



## Review of the systematics, biology and ecology of lice from pinnipeds and river otters (Insecta: Phthiraptera: Anoplura: Echinophthiriidae)

MARIA SOLEDAD LEONARDI<sup>1</sup> & RICARDO LUIS PALMA<sup>2</sup>

<sup>1</sup>Laboratorio de Parasitología, Centro Nacional Patagónico (CONICET), Puerto Madryn, Provincia de Chubut, Argentina

<sup>2</sup>Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand

### Abstract

We present a literature review of the sucking louse family Echinophthiriidae, its five genera and twelve species parasitic on pinnipeds (fur seals, sea lions, walruses, true seals) and the North American river otter. We give detailed synonymies and published records for all taxonomic hierarchies, as well as hosts, type localities and repositories of type material; we highlight significant references and include comments on the current taxonomic status of the species. We provide a summary of present knowledge of the biology and ecology for eight species. Also, we give a host-lice list, and a bibliography to the family as complete as possible.

**Key words:** Phthiraptera, Anoplura, Echinophthiriidae, *Echinophthirius*, *Antarctophthirus*, *Lepidophthirus*, *Proechinophthirus*, *Latagophthirus*, sucking lice, Pinnipedia, Otariidae, Odobenidae, Phocidae, Mustelidae, fur seals, sea lions, walruses, true seals, river otter

### Introduction

Among the sucking lice (Anoplura), the family Echinophthiriidae is the only family with species adapted to live on pinnipeds—a mammalian group that includes fur seals and sea lions (Otariidae), walruses (Odobenidae), and true seals (Phocidae) (Durden & Musser 1994a 1994b)—as well as on the North American river otter (Kim & Emerson 1974). Currently, the Echinophthiriidae comprises 5 genera and 12 species (see below).

Echinophthiriids have developed unique morphological adaptations to cope with the amphibious lifestyle of their hosts. All species possess (i) prehensile tibio-tarsal claws in the second and third pairs of legs adapted to grasping onto hairs firmly; (ii) a membranous abdomen that allows gas exchange, particularly underwater; and (iii) abdominal spiracles with a sophisticated closing device that preserves atmospheric air and prevents water entering the body during the host's immersions (Kim 1975). Morphological and biological traits and host specificity of echinophthiriids suggest that the lice must have coevolved with their hosts during the colonization of the marine environment (Kim 1975, 1985; Kim *et al.* 1975).

Studies on ecology and life cycles of echinophthiriids flourished in the 1960s–1970s, focusing on five species: two from seals—*Lepidophthirus macrorhini* and *Antarctophthirus ogmorhini* (Murray 1958, 1964, 1967; Murray & Nicholls 1965; Murray *et al.* 1965), two species from the northern fur seal—*Antarctophthirus callorhini* and *Proechinophthirus fluctus* (Kim 1971, 1972, 1975), and one from the Cape fur seal—*Proechinophthirus zumpti* (Kim 1979). Recently, Aznar *et al.* (2009) and Leonardi *et al.* (2011, 2012b) studied the ecology of *Antarctophthirus microchir* from the South American sea lion, as well as its morphology in detail (Leonardi *et al.* 2009, 2012a).

The systematics and ecology of Echinophthiriidae have not been reviewed since the 1970s and need to be re-evaluated through a modern approach. A checklist of all 12 species is provided below, as a first step towards a revision. In addition, literature records, hosts, type localities, type material, comments on current taxonomic status, and references to biological and ecological studies are provided for each species.

The taxonomy and nomenclature of the lice follow Durden & Musser (1994a), and those of the hosts follow Reeves *et al.* (2002), with the exception of the Galápagos sea lion which we regard as a full species (*Zalophus*

*wollebaeki* Silvertsen, 1953) following Boness (2002). Under each taxon, synonymies are listed chronologically, with citations also arranged chronologically, and including author, date, page and figure numbers, if applicable.

Repository institutions of type specimens

EMEC	Essig Museum of Entomology, University of California, Berkeley, California, U.S.A.
KCEM	K.C. Emerson Entomology Museum, Oklahoma State University, Stillwater, Oklahoma, U.S.A.
NHML	Natural History Museum, London, United Kingdom.
USNM	United States National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

## Systematics

### Family Echinophthiriidae Enderlein, 1904

Echinophthiriidae Enderlein, 1904b: 136. Type genus: *Echinophthirus* Giebel, 1871 (by original designation). Enderlein 1906: 661; Dalla Torre 1908: 17; Enderlein 1909: 505; Kellogg & Ferris 1915: 48; Ferris 1916a: 180; Tillyard 1926: 132, 134; Freund 1928: 2, 5; Ewing 1929: 148; Ass 1934: 92, 103; Fahrenholz 1936: 56; Herms 1939: 104; Eichler 1941: 384; Séguy 1944: 452; Séguy 1951: 1381; Ferris 1951: 71; Imms 1957: 417; Blagoveshtchensky 1964: 326; Borror & DeLong 1964: 154; Ludwig 1968: 257; Calaby 1970: 386; Pilgrim 1970: 77; Kim & Emerson 1974: 444; Kim *et al.* 1975: 544, fig. 385; Hinton 1976: 73; Kim & Ludwig 1978a: 269, figs 7, 15, 33; Kim & Ludwig 1978b: 918; Murray 1976: 81, 84, figs 4.1–4.8; Marshall 1981: 207, 389; Ludwig 1982: 150; Kim 1982a: 406; Kim 1982b: 124; Kim 1985: 223, 720; Zarubina 1986: 373; Kim *et al.* 1986: 43; Kim 1987: 230, figs 23.9, 23.10, 23.11a; Kim 1988: 93, 96–99, 102, 107–109, figs 7.5, 7.7, 7.8, table 7.3; Calaby & Murray 1991: 427; Beaucournu 1993: 13; Durden & Musser 1994a: 6; Barker 1996: 236; Price & Graham 1997: 113, figs 94–95; Castro & Cicchino 1998: 129, fig. 1; Pajot 2000: 30; Aznar *et al.* 2001: 391, 402, fig. 4; Raga *et al.* 2002: 871, 873, fig. 1m; Grimaldi & Engel 2005: 272, 275; Jensen & Palma 2005: 227, fig. 5.32c.

Echinophthiriinae Enderlein, 1904b; Enderlein 1909: 506; Ferris 1916a: 181; Freund 1928: 2; Ewing 1929: 148; Ass 1934: 92; Ass 1935: 24; Fahrenholz 1936: 56; Eichler 1941: 384; Séguy 1944: 452; Séguy 1951: 1381. Rejected as a subfamily by Ferris 1951: 71.

Antarctophthiriinae Enderlein, 1909: 506. Type genus: *Antarctophthirus* Enderlein, 1906 (by original designation). Ferris 1916a: 182; Freund 1928: 2; Ewing 1929: 148; Fahrenholz 1936: 56; Eichler 1941: 384; Séguy 1951: 1381. Rejected by Ferris 1951: 71.

Echinophthiriidae [sic] Enderlein, 1904; Mjöberg 1910: 176. Misspelling.

Lepidophthiriidae [sic] Mjöberg, 1910: 177. Type genus: *Lepidophthirus* Enderlein, 1904a (by original designation). Synonymised by Ferris 1916a: 180.

Lepidophthiriidae Mjöberg, 1910; Ferris 1916a: 180; Ferris 1951: 71; Ass 1963: 6; Kim & Ludwig 1978a: 270. Emendation.

Lepidophthiriinae Mjöberg, 1910; Ewing 1929: 148. Rejected by Ferris 1951: 71. Emendation.

Antarctophthiriinae [sic] Enderlein, 1909; Bedford 1932: 399; Ass 1934: 92; Ass 1935: 24. Misspelling.

Echinophthiriformia Eichler, 1941: 384.

Phocaphthiriidae Ass, 1962: 55. Type genus: *Echinophthirus* Giebel, 1871 (by original designation). Synonymised by Kim & Ludwig 1978a: 270.

Phocophthiriidae Ass, 1963: 6. Kurochkin & Badamshin, 1968: 202. Unjustified emendation.

Echinophthiriidae [sic] Enderlein; Ledger 1980: 205. Misspelling.

Echinophthiriidae [sic]; Raga 1997: 76. Misspelling.

**Significant references.** Enderlein (1906: 661, key to genera; descriptions); Dalla Torre (1908: 17, list only); Enderlein (1909: 505, Antarctic species); Mjöberg (1910: 176, descriptions); Ferris (1916a: 180, description, species list, synonymies); Freund (1928, revision, many figures); Ewing (1929: 148, key to subfamilies and genera); Ferris (1951: 71, synonymy, description, key to genera); Blagoveshtchensky (1964: 326, key to USSR species); Kim & Emerson (1974: 444, good key to genera of Echinophthiriidae); Kim *et al.* (1975: 544, sucking lice and evolution of otariid seals); Hinton (1976: 73, respiratory adaptations); Murray (1976: 81, 84, host-lice list, key to genera, biology, figures); Kim & Ludwig (1978: 268–270, key to families of Anoplura; synonymy, detailed description of family); Kim (1985: 223, coevolution with pinnipeds); Kim *et al.* (1986: 43, North American species); Kim (1987: 230, key to nymphal stages); Kim (1988: 102, 107, phylogeny, evolution, host-relationships); Durden & Musser (1994a: 6, checklist; 1994b, hosts); Pajot (2000: 31: key to genera); Light *et al.* (2010: 295, phylogeny); Leonardi *et al.* (2011: 62, popular account).

**Hosts.** Aquatic Carnivora: Pinnipedia (sea lions, true seals, fur seals and walruses) and Mustelidae (North American river otter).

## List of genera

### *Echinophthirus* Giebel, 1871

Type species: *Pediculus phocae* Lucas, 1834 = *Echinophthirus horridus* (Olfers, 1816) (by monotypy).  
One species.

### *Lepidophthirus* Enderlein, 1904

Type species: *Lepidophthirus macrorhini* Enderlein, 1904a (by original designation).  
Two species.

### *Antarctophthirus* Enderlein, 1906

Type species: *Antarctophthirus ogmorhini* Enderlein, 1906 (by original designation).  
Six species.

### *Proechinophthirus* Ewing, 1923

Type species: *Echinophthirus fluctus* Ferris, 1916b = *Proechinophthirus fluctus* (Ferris, 1916b) (by original designation).  
Two species.

### *Latagophthirus* Kim & Emerson, 1974

Type species: *Latagophthirus rauschi* Kim & Emerson, 1974 (by monotypy).  
One species.

## Taxonomy

### *Echinophthirus* Giebel, 1871

*Echinophthirus* Giebel, 1871: 174. Type species: *Echinophthirus horridus* Olfers, 1816 (by subsequent designation). Giebel 1874: 43; Piaget 1880: 656; Enderlein 1904a: 44; Enderlein 1904b: 136; Enderlein 1906: 661; Dalla Torre 1908: 17; Enderlein 1909: 507; Kellogg & Ferris 1915: 51; Ferris 1916a: 181; Freund 1928: 6; Ewing 1929: 149; Ferris 1934: 475; Séguy 1944: 452; Webb 1949: 172, 185, table 3; Ferris 1951: 75; Imms 1957: 414; Blagoveshtchensky 1964: 326; Ludwig 1968: 258; Kim *et al.* 1975: 546; Murray 1976: 84, Ludwig 1982: 150; fig. 4.3; Kim 1982b: 125; Kim *et al.* 1986: 50; Zarubina 1986: 373; King 1983: 203; Durden & Musser 1994a: 7; Price & Graham 1997: 113; Aznar *et al.* 2001: 403, fig. 4; Light *et al.* 2010: 295.

*Echinophthirus* Giebel; Mjöberg 1910: 176. Misspelling.

**Hosts.** Phocidae—Seals.

**Significant references.** Webb (1949: 172, 185, phylogenetic relationships); Ferris (1951: 75, synonymy, notes); Kim (1982b: 125, host specificity, phylogeny); Kim (1985: 201, evolution); Kim (1988: 102, phylogeny).

### *Echinophthirus horridus* (Olfers, 1816)

*Pediculus horridus* Olfers, 1816: 84.

*Pediculus phocae* Lucas, 1834: IX, pl. 121, fig 12.

*Pediculus setosus* Burmeister, 1838: Species 12. Page unnumbered.

*Haematopinus setosus* (Burmeister); Denny 1842: 36; Gurlt 1857: 281.

*Haematopinus annulatus* Schilling. In: Gurlt 1857: 281. *Nomen nudum*.

*Haematopinus (Echinophthirus) setosus* (Denny) [sic]; Giebel, 1874: 42.

*Haematopinus annulatus* Schilling, 1857; Gurlt 1878: 187.

*Echinophthirus setosus* Lucas [sic]; Piaget, 1880: 656, pl. 54, fig. 1; Osborn 1896: 188.

*Echinophthirus groenlandicus* Becher, 1886: 60, pl. 5, fig. 1a–d. Enderlein 1909: 507; Ferris 1916a: 181; Freund 1928: 16; Hopkins 1946: 567; Coulson & Refseth 2004: 96.

*Echinophthirus sericans* Meinert, 1897: 177. Breddin 1901: 557; Freund 1928: 17; Ass 1934: 103; Hopkins 1946: 567; Bonner 1972: 491.

*Echinophthirius setosus* (Burmeister, 1838); Breddin 1901: 557.

*Echinophthirius phocae* (Lucas, 1834); Enderlein 1904b: 136; Enderlein 1906: 661; Dalla Torre 1908: 17; Enderlein 1909: 507; Luther 1909: 17; Waterston 1913: 113; Evans 1913: 95, fig. 1; Herms 1939: 105; Kellogg & Ferris 1915: 51; Ferris 1916a: 181; Ewing 1932: 663, figs 4–5; Jancke 1932: 539, fig. 6; Ass 1934: 103; Steel 1964: 35.

*Echinophthirius groenlandicus* Becker [sic], 1885 [sic]; Dalla Torre 1908: 17, fig. 12.

*Echinophthirius sericeus* [sic] Meinert, 1896 [sic]; Dalla Torre 1908: 18; Ferris 1916a: 182. Misspelling.

*Echinophthirus* [sic] *phocae* (Lucas, 1834); Mjöberg 1910: 176. Misspelling.

*Echinophthirius horridus* (Olfers, 1816); Ferris 1916a: 205; Fahrenholz 1917: 6; Fahrenholz 1919: 22; Ferris 1919: 11D; Freund 1928: 6, figs 1–11; Ferris 1934: 476, figs 277–278; Ass 1934: 103; Jancke 1938: 75; Thompson 1939: 9; Séguy 1944: 452, figs 727–729; Hopkins 1946: 566; Webb 1946: 51, 95, figs 205–206; Brinck 1948a: 132; Brinck 1948b: 149; Hopkins 1949: 509; Séguy 1951: 1381, fig. 1214; Ferris 1951: 75, figs 32–33; Margolis 1954: 277; Margolis 1956: 501; Goidanich 1956: 525; Nakagawa 1959: 44; van den Broek & Wensvoort 1959: 60; Swiestra, Jansen & van den Broek 1959: 896; Brown *et al.* 1960: 534; Taylor *et al.* 1961: 976; Ass 1963: 6, fig. 1; Scherf 1963: 25, figs 7–18; van den Broek 1963: 25; Blagoveshtchensky 1964: 326; King 1964: 135, 137; Steel 1964: 35; van den Broek & Jansen 1964: 104; Spencer 1966: 23; Caldwell & Caldwell 1969: 379; Ronald *et al.* 1970: 1038; Mehl 1970: 111; Miller 1971: 670, figs 1–6; Bonner 1972: 491; Dailey & Brownell 1972: 535–540; Margolis & Dailey 1972: 14; Kaisila 1973: 63; Vauk 1973: 120; Anderson *et al.* 1974: 437; Wipper 1974: 105; Kim *et al.* 1975: 547; Kurochkin 1975: 364; Murray 1976: 88, fig. 4.3; Dunn & Wolke 1976: 532, 535; van den Broek 1977: 15, 21; Geraci 1978: 40; McClelland 1980: 406; Conlogue *et al.* 1980: 1184; Reijnders *et al.* 1981: 34, 36; Bonner 1981: 126; Geraci *et al.* 1981: 1457; King 1983: 203; Kim *et al.* 1986: 50, pl. 4; Zarubina 1986: 374; Geraci & St Aubin 1987: 408; Schumann 1989; Dailey & Fallace 1989: 5, 8; Skírnisson & Ólafsson 1990: 96, 102, fig. 2; Beder 1990: 512, figs 1–12; Schumacher *et al.* 1990: 300; Lunneryd 1992: 270; Durden & Musser 1994a: 7; Durden & Musser 1994b: 141; Price & Graham 1997: 113; Thompson *et al.* 1998: 393; Kadulski 2001: 270; Coulson & Refseth 2004: 96; Hoffmann *et al.* 2004: 659; Essink *et al.* 2005: 306; Grimaldi & Engel 2005: 273, fig. 8.10; Leidenberger *et al.* 2008: 242, figs 4–7; Light *et al.* 2010: 296, 298.

*Echinophthirius* [sic] *horridus*; Wülker 1930: 298. Misspelling.

*Echinophthirius groenlandicus horrophthirius* Ass 1934: 103. *Nomen nudum*.

*Echinophthirius groenlandicus sericans* Meinert, 1897; Ass 1934: 103.

*Echinophthirius horridus typicus* Ass, 1935: 25, figs 2, 3–5.

*Echinophthirius horridus baicalensis* Ass, 1935: 25, fig. 1. Hopkins 1946: 567; Hopkins 1949: 509; Goidanich 1956: 530; Tijskens 1969: 132.

*Echinophthirius horridus horridus* (Olfers, 1816); Hopkins 1949: 509; Goidanich 1956: 530.

*Echinophthirius horridus groenlandicus* Becher, 1886; Hopkins 1949: 509; Goidanich 1956: 530.

*Echinophthirus* [sic] ? *horridus* (Olfers); Gressitt & Weber 1959: 447. Misspelling.

*Echinophthirius horridus erignathi* Blagoveshtchensky, 1966: 806, figs 1–3. Zarubina 1986: 374; Leidenberger *et al.* 2007: 243.

*Echinophthirius horridus* var. *caspicus* Kurochkin & Badamshin, 1968: 200, figs 1–4.

*Echinophthirius* [sic] *hondus* [sic]; Clausen 1978: 39. Misspellings.

*Echinophthirius horridus baikalensis* [sic] Ass, 1935. Durden & Musser 1994a: 7. Leidenberger *et al.* 2007: 243. Misspelling.

*Echinophthirius horridus caspicus* Kurochkin & Badamshin, 1968; Leidenberger *et al.* 2007: 243.

**Type host.** *Phoca vitulina* Linnaeus, 1758—Harbour seal.

**Type locality.** Europe, without specific locality.

**Type specimen/s data.** Syntypes, presumably originally deposited in the Zoologisches Museum, Berlin, but now considered lost (Kim *et al.* 1986: 51).

**Other hosts.** *Cystophora cristata* (Erxleben, 1777)—Hooded seal; *Erignathus barbatus* (Erxleben, 1777)—Bearded seal; *Halichoerus grypus* (Fabricius, 1791)—Grey seal; *Pagophilus groenlandicus* (Erxleben, 1777)—Harp seal; *Pusa hispida* (Schreber, 1775)—Ringed seal; *Pusa sibirica* (Gmelin, 1788)—Baikal seal; *Pusa caspica* (Gmelin, 1788)—Caspian seal.

**Geographic distribution.** Palearctic, Nearctic and Arctic Regions.

**Significant references.** Freund (1928: 6, many detailed figures); Ferris (1934: 476, synonymy, description, figures, hosts); Hopkins (1946: 566, type hosts of synonyms); Webb (1946: 95, spiracle structure); Ferris (1951: 75, synonymy, figures, notes); Scherf (1963: 25, descriptions of eggs, three nymphal stages and adults); Miller (1971: 670, scanning electron microscopy of antennae); Geraci *et al.* (1981: 1457, as intermediate host of a nematode); Kim *et al.* (1986: 50, redescription, figures); Beder (1990: 512, scanning electron microscopy of all stages); Durden & Musser (1994a: 7, synonymy, hosts, distribution); Thompson *et al.* (1998: 393, ecology on harbour seals); Leidenberger *et al.* (2007: 242, taxonomy, morphology, epidemiology, intermediate host); Light *et al.* (2010: 296, 298, phylogeny).

**Remarks.** While describing the new subspecies *Echinophthirius horridus baicalensis*, Ass (1935: 25) inadvertently created another new subspecies: *Echinophthirius horridus typicus* Ass, 1935, which should have been named as the nominate subspecies *Echinophthirius horridus horridus* (Olfers, 1816). We follow Ferris (1951) and Durden & Musser (1994a) in not recognising subspecies of *Echinophthirius horridus*.

### ***Antarctophthirus* Enderlein, 1906**

*Antarctophthirus* Enderlein, 1906: 661. Type species *Antarctophthirus ogmorhini* Enderlein, 1906 (by original designation). Dalla Torre 1908: 17; Enderlein 1909: 506, 508; Kellogg & Ferris 1915: 48; Ferris 1916a: 182; Freund 1928: 17; Ewing 1929: 148; Ferris 1934: 484; Harrison 1937: 10; Webb 1949: 172, 185, table 3; Ferris 1951: 72; Blagoveshtchensky 1964: 326; Murray 1967: 189; Clay & Moreby 1967: 166, figs 179–180; Ludwig 1968: 258; Kim *et al.* 1975: 546; Murray 1976: 85, fig. 4.3; Ledger 1980: 206; Kim 1982b: 125; Ludwig 1982: 150; King 1983: 203; Kim 1985: 201, fig. 5.1c; Kim *et al.* 1986: 43; Zarubina 1986: 373; Kim 1988: 102, 107; Durden & Musser 1994a: 6; Price & Graham 1997: 113; Castro & Cicchino 1998: 129; Pajot 2000: 31; Aznar *et al.* 2001: 403, fig. 4; Light *et al.* 2010: 295.

*Arctophthirus* Mjöberg, 1910: 177. Type species: *Arctophthirus trichechi* (Bohemann, 1865) (by monotypy). Synonymised by Ewing 1929: 149.

*Arctophthirus* Mjöberg, 1910; Kellogg & Ferris 1915: 48; Ewing 1929: 149. Unjustified emendation.

*Antarctophthirus* Enderlein, 1906; Ass 1934: 92; Ass 1963: 6. Misspelling.

*Achimella* Eichler, 1941: 375. Type species: *Haematopinus callorhini* Osborn, 1899 (by original designation).

**Hosts.** Phocidae, Odobenidae, Otariidae—Seals, walruses, fur seals and sea lions.

**Significant references.** Enderlein (1909: 508, key to species, many figures); Harrison (1937: 10, key to species); Webb (1949: 172, 185, phylogenetic relationships); Ferris (1951: 75, synonymy, key to species, notes); Clay & Moreby (1967: 166, key to Antarctic species); Kim (1982b: 125, host specificity, phylogeny); Kim (1985: 201, evolution); Kim (1988: 102, phylogeny).

### ***Antarctophthirus trichechi* (Bohemann, 1865)**

*Haematopinus Trichechi* Bohemann, 1865: 577, pl. 35, figs 2, 2a,b.

*Haematopinus trichechi* Bohemann, 1865; Piaget 1880: 656; Breddin 1901: 557; King 1964: 139.

*Haematopinus tricheci* [sic] Bohemann, 1865; Dalla Torre 1908: 11. Misspelling.

*Antarctophthirus trichechi* (Bohemann, 1865); Enderlein 1909: 508, 512, pls 55–56, pl. 60, figs 185–188; Neumann 1909: 532, figs 30–31; Kellogg & Ferris 1915: 49, fig. 17B, pl. 3, fig. 1; Ferris 1916a: 183; Cummings 1916: 172; Fahrenholz 1917: 5; Freund 1928: 25, figs 24–29; Ferris 1934: 492, figs 287–288; Maltbaek 1937: 20; Thompson 1938: 94; Herms 1939: 105; Eichler 1941: 375, fig. 34; Hopkins 1949: 509; Weber 1950: 172; Ferris 1951: 75; Blagoveshtchensky 1958: 377; Scherf 1963: 17, figs 1–6, 19–20; Blagoveshtchensky 1964: 326; King 1964: 139; Spencer 1966: 23; Margolis & Dailey 1972: 14; Kaisila 1973: 64; Kim *et al.* 1975: 547; King 1983: 203; Kim *et al.* 1986: 48, pl. 3; Zarubina 1986: 373; Kim 1988: 108; Durden & Musser 1994a: 7; Durden & Musser 1994b: 140; Jensen & Palma 2005: 227, fig. 5.32c.

*Arctophthirus trichechi* (Bohemann, 1865); Mjöberg 1910: 178, 259, figs 89–92, 154.

*Antarctophthirus* [sic] *trichechi* (Bohemann, 1865); Ass 1934: 94, 103, figs 2–13. Misspelling.

*Antarctophthirus* [sic] *trichoeci* [sic] (Bohemann, 1865); Ass 1963: 6, figs 2–5. Misspellings.

*Antarctophthirus tricechi* [sic] (Bohemann, 1865); Coulson & Refseth 2004: 96. Misspelling.

**Type host.** *Odobenus rosmarus* (Linnaeus, 1758)—Walrus.

**Type locality.** Spitsbergen Island, Hinlopen Strait, Norway.

**Type specimen/s data.** None designated, repository unknown. Probably lost.

**Other hosts.** None.

**Geographic distribution.** Arctic Region.

**Significant references.** Freund (1928: 25, detailed figures); Ferris (1934: 492, synonymy, description, figures, hosts); Ass (1934: 94, descriptions and figures of adults, egg, and nymphs); Scherf (1963: 17, descriptions of eggs, nymphs and adults); Kim *et al.* (1986: 48, redescription, figures); Durden & Musser (1994a: 7, synonymy, hosts, distribution).



## *Antarctophthirus microchir* (Trouessart & Neumann, 1888)

*Echinophthirus microchir* Trouessart & Neumann, 1888: 80, figs a–c.

*Antarctophthirus microchir* (Trouessart & Neumann, 1888); Enderlein, 1906: 663, figs 3–4; Dalla Torre 1908: 17, fig. 11; Enderlein 1909: 504, 508, 511, pl. 58, pl. 60, figs 183–184; Neumann 1909: 537; Ferris 1916a: 183; Ferris 1916b: 370; Tillyard 1926: 135; Freund 1928: 21, figs 17–19; Ferris 1934: 489, figs 285–286; Thompson 1938: 94; Webb 1946: 51, 95, figs 207–208; Séguy 1951: 1381; Ferris 1951: 73; Jellison 1952: 274; Margolis 1954: 277; Margolis 1956: 502; Thorsteinson & Lensink 1962: 358; Clay 1964: 233; Gressitt 1964: 539; King 1964: 140; Spencer 1966: 23; Dailey & Hill 1970: 128, 130; Clay & Moreby 1970: 220; Gressitt 1970: 329; Dailey & Brownell 1972: 529–531, fig. 9–13; Margolis & Dailey 1972: 14; Kim *et al.* 1975: 547; Marlow 1975: 171; King 1983: 203; Kim *et al.* 1986: 46, pl. 2; Kim 1987: 230, figs 23.24–23.27; Kim 1988: 107, 109; Durden & Musser 1994a: 7; Durden & Musser 1994b: 140; Barker 1996: 236; Dailey *et al.* 2005: 614; King 2005: 234; Morgades *et al.* 2006: 91, fig. 3; McIntosh & Murray 2007: 103; Leonardi *et al.* 2009: 1086, figs 1–7; Aznar *et al.* 2009: 293, figs 1–4; Palma 2010: 409; Leonardi *et al.* 2011: 62, figs 2–3, 6; Leonardi *et al.* 2012a: 929, figs 1–12; Leonardi *et al.* 2012b: 2, figs 1–3.

*Antarctophthirus* [sic] *microchir* (Trouessart & Neumann, 1888); Ass 1934: 103. Misspelling.

*Antarctophthirus microchir californianus* Fahrenholz, 1939: 42. Hopkins 1949: 508. Rejected as a subspecies by Ferris 1951: 73.

*Antarctophthirus* [sic] ?*microchir*; Clay in Hamilton 1939: 164. Misspelling.

*Antarctophthirus microchir microchir* (Trouessart & Neumann, 1888); Hopkins 1949: 508.

*Antarctophthirus* [sic] *microchir*; Raga 1997: 76, fig 5. Misspelling.

**Type host.** *Phocarctos hookeri* (Gray, 1844)—New Zealand sea lion.

**Type locality.** Auckland Islands, New Zealand.

**Type specimen/s data.** Syntypes ♂♀ probably lost (Enderlein 1906: 665; Kim *et al.* 1986: 46). There is no information about their original deposition.

**Other hosts.** Family Otariidae—Sea lions: *Neophoca cinerea* (Péron, 1816)—Australian sea lion; *Zalophus californianus* (Lesson, 1828)—California sea lion; *Zalophus wollebaeki* Silvertsen, 1953—Galápagos sea lion; *Otaria flavescens* (Shaw, 1800)—Southern American sea lion; *Eumetopias jubatus* (Schreber, 1776)—Northern sea lion.

**Geographic distribution.** Palearctic, Nearctic, Neotropical and Australasian Regions.

**Significant references.** Enderlein (1909: 508, description, figures of both sexes); Freund (1928: 21, detailed figures); Ferris (1934: 489, synonymy, description, figures, hosts); Webb (1946: 95, spiracle structure); Ferris (1951: 75, synonymy, hosts, notes); Kim *et al.* (1986: 46, redescription, figures, biology); Kim (1987: 230, figures of egg and all nymphal stages); Durden & Musser (1994a: 7, synonymy, hosts, distribution); McIntosh & Murray (2007: 103, ecology); Leonardi *et al.* (2009: 1086, redescription of nymphs and adults); Aznar *et al.* (2009: 293, population dynamics); Leonardi *et al.* (2011: 62, popular account); Leonardi *et al.* (2012a: 929, scanning electron microscopy of egg, adults and nymphs); Leonardi *et al.* (2012b: 2, ecology).

**Remarks.** *A. microchir* probably represents a complex of morphologically indistinguishable cryptic species. Leonardi *et al.* (2009, 2012a) compared specimens with reference material from the New Zealand, Australian, Steller and Californian sea lions, without finding morphological differences. Ferris (1934: 498) reported as “*Antarctophthirus* sp.” a fragmentary specimen collected from an *Arctocephalus* sp. without locality data which, according to him, had scales of the type present on *A. microchir* but more elongate.

## *Antarctophthirus callorhini* (Osborn, 1899)

*Haematopinus callorhini* Osborn, 1899: 553, fig. 1.

*Antarctophthirus monachus* Kellogg & Ferris, 1915: 49, figs 17A, 18, pl. 3, fig. 4. Ferris 1916a: 183; Freund 1928: 23, figs 20–23.

*Antarctophthirus callorhini* (Osborn, 1899); McAtee 1923: 142; Ferris 1934: 495, figs 289–290; Ferris 1951: 72; Jellison 1952: 274; Margolis 1954: 277; Jellison & Milner 1958: 200; King 1964: 139; Keyes 1965: 1094; Miller 1971: 670, figs 7–11; Kim 1971: 280, figs 1–26; Kim 1972: 2028, figs 1–3; Margolis & Dailey 1972: 14; Kim *et al.* 1974: 281; Kim *et al.* 1975: 547; Kim 1975: 504, figs 342–348; Murray 1976: 92, fig. 4.7; Lyons *et al.* 1978: 455; Lyons *et al.* 1980: 56; Marshall 1981: 175, 247, 292; Kim 1982b: 125; King 1983: 203; Kim *et al.* 1986: 44, pl. 1; Kim 1988: 108; Durden & Musser 1994a: 7; Durden & Musser 1994b: 140; Price & Graham 1997: 119.

*Achimella callorhini* (Osborn, 1899); Eichler 1941: 375.

*Antarctophthirus* (*Achimella*) *callorhini* (Osborn, 1899); Hopkins 1949: 508.

*Antarctophthirus* [sic] *monachus* Kellogg & Ferris, 1915; Ass 1934: 103; Dubinin 1955: 29. Misspelling.  
*Antarctophthirus* [sic] *callorhini*; Raga 1997: 76. Misspelling.

**Type host.** *Callorhinus ursinus* (Linnaeus, 1758)—Northern fur seal.

**Type locality.** Pribilof Islands, Alaska, U.S.A.

**Type specimen/s data.** Syntypes of *A. callorhini* probably lost (Kim 1971: 283, proposed the need of a neotype; Kim *et al.* 1986: 44). The holotype ♂ of *A. monachus* is deposited in the Ferris Collection at EMEC under the number 52226.

**Other hosts.** None.

**Geographic distribution.** North Pacific Ocean and Bearing Sea.

**Significant references.** Ferris (1934: 495, synonymy, description, figures, hosts); Freund (1928: 23, detailed figures, as *A. monachus*); Ferris (1951: 75, synonymy, hosts); Dubinin (1955: 29, resistance or “parasitophoria”); Miller (1971: 670, scanning electron microscopy of antennae); Kim (1971: 280, egg, nymphs and adults described and illustrated); Kim (1972: 2027, population dynamics); Kim *et al.* (1974: 281, mercury contamination); Kim (1975: 504, ecology; adaptation; population dynamics); Lyons *et al.* (1978: 463, control by pesticides); Kim *et al.* (1986: 44, redescription, figures, biology); Durden & Musser (1994a: 7, synonymy, hosts, distribution).

**Remarks.** Jellison (1952: 274) reported three Arctic foxes (*Alopex pribilofensis* (Merriam 1902)) with *Antarctophthirus callorhini* originating from northern fur seals, due to the foxes’ habit of feeding on dead seals.

### ***Antarctophthirus ogmorhini* Enderlein, 1906**

“*Echinophthirus setosus*” Rothschild, 1902: 224. Not *Echinophthirus setosus* (Burmeister, 1838) = *Echinophthirus horridus* (Olfers, 1816).

*Antarctophthirus ogmorhini* Enderlein, 1906: 662, figs 1–2. Neumann 1907: 13, in part; Dalla Torre 1908: 17; Enderlein 1909: 508, pl. 57, pl. 60, figs 181–182; Neumann 1909: 537; Cummings 1916: 172; Ferris 1916a: 183; Tillyard 1926: 135; Freund 1928: 19, figs 12–13; Ferris 1934: 486, figs 282–283; Harrison 1937: 11; Thompson & Plomley 1938: 116, 124; Hopkins 1949: 509; Séguy 1951: 1381; Ferris 1951: 73, fig. 31; Gressitt & Weber 1959: 447; King 1964: 137; Murray 1964: 243; Murray *et al.* 1965: 761, fig. 1, pls 1–2; Murray 1967: 190; Clay & Moreby 1967: 166, fig. 179; Calaby 1970: 107, fig. 5.1; Clay & Moreby 1970: 220; Gressitt 1970: 329; Dailey & Brownell 1972: 542; Kim *et al.* 1975: 547; Arthur 1976: 170; Murray 1976: 93, figs 4.1–4.3; Ledger 1980: 206, fig. 214; Marshall 1981: 175, 249, 292 fig. 8.4; Kim 1982a: 408, fig.; King 1983: 203; Rounsevell & Horne 1986: 312, 323; Kim 1988: 108; Calaby & Murray 1991: 69, fig. 3.1; Durden & Musser 1994a: 7; Durden & Musser 1994b: 141; Barker 1996: 237; Price & Graham 1997: 119; Pajot 2000: 32, fig. 4; Mehlhorn *et al.* 2002: 651, figs 1–17; King 2005: 234; Palma 2010: 409.

*Antarctophthirus* [sic] *ogmorhini* Enderlein, 1906; Ass 1934: 103. Misspelling.

*Antarctophthirus* sp.; Harrison 1937: 13 [ex *Leptonychotes weddelli*, Adelie Land, Antarctica]; Clay 1940: 296 [ex *Leptonychotes weddelli*, W. Graham Land, Antarctica].

*Antarctophthirus* ? *ogmorhini* (Enderlein) [sic]; Hopkins 1949: 510.

*Antarctophthirus* [sic] *ogmorhini*; Paulian 1953: 123, 232. Misspelling.

*Antarctophthirus ogmorphini* [sic]; Marshall 1981: 145. Misspelling.

**Type host.** *Hydrurga leptonyx* (Blainville, 1820)—Leopard seal.

**Type locality.** Victoria Land and Booth Wandell Island, Antarctica.

**Type specimen/s data.** Syntypes ♂♀ in NHML (♂ BM 1901-284, ♀ BM 1901-254).

**Other hosts.** *Leptonychotes weddellii* (Lesson, 1826)—Weddell seal.

**Geographic distribution.** Antarctica and Southern Oceans.

**Significant references.** Enderlein (1909: 508, description, figures of both sexes); Freund (1928: 19, figure of scales); Ferris (1934: 486, synonymy, description, figures, hosts); Ferris (1951: 73, synonymy, figure, hosts); Murray (1964: 243, ecology); Murray *et al.* (1965: 761, ecology); Durden & Musser (1994a: 7, synonymy, hosts, distribution); Mehlhorn *et al.* (2002: 651, scanning electron microscopy and light micrographs of sections).

**Remarks.** Descriptions of nymphal stages are needed.

### ***Antarctophthirus lobodontis* Enderlein, 1909**

“*Antarctophthirus ogmorhini*” Neumann 1907: 13. Not *Antarctophthirus ogmorhini* Enderlein, 1906. In part.  
*Antarctophthirus lobodontis* Enderlein, 1909: 508, 510, figs KK–NN. Freund 1928: 20, figs 14–16; Ferris 1934: 488, fig. 284; Thompson & Plomley 1938: 116, 124; Clay 1940: 296; Hopkins 1949: 509; Ferris 1951: 73; Gressitt & Weber 1959: 447; King 1964: 137; Clay & Moreby 1967: 166, fig. 180; Clay & Moreby 1970: 220; Gressitt 1970: 329; Wolcott 1971: 608, fig. on page 607; Dailey & Brownell 1972: 541; Pilgrim 1974: 1031, fig. 3; Kim *et al.* 1975: 547; Murray 1976: 92, fig. 4.8; Ledger 1980: 206; King 1983: 203; Kim 1988: 108; Durden & Musser 1994a: 7; Durden & Musser 1994b: 141; Barker 1996: 236; Pajot 2000: 32; King 2005: 234; Palma 2010: 409.  
*Antarctophthirus* [sic] *lobodontis* Enderlein, 1909; Ass 1934: 103. Misspelling.

**Type host.** *Lobodon carcinophaga* (Hombron & Jacquinot, 1842)—Crabeater seal.

**Type locality.** Booth Wandell Island, Antarctica.

**Type specimen/s data.** Syntypes ♂♀; repository unknown.

**Other hosts.** None.

**Geographic distribution.** Antarctica and Southern Oceans.

**Significant references.** Freund (1928: 20, detailed figures); Ferris (1934: 488, synonymy, figures); Durden & Musser (1994a: 7, synonymy, hosts, distribution).

**Remarks.** Redescriptions of adults and descriptions of nymphal stages are needed.

### ***Antarctophthirus mawsoni* Harrison, 1937**

*Antarctophthirus mawsoni* Harrison, 1937: 11, pl. 1, fig. 1. Hopkins 1949: 509; Ferris 1951: 73; Gressitt & Weber 1959: 447; King 1964: 137; Clay & Moreby 1967: 166; Clay & Moreby 1970: 220; Gressitt 1970: 329; Dailey & Brownell 1972: 543; Kim *et al.* 1975: 547; King 1983: 203; Kim 1988: 108; Durden & Musser 1994a: 7; Durden & Musser 1994b: 141; Barker 1996: 236; King 2005: 234.

**Type host.** *Ommatophoca rossii* Gray, 1844—Ross seal.

**Type locality.** King George V Island, Antarctica.

**Type specimen/s data.** Holotype ♀ (Catalogue number K.64350) in the Australian Museum, Sydney, Australia (Australian Museum 2012).

**Other hosts.** None.

**Geographic distribution.** Antarctica and Southern Oceans.

**Significant references.** Durden & Musser (1994a: 7, synonymy, hosts, distribution); Barker (1996: 236, taxonomy).

**Remarks.** Redescriptions of adults and descriptions of nymphal stages are needed.

### ***Lepidophthirus* Enderlein, 1904**

*Lepidophthirus* Enderlein, 1904a: 44. Type species: *Lepidophthirus macrorhini* Enderlein, 1904a. Enderlein, 1906: 661; Dalla Torre 1908: 18; Enderlein 1909: 513, pl. 59; Ferris 1916a: 184; Freund 1928: 31; Ewing 1929: 148; Ferris 1934: 498; Harrison 1937: 13; Webb 1949: 172, 185, table 3; Ferris 1951: 78; Ludwig 1968: 258; Kim *et al.* 1975: 546; Murray 1976: 85, figs 4.3–4.6; Ledger 1980: 206; Marshall 1981: 247; Kim 1982b: 125; Ludwig 1982: 150; King 1983: 203; Kim 1985: 201, fig. 5.1d; Kim 1988: 93, 102, 107; Durden & Musser 1994a: 8; Price & Graham 1997: 113; Castro & Cicchino 1998: 129; Pajot 2000: 31, 33; Aznar *et al.* 2001: 403, fig. 4; Light *et al.* 2010: 295.

**Hosts.** Phocidae—Elephant seals and monk seals.

**Significant references.** Webb (1949: 172, 185, phylogenetic relationships); Ferris (1951: 78, diagnosis); Kim (1982b: 125, host specificity, phylogeny); Kim (1985: 201, evolution); Kim (1988: 102, phylogeny).



## ***Lepidophthirus macrorhini* Enderlein, 1904**

*Lepidophthirus macrorhini* Enderlein, 1904a: 46, figs 1–5. Dalla Torre 1908: 18; Enderlein 1909: 515, figs OO–QQ, pl. 59, pl. 60, fig. 180; Ferris 1916a: 184; Tillyard 1926: 135; Freund 1928: 32, figs 30–35; Ferris 1934: 499, figs 291–292; Bedford 1929: 507; Bedford 1932: 399, 474; Harrison 1937: 13; Thompson 1938: 94; Hopkins 1949: 510; Séguéy 1951: 1381; Ferris 1951: 78, fig. 34; Murray 1958: 404; Gressitt 1964: 539; King 1964: 137; Murray 1964: 242; Murray & Nicholls 1965: 437, figs 1–2, pls 1–4; Murray 1967: 189; Clay & Moreby 1967: 166, fig. 181; Clay & Moreby 1970: 220; Gressitt 1970: 329; Dailey & Brownell 1972: 541; Kim *et al.* 1975: 547; Arthur 1976: 170; Murray 1976: 90, figs 4.3–4.6; Ledger 1980: 206, fig. 215; Marshall 1981: 145, 175, 249, 292, fig. 8.4; King 1983: 203; Kim 1988: 108; Durden & Musser 1994a: 8; Durden & Musser 1994b: 141; Barker 1996: 237; Price & Graham 1997: 118, fig. 95; Castro & Cicchino 1998: 131, fig. 1; Becker *et al.* 2000: 255; Pajot 2000: 34, fig. 5; Green & Turner 2004: 74; Grimaldi & Engel 2005: 272; Lehane 2005: 118; Palma 2010: 409.

*Lepidophthirus* [sic] *macrorhini* [sic]; Ass 1934: 103. Misspelling.

*Lepidophthirus* [sic] *macrorhini*; King 2005: 234. Misspelling.

**Type host.** *Mirounga leonina* (Linnaeus, 1758)—Southern elephant seal.

**Type locality.** Kerguelen Islands, Indian Ocean.

**Type specimen/s data.** Syntypes ♂♀; repository unknown (Barker 1996: 237).

**Other hosts.** None.

**Geographic distribution.** Antarctica and Southern Oceans.

**Significant references.** Freund (1928: 32, detailed figures); Ferris (1934: 499, synonymy, description, figures, hosts); Ferris (1951: 78, synonymy, figure, host); Murray (1958: 404, ecology); Murray (1964: 242, ecology); Murray & Nicholls (1965: 437, ecology); Durden & Musser (1994a: 8, hosts, distribution); Green & Turner (2004: 74, scanning electron microscopy of head, and claw).

**Remarks.** Nymphal stages have not been described yet.

## ***Lepidophthirus piriformis* Blagoveshtchensky, 1966**

*Lepidophthirus piriformis* Blagoveshtchensky, 1966: 806, figs 4–8. Kim *et al.* 1975: 547; King 1983: 203; Kim 1988: 108; Durden & Musser 1994a: 8; Durden & Musser 1994b: 141; Aznar *et al.* 2001: 385, fig. 1B.

**Type host.** *Monachus monachus* (Hermann, 1779)—Mediterranean monk seal.

**Type locality.** Black Sea coast of Anatolia, Turkey.

**Type specimen/s data.** Holotype ♀, and 47 paratypes (29 ♀♀ and 18 ♂♂) in the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Other hosts.** None.

**Geographic distribution.** Mediterranean and Black Seas, and Atlantic coast of northwestern Africa.

**Significant references.** Durden & Musser (1994a: 8, hosts, distribution).

**Remarks.** The original description is in Russian, but an English translation is available (see below in References).

## ***Proechinophthirus* Ewing, 1923**

*Proechinophthirus* Ewing, 1923: 149. Type species: *Echinophthirus fluctus* Ferris, 1916b = *Proechinophthirus fluctus* (Ferris, 1916b) (by original designation). Ewing 1929: 149; Ferris 1934: 480; Webb 1949: 172, 185, table 3; Ferris 1951: 81; Kim *et al.* 1975: 546; Murray 1976: 85, fig. 4.3; Marshall 1981: 247; Kim 1982b: 125; Ludwig 1982: 150; King 1983: 203; Kim 1985: 201; Kim *et al.* 1986: 54; Zarubina 1986: 373; Kim 1988: 93, 102, 107; Durden & Musser 1994a: 8; Price & Graham 1997: 113; Pajot 2000: 31, 35; Aznar *et al.* 2001: 402, fig. 4; Light *et al.* 2010: 295.

*Proechinophthirus* [sic] Ewing, 1923; Ludwig 1968: 258; Ledger 1980: 207. Misspelling.

**Hosts.** Otariidae—Fur seals.

**Significant references.** Webb (1949: 172, 185, phylogenetic relationships); Ferris (1951: 81, diagnosis); Kim (1982b: 125, host specificity, phylogeny); Kim (1985: 201, evolution); Kim (1988: 102, phylogeny).

## ***Proechinophthirus fluctus* (Ferris, 1916)**

*Echinophthirus fluctus* Ferris, 1916b: 366, figs 1–4. McAtee 1923: 142; Freund 1928: 17; Ass 1934: 103.

*Proechinophthirus fluctus* (Ferris, 1916b); Ewing 1923: 149; Ferris 1934: 481, figs 279–281; Hopkins 1949: 508; Ferris 1951: 81, fig. 36; Jellison 1952: 274; Margolis 1954: 277; Jellison & Milner 1958: 200; King 1964: 139; Keyes 1965: 1094; Spencer 1966: 24; Miller 1971: 670, figs 12–18; Kim 1971: 286, figs 27–40; Kim 1972: 2028, figs 1–3; Margolis & Dailey 1972: 14; Kim *et al.* 1974: 281; Kim 1975: 504, figs 342–348; Kim *et al.* 1975: 547; Murray 1976: 92, fig. 4.3; Lyons *et al.* 1978: 455; Lyons *et al.* 1980: 56; Marshall 1981: 175, 247, 292; Kim 1982b: 125; King 1983: 203; Kim 1985: 201; Kim *et al.* 1986: 54, pl. 6; Kim 1987: 230, figs 23.20–23.23; Kim 1988: 108–109; Durden & Musser 1994a: 8; Durden & Musser 1994b: 140; Light *et al.* 2010: 296, 298.

*Proechinophthirus fluctus ochotensis* Blagoveshtchensky, 1966: 808, figs 10–12. Zarubina 1986: 374, fig. 196.6. Synonymised by Kim (1971: 286).

**Type host.** *Eumetopias jubatus* (Schreber, 1776)—Northern sea lion, in error. The type series of *P. fluctus* originated from a skin held in the Stanford University Zoology Museum. According to Ferris (1934), it is likely that the skin had been misidentified and that it was a northern fur seal (*Callorhinus ursinus*).

**Type locality.** Not given; presumably Alaska, according to Kim (1971: 286).

**Type specimen/s data.** Syntypes ♂♀ and nymphs, deposited in EMEC under numbers 57973 and 52227.

**Other host.** *Callorhinus ursinus* (Linnaeus, 1758)—Northern fur seal.

**Geographic distribution.** North Pacific Ocean and Bearing Sea.

**Significant references.** Ferris (1934: 481, synonymy, description, figures, hosts); Ferris (1951: 81, synonymy, figures, hosts); Miller (1971: 670, scanning electron microscopy of antennae); Kim (1971: 286, detailed descriptions and illustrations of adults and nymphs); Kim (1972: 2027, population dynamics); Kim *et al.* (1974: 281, mercury contamination); Kim (1975: 504, ecology; adaptation; population dynamics); Lyons *et al.* (1978: 463, control by pesticides); Kim *et al.* (1986: 52, redescription, figures, biology); Kim (1987: 230, figures of egg and all nymphal stages); Durden & Musser (1994a: 8, synonymy, hosts, distribution); Light *et al.* (2010: 296, 298, phylogeny).

**Remarks.** Kim (1971: 286) refers to a “Holotype male” but Ferris (1916b: 368) did not designate a holotype, he only wrote “Types, a mature male and a mature female” and then a “paratype” from another source. Ferris’s statement cannot be taken as designating a holotype; therefore they are all syntypes.

Jellison (1952: 274) reported two Arctic foxes (*Alopex pribilofensis* (Merriam 1902)) with *Proechinophthirus fluctus* originating from northern fur seals, due to the foxes’ habit of feeding on dead seals.

## ***Proechinophthirus zumpti* Werneck, 1955**

*Proechinophthirus zumpti* Werneck, 1955: 419, figs 1–5. King 1964: 139; Dailey & Brownell 1972: 533; Kim *et al.* 1975: 547; Kim 1979: 497, figs 1–6; King 1983: 203; Kim 1985: 201, fig. 5.2; Kim 1988: 108–109; Durden & Musser 1994a: 8; Durden & Musser 1994b: 140; Pajot 2000: 35, fig. 6; Castro *et al.* 2002: 813, figs 1–19; Morgades *et al.* 2006: 92.

*Proechinophthirus* [sic] *zumpti* Werneck, 1955; Ledger 1980: 207, fig. 216. Misspelling.

**Type host.** *Arctocephalus pusillus* (Schreber, 1775)—Cape fur seal.

**Type locality.** Mossel Bay, Cape Province, South Africa.

**Type specimen/s data.** Holotype ♂, allotype ♀, one ♂, two ♀ and one nymph paratypes (Werneck 1955: 419). Two paratypes deposited in NHML: ♀ (BM1901-254), ♂ (BM1901-284). The remaining types have not been located. No types are held in the Entomological Collection of the Oswaldo Cruz Institute, Rio de Janeiro, Brazil (Márcio Felix pers. comm. 2012).

**Other hosts.** *Arctocephalus australis* (Zimmermann, 1783)—South American fur seal.

**Geographic distribution.** Neotropical and southern Ethiopian Regions.

**Significant references.** Kim (1979: 497, population dynamics; phylogeny; detailed descriptions of adults, nymphs and egg); Durden & Musser (1994a: 8, hosts, distribution); Castro *et al.* (2002: 813, scanning electron microscopy of egg, adults and last nymph).

## ***Latagophthirus* Kim & Emerson, 1974**

*Latagophthirus* Kim & Emerson, 1974: 442. Type species *Latagophthirus rauschi* Kim & Emerson, 1974 (by monotypy). Kim 1982b: 124; Ludwig 1982: 150; Kim *et al.* 1986: 52; Kim 1988: 96, 102, 107; Durden & Musser 1994a: 8; Price & Graham 1997: 113; Aznar *et al.* 2001: 404, fig. 4; Light *et al.* 2010: 295.

**Hosts.** Mustelidae—Otters.

**Significant references.** Kim (1982b: 124, host specificity, phylogeny); Kim (1985: 201, evolution); Kim (1988: 102, phylogeny).

## ***Latagophthirus rauschi* Kim & Emerson, 1974**

*Latagophthirus rauschi* Kim & Emerson, 1974: 442, figs 1–7. Marshall 1981: 207; Kim 1982b: 124; Kim *et al.* 1986: 52, pl. 5; Beaucournu 1993: 13; Durden & Musser 1994a: 8; Durden & Musser 1994b: 140.

**Type host.** *Lontra canadensis pacifica* (Rhoads, 1898)—North American river otter.

**Type locality.** 1.6 km NE of Broadbent, Coos Co., Oregon, U.S.A.

**Type specimen/s data.** Holotype ♂ and allotype ♀ in USNM (Kim *et al.* 1986: 52; Durden & Adams 2005: 49) and 35 paratypes (2♂♂, 4♀♀ and 29 nymphs) in KCEM.

**Other hosts.** None.

**Geographic distribution.** Western North America.

**Significant references.** Kim *et al.* (1986: 52, diagnosis, figures); Durden & Musser (1994a: 8, hosts, distribution).

**Remarks.** Nymphal stages have not yet been described.

## **Biology**

We give summarized information taken from the literature on *Habitat selection*, *Life cycle*, and *Quantitative data* for eight species of echinophthiriid lice. We have not been able to find published data for the following four species: *Antarctophthirus trichechi*, *A. lobodontis*, *A. mawsoni*, and *Latagophthirus rauschi*.

## ***Echinophthirus horridus* (Olfers, 1816)**

**Habitat selection.** *Echinophthirus* is mainly found on the head, neck and shoulders of the host body (Lucas 1834; Luther 1909; Mjöberg 1910; Evans 1913; Wipper 1974; Conlogue *et al.* 1980; Reijnders *et al.* 1981; Kadulski 2001).

**Life cycle.** There is no information about the duration of the life cycle of *E. horridus*. Thompson *et al.* (1998) suggested that it should be longer than those of Antarctic lice because *E. horridus* is found in low numbers on adult females and weaned pups.

**Quantitative data.** Evans (1913) reported this louse from a harbour seal shot in the Isle of May, Scotland, which was very heavily infested, counting 43 lice on just one square inch of shoulder skin. Ronald *et al.* (1970) found *E. horridus* occasionally on pups of the harp seal, but not on adults.

Bonner (1981) reports that *E. horridus* is common on grey seals and, although they do not appear to cause any pathological symptoms, very high infestations are usually associated with poor nutritional status.

Prevalence varies among different geographic populations of harbour seals. For example, it was recorded as 41.3% on seals from the Wadden Sea by Wipper (1974: 107), as 39% on seals from northwest Scotland by Thompson *et al.* (1998: 396), and as 45.5% in the Pacific coast of North America by Dailey & Fallace (1989: 5). Furthermore, Lunneryd (1992) reported a total absence of *E. horridus* on 158 harbour seals examined for ectoparasites in populations from the Kattogat-Skagerrak and the Baltic sea.

**Remarks.** Wülker (1930) suggested the possibility that *E. horridus* could act as intermediate host or vector of the heartworm *Dipetalonema spirocauda* (as *Acanthocheilonema*) and several authors tried to test that hypothesis (see Leidenberger *et al.* 2007). However, the only evidence of microfilariae in lice was provided by Geraci *et al.*

(1981) who found at least one of the developmental stages of the nematode in 70 out of 102 lice dissected. The review of the association between lice, heartworms and seals by Leidenberger *et al.* (2007) concluded that there is not enough evidence to regard *E. horridus* as directly involved in the life cycle of the worm; instead, it is likely that the louse has become a paratenic host of the heartworms.

#### ***Antarctophthirus microchir* (Trouessart & Neumann, 1888)**

**Habitat selection.** Eggs are laid on the dorsal surface; nymphs hatch there and then migrate to the belly, where they develop into adults and copulate. Ovigerous females return to the dorsal surface (Leonardi *et al.* 2012).

**Life cycle.** Based on deterministic models for population growth, Aznar *et al.* (2009) suggested generation times from 18 to 23 days, estimating a week for embryo development and 4 days for each nymphal stage.

**Quantitative data.** Mean intensity on South American sea lions pups: Nymph 1 (N1) 17.3; N2 30.4; N3 15.6; adults 8.8; total 63.5. Prevalence: N1 69.4%; N2 82.5%; N3 82.6%; adults 85.8%; total 91% (Aznar *et al.* 2009). McIntosh & Murray (2007) examined 47 Australian sea lion pups, finding 23 (48.94%) infested with lice, but there were no lice found on adults (n=3).

**Remarks.** There are no studies available on the ecology and biology of the louse species from the Northern sea lion, the California sea lion, or the New Zealand sea lion. However, it has been suggested that populations of *A. microchir* from different species of sea lions represent a complex of distinct but cryptic species (Leonardi *et al.* 2009, 2012a). Ongoing molecular studies found significant differences between samples of *A. microchir* from *Otaria flavescens* and *Neophoca cinerea*, enough for them to be considered as different species (S.C. Barker, pers. comm. 2011), but that research is still uncompleted.

#### ***Antarctophthirus callorhini* (Osborn, 1899)**

**Habitat selection.** Nostrils, auditory canal, eyelids, penile orifice, and umbilical area on black pups; head, hips, back, and abdomen on silver pups; and hips on adults (Kim 1972, 1975).

**Life cycle.** The whole cycle takes approximately 20–22 days. Kim (1972) estimated one week for the embryo development, 2–3 days for N1, and 4 days each for N2 and N3. The estimated fecundity was 8–9 eggs per day.

**Quantitative data.** Mean intensity: 74.8 on black pups, 88.7 on silver pups and 28 on adults. Prevalence: 100% on pups and 80% on adults.

**Remarks.** *Callorhinus ursinus* is the only host species parasitised simultaneously by two species of echinophthirid lice, i.e. *Proechinophthirus fluctus* and *Antarctophthirus callorhini* (see Kim 1971).

#### ***Antarctophthirus ogmorhini* Enderlein, 1906**

**Habitat selection.** Hind flippers, tail, ankle, hips. Less common around anal and penile orifices (Murray *et al.* 1965).

**Life cycle.** Murray *et al.* (1965) estimated a week for embryo development, but no information is available for the nymphal instars. The whole cycle probably takes between 3 and 4 weeks.

**Quantitative data.** Murray *et al.* (1965) found that 75% of 30 pups examined, 100% of 15 yearlings, and 5% of 275 adults (mostly females) were infested with lice at McMurdo Sound, Antarctica.

#### ***Lepidophthirus macrorhini* Enderlein, 1904**

**Habitat selection.** On hind flippers of all hosts, but also on body and fore flippers of some hosts (Murray & Nicholls 1965).

**Life cycle.** Murray & Nicholls (1965) studied restrained live seals and determined the life cycle of *L. macrorhini* as follows: females oviposit between 6 to 9 eggs that hatch after 5 to 10 days depending on the air temperature. Each nymphal stage has a duration of 3 to 4 days. Therefore, the whole cycle takes between 14 and 22 days. The survival of adults was estimated at more than 28 days.

**Quantitative data.** Mean intensity 46.2 lice, in a sample of 4 hosts examined. Prevalence 86% of 50 pups infested within 4 months of birth (Murray & Nicholls 1965). Becker *et al.* (2000) reported 600 lice (18 males, 53 females and 529 nymphs) from 18 elephant seals examined in the South Shetland Islands.

**Remarks.** Elephant seals are characterized by their moulting. Once a year they shed the outer layer of the stratum corneum and hairs. Therefore, to avoid losses, *L. macrorhini* burrows into the skin through the stratum corneum, thus reducing the probability of being dislodged during the host moulting (Murray & Nicholls 1965). Descriptions of nymphal stages are needed.

***Lepidophthirus piriformis* Blagoveshtchensky, 1966**

**Habitat selection.** No data available.

**Life cycle.** No data available.

**Quantitative data.** Not available.

**Remarks.** The only known host of *L. piriformis*, the Mediterranean monk seal, is considered to be a critically endangered species, being among the most endangered mammals, with only 350 to 450 individuals remaining (IUCN 2012). Therefore, considering that not all those individuals would be infested with echinophthiriid lice, we suggest that *L. piriformis* is even closer to extinction than its host and, therefore, it should also be listed as a critically endangered species.

***Proechinophthirus fluctus* (Ferris, 1916)**

**Habitat selection.** Hips and abdomen on black pups; head, back and abdomen on silver pups; and neck, abdomen, back and hips on adults (Kim 1972, 1975).

**Life cycle.** The whole cycle takes approximately 20 days. Kim (1972) estimated a duration of one week for the embryo development, 2–3 days for N1, and 4 days for each, N2 and N3. The estimated fecundity was 8–9 eggs per day.

**Quantitative data.** Mean intensity: 88.5 on black pups (n = 8), 8.7 on silver pups (n = 3) and 20.3 on adults (n = 7). Prevalence: 100% (adult lice and N1 mainly) on pups, and 88% on adults (Kim 1972, 1975).

**Remarks.** Unlike *P. zumpti*, adults of *P. fluctus* do not retain nymphal characters (Kim 1971, 1979). *Callorhinus ursinus* is the only host species parasitised simultaneously by two species of echinophthiriid lice: *Proechinophthirus fluctus* and *Antarctophthirus callorhini* (see Kim 1971).

***Proechinophthirus zumpti* Werneck, 1955**

**Habitat selection.** Principally on the belly and tail area of the host, similar to the pattern described for *P. fluctus* (Kim 1979).

**Life cycle.** No data available.

**Quantitative data.** Mean intensity 108.5, prevalence 70% (Kim 1979).

**Remarks.** Kim (1979) showed that adults of *P. zumpti* retain morphological characters found in the 3<sup>rd</sup> instar nymph, suggesting a neotonous evolution of the species.

**Host-lice list**

**Order CARNIVORA**

**Family ODOBENIDAE**

**Walrus**

**Genus *Odobenus* Brisson, 1762**

***Odobenus rosmarus* (Linnaeus, 1758)**

**Walrus**

*Antarctophthirus trichechi* (Bohemann, 1865)

**Family OTARIIDAE**

**Fur seals & sea lions**

**Genus *Arctocephalus* Geoffroy Saint-Hilaire & Cuvier, 1826**

***Arctocephalus australis* (Zimmermann, 1783)**

**South American fur seal**

*Proechinophthirus zumpti* Werneck, 1955

***Arctocephalus pusillus* (Schreber, 1775)**

**Cape fur seal**

*Proechinophthirus zumpti* Werneck, 1955

**Genus *Callorhinus* Gray, 1859**

***Callorhinus ursinus* (Linnaeus, 1758)**

**Northern fur seal**

*Antarctophthirus callorhini* (Osborn, 1899)

*Proechinophthirus fluctus* (Ferris, 1916)



<b>Genus <i>Eumetopias</i> Gill, 1866</b> <b><i>Eumetopias jubatus</i> (Schreber, 1776)</b> <i>Antarctophthirus microchir</i> (Trouessart and Neumann, 1888)	<b>Northern sea lion</b>
<b>Genus <i>Neophoca</i> Gray, 1866</b> <b><i>Neophoca cinerea</i> (Péron, 1816)</b> <i>Antarctophthirus microchir</i> (Trouessart and Neumann, 1888)	<b>Australian sea lion</b>
<b>Genus <i>Otaria</i> Péron, 1816</b> <b><i>Otaria flavescens</i> (Shaw, 1800)</b> <i>Antarctophthirus microchir</i> (Trouessart and Neumann, 1888)	<b>South American sea lion</b>
<b>Genus <i>Phocarctos</i> Peters, 1866</b> <b><i>Phocarctos hookeri</i> (Gray, 1844)</b> <i>Antarctophthirus microchir</i> (Trouessart and Neumann, 1888)	<b>New Zealand sea lion</b>
<b>Genus <i>Zalophus</i> Gill, 1866</b> <b><i>Zalophus californianus</i> (Lesson, 1828)</b> <i>Antarctophthirus microchir</i> (Trouessart and Neumann, 1888)	<b>California sea lion</b>
<b><i>Zalophus wollebaeki</i> Silvertsen, 1953</b> <i>Antarctophthirus microchir</i> (Trouessart and Neumann, 1888)	<b>Galápagos sea lion</b>
<b>Family PHOCIDAE</b>	<b>Seals</b>
<b>Genus <i>Cystophora</i> Nilsson, 1820</b> <b><i>Cystophora cristata</i> (Erxleben, 1777)</b> <i>Echinophthirus horridus</i> (Olfers, 1816)	<b>Hooded seal</b>
<b>Genus <i>Erignathus</i> Gill, 1866</b> <b><i>Erignathus barbatus</i> (Erxleben, 1777)</b> <i>Echinophthirus horridus</i> (Olfers, 1816)	<b>Bearded seal</b>
<b>Genus <i>Halichoerus</i> Nilsson, 1820</b> <b><i>Halichoerus grypus</i> (Fabricius, 1791)</b> <i>Echinophthirus horridus</i> (Olfers, 1816)	<b>Grey seal</b>
<b>Genus <i>Hydrurga</i> Gistel, 1848</b> <b><i>Hydrurga leptonyx</i> (Blainville, 1820)</b> <i>Antarctophthirus ogmorhini</i> Enderlein, 1906	<b>Leopard seal</b>
<b>Genus <i>Leptonychotes</i> Gill, 1872</b> <b><i>Leptonychotes weddellii</i> (Lesson, 1826)</b> <i>Antarctophthirus ogmorhini</i> Enderlein, 1906	<b>Weddel seal</b>
<b>Genus <i>Lobodon</i> Gray, 1844</b> <b><i>Lobodon carcinophaga</i> (Hombron &amp; Jacquinot, 1842)</b> <i>Antarctophthirus lobodontis</i> Enderlein, 1909	<b>Crabeater seal</b>
<b>Genus <i>Mirounga</i> Gray, 1827</b> <b><i>Mirounga leonina</i> (Linnaeus, 1758)</b> <i>Lepidophthirus macrorhini</i> Enderlein, 1904	<b>Southern elephant seal</b>

- Genus *Monachus* Fleming, 1822**  
***Monachus monachus* (Hermann, 1779)** **Mediterranean monk seal**  
*Lepidophthirus piriformis* Blagoveshtchensky, 1966
- Genus *Ommatophoca* Gray, 1844**  
***Ommatophoca rossii* Gray, 1844** **Ross' seal**  
*Antarctophthirus mawsoni* Harrison, 1937
- Genus *Pagophilus* Gray, 1844**  
***Pagophilus groenlandicus* (Erxleben, 1777)** **Harp seal**  
*Echinophthirus horridus* (Olfers, 1816)
- Genus *Phoca* Linnaeus, 1758**  
***Phoca vitulina* Linnaeus, 1758** **Harbor seal**  
*Echinophthirus horridus* (Olfers, 1816)
- Genus *Pusa* Scopoli, 1777**  
***Pusa caspica* (Gmelin, 1788)** **Caspian seal**  
*Echinophthirus horridus* (Olfers, 1816)  
***Pusa hispida* (Schreber, 1775)** **Ringed seal**  
*Echinophthirus horridus* (Olfers, 1816)  
***Pusa sibirica* (Gmelin, 1788)** **Baikal seal**  
*Echinophthirus horridus* (Olfers, 1816)

## Family MUSTELIDAE

- Genus *Lontra* Gray, 1843**  
***Lontra canadensis pacifica* (J.A. Allen, 1898)** **North American river otter  
(western subspecies)**  
*Latagophthirus rauschi* Kim & Emerson, 1974

## Acknowledgements

We thank the following colleagues for providing information, translations, or copies of publications relevant to this review: Martin Lewis, Christine Kiddey and Julia Kasper (Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand); Dale H. Clayton (University of Utah, Salt Lake City, Utah, U.S.A.); Lance A. Durden (Georgia Southern University, Statesboro, Georgia, U.S.A.); Márcio Felix (Oswaldo Cruz Institute, Rio de Janeiro, Brazil); Mercedes Fernández-Martínez (Universitat de València, Valencia, Spain); Sonja Leidenberger (Swedish Museum of Natural History, Stockholm, Sweden); Stephen Marder (Washington D.C., U.S.A.); Valerie McAtear (The Royal Entomological Society, London, United Kingdom); Serge V. Mironov (Zoological Institute, Russian Academy of Sciences, Saint Petersburg, Russia); Jesús M. Pérez (Universidad de Jaén, Jaén, Spain); Oldřich Sychra (University Brno, Brno, Czech Republic); and Michel P. Valim (Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil).

## References

- Anderson, S.S., Bonner, W.N., Baker, J.R. & Richards, R. (1974) Grey seals, *Halichoerus grypus*, of the Dee Estuary and observations on a characteristic skin lesion in British seals. *Journal of Zoology*, 174, 429–440.  
<http://dx.doi.org/10.1111/j.1469-7998.1974.tb03170.x>
- Arthur, D.R. (1976) Interaction between arthropod ectoparasites and warm blooded hosts. Chapter 8. *In*: Kennedy, C.R. (ed.),

- Ecological Aspects of Parasitology*. Amsterdam, Elsevier Scientific Publishing Company. pp. 163–183.
- Ass, M.J. (1934) Anoplura der Walrosse. *Trudy Arkticheskogo Instituta*, Leningrad [*Transactions of the Arctic Institute*, Leningrad], 9, 89–105 [in Russian with German summary].
- Ass, M.J. (1935) Ektoparasiten der Baikalrobbe. *Trudy Baikalskoi Limnologicheskoi Stantsii* [*Travaux de la Station Limnologique du Lac Bajkal*], 6, 23–29 [in Russian with German summary].
- Ass, M.J. (1962) Zur Kenntnis der Anatomie und Morphologie der Robbenläuse. *Bulleten Moskovskogo obshchestva ispytatelei prirody. Otdel biologicheskii*, 67, 55–60 [in Russian with German summary].
- Ass, M.J. (1963) Zur Anatomie und Morphologie der Anoplura pinnipediorum. *Československá Parasitologie*, 10, 5–12 [in Russian with German summary].
- Australian Museum (2012) Australian species of Family Echinophthiriidae. *Antarctophthirus mawsoni* Harrison, 1937. Accessed via the *Atlas of Living Australia* ([www.ala.org.au](http://www.ala.org.au)).  
<http://biocache.ala.org.au/occurrence/2a1b9922-072a-4cfe-ac49-8272b2c3cfc2>
- Aznar, F.J., Balbuena, J.A., Fernandez, M. & Raga, J.A. (2001) Living together: the parasites of marine mammals. Chapter 11. In: Evans, P.G.H. & Raga, J.A. (eds), *Marine Mammals: Biology and Conservation*. Kluwer Academic/Plenum Publishers, New York. pp. 385–421.
- Aznar, F.J., Leonardi M.S., Berón-Vera, B., Vales, D.G., Ameghino, S., Raga, J.A. & Crespo, E.A. (2009) Population dynamics of *Antarctophthirus microchir* (Anoplura: Echinophthiriidae) in pups from South American sea lion, *Otaria flavescens*, in Northern Patagonia. *Parasitology*, 136, 293–303.  
<http://dx.doi.org/10.1017/S0031182008005441>
- Barker, S.C. (1996) Echinophthiriidae. In: Wells, A. (ed.), *Zoological Catalogue of Australia*. Volume 26. *Psocoptera, Phthiraptera, Thysanoptera*. CSIRO Publishing, Melbourne, pp. 236–237.
- Beaucournu, J.-C. (1993) Poux et puces... temoins ou faux temoins de l'histoire de leurs hotes?. [Lice and fleas: true or false indicators?]. *Bulletin de la Société Zoologique de France—Evolution et Zoologie*, 118, 11–24 [in French with English summary].
- Becher, E. (1886) Insekten von Jan Mayen. Gesammelt von Dr. F. Fischer, Arzt der Österreichischen Expedition auf Jan Mayen. In: Kaiserliche Akademie der Wissenschaften (eds), *Die Internationale Polarforschung 1882-1883. Die Österreichische Polarstation Jan Mayen ausgerüstet durch seine Excellenz Graf Hanns Wilczek, geleitet vom k. k. Corvetten-Capitän Emil Edlen von Wohlgenuth. Beobachtungs-Ergebnisse (Zoologie)*. Karl Gerolds's Sohn, Wien. Volume 3. pp. 59–66, pl. 5.
- Becker, G.K., Robaldo, R.B., Bianchini, A., Colares, E.P., Martinez, P.E., Muelbert, M.M. & Brum, J.G.W. (2000) *Lepidophthirus macrorhini* (Anoplura: Echinophthiridae [sic]) em elefante-marinho do sul (*Mirounga leonina*) na Ilha Elefante (Shetlands do Sul - Antártica). *Arquivos do Instituto Biológico, São Paulo*, 67, 255–256.
- Beder, G. (1990) Rasterelektronenmikroskopische studie der robbenlaus *Echinophthiridus horridus* (Olfers, 1816). *Mitteilungen der Deutschen Gesellschaft für Allgemeine und Angewandte Entomologie*, 7, 512–516.
- Bedford, G.A.H. (1929) Anoplura (Siphunculata and Mallophaga) from South African hosts. *15th Annual report of the Director of Veterinary Services, Union of South Africa*, 501–549.
- Bedford, G.A.H. (1932) A synoptic check-list and host-list of the ectoparasites found on South African Mammalia, Aves and Reptilia. (Second edition). *18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa*, 223–523.
- Blagoveshtchensky, D.I. (1958) Mallophaga and Anoplura from animals of the Wrangel Island. *Entomological Review*, 37, 374–379. English translation of *Entomologicheskoe Obozrenie*, 37(2), 374–379 [in Russian with English summary].
- Blagoveshtchensky, D.I. (1964) Order Anoplura. (*Siphunculata*)—Sucking lice. In: Bei-Bienko, G.Y. (ed.), *Keys to the Insects of the European USSR*. Volume I, *Apterygota, Palaeoptera, Hemimetabola*. Akademiya Nauk SSSR. 936 pp. [in Russian]. English translation 1967, pp. 324–334.
- Blagoveshtchensky, D.I. (1966) New forms of lice (Siphunculata) parasitic on seals and hares. *Entomological Review*, 45, 457–460. English translation of *Entomologicheskoe Obozrenie*, 45(4), 806–813 [in Russian with English summary].
- Bohemann, C.H. (1865) Spetsbergens insekt-fauna. *Öfversigt af Kungliga Svenska Vetenskaps-Akademiens Förhandlingar, Kopenhagen*, 22, 563–580, pl. 35.
- Bonner, W.N. (1972) The grey seal and common seal in European waters. *Oceanography and Marine Biology Annual Review*, 10, 461–507.
- Bonner, N. (1981) Grey seal. *Halichoerus grypus* Fabricius, 1791 [sic], figs 1–5. In: Ridgway, S.H. & Harrison, R.J. (eds), *Handbook of marine mammals*. Volume 2: Seals. Academic Press Inc., London, pp. 111–144.
- Boness, D.J. (2002) Sea lions, overview. Pp. 1066–1069, fig. 1. In: Perrin, W.F., Würsig, B. & Thewissen, J.G.M. (eds), *Encyclopedia of marine mammals*. Academic Press, San Diego, California. xxxviii + 1414 pp., 16 pls.
- Borror, D.J. & DeLong, D.M. (1964) *An introduction to the study of insects*. Revised edition. Holt, Rinehart & Winston, Inc., New York. xii + 819 pp.
- Bredden, G. (1901) Die Hemipteren und Siphunculaten des arktischen Gebietes. *Fauna Arctica*, 2, 529–560.
- Brinck, P. (1948a) Catalogus Insectorum Sueciae. IX. Anoplura. *Opuscula Entomologica*, 13, 129–133.
- Brinck, P. (1948b) Notes on Anoplura. Especially with regard to the Swedish species *Opuscula Entomologica*, 13, 134–156.
- Brown, D.H., McIntyre, R.W., Delli Quadri, C.A. & Schroeder, R.J. (1960) Health problems of captive dolphins and seals. *Journal of the American Veterinary Medical Association*, 137, 534–538.
- Burmeister, H.C.C. (1838) *Genera Insectorum. Rhynchota*. 8. Berlin (no pagination).
- Calaby, J.H. (1970). Phthiraptera (Lice). Chapter 25. In: Division of Entomology, CSIRO, *The Insects of Australia*. Melbourne University Press, Carlton. pp. 376–386.
- Calaby, J.H. & Murray, M.D. (1991) Phthiraptera (Lice). Chapter 29. In: Naumann, I.D. (Chief ed.), *The Insects of Australia*, 2nd edition. CSIRO (Division of Entomology). Melbourne University Press, Carlton. pp. 421–428.
- Caldwell, D.K. & Caldwell, M.C. (1969) The harbor seal, *Phoca vitulina concolor*, in Florida. *Journal of Mammalogy*, 50, 379–380.

<http://dx.doi.org/10.2307/1378371>

- Castro, D.C. & Cicchino, A.C. (1998) Anoplura, figs 1–11. In: Morrone, J.J. & Coscarón, S. (eds), *Biodiversidad de artrópodos argentinos—Una perspectiva biotaxonomica*. Ediciones Sur, La Plata, pp. 125–139
- Castro, D.C., Romero, M.D. & Dreon, M. (2002) Ultrastructure of *Proechinophthirus zumpti* (Anoplura, Echinophthiriidae) by scanning electron microscopy. *Memorias do Instituto Oswaldo Cruz*, 97, 813–818.  
<http://dx.doi.org/10.1590/S0074-02762002000600011>
- Clausen, B. (1978) Diseases and toxochemicals in the common seal in Denmark. *Riistatieteellisiä Julkaisuja. Finnish Game Research*, 37, 38–39.
- Clay, T. (1940) Anoplura. *British Graham Land Expedition, 1934–37, Scientific Reports*, 1(5), 295–318, 1 pl.
- Clay, T. (1964) Insects of Campbell Island. Phthiraptera. *Pacific Insects Monograph*, 7, 230–234.
- Clay, T. & Moreby, C. (1967) Mallophaga (biting lice) and Anoplura (sucking lice). Part II: Keys and locality lists of Mallophaga and Anoplura. Pp. 157–169, 177–196. In Gressitt, J.L. (ed.), *Antarctic Research Series*, volume 10 *Entomology of Antarctica*. American Geophysical Union, Washington D.C. xii + 395 pp.
- Clay, T. & Moreby, C. (1970) Mallophaga and Anoplura of subantarctic islands. *Pacific Insects Monographs*, 23, 216–220.
- Conlogue, G.J., Ogden, J.A. & Foreyt W.J. (1980) Pediculosis and severe heartworm infection in a harbor seal. *Journal of Veterinary Medicine and Small Animal Clinician*, 75, 1184–1187.
- Coulson, S.J. & Refseth, D. (2004) The terrestrial and freshwater invertebrate fauna of Svalbard (and Jan Mayen). Chapter 3. Pp. 57–122. In: Prestrud, P., Strøm H. & Goldman, H.V. (eds), *A catalogue of the terrestrial and marine animals of Svalbard*. Norsk Polarinstittut Skrifter, Tromsø. 201, iv + 137 pp.
- Cummings, B.F. (1916) Note on the thorax in Anoplura and in the genus *Nesiotinus* of the Mallophaga. *Annals and magazine of natural history* (Series 18), 17, 171–174.  
<http://dx.doi.org/10.1080/00222931608693762>
- Dailey, M.D. & Brownell, R.L. (1972) A checklist of marine mammal parasites. Chapter 9. Pp. 528–589. In: Ridgway, S.H. (ed.), *Mammals of the sea. Biology and Medicine*. Charles C. Thomas Publisher, Springfield, Illinois. xiv + 812 pp.
- Dailey, M., Ellin, R. & Parás, A. (2005) First report of parasites from pinnipeds in the Galapagos Islands, Ecuador, with a description of a new species of *Philophthalmus* (Digenea: Philophthalmidae). *Journal of Parasitology*, 91, 614–617.  
<http://dx.doi.org/10.1645/GE-3425>
- Dailey, M.D. & Fallace, L.S. (1989) Prevalence of parasites in a wild population of the Pacific harbour seal (*Phoca vitulina richardsi*) from Gray's Harbor, Washington. *Bulletin of the Southern California Academy of Sciences*, 88, 1–10.
- Dailey, M.D. & Hill, B.L. (1970) A survey of metazoan parasites infecting the California (*Zalophus californianus*) and Steller (*Eumetopias jubatus*) sea lion. *Bulletin of the Southern California Academy of Sciences*, 69, 126–132.
- Dalla Torre, K. (1908) Anoplura. In: Wytzman, P. (ed.), *Genera Insectorum*, 81, 1–22, 1 pl.
- Denny, H. (1842) *Monographia anoplurorum Britanniae*. London, Henry G. Bohn. 264 pp., 26 pls.
- Dubinin, V.B. (1955) The phenomenon of “parasitophoria” among ectoparasites and its significance for livestock and wild animal raising. *Trudy Zoological Institute, Leningrad*, 21, 18–35 [in Russian].
- Dunn, J.L. & Wolke, R.E. (1976) *Dipetalonema spirocauda* infection in the Atlantic harbor seal (*Phoca vitulina concolor*). *Journal of Wildlife Diseases*, 12, 531–538.
- Durden, L.A. & Adams, N.E. (2005) Primary type specimens of sucking lice (Insecta: Phthiraptera: Anoplura) in the U.S. National Museum of Natural History, Smithsonian Institution. *Zootaxa*, 1047, 21–60.
- Durden, L.A. & Musser, G.G. (1994a) 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.
- Durden, L.A. & Musser, G.G. (1994b) The mammalian hosts of the sucking lice (Anoplura) of the world: A host-parasite list. *Bulletin of the Society for Vector Ecology*, 19, 130–168.
- Eichler, W. (1941) Zur Klassifikation der Lauskerfe (Phthiraptera Haeckel: Rhynchophthirina, Mallophaga und Anoplura). *Archiv für Naturgeschichte. Neue Folge*. 10, 345–398.
- Enderlein, G. (1904a) *Lepidophthirus* nov. gen., eine Laus der Elefantenrobbe von der Kerguelen-Insel. *Zoologischer Anzeiger* 28, 43–47.
- Enderlein, G. (1904b) Läusestudien. Über die morphologie, klassifikation und systematische stellung der Anopluren nebst bemerkungen zur systematik der insektenordnungen. *Zoologischer Anzeiger*, 28, 121–147.
- Enderlein, G. (1906) Läusestudien. V. Schuppen als sekundäre Atmungsorgane, sowie über eine neue antarktische Echinophthiriiden-Gattung. *Zoologischer Anzeiger*, 29, 659–665.
- Enderlein, G. (1909) Monographie der Robbenläuse. Pp. 505–516, pls 55–60. In: Enderlein G. (ed.), *Die Insekten des Antarktischen Gebietes. Deutsche Südpolar-Expedition 1901–1903* 10, *Zoologie*, 2, 361–528, 24 pls.
- Essink, K., Dettmann, C., Farke, H., Laursen, K., Lüerßen, G., Marencic, H. & Wiersinga W. (eds.) (2005) *Wadden Sea quality status report 2004. Wadden Sea Ecosystem No. 19*. Trilateral Monitoring and Assessment Group, Common Wadden Sea Secretariat, Wilhelmshaven. 360 pp.
- Evans, W. (1913) A list of Anoplura obtained in the Forth Area. *Proceedings of the Royal Physical Society of Edinburgh*, 19, 93–95.
- Ewing, H.E. (1923) New genera and species of sucking lice. *Journal of the Washington Academy of Sciences*, 13, 146–149.
- Ewing, H.E. (1929) *A manual of external parasites*. London, Baillière, Tindall & Cox. xvi + 225 pp.
- Ewing, H.E. (1932) The male genital armature in the order Anoplura, or sucking lice. *Annals of the Entomological Society of America*, 25, 657–669.
- Fahrenheit, H. (1917) Anopluren des Zoologischen Museums zu Hamburg. (3. Beitrag zur Kenntnis der Anopluren). *Mitteilungen aus dem Zoologischen Museums*, 34, 1–22.
- Fahrenheit, H. (1919) Zur Nomenklatur einiger Anopluren-Arten. II. *Jahresbericht des Niedersächsischen zoologischen Vereins zu*

Hannover, 5–10, 22–27.

- Fahrenholz, H. (1936) Zur Systematik der Anopluren. *Zeitschrift für Parasitenkunde*, 9, 50–56.  
<http://dx.doi.org/10.1007/BF02120303>
- Fahrenholz, H. (1939) Beiträge zur Kenntnis der Anopluren. IV. *Mitteilungen aus dem entomologischen Verein Bremen*, 26, 32–47.
- Ferris, G.F. (1916a) A catalogue and host list of the Anoplura. *Proceedings of the California Academy of Sciences (4<sup>th</sup> Series)*, 6, 129–213.
- Ferris, G.F. (1916b) Anoplura from sea-lions of the Pacific Ocean. *Entomological News*, 27, 366–370.
- Ferris, G.F. (1919) Anoplura of the Canadian Arctic Expedition, 1913–18. *Report of the Canadian Arctic Expedition 1913–18. Insects*. Volume 3, 11D. F.A. Acland, Ottawa.
- Ferris, G.F. (1934) Contributions toward a monograph of the sucking lice. Part VII. *Stanford University Publications, Biological Sciences*, 2, 473–526. Stanford University Press, California.
- Ferris, G.F. (1951) The Sucking Lice. *Memoirs of the Pacific Coast Entomological Society* 1, x + 320 pp.
- Freund, L. (1928) Anoplura Pinnipediorum (Robbenläuse). In: Grimpe G. & Wagler, E. (eds), *Tierwelt der Nord- und Ostsee*. Geest und Portig, Leipzig, 4, pp. 1–36.
- Geraci, J.R. (1978) The enigma of marine mammal strandings. *Oceanus*, 21, 38–47.
- Geraci, J.R., Fortin, J.F., St Aubin, D.J. & Hicks, B.D. (1981) The seal louse, *Echinophthirus horridus*: an intermediate host of the seal heartworm, *Dipetalonema spirocauda* (Nematoda). *Canadian Journal of Zoology*, 59, 1457–1459.  
<http://dx.doi.org/10.1139/z81-197>
- Geraci, J.R. & St Aubin, D.J. (1987) Effects of parasites on marine mammals. *International Journal for Parasitology*, 17, 407–414.  
[http://dx.doi.org/10.1016/0020-7519\(87\)90116-0](http://dx.doi.org/10.1016/0020-7519(87)90116-0)
- Giebel, C.G.A. (1871) Analytische Uebersicht der Säugethierläuse, *Haematopinus* und *Trichodectes*. *Zeitschrift für die gesammten Naturwissenschaften*, 37, 173–179.
- Giebel, C.G.A. (1874) *Insecta epizoa. Die auf Säugetieren und Vögeln schmarotzenden Insecten nach Chr. L. Nitzsch's Nachlass bearbeitet*. O. Wiegand, Leipzig. xvi + 308 pp., pls 1–20.
- Goidanich, A. (1956) *Echinophthirus horridus* Olfers (Anoplura Echinophthiriidae) scoperto sulla foca mediterranea *Monachus albiventer* Bodd. (Pinnipedia Phocidae Monachinae) nei mare di Sardegna. *Atti della Accademia delle Scienze di Torino*, 90, 525–532.
- Green, E.D. & Turner, M.L. (2004) Functional micromorphology of the elephant seal louse *Lepidophthirus macrorhini*. *Microscopy Society of Southern Africa - Proceedings*, 34, 74.
- Gressitt, J.L. (1964) Insects of Campbell Island. Summary. *Pacific Insects Monograph*, 7, 531–600.
- Gressitt, J.L. (1970) Subantarctic entomology and biogeography. *Pacific Insects Monograph*, 23, 295–374.
- Gressitt, J.L. & Weber, N.A. (1959) Bibliographic introduction to Antarctic–Subantarctic Entomology. *Pacific Insects*, 1, 441–480.
- Grimaldi, D. & Engel, M.S. (2005) *Evolution of the insects*. Cambridge University Press, New York. xvi + 755 pp.
- Gurlt, E.F. (1857) Verzeichniss der Thiere, auf welchen Schmarotzer - Insekten leben. *Archiv für Naturgeschichte*, 23, 276–304.
- Gurlt, E.F. (1878) Neues Verzeichniss der Thiere, auf welchen Schmarotzer-Insekten leben. *Archiv für Naturgeschichte*, 44, 167–210.
- Hamilton, J.E. (1939) A second report on the southern sea lion, *Otaria byronia* (de Blainville). *Discovery Reports*, 19, 121–164, 8 pls.
- Harrison, L. (1937) Mallophaga and Siphunculata. 2(1), 1–47, pls 1–3, 7 figs. In: Johnston, T.H. (ed.), *Scientific reports, Australasian Antarctic Expedition 1911–14, series C, Zoology and Botany*. Sydney, Government Printer.
- Hermes, W.B. (1939) *Medical entomology*. 3<sup>rd</sup> edition. The Macmillan Company, New York. xxii + 582 pp.
- Hinton, H.E. (1976) Respiratory adaptations of marine Phthiraptera. Pp. 73–74, fig. 3.14.A. In: Cheng, L. (ed.), *Marine Insects*. North Holland Publishing Company, Amsterdam. xii + 581 pp.
- Hoffmann, V., Nolan, T.J. & Schoelkopf, R. (2004) First report of the giant kidney worm (*Diocotophyme renale*) in a harbor seal (*Phoca vitulina*). *Journal of Parasitology*, 90, 659–660.  
<http://dx.doi.org/10.1645/GE-198R>
- Hopkins, G.H.E. (1946) [1945] Stray notes on Anoplura. 4. The hosts of certain seal-lice. *Annals and Magazine of Natural History (Series 11)*, 12, 566–567.
- Hopkins, G.H.E. (1949) The host-associations of the lice of mammals. *Proceedings of the Zoological Society of London*, 119, 387–604.  
<http://dx.doi.org/10.1111/j.1096-3642.1949.tb00888.x>
- Imms, A.D. (1957) *A general textbook of entomology*. Ninth Edition. (Revised by O.W. Richards & R.G. Davies). Methven & Co. Ltd., London. x + 886 pp.
- International Union for the Conservation of Nature [IUCN] (2012) Mediterranean monk seal, *Monachus monachus*. In: *The IUCN Red List of Threatened Species*. <http://www.iucnredlist.org/details/13653/0> [Accessed 11 October 2012].
- Jancke, O. (1932) Mitteilungen über Anopluren. IV–IX. *Zeitschrift für Parasitenkunde*, 4, 522–541.  
<http://dx.doi.org/10.1007/BF02119998>
- Jancke, O. (1938) Flöhe oder Aphaniptera (Suctoria). Läuse oder Anoplura (Siphunculata). In: Dahl, F. (ed.), *Die Tierwelt Deutschlands und der angrenzenden Meeresteile nach ihren Merkmalen und nach ihrer Lebensweise*. Volume 35. Gustav Fischer Verlag, Jena. 78 pp.
- Jellison, W.L. (1952) Anoplura from mammals of the Pribilof Islands. *Journal of Parasitology*, 38, 274–275.  
<http://dx.doi.org/10.2307/3274048>
- Jellison, W.L. & Milner, K.C. (1958) Salmonellosis (bacillary dysentery) of fur seals. *Journal of Wildlife Management*, 22, 199–200.  
<http://dx.doi.org/10.2307/3797329>
- Jensen, K. & Palma, R.L. (2005) Insecta (insects). Pp. 226–230, 491–492, fig. 5.32. In: Rohde, K. (ed.), *Marine Parasitology*. CSIRO Publishing, Collingwood, Victoria. 592 pp.



- Kadulski, S. (2001) *Echinophthirius horridus* (Olfers, 1816) (Anoplura) rare parasite on seals. *Wiadomosci Parazytologiczne*, 47, 269–271.
- Kaisila, J. (1973) 16. The Anoplura and Siphonaptera of Spitsbergen. *Annales Entomologici Fennici*, 39(2), 63–66.
- Kellogg, V.L. & Ferris, G.F. (1915) *The Anoplura and Mallophaga of North American mammals*. Leland Stanford Junior University Publications University Series, Stanford University Press, California. 74 pp., 8 pls.
- Keyes, M.C. (1965) Pathology of the northern fur seal. *Journal of the American Veterinary and Medical Association*, 147, 1090–1095.
- Kim, K.C. (1971) The sucking lice (Anoplura: Echinophthiriidae) of the northern fur seal; descriptions and morphological adaptation. *Annals of the Entomological Society of America*, 64, 280–292.
- Kim, K.C. (1972) Louse populations of the northern fur seal (*Callorhinus ursinus*). *The American Journal of Veterinary Research*, 33, 2027–2036.
- Kim, K.C. (1975) Ecology and morphological adaptation of the sucking lice (Anoplura, Echinophthiriidae) on the northern fur seal. *Rapport et Procès verbaux des Réunions du conseil Permanent International pour l'Exploration de la Mer*, 169, 504–515.
- Kim, K.C. (1979) Life stages and population of *Proechinophthirus zumpti* (Anoplura: Echinophthiriidae), from the Cape fur seal (*Arctocephalus pusillus*). *Journal of Medical Entomology*, 16, 497–501.
- Kim, K.C. (1982a) Anoplura. Pp. 406–409. In: Parker, S.P. (ed.) *Synopsis and classification of living organisms*. McGraw-Hill Book Company, New York. 1232 pp.
- Kim, K.C. (1982b) Host specificity and phylogeny of Anoplura. *Mémoires du Muséum National d'Histoire Naturelle. Nouvelle Série. A, Zoologie*, 123, 123–127.
- Kim, K.C. (ed.) (1985) *Coevolution of parasitic arthropods and mammals*. John Wiley & Sons, New York. xiv + 800 pp.
- Kim, K.C. (1987) Order Anoplura. figs 23.1–23.77. In: Stehr, F.W. (ed.), *Immature insects*. Kendall / Hunt Publishing Company, Dubuque, Iowa, pp. 224–245.
- Kim, K.C. (1988) Evolutionary parallelism in Anoplura and eutherian mammals. Chapter 7. Pp. 91–114, 8 figs. In: Service, M.W. (ed.), *Biosystematics of haematophagous insects*. Systematics Association, Clarendon Press, Oxford. xii + 363 pp.
- Kim, K.C., Chu, R.C. & Barron, G.P. (1974) Mercury in tissues and lice of northern fur seals. *Bulletin Environmental Contamination & Toxicology*, 11, 281–284.  
<http://dx.doi.org/10.1007/BF01685109>
- Kim, K.C. & Emerson, K.C. (1974) *Latagophthirus rauschi*, new genus and new species (Anoplura: Echinophthiriidae) from the river otter (Carnivora: Mustelidae). *Journal of Medical Entomology*, 11, 442–446.
- Kim, K.C. & Ludwig, H.W. (1978a) The family classification of Anoplura. *Systematic Entomology*, 3, 249–284.  
<http://dx.doi.org/10.1111/j.1365-3113.1978.tb00120.x>
- Kim, K.C. & Ludwig, H.W. (1978b) Phylogenetic relationships of parasitic Psocodea and taxonomic position of the Anoplura. *Annals of the Entomological Society of America*, 71, 910–922.
- Kim, K.C., Pratt, H.D. & Stojanovich, C.J. (1986) *The sucking lice of North America—An illustrated manual for identification*. The Pennsylvania State University Press, University Park & London. xii + 241 pp.
- Kim, K.C., Repenning, C.A. & Morejohn, G.V. (1975) Specific antiquity of the sucking lice and evolution of otariid seals. *Rapport et Procès verbaux des Réunions du conseil permanent International pour l'Exploration de la Mer*, 169, 544–549.
- King, C.M. (ed.) (2005) *The handbook of New Zealand mammals*. Oxford University Press, South Melbourne. i–xx + 610 pp.
- King, J.E. (1964). List of parasites. Pp 134–140. In: King, J.E., *Seals of the world*. Trustees of the British Museum (Natural History), London. v + 154 pp.
- King, J.E. (1983). Parasites. Chapter 15. Pp 201–204. In: King, J.E., *Seals of the world*. Second Edition. British Museum (Natural History), London and Oxford University Press, Oxford. 240 pp.
- Kurochkin, Y.V. (1975) Parasites of the Caspian seal *Pusa caspica*. *Rapport et Procès verbaux des Réunions du conseil Permanent International pour l'Exploration de la Mer*, 169, 363–365.
- Kurochkin, Y.V. & Badamshin, B.I. (1968) Finding of the seal lice *Echinophthirius horridus* Olfers, 1816 on the Caspian seal and the problem of origin of its parasite fauna. *Trudy Astrakhanskogo Zapovednika*, 11, 199–208 [in Russian].
- Ledger, J.A. (1980) The arthropod parasites of vertebrates in Africa south of the Sahara. IV. Phthiraptera (Insecta). *Publications of the South African Institute for Medical Research*, 56, vi + 327 pp.
- Lehane, M.J. (2005) *The biology of blood-sucking in insects*. Second Edition. Cambridge University Press, New York. xiv + 321 pp.
- Leidenberger, S., Harding, K. & Härkönen, T. (2007) Phocid seals, seal lice and heartworms: a terrestrial host-parasite system conveyed to the marine environment. *Diseases of Aquatic Organisms*, 77, 235–253.  
<http://dx.doi.org/10.3354/dao01823>
- Leonardi, M.S., Crespo, E.A., Raga, J.A. & Fernández, M. (2009) Redescription of *Antarctophthirus microchir* (Anoplura: Echinophthiriidae) from South American sea lion, *Otaria flavescens*, from Patagonia, Argentina. *Journal of Parasitology*, 95, 1086–1092.  
<http://dx.doi.org/10.1645/GE-2050.1>
- Leonardi, M.S., Crespo, E.A., Raga, J.A. & Aznar, F. (2011) Insectos oceánicos: los piojos buceadores. *Ciencia Hoy*, 21, 58–64.
- Leonardi, M.S., Crespo, E.A., Raga, J.A. & Fernández, M. (2012a) Scanning electron microscopy of *Antarctophthirus microchir* (Phthiraptera: Anoplura: Echinophthiriidae): Studying morphological adaptations to aquatic life. *Micron*, 43, 929–936.  
<http://dx.doi.org/10.1016/j.micron.2012.03.009>
- Leonardi, M.S., Crespo, E.A., Vales, D.G., Feijoo, M., Raga, J.A. & Aznar, F.J. (2012b) Life begins when the sea lion is ashore: habitat use by a louse of a diving mammal host. *Bulletin of Entomological Research*, 102, 444–452.
- Light, J.E., Smith, V.S., Allen, J.M., Durden, L.A. & Reed, D.L. (2010) Evolutionary history of mammalian sucking lice (Phthiraptera: Anoplura). *BMC Evolutionary Biology*, 10, 292–306.  
<http://dx.doi.org/10.1186/1471-2148-10-292>

- Lucas, H. (1834) *Pediculus phocae*. In: Guérin, F.-E. *Magasin de Zoologie Journal*, 4, 120–122.
- Ludwig, H.W. (1968) Zahl, Vorkommen und Verbreitung der Anoplura. *Zeitschrift für Parasitenkunde*, 31, 254–265.  
<http://dx.doi.org/10.1007/BF00259705>
- Ludwig, H.W. (1982) Host specificity in Anoplura and coevolution of Anoplura and Mammalia. *Mémoires du Muséum National d'Histoire Naturelle. Nouvelle Série. A, Zoologie* 123, 145–152.
- Lunneryd, S.G. (1992) *Dipetalonema spirocauda* (Leidy) (Nematoda) and *Corynosoma strumosum* (Rudolphi) (Acanthocephala) infection in harbor seal from the Kattegat-Skagerrak and the Baltic. *Sarsia*, 76(4), 267–271.
- Luther, A. (1909) Über *Echinophthirius phocae* (Luc.) als parasit der SaimaRobbe (*Phoca foetida* v. *saimensis* Nordqv.). *Meddelanden af Societas pro fauna et flora fennica*, 36, 17–19.
- Lyons, E.T., Keyes, M.C. & Conlogue, J. (1978) Activities of dichlorvos or disophenol against the hookworm (*Uncinaria lucasi*) and sucking lice of northern fur seal pups (*Callorhinus ursinus*) on St. Paul Island, Alaska. *Journal of Wildlife Diseases*, 14, 455–464.
- Lyons, E.T., Kim, K.C. & Keyes, M.C. (1980) Variable activity of disophenol against hookworms and lice of northern fur seal pups on St. Paul Island, Alaska. *Journal of Wildlife Diseases*, 16, 53–57.
- Maltbaek, J. (1937) Lice from foreign mammals in Danish collections. *Entomologiske Meddelelser*, 20, 20–21.
- Margolis, L. (1954) List of the parasites recorded from sea mammals caught off the west coast of North America. *Journal of the Fisheries Research Board of Canada*, 11, 267–283.  
<http://dx.doi.org/10.1139/f54-017>
- Margolis, L. (1956) Parasitic helminths and arthropods from Pinnipedia of the Canadian Pacific Coast. *Journal of the Fisheries Research Board of Canada*, 13, 489–505.  
<http://dx.doi.org/10.1139/f56-030>
- Margolis, L. & Dailey, M.D. (1972) Revised annotated list of parasites from sea mammals caught off the west coast of North America. *Noaa Technical Report*, 647, 1–23.
- Marlow, B.J. (1975) The comparative behaviour of the Australasian sea lions *Neophoca cinerea* and *Phocarcos hookeri* (Pinnipedia: Otariidae). *Mammalia*, 39, 159–230.  
<http://dx.doi.org/10.1515/mamm.1975.39.2.159>
- Marshall, A.G. (1981) *The ecology of ectoparasitic insects*. Academic Press, London. xvi + 459 pp.
- McAtee, W.L. (1923) II. Insects, arachnids, and chilopods. Pp. 129–244, 8 pls. In: *North American Fauna 46. A biological survey of the Pribilof Islands, Alaska*. U.S. Department of Agriculture, Bureau of Biological Survey, Government Printing Office, Washington, D.C. iv + 255 pp.
- McClelland, G. (1980) *Phocanema decipiens*: pathology in seals. *Experimental Parasitology*, 49, 405–419.  
[http://dx.doi.org/10.1016/0014-4894\(80\)90075-2](http://dx.doi.org/10.1016/0014-4894(80)90075-2)
- McIntosh, R. & Murray, M.D. (2007) Louse infestations of the Australian sea lion *Neophoca cinerea*. *Australian Mammalogy*, 29, 103–106.  
<http://dx.doi.org/10.1071/AM07014>
- Mehl, R. (1970) Records of ectoparasitic insects and mites on birds and mammals in Norway. *Norsk Entomologisk Tidsskrift*, 17, 109–113.
- Mehlhorn, B., Mehlhorn, H., & Plötz, J. (2002) Light and scanning electron microscopical study on *Antarctophthirus ogmorhini* lice from the Antarctic seal *Leptonychotes weddellii*. *Parasitology Research*, 88, 651–660.  
<http://dx.doi.org/10.1007/s00436-002-0630-7>
- Meinert, F. (1897) Neuroptera, Pseudoneuroptera, Thysanopoda [sic], Mallophaga, Collembola, Suctorina, Siphunculata Groenlandica. *Videnskabelige Meddelelser fra den Naturhistoriske Forening Kjøbenhavn*, 1896, 154–177.
- Miller, F.H. (1971) Scanning electron microscopy of *Echinophthirius horridus* (von Olfers), *Antarctophthirus callorhini* (Osborn), and *Proechinophthirius fluctus* (Ferris) with emphasis on the antennal structures (Anoplura: Echinophthiriidae). *Journal of Parasitology*, 57, 668–674.  
<http://dx.doi.org/10.2307/3277937>
- Mjöberg, E. (1910) Studien über mallophagen und anopluren. *Arkiv för Zoologi*, 6, 1–296.
- Morgades, D., Katz, H., Castro, O., Capellino, D., Casas, L., Benítez, G., Venzal, J.M. & Moraña, A. (2006) Fauna parasitaria del lobo fino *Arctocephalus australis* y del león marino *Otaria flavescens* (Mammalia, Otariidae) en la costa uruguaya. Pp. 89–96, figs 1–3. In: Menafrá, R., Rodríguez-Gallego, L., Scarabino, F. & Conde, D. (eds), *Bases para la conservación y manejo de la costa uruguaya*. Vida Silvestre, Uruguay, Montevideo. xiv + 668 pp.
- Murray, M.D. (1958) Ecology of the louse *Lepidophthirus macrorhini* Enderlein 1904 on the elephant seal *Mirounga leonina* (L.). *Nature*, 182, 404–405.  
<http://dx.doi.org/10.1038/182404b0>
- Murray, M.D. (1964) Ecology of the ectoparasites of seals and penguins. Pp. 241–245. In: Carrick, R., Holdgate, M.W. & Prevost, J. (eds), *Biologie Antarctique/Antarctic Biology*. Proceedings of 1st SCAR/IUBS Symposium on Antarctic Biology, Paris, 2–8 September 1962. Hermann, Paris. 651 pp.
- Murray, M.D. (1967) Ectoparasites of Antarctic seals and birds. Pp. 185–191. In: Nagata, T. (ed.), *Jare Scientific Reports. Special Issue 1. Proceedings of the Symposium on Pacific-Antarctic Sciences*. [Papers presented at the eleventh Pacific Science Congress, held at the University of Tokyo, Tokyo, Japan, August 23–27, 1966]. Department of Polar Research, National Science Museum, Tokyo. ii + 275 pp.
- Murray, M.D. (1976) Insect parasites of marine birds and mammals. Chapter 4: 79–96, 8 figs. In: Cheng, L. (ed.), *Marine Insects*. North Holland Publishing Company, Amsterdam. xii + 581 pp.
- Murray, M.D. & Nicholls, D.G. (1965) Studies on the ectoparasites of seals and penguins. I. The ecology of the louse *Lepidophthirus macrorhini* Enderlein on the southern elephant seal, *Mirounga leonina* (L.). *Australian Journal of Zoology*, 13, 437–454, 4 pls.

<http://dx.doi.org/10.1071/ZO9650437>

- Murray, M.D., Smith, M.S.R. & Soucek, Z. (1965) Studies on the ectoparasites of seals and penguins II. The ecology of the louse *Antarctophthirus ogmorhini* Enderlein on the Weddell seal, *Leptonychotes weddelli* Lesson. *Australian Journal of Zoology*, 13, 761–771, 2 pls.  
<http://dx.doi.org/10.1071/ZO9650761>
- Nakagawa, H. (1959) A note on the lice from *Phoca hispida* [sic] *ochotensis* collected in the Sea of Japan (Phthiraptera, Anoplura). *Miscellaneous Reports of the Research Institute for Natural Resources* (Tokyo), 51(2), 44–46 [in Japanese with English summary].
- Neumann, L.G. (1907) Pédiculines, Mallophages, Ixodídes. Pp. 13–17. In: Charcot, J. *Expédition Antarctique Française (1903–1905). Sciences naturelles: documents scientifiques*. Arthropodes. Mason et C<sup>ie</sup>, Paris. Volume 9, 100 pp.
- Neumann, L.G. (1909) Notes sur les pédiculidés. *Archives de Parasitologie*, 13, 497–537.
- Olfers, I.F.J.M. von (1816). *De vegetativis et animatis corporibus in corporibus animatis reperiundis commentarius*. Taberna Libraria Maureriana, Berolini. i + vi, 113 pp., 1pl.
- Osborn, H. (1896) Insects affecting domestic animals: an account of the species of importance in North America, with mention of related forms occurring on other animals. *Bulletin U.S. Department of Agriculture Division Entomology (new series)* 5, 1–302, 2 pls.
- Osborn, H. (1899) IX. Acarina. Pp. 553–554. In: Jordan, D.S. (ed.), *The fur seals and fur-seal Islands of the North Pacific Ocean*. Part 3. *Special papers relating to the fur seal and to the natural history of the Pribilof Islands*. United States Government Printing Office, Washington, D.C. xii + 629 pp.
- Pajot, F.-X. (2000) Les poux (Insecta, Anoplura) de la région Afrotropicale. Editions de l'IRD: Institut de Recherche pour le Développement, Paris. *Collection Faune et Flore tropicales*, 37, 1–294.
- Palma, R.L. (2010) Order Phthiraptera: Lice. Pp. 294–296, 407–409. In Gordon, D.P. (ed.) *New Zealand Inventory of Biodiversity. Volume Two. Kingdom Animalia—Chaetognatha, Ecdysozoa, Ichnofossils*. Canterbury University Press, Christchurch. 528 pp.
- Paulian, P. (1953) Pinnipèdes, cétacés, oiseaux des Iles Kerguelen et Amsterdam. Mission Kerguelen 1951. *Mémoires de l'Institut Scientifique de Madagascar, Série A*, 8, 111–234.
- Piaget, E. (1880) *Les Pédiculines. Essai Monographique*. E.J. Brill, Leide. xxxix + 714 pp., pls 1–56.
- Pilgrim, R.L.C. (1970) Knowledge of New Zealand Mecoptera, Mallophaga, Anoplura and Siphonaptera. *New Zealand entomologist*, 4, 72–79.  
<http://dx.doi.org/10.1080/00779962.1970.9722925>
- Pilgrim, R.L.C. (1974) Lice and fleas (1). *New Zealand's Nature Heritage*, 37, 1030–1036.
- Price, M.A. & Graham, O.H. (1997) Chewing and sucking lice as parasites of mammals and birds. *United States Department of Agriculture, Agricultural Research Service, Technical Bulletin*, 1849, vi + 257 pp., 2 appendices.
- Raga, J.A. (1997) Parasitology of marine mammals. Chapter 8. Pp. 67–90. In: Jauniaux, T., Bouquegneau, J.-M. & Coignoul F. (eds), *Marine mammals, seabirds and pollution of marine systems*. Presse de la Faculté de Médecine Vétérinaire de l'Université de Liège, Liège, Belgium. vi + 181 pp.
- Raga, J.A., Aznar, F.J., Balbuena, J.A. & Fernández, M. (2002) Parasites. Pp.867–876. In: Perrin, W.F., Würsig, B. & Thewissen, J.G.M. (eds), *Encyclopedia of marine mammals*. Academic Press, San Diego, California. xxxviii + 1414 pp., 16 pls.
- Reeves, R.R., Stewart, B.S., Clapman, P.J., Powell, J.A. & Folkens, P.A. (2002) *National Audubon Society guide to marine mammals of the world*. Chanticleer Press Inc., Alfred A. Knopf, New York. 528 pp.
- Reijnders, P.J.H., Clausen, B., van Haften, J.L. & van der Kamp, J. (1981) Diseases and parasites in harbour seals of the Wadden Sea. Chapter 7. Pp. 33–37. In: Reijnders, P.J.H. & Wolff (eds), *Marine mammals of the Wadden Sea*. A.A. Balkema, Rotterdam. 64 pp.
- Ronald, K., Johnson, E., Foster, M. & Vander Pol, D. (1970) The harp seal, *Pagophilus groenlandicus* (Erleben, 1777). I. Methods of handling, molt, and diseases in captivity. *Canadian Journal of Zoology*, 48(5), 1035–1040, 3 pls.  
<http://dx.doi.org/10.1139/z70-182>
- Rothschild, N.C. (1902) 9. Insecta: Hemiptera parasitica: Pediculidae. P. 224. In: Sharpe, R.B., Barrett-Hamilton, G.E.H., Wilson, E.A., Hanson, N. & Boulenger, G.A. (eds), *Report on the collections of natural history made in the Antarctic Regions during the voyage of the "Southern Cross"*. London, Trustees of the British Museum (Natural History). ix + 344 pp., 53 pls.
- Rounsevell, D.E. & Horne, P.A. (1986) Terrestrial, parasitic and introduced invertebrates of the Vestfold Hills. Pp. 309–331. In: Pickard, J. (ed.), *Antarctic oasis - Terrestrial environments and history of the Vestfold Hills*. Sydney, Academic Press. xii + 367 pp.
- Scherf, H. (1963) Ein Beitrag zur Kenntnis zweier Pinnipedierläuse (*Antarctophthirus trichechi* Boheman und *Echinophthirus horridus* Olfers). *Zeitschrift für Parasitenkunde*, 23, 16–44.  
<http://dx.doi.org/10.1007/BF00260335>
- Schumacher, U., Horny, H.-P., Heidemann, G., Schultz, W. & Welsch, U. (1990) Histopathological findings in harbour seals (*Phoca vitulina*) found dead on the German North Sea coast. *Journal of Comparative Pathology*, 102, 299–309.  
[http://dx.doi.org/10.1016/S0021-9975\(08\)80019-9](http://dx.doi.org/10.1016/S0021-9975(08)80019-9)
- Schumann, W. (1989) *Seehunde im Wattenmeer*. 2nd edition. Landbuch-Verlag, Hannover. 111 pp.
- Séguy, E. (1944) Insectes Ectoparasites (Mallophages, Anoploures, Siphonaptères). *Faune de France* 43, 1–684.
- Séguy, E. (1951) Ordre des anoploures ou poux (Anoplura Lucas, 1840). Pp. 1365–1384. In: Grassé, P.-P. (ed.), *Traité de Zoologie - Anatomie, systématique, biologie*. Tome X. *Insectes supérieurs et hémiptéroïdes*. (Fascicule II). Masson et Cie Éditeurs, Paris. 977 pp.
- Skírnisson, K. & Ólafsson, E. (1990) Sníkjudýr í selum við Island með umfjöllun um hjartaorminn *Dipetalonema spirocauda* og selalúsina *Echinophthirus horridus* [Parasites of seals in Icelandic waters, with special reference to the heartworm *Dipetalonema spirocauda* and the sucking louse *Echinophthirus horridus*]. *Náttúrufræðingurinn*, 60, 93–102.

- Spencer, G.J. (1966) Anoplura from British Columbia and some adjacent areas. *Journal of the Entomological Society of British Columbia*, 63, 23–30.
- Steel, W.O. (1964) Order XVIII: Siphunculata. Pp. 35. In: Kloet, G.S. & Hincks, W.D. *A Check list of British insects*. Part 1: Small orders and Hemiptera. Second edition (Revised). *Handbooks for the Identification of British Insects*, 11, xvi + 119 pp.
- Swiestra, D., Jansen, J. Jr, & van den Broek, E. (1959) Parasites of animals in the Netherlands. *Tijdschrift voor Diergeneeskunde*, 84, 892–900.
- Taylor, A.E.R., Brown, D.H., Heyneman, D. & McIntyre, R.W. (1961) Biology of filarioid nematode *Dipetalonema spirocauda* (Leidy, 1858) from the heart of captive harbor seals and sea lions, together with pathology of the hosts. *Journal of Parasitology*, 47, 971–976.  
<http://dx.doi.org/10.2307/3275035>
- Thompson, G.B. (1938) The Siphunculata or sucking-lice recorded from the Pacific Islands. *Entomologist's Monthly Magazine*, 74, 90–94.
- Thompson, G.B. (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.
- Thompson, G.B. & Plomley, N.J.B. (1938) A list of the insect ectoparasites recorded from Australian birds and mammals. *Proceedings of the Linnean Society of New South Wales*, 63, 105–127.
- Thompson, P.M., Corpe, H.M. & Reid, R.J. (1998) Prevalence and intensity of the ectoparasite *Echinophthirius horridus* on harbour seals (*Phoca vitulina*): effects of host age and inter-annual variability in host food availability. *Parasitology*, 117, 393–403.  
<http://dx.doi.org/10.1017/S0031182098003072>
- Thorsteinson, F.V. & Lensink, C.J. (1962) Biological observations of Steller sea lions taken during an experimental harvest. *The Journal of Wildlife Management*, 26, 353–359.  
<http://dx.doi.org/10.2307/3798011>
- Tillyard, R.J. (1926) *The Insects of Australia and New Zealand*. Angus & Robertson, Ltd, Sydney. xvi + 560 pp.
- Tijskens, J. (1969) Le pou parasitant le phoque du lac Baikal (*Echinophthirius horridus baicalensis* Ass). *Zoo Anvers*, 34, 132–134.
- Trouessart, E. & Neumann, G. (1888) Le pou de l'otarie (*Echinophthirius microchir*, n. sp.). *Le Naturaliste*, 10, 80–81.
- van den Broek, E. (1963). Mededelingen betreffende parasitologisch onderzoek bij de gewone zeehond, *Phoca vitulina* L. *Lutra - Orgaan van de Vereniging voor Zoogdierkunde en Zoogdierbescherming*, 5, 22–30.
- van den Broek, E. (1977) De luizen (Anoplura en Mallophaga) van zoogdieren in Nederland. *Wetenschappelijke Mededelingen Koninklijke Nederlandse Natuurhistorische Vereniging*, 121, 1–32.
- van den Broek, E. & Jansen, J. Jr (1964) Parasites of animals in the Netherlands. Supplement II. Parasites of wild mammals. *Bijdragen tot de Dierkunde*, 34, 103–105.
- van den Broek, E. & Wensvoort, P. (1959) On parasites of seals from the Dutch coastal waters and their pathogenity [sic]. *Säugetierkundliche Mitteilungen*, 7, 58–62.
- Vauk, von G. (1973) Beobachtungen am Seehund (*Phoca vitulina* L.) auf Helgoland. *Zeitschrift für Jagdwissenschaft*, 19, 117–121.  
<http://dx.doi.org/10.1007/bf01901917>
- Waterston, J. (1913) *Echinophthirius phocae*, Lucas, in N. Mavine, Shetland. *Entomologist's Monthly Magazine*, 49, 113.
- Webb, J.E. (1946) Spiracle structure as a guide to the phylogenetic relationships of the Anoplura (biting and sucking lice), with notes on the affinities of the mammalian hosts. *Proceedings of the Zoological Society of London*, 116, 49–119.  
<http://dx.doi.org/10.1111/j.1096-3642.1946.tb00109.x>
- Webb, J.E. (1949) The evolution and host-relationships of the sucking lice of the Ferungulata. *Proceedings of the Zoological Society of London*, 119, 133–188.  
<http://dx.doi.org/10.1111/j.1096-3642.1949.tb00873.x>
- Weber, N.A. (1950) A survey of the insects and related arthropods of Arctic Alaska. Part I. *Transactions of the American Entomological Society*, 76, 147–206.
- Werneck, F.L. (1955) Novo anopluro de leão marinho. *Revista Brasileira de Biologia*, 15, 419–421.
- Wipper, E. (1974) *Die ökologischen und pathologischen Probleme beim europäischen Seehund (Phoca vitulina Linné, 1758) an der niedersächsischen Nordseeküste*. PhD Thesis, Medizinischen Tierklinik der Tierärztlichen Fakultät der Universität München, Germany. 211 pp.
- Wolcott, G.N. (1971) Clase VI. Los insectos (Insecta). Pp. 567–898. In: Cendrero, L. (ed.), *Zoología Hispanoamericana. Invertebrados*. Editorial Porrúa, S.A., México, D.F. xxiv + 1151 pp.
- Wülker, G. (1930) Über Nematoden aus Nordseetieren. I. *Zoologischer Anzeiger*, 87, 293–302.
- Zarubina, V.N. (1986) Order Anoplura—lice. Pp. 370–380, figs 196–197. In: Ler, P.A. (ed.), *A guide to identifying insects of the Soviet Far East*. Volume 1. *Apterygota, Palaeoptera, with incomplete metamorphosis*. Leningrad, Academy of Sciences of the USSR, “Nauka” Publishers. 451 pp. [in Russian].