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The blood sucking lice (Phthiraptera: Anoplura) of Croatia: review and new data

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Abstract: The present faunistic study of blood sucking lice (Phthiraptera: Anoplura) has resulted in the recording of the 4 species: *Hoplopleura acanthopus* (Burmeister, 1839); *Ho. affinis* (Burmeister, 1839); *Polyplax serrata* (Burmeister, 1839), and *Haematopinus apri* Goureaux, 1866 newly reported for the fauna of Croatia. Thirteen species and 2 subspecies are currently known from Croatia, belonging to 6 families. Linognathidae and Haematopinidae are the best represented families, with four species each, followed by Hoplopleuridae and Polyplacidae with two species each, Pediculidae with two subspecies, and Pthiridae with one species. Blood sucking lice were collected from 18 different host species. Three taxa, one species, and two subspecies were recorded on the *Homo sapiens* Linnaeus, 1758. Two species were recorded on *Apodemus agrarius* (Pallas, 1771); *A. sylvaticus* (Linnaeus, 1758); *Bos taurus* Linnaeus, 1758; and *Sus scrofa* Linnaeus, 1758 per host species. On the remaining 13 host species, one Anoplura species was collected. The recorded species were collected from 17 localities covering 17 fields of 10 × 10 km on the UTM grid of Croatia.

Key words: Phthiraptera, Anoplura, Croatia, species list

Phthiraptera have no free-living stage and represent the only insect order in which all species are known to be permanent obligate ectoparasites of birds and mammals in all developmental stages (Lyal, 1985; Mey, 2003; İnci et al., 2010). This order comprises about 5000 species classified in the following suborders: Anoplura, Amblycera, Ischnocera, and Rhyncophthirina (İnci et al., 2010; Kenis and Roques, 2010). Adults range in length from less than 0.5 to 11 mm, and have diversified into a great variety of morphological types (İnci et al., 2010). The blood sucking lice (Anoplura) are one of the smallest suborders of the order Phthiraptera, with more than 540 described species (Light et al., 2010). They are ectoparasites of eutherian mammals, parasitizing members of 12 of the 29 recognized mammalian orders and approximately 20% of all mammalian species (Durden and Musser, 1994; Reed et al., 2007; Hornok et al., 2010; Light et al., 2010). Sucking lice have great veterinary significance; firstly they cause economic loss in livestock production and secondly some species can transmit louse-borne pathogens to the hosts (Hornok et al., 2010). This explains why they are the best studied suborder of the order Phthiraptera (Smith, 2003). Unfortunately, data on the fauna of blood sucking lice in Croatia are very scarce. The earliest data about the fauna of blood sucking lice from Croatia appeared during the 1920s in *Contributions toward a Monograph of the Sucking*

Lice (Ferris, 1923). Ten years later, the first research of the fauna of ectoparasites on domestic animals in Croatia was carried out at the Department of Parasitology of the Veterinary Faculty in Zagreb (Babić, 1934). In that study 22 species of Acari and 52 species of insects were recorded, of which seven species belong to blood sucking lice (Babić, 1934). From 5 October 1936 to 5 November 1937 studies of 50 sheep were carried out at the same faculty in order to determine the fauna of endoparasites. In that study one species of blood sucking lice was recorded (Mikačić, 1938). Moreover, in a study of parasite fauna of cattle in the period from 11 October 1937 to 29 July 1940, two species of blood sucking lice were recorded (Mikačić, 1941). All together eight species of blood sucking lice were collected in Croatia in the period from 1934 to 1940. Some specimens of blood sucking lice (Anoplura) were collected from the 1960s to the 1980s during studies of the ectoparasitological entomofauna of Yugoslav mammals. In that research Savo Brelj and coworkers mainly presented the distribution and taxonomic characteristic of fleas (Siphonaptera) and chewing lice (Amblycera and Ischnocera), while blood sucking lice remained unpublished. Recently, in 2012 and 2014, some species of blood sucking lice were collected in eastern Croatia; thus the principal aim of the present study was to summarize all available data on the blood sucking lice fauna of Croatia.

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The sampling sites are listed numerically on the map in the Figure and UTM 10×10 km grid coordinates are given in the third column of the Table. The exact geographical coordinates of sampling sites are given in the second column of the Table and were determined using Google Earth. The map was created by GPS Visualizer (Schneider, 2003–2015). Most of the studied specimens are deposited in the collections of the Slovenian Museum of Natural History (PMSL) in Ljubljana and in the Department of Biology, JJ Strossmayer University of Osijek. Identification was carried out using standard keys for Anoplura (Toulechkoff, 1954; Piotrowski, 1970). The nomenclature of Anoplura species and hosts follows the Fauna Europaea database (de Jong, 2014) and integrated taxonomic information system for livestock (<http://www.itis.usda.gov/>). Six species of blood sucking lice were collected from domestic animals, as well as six species from wild animals and two species from humans. From the material examined, four species of Anoplura are new to the fauna of Croatia. These are *Hoplopleura acanthopus*, *Ho. affinis*, *Polyplax serrata*, and *Haematopinus apri*. *Ho. acanthopus* was collected in mountainous regions of Croatia on four different rodents. *Ho. affinis* was collected from one species

of rodent in central and eastern Croatia. The third new record *P. serrata* was collected in the lowlands, mountains, and Mediterranean part of Croatia on four different rodent hosts, while the fourth new record, *Hae. apri*, was collected from Mount Velebit on wild boar. Most of the species are cosmopolitan ($n = 9$), (Durdan and Musser, 1994). These species are *Linognathus pedalis* (Osborn, 1896), *L. setosus* (von Olfers, 1816), *L. stenopsis* (Burmeister, 1838), *L. vituli* (Linnaeus, 1758), *P. spinulosa*, (Burmeister, 1839), *Pthirus pubis* (Linnaeus, 1758), *Hae. asini* (Linnaeus, 1758), *Hae. suis* (Linnaeus, 1758), and *Pediculus humanus* Linnaeus, 1758. The Eurasian endemic fauna is represented by the following species: *Ho. affinis*, *P. serrata*, and *Hae. apri*. *Ho. acanthopus* belongs to a Holarctic group of species, while *Hae. eurysternus* (Nitzsch, 1818) is mainly distributed worldwide in temperate zones. In the first article about ectoparasites on domestic animals in Croatia, Babić (1934) used the names *L. piliferus* (Burmeister), Enderlein 1904, and *Hae. spinulosus* Burmeister, which have become junior synonyms for *L. setosus* and *P. spinulosa*. During the 1950s in Croatia, most studies on parasitic lice focused on chewing lice fauna from the suborders Amblycera and Ischnocera (Vražić, 1956, 1957). Furthermore, during the second

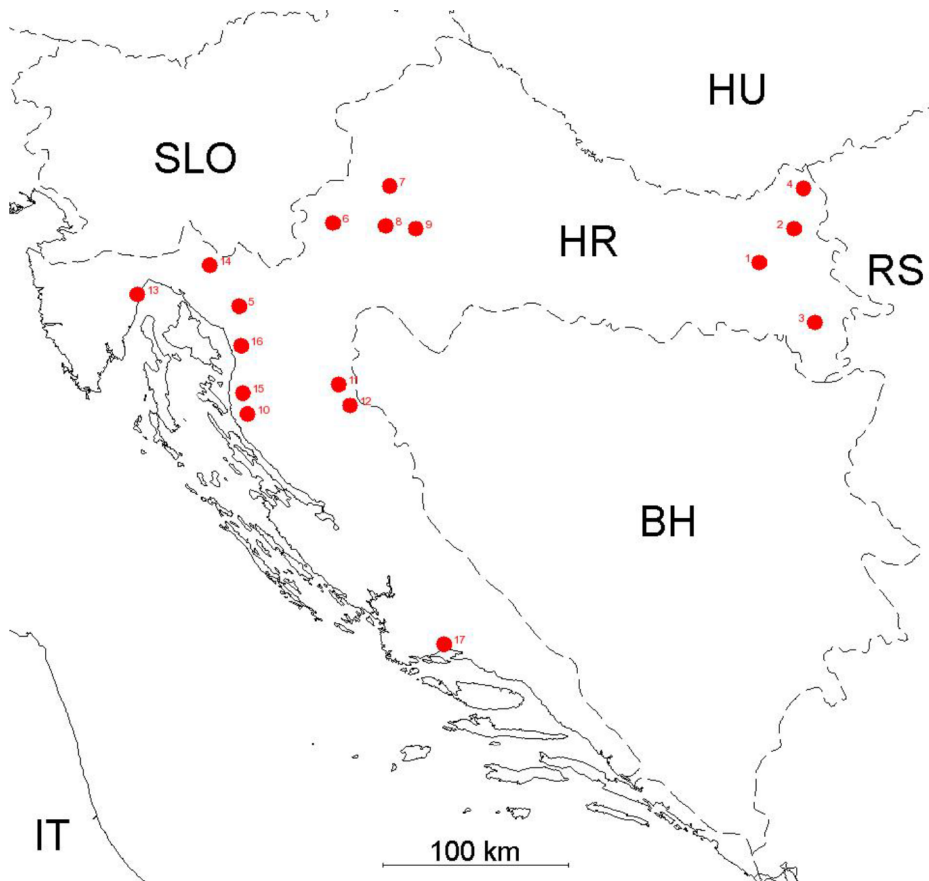


Figure. Sampling sites of blood sucking lice (Phthiraptera: Anoplura) in Croatia.

Table. List of sampling sites.

	Locality	Altitude-latitude (degree/min/sec)	UTM
1.	Vuka	45°26'21"N, 18°30'23"E	CR 03
2.	Bilje	45°36'16"N, 18°44'39"E	CR 25
3.	Otok	45°08'47"N, 18°53'01"E	CR 30
4.	Zmajevac	45°47'59"N, 18°48'23"E	CR 37
5.	Velika Kapela, Vrelo	45°13'34"N, 14°56' 55"E	WL 00
6.	Domagović	45°37'51"N, 15°35'27"E	WL 45
7.	Zagreb	45°48'47"N, 15°58'40"E	WL 77
8.	Vukmeričke Gorice, Prkovec	45°37'00"N, 15°56'59"E	WL 84
9.	Peščenica na Odri	45°36'14"N, 16°09'22"E	WL 95
10.	Velebit, Golići	44°42'09"N, 15°00'15"E	WK 04
11.	Plitvice, Crna rijeka	44°50'41"N, 15°37'45"E	WK 46
12.	Korenica	44°44'37"N, 15°42'24"E	WK 56
13.	Učka	45°17'01"N, 14°14'58"E	VL 31
14.	Risnjak	45°25'37"N, 14°44'45"E	VL 53
15.	Velebit, Zavižan	44°48'09"N, 14°58'25"E	VK 96
16.	Velebit, Krivi Put	45°01'56"N, 14°57'47"E	VK 98
17.	Kozjak, Malačka	43°34'44"N, 16°21'04"E	XJ 02

half of the last century, the ectoparasitic entomofauna of mammals was intensively studied by entomologists from the Slovenian Museum of Natural History in the territory of the former Yugoslavia (Brelj, 1986; Brelj and Trilar, 2000, 2004). In addition, in these studies, some specimens of blood sucking lice from different hosts in Croatia were collected. Summarized data of blood sucking lice fauna of Croatia are hard to compare with those of other neighboring countries in the Western and Central Balkans or other European countries, mainly due to sporadic sampling. In neighboring Hungary, 43 species of Anoplura classified in 7 families were recorded (Vas et al., 2012), while in Turkey 20 species were recorded (İnci et al., 2010) from which 12 species occur in Croatia. To date, in Croatian fauna only 13 species and two subspecies from the suborder Anoplura have been recorded. These data clearly show that the fauna of blood sucking lice from the suborder Anoplura have been poorly studied in Croatia. Similarly, in Italy and in the Republic of Macedonia, Anoplura fauna has also been poorly studied (Fois, 2014; Hristovski et al., 2015). Only 14 species of blood sucking lice were recorded on Sardinia and in the territory of the Republic of Macedonia (Fois, 2014; Hristovski et al., 2015). In December 2012, the heads of two pupils from an elementary school, Kneževi Vinogradi, were infected with 17 specimens of human lice (*Ped. humanus capitis*). Pediculosis was observed only on nine children in the school. In the territory of Osječko-baranjska county in the period from 1996 till 2010, only in

2003, 2007, and 2010 in autumn from the period of October to December were sporadic cases of pediculosis recorded (Tucak et al., 2012). In 2014, one of us (SK) received 12 specimens of lice collected from calves on a small family farm in the village of Vuka (Osječko-baranjska county). All collected specimens were the long-nosed sucking louse (*L. vituli*). Within two months, three calves died, possibly as a consequence of infestation with *L. vituli* that had been present in high numbers on the calves. Heavy infestations with *L. vituli* are often the cause of anemia and mortality in calves (Otter et al., 2003). A large number of *L. vituli* were also observed on calves in the village of Vuka in September. Lice are often difficult to find on live animals during the summer months, when they are probably present in low numbers in refugia; some parts of the body are difficult to examine on live animals (Colwell, 2014). In the louse-infested calves, high frequency of infestation always causes significant changes in host behavior, manifested by persistent rubbing, scratching, and self-licking (Weeks et al., 1995). Similar behavior was observed in calves on the farm in the village of Vuka. The present list does not represent a complete report of Croatian Anoplura. We can expect to record some species that are known in neighboring countries, for instance in Hungary.

A list of the host species and blood sucking lice collected on them

Class Mammalia
Order Artiodactyla

Family Bovidae

Genus *Bos* Linnaeus, 1758***B. taurus* Linnaeus 1758**Anoplura species: *L. vituli*, *Hae. eurysternus***Genus *Capra* Linnaeus, 1758*****Ca. hircus* (Linnaeus, 1758)**Anoplura species: *L. stenopsis***Genus *Ovis* Linnaeus, 1758*****O. aries* Linnaeus, 1758**Anoplura species: *L. pedalis*

Family Suidae

Genus *Sus* Linnaeus, 1758***S. scrofa* Linnaeus, 1758**Anoplura species: *Hae. apri*, *Hae. suis*

Order Carnivora

Family Canidae

Genus *Canis* Linnaeus, 1758***C. lupus* Linnaeus, 1758**Anoplura species: *L. setosus****C. lupus familiaris* Linnaeus, 1758**Anoplura species: *L. setosus*

Order Perissodactyla

Family Equidae

Genus *Equus* Linnaeus, 1758***E. asinus* Linnaeus, 1758**Anoplura species: *Hae. asini****E. caballus* Linnaeus, 1758**Anoplura species: *Hae. asini*

Order Rodentia

Family Muridae

Genus *Apodemus* Kaup, 1829***A. agrarius* (Pallas, 1771)**Anoplura species: *Ho. affinis*, *P. serrata****A. flavicollis* (Melchior, 1834)**Anoplura species: *P. serrata****A. mystacinus* (Danford et Alston, 1877)**Anoplura species: *P. serrata****A. sylvaticus* (Linnaeus, 1758)**Anoplura species: *Ho. acanthopus*, *P. serrata***Genus *Clethrionomys* Tilesius, 1850*****Cl. glareolus* (Schreber, 1780)**Anoplura species: *Ho. acanthopus***Genus *Microtus* Schrank, 1798*****M. liechtensteini* (Wettstein, 1927)**Anoplura species: *Ho. acanthopus****M. subterraneus* (de Selys-Longchamps, 1836)**Anoplura species: *Ho. acanthopus***Genus *Rattus* Fischer, 1803*****R. norvegicus* (Berkenhout, 1769)**Anoplura species: *P. spinulosa****R. rattus* (Linnaeus, 1758)**Anoplura species: *P. spinulosa*

Order Primates

Family Hominidae

Genus *Homo* Linnaeus, 1758***H. sapiens* Linnaeus, 1758**Anoplura species and subspecies: *Pth. pubis*, *Ped. humanus capitis*, *Ped. humanus humanus***The list of Anoplura species and subspecies recorded in Croatia**

For each species and subspecies: sex, locality, month or date, host species, and data source are recorded.

Order Phthiraptera

Suborder Anoplura

Superfamily Linognathoidea

Family Hoplopleuridae

Genus *Hoplopleura* Enderlein, 1904***Ho. acanthopus* (Burmeister, 1839)**♂♂ Risnjak, 8.VIII.1967, from *A. sylvaticus*, Leg: S. Brelih♀♀, ♂♂ Plitvice, Crna rijeka, 12.VIII.1968, from *M. subterraneus*, Leg: S. Brelih♀♀, ♂♂ Učka, 12.VII.1969, from *M. subterraneus*, Leg: S. Brelih♀♀ Velebit, Golići, 7.VIII. 1977, from *M. liechtensteini*, Leg: N. Tvrtković♀♀, ♂♂ Korenica, 20.IX.1987, from *Cl. glareolus*, Leg: N. Tvrtković***Ho. affinis* (Burmeister, 1839)**♂♂ Peščenica na Odri, 10.VII.1974, from *A. agrarius*, Leg: N. Tvrtković♀♀ Vukmeričke Gorice, Prkovec, 19.VII.1974, from *A. agrarius*, Leg: N. Tvrtković♀♀ Bilje, 12.X.1974, from *A. agrarius*, Leg: N. Tvrtković

Family Linognathidae

Genus *Linognathus* Enderlein, 1905***L. pedalis* (Osborn, 1896)**♀♀, ♂♂ Zagreb, - VI.1937, from *O. aries*, (Mikačić, 1938)***L. setosus* (von Olfers, 1816)**♀♀, ♂♂ Krivi Put, date unknown, from *C. lupus*, (Ferris, 1923, 1951)♀♀, ♂♂ Zagreb, date unknown, from *C. lupus familiaris*, (Babić, 1934)***L. stenopsis* (Burmeister, 1838)**♀♀, ♂♂ Zagreb, date unknown, from *Ca. hircus*, (Babić, 1934)***L. vituli* (Linnaeus, 1758)**♀♀, ♂♂ Zagreb, 11.X.1937–29.VII.1940, from *B. taurus*, (Babić, 1934; Mikačić, 1941)♀♀, ♂♂ Vuka, 11.IX.2014, from *B. taurus*, Leg: S. Šegović

Family Polyplacidae

Genus *Polyplax* Enderlein, 1904***P. serrata* (Burmeister, 1839)**♀♀ Bilje, 29.IV.1970, from *A. agrarius*, Leg: G. Džukić

♀♀, ♂♂ Kozjak, Malačka, 29.IV.1974, from *A. mystacinus*, Leg: S. Brelih

♀♀, ♂♂ Risnjak, 8.VIII.1976, from *A. sylvaticus*, Leg: S. Brelih

♂♂ Risnjak, 9.VIII.1976, from *A. flavicollis*, Leg: S. Brelih

***P. spinulosa* (Burmeister, 1839)**

♀♀, ♂♂ Zagreb, date unknown, from *R. norvegicus*, (Babić, 1934)

♀♀, ♂♂ Velika Kapela, Vrelo, 19.VIII.1968, from *R. rattus*, Leg: S. Brelih

♀♀, ♂♂ Otok, Domagović -, II.-VI.2001, from *R. norvegicus*, (Stojčević et al., 2004)

Family Pthiridae

Genus *Pthirus* Leach, 1815

***Pth. pubis* (Linnaeus, 1758)**

♀♀, ♂♂ Zagreb, date unknown, from *H. sapiens*, (Budimčić et al., 2009)

Superfamily Pediculoidea

Family Haematopinidae

Genus *Haematopinus* Leach, 1815

***Hae. apri* Goureaux, 1866**

♀♀, ♂♂ Zavizan, 5.VIII.1977, from *S. scrofa*, Leg: A. Vukušić

***Hae. asini* (Linnaeus, 1758)**

♀♀, ♂♂ Zagreb, date unknown, from *E. caballus*, (Babić, 1934).

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♀♀, ♂♂ Zagreb, date unknown, from *E. asinus*, (Vražić and Rijavec, 1960)

***Hae. eurysternus* (Nitzsch, 1818)**

♀♀, ♂♂ Zagreb, 11.X.1937–29.VII.1940, from *B. taurus*, (Babić, 1934; Mikačić, 1941)

***Hae. suis* (Linnaeus, 1758)**

♀♀, ♂♂ Zagreb, date unknown, *S. domesticus*, (Babić, 1934)

♀♀, ♂♂ Zagreb, 1.XII.1965, from *S. scrofa*, Leg: J. Dovič

Family: Pediculidae

Genus *Pediculus* Linnaeus, 1758

***Ped. humanus capitis* (Degeer, 1778)**

♀♀, ♂♂ Croatia, (Richter, 1982)

♀♀, ♂♂ Zmajevac, 4. XII. 2012, from *H. sapiens*, Leg: S. Krčmar

***Ped. humanus humanus* (Linnaeus, 1758)**

♀♀, ♂♂ Croatia, (Richter, 1982)

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