Trichodectes
(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. Infestations by *Trichodectes canis* in dogs have been associated with irritation, inflammation, pruritus, alopecia and excoriation.

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:	*Trichodectes* (parasitic on skin/hair of dogs)
Species:	*T. canis* (causes pruritus and dermatitis in dogs)

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 Trichodectinae (subgenital lobes present on females, often with serrate margin, six or fewer abdominal spiracles, carnivora/primate hosts) contains the genus *Trichodectes* (at least one pair of abdominal spiracles present, small abdominal tergal and sternal setae), and 3 subgenera are recognized: *T.* (*Trichodectes*) (other than 5 pairs of abdominal spiracles, subgenital lobe bifurcate, mesomeres unfused, parameres fused), *T.* (*Paratrichodectes*) (5 pairs of abdominal spiracles, subgenital lobe not bifurcate, parameres not fused, mesomeres absent, abdominal terga with median setal groups comprising at least 3 setae) and *T.* (*Stachiella*) (other than 5 pairs of abdominal spiracles, subgenital lobe often with basal lateral processes, parameres fused, abdominal terga with median setal group reduced to one seta). Over 20 *Trichodectes* spp. have been described from carnivores, particularly canids and mustelids, and some viverrids, procyonids and ursids.

***Trichodectes* species**	**Hosts**	**Location**	**Clinical signs**	**Distribution**
Subgenus *T.* (*Trichodectes*) [other than 5 pairs of abdominal spiracles, subgenital lobe bifurcate, mesomeres unfused, parameres fused]				
T. canis (syn. *T. floridanus, latifrons, latus, octopunctatus, riveti*) (dog biting louse)	Carnivora: canid (dog, raccoon dog, wolf, jackal, coyote, Andean fox, crab-eating fox, Bengal fox, Darwin's fox); viverrid (African civet)	skin (head, neck, tail)	irritation, pruritus, matted coat, inflammation, excoriation, alopecia [plus vector for double-pored tapeworm (*Dipylidium caninum*)]	worldwide
T. emersoni	Carnivora: mustelid (ferret-badger)	skin		Malaysia
T. euarctidos	Carnivora: ursid (black bear)	skin		North America
T. galictidis (syn. *T. paranensis*)	Carnivora: mustelid (wolverine)	skin		South America
T. kuntzi	Carnivora: mustelid (ferret-badger)	skin		South-East Asia
T. melis (syn. *T. crassus*)	Carnivora: mustelid (European badger)	skin		Europe
T. pinguis	Carnivora: ursid (brown bear)	skin		North America, Scandinavia
T. vosseleri	Carnivora: mustelid (honey badger)	skin		Africa
Subgenus *T.* (*Paratrichodectes*) [5 pairs of abdominal spiracles, subgenital lobe does not bifurcate, parameres not fused, mesomeres absent, abdominal terga with median setal groups comprising at least 3 setae]				
T. ovalis	Carnivora: mustelid (striped polecat, African striped weasel)	skin		Africa
T. ugandensis	Carnivora: mustelid (African striped weasel)	skin		Africa
T. zorillae	Carnivora: mustelid (Sahara striped polecat)	skin		Africa
Subgenus *T.* (*Stachiella*) [other than 5 pairs of abdominal spiracles, subgenital lobe often with basal lateral processes, parameres fused, abdominal terga with median setal group reduced to one seta]				
T. divaricatus	Carnivora: mustelid (lesser grison)	skin		South America
T. emeryi	Carnivora: mustelid (yellow-throated marten)			Asia
T. ermineae	Carnivora: mustelid (stoat)	skin		North America, Europe, New Zealand
T. fallax	Carnivora: procyonid (crab-eating raccoon)	skin		Americas
T. jacobi	Carnivora: mustelid (European polecat)	skin		Eurasia, Africa
T. kingi	Carnivora: mustelid (least weasel)	skin		Eurasia, North America
T. larseni	Carnivora: mustelid (American mink)			North America, Eurasia
T. martis	Carnivora: mustelid (American marten)	skin		North America
T. mustelae (syn. *S. dubia, pusilla*)	Carnivora: mustelid (Siberian weasel, least weasel)	skin		Eurasia
T. octomaculatus (syn. *S. procyonis*)	Carnivora: mustelid (common raccoon)	skin		North America
T. potus	Carnivora: procyonid (kinkajou)	skin		Americas
T. retusa	Carnivora: mustelid (beech marten, weasel)	skin		Eurasia
T. salfii	Carnivora: mustelid (European pine marten)	skin		Europe

Parasite morphology: Like all lice, *Trichodectes* spp. form three different types of developmental stages: eggs (nits); nymphs (3 instars); and adults. The eggs are subcylindrical around 1 mm long and have rounded ends with the posterior ends glued to host hairs and the anterior ends having a convex operculum (cap) with aeropyles (breathing holes). The eggs are embryonated and hatch to release first-stage nymphs (N1). These stages undergo gradual (incomplete) metamorphosis and moult through another two nymphal stages before forming adults. All nymphs are similar in morphology to adult lice but are smaller, less sclerotized, have fewer body setae (hairs) and lack genitalia. Adult lice are small (1.6-2.0 mm long), pale yellow, dorsoventrally flattened (dorsal tergum, ventral sternum) and have three distinct body parts (broad blunt head, small triangular thorax, and large ovoid abdomen). The head is wider than the thorax and is rounded anteriorly with a groove in the ventral surface which accommodates hair shafts of their hosts. They have a pair of short filiform antennae situated laterally and often projecting posteriorly. The antennae are clearly visible and not hidden in grooves (like amblyceran lice) and they have three segments (rather than 5 segments like those of bird lice in the family Philopteridae). Trichodectid lice are chewing lice and do not have long piercing/sucking mouthparts but feed by the biting or scraping action of large ventral dentate mandibles with food particles pushed into the preoral cavity by the posterior plate-like labrum, often with an anterior hyaline pad-like protrusion (pulvinus), lateral maxillae and an anterior labium (salivary secretions added through a central hypopharynx). In ischnoceran lice, the sclerotized ridged mandibles are inserted at right angles to the head (such that the condyles are posterior and the ginglymus is anterior), the maxillae and labium are reduced in size with single-lobed maxillae attached to the tripartite labium, and they lack maxillary palps (present in amblyceran lice). The mouth opens to the foregut (with pharynx, oesophagus and tubular crop) connected to the large midgut (with ventriculus and anterior caeca) and hindgut (with pylorus, papillae and rectum). In ischnoceran chewing lice, the midgut also contains a rounded mycetome (special organ, sometimes called bacteriome or stomach disc) harbouring bacterial/fungal symbionts (mycetome more developed in anopluran sucking lice, but absent in amblyceran chewing lice). The thoracic segments are fused together with indistinct boundaries and the ventral surface gives rise to three pairs of legs which are similar in size. The legs consist of 5 segments (coxa, trochanter, femur, tibia, tarsus) and terminate in single tarsal claws (in contrast to the double claws found on members of the family Philopteridae on birds) but the claws do not close on tibial spurs (i.e. they are not specialized tibiotarsal claws like those found on anopluran lice). The large rounded abdomen has nine distinct segments each bearing a transverse row of long dense setae both dorsally and ventrally. The abdomen also possesses six pairs of respiratory spiracles located along the dorsal edges of segments 4 to 9. Adult lice are sexually dimorphic with males being smaller than females (1.6-1.7 mm cf. 1.7-2.0 mm long) and males having a larger first antennal segment. Male genitalia are large and conspicuous comprising 2 pairs of compact testes (3 pairs in amblyceran lice) connected to tubular vas deferens which join to form a seminal vesicle basal to the genital sac containing a spiny aedeagus (tube-like copulatory or intromittent organ with dorsal gonopore and terminal endophallus) supported by a basal plate-like sclerite (apodeme) and lateral rod-like sclerites (parameres). Female genitalia consist of ovaries with polytrophic ovarioles connected to tubular oviducts joined to a globular uterus with accessory glands (produce glue) and spermatheca (store sperm) opening into a vagina with genital plate, valvula, setae and two posterior finger-like gonopods (lobes on posterior segment to aid in oviposition).

Site of infection: Trichodectids are commonly known as fur lice as they are ectoparasitic in the fur on the external surfaces of their carnivorous hosts. Many species are considered to be host specific and most show some site specificity as ischnoceran chewing lice are more sedentary and specialized than the more mobile unspecialized amblyceran chewing lice. For example, the dog biting louse *T. canis* is commonly found on the head, neck and tail of canids and tends to aggregate around body openings and wounds.

Pathogenesis: Infestations by a few lice may remain asymptomatic and go unnoticed by their hosts but heavier burdens may cause mild-severe disease with inflammation, pruritus and unkempt coats. Lice may cause irritation and annoyance when moving and feeding on their hosts. Nymphs and adults feed on flakes of skin and host fluids using their mandibular mouthparts to scrape epidermal tissues, often congregating around body openings or wounds seeking moisture. Their feeding behaviour may cause inflammation (dermatitis) which is often exacerbated by host allergic responses to louse antigens in saliva and/or faeces. Heavy infestations may result in intense pruritus with restlessness, sleeplessness, nervousness, and biting-stress with animals attempting to relieve the itching by self-grooming (biting, licking, scratching or rubbing afflicted body parts) which may cause unsightly matted dull coats with alopecia (hair loss) and excoriations (lesions) prone to crusting and secondary bacterial infections. Louse populations are usually readily controlled on well-nourished, healthy, well-groomed pets but louse numbers and clinical manifestations may be worse on very young, old, sick or stressed animals because of their compromised immunological and/or physiological conditions.

The species *T. canis* has also been shown to act as an intermediate host for *Dipylidium caninum* (the double-pore or cucumber tapeworm). Lice which ingest tapeworm eggs from dog faeces harbour cysticercoid stages which remain quiescent until ingested by dogs during grooming, or accidentally by humans (usually children playing with pets). Enigmatically, recent molecular studies have detected DNA from spirochaete bacteria *Borrelia* spp. in *Trichodectes melis* lice recovered from badgers but without detecting bacterial infections in those badgers. Further studies are required to determine whether chewing lice may be involved as mechanical or biological vectors in the transmission of borreliosis (including Lyme disease and relapsing fevers).

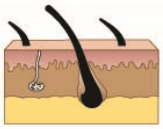
Developmental cycle and mode of transmission: Fur lice are obligate ectoparasites that live permanently in the host pelage, with transmission occurring when nymphs and/or adult lice are dislodged and crawl onto new hosts in close proximity. Gravid female lice glue their eggs to hair shafts where they develop and hatch after 5-14 days releasing first-stages nymphs. The emergent undergo hemimetabolous development with simple (incomplete) metamorphosis involving moults through another two nymphal stages

before forming adult lice after 2 weeks. Each stage must feed in order to undergo further development. Adult lice mate and fertilized females begin laying eggs at the rate of several eggs per day for up to 30 days. The entire life-cycle may be completed on the same host in 3-6 weeks. Lice do not survive for long off the host and usually die within a week, although *T. canis* has been shown to withstand a range of environmental conditions but not for protracted periods. Infestations are transmitted between hosts when lice move from one to another either by direct contact or via contaminated bedding or grooming equipment (shared brushes and combs). Louse populations generally increase during cooler months of the year, with peak infestations typically occurring in late autumn or winter. Some lice (mostly ischnoceran chewing lice) have also been observed to be transmitted by phoresy when they use their mandibles to become temporarily attached to other larger insects that move between hosts. Stages of several *Trichodectes* spp. have been found attached to hippoboscid louse-flies and several times to adult fleas collected from wild animals, notably badgers.

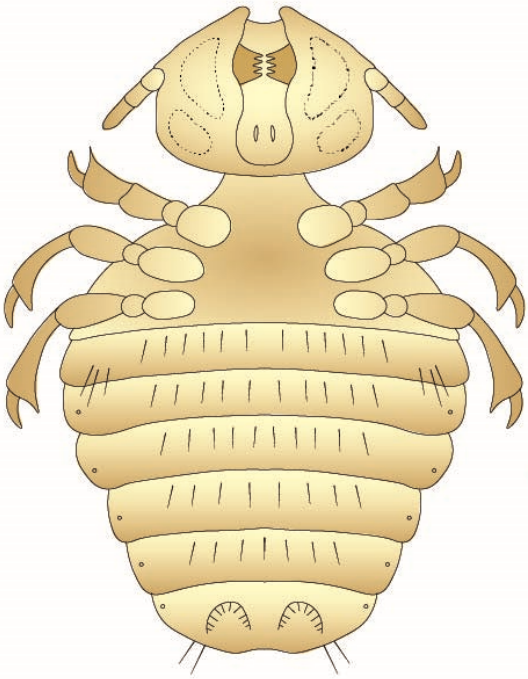
Differential diagnosis: Infestations are usually detected by the direct demonstration of parasites on hosts, either eggs or empty egg cases (nits) attached to the bases of hair shafts, or motile stages (nymphs, adults) clinging to hairs or feeding on skin. Parasites may be visible to the naked eye when parting the coat, but the use of strong lights and magnifying lenses greatly aids their detection. Parasites may also be collected using tweezers, sticky tape impression smears or brisk coat brushings for subsequent light microscopic examination and identification. Potassium hydroxide digestion techniques have also been used to recover lice from fresh wolf hides. Molecular studies have recently shown that the mitochondrial genome of trichodectid lice from mammals is fragmented into many mini-chromosomes like that of anopluran and rhynchophthirinid lice, while that of philopterid lice from birds is retained in a single chromosome. The shared derived feature of mitochondrial genome fragmentation has prompted the erection of a novel clade (Mitodivisia) which has been tentatively supported by phylogenetic studies on mitochondrial genes (cytochrome c oxidase subunit I).

Treatment and control: Infestations may be treated effectively using insecticidal chemicals applied at least twice at an interval of 7-14 days to ensure that any nymphs hatching from resistant eggs are killed. Insecticides exhibiting good activity have included chloronicotinyl (imidacloprid), pyrethroids (permethrin), carbamates (carbaryl), organochlorides (lindane, dichloro-diphenyl-trichloroethane (DDT)), organophosphates (malathion, chlorpyrifos, diazinon), arylpyrazole (fipronil) and macrocyclic lactones (selamectin, ivermectin). Most chemicals are available as topical applications (shampoos/rinses, sprays/aerosols, powders/fogs) although some are available as systemic formulations (injectable, oral or spot-on). Careful attention should be paid to regulations governing chemical usage (especially contra-indications, residues and environmental toxicity). Various grooming devices (brushes and fine-toothed combs) may be used to assist in the removal of lice, although adherent nits can be difficult to dislodge without using conditioners to lubricate coats and ease tangles. It is advisable to treat all animals in contact if possible, and to ensure they are kept healthy, well-nourished and well-groomed. Control through preventive management practices are based around minimizing contact with infested individuals (through quarantine, isolation or exclusion) and decontaminating shared facilities (through cleaning, washing or chemical treatment of pens, cages, bedding and grooming equipment).

Trichodectes

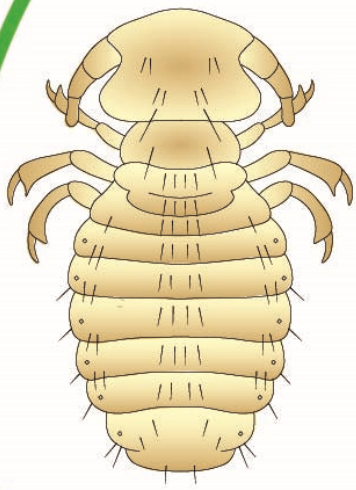


skin/pelage
(dermatitis, pruritus,
alopecia, excoriation)
(some vector infectious
microbial diseases)

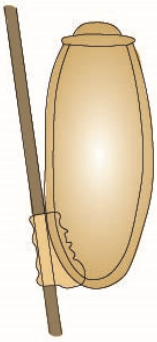


adult (ventral)
(~ 2 mm)

Definitive Hosts
(carnivores)



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

Trichodectes adult