Bovicola, Damalinia
(insect: louse)

Overview

Arthropods are coelomate metameric invertebrate animals with a chitinous exoskeleton and jointed limbs. They undergo protostomial embryonic development and grow by cuticular moulting (ecdysis). Three main subphyla are recognized: Chelicerata, Crustacea and Hexapoda. Insects are hexapods with three pairs of uniramous legs, three tagmata (head, thorax, abdomen), ectognathous mouthparts with whole-limb mandibles, and one pair of antennae. Lice (Phthiraptera) are small wingless dorsoventrally-flattened hemipterodeans which are permanent obligate ectoparasites on other animals. All lice undergo gradual metamorphosis and there are no free-living stages. Eggs are cemented to host hairs whereas nymphs and adults cling to hairs using enlarged tarsal claws. Lice do not survive long off their hosts so transmission is usually by direct contact. Mallophagan (chewing) lice have blunt rounded heads with mouthparts adapted for feeding on keratin in superficial skin layers. Chewing lice are ectoparasitic on mammals and birds, most species being highly host specific and even site-specific. Ischnoceran lice have prominent filiform antennae but lack maxillary palps. Trichodectids have three antennal segments, single tarsal claws and are found on mammals. Many species were originally described in the genera *Damalinia* and *Werneckiella* but have subsequently been transferred to the genus *Bovicola* on the basis of molecular phylogenetic studies. Infestations by *Bovicola* spp. have been associated with dermatitis, pruritus, alopecia and excoriation in ruminants and horses.

Classification:

Domain:	Eukaryota (membrane-bound nucleus)
Supergroup:	Amorphea (unikonts with single flagellum, or nonflagellated amoebae)
Kingdom:	Metazoa (multicellular eukaryotes, heterotrophs, notably animals)
Group:	Protostomia (triploblastic, spiral cleavage)
Subgroup:	Ecdysozoa (cuticle moulted = ecdysis)
Phylum:	Arthropoda (chitinous exoskeleton, segmented body, jointed limbs, haemocoel)
Subphylum:	Hexapoda (three tagmata, three pairs uniramous legs, whole-limb mandibles, Malpighian tubules)
Class:	Insecta (ectognathous mouthparts (bases lie outside head capsule), single pair antennae, many with wings)
Superorder:	Hemipterodea (Exopterygota) (young resemble adults, externally developing wings)
Order:	Phthiraptera (lice, wingless, ectoparasites, dorsoventrally flattened, stout legs, claws, eggs, nymphs, adults)
Suborder:	Mallophaga (= wool-eating) (chewing lice, broad rounded head, feed on keratin, host/site specific)
Superfamily:	Ischnocera (without maxillary palps, prominent filiform antennae, keratin feeders (hairs/feathers))
Family:	Trichodectidae (parasitize mammals, 3-segmented antennae, single claw on tarsi)
Genus:	*Bovicola, Damalinia* (parasitic on skin/fleece/hair of sheep/cattle/horses)
Species:	various species cause pruritus and dermatitis in livestock

Parasite biodiversity and host range: Most Metazoa are multicellular triploblastic animals with differentiated tissues, many being bilaterally symmetrical with a body cavity. Most invertebrate animals are protostomes as their embryonic development involves spiral determinate cleavage. Those that moult their external cuticles during their life-cycles (process known as ecdysis) are grouped together in the unique clade Ecdysozoa, including the nematodes (roundworms), onychophorans (velvet worms), tardigrades (water bears) and arthropods (myriapods, chelicerates, crustaceans and hexapods). Arthropods have small segmented bodies encased in chitinous exoskeletons with articulated limbs. Most species are free-living in terrestrial and aquatic habitats, although a small range are ectoparasitic on other animals, some feeding on the blood or skin of vertebrates. Five subphyla are recognized: Chelicerata, Crustacea, Hexapoda, Myriapoda and Trilobita. Insects are hexapods with six legs, three distinct body parts, two antennae and mouthparts with whole-limb mandibles. Insects are the most biodiverse group on the planet, with millions of species described in numerous taxa. Notorious ectoparasitic species belong to four orders in two superorders: the Hemipterodea (Exopterygota) containing the orders Hemiptera (bugs) and Phthiraptera (lice); and the Holometabola (Endopterygota) containing the orders Siphonaptera (fleas) and Diptera ('true' flies). Lice are small wingless hemipterodeans that undergo gradual (hemimetabolous) metamorphosis and are permanent obligate ectoparasites on other animals. Four suborders are recognized: the Anoplura containing the haematophagous sucking lice of placental mammals; the Ischnocera and Amblycera (previously classified together as Mallophaga) comprising the chewing or biting lice of birds, marsupials and placental mammals; and the Rhynchophthirina confined to elephants and warthogs in Africa.

Major parasitic phthirapteran families	Biodiversity	Hosts	Parasitic stages	Patho-genesis	Disease transmission
Suborder: Ischnocera [Mallophaga p.p.] (chewing lice of mammals and birds, broad rounded head, without maxillary palps, prominent filiform antennae, keratin feeders) [2 families, 158 genera, 3,371 species]					
Trichodectidae (fur lice)	20 genera, 413 spp.	mammals (bovids, equids, carnivores)	nymphs, adults	biting	helminth
Philopteridae(bird lice)	138 genera, 2,958 spp.	birds	nymphs, adults	biting, chewing	-
Suborder: Amblycera [Mallophaga p.p.] (chewing lice of mammals and birds, large rounded head, with maxillary palps, 4-segmented antennae in antennal grooves, keratin feeders) [6 families, 96 genera, 1,550 species]					
Menoponidae (bird lice)	68 genera, 1,150 spp.	birds	nymphs, adults	biting, chewing	-
Boopiidae (marsupial chewing lice)	8 genera, 57 spp.	mammals (incl. marsupials)	nymphs, adults	biting	helminth
Suborder: Rhynchophthirina (sucking lice of African wildlife) [1 family, 1 genus, 4 species]					
Haematomyzidae (elephant & warthog lice)	1 genus, 4 spp.	mammals (elephants, warthogs)	nymphs, adults	blood-sucking	-
Suborder: Anoplura (sucking lice of placental mammals) (narrow pointed head, pierce skin and feed on fluids (solenophagy)) [16 families, 51 genera, 694 species]					
Haematopinidae (ungulate lice, short-nosed lice)	1 genus, 21 spp.	mammals (equids, bovids, suids)	nymphs, adults	blood-sucking	viral, bacterial
Linognathidae (pale lice, long-nosed lice)	3 genera, 73 spp.	mammals (bovids, canids)	nymphs, adults	blood-sucking	-
Pediculidae (head & body lice)	1 genus, 4 spp.	mammals (hominids, New World primates)	nymphs, adults	blood-sucking	bacterial
Pthiridae (pubic lice)	1 genus, 2 spp.	mammals (hominids)	nymphs, adults	blood-sucking	-

Over 4,900 species of biting/chewing lice have been described in 253 genera in 8 families, around 4,400 species associated with birds and 500 species with mammals. Members of the suborder Ischnocera have broad rounded heads with conspicuous filiform antennae but lacking maxillary palps, while members of the suborder Amblycera have large rounded heads with maxillary palps and inconspicuous antennae hidden in grooves. Some 158 ischnoceran genera have been assigned to 2 families (Trichodectidae and Philopteridae), while 96 amblyceran genera have been classified in 6 families (Boopiidae; Gyropidae, Laemobothriidae, Menoponidae, Ricinidae, Trimenoponidae). Species of veterinary importance include members of the ischnoceran families Trichodectidae (bovids, canids, equids) and Philopteridae (poultry), and the amblyceran families Menoponidae (poultry) and Boopiidae (carnivores). Most ischnoceran lice are parasitic on birds but the trichodectids are found on mammals and are commonly known as fur lice. Members of the family Trichodectidae possess antennae with 3 segments and their legs terminate in tarsi with single claws (in contrast to members of the family Philopteridae which have 5-segmented antennae and paired tarsal claws). Over 400 trichodectid species have been described from 20 genera, namely *Bisonicola*, *Bovicola*, *Cebidicola*, *Damalinia*, *Dasyonyx*, *Eurytrichodectes*, *Eutrichophilus*, *Felicola*, *Geomydoecus*, *Lorisicola*, *Lutridia*, *Neotrichodectes*, *Procavicola*, *Procaviphilus*, *Protelicola*, *Thomomydoecus*, *Tragulicola*, *Trichodectes*, *Werneckiella* and *Werneckodectes*. The subfamily Bovicolinae contains the genera *Bovicola* (subgenera *Bovicola*, *Holakartikos*, *Lepikentron*, *Spinibovicola*), *Bisonicola*, *Damalinia* (subgenera *Damalinia*, *Cervicola*, *Tricholipeurus*), *Tragulicola*, and *Werneckiella.* Taxonomic ranks differ in various classification schemes as many early descriptions were inconsistent and species were assigned to pleomorphic genera, sometimes to the point that texts used the names *Bovicola* and *Damalinia* almost interchangeably. A comprehensive cladistic analysis provided some structure to taxonomic classifications, although the author conceded that most genera/subgenera be considered *sedis mutabilis* ("of uncertain relationship") pending detailed molecular phylogenetic analyses. Currently, some 15 *Bovicola* spp., 51 *Damalinia* spp., 7 *Werneckiella* spp., 1 *Bisonicola* sp. and 1 *Tragulicola* sp. are considered valid from artiodactyls (bovids, cervids, camelids, tragulids) and perissodactyls (equids) around the world. Most species are highly host specific and their distributions mirror those of their hosts, with many species infesting domestic animals being cosmopolitan. These lice have interesting sex lives and many species are regarded to be parthenogenetic as male lice are rare or absent.

Bovicolinid species	Hosts	Location	Clinical signs	Distribution
***Bovicola* (subgenus *Bovicola*)** [body and head with short setae, gonopods conspicuous but not distinctly lobular, mesomeres not pentagonal, never bipartite, bovid/cervid hosts]				
B. alpinus (syn. *B. rupicaprae*)	Artiodactyla: bovid (chamois)			Europe
B. bovis (syn. *B. scalaris, tauri*) (cattle chewing louse, cattle biting louse, red louse)	Artiodactyla: bovid (cattle)	skin (head, neck, shoulders, back, rump, tail switch)	irritation, pruritus, inflammation, excoriation, alopecia, anorexia	worldwide
B. caprae (syn. *B. climacius, climax, mambricus, peregrinus, solidus*) (goat biting louse, red louse)	Artiodactyla: bovid (goats)	skin (shoulders, back, rump)	irritation, pruritus, inflammation, excoriation, alopecia	worldwide
B. concavifrons	Artiodactyla: cervid (red deer)			cosmopolitan
B. jellisoni	Artiodactyla: bovid (Dall sheep, bighorn sheep)			North America
B. limbatus (syn. *B. madagascarensis, painei, sachtlebeni, wernecki*) (red louse)	Artiodactyla: bovid (Angora goat)	skin (shoulders, back, rump)	irritation, pruritus, inflammation, excoriation, alopecia	worldwide
B. longicornis (syn. *B. americanus, similis*)	Artiodactyla: cervid (red deer)	skin	irritation, pruritus, inflammation	Europe
B. oreamnidis	Artiodactyla: bovid (mountain goat)			North America
B. ovis (syn. *B. ovisarietis, sphaerocephalus*) (sheep biting louse)	Artiodactyla: bovid (sheep)	skin (shoulders, back, rump)	irritation, pruritus, inflammation, wool matting, excoriation, alopecia	worldwide
B. tarandi	Artiodactyla: cervid (reindeer)			Europe
B. tibialis (syn. *B. punctus*)	Artiodactyla: cervid (fallow deer, chital, black-tailed deer, Rocky Mountain mule deer)	skin	irritation, pruritus, inflammation, hair loss syndrome	Europe, North America
***Bovicola* (subgenus *Holakartikos*)** [body and head with long dense setae, gonopods small and lobose, mesomeres not pentagonal and fused apically, caprine hosts]				
B. crassipes (syn. *B. hermsi, ibicis, penicillatus*) (Angora goat biting louse)	Artiodactyla: bovid (goat, ibex)			Europe
***Bovicola* (subgenus *Lepikentron*)** [body with short setae, head with long fine setae, gonopods conspicuous and distinctly lobular, mesomeres not pentagonal and bipartite, camelid hosts]				
B. breviceps (syn. *B. aucheniaelamae, inaequalemaculatus*)	Artiodactyla: camelid (llama, guanaco, alpaca)			South America
***Bovicola* (subgenus *Spinibovicola*)** [body and head with medium setae, gonopods rounded, parameres fused, mesomeres absent, ovine hosts]				
B. hemitragi	Artiodactyla: bovid (Himalayan tahr)			Himalayas
B. multispinosus	Artiodactyla: bovid (blue sheep)			Himalayas

Bisonicola [body and head with short setae, gonopods wide and truncate, parameres separate and attached to mesomeral arch, bison hosts]				
B. sedecimdecembrii	Artiodactyla: bovid (American bison, European bison)			North America
Werneckiella [gonopods broad and truncate, mesomeres pentagonal, equid/bovid hosts]				
W. aspilopygus	Perissodactyla: equid (plains zebra)			Africa
W. equi (syn. *W. hemioni, B. parumpilosus, pilosus, pubescens, trampel, vestitus*) (horse biting louse)	Perissodactyla: equid (horse, onager); Artiodactyla: camelid (Bactrian camel?)	skin (neck, mane, flanks, tail base)	irritation, pruritus, inflammation, hair matting, excoriation, alopecia	worldwide
W. fulva	Artiodactyla: bovid (Barbary sheep)			North Africa
W. neglecta	Artiodactyla: bovid (Barbary sheep)			North Africa
W. ocellata	Perissodactyla: equid (horse, donkey, plains zebra)			Africa
W. zebrae	Perissodactyla: equid (mountain zebra)			Africa
W. zuluensis	Perissodactyla: equid (plains zebra)			Africa
Tragulicola [gonopods broad and tapering, mesomeres fused apically, tragulid (mouse-deer) hosts]				
T. balabacensis	Artiodactyla: cervid (Philippine mouse-deer)	skin		Philippines
T. traguli	Artiodactyla: cervid (Java mouse-deer, greater mouse-deer)	skin		South-East Asia
***Damalinia* (subgenus *Damalinia*)** [broad lice, subgenital lobe absent or reduced to flap, gonopods not hook-shaped, mesomeres fused to parameres, bovid hosts]				
D. adenota	Artiodactyla: bovid (kob, puku)	skin		Africa
D. appendiculata	Artiodactyla: bovid (goitered gazelle)	skin		Indo-Asia
D. baxi	Artiodactyla: bovid (sassabies)	skin		Africa
D. chorleyi	Artiodactyla: bovid (hartebeest)	skin		Africa
D. crenelata	Artiodactyla: bovid (sassabies)	skin		Africa
D. dimorpha	Artiodactyla: bovid (goral)	skin		Himalayas
D. fahrenholzi	Artiodactyla: bovid (Arabian gazelle)	skin		Arabian Peninsula
D. harrisoni	Artiodactyla: bovid (gnu)	skin		Africa
D. hilli	Artiodactyla: bovid (waterbuck)	skin		Africa
D. neotheileri	Artiodactyla: bovid (wildebeest)	skin		Africa
D. orientalis	Artiodactyla: bovid (serow)	skin		Japan, Taiwan
D. ornata	Artiodactyla: bovid (hartebeest)	skin		Africa
D. pelea	Artiodactyla: bovid (rhebok)	skin		Africa
D. semitheileri	Artiodactyla: bovid (wildebeest)	skin		Africa
D. theileri	Artiodactyla: bovid (wildebeest)	skin		Africa
D. thompsoni	Artiodactyla: bovid (serow)	skin		China
***Damalinia* (subgenus *Cervicola*)** [broad lice, subgenital lobe absent or reduced to flap, gonopods hook-shaped, endopallus lacking spicular patch, mesomeres unfused, bovid/cervid hosts]				
D. annectens	Artiodactyla: bovid (sitatunga, kewel)	skin		Africa
D. cordillerai	Artiodactyla: cervid (samba deer)	skin		Indo-Asia
D. forficula	Artiodactyla: cervid (chital, Indian hog deer, muntjac)	skin	irritation, pruritus, inflammation	Asia
D. hendrickxi	Artiodactyla: bovid (duiker)	skin		Africa
D. hopkinsi	Artiodactyla: bovid (eland)	skin		Africa
D. hydropotis	Artiodactyla: cervid (water deer)	skin		China
D. lerouxi	Artiodactyla: bovid (bush duiker)	skin		Africa
D. maai	Artiodactyla: cervid (sika deer)	skin	irritation, pruritus, inflammation	Eurasia
D. martinaglia	Artiodactyla: bovid (lechwe)	skin		South Africa

D. meyeri (syn. *D. tibialis*)	Artiodactyla: cervid (roe deer)	skin	irritation, pruritus, inflammation	Eurasia
D. muntiaca	Artiodactyla: cervid (muntjac)	skin		Indo-Asia
D. natalensis	Artiodactyla: bovid (kewel)	skin		Africa
D. reduncae	Artiodactyla: bovid (reedbuck)	skin		southern Africa
D. siamensis	Artiodactyla: cervid (muntjac)	skin		Indo-Asia
D. trabeculae	Artiodactyla: bovid (reedbuck)	skin		Africa
D. ugandae	Artiodactyla: bovid (reedbuck)	skin		Africa
***Damalinia* (subgenus *Tricholipeurus*)** [long slender lice, subgenital lobe present, endophallus with dense patch of spicules, mesomeres unfused, bovid/cervid hosts]				
D. aepycerus	Artiodactyla: bovid (impala)	skin		Africa
D. albimarginata	Artiodactyla: cervid (gray brocket, red brocket)	skin		South America
D. antidorcus	Artiodactyla: bovid (springbok)	skin		Africa
D. balanicus	Artiodactyla: bovid (blackbuck)	skin		Africa
D. bedfordi	Artiodactyla: bovid (blue duiker)	skin		Africa
D. clayi	Artiodactyla: bovid (royal antelope)	skin		Africa
D. conectens	Artiodactyla: bovid (klipspringer)	skin		Africa
D. cornuta	Artiodactyla: bovid (blackbuck, dorcas gazelle)	skin		Africa
D. dorcephali	Artiodactyla: cervid (Pampas deer)	skin		South America
D. elongata	Artiodactyla: bovid (impala)	skin		Africa
D. indica	Artiodactyla: cervid (Reeve's muntjac, Indian muntjac)	skin		Indo-China
D. lineata	Artiodactyla: bovid (steenbok, Cape grysbok, Sharpe's grysbok)	skin		Africa
D. lipeuroides (syn. *D. mazama*, *mexicanus, virginianus*)	Artiodactyla: cervid (white-tailed deer, mule deer, sambar deer)	skin		North America
D. longiceps	Artiodactyla: bovid (Arabian gazelle)	skin		Middle-East
D. moschatus	Artiodactyla: bovid (suni)	skin		Africa
D. ourebiae	Artiodactyla: bovid (oribi)	skin		Africa
D. pakenhami	Artiodactyla: bovid (Ader's duiker, common duiker)	skin		Africa
D. parallela (syn. *D. odocoilei*)	Artiodactyla: cervid (white-tailed deer, mule deer, sambar deer)	skin		North America
D. parkeri	Artiodactyla: bovid (Thomson's gazelle)	skin		Africa
D. spinifer	Artiodactyla: bovid (Grant's gazelle)	skin		Africa
D. victoriae	Artiodactyla: bovid (Kirk's dik-dik, Gunther's dik-dik)	skin		Africa
D. zaganseeri	Artiodactyla: bovid (Mongolian gazelle)	skin		Eurasia

Parasite morphology: Chewing lice belonging to the subfamily Bovicolinae form three different types of morphological stages during their development: namely, eggs (nits); nymphs (3 instars); and adults. Eggs are small beige barrel-shaped stages ranging in length from 0.5-1.0 mm depending on species. They are attached to hair shafts at their posterior ends and their anterior ends have a convex operculum (cap) with a small rim. Mature eggs are embryonated and they release first-stage nymphs (N1) when they hatch. These lice undergo gradual (incomplete) metamorphosis and moult through another two nymphal stages before moulting to adults. All nymphal stages resemble adult lice but are smaller, less sclerotized, have fewer body setae (hairs) and lack abdominal bands and genitalia. Adult lice have pale red-brown dorsoventrally-flattened bodies ranging from 1.0-2.5 mm in length with three distinct body parts (comprising a broad blunt head, cylindrical thorax and ellipsoidal abdomen). The head is short, broader than long and rounded anteriorly with a longitudinal groove in the ventral surface that accommodates host hairs. The head possesses a pair of prominent filiform antennae projecting laterally and not confined to antennal grooves. The antennae of trichodectid lice are composed of three segments (while those of philopterid lice from birds are composed of five segments). These ischnoceran chewing/biting lice do not have long piercing mouthparts like anopluran sucking lice, but feed by the biting/scraping action of large ventral dentate mandibles inserted at right angles to the head (such that the condyles are posterior and the ginglymus is anterior). Food particles are delivered to the preoral cavity by a posterior plate-like labrum (often with an anterior hyaline pad-like protrusion (pulvinus)), 2 lateral

maxillae and an anterior labium (salivary secretions added through a central hypopharynx). In ischnoceran chewing lice, the maxillae and labium are reduced in size (compared to anopluran sucking lice), the maxillae are single lobed and attached to the lateral margins of the tripartite labium, and maxillary palps are absent (present in amblyceran lice). The mouth opens into the foregut (with pharynx, oesophagus and fusiform crop), a large midgut (with ventriculus and anterior caeca) and a hindgut (with pylorus, papillae and rectum). The midgut also contains a special organ known as a mycetome (or bacteriome or stomach disc) harbouring bacterial/fungal symbionts (but the mycetome is less developed than in anopluran sucking lice and is absent in amblyceran chewing lice). The segments of the thorax are fused with indistinct boundaries and the ventral surface gives rise to three pairs of legs, each composed of five segments (coxa, trochanter, femur, tibia, tarsus) and terminating in a single tarsal claw (in contrast to double claws on philopterid lice from birds, and specialized tibio-tarsal claws on anopluran lice). The fore-legs on the prothorax are slightly smaller than the mid- or hind-legs and are used to grasp host hairs together with the mandibles in the ventral groove. The abdomen is ellipsoidal in shape and appears yellow-white in colour with distinct brown transverse bands on most segments. Each segment bears at least one row of short to medium setae and respiratory spiracles are located dorsolaterally on segments 2 to 7. Adult lice are sexually dimorphic with male lice slightly smaller than females, but sex ratios are highly female biased (males unknown, particularly in cervid species, or few in number (<5% in bovid species or <1% in equid species) and parthenogenesis appears to a common phenomenon in many species. Females have polytrophic ovarioles connected by tubular oviducts to a globular uterus with accessory glands (that produce the cement used to glue eggs) and a saccular spermatheca (used to store sperm after mating). The uterus opens into the vagina which has a genital plate with valvula, and the gonopore is located between two lateral terminal gonopods or gonapophyses (protuberances of the terminal abdominal segment that aid oviposition) often bearing long setae. When present, males have 2 pairs of compact testes (3 pairs in amblyceran lice) with tubular vas deferens joining to form a seminal vesicle which is connected to the genital sac containing a tubular copulatory aedeagus (intromittent organ with dorsal gonopore and endophallus) supported by sclerotized elements (basal apodemal plate, lateral paramere rods and dorsal arched mesomeres). Different bovicolinid genera and subgenera are recognized primarily by differences in their setate ornamentation, genital structures and host ranges. Members of the subgenus *B.* (*Bovicola*) have short setae, conspicuous non-lobular gonopods, rod-like non-bipartite mesomeres and bovid/cervid hosts, those of *B.* (*Spinibovicola*) have medium setae, rounded gonopods, fused parameres but not mesomeres and ovine hosts, those of *B*. (*Holakartikos*) have long dense setae, small lobose gonopods, fused rod-like mesomeres and caprine hosts, and those of *B.* (*Lepikentron*) have long head setae but short body setae, conspicuous lobular gonopods, rod-like bipartite mesomeres and camelid hosts. Members of the subgenus *D.* (*Damalinia*) are broad lice with subgenital lobes reduced to flaps, tapering gonopods and fused mesomeres, those of *D.* (*Cervicola*) are similar but have hook-shaped gonopods and unfused mesomeres, while those of *D.* (*Tricholipeurus*) are long slender lice with rounded subgenital lobes, unfused mesomeres, and the endophallus bears a dense patch of spicules. The genus *Bisonicola* comprises species with short setae, wide truncate gonopods, separate parameres fused to the mesomeral arch, and bison hosts, *Werneckiella* contains species with broad truncate gonopods, pentagonal mesomeres, and equid/bovid hosts, while *Tragulicola* has species with broad tapering gonopods, fused mesomeres and tragulid (mouse-deer) hosts.

Site of infection: These chewing lice are ectoparasitic on the skin of their ungulate hosts and crawl amongst hairs/fibres close to the skin surface. Most louse species are highly host-specific and have a clumped or aggregated distribution as they have preferred sites of infestation, especially along the top line of the back, particularly the shoulders and withers from where they may spread to the neck, head, rump and poll. These lice avoid light and are usually found in regions with long hair or wool, but they avoid areas with coarse hairs such as the ears, mane, tail and lower legs. In heavy infestations, they may be found underneath heavily encrusted scurf.

Pathogenesis: Light infestations involving a few lice often remain asymptomatic and are unnoticed by their hosts, but heavier infestations by feeding nymphs and adults may cause clinical signs predominantly involving skin irritation, inflammation and sometimes lesions. Feeding stages abrade the skin using their chewing mouthparts and eat scurf (dead skin cells), skin secretions (oils/lipids from sebaceous and sweat glands, including wool grease) and skin bacteria. The surface of the skin usually remains intact although there may be some abrasion of the upper superficial layers (moist scabs do not form as occurs in infestations by psoroptic mange mites). The lice may cause skin irritation, discomfort, hyperkeratosis, inflammation (dermatitis) and intense itching (pruritus), which may be exacerbated by allergic responses to louse antigens (some animals have been shown to develop antibodies to louse salivary secretions). Infested animals attempt to relieve the annoyance by vigorous self-grooming (by biting, licking, scratching or rubbing afflicted body parts) which may result in unsightly coats/fleeces (matting, discolouration), loss of hair/wool (alopecia), skin damage (scaling, crusts) and self-trauma (sores, wounds) which are susceptible to secondary microbial infections. Infested animals may exhibit distress, impaired thermoregulation, poor feed conversion efficiency, suboptimal meat/milk/fibre production, and even hide damage (thickened discoloured patches or nodules known as ‘spot and fleck’ in cattle hides and ‘scatter cockle’ in sheep skins).Healthy animals able to groom effectively often do not develop severe infestations, and there is growing evidence that animals develop resistance after protracted exposure. Infestations are generally worse on young, old, sick or stressed (undernourished, overcrowded) animals due to their compromised physiological and/or immunological states. Lice are more prevalent during winter when animals have long coats and environmental conditions are more conducive to louse multiplication and survival.

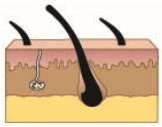
Ischnoceran chewing lice (*Werneckiella equi*) have also been implicated in the mechanical transmission of equine infectious anaemia, a blood-borne disease caused by a horse specific lentivirus normally transmitted by dipteran insects (horseflies, deer flies and stable flies). Both sucking and chewing lice of cattle have also been shown to act as mechanical vectors for the skin fungus *Trichophyton verrucosum* which causes dermatomycosis (ringworm).

Developmental cycle and mode of transmission: Chewing lice are obligate ectoparasites that live permanently in the host pelage and are able to complete their entire life-cycles on individual hosts. Transmission between hosts occurs by direct intimate contact when dislodged lice crawl onto new hosts or are transferred on contaminated equipment. Mature female lice lay eggs attaching them to hair shafts close to the skin, where they hatch after 5-14 days depending on temperature and humidity (favouring warm humid conditions). Emergent nymphs feed on the host and undergo gradual (hemimetabolous) metamorphosis moulting through another 2 nymphal stages over the next 14-21 days and then moulting to adults 3-4 days later. Most adult lice are female (comprising 95-99% of the population) and males are only occasionally seen. Many species are parthenogenetic and females can reproduce without mating. Female lice lay 1-2 eggs each day for 6-10 weeks. The whole life-cycle may be completed in 25-42 days but may be extended in warmer conditions (higher temperatures inhibit egg laying and survival of lice). None of the developmental stages are free-living and nymphs and adult lice can only survive for short periods (3-4 days) if dislodged from hosts. Direct transmission therefore occurs when lice move from host to host through close contact or via infested equipment. Transmission often occurs when animals are in close contact during feeding (including suckling) or when crowded into yards, stalls, barns or feedlots. Infestations may also be transmitted between hosts by contaminated bedding, rugs, harnesses or shared grooming equipment (combs, brushes). Some lice (mostly ischnoceran chewing lice) have occasionally been observed to be transmitted between hosts by phoresy, that is, when lice become temporarily attached to the external surfaces of larger winged insects (particularly hippoboscid and muscid flies) which move between hosts. Infestations are common in domestic ungulates in most grazing areas around the world, except those with very hot or very wet climates. Most infestations exhibit marked seasonal changes in prevalence and abundance, increasing during the cooler months of winter and spring when animals have longer coats, crowd together for warmth, have poorer nutrition and reduced vigour (all of which favour the breeding and spread of lice).

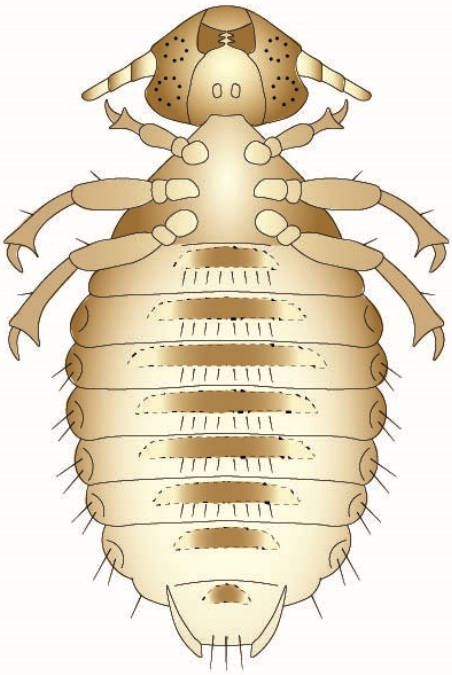
Differential diagnosis: Infestations may be suspected when animals show signs of irritation with rubbing resulting in unkempt coats (hair loss/matting) and skin lesions (due to self-trauma) in cooler months (late autumn, winter, early spring). Infested animals may also exhibit reduced feed intake and even weight loss. Visual examination of affected body regions by several partings of the coat may reveal the presence of lice (whitish nits or red-brown nymphs/adults). Most species are colonial and their motile stages are photophobic moving quickly away from light. Searches may be assisted by using magnifying glasses or fine-toothed combs, although light infestations may be overlooked. Any lice detected may be collected for microscopic examination and identification. Molecular techniques have recently been used to characterize louse species following polymerase chain reaction (PCR) amplification and sequencing of nuclear genes (18S ribosomal RNA).

Treatment and control: Clinical infestations may be treated with a range of insecticidal compounds, including synthetic pyrethroids (permethrin, cypermethrin, alphamethrin, deltamethrin, flumethrin, zetacypermethrin, cyfluthrin, cyhalothrin), synergized pyrethrins, organophosphates (diazinon, tetrachlorvinphos, coumaphos, chlorfenvinphos, chlorpyrifos, crotoxyphos, trichlorfon, phosmet, propetamphos, famphur), organochlorides (dieldrin, aldrin), macrocyclic lactones (ivermectin, eprinomectin, abamectin, moxidectin, doramectin), insect growth regulators (diflubenzuron), spinosyns (spinosad) and formamidines (amitraz), although the latter 2 have been discontinued in many countries as have some organochlorines and organophosphates. Animals may be treated by external topical applications (baths/dips, showers/sprays) or systemic treatments (oral, injectable, pour-on or impregnated ear tags), but careful attention should be given to drug guidelines and regulations concerning contra-indications, side-effects and toxic residues, particularly since some animal breeds have drug hypersensitivities (e.g. certain Brahman-cross cattle and some dairy cattle react adversely to organophosphates) and some drugs differ in their efficacy depending on their route of administration (e.g. injectable macrocyclic lactones are generally less effective against chewing lice). In most cases, treatment should be repeated after 1-2 weeks, because the chemicals are not effective against egg stages and most have little residual activity. Some louse species have also developed resistance to various insecticides, including cypermethrin, deltamethrin, cyhalothrin, diazinon, aldrin and dieldrin, and it is recommended that periodic treatments rotate between different chemical classes to reduce the risk of selection for further resistance. Animals are generally treated in autumn to prevent the escalation of louse populations during cooler months and all animals on the property should be treated. Good control through preventive management practices are based around maintaining healthy animals (well-nourished groomed individuals are less susceptible), minimizing contact between animals (avoiding overcrowding, quarantining new livestock or infested individuals) and decontaminating shared facilities and equipment (through cleaning, washing or chemical treatment of pens, stalls, rugs, harnesses, saddlery and grooming devices). Fibre-producing animals should be shorn before or during summer to reduce louse burdens (exposure to solar radiation and dehydration markedly reduce louse reproduction and survival).

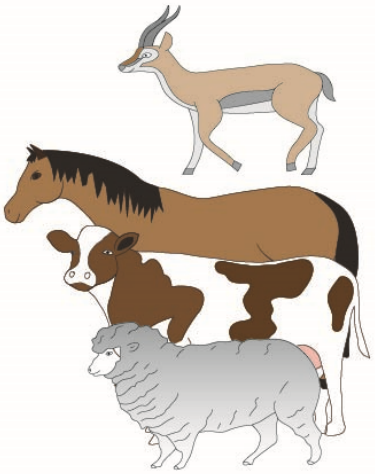
Bovicola, Damalinia



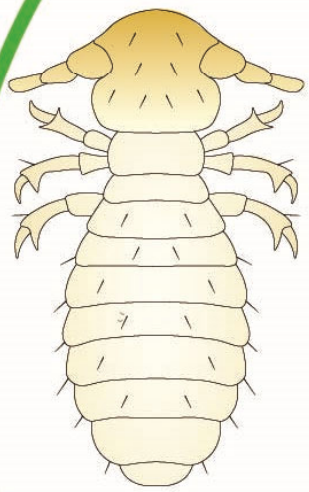
skin/pelage
(dermatitis, pruritus,
alopecia, excoriation)
(some vector infectious
microbial diseases)



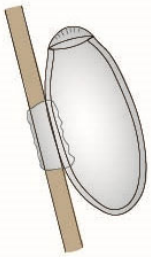
adult (ventral)
(~ 2 mm)



Definitive Hosts
(ungulates)



nymph (dorsal)
(~ 1.5 mm)

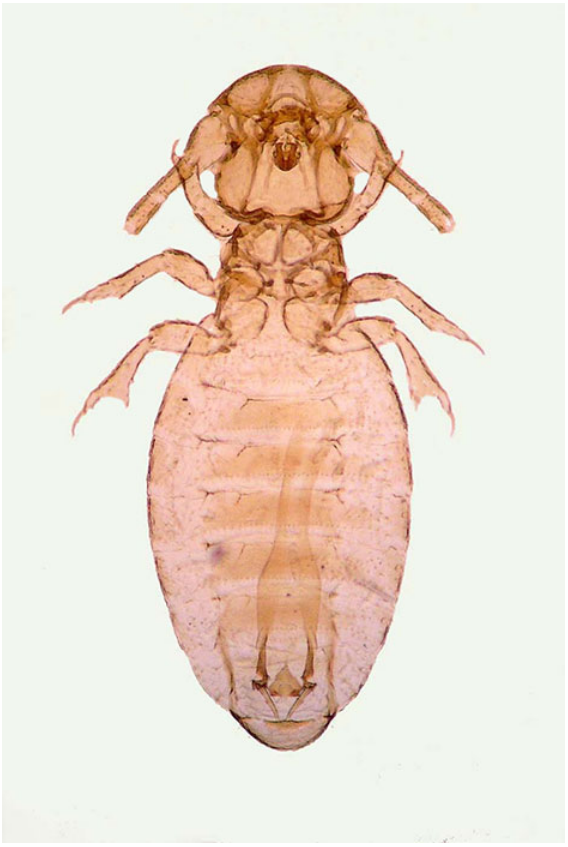


egg
(~ 1 mm)

all stages ectozoic on host
(motile stages feed on skin/scurf)

transmission between hosts
through transfer of motile stages
by direct contact or via fomites

Bovicola adult female



Bovicola adult male