

Cheyletiella

(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. Trombidiform mites have stigmata on the gnathosoma and distinct setae on their bodies and legs. Many species are free-living, some have been associated with allergy (including asthma), and several are obligate ectoparasites on mammals or birds. Cheyletiellids include predatory and parasitic mites whose bodies have a waist, enlarged palps and legs terminating in combs. Infestations by *Cheyletiella* spp. may cause scaly dermatitis on dogs, cats and rabbits.

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: Prostigmata [Trombidiformes] (sucking mites, stigmata on gnathosoma)
Suborder: Eleutherengona (thumb-claw process, tube-like midgut, females with adjacent anal-genital openings)
Superfamily: Cheyletoidea (chelicerate with basal stylophore and stylet-shaped movable segments)
Family: Cheyletiellidae (predatory and parasitic mites, body with waist, palps enlarged, legs terminate in combs)
Genus: *Cheyletiella* (parasitic on skin of dogs/cats/rabbits)
Species: various species cause scaly dermatitis on dogs, cats, rabbits

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 (chelicerate) 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 sac-like 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 2 nd & 4 th 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 prostigmatid mites have been described: many species being free-living (including most trombiculids although some have parasitic larvae); and others being obligate ectoparasites on mammals or birds. Parasitic species spend their entire lives on individual hosts, so horizontal transmission between hosts is primarily by physical contact. Prostigmatid mites are characterized by having oval-ellipsoidal bodies (sometimes vermiform) with distinctive setation, piercing chelicerae (sometimes pincer-like), unbarbed hypostomes, well-developed palps, and short legs with coxae fused to the body wall and terminal tarsi with 1-2 claws (but lacking complex pulvilli). A total of 34 superfamilies have been recognized in 4 suborders: Anystina (with 17 superfamilies); Eleutherengona (10); Endeostigmata (3); and Eupodina (4). Many members of the suborders Anystina and Eleutherengona have legs with distinctive arrangements of the terminal

tibiotarsal segments referred to as the 'thumb-claw' process. Eleutherengone mites have simple tube-like postventricular midguts, small salivary glands (if present), females with anal and genital openings located close together posteriorly, and males with few glandular components of their testicular epithelia and accessory glands. Ten superfamilies are recognized (Cheyletoidea, Eriophyoidea, Pomerantzioidea, Pterygosomatoidea, Pyemotoidea, Pygmephorosidea, Raphignathoidea, Tarsocheyloidea, Tarsonemoidea, Tetranychosidea)

The superfamily Cheyletoidea comprises free-living predators, nidicolous forms and highly specialized ecto- or endoparasites. Adult mites have chelicerae with basal segments fused into a single unit (stylophore), movable segments that are stylet-shaped, and the female anal and genital openings are located ventrally. A total of 8 families are recognized (Cheyletidae, Cloacaridae, Demodicidae, Harpyrhynchidae, Myobiidae, Ophioptidae, Psorergatidae, Syringophilidae). The family Cheyletidae contains many free-living predatory mites (sometimes feeding on other mites) but also some ectoparasitic mites living in the fur of mammals. Adult mites have oval bodies with a middle waist-like constriction, one or more dorsal shields, enlarged palps with large terminal claws (often toothed), a strong peritreme which frames the gnathostoma, and legs terminating in narrow pad-like empodia with comb-like pulvilli. Three subfamilies have been recognized (Cheyletinae, Metacheyletinae, Niheliinae) and 10 tribes have been described for the subfamily Cheyletinae (Acaropsellini, Bakini, Cheletogenini, Cheletomorphini, Cheletosomatini, Chelonotini, Cheyletiellini, Cheyletiini, Cheyletini, and Criokerontini). The tribe Cheyletiellini contains 2 genera (*Cheyletiella*, *Eucheyletiella*) comprising mites with anterior stigmata opening at the cheliceral bases with a conspicuous M-shaped peritreme framing the gnathostoma, chelicerae fused with the rostrum to form a cone, opposable palps with a thumb-claw complex, most legs with claws, and short oval bodies with some elongate and some feathery setae. Some 18 species have been described in the genus *Cheyletiella*, most as ectoparasites on lagomorphs and carnivores, but sometimes on primates (including humans) and birds. Several species have been associated with inflammatory skin conditions in domestic pets and laboratory animals, including exfoliative dermatitis evident as dry scaly skin producing white flakes (infestations known as 'walking dandruff').

<i>Cheyletiella</i> species	Hosts	Location	Clinical signs	Distribution
<i>C. blakei</i> (cat fur mite)	Carnivora: felid (cat); Primates: hominid (human)	skin (face, occasionally over body)	irritation, pruritus, dermatitis, scaling	worldwide
<i>C. canadensis</i>	Piciformes: picid (European green woodpecker)			North America
<i>C. chanayi</i>	Passeriformes: motacillid (white wagtail)			Europe
<i>C. curvidens</i>	Carnivora: herpestid (slender mongoose)			Africa
<i>C. dengi</i>	Lagomorpha: leporid (European rabbit)			China
<i>C. furmani</i>	Lagomorpha: leporid (marsh rabbit)			North America
<i>C. johnstoni</i>	Lagomorpha: ochotonid (American pika)			North America
<i>C. katangae</i>	Lagomorpha: leporid (African savannah hare)			Africa
<i>C. lemuricola</i>	Primates: galagid (brown greater galago)			Africa
<i>C. mexicana</i>	Lagomorpha: leporid (volcano rabbit)			North America
<i>C. microrhyncha</i>	Passeriformes: hirundinid (barn swallow)			Europe
<i>C. ochotonae</i>	Lagomorpha: ochotonid (large-eared pika)			Asia
<i>C. parasitivorax</i> (rabbit fur mite)	Lagomorpha: leporid (European rabbit, marsh rabbit, volcano rabbit, eastern cottontail, Jameson's red rock hare, snowshoe hare); Carnivora: felid (cat); Primates: hominid (human)	skin (back, occasionally over body)	irritation, dermatitis, scaling (plus vector for myxomatosis virus)	worldwide
<i>C. pinguis</i>	Passeriformes: turdid (common blackbird)			Europe
<i>C. romerolagi</i>	Lagomorpha: leporid (volcano rabbit)			North America
<i>C. strandtmanni</i>	Lagomorpha: leporid (rabbit)			Asia
<i>C. takahashii</i>	Lagomorpha: ochotonid (northern pika)			Japan
<i>C. yasguri</i>	Carnivora: canid (dog); Primates: hominid (human)	skin (back, head, occasionally over body)	irritation, dermatitis, scaling	worldwide

Parasite morphology: *Cheyletiella* spp. form 4 different types of morphological developmental stages: namely, eggs, larvae (within eggs), nymphs (2 instars), and adults. The eggs are elongate ellipsoidal stages ranging in size from 190-260 x 115-135 μm . They are non-operculate and cream-tan in colour. They are glued along their long axes to hair shafts 2-3 mm above the skin and are held in place by a tangled web of threads. Within the eggs, prelarvae appear as legless sacs which then develop into hexapod (6-legged) larvae. Many studies have reported that the hexapod larvae hatch from eggs and then rapidly moult to octopod nymphs, but a few studies have reported that fully-developed octopod nymphs emerge from eggs. Observations on free hexapod larva show semitransparent ovate stages 200-300 μm long with a small midbody waist-like constriction, 2 prominent caudal setae and conspicuous anterior palps with recurved claws. Nymphs are more robust and larger with a triangular anterior gnathosoma (head or capitulum) and a posterior ovate-rounded idiosoma (body) measuring 250-400 μm in length. Two nymphal instars occur (protonymphs and deutonymphs), both having 4 pairs of anteroventral legs, with the first 2 pairs often projecting anteriorly and the last 2 pairs extending backwards. Adult mites have slightly elongated ovoid bodies measuring from 400-500 μm long with a middle waist-like constriction. The integument is white-yellow and has light striations around the margins and near the waist. They have a distinct anterior gnathosoma bearing stout mouthparts (chelicerae) flanked by robust palps. The palps have 4 segments whereas other mites have 2-3 (prostigmatids and astigmatids) or 5-6 (mesostigmatids). The palps are unique in that they have large terminal recurved claws (often toothed) used to grasp fur or feathers when feeding. The palpal femur also bears long serrated dorsal setae. The paired chelicerae are adapted for piercing and have distal stylet-shaped segments that are movable, while the basal segments are fused with the rostrum to form a cone over the mouth. The alimentary tract comprises a tubular foregut (oesophagus, pharynx), saccular midgut (ventriculus with diverticulae), tubular hindgut (with excretory Malpighian tubules) and a subterminal ventral anus. The idiosoma has a sclerotized dorsal shield located anteriorly in front of the waist-like constriction. The body surface bears several large setae, sometimes plumose (with a finely-feathered appearance) and with a pair of long plain setae projecting posteriorly. Four pairs of well-developed legs arise ventrally, each leg comprising 6 segments (coxa, trochanter, femur, genu, tibia and tarsus) and terminating in narrow pad-like empodia with comb-like pulvilli (not claws or suckers). The coxae are fused to the body wall and are extended in at least the first 2 pairs of legs into sclerotized epimerites. The legs bear short branched setae, and the genu of the forelegs have special sensory projections (called solenidia) that vary in shape depending on species (globose in *C. parasitovorax*, conical in *C. blakei*, heart-shaped in *C. yasguri*). Adults have lateral respiratory openings (stigmata) located anteriorly near the cheliceral bases and they have strong M-shaped peritremes framing the gnathosoma. Male and female mites exhibit moderate external sexual dimorphism, with females being slightly larger in body size and having larger genital openings. Males have paired testes linked by tubular vas deferens to an ejaculatory duct and long sheathed aedeagus (straight or curved penis) that extends from between the hindlegs to the posterior of the body. Female mites have paired ovaries (with ovarioles) joined by tubular oviducts to a globular uterus (with accessory glands) and vagina (with accessory organs for sperm reception and storage). The genital opening (gonopore) appears as a short longitudinal cleft supported by lateral plates on the ventrum of the posterior body.

Site of infection: *Cheyletiella* spp. are non-burrowing mites that attach to the hair or feathers of their hosts. Infestations by 14 mite species have been recorded on mammals belonging to 7 families in 3 orders (including small carnivores, lagomorphs and primates). Mites are found most often on the back, shoulders and neck, but may extend over the whole body in heavy infestations. They vary in their host specificity, with many being specific for individual hosts (particularly lagomorphs) while a few have broader specificities and may infest several mammalian hosts, including humans. Another 4 species have been found exclusively on birds belonging to 3 passerine families and one non-passerine family (woodpeckers).

Pathogenesis: Light infestations may remain asymptomatic, but heavier infestations can cause mild-severe disease (cheyletiellosis) manifest as exfoliative (scaling) dermatitis with variable pruritus, sometimes exacerbated by host hypersensitivity responses. Mites live on the surface of the skin in close association with the keratin layer where they use their palpal claws to grasp hairs/feathers and their stylet-like mouthparts to secrete digestive enzymes and feed on liquefied skin cells, extracellular fluid and lymph. The most common clinical signs observed in non-hypersensitive animals are irritation, hyperkeratosis, and exfoliative (dry scaly) dermatitis producing white flakes (dandruff) resulting in eczema-like skin lesions (more common in dogs and rabbits than cats). Mites may be observed as 'walking dandruff' moving among the scurf, particularly along the dorsal midline. Animals may develop oily coats, erythema, excoriated lesions and alopecia, but pruritus is usually minimal. In animals that develop hypersensitivity, there may be extreme irritation and discomfort with severe pruritus and self-inflicted lesions due to scratching resulting in alopecia (loose hair can sometimes be pulled out in clumps) and scab formation (sometimes evident as miliary dermatitis with small crusted lesions). Heavy infestations may cause papules (which become pustules), but macules, plaques, vesicles or crusts may also occur. Several *Cheyletiella* spp. have zoonotic potential as mites can bite humans but do not complete their development. Infestations often cause pruritic red papules, particularly on the arms and trunk of people handling animals, and often before any clinical signs are observed in the animals. The papules may become vesicular, then pustular, and burst to produce yellow crusts, sometimes accompanied by peripheral eosinophilia, and immune complex formation with joint pain. Cheyletiellosis occurs more frequently in young individuals (puppies, kittens and kits) kept in poor husbandry conditions or crowded situations (such as breeding facilities or pet shops). The species *C. parasitovorax* has also been shown to act as a vector for the transmission of the myxoma virus causing myxomatosis in rabbits.

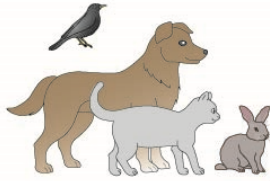
Developmental cycle and mode of transmission: Like all mites, *Cheyletiella* spp. exhibit incomplete (hemimetabolous) metamorphosis in that eggs produce larvae that moult to nymphs and then adult mites. All developmental stages in the life-cycle may occur on the same host, but mites can survive off hosts for longer periods than most other mange mites. Gravid females attach eggs to host hairs using glue-like secretions and webs of threads. The eggs embryonate over 2-7 days and then hatch releasing hexapod (6-legged) larvae which rapidly moult to the first octopod (8-legged) nymphal instar (protonymphs), although there have been a few reports that the eggs of some mite species hatch to release octopod nymphs. All reports indicate that 2 nymphal stages occur, wherein the protonymph feed for several days before moulting to the second nymphal instar (deutonymphs). The deutonymphs feed for several days before moulting to adult mites. Adults are highly motile and able to move rapidly through the pelage where they feed, mature and mate. Fertilized females oviposit eggs attaching them to host hairs/feathers, sometimes several close together. Little is known about mite fecundity and longevity, but the entire life-cycle may be completed in 2-5 weeks. Transmission is often by direct physical contact when mites crawl from host-to-host, especially when they are crowded together when nursing, huddling, sleeping, etc. Female mites have been shown to survive for up to 10 days off hosts, while other stages do not survive for longer than 2 days. Some transmission may therefore occur by contamination of fomites when mites are spread on objects such as bedding, pens, leashes, collars, and grooming equipment. People regularly handling or sleeping with animals may be bitten by mites as accidental hosts, but there is no evidence that mites can be transmitted from person-to-person. Curiously, there are a growing number of reports of *Cheyletiella* mites being found attached to fleas, flies and lice, and it has been posited that these larger arthropods may assist in transmission by phoretic transfer (phoresis).

Differential diagnosis: While clinical signs may be suggestive of cheyletiellosis, other conditions may cause similar exfoliative dermatitis, such as other mites, fleas, diabetes mellitus, liver disease, seborrhoea, poor nutrition and even ineffective grooming due to dental disease, obesity or spinal disorders. Hypersensitivity responses may also be caused by food allergies, atopic dermatitis, flea bites and other mites. In the presence of excess scaling, the skin should be examined for mites and various samples collected for microscopic examination. Mites may be detected by visual examination of affected patches of skin as motile stages (walking dandruff) in the scurf, especially if a magnifying glass is used. Specimens may be collected by combing, brushing or even vacuuming the pelage, plucking hairs (trichograms) or taking sticky tape impressions from the skin. Animals may also be massaged or handled over paper or plastic drop sheets and collecting any debris. Mites are quite motile so any samples collected should be wetted (in water, saline, alcohol, or mineral oil) to prevent them from escaping. Alternatively, samples may be subject to caustic (potassium hydroxide) digestion as one would process skin scrapings (but actual skin scrapings are not highly effective in this instance as the mites are non-burrowing surface dwellers). Coprological examination of faecal samples by floatation techniques may also reveal mites or eggs swallowed during grooming.

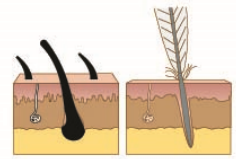
Treatment and control: Clinical infestations may be difficult to treat due to the large numbers of mites present and the high probability of re-infestation from the environment. Animals are usually treated with topical or systemic acaricides, including lime-sulphur, organophosphates (dichlorvos, phosmet, chlorpyrifos, malathion, diazinon), carbamates (carbaryl), pyrethrin and synthetic pyrethroids (permethrin), amidines (amitraz), arylpyrazoles (fipronil) and macrocyclic lactones (ivermectin, selamectin). In severe cases involving crusted lesions, shampoos and/or conditioners may be used to remove crusts and debris before topical treatment. All in-contact animals should be treated at the same time, and repeated or prolonged treatments may be required (even after the resolution of clinical signs). Lesions on humans generally disappear after the elimination of infestations on pets. Various preventive measures may be adopted to break transmission cycles, including regular health surveillance (predicating treatment, isolation/quarantine or culling), improved sanitation and hygiene (cleaning animal holding facilities and bedding, especially in breeding quarters) and possibly using residual acaricides (e.g. pyrethroids) to help decontaminate porous and nonporous fomites (e.g. runs or hides with timber or paved areas, pebbles, mulch and other organic litter).

Cheyletiella

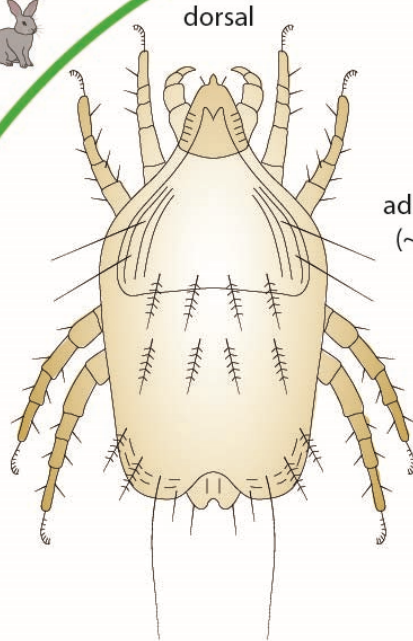
transmission between hosts by close contact
or via contaminated fomites
(occasional phoretic transport by other ectoparasites)



Hosts
(mammals,
birds)

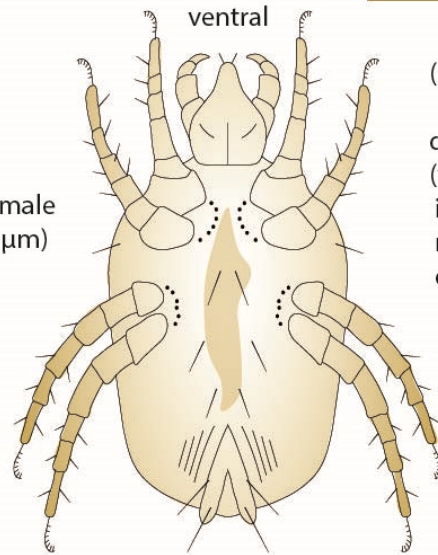


skin
(exfoliative
'scaly'
dermatitis)
(vector for
infectious
microbial
diseases)



dorsal

adult female
(~ 500 μ m)

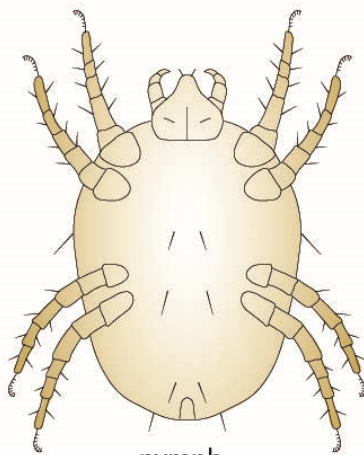


ventral

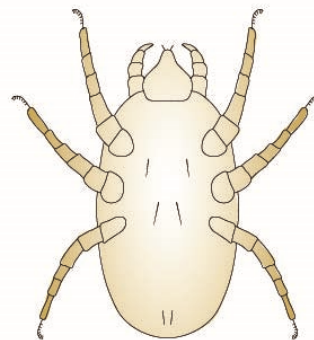


tarsal
elements

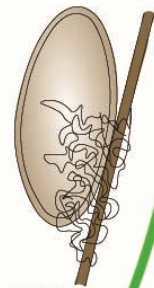
eggs attached to
pelage/plumage



nymph
(ventral)
(~ 400 μ m)



larva
(ventral)
(~ 300 μ m)



egg
(~ 200 μ m)

hatch

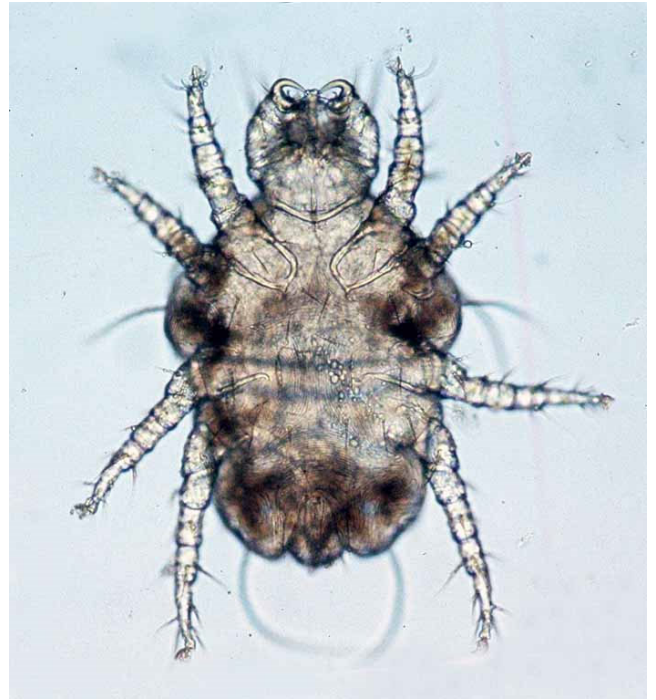
larvae
moult
rapidly

2 nymphal instars
(proto- & deuto-nymphs)

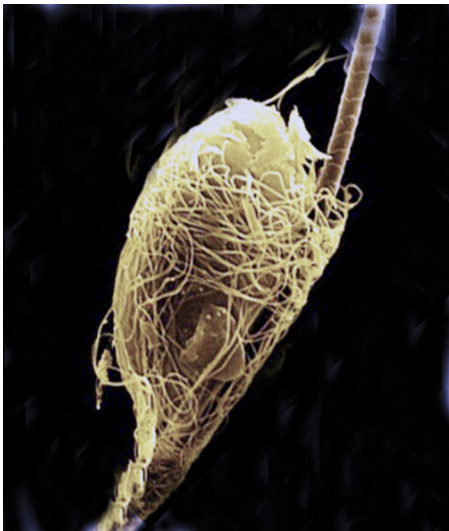
all motile stages are ectoparasitic
(feed on host fluids/cells)



Cheyletiella adult



Cheyletiella adult



Cheyletiella egg