Chirodiscoides
(arachnid: mite)

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. Arachnids have chelicerate mouthparts, two tagmata (cephalothorax and abdomen), four pairs of legs and slit sensilla, but no antennae or wings. All species exhibit incomplete metamorphosis whereby eggs hatch larvae which moult to nymphs and then adults. Acarines comprise the ticks and mites which have sac-like bodies with inconspicuous segmentation and their mouthparts are confined to an anterior gnathosoma. Four major groups are recognized primarily on the location of their respiratory stigmata: ixodid ticks (Metastigmata), gamesid mites (Mesostigmata), trombidiform mites (Prostigmata) and sarcoptiform mites (Astigmata). Ectoparasitic mites inhabit the skin of mammals and birds, feeding on fluids and/or tissues. Most spend their entire lives on individual hosts, so horizontal transmission between hosts is primarily by physical contact. Sarcoptiform mites lack stigmata but respire directly through the cuticle. They have unique legs which lack claws but have terminal sucker-like modifications. They are ectoparasitic on a range of birds and mammals and may cause severe dermatitis (known as mange). Listrophorids are fur mites found on small mammals and birds. Infestations by *Chirodiscoides caviae* may cause dermatitis in guinea pigs.

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:	Chelicerata (chelicerate mouthparts, two tagmata, no antennae)
Class:	Arachnida (spiders & allies, four pairs of legs, slit sensilla, incomplete metamorphosis)
Subclass:	Acari (Acarina) (ticks and mites, segmentation inconspicuous, sac-like body, mouthparts on gnathosoma)
Superorder:	Acariformes (diverse group of mites, without posterior stigmata)
Order:	Astigmata [Sarcoptiformes] (mange mites, without stigmata, legs separated, with suckers)
Superfamily:	Sarcoptoidea (mites associated with mammals, ecto- or endo-parasitic)
Family:	Listrophoridae (parasitic on fur-bearing mammals, distinct dorsal shield, legs modified for grasping hairs)
Genus:	*Chirodiscoides* (parasitic on skin of guinea pigs)
Species:	*C. caviae* causes dermatitis in guinea pigs

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. The chelicerates typically have appendages (chelicerae) in the form of pincers or fangs anterior to the mouthparts, 2 body parts (cephalothorax and abdomen), but no antennae or wings. Three classes are recognized: Arachnida (spiders and allies), Merostomata (horseshoe crabs) and Pycnogonida (sea spiders). Arachnids have 8 legs, slit sensilla and life-cycles involving incomplete metamorphosis whereby larvae and nymphs resemble adults. They are classified in 4 orders: Acari (acarines), Araneae (spiders), Opiliones (harvestmen) and Scorpiones (scorpions). The Acari comprises the ticks and mites which have saccular bodies and mouthparts confined to an anterior gnathosoma. Four major groups are recognized primarily on the location of their respiratory stigmata (called spiracles in insects): ixodid ticks (posterior Metastigmata), gamesid mites (middle Mesostigmata), trombidiform mites (anterior Prostigmata) and sarcoptiform mites (without stigmata = Astigmata).

Major parasitic families	Biodiversity	Hosts	Parasitic stages	Pathogenesis	Disease transmission
Superorder: Parasitiformes (ticks and some mites, with posterior stigmata)					
Order: Ixodida [Metastigmata] (ticks, macroscopic, stigmata posterior to legs) [3 families]					
Argasidae (soft ticks)	5 genera, 193 species	birds, mammals	larvae, nymphs, adults	blood-sucking	viral, bacterial
Ixodidae (hard ticks)	14 genera, 705 species	birds, mammals	larvae, nymphs, adults	blood-sucking, paralysis	viral, bacterial, protozoal
Order: Mesostigmata [Gamasida] (gamesid mites, stigmata between 2nd & 4th legs) [100 families, 662 genera, 5,360 species]					
Macronyssidae (sucking mites)	26 genera, 127 species	birds, reptiles, mammals	nymphs, adults	blood-sucking	bacterial
Dermanyssidae (sucking mites)	5 genera, 37 species	birds, mammals	nymphs, adults	blood-sucking	viral, bacterial
Halarachnidae (lung/ear mites)	7 genera, 10 species	mammals	nymphs, adults	mucosal erosion	-
Raillietiidae (ear mites)	1 genus, 7 species	mammals	nymphs, adults	ear wax	-
Rhinonyssidae (nasal mites)	30 genera, 160 species	birds	nymphs, adults	inflammation	-
Varroidae (bee mites)	1 genus, 5 species	bees	nymphs, adults	haemolymph-feeding	viral
Superorder: Acariformes (diverse group of mites, without posterior stigmata) [351 families, 32,000 species]					
Order: Prostigmata [Trombidiformes, Actinedida] (sucking mites, stigmata on gnathosoma) [121 families, 17,000 species]					
Demodecidae (follicle mites)	7 genera, 65 species	mammals	larvae, nymphs, adults	inflammation	-
Cheyletidae (fur mites)	80 genera, 500 species	mammals (dogs, cats, rabbits), birds	larvae, nymphs, adults	pruritus	-
Myobiidae (fur mites)	46 genera, 185 species	mammals (rodents, bats, marsupials)	larvae, nymphs, adults	mange	-
Psorergatidae (itch mites)	3 genera, 77 species	mammals (rodents, artiodactyls)	larvae, nymphs, adults	mange	-
Trombiculidae (chigger mites)	71 genera, 3,000 species	mammals, birds	larvae	skin-feeding	bacterial
Order: Astigmata [Sarcoptiformes, Acaridida] (fur/feather/itch/dust mites, lacking stigmata) [230 families, 15,000 species]					
Sarcoptidae (itch mites)	3 genera, 42 spp./ssp.	mammals	larvae, nymphs, adults	scabies, mange	-
Psoroptidae (scab mites)	20 genera, species	mammals (carnivores, ungulates)	larvae, nymphs, adults	mange	-
Listrophoridae (fur mites)	20 genera, 170 species	mammals (esp. rodents)	larvae, nymphs, adults	mange	-
Myocoptidae (fur mites)	10 genera, 70 species	mammals (esp. rodents)	larvae, nymphs, adults	myocoptic mange	-
Cytoditidae (airsac/nasal mites)	2 genera, 12 species	birds	larvae, nymphs, adults	respiratory signs	-
Knemidokoptidae (burrowing mites)	7 genera, 16 species	birds	larvae, nymphs, adults	scaly face, scaly leg	-
Laminosioptidae (quill/skin mites)	8 genera, 25 species	birds	larvae, nymphs, adults	flesh/skin lesions	-

The superorder Acariformes comprises acarines without posterior respiratory stigmata and includes two major orders of parasites: trombidiform mites (order Prostigmata) with stigmata on the gnathosoma (capitulum) or propodosoma; and sarcoptiform mites (order Astigmata) which lack stigmata and peritremes and respire through their cuticles. Over 16,000 species of astigmate mites have been described in 230 families: with around 12,000 species in 154 families being free-living or predatory in terrestrial or aquatic environments (including a large assemblage of soil-dwelling oribatid mites); and some 4,000 species in 76 families occurring as commensals or parasites of arthropods and vertebrates (notably birds and mammals). Parasitic species may be ectoparasitic (on external surfaces of the host) or endoparasitic (within host epidermal or respiratory tissues) and their development often only includes 2 nymphal stages (in contrast to 3 nymphal stages in free-living species, sometimes including a specialized heteromorphic deutonymph (hypopus) adapted for phoretic dispersal or tolerance of adverse conditions). Common names for many of the parasitic groups include mange, itch, or scab mites as they may cause serious inflammatory skin conditions in their hosts. Adult mites tend to be small, slow moving, whitish stages with soft cuticles and round-oval bodies (never vermiform) often with

long setae. They possess chelate or dentate chelicerae, unbarbed hypostomes, small inconspicuous palps, legs with coxae fused to the body wall and tarsal segments bearing complex pulvilli (pad-like or trumpet-like) and empodia (claw-like or sucker-like, but never bearing tenet hairs). Most parasitic species may complete their entire life-cycles on individual hosts, so horizontal transmission between hosts is primarily by physical contact. A total of 10 astigmate superfamilies have been recognized (Acaroidea, Analgoidea, Canestrinioidea, Freyanoidea, Glycyphagoidea, Hemisarcoptoidea, Histiostomatoidea, Hypoderatoidea, Pterolichoidea, Sarcoptoidea) and an additional 2 families are currently unplaced (Cytoditidae, Heteropsoridae).

Early classification schemes identified different assemblages principally on the basis of host and site specificity; including bird-associated feather mites (e.g. Analgoidea); bird-associated skin mites (e.g. Knemidokoptidae), mammal-associated fur mites (e.g. Listrophoridae), mammal-associated skin mites (e.g. Psoroptidae); and mammal-associated skin-burrowing mites (e.g. Sarcoptoidea). However, phylogenetic studies (both cladistic and molecular) have revealed that many groups are not monophyletic but para- or poly-phyletic, so further studies are required to resolve the fidelity of most groups. Recently, molecular studies suggested that 16 sarcoptoidean families may belong to 2 main lineages: 13 families identified in a 'sarcoptid' complex (Atopomelidae, Audycoptidae, Chirodiscidae, Chirorhynchobiidae, Galagalgidae, Gastronyssidae, Lemurnyssidae, Listrophoridae, Listropsoralgidae, Myocoptidae, Pneumocoptidae, Rhyncoptidae, Sarcoptidae), and 3 families in a 'psoroptid' complex (Lobalgidae, Paracoroptidae, Psoroptidae). Nevertheless, most families can still be categorized into 4 broad 'morphoecotypes': namely; fur mites (Atopomelidae, Chirodiscidae, Listrophoridae, Lobalgidae), skin mites (Chirorhynchobiidae, Myocoptidae, Psoroptidae), skin-burrowing and follicle mites (Rhyncoptidae, Sarcoptidae), and respiratory mites (Gastronyssidae, Lemurnyssidae, Pneumocoptidae). The family Listrophoridae comprises small elongate mites with palps and legs modified for grasping hairs in a wide variety of fur-bearing mammalian hosts. Some 26 genera have been recognized: namely, *Aeromychirus*, *Afrolistrophorus*, *Asiochirus*, *Carnilistrophorus*, *Centetesia*, *Chirodiscoides, Cryptocoptes*, *Echinosorella*, *Eurychiroides*, *Geomylichus*, *Hemigalichus*, *Indochirus*, *Lemuroecius*, *Lemuroptes*, *Leporacarus*, *Listrophorus*, *Lynxacarus*, *Metalistrophorus*, *Olistrophorus*, *Prolistrophorus*, *Pteromychirus*, *Quasilistrophorus*, *Schizocarpus*, *Sclerolistrophorus*, *Spalacarus*, and *Tenrecobia*. The genus *Chirodiscoides* (syn. *Campylochirus*) contains long narrow mites with triangular 'heads' (gnathosoma) and dorsoventrally flattened 'bodies' (idiosoma). They have 4 pairs of legs (2 pairs directed anteriorly, 2 pairs posteriorly), all legs bearing bell-like pulvilli on very short stalks. A total of 12 species have been described from a small range of rodents and marsupials from South America, although the species *C. caviae* is common on guinea pigs around the world, sometimes causing pruritic dermatitis and alopecia.

***Chirodiscoides* species**	**Hosts**	**Location**	**Clinical signs**	**Distribution**
C. ascuamatus (= *asquamatus*?)	Didelphimorphia: didelphid (Linnaeus's mouse opossum)			South America
C. bolivianus	Rodentia: echimyid (Tome's spiny rat)			South America
C. caviae (syn. *Campylochirus caviae, Indochirus utkalensis*) (guinea pig fur mite)	Rodentia: caviid (guinea pig, Brazilian guinea pig, southern mountain cavy, common yellow-toothed cavy)	skin	irritation, dermatitis, pruritus, scales, crusts, alopecia	worldwide, esp. Asia, Europe
C. cercomys	Rodentia: echimyid (common punare)			South America
C. didelphicola	Didelphimorphia: didelphid (white-eared opossum); Rodentia: echimyid (Atlantic bamboo rat)			South America
C. echimys	Rodentia: echimyid (giant Atlantic tree rat)			South America
C. euryzygomatomys	Rodentia: echimyid (Fischer's guiara)			South America
C. galeae	Rodentia: caviid (Spix's yellow-toothed cavy)			South America
C. inglesae	Carnivora: canid (pampas fox); Rodentia: echimyid (Guyenne spiny rat)			South America
C. interruptus	Rodentia: echimyid (Guyenne spiny rat); Didelphimorphia: didelphid (bare-tailed woolly opossum)			South America
C. longipilis	Rodentia: echimyid (Atlantic bamboo rat)			South America
C. proechimys	Rodentia: echimyid (Guyenne spiny rat, short-tailed spiny rat, Cuvier's spiny rat, Napo spiny rat)			South America

Parasite morphology: *Chirodiscoides* spp. form 4 different morphological types of developmental stages: eggs; larvae; nymphs (2 instars); and adult mites (males and females). The eggs are thin-shelled prolate-ellipsoidal stages measuring 250-262 x 60-81 μm that are glued at one pole to host hair shafts by mucilaginous material such that egg is directed towards the hair tip. Larvae are oval stages that are ventrally flattened but dorsally arched, ranging in size from 214-343 x 81-114 μm. They have small triangular heads and rounded posterior ends with distinct tail processes. The body has a small lightly-reticulated pro-dorsal plate, a ventral sternal plate with unique strong tangential striations arranged in 4 quartile fields, and the rest of the integument bears small denticles. Larvae have 3 pairs of ventral legs, 2 anterior pairs of small legs projecting forwards and a third pair of longer legs arising from the midbody and projecting backwards. Two nymphal stages have been described: protonymphs measuring 288-455 x 119-171 μm; and deutonymphs (sometimes called tritonymphs) measuring 371-498 x 136-176 μm. All nymphs have rounded pro-dorsal plates while the rest of the dorsum is ornamented with large denticles anteriorly grading into smaller ones posteriorly, but with the midline having a ridge of paired intersecting denticles. They all have ventral sternal plates with the characteristic tangential striations, but none have genital openings. Nymphs have 4 pairs of legs, having developed another pair of long well-developed hindlimbs. Female nymphs have pocket-like structures in the posterior coxal epimera of the second pair of legs, and male nymphs have wrinkled tail-like processes. Adult mites have long narrow dorso-ventrally flattened bodies ranging in length from 340-530 μm. They have 2 main tagma: a small anterior gnathosoma (head) and a large posterior idiosoma (body). The gnathosoma is well developed and distinctly triangular, with a dorsal gnathosomal plate. The anterior mouthparts are modified for grasping hairs and consist of a pair of 3-segmented chelicerae terminating in claw-like chelae, and a flanking pair of 2-segmented palps without terminal claws (apoteles) but with short anterior solenidia (sensory hairs) and cup-like membranous flaps. The alimentary tract consists of a ventral mouth (with an unbarbed hypostome), a short tubular foregut (oesophagus, pharynx), saccular midgut (ventriculus with caeca), and short tubular hindgut (with excretory Malpighian tubules) opening to a posterior anus. The cuticular covering of the idiosoma has numerous striations running transversely or tangentially across the body. Adult mites have 3 dorsal plates (quadrate pro-dorsal, trapezoidal mid-dorsal and elongate post-dorsal) which are sclerotized and ornamented with polygonal reticulum. The post-dorsal plate covers the entire hysterosoma in males but only the anterior half in females. Ventrally, adults have retained the unique propodosomal sternal shield which has strong tangential striations located in 4 quartile fields. Like other Astigmata, respiratory stigmata are absent, but tracheal tubes have sometimes been observed under the cuticle. The ventral idiosoma is the point of attachment for 4 pairs of long slender legs modified for grasping hairs; 2 small stout pairs directed anteriorly, and 2 longer slender pairs directed posteriorly. The legs consist of 6 segments (coxa, trochanter, femur, genu, tibia, and tarsus) except for the third pair of legs in males and the fourth pair in females which have 5 segments (fused tibio-tarsi). The coxae are fused to the body wall with the first 2 pairs of legs having anterior coxal ridges used for grasping hairs. The tibia and tarsi have modified club-like structures also used for grasping hairs. All tarsi have setae and an apical ambulacrum (sucker-like caruncle) with a short pretarsal stalk supporting a bell-like pulvillus. Adult mites display considerable sexual dimorphism, with males being smaller than females (340-400 x 130-148 μm cf. 480-529 x 140-174 μm). The posterior margin of male mites has pairs of small and large adanal suckers with caudal setae, as well as a distinctive semicircular flap supported by bifid sclerites (inferior ventral and superior sub-dorsal rods). Males have 2 testes with tubular vas deferens leading to the ejaculatory duct and long sheathed aedeagus (penis) opening through a genital pore located between the coxae of the hindlegs. Males also have a conspicuous transverse arch joining the coxae of the last pair of legs, which are notably longer and hook-shaped. Most adult males are found attached to the backs of female nymphs, with their posterior legs hooked into the pocket-like structures on the second epimera on the sternum of the females. These joined pairs are not in copula, but the males are simply carried around and are readily available for mating with newly emergent females. Adult female mites have rounded posterior ends with a terminal anus surrounded by para-anal plates. Females have 2 ovaries with tubular oviducts leading to a globular uterus (with shell gland) and vagina (with accessory organs (bursa copulatrix, spermathecae) for sperm reception and storage). The genital opening is slit-like or V-shaped and located on the ventral midbody between the coxae of the third pair of legs.

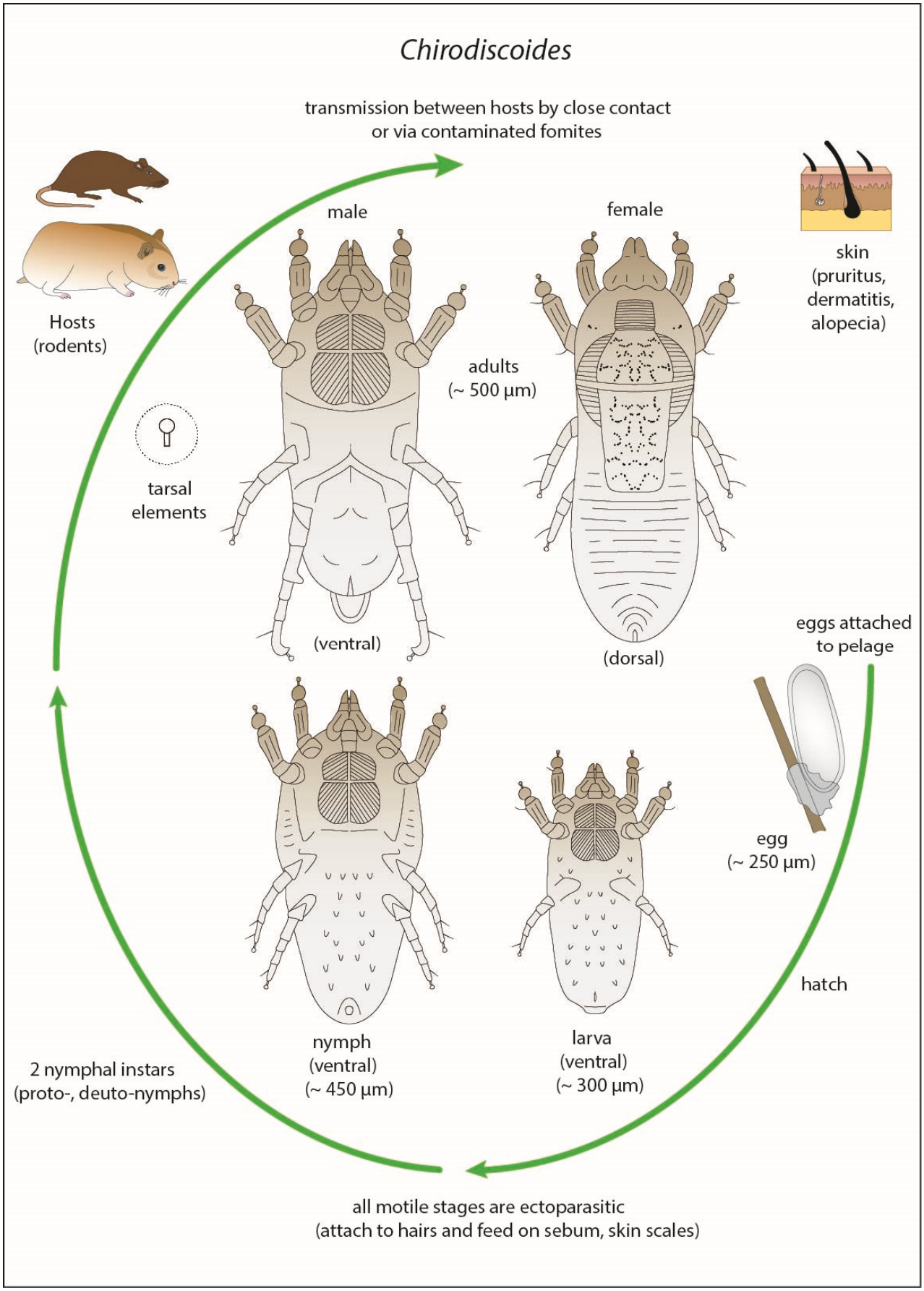
Site of infection: These mites are non-burrowing surface dwellers that live on hairs rather than the skin of a variety of fur-bearing mammals. A total of 12 species have been described from several rodents (caviids, echimyids), marsupials (didelphids) and one carnivore (pampas fox) from South America, while the species *C. caviae* is common on guinea pigs around the world.

Pathogenesis: Most infestations remain asymptomatic or subclinical, even when mites are present in large numbers. However, heavy infestations have occasionally been associated with mild disease (pruritic dermatitis and patchy alopecia) in some individuals, possibly aggravated by allergic/hypersensitivity reactions to mite antigens (saliva/faeces). All motile mite stages are thought to feed on hair scales, cellular debris and possibly tissue fluid at the bases of hair shafts. Infestations may cause pruritus, rough coat and alopecia, while the underlying skin may be unaffected or show mild inflammation with erythema and some scaling, but rarely overt lesions with crusting and scabbing. Animals may experience some irritation and resort to grooming behaviours (biting, scratching, rubbing) exacerbating hair loss (fragmented alopecia), particularly along the posterior trunk, flanks and around the perineum. Infestations appear to be heavier on sick and debilitated animals unable to groom properly. Small scale outbreaks have been reported in guinea pigs and rats raised in laboratory animal colonies, pet stores and private households.

Developmental cycle and mode of transmission: *Chirodiscoides* spp. exhibit gradual/incomplete (hemimetabolous) metamorphosis whereby eggs hatch larvae that moult through nymphs to form adults. The entire development cycle may take place on the same individual host, and transmission generally occurs through direct host-to-host contact or via contaminated fomites. Few details are known about the duration of the different developmental stages, nor the fecundity and longevity of adult mites. Gravid females glue eggs individually to hair shafts where they hatch in several days releasing hexapod larvae. The larvae attach to hairs using their modified mouthparts and forelimbs and move along and between hairs using their remaining pairs of legs. They moult after several days to form octopod nymphs, the first-stage nymphs (protonymphs) subsequently moulting to second-stage nymphs (deutonymphs, sometimes called tritonymphs) after several days. In turn, the nymphs moult to form adult male and female mites. Adult male mites are most frequently found paired with female nymphs, riding on their backs using their hooked hindlimbs. The paired mites are not copulating as the nymphs lack genital orifices. It seems that the males are being carried about while waiting for the female nymphs to moult to adults so that copulation may occur. Following mating, fertilized females then begin producing eggs one at a time and ovipositing them on hair shafts. The whole life cycle may be completed in as little as 14 days. Studies on laboratory animal colonies have shown that transmission may occur by direct physical contact between animals (especially in crowded cages, in animals huddling together for security and/or warmth, from mothers nursing their young, and even by contact with infested carcases) as well as by contact with cage materials (especially litter and bedding) contaminated with mites displaced from hosts (off-host survival times are not known).

Differential diagnosis: Most infestations are subclinical and go unnoticed until mites are observed moving in the fur. Careful visual examination may reveal the presence of paired mites (adult males carried on female nymphs) and some animal handlers report that they can feel bumpy coats when stroking the fur due to the presence of mites and eggs attached to hairs. Many infestations are first detected post-mortem when mites are observed leaving the cooling carcase. When clinical signs are apparent (pruritus, inflammation, alopecia), other aetiological agents need to be discounted, including other ectoparasites (mites, lice and fleas) and other dermatological conditions (infections and allergies). Definitive diagnosis is made by the direct detection and microscopic identification of mites in samples collected by vacuum aspiration, hair plucks (trichograms), sticky tape impressions, brushing or combing fur, and sometimes simply by massage animals over paper and examining what drops off. The examination of skin scrapings is not appropriate for these surface-dwelling fur mites which do not borrow or live on the skin.

Treatment and control: Infestations in laboratory animals have been successfully managed by treatment with chemical acaricides, either as topical (dusts, sprays, baths) or systemic (oral, injectable, spot-on) applications, including carbamates (carbaryl), organophosphates (malathion), pyrethroids (pyrethrin), neonicotinoids (imidacloprid) and macrocyclic lactones (ivermectin, selamectin, moxidectin). Many chemicals are not strongly ovicidal so repeated or protracted treatments are required to combat newly emergent stages. Animals may also benefit by pre-treatment bathing in medicated shampoos to remove cutaneous debris, or by trimming or shaving infested areas. A variety of preventive measures have been adopted to curtail transmission cycles, including health surveillance (regular monitoring and treatment with isolation or quarantine), improved sanitation (cleaning cages and other animal holding facilities, periodically replacing litter and bedding), environmental decontamination (using insecticidal/acaricidal dusts or sprays with long-lasting residual activity) and maintaining biosecurity (not breeching physical or procedural barriers in animal colonies, avoiding cross-cohort contamination, and excluding wildlife and vermin).


Chirodiscoides
transmission between hosts by close contact
or via contaminated fomites
Hosts
(rodents)
male
female
skin
(pruritus,
dermatitis,
alopecia)
adults
(~ 500 µm)
tarsal
elements
(ventral)
(dorsal)
eggs attached
to pelage
egg
(~ 250 µm)
hatch
nymph
(ventral)
(~ 450 µm)
larva
(ventral)
(~ 300 µm)
2 nymphal instars
(proto-, deuto-nymphs)
all motile stages are ectoparasitic
(attach to hairs and feed on sebum, skin scales)

Chirodiscoides adult

Chirodiscoides eggs