Argas
(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/soil in the surrounding environment, especially nests and dens. Infestations by *Argas* spp. on domestic birds may cause irritation, anaemia and paralysis as well as transmit bacterial and viral diseases.

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:	*Argas* (parasitic on skin of birds)
Species:	various species cause irritation and anaemia in chickens

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 (*Aponomma*)	anterior	rectangular	long	long	ornate	present	present	indistinct	3
	anterior	rectangular	long	long	often ornate	present	absent	absent	3
Rhipicephalus (*Boophilus*)	anterior	hexagonal	short	medium	some ornate	present	present	present	3
	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 Argasinae have dorsoventrally flattened bodies with roughly-stippled integuments whose dorsal and ventral surfaces meet to form distinct lateral suture-like margins. All motile developmental stages are transient ectoparasites, often emerging nocturnally from host nests or residences to feed. A small number of taxa have been identified within the subfamily, but their taxonomic ranks vary according to different authorities (being recognized as separate genera, or as subgenera in the genus *Argas*). Consensus opinion recognizes 3 genera (*Argas*, *Ogadenus* and *Reticulinasus*) from a range of avian hosts as well as small mammals such as bats and rodents. Around 74 *Argas* spp. belonging to 5 subgenera (*A.* (*Argas*), *A.* (*Carios*), *A.* (*Chiropterargas*), *A.* (*Persicargas*) and *A.* (*Secretargas*)) have been described mostly from birds and bats around the world, particularly in areas with dry (even arid) climates. Most species are not strictly host specific (oioxenous), but can feed opportunistically on related hosts, such as other birds (stenoxenous), and sometimes even on non-related hosts, such as rodents and occasionally humans (euryxenous). The fowl tick, *A. persicus*, is cosmopolitan in distribution and infestations may cause significant problems in domestic poultry, particularly in birds kept in aged timber structures where developmental stages may sequester in cracks and crevices.

***Argas* species**	**Hosts**	**Clinical signs**	**Distribution**
A. (*Persicargas*) *abdussalami*	Accipitriformes: accipitrid (white-rumped vulture); Columbiformes: columbid (pigeon, cote); Galliformes: phasianid (chicken, nests)		Pakistan
A. aequalis (syn. *Ornithodorus*)	host unknown		Africa
A. (*Chiropterargas*) *afghanistaniensis*	Chiroptera: rhinopomatid (greater mouse-tailed bat)		Afghanistan
A. (*Argas*) *africolumbae*	Columbiformes: columbid (speckled pigeon); Pelecaniformes: threskiornithid (southern bald ibis); Passeriformes: hirundinid (rock martin)		Africa
A. (*Carios*) *aragaoi* (syn. *Ornithodorus*)	Rodentia: cricetid (yellowish rice rat)		South America
A. (*Persicargas*) *arboreus*	Accipitriformes: accipitrid (martial eagle); Galliformes: phasianid (chicken); Gruiformes: gruid (black crowned crane); Passeriformes: corvid (pied crow, hooded crow); Pelecaniformes: ardeid (western cattle egret); pelecanid (pink-backed pelican)		Egypt
A. (*Argas*) *assimilis*	Passeriformes: hirundinid (red-rumped swallow)		Asia
A. (*Carios*) *australiensis*	host unknown, collected from bat-infested house		Australia

A. (*Argas*) *beijingensis*	Columbiformes: columbid (rock dove)		China
A. beklemischevi	Accipitriformes: accipitrid (Egyptian vulture)		Europe
A. (*Chiropterargas*) *boueti*	Chiroptera: emballonurid (naked-rumped tomb bat, Egyptian tomb bat), hipposiderid (trident bat), megadermatid (heart-nosed bat), molossid (Egyptian free-tailed bat, European free-tailed bat), nycterid (Egyptian slit-faced bat), pteropodid (Egyptian fruit bat), rhinolophid (greater horseshoe bat, lobed horseshoe bat, Geoffroy's horseshoe bat, Mehely's horseshoe bat, Bokhara horseshoe bat, Arabian horseshoe bat), rhinopomatid (greater mouse-tailed bat, lesser mouse-tailed bat, Egyptian mouse-tailed bat), vespertilionid (desert long-eared bat, Christie's long-eared bat, Kuhl's pipistrelle, Christmas Island pipistrelle, white-winged serotine); Primates: hominid (human)		Mediterranean
A. brevipes	Falconiformes: falconid (American kestrel); Passeriformes: hirundinid (violet-green swallow), troglodytid (cactus wren); Piciformes: picid (gilded flicker, Mearn's woodpecker, ant-eating woodpecker); Strigiformes: strigid (ferruginous pygmy owl, eastern screech owl)		North America
A. brumpti	Artiodactyla: suid (desert warthog); Hyracoidea: procaviid (rock hyrax, yellow-spotted rock hyrax); Rodentia: hystricid (crested porcupine), murid (grey spiny mouse, eastern spiny mouse, Cairo spiny mouse, house mouse), caviid (guinea pig); Lagomorpha: leporid (rabbit); Carnivora: herpestid (meerkat), felid (lion) Primates: hominid (human); Sauria: agamid (spiny agama, ocellated spinytail, rock agama), gerrhosaurid (giant plated lizard), phyllodactylid (white-spotted wall gecko); Columbiformes: columbid (pigeon); Galliformes: numidid (helmeted guineafowl); Passeriformes: passerid (sparrow)	lesions (potential vector for saurian hepatozoonosis)	Africa
A. bureschi	Rodentia: sciurid (European ground squirrel, nest)		Europe
A. (Carios) capensis	Charadriiformes: larid (red-billed gull, brown noddy, sooty tern); Procellariiformes: procellariid (black-winged petrel, Kermadec petrel, little shearwater); Phaethontiformes: phaethontid (red-tailed tropicbird); Suliformes: phalacrocoracid (spotted shag), sulid (Australasian gannet); Gruiformes: rallid (spotless crake)		New Zealand
A. (*Chiropterargas*) *ceylonensis*	Chiroptera: emballonurid (black-bearded tomb bat, cave)		Sri Lanka
A. columbarum	Columbiformes: columbid (pigeon); Primates: hominid (human)		Europe
A. coniceps	Passeriformes: passerid (house sparrow)		Europe
A. (*Chiropterargas*) *confusus*	Chiroptera: emballonurid (naked-rumped tomb bat, Egyptian tomb bat), hipposiderid (trident bat), miniopterid (Natal long-fingered bat, small bent-winged bat), molossid (lappet-eared free-tailed bat, Egyptian free-tailed bat), nycterid (Egyptian slit-faced bat), rhinolophid (greater horseshoe bat), rhinopomatid (Egyptian mouse-tailed bat), vespertilionid (desert long-eared bat, Kuhl's pipistrelle, yellow bat, Cape serotine, thick-eared bat); Rodentia: dipodid (Euphrates jerboa)		Africa
A. (*Argas*) *cooleyi*	Accipitriformes: cathartid (California condor); Passeriformes: hirundinid (cliff swallow); Strigiformes: strigid (northern barred owl)		North America
A. (*Chiropterargas*) *cordiformis*	Chiroptera: nycterid (Egyptian slit-faced bat)		Africa
A. cucumerinus	host unknown, collected from soil		South America
A. (*Argas*) *dalei*	Strigiformes: strigid (burrowing owl)		South America
A. (*Carios*) *daviesi*	Chiroptera: vespertilionid (eastern forest bat)		Australia
A. (*Carios*) *dewae*	Chiroptera: rhinolophid (smaller horseshoe bat),		Australia

	vespertilionid (Gould's wattled bat, large-eared pied bat, lesser long-eared bat, eastern forest bat, eastern false pipistrelle)		
A. (*Argas*) *dulus*	Passeriformes: bombycillid (palmchat, nest)		Central America
A. (*Secretargas*) *echinops*	Afrosoricida: tenrecid (lesser hedgehog tenrec)		Madagascar
A. (*Argas*) *falco*	Falconiformes: falconid (Nankeen kestrel, nest)		Australia
A. (*Persicargas*) *giganteus*	Galliformes: odontophorid (Gambel's quail); Passeriformes: corvid (pinyon jay, Tamaulipas crow), mimid (curve-billed thrasher, crissal thrasher, Bendire's thrasher, sage thrasher, parid (mountain chickadee), passerellid (fox sparrow, white-crowned sparrow, eastern towhee, canyon towhee, Abert's towhee, dark-eyed junco); Strigiformes: strigid (eastern screech owl, burrowing owl)		North America
A. (*Persicargas*) *gilcolladoi*	Accipitriformes: accipitrid (Griffon vulture)		Europe
A. (*Carios*) *gujaratensis*	Chiroptera: vespertilionid (greater Asiatic yellow bat)		India
A. hermanni (incl. subspp. *latus, macrostigmatus, vulgaris*)	Columbiformes: columbid (pigeon, rock dove); Coraciiformes: coraciid (European roller); Falconiformes: falconid (lanner falcon); Passeriformes: corvid (hooded crow, brown-necked raven, fan-tailed raven); Strigiformes: strigid (little owl); Suliformes: phalacrocoracid (European shag); Chiroptera: vespertilionid (desert long-eared bat)	(possible vector for borreliosis, arboviruses, Tunis, Quaranfil, Chenuda and West Nile viruses)	Europe
A. (*Argas*) *himalayensis*	Galliformes: phasianid (snow partridge)		Nepal
A. hoogstraali	Sauria: oplurid (Anzamala Madagascar swift, Cuvier's Madagascar swift, Dumeril's Madagascar swift, Grandidier's Madagascar swift)		Madagascar
A. (*Carios*) *hoogstraali* [name preoccupied, as above]	Chiroptera: emballonurid (long-winged tomb bat)		India
A. (*Carios*) *indicus*	Chiroptera: molossid (Egyptian free-tailed bat)		India
A. (*Argas*) *japonicus*	Passeriformes: hirundinid (lesser striated swallow, common house martin); Artiodactyla: bovid (cattle)	(possible vector for rickettsiosis and anaplasmosis)	Asia
A. (*Persicargas*) *keiransi*	Falconiformes: falconid (Chimango caracara)		South America
A. (*Argas*) *lagenoplastis*	Passeriformes: hirundinid (Australian fairy martin)		Australia
A. latus	Columbiformes: columbid (rock dove, European turtle dove); Coraciiformes: coraciid (European roller); Passeriformes: corvid (fan-tailed raven)		Central Asia
A. (*Argas*) *lowryae*	Falconiformes: falconid (Nankeen kestrel)		Australia
A. (*Carios*) *macrodermae*	Chiroptera: megadermatid (ghost bat)		Australia
A. (*Argas*) *macrostigmatus*	Siluriformes: phalacrocoracid (crested cormorant)		Europe
A. magnus	Columbiformes: columbid (rock dove); Galliformes: phasianid (chicken)		South America
A. (*Argas*) *monachus*	Psittaciformes: psittacid (monk parakeet)		South America
A. (*Argas*) *monolakensis*	Charadriiformes: larid (California gull); Primates: hominid (human)	(possible vector for Q fever)	North America
A. (*Argas*) *moreli*	hosts unknown, collected from infested house		South America
A. (*Argas*) *neghmei*	Galliformes: phasianid (chicken); Columbiformes: columbid (dovecotes); Lagomorpha: leporid (rabbit); Primates: hominid (human)	pruritus	South America
A. (*Persicargas*) *nullarborensis*	Passeriformes: corvid (little crow)		Australia
A. passerinus	Passeriformes: passerid (sparrow, nest)		China
A. (*Persicargas*) *persicus* (syn. *A. chinche, mauritianus, miniatus, minutus*) (fowl tick, chicken tick, adobe tick, blue bug)	Accipitriformes: accipitrid (golden eagle, eastern imperial eagle, martial eagle, white-rumped vulture, black kite, Swainson's hawk, Eurasian sparrowhawk, long-legged buzzard, pallid harrier), cathartid (black vulture, turkey vulture), pandionid (osprey), sagittariid (secretary bird); Anseriformes: anatid (duck, mallard, cinnamon teal,	irritation, anaemia, toxicosis, paralysis (vector for borreliosis, fowl spirochaetosis, aegyptianellosis,	worldwide

	goose); Bucerotiformes: upupid (Eurasian hoopoe); Columbiformes: columbid (pigeon, rock dove, laughing dove, spotted dove, European turtle dove, Oriental turtle dove, mourning dove); Coraciiformes: coraciid (European roller), meropid (European bee-eater); Cuculiformes: cuculid (greater roadrunner, rufous-vented ground cuckoo); Falconiformes: falconid (saker falcon, common kestrel, lesser kestrel, red-footed falcon); Galliformes: numidid (helmeted guineafowl, Transvaal guineafowl), phasianid (chicken, red junglefowl, turkey, California valley quail, Gambel's quail, rock partridge, pheasant); Gruiformes: gruid (wattled crane, black crowned crane); Passeriformes: alaudid (Calandra lark), corvid (pied crow, rook, western jackdaw, white-necked raven, black-headed jay, Eurasian magpie, black-billed magpie), emberizid (red-headed bunting), fringillid (canary), hirundinid (barn swallow), icterid (western meadowlark), laniid (great grey shrike), passerid (house sparrow, Spanish sparrow, Eurasian tree sparrow, rock sparrow), passerellid (golden-crowned sparrow), sturnid (common starling, rosy starling, pale-winged starling), turdid (mistle thrush); Pelecaniformes: ardeid (common heron, grey heron, cattle egret), pelecanid (pelican), threskiornithid (Hadada ibis); Piciformes: picid (great spotted woodpecker, European green woodpecker); Psittaciformes: psittacid (monk parakeet); Strigiformes: strigid (short-eared owl, little owl, Eurasian eagle-owl, brown fish owl, western screech owl); Struthioniformes: struthionid (ostrich); Suliformes: anhingid (snakebird); Artiodactyla: bovid (cattle, goat), suid (pig); Lagomorpha: leporid (European rabbit, Texas jack rabbit); Rodentia: cricetid (grey dwarf hamster, European hamster), heteromyid (chisel-toothed kangaroo-rat), murid (African grass rat, black rat, Turkestan rat, mouse); Carnivora: canid (dog); Primates: hominid (human); Anura: bufonid (common toad)	anaplasmosis, Crimean-Congo haemorrhagic fever, Kyasanur forest disease)	
A. pipistrellae (syn. *A. fischeri*)	Chiroptera: hipposiderid (Greggory's trident leaf-nosed bat), vespertilionid (common pipistrelle, Kuhl's pipistrelle, Savi's pipistrelle, lesser Papuan pipistrelle, Japanese house bat)		Egypt, Asia
A. (*Argas*) *polonicus*	Columbiformes: columbid (rock dove); Primates: hominid (human)	itchy lesions	Europe
A. pusillus	Chiroptera: vespertilionid (lesser Asiatic yellow bat, Temminck's bat, brown pipistrelle, Japanese house bat); Primates: hominid (human)		Asia
A. (*Persicargas*) *radiatus*	Galliformes: phasianid (chicken)		North America
A. (*Argas*) *reflexus* (syn. *Ixodes columbae*) (pigeon tick)	Accipitriformes: accipitrid (eagle, long-legged buzzard, black kite), cathartid (California condor); Anseriformes: anatid (Muscovy duck, goose); Apodiformes: apodid (swift); Cathartiformes: cathartid (condor); Columbiformes: columbid (blue hill pigeon, rock dove, stock dove, European turtle dove); Coraciiformes: coraciid (European roller); Falconiformes: falconid (Lanner falcon); Galliformes: numidid (helmeted guineafowl), phasianid (chicken, turkey, rock partridge); Passeriformes: corvid (hooded crow, western jackdaw, brown-necked raven, fan-tailed raven), hirundinid (cliff swallow, barn swallow, common house martin, Eurasian crag martin), laniid (brown shrike, woodchat shrike), muscicapid (bluethroat, common rock thrush), passerid (house sparrow, Spanish sparrow, tree sparrow, rock sparrow); Strigiformes: strigid (eastern screech owl, little owl); Artiodactyla: bovid (harnessed bushbuck); Perissodactyla: equid (horse); Eulipotyphla: erinaceid	irritation, anaemia, toxicosis (vector for borreliosis, fowl spirochaetosis, aegyptianellosis, West Nile virus, Chenuda virus, Quaranfil virus)	Europe, Asia, Africa

	(long-eared hedgehog); Rodentia: cricetid (hamster), murid (great gerbil); Chiroptera: vespertilionid (Asian long-tailed bat); Carnivora: felid (cat); Primates: hominid (human)		
A. (*Persicargas*) *ricei*	Accipitriformes: cathartid (black vulture, turkey vulture, roosts)		North America
A. (*Persicargas*) *robertsi*	Anseriformes: anatid (lesser whistling teal, ruddy shelduck, Eurasian teal, garganey); Ciconiiformes: ciconiid (stork, Asian openbill); Cuculiformes: cuculid (Asian koel); Galliformes: phasianid (chicken); Passeriformes: corvid (jungle crow), sturnid (pied myna, Javan myna, black-collared myna); Pelecaniformes: ardeid (cattle egret, great egret, little egret, intermediate egret, grey heron, pied heron, black-crowned night heron, African heron, Javan pond heron), pelecanid (grey pelican), threskiornithid (Oriental white ibis, Australian white ibis, glossy ibis); Psittaciformes: cacatuid (galah); Siluriformes: anhingid (Oriental darter), phalacrocoracid (great cormorant, pygmy cormorant, little black cormorant, little pied cormorant, little cormorant); Strigiformes: strigid (Indian scops owl, spotted owlet)		Australia
A. sanchezi	Columbiformes: columbid (mourning dove, turtle dove); Galliformes: phasianid (chicken, turkey)		North America
A. (*Carios*) *sinensis*	Chiroptera: vespertilionid (Japanese house bat)		China
A. (*Carios*) *sonenshinei*	Chiroptera: vespertilionid (Dormer's bat)		India
A. (*Persicargas*) *streptopelia*	Columbiformes: columbid (European turtle dove)		Cyprus
A. striatus	Passeriformes: ploceid (sociable weaver, nest)		Africa
A. (*Persicargas*) *theilerae*	Accipitriformes: accipitrid (white-backed vulture, nest)		Africa
A. (*Secretargas*) *transgariepinus* (syn. *A. kochi*)	Chiroptera: rhinolophid (greater horseshoe bat), rhinopomatid (Egyptian mouse-tailed bat, lesser mouse-tailed bat), vespertilionid (serotine bat, meridional serotine, Savi's pipistrelle, Nathusius's pipistrelle, grey long-eared bat, desert long-eared bat, Christie's long-eared bat, greater mouse-eared bat, whiskered bat, Geoffroy's bat); Primates: hominid (human)	(possible vector for rickettsioses)	Mediterranean
A. transverse	host unknown, collected from vegetation		Galapagos Islands
A. (*Argas*) *tridentatus*	Passeriformes: passerid (house sparrow)		Europe
A. (Carios) vespertilionis (short-legged bat tick)	Chiroptera: emballonurid (naked-rumped tomb bat, Egyptian tomb bat, yellow-bellied sheath-tailed bat, Pel's pouched bat), hipposiderid (trident bat, great roundleaf bat), miniopterid (common bent-wing bat, pale bent-wing bat), molossid (European free-tailed bat, Egyptian free-tailed bat, eastern free-tailed bat), noctilionid (lesser bulldog bat); nycterid (Egyptian slit-faced bat), rhinolophid (greater horseshoe bat, lesser horseshoe bat, Blasius's horseshoe bat, Geoffroy's horseshoe bat, Mehely's horseshoe bat, Mediterranean horseshoe bat), rhinopomatid (lesser mouse-tailed bat, greater mouse-tailed bat, Egyptian mouse-tailed bat), pteropodid (Egyptian fruit bat), vespertilionid (western barbastelle, serotine bat, meridional serotine, banana serotine, Cape serotine, northern bat, common pipistrelle, Alashanian pipistrelle, Savi's pipistrelle, Kuhl's pipistrelle, Madeira pipistrelle, Nathusius's pipistrelle, Soprano pipistrelle, lesser Papuan pipistrelle, Japanese house bat, Moloney's mimic bat, Alcathoe bat, Bechstein's bat, Brandt's bat, Daubenton's bat, Geoffroy's bat, Gould's wattled bat, Natterer's bat, lesser mouse-eared bat, greater mouse-eared bat, pond bat, northern bat, whiskered bat, greater noctule bat, lesser noctule, common noctule, desert long-eared bat, brown long-eared bat, grey long-eared bat,	pruritus (possible vector for rickettsioses, ehrlichiosis, borreliosis, babesiosis, bat nairoviruses and flaviviruses)	Middle-East

	Christie's long-eared bat, Gaisler's long-eared bat, Ruppell's broad-nosed bat, parti-coloured bat); Carnivora: canid (dog); Primates: hominid (human); Galliformes: phasianid (chicken); Piciformes: picid (European green woodpecker); Procellariiformes: procellariid (Yelkouan shearwater)		
A. victoriensis	Galliformes: phasianid (chicken)		Australia
A. vulgaris (syn. *A. delicatus*)	Accipitriformes: accipitrid (long-legged buzzard, Egyptian vulture); Anseriformes: anatid (ruddy shelduck); Columbiformes: columbid (rock dove, pigeon); Coraciiformes: coraciid (European roller); Galliformes: phasianid (chukar partridge); Passeriformes: corvid (rook, western jackdaw), hirundinid (barn swallow), muscicapid (Finsch's wheatear), passerid (house sparrow, rock sparrow), sturnid (common starling); Strigiformes: strigid (little owl); Primates: hominid (human)		Europe
A. (*Persicargas*) *walkerae* (chicken tick, fowl tampan)	Galliformes: phasianid (chicken, turkey); Struthioniformes: struthionid (ostrich)	irritation, anaemia, paralysis (vector for borreliosis, aegyptianellosis)	Africa
A. (*Chiropterargas*) *wilsoni*	Chiroptera: rhinopomatid (greater mouse-tailed bat)		India
A. (*Persicargas*) *zumpti*	Accipitriformes: accipitrid (Cape vulture)		Africa

Parasite morphology: Argasid ticks form 4 different types of morphological stages during their developmental cycles: namely, eggs; larvae (one instar); nymphs (2-7 instars); and adults (male and female). The eggs are spherical to oval in shape measuring around 0.5 mm long and are usually clustered together in large masses. They are initially light orange in colour but gradually turn grey just before hatching. Larvae have dorsoventrally-flattened ovate bodies measuring around 0.75 mm in length. They are covered by a leathery tan cuticle with irregular dark markings and characteristically have 6 long thin legs. Larvae lack stigmata and tracheae as respiration and water loss occurs direct through the tegument. Nymphs also have dorsoventrally-flattened ovate bodies but they characteristically have 8 long thin legs. They develop through several (2-7) nymphal instars growing in size up to 4 mm in length. Most stages are brown, orange or black in colour and have irregular dark markings. Nymphs possess a pair of respiratory openings (stigmata) usually surrounded by a circular-oval plate. Adult ticks have oval bodies 4-15 mm long when viewed dorsally. They are covered by unsclerotized leathery cuticles with wrinkled roughened surfaces due to the presence of fine irregular folds with numerous tiny button-like protuberances with central pit (in contrast, ixodid ticks have sclerotized dorsal plates). The dorsal and ventral surfaces meet to form a distinct lateral margin or suture composed of irregular quadrangular plates or cells (not present in *Ornithodorus*). Unfed ticks have dorsoventrally-flattened discoid bodies, whereas engorged ticks become swollen and rounded. The body is usually yellow-brown in colour in unfed ticks, but turns reddish-brown or slaty blue after bloodmeals. All ticks have 2 main parts, the head (capitulum) and the body (idiosoma). In argasids, the capitulum is hidden in a ventral depression (camerostome) underneath the anterior idiosoma and is not visible in dorsal view, whereas the capitulum in ixodid ticks projects forwards and is visible dorsally. It also lacks porose areas which are present on the dorsal surfaces of ixodid females. The capitulum comprises the basis capitulum (integumental ring encircling mouthparts) and the gnathosoma (feeding structure comprising 2 palps, 2 chelicerae and toothed hypostome). The mouthparts are adapted for piercing skin and sucking blood, and are small relative to the size of the body. The palps are sensory structures that move laterally and do not enter skin when feeding (ticks lack antennae). Each palp has 4 segments of equal length (unlike ixodids where they are not equal), although the last segment may appear slightly smaller as it is located in a recess in segment 3 and fitted with small setae. The chelicerae are specialized appendages used for cutting the skin of the host enabling soft ticks to reach down to dermal capillaries. They have 2 segments and are tubular with long curved shafts in spinose sheaths, ending in 2 cutting digits with recurved teeth/denticles. The chelicerae have a horizontal cutting action, ripping and tearing flesh to form a small pool of blood. The hypostome is then inserted into the blood pool to facilitate feeding as well as anchoring the tick to the host. The hypostome is an extension of the basis capitulum and is dentate (with retrograde denticles) and may be notched apically (e.g. *A. persicus*) or not (e.g. *A. reflexus*). The alimentary tract consists of a tubular buccal canal (formed dorsally by the chelicerae and ventrally by the hypostome), paired salivary glands (like clusters of grapes), muscular sucking pharynx (with pharyngeal valve), short tubular oesophagus, large saccular midgut (sometimes called stomach or ventriculus) with several pairs of looped or branched diverticula (caeca) with excretory elements (Malpighian tubules and coxal glands), then a short tube to the vesicular rectal sac (replacing the hindgut in ticks) and subterminal ventral anus. The idiosoma lacks hard sclerotized plates (only present on ixodids) and consists of an anterior podosoma (with legs and genital pore) and a posterior opisthosoma (area behind coxae bearing spiracles and anus). Argasids have small respiratory spiracular plates (stigmata) located between coxae III and IV (whereas ixodids have large spiracular plates behind coxae IV). The podosoma bears 8 long slender legs, each with 6 segments (coxae, trochanter, femur, patella (genu), tibia, and tarsus) and all ending in a pair of claws without pad-like pulvilli (present in ixodids). The coxae lack spur-like projections (present in ixodids) and the dorsal tarsus I has a unique sensory apparatus (Haller's organ) with an anterior pit and posterior capsule (used for odour, temperature, light and mechanical sensation). Argasids generally

show limited sexual dimorphism, although females are able to engorge to several times the size of males and they have wider genital apertures. Females have a single saccular ovary (grape-like when gravid) with paired tubular oviducts (with distal ampulla) leading to a common uterus (with associated accessory glands) opening to the vagina (with cervical and vestibular regions). The cervical region acts as a receptaculum seminis and the vestibular vagina actively prolapses during oviposition. The genital aperture consists of a transverse slit (wider than long) surrounded by a prominent fold and connected to special Gene's organs which produce waxy egg coatings during oviposition. Males have 2 testes connected by tubular vas efferentia to a common vas deferens with a large multilobed accessory gland leading to the ejaculatory duct. The genital aperture is circular to crescent-shaped without an apron and without external genitalia. Males produce spermatophores (packets of spermatids) which are grasped by his chelicerae and placed under the genital operculum of females.

Site of infection: Larvae, nymphs and adult argasid ticks are temporary ectoparasites of birds and mammals. Over 70 *Argas* spp. have been described from birds belonging to 17 passeriform and 34 non-passeriform families (including terrestrial and water birds, fowl and birds of prey), mammals belonging to 29 families (rodents, bats, carnivores, ungulates and humans), 4 lizard families and one toad family. While many species appear to have preferred feeding sites, such as on the breast or under the wings of birds, they generally feed opportunistically and rapidly before dropping off into the surrounding environment (particularly nests, burrows, caves and other resting sites). Argasids may bite humans on exposed areas such as legs and arms.

Pathogenesis: All motile stages of *Argas* spp. are haematophagous parasites which use their chelicerae to cut into host skin forming blood pools into which they insert their hypostomes to suck blood (feeding process known as telmophagy). Larvae, nymphs and adult ticks do not attach firmly to the host like ixodid ticks do, but rather feed quickly (usually < one hour) and then detach to drop off the host (although the larvae of some species may stay on hosts for longer periods). Many argasid bites are painless and go unnoticed as the ticks inject saliva containing analgesic properties as well as cytolytic, anticoagulant, vasodilatory and vascular permeability activities. During feeding, the ticks may regurgitate excess fluids back into the host, and argasids have special secretory coxal glands that aid in fluid regulation. Bite sites often become irritated and inflamed with pruritus (itching), oedema (fluid build-up), and erythema (redness of skin). Small granulomas may develop at feeding sites as they become infiltrated by host inflammatory cells (esp. eosinophils) and surrounded by fibrotic reactions. Heavy infestations may cause restlessness and unthriftiness with weakness, reduced weight gain (sometimes emaciation), reduced egg production, and anaemia, sometimes severe enough as to prove fatal. Lesions may be more severe in some individual hosts which exhibit hypersensitivity reactions to tick saliva, and heavy infestations (particularly by larvae) have been associated with toxicosis and partial paralysis in domestic fowl. Argasid ticks biting humans have been associated with a range of vague symptoms, including headaches, dizziness, sweating, chills, and anaphylaxis. Because the feeding stages constantly move on and off hosts, they are efficient vectors for the transmission of various infectious diseases; particularly bacterial causing avian spirochaetosis (*Borrelia anserina*) and anaplasmosis (*Aegyptianella pullorum*). Molecular screening studies have also detected numerous other micro-organisms with unproven pathogenicity in ticks from wild and domestic birds: including bacteria in the genera *Anaplasma*, *Bartonella*, *Borrelia*, *Coxiella*, *Ehrlichia*, *Francisella*, *Rickettsia* and *Rickettsiella*; viruses belonging to the families Flaviviridae, Orthomyxoviridae, Orthonairoviridae, Phenuiviridae and Reoviridae; and the haemoprotozoan genera *Babesia* and *Hemolivia.*

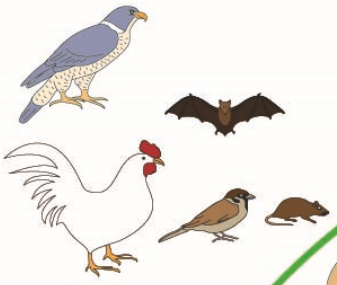
Developmental cycle and mode of transmission: Like all ticks, *Argas* spp. exhibit incomplete (hemimetabolous) metamorphosis whereby eggs hatch larvae which moult through several nymphal stages before forming adults. They have multi-host life-cycles as each developmental stage is a temporary ectoparasite feeding on the blood of a succession of hosts. They do not attach permanently but drop off after each bloodmeal and rest in the surrounding environment. Most species are nidicolous and occur in nests, dens, burrows or host resting areas. The ticks can survive for long periods without feeding (weeks or months), even under harsh dry conditions. They have long life-spans and can persist within seasonal breeding areas from year to year, but are able to complete multiple generations each year when conditions are favourable and when suitable hosts are readily available (as occurs with domestic poultry). Gravid female ticks lay eggs off their hosts in nests and burrows where they hatch in several days releasing 6-legged larvae. The larvae can survive for months without feeding but they must eventually locate a host to feed on blood in order to develop further (in contrast, *Ornithodorus* larvae do not feed; whereas adult *Otobius* do not feed). Of all the *Argas* developmental stages, larvae stay on hosts the longest feeding over several (4-10) days. When replete, the larvae drop off the hosts into the surrounding environment where they moult into first-stage 8-legged nymphs over several days. The nymphs can also survive for many weeks without feeding but they also require bloodmeals in order to develop further. Nymphs feed rapidly (within an hour) and then drop off their hosts and moult into second-stage nymphs. Argasid species form multiple nymphal instars, ranging from 2 up to 7 (whereas ixodid ticks only form one). All instars feed rapidly on hosts and then drop off to moult in the nest/burrow. The final nymphal instars moult to form adult ticks (male or female) which are usually nocturnal feeders, emerging from cracks and crevices in nests or burrows to feed on resting or sleeping hosts before returning to their shelters to avoid daylight desiccation. Adults have been shown to travel long distances (kilometres) searching for hosts and they can survive without feeding for long periods (up to 2 years) by entering diapause. Ticks feed periodically on hosts and become sexually mature, although mating and egg laying occurs off hosts in sheltered environments. Argasids may mate multiple times (whereas ixodid ticks mate only once) and females usually lay batches of 25-200 eggs after bloodmeals. Females may lay up to several thousand eggs during her lifetime. The entire life-cycle (egg-to-egg) may be completed in as little as 30 days but more often takes 100-130 days in warm humid conditions, so ticks may rapidly become abundant, particularly in intensive poultry facilities. Infestations in wild animals, however, often appear seasonally

as ticks are able to survive in breeding sites that are frequented only annually by hosts. Argasids are more common in dry conditions, including deserts, especially when hosts construct nests or burrows with copious shelters.

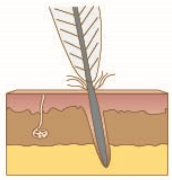
Differential diagnosis: While infestations may be suspected on the basis of clinical grounds (skin lesions, anaemia, unthriftiness), other ectoparasites or disease processes may cause similar symptoms/signs. Infestations are usually detected by the direct observation of tick developmental stages (larvae, nymphs and/or adults) feeding on hosts, although most stages feed nocturnally and transiently. Examination of host resting sites (nests, roosts and burrows) may reveal marked contamination by tick scat (black faecal deposits) and tick stages may be found amongst nesting/bedding materials. Diagnoses are best confirmed by the microscopic examination and identification of captured specimens by their morphological characteristics. Molecular biological techniques have been used to characterize species and infer phylogenetic relationships following the polymerase chain reaction (PCR) amplification of nuclear (18S and 28S ribosomal RNA, internal transcribed spacer regions 1 and 2) and mitochondrial (12S and 16S ribosomal RNA, cytochrome c oxidase subunit I) gene sequences.

Treatment and control: Infestations by individual ticks may be countered by physical removal of the tick using fine surgical instruments (forceps, tweezers, needles) or a range of specially-designed plastic devices (tick keys, lassos, tweezers, twists or V-shaped tools). Care should be taken not to crush or squeeze the ticks (which can force salivary and gut contents into wounds) and gentle pressure should be applied so as to not rip out their mouthparts (leaving them embedded can exacerbate lesions). While many folklore remedies suggest that different oily, stringent or volatile chemicals applied to the backs of attached ticks may help in their removal (including mineral oil, eucalyptus oil, peppermint oil, soap, rubbing alcohol, nail polish, chloroform, vinegar, lemon juice, baking soda, vaseline, petroleum jelly, heated probes or hot extinguished matches), such treatment may also cause them to regurgitate or secrete material back into the hosts. A wide range of acaricides have been developed for the treatment of tick infestations in livestock, available as ointments, emulsions, powders, dusts, dips, sprays, showers, footbaths, drenches, injections, or as pour-on or spot-on applications. A range of self-treatment devices have also been developed to treat wildlife or extensively-farmed animals, including medicated nesting materials, bait boxes, rubbing posts or rollers, and supplementary feed bins. Many early preparations required multiple applications as they exhibited limited penetration into host plumage or pelage or had poor efficacy against some developmental stages. However, more modern formulations have longer-lasting residual activity and are available in slow-release formulations or as systemic applications. Successful treatments have been reported using arsenical preparations, kerosene emulsions, organochlorines (dichloro-diphenyl-trichloroethane (DDT), lindane), organophosphates (dioxathion, fenchlorphos), organophosphonates (chlorfenvinphos, dichlorvos, tetrachlorvinphos, trichlorfon), monothiophosphates (chlorpyrifos, coumaphos, cythioate, diazinon, fenthion, propetamphos), dithiophosphates (malathion, phosmet), carbamates (carbaryl), pyrethroids (permethrin, flumethrin, deltamethrin, decamethrin, cypermethrin, cyprothrin), formamidines (amitraz), macrocyclic lactones (ivermectin, selamectin), phenylpyrazole (fipronil), chloronicotinyl (imidacloprid), isoxazolines (afoxolaner, fluralaner), natural products (rotenone) and some insect growth regulators or chitin synthesis inhibitors (methoprene, pyriproxyfen). Some acaricide resistance has been found in tick populations against arsenic compounds, some organochlorines and organophosphates, pyrethroids and formamidines. It is recommended that acaricides be used strategically during peak seasons as well as intermittently or in rotation to avoid the further development of drug resistance. Treatment protocols are also best used in integrated tick management strategies, involving environmental management (spraying sheds with residual acaricides, removing litter, clearing vegetation), livestock management (avoid overstocking, grazing management with pasture/pen rotation/spelling), regular health surveillance (screening, culling, quarantine), vermin control (using barriers, traps, baits) and wildlife management (by fencing, hunting, trapping or diverting migration routes).

Argas

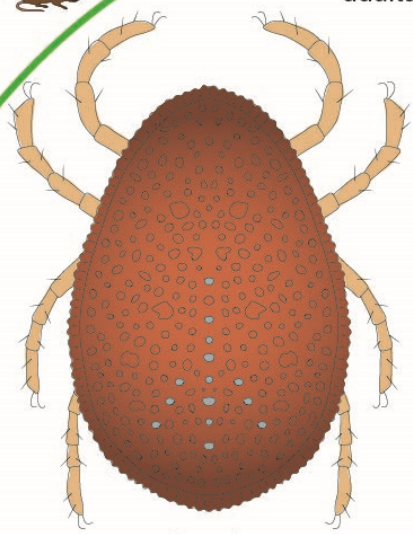


Hosts
(birds, bats,
rodents)

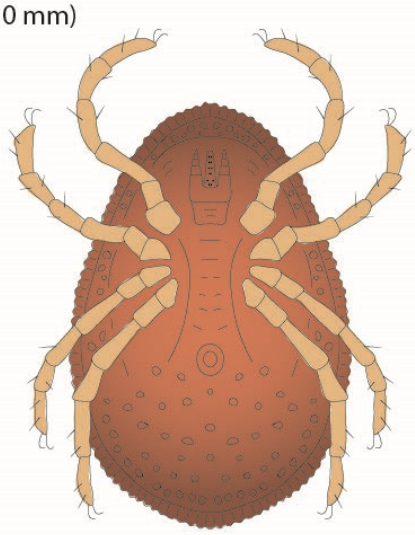


skin
(blood loss,
irritation,
lesions,
toxicosis)
(vectors for
infectious
microbial
diseases)

adults (~ 10 mm)

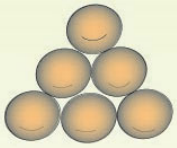


dorsal



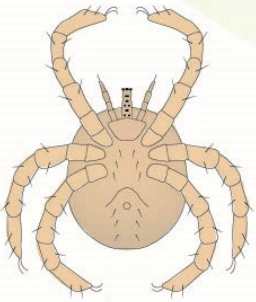
ventral

eggs laid in
soil/nests/burrows

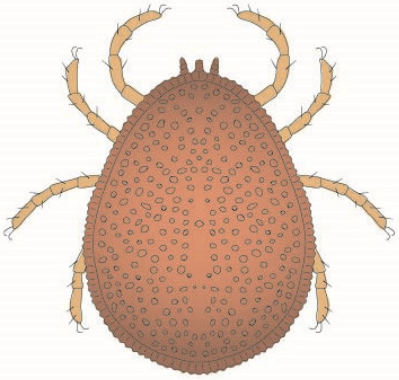


eggs
(~ 0.5 mm)

hatch



larva
(ventral)
(~ 0.75 mm)

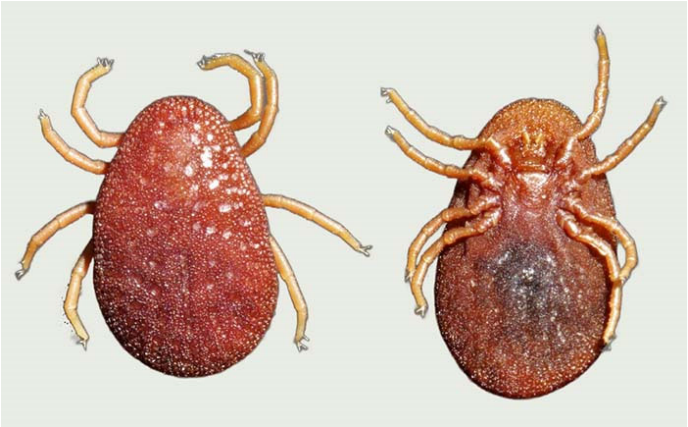


nymph (dorsal)
(~ 4 mm)
[2-7 instars]

most species
are nidiculous
(reside in nests/burrows)

motile stages (L+N+A)
are transient ectoparasites
emerging to feed on host blood

Argas spp. have multi-host cycles where
larvae (L), nymphs (N) and adults (A)
occur on a succession of individual hosts



Argas adults

Argas adult female and eggs

Argas larva

Argas nymphs