



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

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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-louse 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.

Antarctophthirinae 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.

Phocophthiriidae 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.

Arctophthirius Mjöberg, 1910: 177. Type species: *Arctophthirius 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.

Arctophthirius 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 Wandel 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; Séguy 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 Kattegat-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 echinophthiriid 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 3rd 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)

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

Genus *Monachus* Fleming, 1822

Monachus monachus (Hermann, 1779)

Lepidophthirus piriformis Blagoveshtchensky, 1966

Mediterranean monk seal

Genus *Ommatophoca* Gray, 1844

Ommatophoca rossii Gray, 1844

Antarctophthirus mawsoni Harrison, 1937

Ross' seal

Genus *Pagophilus* Gray, 1844

Pagophilus groenlandicus (Erxleben, 1777)

Echinophthirus horridus (Olfers, 1816)

Harp seal

Genus *Phoca* Linnaeus, 1758

Phoca vitulina Linnaeus, 1758

Echinophthirus horridus (Olfers, 1816)

Harbor seal

Genus *Pusa* Scopoli, 1777

Pusa caspica (Gmelin, 1788)

Echinophthirus horridus (Olfers, 1816)

Caspian seal

Pusa hispida (Schreber, 1775)

Echinophthirus horridus (Olfers, 1816)

Ringed seal

Pusa sibirica (Gmelin, 1788)

Echinophthirus horridus (Olfers, 1816)

Baikal seal

Family MUSTELIDAE

Genus *Lontra* Gray, 1843

Lontra canadensis pacifica (J.A. Allen, 1898)

Latagophthirus rauschi Kim & Emerson, 1974

**North American river otter
(western subspecies)**

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