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Lice and Fleas (Phthiraptera and Siphonaptera) Chapter 13.4

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Abstract

A total of 31 Phthiraptera species alien *to* Europe are listed. They include 24 chewing lice and seven sucking lice of 12 different families. The families Goniodidae (Ischnocera) and Menoponidae (Amblycera) largely dominate the alien entomofauna of chewing lice. Asia is the major supplier of alien Phthiraptera which are mostly associated with poultry farming, game birds, guinea pigs and invasive alien mammals. The recent period did not show any acceleration in alien arrival in Europe. Alien fleas include six species in the families Pulicidae and Ceratophyllidae. Three of them are primarily associated with rats and are capable of transmiting major human diseases such as the bubonic plague and the murine typhus.

Keywords

Phthiraptera, lice, flea, Siphonaptera, alien, Europe

13.4.1. Introduction

Phthiraptera (lice) and Siphonaptera (fleas) are obligate ectoparasitic insects of birds and mammals, including humans. Some are of high importance for human and animal health because they cause itches and skin infection, and transmit serious diseases, e.g. the head louse (*Pediculus capitis* De Geer), the crab louse (*Phtirus pubis* (*L.*)), the cat flea (*Ctenocephalides felis felis* (Bouché)), the rat flea (*Xenopsylla cheopis* (Rothschild)) or the human flea (*Pulex irritans* L.). Although many of these are of unknown origin, they

are probably allochtonous in Europe, having arrived in ancient times with their hosts (Mey, 1988; Beaucournu and Launay, 1990). Thus, *Pulex irritans* was shown to have been present in Europe since the Bronze Age at least, having been found in remains of lake dwellings in the French Jura, dating back to 3100 B.C. (Yvinec et al 2000).

Only the species considered as possibly neozoans*, i.e. 27 lice and six fleas, were originally included in the DAISIE database. Four further species have subsequently been added to the list of alien species and this review is therefore based on 31 species.

Although a large part of these alien species were recorded in Europe for the first time at the end of the 19th century, many probably came much earlier; the exact date of arrival remaining unclear in nearly all cases.

13.4.2 Phthiraptera

Lice are *exopterygotes** of birds and mammals. Most species are host-specific but others are rather polyphagous. They spend their entire life on their host animal, feeding on epidermal tissue debris, parts of feathers, blood or sebaceous secretions. Until recently, they were divided into two orders, Anoplura (sucking lice) and Mallophaga (chewing lice), but they are presently grouped into a single order, Phthiraptera (Barker et al 2003; Price et al 2003). The order Phthiraptera comprises about 5,000 described species present in four sub-orders, Anoplura (543 spp. on mammals), Amblycera (ca. 1360 spp. on birds, mammals and marsupials), Ischnocera (ca. 3080 spp. on birds and mammals) and Rhynchophthirina (3 spp. on elephants and warthogs), this latter group being not present in Europe (Smith 2003).

A total of 31 Phthiraptera species alien *to* Europe have been listed here, including 16 species known to be of exotic origin and 14 cryptogenic species, to be compared to the 691 species considered as native to Europe included in Fauna Europaea (Mey 2005). They include 24 chewing lice belonging to 8 different families and 7 sucking lice belonging to 4 different families (Table 13.4.1). Three of the families have no representatives in Europe (Gliricolidae, Gyropidae, Trimenoponidae; all in the Amblycera suborder). The families Goniodidae (Ischnocera) and Menoponidae largely dominate the alien entomofauna (Figure 13.4.1). In a number of families, the arrival of aliens has largely modified the composition of the total entomofauna currently present in Europe.

In contrast to the trends reported in other arthropod groups, the majority of the alien lice were first observed in Europe during the 18th and 19th century (18 species out of 31- 58.1%), although they probably arrived much earlier with their animal host, in most cases a domestic species. The recent period did not show any acceleration in alien arrival in Europe with only 4 species (12.9 % of the total species) newly observed during the period 1975- 2007. Eight out the 17 alien species of known exotic origin came from Asia (47.0 %), with earlier arrival dates than those from North America (4 spp.; 23.5 %) or South America (4 spp.).

Several chewing lice of cryptogenic origin are important pests of poultry farming, in particular *Menopon gallinae, Goniocotes gallinae* and *Eomenacanthus stramineus*

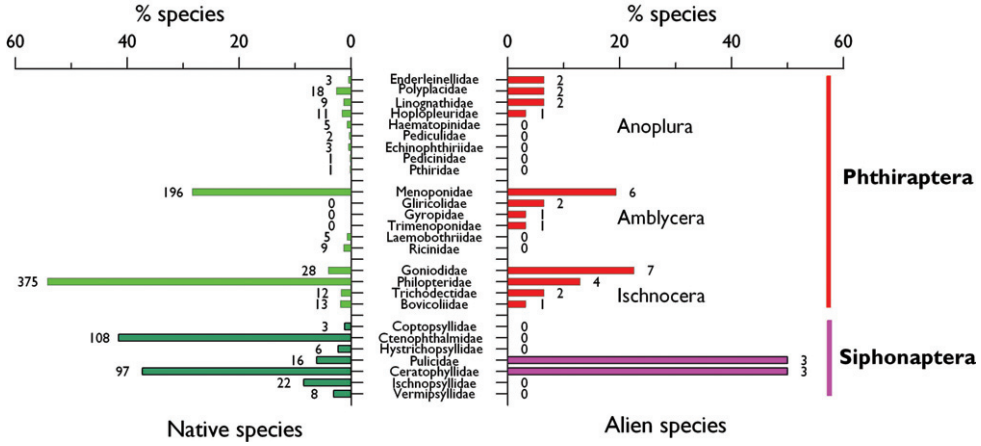

Figure 13.4.1. Relative importance of the Phthiraptera and Siphonaptera suborders and families in the alien and native fauna in Europe. Families of Phthiraptera are presented per suborder in a decreasing order based on the number of alien species. Species alien *to* Europe include cryptogenic species. The number over each bar indicates the number of species observed per family.

(Sychra et al 2008). Other species parasitize pheasants (*Phasianus* spp.) and came with their host from Asia, such as *Goniocotes chrysocephalus, Lagopoecus colchicus, Lipeurus maculosus, Uchida phasiani, Zlotorzyckella colchici* (Kopocinski et al 1998). Chewing lice parasitising mammals in Europe are listed in Mey (1988). Some species are known to be of alien origin, such as the three South American species, *Gyropus ovalis*, *Gliricola porcelli* and *Trimenopon hispidum,* arriving in Europe with guinea pigs (*Cavia porcellus* L.) and causing scratching, loss of hair, and scabs to domestic and laboratory animals. Other species worth mentioning are the cryptogenic dog louse, *Trichodectes canis,* and the sheep louse, *Bovicola ovis*, which cause pruritus and skin infections such as eczema to their host animal. Finally, a few species are associated with invasive alien mammals, such as the South American *Pitrufquenia coypus* on coypu (*Myocastor coypus* (Molina)); (Laurie 1946; Newson and Holmes 1968) and the North American *Trichodectes* (*Stachiella*) *octomaculatus* on raccoon (*Procyon lotor* (L.)); (Hellenthal et al 2004).

Only seven sucking lice of four families (Enderleinellidae, Hoplopleuridae, Linognathidae, and Polyplacidae) are considered Neozoans in Europe (Table 13.4.1). The Asian *Polyplax spinulosa* (spined rat louse) causes hair loss and pruritus to wild and domestic rats (*Rattus* spp.). The cryptogenic species *Linognathus stenopsis* and *Haemodipsus lyriocephalus* parasitize goats (*Capra hircus* L.) and hares (*Lepus europaeus* Pallas), respectively. According to Durden and Musser (1994), another *Haemodipsus* species, *H. setoni* Ewing associated with *Lepus* spp. in North America is possibly an introduced species in Eurasia (this species has not been included here). Three species have been introduced to Europe with their Sciuridae host from either North America (*Enderleinellus longiceps* and *Hoplopeura sciuricola* with grey squirel, *Sciurus carolinensis* Gmelin; Britt and Molineux 1979) or Asia (*Enderleinellus tamiasis* with Siberian chipmunk, *Tamia sibiricus* (Laxmann); Beaucornu et al 2008). *Solenopotes muntiacus* has also been

Figure 13.4.2. Alien Phthiraptera (Anoplura)**.** *Solenopotes muntiacus* female from Muntjac deer, *Muntiacus muntjak* (Credit: British Museum of Natural History, London)

introduced from Asia to Great Britain with muntjac deers, *Muntiacus reevesi* (Ogilby) (Dansie et al 1983).

In addition, *Haemodipsus ventricosus* (Denny) which lives on rabbits (*Oryctolagus cuniculus* L.) can be considered as alien *in* Europe, originating, as its host, from the Iberic pensinsula (Durden and Musser 1994).

13.4.3 Siphonaptera

Fleas are holometabolous insects whose adults must feed on blood of mammals and birds in order to reproduce. Larvae feed on organic matter, often in the host's nest. In the DAISIE database, six fleas are listed as alien to Europe, including 5 species known to be of exotic origin and 1 cryptogenic species, in comparison to the 260 species considered as native to Europe (Soledad Gomez Lopez 2005) (Table 13.4.1). The aliens belong equally to two families, Pulicidae and Ceratophyllidae, whereas the latter family largely dominates the native entomofauna. Three of these fleas have rats as their main host (Beaucornu and Launay, 1990). The tropical rat flea, *Xenopsylla cheopis*, probably originates from the Nile area (Beaucornu 1999). It became synanthropic in most of Southern Europe where it could not survive before because of large temperature variations between summer and winter within human habitats (Beaucornu 1999). *X. brasiliensis,* originates from tropical Africa and invaded the Canary islands (Beaucornu and Launay, 1990); it has also been

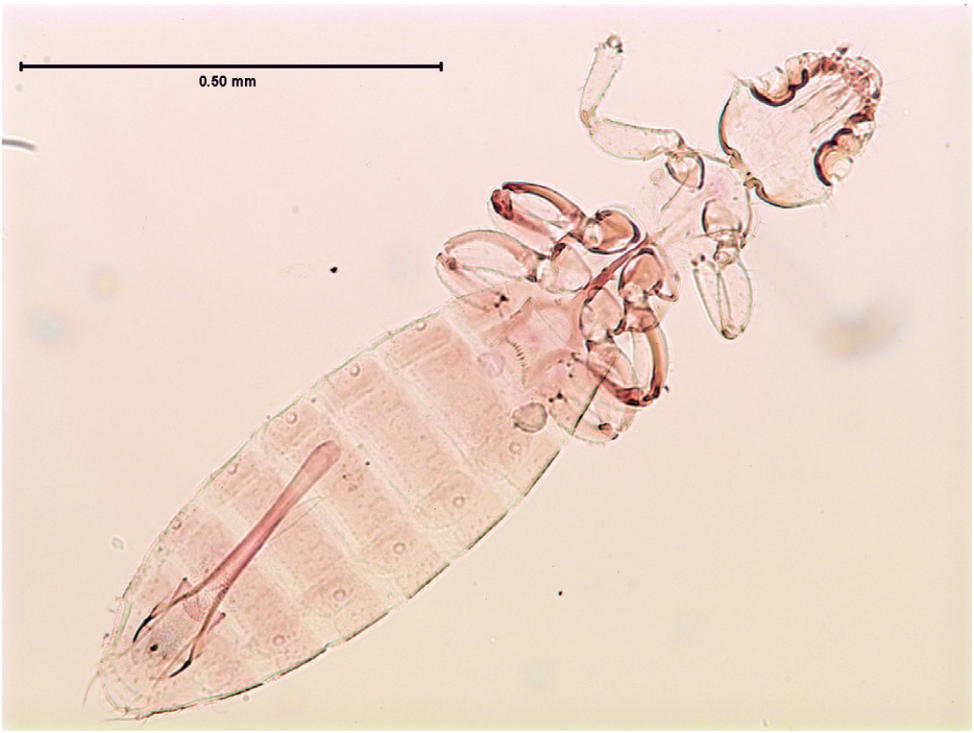

Figure 13.4.3. Alien Phthiraptera (Amblycera). *Gliricola porcelli* male from guinea pig, *Cavia porcellus* (Credit: British Museum of Natural History, London)

found sporadically in port areas and elsewhere, e.g. it was recorded from Wales in the 1950s (Hopkins and Rotschild 1953). The third species, *Nosopsyllus fasciatus,* is a temperate species from Asia. Rat fleas are also able to feed on other mammals, including humans, to which they can transmit the bubonic plague by carrying the bacteria *Yersinia pestis* (Audouin-Rouzeau, 2003). *Xenopsylla cheopis* is also a vector of another human disease, the murine typhus fever caused by the bacteria *Rickettsia typhi* (Beaucournu and Launay, 1990). The North American species *Orchopeas howardi* is found on the grey squirrel (*Sciurus carolinensis*), an invasive rodent in Europe (Keymer, 1983).

In addition, a rabbit flea, *Spilopsyllus cuniculi* (Dale), can be considered as alien *in* Europe, probably originating with its host from the Iberian Peninsula. It has invaded a large part of Western and Central Europe (Soledad Gomez Lopez 2005). It is the principal vector of rabbit myxomatosis, a disease which was deliberately introduced from South America into Europe in 1952 in order to control rabbit populations (Beaucournu and Launay, 1990). Another flea of Mediterranean origin, the ceratophyllid *Nosopsyllus* (*Nosopsyllus*) *londinensis londinensis* (Rothschild), hosted by mice (*Mus domesticus*) and rats (*Rattus* spp.), has been introduced in urban habitats in Belgium, Switzerland, Great Britain and in the Oceanic islands (Madeira, The Azores) (Rothschild 1903; Smit 1957; Mahnert 1974; Beaucournu and Launay, 1990).

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References

Anonymous (1994) *Orchopeas howardi* reported from S.E. London. *British Journal of Entomology and Natural History* 7: 102–109.

Audouin-Rouzeau F (2003) *Les Chemins de la Peste - Le Rat, la Puce et l'Homme*. Rennes, France : Presses universitaires de Rennes.

Barker SC, Whiting M, Johnson KP, Murrell A (2003) Phylogeny of the lice (Insecta: Phthiraptera) inferred from small subunit rRNA. *Zoologica Scripta* 3: 407–414.

Beaucornu JC (1972) Sur quelques ectoparasites (Siphonaptères, anoploures et nyctéribies) du Portugal. *Anais da Escola Nacional de Saúde Pública e de Medicina Tropical* 6: 65–71.

Beaucornu JC (1976) Notes sur les Ceratophyllidae (Siphonaptera) de la faune française, parasites de mammifères. *Annales de la Société Entomologique de France* (N.S.) 12: 199–213.

Beaucornu JC (1978) Enquête sur les arthropodes vecteurs dans la Péninsule Ibérique: Liste des Siphonaptères. *Médecine et maladies infectieuses* 8: 121–124.

Beaucournu JC (1999) Diversité des puces vectrices en fonction des foyers pesteux. *Bulletin de la Société de pathologie exotique* 92: 419–421.

Beaucornu JC, Alcover JA (1984) Siphonaptera from Small Terrestrial Mammals in the Pityusic Islands. In Kuhbier H, Alcover JA, d'Arellano Tur G (Eds), *Biogeography and Ecology of the Pityusic Islands*. The Hague: Dr. W. Junk Publisher, 377–392.

Beaucornu JC, Aeschlimann A (1985) Une Puce nouvelle pour la region Paléarctique Occidentale : Présence en Suisse de *Callopsylla gemina* (Ioff, 1946) (Siphonaptera: Ceratophyllidae). *Bulletin de la Société Neuchâteloise des Sciences Naturelles* 108: 55–62.

Beaucournu JC, Launay H (1977) Présence en France d'une Xenopsylla selvatique *X. cunicularis* Smit, 1957 (Siphonoptera, pulcidae) parasite du lapin de garenne. Bulletin de la Société de Pathologie Exotique 70: 299–301.

Beaucournu JC, Launay H (1990) Les puces (Siphonaptera) de France et du Bassin méditerranéen occidental. *Faune de France* 76. Paris: Fédération Française des Sociétés de Sciences Naturelles. 548 pp.

Beaucournu JC, Pascal M (1998) Origine biogéographique de *Nosopsyllus fasciatus* (Bosc, 1800) (Siphonaptera - Ceratophyllidae) et observations sur son hôte primitif. *Biogeographica* 74: 125–132.

Beaucournu JC, Pisanu B, Chapuis JL (2008). *Enderleinellus tamiasis* Fahrenholz, 1916 (Anoplura: Enderleinellidae), espèce importée, implantée et nouvelle pour la faune de France. *Parasite* 15: 75–78.

Beaucournu JC, Valle M, Launay H (1981) Siphonaptères d'Italie Méridionale ; description de cinq nouveaux taxa. *Rivista di Parassitologia* 42: 483–505.

Bernard L, Dounet G, Jaujou (1947) Une épidémie de Pest bubonique à Ajaccio (1945). *Recueil des Travaux de l'Institut National d'Hygiène de Paris* 3: 355–375

Bordeau W (2008) Phtiriose à *Gliricola porcelli* chez le cobaye: l'association imidaclopride-moxidectine est efficace. *Sciences et Pratique* 999, 13–19.

Britt D, Molyneux DH (1979) Parasites of Grey Squirrels in Cheshire, England. *The Journal of Parasitology* 65: 408.

Broekhuizen S (1971) On the occurrence of hare lice, *Haemodipsus spp*. (Anoplura: Hoplopleuridae) on hares, *Lepus europaeus*, in the Netherlands. *Zeitschrift für Parasitenkunde* 36: 158–168.

Büttiker W, Mahnert V (1978) Vorläufige Liste der Anoplura (Insecta der Schweiz). *Mitteilungen der Schweizerischen Entomologischen Gesellschaft* 51: 299–306.

Cartana Castella P, Gil Collado J (1934) *Estudio de la ratas y de sus ectoparasitos en ocasion del brote epidemico de peste en Barcelona en 1931*. Madrid: Commission Permanente de Investigaciones sanitarias. 316 pp.

Clay T (1938) A revision of the genera and species of Mallophaga occuring on gallinaceous hasts. Part. 1. *Lipeurus* and related genera. *Proceedings of the Zoological Society of London (D)* 108: 109–204.

Cummings BF (1916) Studies on the Anoplura and Mallophaga, being a report upon a collection from the Mammals and Dirds in the Society's gardens. *Proceedings of the Zoological Society of London*: 253–295.

Dale CW (1878), *The History of Glanville's Wootton in the county of Dorset, including its zoology and botany*. London. 392 pp.

Dansie O, Cooke A, Farrell L (1983) *Muntjac and Chinese Water Deer*. London: The British Deer Society. 43pp.

Denny H (1842) *Monographia Anoplurorum Britanniae, or an Essay on the British species of parasitic insects belonging to the order Anoplura of Leach*. London: Bohn. 263 pp.

Dlabola J (Ed.) (1977) *Check-list of Czechoslovak Insects I*. Praha: Národní Muzeum. 160 pp.

Donisthorpe H (1925) Insects in the nest of the grey squirrel. *Entomologist's Record* 37: 163.

Durden LA, Musser GG (1994) The sucking lice (Insecta, Anoplura) of the world: a taxonomic checklist with records of mammalian hosts and geographical distributions. *Bulletin of the American Museum of Natural History* 218: 1–90.

Fauna Italia (2003) *Families Anoploura, Mallophaga, Siphonaptera*. available at [http://www.faunaitalia.it/checklist/invertebrates/families]. last update December 3, 2003.

Galli- Valerio B (1900) Sur les puces d'*Arvicola nivalis*. *Archives de Parasitologie* 3: 96–101

Geiter O, Homma S, Kinzelbach R (2002) *Bestandsaufnahme und Bewertung von Neozoen in Deutschland*. Berlin: Umweltbundesamt 25: 1–173.

Giles GM (1905), *Pulex cheopis*, Rothschild, in England. *Entomologist's Monthly Magazine* 41: 139.

Gomez MS, Gallego J, Bernat G (1987) Observaciones sobre la fauna de anopluros parásitos de micromamíferos de la región catalana (España). *Revista iberica de parasitología* 47: 81–87

Hellenthal RA, Price RD, Palma RL (2004) *Chewing Lice of Belgium*. http://bch-cbd.naturalsciences.be/belgium/biodiversity/faunaflorahabitats/belchewinglice.pdf.

Himonas CA, Liakos VD (1989) Field trial of cypermethrin against lice infestation in goats. *The Veterinary Record* 125: 420–421.

Hopkins GHE, Rothschild M (1953) *An illustrated catalogue of the Rothschild collection of fleas (Siphonaptera) in the British Museum (Natural History). Vol.I: Tungidae, Pulicidae*. London: The Trustees of the British Museum.

Ilieva M (2009) Checklist of the chewing lice (Insecta: Phthiraptera) from wild birds in Bulgaria. *Zootaxa* 2138: 1–66.

Ilvento A (1913) Hygienische Beobachtungen über Ratten und Pestprophylaxie im Hafen von Palermo (1906–1910). *Archiven für Schiffs-und Tropen- Hygiene* 17: 404–413.

Kenis M (2005) Insects-Insecta. In: Wittenberg R (Ed) *An inventory of alien species and their threat to biodiversity and economy in Switzerland*. Délemont: CABI Bioscience Switzerland, 131–212.

Keymer IF (1983) Diseases of squirrels in Britain. *Mammal Review* 13: 155–158.

Kopocinski B, Lonc E, Modrzejewska M (1998) Fitting a bivariate negative binomial model to the distribution of bird lice (Phthiraptera, Mallophaga) parasitizing the pheasant (*Phasianus colchicus* L.). *Acta Parasitologica* 43: 81–85.

Krause AH (1911) Beitrage zur kenntnis der insektenfauna Sardiniens. Entomologische *Rundschau* 28: 1–149.

Laurie EMO (1946) The coypu (*Myocastor coypus*) in Great Britain. *Journal of Animal Ecology* 15: 22–34.

Lavier G (1921) *Les parasites des Invertébrés hématophages, parasites qui leur sont propres, parasites qu'ils transmettent aux Vertébrés*. Paris: Vigot. 218 pp.

Mahnert V (1974) Quelques parasites (Anoploures, Siphonaptères) de micromammifères nouveaux pour la région de Genève. *Bulletin de la Société Entomologique Suisse* 47: 327–330

Mey E (1988) Uebersicht über die Säugtiere-Mallophagen Europas. *Angewandte Parasitologie* 29: 113–126.

Mey E (2005) *Fauna Europaea. Phthiraptera.* Available at [http//www.faunaeur.org] Retrieved 15.02. 2010.

Mifsud D, Borg JJ, Sultana J (2008) First record of *Xenopsylla gratiosa* Jordan & Rotschild, 1923 from the Maltese islands (Siphonaptera: Pulicidae). *Bulletin of the Entomological Society of Malta* 1: 43–45.

Mouchet J, Morel P (1957) Contribution a l'étude des Mallophages de France. *Bulletin de la Société Entomologique de France* 62: 153–159.

Najera L (1942) La distribution geografica de las especies de pulgas de interés epidemiologico. *Boletín de la real Sociedad Española de Historia Natural*. 40: 497–502.

Newson RM, Holmes RG (1968) Some Ectoparasites of the Coypu (Myocastor coypus) in Eastern England. *Journal of Animal Ecology* 37: 471–481.

Nitzsch CL (1818) Die Familien u. Gattungen der Thierinsecten (Insecta epizoica) aIs ein Prodromus der Naturgeschichte derselben. *Magazin für die Entomologie, Germar, Zincken* 3: 261–316.

O'Connor JP, Sleeman DP, Butler FT (2005) A review of the Irish Anoploura (Insecta: Phthiraptera). *Irish Naturalist Journal* 28: 62–67.

Paradiznik V (1989) *Gliricola porcelli* (L. 1758), Mallophaga, Amblycera, on the guineapig, *Cavia cobaya. Zbornik Biotehniske Fakultete Univerze Edvarda Kardelja v Ljubljani, Veterinarstvo* 26: 211–213.

Pavlovic I, Nesic D (1991) Parasite fauna in intensively farmed poultry in Serbia in 1989. *Veterinarski Glasnik* 45: 390–394.

Peus F (1963) Flöhe aus dem Mittelmeergebiet (Siphonaptera). IV. Sardinien, Korsika und benachbarte kleine Inseln. *Beiträge zur Entomologie* 13: 429–438

Piaget E (1880) *Les Pédiculines. Essai monographique*. Leyden: E. J. Brill. 714 pp.

Prelezov PN, Koinarski VTs (2006) Species variety and population structure of Mallophaga (Insecta: Phthiraptera) on chickens in the region of Stara Zagora. *Bulgarian Journal of Veterinary Medecine* 9: 193–200.

Price RD, Hellenthal RA, Palma RL, Johnson KP, Clayton DH (2003) *The chewing lice: world checklist and biological overview.* Illinois Natural History Survey Special Publication 24. 501 pp.

Rothschild NC (1899), Irish fleas. Irish Naturalist 8(12): 266.

Rothschild NC (1903), A new British flea: *Ceratophyllus londiniensis*. *Entomologist's Record* 15: 64–65.

Schrank F von P (1781) *Enumeratio Insectorum Austriae Indigenorum*. Vienna, Austria: August Vindelicor, Klett. 548 pp.

Šefrová H, Laštùvka Z (2005) Catalogue of alien animal species in the Czech Republic. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* 53: 151–170.

Séguy E (1924) *Les Insectes parasites de l'homme et des animaux domestiques*. Paris: Paul Lechevalier. 422 pp.

Séguy E (1944) *Insectes Ectoparasites (Mallophages, Anoploures, Siphonaptéres), 43. Faune de France*. Paris: Paul Lechevalier et Fils. 684 pp.

Silfverbeg H (1984) Mallophaga. In: Huldén L (Ed) A Check list of the Finnish Insects Small Orders. *Notulae Entomologicae* 64: 1–29. Available on http://www.funet.fi/pub/sci/bio/life/warp/insects-fi-Finnish-list.html.

Smit FGAM (1957) *Siphonaptera. Handbooks for the Identification of British Insects Vol. 1 Part 16*. London: Royal Entomological Society. 94 pp.

Smit FGAM (1966) *Insecta Helvetica. I Siphonaptera*. Lausanne: Société Entomologique de Suisse. 106 pp

Smith VS (2003) Lousy Phylogenies: Phthiraptera Systematics and the Antiquity of Lice. *Entomologische Abhandlungen* 61: 150–151.

Soledad Gomez Lopez M (2005) *Fauna Europaea. Siphonaptera.* http//www.faunaeur.org. [accessed 22.2. 2010].

Stefański W (1970) *Parazytologia weterynaryjna tom II*. Warszawa: Państwowe Wydawnictwo Rolnicze i Leśne. 77 pp.

Stojcevic D, Mihaljevic Z, Marinculic A (2004) Parasitological survey of rats in rural regions of Croatia. *Veterinární medicína Czech* 49: 70–74.

Sychra O, Harmat P, Literák I (2008) Chewing lice (Phthiraptera) on chickens (*Gallus gallus*) from small backyard flocks in the eastern part of the Czech Republic. *Veterinary parasitology* 152: 344–348.

Tanon L (1923) Le laboratoire de prophylaxie de la Peste à la Préfecture de Police. *Annales d'hygiène publique, industrielle et sociale*: 606–625.

Thompson GB (1939) A check-list and host-list of the ectoparasites recorded from British birds and mammals. Part I. Mammals (excluding Bats). *Transactions of the Society for British Entomology* 6: 1–22

Tiraboschi C (1904) Les rats, les souris et leurs parasites cutanés dans leur rapport avec la propagation de la pest bubonique. *Archives de Parasitologie* 8: 161–349.

Touleshkov K (1954) Les poux (Anoplura) ectoparasites sur les animaux domestiques et l'homme. *Izvestiya na Zoologicheskiya Institut* 3: 125–160.

Touleshkov K (1955a) Mallophaga - ectoparasites on domestic animals in Bulgaria. *Comptes-Rendus de l'Academie Bulgare des Sciences* 8: 77–80.

Touleshkov K (1955b) Les *Trichodectes* (Trichodectoidea, Mallophaga) ectoparasites sur les mammifères de Bulgarie. *Izvestiya na Zoologicheskiya Institut* 4: 423–434.

Touleshkov K (1957) [Mallophaga of birds of prey in Bulgaria] (in Bulgarian). *Izvestiya na Zoologicheskiya Institut* 6: 275–303.

Touleshkov K (1974) Mallophagen auf den Vögeln des Balkangebirges. *Izvestiya na Zoologicheskiya Instituts Muzey* 41: 207–228.

Wegner Z (1966) Wszy Anoplura. *Catalogus faunae Poloniae* 19 (2): 1–32.

Wegner Z, Eichler WD (1968) Fauna of Lice found on Hares in the Poznań province (Poland). *Biuletyn Instytutu Medycyny Morskiej w Gdansku* 19: 217–224.

Yvinec JH, Ponel P, Beaucournu JC (2000) Premiers apports archéoentomologiques de l'étude des puces (Insecta-Siphonaptera), aspects historiques et anthropologiques (Siphonaptera). *Bulletin de la Société entomologique de France* 105: 419–425.

Zapatero Ramos LM, Rodríguez Rodríguez JA, González-Santiago PI (1982). Ectoparásitos de Múridos Ibéricos e Insulares. *Revista Ibérica de Parasitologia* vol. extra: 113–124.

Table 13.4.1. List and characteristics of the Phthiraptera and Siphonatera species alien *to* Europe. Status: **A** Alien to Europe **C** cryptogenic species. Country codes abbreviations refer to ISO 3166 (see appendix I). Habitat abbreviations refer to EUNIS (see appendix II). Last update 27/03/2010;

Order *Suborder* Family	Species	Status	Regime	Native range	1st record in Europe	Invaded countries	Habitat	Host	References
Phthiraptera *Anoplura*									
Enderleinellidae	*Enderleinellus longiceps* Kellogg & Ferris, 1915	A	parasitic/ predator	North America	1979	GB	G, I2	*Sciurus carolinensis*	Britt and Molyneux (1979), O'Connor et al (2005)
Enderleinellidae	*Enderleinellus tamiasis* Fahrenholz, 1916	A	parasitic/ predator	Asia (Korea)	1916	DE, FR	G, I2	*Tamias sibiricus*	Beaucournu et al (2008), Durden and Musser (1994)
Hoplopleuridae	*Hoplopleura sciuricola* Ferris, 1921	A	parasitic/ predator	North America	1976	GB, IE	G, I2	*Sciurus carolinensis*	Britt and Molyneux (1979), O'Connor et al (2005)
Linognathidae	*Linognathus stenopsis* (Burmeister, 1838)	C	parasitic/ predator	Crypto-genic	1838	BG, CH, CZ, DE, FR, GR, IT	J	Goat (*Capra*)	Fauna Italia (2003), Himonas and Liakos (1989), Piaget (1880), Šefrová and Laštùvka (2005), Séguy (1924, 1944) Touleshkov(1954)
Linognathidae	*Solenopotes muntiacus* Thompson, 1938	A	parasitic/ predator	Asia	1983	GB	G	Muntjac deer (*Muntiacus reevesi*)	Dansie et al (1983), Durden and Musser (1994)
Polyplacidae	*Haemodipsus lyriocephalus* (Burmeister, 1839)	C	parasitic/ predator	Crypto-genic	1839	BG, CH, CZ, DE, FI, FR, GB, IT, NL, PL	E	Hares (*Oryctolagus*)	Broekhuizen (1971), Fauna Italia (2003), Geiter et al (2002), Kenis (2005), Piaget (1880), Séguy (1924, 1944), Thompson (1939), Touleshkov(1954), Wegner (1966), Wegner and Eichler (1968), Büttiker and Mahnert (1978), Šefrová and Laštùvka (2005), Silfverbeg (1984)

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Polyplacidae	*Polyplax spinulosa* (Burmeister, 1839)	A	parasitic/ predator	Asia	1839	BG, CH, CZ, DE, ES, FI, FR, HR, PL	J	Rats(*Rattus* spp.)	Geiter et al (2002), Gomez et al (1987), Kenis (2005), Šefrová and Laštùvka (2005), Séguy (1944), Silfverbeg (1984), Stojcevic et al (2004), Touleshkov (1954)
Phthiraptera ***Amblycera***									
Gliricolidae	*Gliricola porcelli* (Schrank 1781)	A	parasitic/ predator	C & S America	1781	AT, BG, CH?, DE, ES, FI, FR, HU, IT, PL, RO, SI	J	Guinea pigs (*Cavia porcellus*)	Bordeaul (2008), Fauna Italia (2003), Geiter et al (2002), Kenis (2005), Mouchet and Morel (1957), Paradiznik (1989), Piaget (1880), Schrank (1781), Séguy (1924, 1944) Touleshkov (1955a)
Gyropidae	*Gyropus ovalis* Burmeister, 1838	A	parasitic/ predator	C & S America	1838	AT, BG, CH?, DE, ES, FI, FR, HR, HU, IT, PL	J	Guinea pigs (*Cavia porcellus*)	Bordeau (2008), Fauna Italia (2003), Geiter et al (2002), Kenis (2005), Mouchet and Morel (1957), Piaget (1880), Séguy (1924, 1944), Stojcevic et al (2004),Touleshkov (1955a)
Gliricolidae	*Pitrufquenia coypus* Marelli 1932	A	parasitic/ predator	C & S America	1932	AT, BE, CH? , DE, GB	C2	Coypu (*Myocastor coypus*)	Hellenthal et al (2004), Kenis (2005), Laurie (1946), Newson and Holmes (1968)
Menoponidae	*Eomenacanthus stramineus* (Nitzsch 1818)	C	parasitic/ predator	Crypto-genic	1818	BG, DE, ES, FI, FR, IT, PL, RS, UA	E, J	Pheasant (*Phasianus*), Domestic fowl (*Gallus gallus domesticus*), Turkey (*Meleagris*)	Geiter et al (2002), Ilieva (2009), Mouchet and Morel (1957), Nitzsch (1818), Pavlovic and Nesic (1991), Prelezov and Koinarski (2006), Séguy (1924, 1944),

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Menoponidae	*Hohorstiella gigantea lata* (Piaget 1880)	C	parasitic/ predator	Crypto-genic	1880	BE, BG, DE, ES, FI, FR, HU, PL, RO	J	*Columba*	Hellenthal et al (2004), Ilieva (2009), Piaget (1880), Séguy (1924, 1944), Touleshkov (1974)
Menoponidae	*Menopon gallinae* (L. 1758)	C	parasitic/ predator	Crypto-genic	1781	BE, BG, DE, ES, FI, FR, GB, HU, IT, PL, RO, RS, UA	J	Domestic fowl (*Gallus gallus domesticus*), Turkey (*Meleagris*)	Denny (1842), Geiter et al (2002), Hellenthal et al (2004), Ilieva (2009), Mouchet and Morel (1957), Pavlovic and Nesic (1991), Pigate (1880), Prelezov and Koinarski (2006), Schrank (1781), Séguy (1924, 1944), Silfverbeg (1984), Touleshkov (1955a)
Menoponidae	*Myrsidea quadrifasciata* (Piaget, 1880)	A	parasitic/ predator	Asia	1880	BE, CZ, DE, FR, HU, IT	J, J1	House sparrow (*Passer domesticus*)	Hellenthal et al (2004), Piaget (1880), Šefrová and Laštùvka (2005), Séguy (1924, 1944),
Menoponidae	*Neocolpocephalum turbinatum* (Denny 1842)	C	parasitic/ predator	Crypto-genic	1842	BG, DE, ES, FR, GB, HU, IT, IT-SAR, PL, RO	G, J	Falcons (*Falco*), *Columba*	Denny (1842), Geiter et al (2002), Ilieva (2009), Piaget (1880), Séguy (1944), Touleshkov (1957)
Menoponidae	*Uchida phasiani* (Modrzejewska & Zlotorzycka, 1977)	A	parasitic/ predator	Asia	1998	CZ, DE, PL	E, J	Pheasant (*Phasianus*)	Šefrová and Laštùvka (2005)
Trimeno-ponidae	*Trimenopon hispidum* Burmeister, 1838	A	parasitic/ predator	C & S America	1966	AT, CH?, DE, FR, FI, HU, PL	J	Guinea pigs (*Cavia porcellus*)	Geiter et al (2002), Kenis (2005), Mouchet and Morel (1957)
Phthiraptera ***Ischnocera***									
Bovicoliidae	*Bovicola* (*Bovicola*) *ovis* (Schrank, 1781)	C	parasitic/ predator	Crypto-genic	1916	BE, BG, CZ, ES, FI, FR, GB, HU, IT, LT, NL, PL, RO	J	Sheep (*Ovis*)	Cummings (1916), Hellenthal et al (2004), Šefrová and Laštùvka (2005), Séguy (1944), Silfverbeg (1984), Touleshkov (1955b)

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Goniodidae	*Chelopistes meleagridis* (Linnaeus, 1758)	A	parasitic/ predator	North America	1877	CZ, DE, ES, FI, FR, HU, IT, NL, PL, PT, RO	J1, G	Wild and domesticated Turkey (*Meleagris*)	Geiter et al (2002), Mouchet and Morel (1957), Piaget (1880), Šefrová and Laštùvka (2005), Séguy (1924, 1944),
Goniodidae	*Goniocotes chrysocephalus* Giebel 1874	C	parasitic/ predator	Crypto-genic	1874	BE, DE, FR, HU, IT, NL, PL, RO, ES	E, J	Pheasant (*Phasianus* spp.)	Fauna Italia (2003), Geiter et al (2002), Hellenthal et al (2004), Piaget (1880), Séguy (1924, 1944),
Goniodidae	*Goniocotes gallinae* (De Geer 1778)	C	parasitic/ predator	Crypto-genic	1880	BE, BG, DE, ES, FI, FR, HU, IT, PL, RS, UA	J	Domestic fowl (*Gallus gallus domesticus*)	Geiter et al (2002), Hellenthal et al (2004), Mouchet and Morel (1957), Pavlovic and Nesic (1991), Piaget (1880), Prelezov and Koinarski (2006), Séguy (1944), Touleshkov (1955a)
Goniodidae	*Goniodes pavonis* (Linnaeus, 1758)	C	parasitic/ predator	Crypto-genic	1892	BG, DE, FI, FR, HU, IT, PL, RO	J	Indian Peafowl (*Pavo cristatus*)	Geiter et al (2002), Fauna Italia (2003), Séguy (1924, 1944), Touleshkov (1955a)
Goniodidae	*Goniocotes rectangulatus* Nitzsch, 1818	C	parasitic/ predator	Crypto-genic	1818	DE, HU, RO	J	Helmeted Guinea Fowl (*Numida meleagris*), Indian Peafowl (*Pavo cristatus*)	Geiter et al (2002), Nitzsch (1818), Piaget (1880)
Goniodidae	*Stenocrotaphus gigas* (Taschenberg 1879)	A	parasitic/ predator	Tropical, sub-tropical	1924	BE, BG, DE, ES, FR, GB, IT, PL	J1	Domestic fowl (*Gallus gallus domesticus*), Turkey (*Meleagris*)	Geiter et al (2002), Hellenthal et al (2004), Ilieva (2009), Séguy (1924), Touleshkov (1955a)

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Goniodidae	*Zlotorzyckella colchici* (Denny, 1842)	A	parasitic/ predator	Asia	1977	BE, CZ, DE, ES, IT, PL, RO	G, I2	Pheasant (*Phasianus*)	Dlabola (1977), Hellenthal et al (2004)
Philopteridae	*Cuclotogaster heterographa* (Nitzsch in Giebel 1866)	C	parasitic/ predator	Crypto-genic	1876	BE, BG, DE, ES, FI, FR, HU, IT, NL, PL, RO,UA	J	Domestic fowl (*Gallus gallus domesticus*)	Fauna Italia (2003), Geiter et al (2002), Hellenthal et al (2004), Mouchet and Morel (1957), Piaget (1880), Séguy (1924, 1944), Touleshkov (1955a)
Philopteridae	*Lagopoecus colchicus* Emerson, 1949	A	parasitic/ predator	Asia	1989	BE, CZ, DE, PL	G, I2	Pheasant (*Phasianus colchicus*)	Geiter et al (2002), Hellenthal et al (2004), Šefrová and Laštùvka (2005)
Philopteridae	*Lipeurus maculosus* Clay, 1938	A	parasitic/ predator	Asia	1938	BE, CZ, DE, GB, HU, IT, PL, RO	G, I2	Pheasant (*Phasianus colchicus*), Partridge (*Perdrix perdrix*)	Clay (1938), Dlabola (1977), Fauna Italia (2003), Geiter et al (2002), Hellenthal et al (2004)
Philopteridae	*Reticulipeurus* (=*Oxylipeurus*) *polytrapezius* (Burmeister 1838)	C	parasitic/ predator	Crypto-genic	1880	BG, DE, FR, IT	J	Turkey (*Meleagris*)	Fauna Italia (2003) Geiter et al (2002), Mouchet and Morel (1957), Piaget (1880), Séguy (1944)
Trichodectidae	*Trichodectes* (*Stachiella*) *octomaculatus* Paine 1912	A	parasitic/ predator	North America	Unknown	AT, BE, CH?, DE	F9	Raccoon (*Procyon lotor*)	Geiter et al (2002), Hellenthal et al (2004), Kenis (2005)
Trichodectidae	*Trichodectes* (*Trichodectes*) *canis* (De Geer 1778)	C	parasitic/ predator	Crypto-genic	<1880	BE, BG, DE, ES, FI, FR, IT, PL	J	Dogs (*Canis domesticus*)	Fauna Italia (2003), Hellenthal et al (2004), Mouchet and Morel (1957), Piaget (1880), Séguy (1924, 1944), Touleshkov (1955b)

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Siphonaptera									
Ceratophyllidae	*Callopsylla* (*Geminopsylla*) *gemina* (Ioff, 1946)	A	parasitic/ predator	Asia	1985	CH	J1	Man (*Colomba livia* in the native range)	Beaucornu and Aeschlimann (1985)
Ceratophyllidae	*Leptopsylla* (*Leptopsylla*) *segnis* (Schönherr, 1811)	C	parasitic/ predator	Crypto-genic	1811	AL, AD, AT, BA, BE, BG, CH, CY, CZ, DE, DK, EE, ES, ES-BAL, ES-CAN, FI, FÖ, FR, FR-COR, GR, GR-CRE, GR_NEG, GR-SEG, GB, HR, HU, IE, IS, IT, IT-SAR, IT-SIC, LI, LT, LU, MD, MK, MT, NL, PL, PT, PT-AZO, PT-MAD, RO, SK	J1, J2	*Mus domesticus*, *Rattus rattus* and other Muridae (fur fleas)	Beaucornu and Launay (1990), Dale (1878), Rotschild (1899), Soledad Gomez Lopez (2009), Stojcevic et al (2004)
Ceratophyllidae	*Nosopsyllus* (*Nosopsyllus*) *fasciatus* (Bosc dAntic, 1800)	A	parasitic/ predator	Asia-Tempe-rate	1900	AT, BE, CH, CZ, DE, DK, ES, ES-BAL, FÖ, FR, FR-COR, GB, GR, HU, IE, IT, IT-SAR, IT-SIC, LT, LU, ME, MT, NL, PL, PT, PT-AZO, PT-MAD, RO, RS, SK	E,J	*Rattus* spp., *Apodemus* spp., *Mus* spp. and other Muridae	Beaucornu (1972, 1976, 1978), Beaucornu and Alcover (1984), Beaucornu and Launay (1990), Beaucornu and Pascal (1998), Galli-Valerio (1900), Krause (1911), Mifsud et al (2008), Peus (1963), Smit (1957, 1966), Soledad Gomez Lopez (2009)

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Ceratophyllidae	*Orchopeas howardi* Baker 1895	A	parasitic/ predator	North America	1800	GB, IE	G, X11	*Sciurus carolinensis* (grey squirrel), *Clethrionomys glareolus, Glis glis, Dama dama, Vulpes vulpes, Oryctolagus cuniculus*	Anonymous (1994),Donisthorpe (1925)
Pulicidae	*Euhoplopsyllus glacialis affinis* (Baker, 1904)	A	parasitic/ predator	North America	1977	FR, IT	E, F, G	cottontail, rabbit *Sylvilagus floridanus, Oryctolagus cuniculus*	Beaucornu and Launay (1977), Beaucornu et al (1981), Fauna Italia (2003)
Pulicidae	*Xenopsylla brasiliensis* (Baker, 1904)	A	parasitic/ predator	Africa	1942	ES-CAN, GB	J1	*Rattus* spp., vector of plague and murine typhus	Beaucornu and Launay (1990), Hopkins and Rotschild (1953), Najera (1942), Smit (1957),
Pulicidae	*Xenopsylla cheopis cheopis* (Rothschild, 1903)	A	parasitic/ predator	Africa(Nile region)	1904	DE, ES, ES-CAN, FR, FR-COR, GB, GR, HU, IE, IT-SIC, IT, MT, PL, PT-AZO, PT-MAD, PT, RU	J1	*Rattus norvegicus*, *R. rattus*, humans, *Mus musculus*; vector of plague	Bernard et al (1947), Beaucornu and Launay (1990), Cartana Castella and Gil-Collado (1934), Giles (1905), Ilvento (1913), Lavier (1921), Najera (1942), Séguy (1924), Tanon (1923), Tiraboschi (1904), Zapatero-Ramos et al (1982),