

***Linognathus***  
(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. Anopluran (sucking) lice have narrow pointed heads adapted to piercing the skin and feeding on tissue fluids (solenophage mode of feeding). Sucking lice are ectoparasitic on mammals and most species are highly host specific and even site-specific, being found predominantly in areas with coarse hairs. Linognathids are long-nosed lice whose tarsal claws are smaller on the first legs than on other legs. *Linognathus* spp. are commonly found on the skin/hair of ruminants and carnivores and infestations have been associated with dermatitis, anaemia, pruritus, alopecia, excoriation and self-wounding. Some species may transmit other infectious micro-organisms, including bovine anaplasmosis, theileriosis, dermatomycosis (ringworm) and ovine eperythrozoonosis.

## 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: Hemipteroidea (Exopterygota) (young resemble adults, externally developing wings)  
Order: Phthiraptera (lice, wingless, ectoparasites, dorsoventrally flattened, stout legs, claws, eggs, nymphs, adults)  
Suborder: Anoplura (sucking lice, narrow pointed head, pierce skin and feed on fluids (solenophagy))  
Family: Linognathidae (long-nosed lice, claws on first leg smaller than those on other legs)  
Genus: *Linognathus* (parasitic on skin/hair of ruminants/dogs/foxes)  
Species: various species cause skin lesions in domestic animals

**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 Hemipteroidea (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	Pathogenesis	Disease transmission
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	-
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: 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

Some 700 species of anopluran sucking lice have been described in 51 genera in 16 families, namely: Echinophthiriidae (*Antarctophthirus*, *Echinophthirus*, *Latagophthirus*, *Lepidophthirus*, *Proechinophthirus*); Enderleinellidae (*Atopophthirus*, *Enderleinellus*, *Microphthirus*, *Phthirunculus*, *Werneckia*); Haematopinidae (*Haematopinus*); Hamophthiriidae (*Hamophthirus*); Hoplopleuridae (*Ancistroplox*, *Ferrisella*, *Haematopinoidea*, *Hoplopleura*, *Paradoxophthirus*, *Pterophthirus*, *Schizophthirus*, *Typhlomyophthirus*); Hybophthiridae (*Hybophthirus*); Linognathidae (*Linognathus*, *Prolinognathus*, *Solenopotes*); Microthoraciidae (*Microthoracius*); Mirophthiridae (*Mirophthirus*); Neolinognathidae (*Neolinognathus*); Pecaroecidae (*Pecaroecus*); Pedicinidae (*Pedicinus*); Pediculidae (*Pediculus*); Polyplacidae (*Abrocomaphthirus*, *Ctenophthirus*, *Cuyana*, *Docophthirus*, *Eulinognathus*, *Fahrenholzia*, *Galeophthirus*, *Haemodipsus*, *Johnsonphthirus*, *Lagidiophthirus*, *Lemurpediculus*, *Lemurphthirus*, *Linognathoides*, *Neohaematopinus*, *Phthirpediculus*, *Polyplax*, *Proenderleinellus*, *Sathrax*, *Scipio*); Pthiridae (*Pthirus*); and Ratemiidae (*Ratemia*). Those of medical significance are found in the families Pediculidae (hominids, New World primates) and Pthiridae (hominids), while those of particular veterinary significance occur in the families Haematopinidae (equids, bovids, suids), Linognathidae (bovids, canids), Hoplopleuridae (rodents), Pedicinidae (Old World primates) and Polyplacidae (rabbits, rodents). Linognathids are commonly known as pale lice or long-nosed lice. The tarsal claws on the first pair of legs are smaller than those on the second and third pairs of legs. Two genera are of particular veterinary importance: several *Linognathus* spp. cause disease in domestic ruminants and companion animals; and several *Solenopotes* spp. cause disease in cattle and deer. Over 50 *Linognathus* species have been described, most associated with ungulates (especially African artiodactyls) and six species with carnivores (canids). They are highly host-specific and are found wherever their hosts occur, those of domestic livestock being cosmopolitan in distribution.

<i>Linognathus</i> species	Hosts	Location	Clinical signs	Distribution
<i>L. aepycerus</i>	Artiodactyla: bovid (impala)	skin		Africa
<i>L. africanus</i> (African blue louse)	Artiodactyla: bovid (goats, sheep, gazelle); cervid (deer)	skin	irritation, dermatitis, anaemia	worldwide
<i>L. angasi</i>	Artiodactyla: bovid (nyala)	skin		Africa
<i>L. angulatus</i> (syn. <i>L. unguulatus</i> )	Artiodactyla: bovid (duiker)	skin		Africa
<i>L. antennatus</i>	Artiodactyla: bovid (hartebeest)	skin		Africa
<i>L. antidorcitis</i>	Artiodactyla: bovid (springbok)	skin		Africa
<i>L. armatus</i>	Artiodactyla: bovid (springbok)	skin		Africa
<i>L. bedfordi</i>	Artiodactyla: bovid (springbok)	skin		Africa
<i>L. bhatii</i>	Carnivora: canid (Bengal fox)	skin		India

<i>L. breviceps</i> (syn. <i>L. gazella, gilvus</i> )	Artiodactyla: bovid (Maxwell's duiker, blue duiker, red forest duiker, common duiker)	skin		Africa
<i>L. brevicornis</i>	Artiodactyla: giraffid (giraffe)	skin		Africa
<i>L. cervicaprae</i>	Artiodactyla: bovid (blackbuck)	skin		Africa
<i>L. contractus</i>	Artiodactyla: bovid (oribi)	skin		Africa
<i>L. damaliscus</i> (syn. <i>L. albifrontis</i> )	Artiodactyla: bovid (bontebok)	skin		Africa
<i>L. damarensis</i>	Artiodactyla: bovid (dikdik)	skin		Africa
<i>L. digitalis</i>	Artiodactyla: bovid (springbok)	skin		Africa
<i>L. elblae</i>	Artiodactyla: bovid (duiker)	skin		Africa
<i>L. euchore</i>	Artiodactyla: bovid (springbok)	skin		Africa
<i>L. fahrenheiti</i> (syn. <i>L. forficula</i> )	Artiodactyla: bovid (southern reedbuck, mountain reedbuck, Bohor reedbuck)	skin		Africa
<i>L. fenneci</i>	Carnivora: canid (fennec)	skin		North Africa, Middle-East
<i>L. fractus</i>	Artiodactyla: bovid (bushbuck)	skin		Africa
<i>L. geigyi</i>	Artiodactyla: bovid (Salt's dik-dik, Kirk's dikdik)	skin		Africa
<i>L. gnu</i> (syn. <i>L. ferrisi</i> )	Artiodactyla: bovid (wildebeest)	skin		Africa
<i>L. gonolobatus</i>	Artiodactyla: bovid (roan antelope)	skin		Africa
<i>L. gorgonus</i>	Artiodactyla: bovid (wildebeest)	skin		Africa
<i>L. hippotrugi</i>	Artiodactyla: bovid (sable antelope)	skin		Africa
<i>L. kimi</i>	Artiodactyla: bovid (Sharpe's grysbok, Cape grysbok)	skin		Africa
<i>L. lewisi</i>	Artiodactyla: bovid (Thomson's gazelle, dorcas gazelle)	skin		Africa
<i>L. limnotrugi</i>	Artiodactyla: bovid (sitatunga, bushbuck)	skin		Africa
<i>L. nesotrugi</i>	Artiodactyla: bovid (suni)	skin		Africa
<i>L. nevillei</i>	Artiodactyla: bovid (impala)	skin		Africa
<i>L. oryx</i>	Artiodactyla: bovid (gemsbok)	skin		Africa
<i>L. ourebiae</i>	Artiodactyla: bovid (oribi)	skin		Africa
<i>L. ovillus</i> (sheep face louse)	Artiodactyla: bovid (sheep)	skin (face)	irritation, dermatitis, anaemia	worldwide
<i>L. panamensis</i> (syn. <i>L. tragelaphi</i> )	Artiodactyla: bovid (kudu, bushbuck); cervid (white-tailed deer)	skin		Africa, North America
<i>L. pedalis</i> (syn. <i>L. micerocephalus</i> ) (sheep foot louse)	Artiodactyla: bovid (sheep, mountain goat)	skin (feet, legs, belly)	irritation, dermatitis, anaemia	worldwide
<i>L. peleus</i>	Artiodactyla: bovid (rhebok)	skin		Africa
<i>L. petasmatus</i>	Artiodactyla: bovid (oryx, addax)	skin		Africa
<i>L. pithodes</i>	Artiodactyla: bovid (blackbuck)	skin		Africa
<i>L. raphiceri</i>	Artiodactyla: bovid (steenbok, impala)	skin		Africa
<i>L. reduncae</i>	Artiodactyla: bovid (mountain reedbuck, southern reedbuck)	skin		Africa
<i>L. samburi</i>	Artiodactyla: bovid (Gunther's dik-dik)	skin		Africa
<i>L. setosus</i> (syn. <i>L. bicolor, flavidus, isopus, piliferus</i> ) (dog sucking louse)	Carnivora: canid (dog, gray wolf, red fox, Ruppell's fox, jackal, coyote, Arctic fox); otariid (sea lion)	skin (head, neck)	irritation, anaemia	worldwide
<i>L. sosninae</i>	Carnivora: canid (red fox)	skin		Europe
<i>L. spicatus</i>	Artiodactyla: bovid (wildebeest)	skin		Africa
<i>L. stenopsis</i> (syn. <i>L. hirci, schistopyga, rupicaprae</i> ) (goat sucking louse)	Artiodactyla: bovid (goat, ibex, chamois)	skin	irritation, dermatitis, anaemia	worldwide
<i>L. taeniotrichus</i>	Carnivora: canid (maned wolf, crab-eating fox)	skin		South America
<i>L. taurotragus</i>	Artiodactyla: bovid (kudu, eland)	skin		Africa
<i>L. tibialis</i>	Artiodactyla: bovid (dama gazelle, mountain gazelle, red-fronted gazelle, goitered gazelle)	skin		Africa

<i>L. vituli</i> (syn. <i>L. oxyrrhynchus</i> , <i>tenuirostris</i> ) (long-nosed cattle louse)	Artiodactyla: bovid (cattle)	skin (head, neck, dewlap)	irritation, dermatitis, pruritus	worldwide
<i>L. vulpis</i>	Carnivora: canid (red fox, Bengal fox)	skin		Europe, India
<i>L. weissei</i>	Artiodactyla: bovid (impala)	skin		Africa
<i>L. zumpti</i>	Artiodactyla: bovid (common duiker, steenbok)	skin		Africa

**Parasite morphology:** *Linognathus* spp. form three different types of developmental stages: eggs; nymphs (3 instars); and adults. The eggs are ellipsoidal measuring around 500 µm in length and are attached by their bases to host hairs but lay longitudinally with their straight side along the hair. They are dark brown-blue in colour and are operculate with a distinct anterior cap (operculum) with a ridged lip. The eggs contain a developing embryo which hatches as a first-stage nymph (sometimes designated N1) measuring 1-2 mm in length. Nymphs resemble adult lice but are smaller, less sclerotized, have fewer body setae, and lack genitalia. They undergo incomplete (gradual) metamorphosis and moult through another two instars (N2, N3) before moulting to adults which measure up to 2.5 mm long. Adult lice are dorsoventrally flattened (dorsal tergum, ventral sternum), tan-coloured with dark blue-black markings, and have three prominent body parts (head, thorax, abdomen). *Linognathus* spp. have narrow elongate heads, twice as long as broad (in contrast to short blunt heads in members of the sister genus *Solenopotes*). Their heads lack eyes and ocular points, but have two short stout lateral antennae, each consisting of 5 segments. The head is pointed anteriorly and has long thin mouthparts modified for piercing and sucking. The mouthparts are located in a snout-like proboscis (labrum) comprising an eversible tubular haustellum armed with teeth and 4 retractable stylets (2 supported by maxillae to form a food channel, one derived from the hypopharynx and connected to the salivary gland, and one derived from the labium which is flattened with a serrated tip and guides the other stylets). When not in use, the mouthparts are retracted into a pocket in the head. Sucking lice lack maxillary palps (present in amblyceran chewing lice), and mandibles and pulvini pads (present in other chewing/biting lice). Adults have an elaborate alimentary tract comprising a foregut (with buccal funnel, cibarial pump, pharynx and oesophagus), a large midgut (with ventriculus, caeca and special mycetome (stomach disc containing endosymbiotic bacteria and/or fungi)), and a short hindgut (with pylorus, papillae and rectum). The thorax has three segments fused together without obvious divisions, and has a distinct dorsal notal pit but lacks a ventral sternal plate (present in *Solenopotes* spp.). The ventral thorax gives rise to three pairs of legs, each consisting of five segments (coxa, trochanter, femur, tibia, tarsus). The legs have highly specialized pincer-like tibiotarsal claws closing on tibial spurs, and the fore-legs and claws are smaller than mid- and hind-legs and claws (the diameter enclosed by the latter typically conforms to the hair diameter of the host). The abdomen is elongate and consists of 9 membranous segments without sclerotized plates except for those associated with genital or terminal segments. Each segment has two rows of ventral setae and the lateral spiracles (openings to the respiratory (tracheal) system) are not located on raised tubercles (present in *Solenopotes*). Female lice are slightly larger than males (average of 2.4 cf. 1.8 mm) and they are readily identified by the appearance of their posterior abdominal segments (bifurcated in females and rounded in males). Mature males have compact bilobed testes, tubular vas deferens which coalesce to form the seminal vesicle, and a genital sac with a conspicuous copulatory (intromittent) organ called the aedeagus (penis-like tube with dorsal gonopore and terminal pseudopenis) supported by a slender basal plate-like sclerite (apodeme) and well-developed lateral rod-like sclerites (parameres). Mature females have paired ovaries with polytrophic ovarioles, tubular oviducts and glue-producing accessory glands connected to a globular uterus, a weakly sclerotized spermatheca (sperm storage organ), and a genital opening (vagina) supported by a genital plate, valvula, and well-developed gonopods with terminal horns and/or long pointed genital setae. Gravid females often contain 1-2 large eggs developing in the uterus.

**Site of infection:** *Linognathus* spp. are blood-sucking ectoparasites on the skin of artiodactyls (mostly bovids) and carnivores (mostly canids). They are highly host specific (oioxenous) although a few may be found on closely-related host species (stenoxenous). Most species also exhibit some tissue tropism (site specificity) with lice being found preferentially on particular parts of the body, although they may be more widespread over the body in heavy infestations. For example, the long-nosed cattle louse (*L. vituli*) is commonly found on cattle occur in distinct clusters, mainly on the head, face, neck (esp. dewlap) and sometimes the shoulders, back, rump, udder and perineum. The sheep face louse (*L. ovillus*) and the sheep foot louse (*L. pedalis*) are found on sheep on the hairy (non-woolled) areas of the face and foot, respectively. The dog sucking louse (*L. setosus*) is found mainly on dogs (esp. long-haired breeds) on the neck and shoulders.

**Pathogenesis:** While sucking lice are not considered to be highly pathogenic, infestations may cause clinical disease depending on the numbers present and the general health of the hosts (infestations more severe in individuals with compromised physiological and/or immunological status). Nymphs and adult lice feed by piercing the skin, injecting saliva with anticoagulant properties and then sucking host blood. Clinical signs are usually limited to superficial dermatitis and secondary self-trauma, although blood loss in heavy infestations may result in mild anaemia. Lice moving and feeding on their hosts irritate the skin causing inflammation (dermatitis) with pruritus (itching), and then induration (fibrosis) and granuloma formation. These responses appear to be exacerbated by host allergic responses to louse antigens (saliva and/or faeces), but they do not progress to disruption and scabbing of the skin surface that is commonly associated with psoroptic scab mites. Infested animals endeavour to relieve the irritation by intense grooming (biting, licking, scratching, rubbing) which may lead to self-trauma with skin lesions (scaling and crust

formation), alopecia (loss of hair, fur, fibre), unsightly appearance (matted dull coats, wool breaks in sheep) and sometimes hide damage (superficial spots or flecks). Female lice may also pull several hairs together and attach their eggs, accentuating matting particularly in sheep and goats. Chronically infested areas develop thick tender skin which may crack in severe cases resulting in further hide damage evident at slaughter. Infested animals become restless and unthrifty and may exhibit impaired thermoregulation, poor feed conversion efficiency and reduced productivity (suboptimal meat, milk, fibre production). Clinical manifestations are worse in young, old, malnourished or stressed individuals, as well as those sick with other disease conditions. Animals that are well nourished, healthy and able to groom can usually keep louse burdens low and minimize or avoid clinical disease.

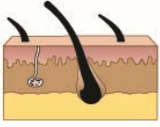
The species *L. setosus* from dogs has also been shown to act as a transmission vector for the nematode *Dipetalonema reconditum*. Recent molecular biological studies using polymerase chain reaction (PCR) amplification techniques have detected DNA from a range of bacteria in sucking lice; including *Acinetobacter soli*, *Anaplasma marginale*, *Anaplasma ovis*, *Rickettsia helvetica* and *Rickettsia africae* in *L. vituli* from cattle, *Anaplasma marginale* and *Rickettsia helvetica* in *L. stenopsis* from goats, *Rickettsia africae* in *L. africanus* from goats, and *Rickettsia felis* in *L. setosus* from dogs; but their role in disease transmission remains to be determined. Similar molecular studies have detected DNA from the haemoprotozoan *Theileria orientalis* in *L. vituli* from cattle, supporting previous work implicating sucking lice in the mechanical transmission of this piroplasm (via regurgitation, rather than cyclic transmission via saliva as occurs in ticks).

**Developmental cycle and mode of transmission:** These lice complete their whole life-cycles in the pelage (fur, hair, wool) of their hosts, with each mobile stage requiring a bloodmeal to develop further. Gravid female lice glue their eggs to host hairs/fibres using an adhesive cement. The eggs hatch in 1-2 weeks and release first-stage nymphs (N1) which feed and undergo hemimetabolous (incomplete) metamorphosis moulting through another two nymphal stages (N2, N3) before forming adult lice. After feeding and mating, female lice lay on average one egg per day for several weeks. Adults live for 6-10 weeks but the entire life-cycle may be completed within 3-4 weeks. Lice do not survive longed periods off hosts and die within 3-5 days if dislodged (the exception being the sheep foot louse *L. pedalis* which can survive in pastures for up to 18 days). Transmission occurs when lice (adults and sometimes nymphs) crawl from one host to another or temporarily contaminate fomites (especially shared bedding and grooming equipment). The highest transmission rates occur when hosts come into close contact, such as when herded, yarded, stabled or kennelled. Populations of lice increase during cooler months when lower temperatures, rainfall, reduced daylight, crowding and poor nutrition favour the breeding and spread of lice. Conversely, populations decrease during warmer months when drier conditions, loss of winter coats, better nutrition and less gregarious behaviours are detrimental to louse development. Nevertheless, lice persist over the summer months on a small number of highly susceptible animals.

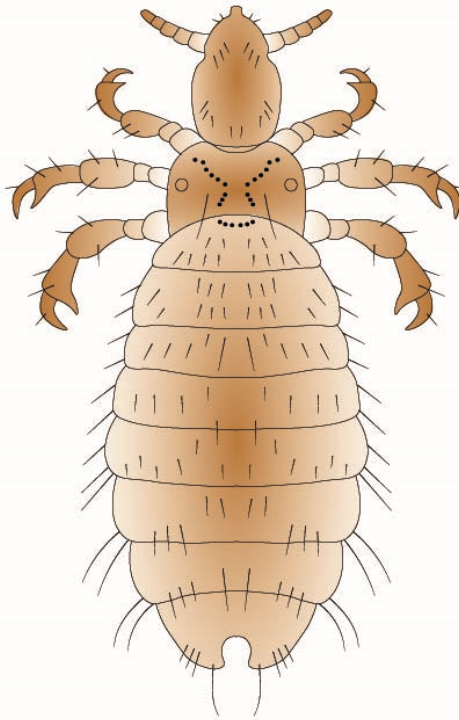
**Differential diagnosis:** Infestations may be suspected on the basis of clinical symptomatology involving manic self-grooming leading to traumatic lesions and alopecia, especially in cooler months over winter. Definitive diagnosis relies on the direct detection of lice (nymphs and adults) and/or their eggs (nits) in the host pelage. The parasites are large enough to be visible when parting the coat and they are slow moving and generally do not move to avoid light (while biting/chewing lice move readily to avoid light). Lice may be collected using tweezers (or sticky-tape impression smears) for microscopic examination to confirm identity. Modern molecular biological techniques have been used to infer phylogenetic relationships between various species following the PCR amplification of nuclear genes (18S ribosomal RNA).

**Treatment and control:** A range of insecticidal chemicals have shown good efficacy in the treatment of louse infestations: including organochlorides (dichloro-diphenyl-trichloroethane (DDT), lindane), organophosphates (chlorpyrifos, diazinon, malathion), synthetic pyrethroids (permethrin, deltamethrin, flumethrin, cypermethrin), macrocyclic lactones (milbemycin, selamectin, moxidectin, ivermectin, abamectin, eprinomectin, doramectin), formamidines (amitraz), chloronicotinyl (imidacloprid), arylpyrazole (fipronil), spinosyns (spinosad), and insect growth regulators (diflubenzuron). Most insecticides are not very effective against eggs, so treatments are usually repeated after several weeks to kill newly-emergent stages, although some formulations with good residual activity only require single applications. It is advisable to treat all animals at risk, particularly new animals before they are released into the general population. Treatment is best conducted in autumn to counter louse populations increases during the cold months over winter. Chemical usage should conform to government regulations regarding residues, with-holding periods and environmental toxicity. Insecticides may be applied to animals as topical (powders/fogs, aerosols/sprays, shampoos/rinses) or systemic preparations (oral, injectable, pour-ons, impregnated tags), and some are suitable for use in self-treatment devices (dust bags, back rubbers, oilers). A variety of grooming devices (brushes, combs) and lotions (essentially conditioners) may be used to help remove lice, although they are unsuited for use on long, curly or woolly coats. Matted coats on heavily infested animals should also be trimmed or clipped before treatment. Animals kept healthy and well-nourished are often able to control louse populations if they are able to self-groom, so husbandry practices should avoid over-crowded unsanitary conditions. Other preventive control measures involve decontaminating facilities and equipment (by washing, chemical or heat treatments) and restricting contact between individuals (isolate infested individuals, quarantine new livestock).

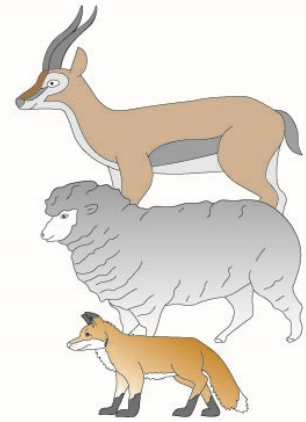
# Linognathus



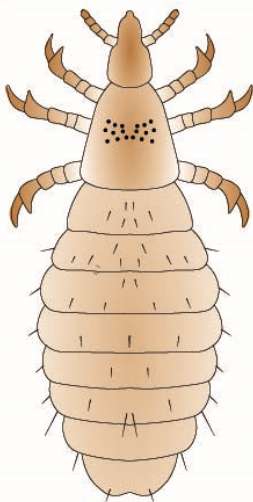
skin/pelage  
(dermatitis, anaemia,  
alopecia, excoriation)  
(vectors for infectious  
microbial diseases)



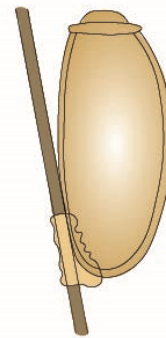
adult (dorsal)  
(~ 3 mm)



Definitive Hosts  
(ruminants, carnivores)



nymph (dorsal)  
(~ 2 mm)



egg  
(~ 0.5 mm)

all stages ectozoic on host  
(motile stages feed on blood)

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



*Linognathus* adult



*Linognathus* adult



*Linognathus* egg

*Linognathus* adult