Otobius
(arachnid: tick)

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 capitulum. 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). Ticks have respiratory stigmata posterior to their legs. They are obligate blood-feeding ectoparasites on vertebrate hosts and their hypostomes are toothed and exposed. Two families are recognized: Argasidae and Ixodidae, known as soft and hard ticks, respectively. Argasids have soft leathery bodies lacking a dorsal scutum and the capitulum is covered by the body. They are transient feeders on mammals and birds and have multi-host life-cycles, spending the majority of time hiding in cracks/crevices in the surrounding environment, especially nests and dens. Infestations by *Otobius* spp. occur in the ears of domestic animals and rabbits, causing inflammation and eliciting scratching trauma.

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 capitulum)
Superorder:	Parasitiformes (ticks and some mites, with posterior stigmata)
Order:	Ixodida (Metastigmata) (ticks, macroscopic, stigmata posterior to legs, hypostome toothed, ectoparasites)
Family:	Argasidae (soft ticks, lack dorsal scutum, capitulum covered by body, hide in cracks/crevices)
Genus:	*Otobius* (parasitic in ears of mammals)
Species:	various species cause inflammation and lesions in the ears of domestic animals and 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 (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 capitulum. 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 capitulum) [34 superfamilies]					
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 (behind coxae III or IV); and the gamesid mites (order Mesostigmata) where they are located between the legs, sometimes associated with sinuous processes (peritremes). Ticks are further characterized by macroscopic bodies with an exposed ventral hypostome (toothed with backwardly-directed barbs), chelicerae with only 2 joints, long legs with free articulated coxae (not fused to the body wall) and tarsi I each bearing a complex sensory pit (Haller's organ). They are obligate blood-sucking parasites which feed on terrestrial vertebrates (mammals, birds, reptiles and some amphibians) as larvae, nymphs and adults with 1-, 2- or 3-host life-cycles. Almost 1,000 tick species have been classified within some 20 genera from numerous wild and domesticated animals around the world. Two main families are recognized: the Argasidae containing ~200 species of 'soft' ticks with flexible leathery cuticles, ventral capitula, short feeding times (< 1 hour) and long life-spans (up to 20 years); and the Ixodidae containing ~800 species of 'hard' ticks with rigid dorsal scutal plates, anterior capitula, long feeding times (hours to days) and shorter life-span (2-6 years). Basic characteristics of representative genera considered in this resource are tabulated below.

Genus	Capitulum				Idiosoma				Usual no. of hosts
	location	basis capitulum	mouth-parts	palps	integument	festoons	eyes	male ventral plates	
Argasidae (soft ticks with leathery cuticle, stigmata between coxae III)									
Argas	ventral	triangular	short	leg-like	stippled with lateral suture	absent	absent	absent	>3
Ornithodorus	ventral	rectangular	short	leg-like	mamillated	absent	usually absent	absent	>3
Otobius	ventral	rectangular	short	leg-like	spinose (nymphs), granulated (adult)	absent	absent	absent	1
Ixodidae (hard ticks with sclerotized dorsal plate (scutum), stigmata behind coxae IV)									
Prostriata (anal groove anterior)									
Ixodes	anterior	triangular	long	long	inornate	absent	absent	present	3
Metastriata (anal groove posterior)									
Amblyomma	anterior	rectangular	long	long	ornate	present	present	indistinct	3
(*Aponomma*)	anterior	rectangular	long	long	often ornate	present	absent	absent	3
Rhipicephalus	anterior	hexagonal	short	medium	some ornate	present	present	present	3
(*Boophilus*)	anterior	hexagonal	short	short	inornate	absent	present	present	1
Dermacentor	anterior	rectangular	short	medium	often ornate	present	present	absent	3
Haemaphysalis	anterior	rectangular	short	short	inornate	present	absent	absent	3
Hyalomma	anterior	rectangular	long	long	inornate	present	present	present	2
Bothriocroton	anterior	pentagonal	long	long	ornate	present	absent	absent	3

The family Argasidae contains 5 subfamilies (Antricolinae, Argasinae, Nothoaspisinae, Ornithodorinae, Otobinae) which vary in morphology, biology, host range and specificity. Members of the subfamily Otobinae have flattened bodies with spinose integuments but lacking distinct lateral margins. They are unusual argasid ticks in that only the early developmental stages (larvae and nymphs) are parasitic in the ear canals of individual hosts while the resultant adult stages are not parasitic and do not feed. Only one genus (*Otobius*) has been described with 2 species, one (*O. megnini*) reported from a range of domestic and wild mammals, and another (*O. lagophilus*) being restricted to rabbits. Infestations have been associated with inflammation and blockages of the ear canals, with consequential behavioural disorders resulting in self-trauma, ulcerations and secondary infections.

***Otobius* species**	**Hosts**	**Location**	**Clinical signs**	**Distribution**
O. lagophilus (rabbit ear tick)	Lagomorpha: leporid (white-tailed jackrabbit, black-tailed jackrabbit, desert jackrabbit, desert cottontail, mountain cottontail, hare), ochotonid (American pika); Rodentia: cricetid (canyon mouse, southern grasshopper mouse), sciurid (Townsend's ground squirrel); Carnivora: felid (cat); Perissodactyla: equid (donkey); Chiroptera: vespertilionid (pallid bat); Passeriformes: alaudid (horned lark) (1-host cycle)	ears (larval and nymphal stages)	irritation, inflammation, waxy exudate, scratching trauma (vector for Colorado tick fever, Rocky Mountain spotted fever)	North America
O. megnini (syn. *Argas*, *Ornithodorus*) (spinose ear tick)	Carnivora: canid (dog, coyote), felid (cat, lion); Artiodactyla: antilocaprid (pronghorn), bovid (cattle, zebu, sheep, mountain sheep, bighorn sheep, goat, mountain goat), camelid (camel, llama, alpaca), cervid (white-tailed deer, black-tailed deer, mule deer, elk), suid (pig); Perissodactyla: equid (horse, donkey, mule), tapirid (Baird's tapir); Lagomorpha: leporid (rabbit, black-tailed jackrabbit, cottontail, hare); Primates: hominid (human); Struthioniformes: struthionid (ostrich) (1-host cycle)	ears (larval and nymphal stages)	irritation, inflammation, otitis, waxy exudate, scratching trauma, ulceration, paralysis (suspected vector for Q fever)	Americas, India, Africa, Australia

Parasite morphology: *Otobius* spp. form 4 different types of developmental stages; namely eggs; larvae; nymphs (2 instars); and adults. The eggs are small spherical to ovoid stages ranging in size from 0.2-0.8 mm long and from brown to red in colouration. Larvae are small round stages measuring 2-3 mm in length and are often tan in colour, sometimes with darker reticulated patterns, but becoming red when feeding on blood. They have a conspicuous gnathosoma (head) with forward-protruding mouthparts, and a larger rounded idiosoma (body) with 6 long thin ventral legs. Larvae lack stigmata and tracheae as respiration and fluid regulation occurs through the cuticle. Nymphs are larger ovate to ellipsoidal stages which usually have a grey-brown mottled appearance, but become red-black when feeding. There are 2 nymphal instars which grow up to 7-10 mm long when fed. The mouthparts are usually hidden in dorsal view being located ventrally underneath the anterior rim of the idiosoma. The cuticle is leathery (lacking sclerotized plates like ixodid ticks) and is distinctly spinose with numerous small spines. Nymphs have 8 pale long legs, each ending in a pair of claws. They have a pair of lateral respiratory openings (stigmata) often surrounded by a circular-oval stigmatal plate, but nymphs lack genital openings. In larvae and nymphs, the piercing/sucking mouthparts are functional and consist of 2 palps, 2 chelicerae and a toothed hypostome. The palps are sensory and do not enter the skin when feeding (ticks lack antennae). The chelicerae are specialized cutting structures with long curved shafts with dentate terminal digits which rip and tear host flesh to form small blood pools. The toothed hypostome is inserted into the blood pool to facilitate feeding as well as anchoring the tick to the host. The chelicerae and hypostome form a food (buccal) canal to imbibe blood and inject saliva. Blood is sucked up by a muscular pharynx (with pharyngeal valve) and delivered to a saccular midgut with branched diverticula (caeca) and excretory Malpighian tubules. Adult ticks have ellipsoidal bodies that appear moderately dorso-ventrally flattened and have with rounded anterior and posterior margins. They range in colour from beige-brown-black and usually measure 5-8 mm in length. The gnathosoma (head) is small and not visible in dorsal view as it is located underneath the anterior edge of the large idiosoma (body). The cuticular covering is leathery (lacking sclerotized plates like ixodid ticks) and there is no distinct lateral suture or margin between the dorsal and ventral surfaces (whereas *Argas* spp. have distinct lateral margins). The integument is granulated and usually appears speckled with tiny pore-like discs and larger shrinkage indentations. Adults have rudimentary non-functional mouthparts located ventrally between a pair of 4-segmented sensory palps. The mouthparts have small chelicerae and highly reduced hypostomes without teeth (adults do not feed). They also have rudimentary alimentary tracts with a tubular foregut, saccular midgut and vesicular rectal sac. The idiosoma comprises an anterior podosoma (bearing legs and genital pore) and a posterior opisthosoma (area behind coxae bearing respiratory stigmata and anal aperture). Adults have 8 pale stout jointed legs, each composed of 6 segments (coxae, trochanter, femur, patella (genu), tibia, and tarsus) and all terminating in a pair of claws without pad-like pulvilli. The coxae lack spurs (present in ixodids) and the dorsal tarsus I has a sensory structure (Haller's organ) used to detect odour, temperature and tactile stimuli. Like other argasids, *Otobius* spp. have small respiratory spiracular plates located between coxae III and IV (whereas ixodids have larger spiracular plates behind coxae IV). Male and female ticks show little external sexual dimorphism although gravid females are generally larger and their genital aperture is slit-like (rather than crescent-shaped like males). Females have a single saccular ovary with paired oviducts leading to a common uterus (with lateral accessory glands). The uterus opens to the vagina which has a short cervical region (acting as a receptaculum seminis) and a vestibular regions (capable of prolapsing during oviposition). The genital pore appears as a transverse slit (wider than long) surrounded by a prominent fold (apron). Males have paired testes with vas efferentia joining to form a common vas deferens (with multilobed accessory glands) leading to the ejaculatory duct and genital pore. Males produce packets of spermatids (spermatophores) which are transferred to the genital operculum of females.

Site of infection: *Otobius* spp. are unusual ticks as their adult stages are free living and do not feed on hosts, whereas their larval and nymphal stages are ectoparasitic on a small range of mammalian hosts and a few bird species. They are commonly known as spinose ear ticks because of their spiny cuticles and their predilection for the ear canals. Infestations have been recorded on lagomorphs, small carnivores, ungulates, rodents, bats, humans, and occasionally on land birds.

Pathogenesis: Larvae and nymphs are haematophagous ectoparasites that use their cutting/sucking mouthparts to feed on blood from the highly vascular areas of the ear canals. They do not suck blood directly from vessels, but use their cutting chelicerae to create blood pools on which they feed (process known as telmophagy). Larvae and both nymphal stages feed repeatedly but do not become grossly engorged. Bites are painful causing severe irritation to the ear canals with inflammation, fibrosis and pruritus developing over several days (condition known as otoacariasis or parasitic otitis). During feeding, larvae and nymphs inject saliva containing vaso-active compounds (including anticoagulants and vasodilators) which may also elicit allergic or hypersensitivity reactions in certain hosts, leading to further irritation and inflammation. Infestations may cause ear canker or otitis externa with frequent head tilting or shaking, scratching and rubbing, muscle spasms, discoloured or waxy discharges, unpleasant smells, and sometimes perforation of the ear drums. Heavy infestations may cause anaemia, reduced feeding efficiency with anorexia and weight loss (particularly during winter), and some animals (notably cattle and horses) may show nervous disorders (suggestive of tick toxicosis or paralysis) with head-heavy stances, lack of muscle coordination, myotonia, convulsions, collapse and death. Bite sites may also become ulcerated and susceptible to invasion by secondary bacterial infections and fly larvae (screw-worm myiases) resulting in otitis media, otitis interna, and encephalitis with fatal consequences. These ear ticks are also suspected of being vectors for a range of infectious diseases, including coxiellosis (Q fever), tularaemia, Rocky Mountain spotted fever and Colorado tick fever, but their role in natural transmission remains to be determined.

Developmental cycle and mode of transmission: Spinose ear ticks undergo incomplete (hemimetabolous) metamorphosis whereby eggs hatch into larvae which moult into nymphs and then adults. These ticks are unusual, however, in that the adult ticks are free-living whereas the larval and nymphal stages are ectoparasitic in the ear canals of individual hosts (thus categorizing them as having 1-host life-cycles). Gravid female ticks lay eggs in clusters in cracks and crevices on the ground where they hatch in 2-8 weeks releasing 6-legged larvae. The larvae crawl up vegetation and other vertical substrates (rocks, walls, fences) and quest for hosts, not by pursuing them but by waiting for them to brush past. Larvae are able to survive for extended periods (up to 2 months) in the external environment. Once they crawl onto a host, they migrate to the ears and attach to skin in the grooves and folds of the ear canal and feed on blood intermittently for 5-10 days (in comparison, *Argas* larvae also feed on blood, while *Ornithodorus* larvae do not). Larvae then moult *in situ* to form nymphs which develop through 2 instars over several weeks. Reports differ as to whether first-stage nymphs feed or do not feed before moulting in 7-10 days to second-stage nymphs, whereas second-stage nymphs have been reported to feed periodically for 1-7 months, particularly over winter and spring. Nymphs then leave the ears of their hosts and crawl out onto the ground to hide in cracks/crevices, under rocks/litter and sometimes under tree bark. They moult to form adult ticks which mature over 1-6 weeks depending on environmental conditions (longer in colder regions). The adults are free-living non-feeding stages that may survive for almost 2 years (they apparently absorb water from the atmosphere to survive). Adult mate on the ground where males constantly seek females. After mating, females begin to produce eggs after 6-29 days and they may lay batches of 100-250 eggs for several weeks to months, producing up to 1,500 eggs in their life-times. The whole life-cycle may be completed in as little as 2-4 months, although most regions report only 2 generations per year, often coinciding with warmer weather with low-moderate humidity (including arid and semi-arid environments).

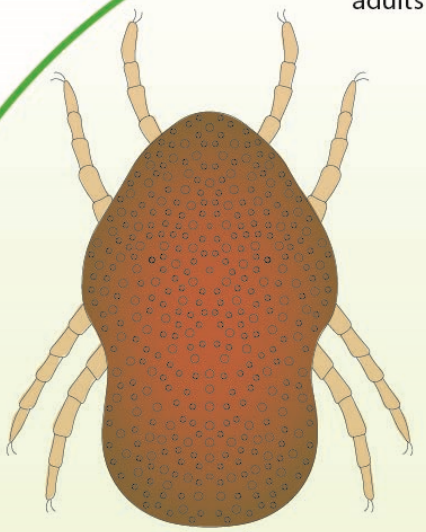
Differential diagnosis: Infestations are usually not diagnosed on clinical grounds as many aetiological agents may cause ear canker or otitis externa. Otoscopic examination of the ear canal may reveal small inflamed nodules, bite sites and sometimes feeding ticks. It is more usual to use cotton swabs or blunt forceps to remove waxy exudates which are then examined for the presence of larvae and nymphs. Tick feeding stages may be identified by their unique morphological characteristics (e.g. the spines on *O. megnini* nymphs are more numerous and thicker anteriorly than posteriorly whereas those of *O. lagophilus* are similar in size and number, the hypostome of *O. megnini* has 4 pairs of ventral teeth while that of *O. lagophilus* only has 3 pairs). Molecular biological techniques have been used to characterize species following polymerase chain reaction (PCR) amplification of nuclear rRNA (18S and 28S ribosomal RNA, internal transcribed spacers 1 and 2) and mitochondrial (12S and 16S ribosomal RNA, cytochrome c oxidase subunit I, nicotinamide adenine dinucleotide dehydrogenase subunit 5) gene sequences.

Treatment and control: Although some individual stages (usually large second-stage nymphs) may be physically removed from the external meatus using tweezers/forceps and gentle pressure, most feeding stages are too small or located too deep in the ear canal to be accessible. Attempts to irrigate or flush the ear canals (ear lavage) are often unsuccessful as feeding stages are firmly attached and often covered in hard waxy exudates. Infestations are usually treated with chemical acaricides either applied topically or systemically as dusts/powders, oils/sprays, spot-on or pour-ons, impregnated collars/tags, or as oral or injectable formulations. Successful treatments of feeding stages have been reported using arsenical preparations, organochlorines (dichloro-diphenyl-trichloroethane (DDT), lindane), organophosphates (coumaphos, chlorfenvinphos, chlorpyrifos, diazinon, dichlorvos, dioxathion, fenchlorphos, malathion, phosmet, propetamphos, trichlorfon), pyrethroids (cypermethrin, cyprothrin, decamethrin, deltamethrin, flumethrin, permethrin), carbamates (carbaryl), formamidines (amitraz), phenylpyrazole (fipronil) and macrocyclic lactones (ivermectin, abamectin), although systemic formulations may be ineffective against non-feeding stages (such as first-stage nymphs) so repeated treatments may be necessary. Ticks infesting human ears have been removed by treating with pine oil containing chlordane, or mixture of pine oil and cottonseed oil. Control programmes should also target free-living stages to prevent re-infestations, so acaricides with long-lasting residual activity (some organochlorines, organophosphates and pyrethroids) may be used as dusts or sprays to treat the surrounding environment (particularly animal housing and human habitations). Other preventive measures may be used to break transmission cycles through improvements to hygiene (cleaning holding facilities, destroying contaminated bedding), health surveillance (regular screening, quarantine, culling), animal management (avoid overstocking, pasture rotation, moving habitual camps), wildlife control (exclusion by barriers, trapping or hunting) and personal protection (applying repellents such as diethyltoluamide (DEET) to the skin or clothing).

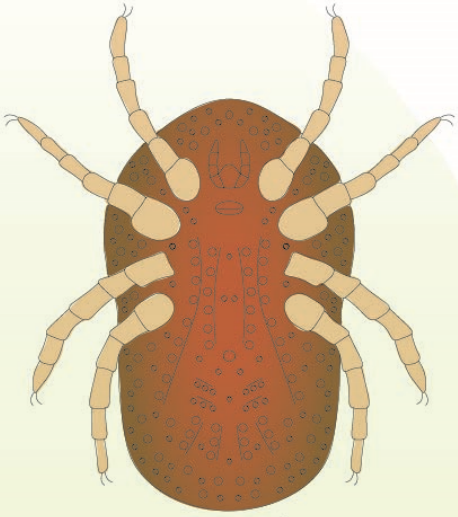
Otobius

adults non-parasitic
(non-feeding stages
free-living in cracks
and crevices in ground)

adults (~ 8 mm)

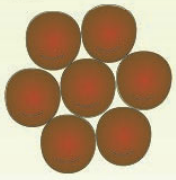


dorsal



ventral

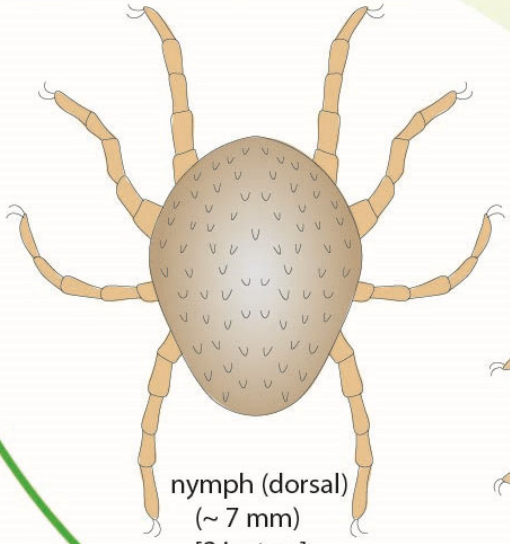
eggs laid in soil



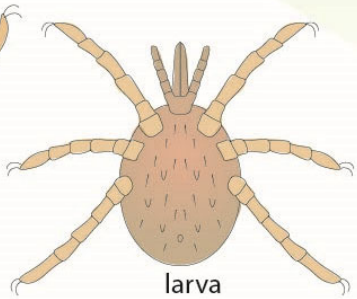
eggs
(~ 0.5 mm)

hatch

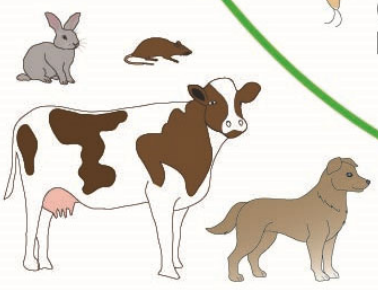
quest



nymph (dorsal)
(~ 7 mm)
[2 instars]

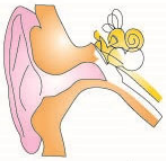


larva
(ventral)
(~ 2 mm)

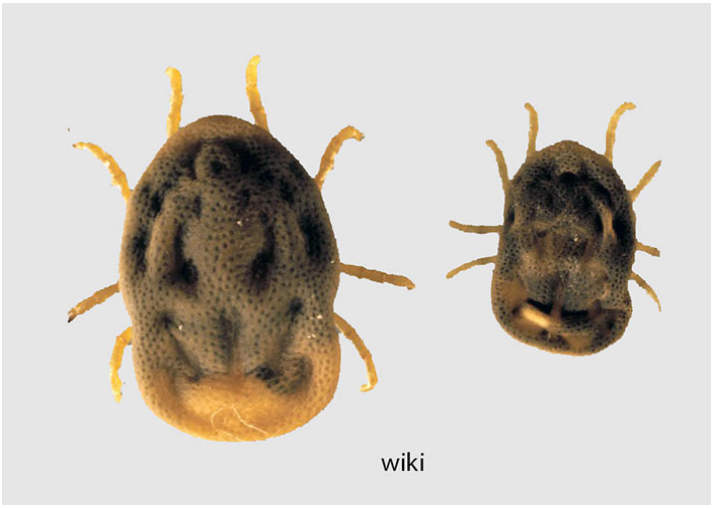


Hosts
(mammals)

larvae (L) and nymphs (N)
are ectoparasitic (feed on blood)
of same individual host



ear canal
(otitis,
pruritus,
lesions)



Otobius adults

Otobius adult

Otobius larva

Otobius nymph