***Pneumonyssus* (incl. *Pneumonyssoides*)**
(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. Gamesid mites have anterior legs with respiratory stigmata located between the second and fourth legs. Most species are predatory, but some are ectoparasitic on mammals, birds and insects. They usually have a large sclerotized dorsal shield and a series of smaller ventral shields. Halarachnid mites are obligate parasites in the respiratory tracts or ears of mammals. Infestations by *Pneumonyssus* (syn. *Pneumonyssoides*) spp. occur in the nasal passages of dogs and the lungs of primates, sometimes causing congestive inflammation.

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:	Parasitiformes (ticks and some mites, with posterior stigmata)
Order:	Mesostigmata (gamesid mites, legs grouped anteriorly, stigmata between second and fourth legs)
Suborder:	Dermanyssina (sclerotized shields, reduced setae, legs with claws)
Superfamily:	Dermanyssoidea (elongate edentate chelicerae, diverse life-styles)
Family:	Halarachnidae (obligate parasites in respiratory tracts or ears of mammals)
Genus:	*Pneumonyssus* (syn. *Pneumonyssoides*) (parasitic in lungs of monkeys and nasal passages of dogs)
Species:	various species cause rhinitis, sinusitis and pulmonary conditions

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 Parasitiformes comprises acarines with posterior respiratory stigmata and includes two major orders: the ixodid ticks (order Metastigmata) with stigmata located posterior to the legs; and the gamesid mites (order Mesostigmata) where they are located between the legs, sometimes associated with sinuous processes (peritremes). Mesostigmatid mites are further characterized by possessing unbarbed hypostomes, and long legs with free coxae (not fused to the body wall). The order Mesostigmata contains thousands of mites, with over 5,000 species recognized in 660 genera and 100 families. Nine suborders are recognized (Antennophoria, Arctacarina, Cercomegistina, Dermanyssina, Epicriina, Microgyniina, Parasitina, Sejina, and Uropodina). The suborder Dermanyssina contains robust mites with distinct sclerotized dorsal and ventral shields, reduced setae, palps with 2-tined apoteles, and legs with tarsal claws. Five superfamilies are recognized (Ascoidea, Dermanyssoidea, Eviphidoidea, Rhodacaroidea, and Veigaioidea). The superfamily Dermanyssoidea contains a diverse array of mites including free-living predators, nidicoles in the nests of vertebrates and insects, obligate and facultative ectoparasites of vertebrates and arthropods, and even respiratory and auditory endoparasites of mammals, birds, and some reptiles. The mites have elongated chelicerae (long first or second segment) with small edentate digits and concave interior margins (functioning as a tube when in opposition). A total of 11

families are recognized (Dermanyssidae, Haemogamasidae, Halarachnidae, Hirstionyssidae, Ixodorhynchidae, Laelapidae, Macronyssidae, Raillietiidae, Rhinonyssidae, Spinturnicidae, and Varroidae), many of them exclusively parasitic.

The family Halarachnidae contains mites that are obligate parasites in the respiratory tracts of mammalian hosts. Adult mites have bodies have small sclerotized plates (shields), stigmata with small peritremes located between their legs, chelicerae with movable digits, palps with 4-5 segments and terminal bifurcate or simple tines, and legs with protarsi, caruncles and claws. A total of 7 genera are recognized (*Halarachne*, *Orthohalarachne*, *Pneumonyssoides*, *Pneumonyssus*, *Rhinophaga*, *Sciurinyssus*, *Zumptiella*) in marine mammals, porcupines, squirrels, canids, and nonhuman primates. The genus *Pneumonyssus* is characterized by robust mites lacking genital plates that occur in the airways of monkeys (Old World monkeys and great apes). Similar mites found in the nasal passages of dogs were originally described as *Pneumonyssus caninum* but were later transferred to the genus *Pneumonyssoides* to distinguish them from *Pneumonyssus* lung mites of monkeys (this reclassification has often been questioned but remains to be resolved - many texts simply report the 2 genera as synonyms).

***Pneumonyssus* species**	**Hosts**	**Location**	**Clinical signs**	**Distribution**
P. africanus	Primates: cercopithecid (blue monkey)	lungs		Europe (zoo)
P. bakeri	Rodentia: sciurid (Douglas squirrel)	respiratory tract		North America
P. caninum (syn. *Pneumonyssoides*) (dog nasal mite)	Carnivora: canid (dog, silver fox)	nasal passages, frontal sinus	head shaking, sneezing, rhinitis, sinusitis, tonsillitis	North America, Europe, Africa, Australia
P. capricorni	Diprotodontia: phalangerid (common spotted cuscus)			Papua New Guinea
P. congoensis	Primates: cercopithecid (baboon)	trachea, lungs		Africa
P. dentatus (now *Domrownyssus*)	Dasyuromorphia: dasyurid (yellow-footed antechinus); Rodentia: murid (fawn-footed mosaic-tailed rat)			Australia
P. dinolti	Primates: cercopithecid (rhesus macaque)	maxillary sinus		zoo (Europe, ex: Indonesia)
P. duttoni	Primates: cercopithecid (greater spot-nosed monkey)	trachea, bronchi		Congo
P. foxi	Primates: cercopithecid (rhesus macaque)			North America (zoo)
P. longus	Primates: cercopithecid (red-tailed monkey), hominid (chimpanzee)	bronchi, trachea		Africa
P. mossambicenis	Primates: cercopithecid (chacma baboon)	lungs		Mozambique
P. oudemansi	Primates: hominid (chimpanzee, gorilla), cercopithecid (guenon)	bronchi, bronchioles		Africa
P. pangorillae	Primates: hominid (western gorilla, bonobo)			Africa
P. procavians	Hyracoidea: procaviid (rock hyrax)	lungs		South Africa
P. rodhaini	Primates: cercopithecid (western red colobus)	lungs, nasal fossae		Africa
P. santos-diasi	Primates: cercopithecid (vervet monkey, chacma baboon)	lungs		Mozambique
P. schoutedeni	Hyracoidea: procaviid (southern tree hyrax)	trachea, bronchus		Africa
P. simicola (syn. *P. foxi, griffithi, Pneumotuber macaci*) (monkey lung mite)	Primates: cercopithecid (rhesus macaque, crab-eating macaque, southern pig-tailed macaque, yellow baboon, silvered leaf monkey, red-shanked douc, gelada, proboscis monkey); Dermoptera: cyanocephalid (flying lemur)	lungs	nodular lesions	tropical and subtropical zones
P. stammeri	Primates: atelid (woolly monkey)	larynx		zoo (Europe, ex: South America)
P. vitzthumi	Primates: hominid (Bornean orangutan)	bronchi, sinuses, nasal fossae		Europe (zoo)
P. vocalis	Primates: cercopithecid (chacma baboon)	larynx		South Africa

Pneumonyssoides				
Pn. phacochoeri	Artiodactyla: suid (desert warthog)	nasal passages		Africa
Pn. potamochoeri	Artiodactyla: suid (red river hog)			Africa

Parasite morphology: Recent studies have shown that *Pneumonyssus* spp. form 4 different types of morphological stages; namely, eggs (but only seen in gravid females); larvae (birthed by females); nymphs (previously thought not to occur, but 2 instars have now been detected); and adults (both males and females). Eggs observed *in utero* were ovoid in shape and measured around 0.5 mm in length. Larvae have ovate bodies measuring up to 0.7 mm in length and they characteristically possessed 3 pairs of anteroventral legs. The 2 nymphal stages detected (protonymphs and deutonymphs) were apparently reduced to ephemeral non-feeding forms. They have ovate bodies measuring 0.7-1.0 mm in length, and 4 pairs of legs with rudimentary tarsal claws. Following moulting, the protonymph exuvia was often retained by the deutonymph, and the exuvia of both nymphal stages was cast simultaneously by teneral adults. The bodies of both male and female adult mites were ovoid measuring 1.0-1.5 x 0.5-0.9 mm with smooth white-yellow cuticles without striations and with few setae. The gnathosoma (head or capitulum) was small and located anteriorly with short mouthparts comprising 2 chelicerae and a hypostome flanked by 2 sensory palps. The palps were short and consisted of 4-5 segments, terminating in bifurcate or simple tines (whereas the palps of other mesostigmatid mites have 5-6 segments, and those of prostigmatids and astigmatids have 1-2 segments). The bases of the palps were fused to form a basis capitulum supporting the mouthparts, and the ventral basis capitulum possessed a longitudinal median (deutosternal) groove with a single column of denticles (while that of other halarachnids had broad denticular rows). The chelicerae were composed of 3 segments ending in claw-like chelae (pincers) with small fixed digits and larger movable digits (in males, the movable digits varied from tubular and sinuate to hook-like and enlarged). The mouth had a dorsal rostrum, ventral buccal cone and unbarbed hypostome (barbed in ticks). The alimentary tract comprised the mouth (with paired salivary glands), tubular foregut (oesophagus, pharynx), saccular midgut (ventriculus with gastric caeca, short intestine), tubular hindgut (with excretory Malpighian tubules, rectum) and subterminal anus. The large idiosoma (body) possessed some dorsal and ventral body armour in the form of small sclerotized plates (shields). The single dorsal shield was irregular and elongate in shape, and densely punctate due to muscle insertions on the inner surface. The ventral idiosoma had 2 shields, a small anterior sternal shield that was variable in shape, and a small posterior anal shield that was circular and encircled the anus. Adults have 4 pairs of stout legs which are attached anteroventrally and project well beyond the body margin. Each leg is jointed with 6 segments (coxa, trochanter, femur, genu, tibia, and tarsus), with the latter having a short pretarsus and pretarsal apparatus (ambulacrum) bearing slender claws (larger on forelegs) with a median empodium (pad-like pulvillus). Many leg segments bear multiple setae (hypertrichy) while the legs of other halarachnids are sparsely setose (hypotrichy). The mites have 2 respiratory openings (stigmata) located between coxae II and IV (like all mesostigmatids) with small processes (peritremes). Adult mites exhibit little external sexual dimorphism, other than males being smaller and having larger movable digits on their chelicerae. Females have paired ovaries (with ovarioles) connected by tubular oviducts to the uterus (with muscular shell-gland) and vagina (with accessory organs (bursa copulatrix and spermathecae) for sperm reception and storage). The genital opening (gonopore) is a transverse slit between coxae IV and lacks a genital (epigynal) plate. Males have 2 testes with tubular vas deferens leading to the ejaculatory duct and sheathed aedeagus (penis). The male gonopore is located at the anterior margin of the sternal shield and lacks an epigynal plate.

Site of infection: *Pneumonyssus* (syn. *Pneumonyssoides* p.p.) are considered to be endoparasitic lung and nasal mites as the larvae, nymphs and adults occur in tissues of the lower and upper respiratory tracts of mammals, particularly cercopithecid and hominid primates, but also a few rodents, hyraxes, marsupials, canids and suids. Many infestations occur in the nasal passages (especially in dogs) while others involve the sinuses, trachea, bronchi and lung tissue (especially in Old World monkeys and great apes).

Pathogenesis: Most infestations by nasal and lung mites remain asymptomatic and are detected incidental to other studies. Heavy infestations by a few species, however, may cause disease (acariasis) notably in domestic dogs and captive primates. The active stages are larvae and adult mites which use their chelicerae to pierce the respiratory epithelium to feed on host fluids (lymph and blood) and epithelial cells (nymphs are thought to be non-feeding immotile stages). Feeding stages cause tissue trauma with inflammation, nodule formation, congestion and sometimes respiratory distress. In dogs, nasal mites (*P. caninum*) infesting the upper respiratory tract may cause rhinitis, sinusitis, excessive nasal discharges, mucosal hyperaemia, sneezing, reverse sneezing, epistaxis (nosebleed), impaired sense of smell (notably in working (tracking/hunting) dogs), pruritus, head shaking, stridor (noisy breathing), and sometimes coughing, restlessness, loss of appetite and collapse. Epidemiological investigations do not support any breed, age or sex predilection, although one report suggested that dogs older than 3 years and large breed dogs were affected more often. In non-human primates, lung mites (e.g. *P. simicola*) infesting the lower respiratory tract may cause pulmonary acariasis with inflammation of the respiratory passages, pulmonary nodules, lung congestion, and host death. Mites attach to the walls of airways and pierce the parenchyma to feed on blood, lymph, and pulmonary epithelial cells. They cause severe inflammation with cellular infiltrates and granulomatous host reactions that encapsulate mites with fibrous connective tissues producing yellowish-grey cystic nodules a few millimetres in diameter. Adjacent nodules may coalesce to form blister-like bullae measuring up to 10 mm in diameter and containing up to 20 mites. These so-called ‘mite-houses’ have a central lumen mostly containing females, although larvae, nymphs and males may also be present. The lesions and surrounding parenchyma often contain birefringent golden brown to black mite pigment. Hosts may develop chronic bronchitis with bronchiolectasis and peribronchiolitis,

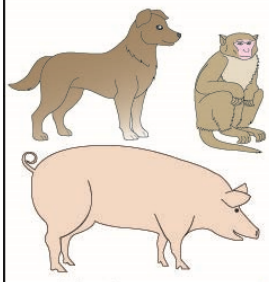
and focal lobular pneumonitis with alveolar collapse or consolidation, resulting in severe coughing and dyspnoea. In massive infestations, deaths occur due to congestion of the lungs and alveolar collapse. Other complications reported in some monkeys include pneumothorax and pulmonary arteritis, as well as extensive pleuritis and pericarditis associated with ruptured nodules. Infestations may also predispose monkeys to other pulmonary diseases due to bronchiolar epithelial changes and impaired mucociliary clearance

Developmental cycle and mode of transmission: Although details about the life-cycles of these mites are largely unknown, they do undergo hemimetabolous (incomplete) metamorphosis whereby larvae moult to nymphs and then adults. All stages occur within the respiratory tract of the host but not all stages actively feed. Gravid females are ovo-viviparous as they produce eggs which hatch *in utero* so they give birth to larvae (free eggs are rarely seen in host tissues). The larvae feed on host fluids and cells and then moult through 2 nymphal instars (protonymphs and deutonymphs) which appear to be ephemeral non-feeding non-motile forms (early studies erroneously thought that larvae transformed directly to adults). The final nymphal stages moult to form male and female adult mites which feed on host fluids and tissues, and often become encapsulated by host fibrous tissue (sometimes forming 'mite houses'). Mating occurs within the respiratory tract and females eventually produce the next generation of larvae. The kinetics and dynamics of metamorphic changes occurring throughout the life-cycle are not known. Transmission is presumed to occur by the transfer of mites from host-to-host by direct contact or via aerosol contamination through sneezing and coughing. Larvae are thought to be the main infective stages as they are small and motile, whereas nymphs are thought to be immotile and adult females in the lungs are generally considered to be too large to climb narrow bronchioles in the respiratory tree, although they may be dislodged from nasal passages.

Differential diagnosis: Infestations are difficult to diagnose due to their cryptic location (respiratory passages) and nonspecific clinical signs (sinusitis, pneumonitis). Other aetiologies include rhinitis (idiopathic, bacterial, fungal, parasitic), oronasal neoplasia, oronasal fistula, and nasopharyngeal disease (foreign body or mass lesions). Medical imaging technologies may help visualize the extent of affected areas with radiographic and computed tomographic (CT) findings including increased interstitial pulmonary and peribronchial density, thickened bronchial walls, pleural thickening, pleural adhesions, and cavitary pulmonary lesions (bullae and subpleural blebs). Diagnosis is generally afforded by antemortem recovery of mites by endoscopic biopsy or washings/lavages of respiratory organs (upper airways) or the post-mortem detection of mites and lesions by histological examination of pulmonary tissues. Endoscopy is suitable for examination of the upper airways and includes rhinoscopy or retroflex nasopharyngoscopy which facilitates nasal biopsies or flushing. Flooding the nasal chambers with anaesthetic gas or oxygen seems to encourage mites to migrate toward the nasopharynx, and nasal flushing is usually performed under general anaesthesia with a cuffed endotracheal tube. Infestations of the lower respiratory tract have been detected by tracheobronchiolar lavage, although false-negative results may occur. Any mites should be identified by microscopic examination. Histological examination of post-mortem samples may be used to reveal mites in tissue lesions containing characteristic dark mite pigments and crystals. There have also been several reports of detecting mites in the faeces on infested nonhuman primates.

Treatment and control: Clinical infestations by lung and nasal mites have been successfully treated with a small range of chemical acaricides, notably systemic applications of macrocyclic lactones (ivermectin, milbemycin, and selamectin). Many treatments had to be repeated or prolonged to eliminate mites, particularly in generalized infestations, and there have been some reports of ivermectin resistance developing in some mite populations. Even when mites are eliminated, the lesions of chronic bronchiolitis, bronchiectasis, and pigmentation persist for some time. Other systemic acaricides have been used without success and some animals also developed toxic reactions to several chemicals. While topical formulations are generally unsuitable for respiratory application, one study used vapours from organophosphate (dichlorvos) strips as inhalants to treat nasal infections in a dog. Various preventive strategies used to curb infestations, primarily in primate colonies, have involved regular health screening (with isolation and treatment of infested individuals), cohort separation (rearing newborns in isolation from infested mothers), and thorough cleaning and disinfection of holding facilities (cages, pens, runs, nests). While hard data are lacking, it is reasoned that the application of residual environmental acaricides (organophosphates and pyrethroids) and the exclusion of vermin from animal colonies should assist in the prevention and spread of infestations.

Pneumonyssus



Hosts
(mammals)

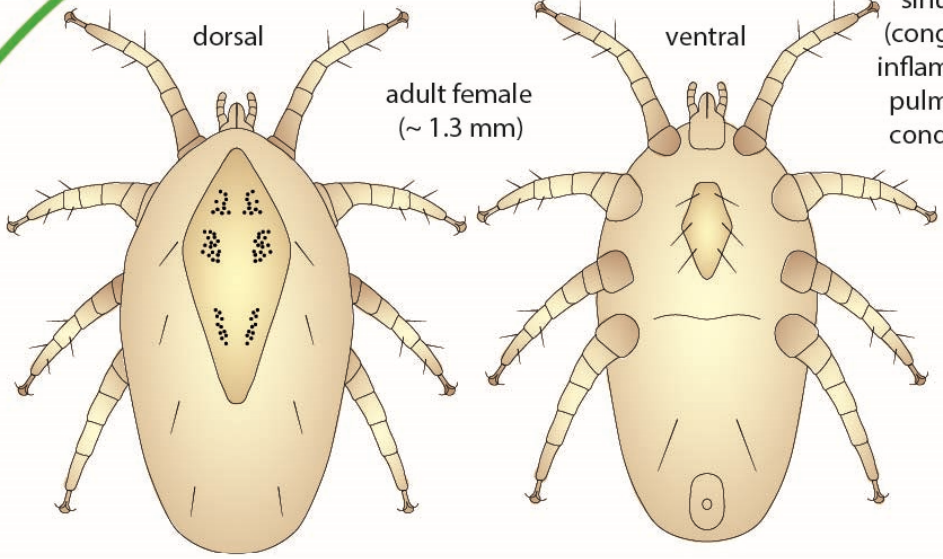
transmission usually by transfer of larvae
by direct contact or via aerosol contamination

lungs, nasal
sinuses
(congestive
inflammation,
pulmonary
conditions)

dorsal

ventral

adult female
(~ 1.3 mm)

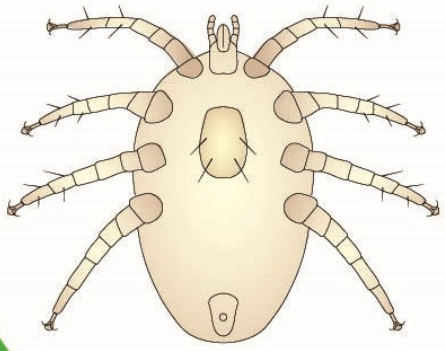


tarsal
elements

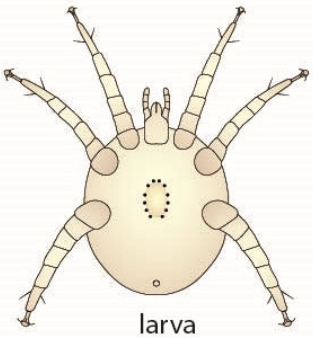
adults often form 'mite houses' encapsulated by
fibrous tissue (adults feed on host fluids/tissues)

eggs hatch *in utero*

egg
(~ 500 µm)



nymph
(ventral)
(~ 1 mm)

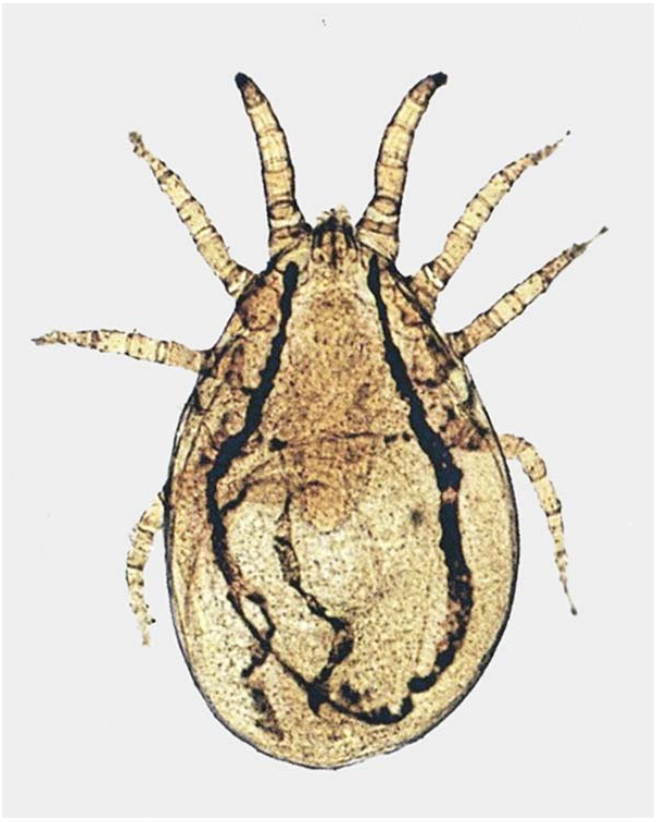


larva
(ventral)
(~ 700 µm)

larvae are motile
and feed on respiratory
epithelia/fluids

2 nymphal instars,
(proto-, deuto-nymphs)
immotile non-feeding stages

'endoparasitic'
(located in respiratory passages)



Pneumonyssus adult