1999, Tupinier & Aellen 2001) and in this roost it could be attacked by this ectoparasite.

***Ixodes (Ixodes) ricinus* (Linnaeus, 1758)**

Records. **Jasov monastery** (KK, 48° 40' 56" N, 20° 58' 01" E, 266 m a. s. l.) 18 July 2009 – 1 ♂ on 1 ♀ sad *Rhinolophus euryale*, A, DZA.

Ixodes ricinus is a Holarctic parasite species, its distribution range stretches over Europe, northwestern Africa, Central Asia, and North America (Arthur 1956, Estrada-Peña et al. 2006, Filippova 1977). It parasitises on reptiles, birds and mammals, including humans.

Despite the wide distribution range of *Ixodes ricinus*, we report here its first record from a bat (*Rhinolophus euryale*) in Slovakia. Records of this tick from bats are rather accidental as it was evidenced in Poland (Siuda et al. 2009). In other countries adjacent to Slovakia, no records of *Ixodes ricinus* from bats are available. Siuda et al. (2009) suggested that the transmission of this parasite to its bat host is possible when the bats forage in low vegetation. *Rhinolophus euryale* is considered a foliage-gleaner foraging in shrublands and meadows (Goiti et al. 2008), where such parasite transfer seems to be well possible. However, we cannot exclude a possibility of transmission from other bat species occurring in the same roost where the affected *Rhinolophus euryale* was found – the attic of the Jasov monastery. At this site, maternity colonies of *Myotis emarginatus* (Geoffroy, 1806), *Rhinolophus hipposideros*, and/or *R. ferrumequinum* are found (Matis et al. 2002). *Ixodes ricinus* does not occur in such kind of roost (attic; cf. Estrada-Peña 2003) and this record can be considered accidental.

Discussion and conclusions

Altogether 114 new records of ticks (2 *Ixodes simplex*, 111 *I. vespertilionis* and 1 *I. ricinus*) from 67 host individuals representing eight bat species from Slovakia are presented (Table 1). Some of these records give a new look at some aspects of biology of these parasites, e.g. their hosts and habitats. Here we report records of ticks from four new habitat types (tree holes, cellars, mines, attics) along with that reported previously (cave). The precedent records were made on seven bat species, viz. *Rhinolophus ferrumequinum*, *R. euryale*, *R. hipposideros*, *Myotis myotis*, *M. blythii*, *Miniopterus schreibersii*, and *Plecotus auritus* (Table 1; Dusbábek 1963, 1972, Černý 1972, Dusbábek & Rosický 1976, Siuda et al. 2009, Uhrin et al. 2010).

Our new data include the records of *Ixodes vespertilionis* from three new host species, viz. *Nyctalus noctula*, *Myotis mystacinus* and *Pipistrellus cf. pygmaeus*. *Ixodes vespertilionis* is the most widespread tick species which parasitises on bats of the families Vespertilionidae and Rhinolophidae (Filippova 1977). Our records of *Ixodes vespertilionis* come from three new habitats (cellar, mine, tree hole). As reproduction and ontogeny of *I. vespertilionis* is almost completely restricted to the host body and is thus habitat-independent, such variety of habitats could be expected. The only exception is the life cycle of males, which often occur inside the roosts, on cave walls, and do not live permanently on the host body (Arthur 1956, Hoogstraal 1956). In accordance with this knowledge, we found the most intensive parasite load in caves, which could be considered a primary habitat of *Ixodes vespertilionis*. On the other hand, we found a similar pattern of parasite load also in man-made underground roosts, mines and cellars, which can be considered microclimatically analogous to caves. For example, the same load of *Ixodes vespertilionis* on *Rhinolophus hipposideros* was found in the underground of the Čabrad' castle ruins as in caves.

Ixodes simplex was found on a new host in Slovakia, *Rhinolophus hipposideros*. However, the presence of *Ixodes simplex* on this bat species could be explained by a transfer from its main bat host, *Miniopterus schreibersii*, whose colony occurs in the same roost where the affected individual of *Rhinolophus hipposideros* was found (Rákoš Baňa mine). On the other hand, the findings of *Ixodes simplex* from *Miniopterus schreibersii* at this site show the host specificity and imply the possibility of such transfer.

We consider the above reported first record of *Ixodes ricinus* on the new host, *Rhinolophus euryale*, as accidental. This tick was an adult male; males are reported to appear on a host only in the period of mating (Nuttall et al. 1908). The transmission of the parasite probably occurred during flight over grass or within a shrubbery, or the parasite was transferred from another host roosting in the same attic of the Jasov monastery. Thus, also the record of this parasite in the new habitat type (attic) can be evaluated as accidental, connected with the host roosting.

The record of *Ixodes vespertilionis* from three host bat species and *I. simplex* from one species increase the number of tick hosts to 36% (10 species) of the bat fauna of Slovakia (cf. Čelúch & Ševčík 2006).

Intensity of evidence of bat parasites depends on the level of survey effort. A more intensive survey in all types of bat shelters could also bring more diversified findings of bat parasites (cf. Zahn 1999, Walther 2002, Čelúch & Ševčík 2008, Bihari 2004, Gebhard & Bogdanowicz 2004, Čelúch et al. 2006, Postava 1995, Kowalski 1995). Hence, we expect even a wider host range of the bat ectoparasites in Slovakia.

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Súhrn

Nové nálezy kliešťov (Acarina: Ixodidae) parazitujúcich na netopieroch Slovenska. Práca prezentuje nové nálezy kliešťov čeľade Ixodidae (*Ixodes simplex* a *I. vespertilionis*) z rokov 2005–2010 v oblasti južného a stredného Slovenska, parazitujúcich na netopieroch. Okrem už doteraz známych siedmich hostiteľov z tohto územia, sa nálezmi rozširuje ich spektrum; pre *Ixodes simplex* o hostiteľský druh *Rhinolophus hipposideros* a pre *Ixodes vespertilionis* o druhy *Nyctalus noctula*, *Myotis mystacinus* a *Pipistrellus* cf. *pygmaeus*. Nálezy kliešťov pochádzajú zároveň z dosiaľ neuvádzaných typov habitatov, kde uvažujeme o mikroklimaticky vhodných pre vývin a permanentné obsadenie parazitom (štôlna, pivničné priestory zrúcaniny), prípadne náhodných, podmienených výskytom hostiteľa (stromová dutina, podkrovie). Z územia je prvýkrát popísaný nález druhu *Ixodes ricinus* parazitujúci na podkovárovi južnom (*Rhinolophus euryale*).

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