Hyalomma
(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. Ixodids have hard bodies with a dorsal scutum (shield-shaped plate) and the capitulum is not covered by the body. Larvae, nymphs and adults attach and feed on host blood, their life-cycles involving one, two or three hosts depending on whether moulting occurs on or off the host. Some 650 species of hard ticks infest mammals, birds and reptiles. Infestations by *Hyalomma* spp. occur as 2- or 3-host ticks on a range of mammals and birds, sometimes causing skin lesions, toxicoses and paralysis as well as transmitting several microbial 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:	Ixodidae (hard ticks, with dorsal scutum, capitulum projects anteriorly, attach and feed on 1, 2 or 3 hosts)
Genus:	*Hyalomma* (parasitic on skin of mammals)
Species:	various species cause lesions, toxicosis and paralysis in mammals

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 a complex sensory pit (Haller's organ) on tarsus I. 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 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 Ixodidae contains 6 subfamilies (Amblyomminae, Bothriocrotoninae, Haemaphysalinae, Hyalomminae, Ixodinae and Rhipicephalinae) which vary in their morphology, biology, host ranges and specificity. [Note that some taxonomic authorities have merged the subfamilies Rhipicephalinae and Hyalomminae, while others have subsequently assigned the subfamilies Amblyomminae and Rhipicephalinae into the new family Amblyommidae, predominantly on the basis of molecular phylogenetic studies]. Hard ticks had previously been divided into 2 groups: the Prostriata (with the anal groove anterior to the anus) and the Metastriata (anal groove absent or posterior to anus). The Prostriata essentially comprises the subfamily Ixodinae with over 230 species assigned to the single extant genus *Ixodes* [plus one fossil genus (*Cornupalpatum*)], while the Metastriata contains members of the remaining subfamilies with over 600 species classified into 18 genera. The subfamily Hyalomminae comprises metastriate inornate ticks with eyes and festoons and adult males have ventral plates. It only contains 2 genera (*Hyalomma* and *Nosomma*) which are medium-sized ticks with elongate palps, an inornate scutum (ornate in the single *Nosomma* sp.) with simple eyes and indistinct festoons, banded legs and males with adanal shields. Around 33 *Hyalomma* species described from a range of mammals, birds and reptiles, most having 2-host life-cycles but some having 3-hosts. Three subgenera have been recognized: namely, *H.* (*Hyalomma*)*, H.* (*Hyalommasta*) and *H.* (*Hyalommina*)*;* but many species remain to be allocated to subgenera. Infestations in domestic animals may cause lesions, anaemia, toxicoses, and sometimes paralysis. The ticks may also transmit infectious viral, bacterial and protozoal diseases to livestock.

***Hyalomma* species**	**Hosts**	**Clinical signs**	**Distribution**
H. (*Hyalommasta*) *aegyptium* (syn. *H. affine, algeriense, cornuger, I. fabricii, forskaelii, gracilentis, hispanus, syriacum, utriculus*) (tortoise tick)	Artiodactyla: bovid (cattle, zebu, buffalo, water buffalo, sheep, urial, goat, west Caucasian tur, Nilgiri tahr, blue wildebeest, Lichtenstein's hartebeest, blackbuck, greater kudu, common eland, oribi, Sudan oribi, Nile lechwe, sitatunga, grysbok, impala, duiker, fringe-eared oryx, sable antelope, roan antelope, Grant's gazelle), camelid (Bactrian camel, dromedary), cervid (red deer, Tibetan red deer), giraffid (giraffe, Cape giraffe), suid (pig, boar, bushpig, warthog, desert warthog); Perissodactyla: equid (horse, donkey, mule, plains zebra, Crawshay's zebra), rhinocerotid (black rhinoceros); Eulipotyphla: erinaceid (four-toed hedgehog, collared hedgehog, northern white-breasted hedgehog, European hedgehog, South African hedgehog, Brandt's hedgehog); Lagomorpha: leporid (rabbit, scrub hare, European hare, Cape hare), ochotonid (pika); Rodentia: caviid (guinea pig), cricetid (grey dwarf hamster), dipodid (jerboa), murid (wood mouse, black rat, fat sand rat); Carnivora: canid (dog, black-backed jackal, Karaganka fox), felid (cat, wildcat, lion), ursid (sloth bear); Primates: hominid (human); Accipitriformes: accipitrid	trauma, irritation (vector for reptile haemogregarines, rickettsiosis, Q fever, borreliosis and possibly anaplasmosis and ehrlichiosis)	Europe, Asia

	(black kite, Swainson's hawk); Bucerotiformes: upupid (European hoopoe); Charadriiformes: burhinid (spotted thick-knee), charadriid (plover); Columbiformes: columbid (pigeon, European turtle dove); Coraciiformes: coraciid (European roller); Galliformes: phasianid (rock partridge, grey partridge, common quail, chicken, turkey); Passeriformes: alaudid (large-billed lark), dicrurid (black drongo), callaeid (huia), emberizid (Cretzschmar's bunting), hirundinid (swallow), laniid (woodchat shrike), motacillid (tree pipit), muscicapid (whinchat, spotted flycatcher, thrush nightingale, Cape robin-chat, common wheatear, northern wheatear, isabelline wheatear, common redstart), passerid (Spanish sparrow), parulid (warbler), phylloscopid (willow warbler), sturnid (common starling), sylviid (common whitethroat, lesser whitethroat), turdid (chat), vangid (rufous vanga); Pelecaniformes: ardeid (cattle egret); Strigiformes: strigid (little owl, barn owl, spotted eagle-owl); Struthioniformes: struthionid (ostrich); Sauria: agamid (starred agama), anguid (glass lizard), chamaeleonid (common chameleon), gekkonid (comb-toed gecko, Mediterranean house gecko), lacertid (snake-eyed lizard, western green lizard, Lebanon lizard); Serpentes: pythonid (African rock python), viperid (puff adder); Testudines: emydid (eastern box turtle, European pond turtle), testudinid (radiated tortoise, yellow-footed tortoise, spur-thighed tortoise, marginated tortoise, geometric tortoise, Greek tortoise, Russian tortoise, Hermann's tortoise, Horsfield's tortoise, Kleinmann's tortoise) (2-host cycle)		
H. aequipunctatum	Artiodactyla: camelid (camel), cervid (sika deer)		Middle-East
H. (*Euhyalomma*) *albiparmatum*	Artiodactyla: bovid (cattle, buffalo, sheep, goat, gemsbok, eland, hartebeest, blue wildebeest, greater kudu, impala, Grant's gazelle), giraffid (Masai giraffe), suid (desert warthog); Perissodactyla: equid (Burchell's zebra, Grant's zebra), rhinocerotid (black rhinoceros); Lagomorpha: leporid (Cape hare); Carnivora: canid (dog), felid (lion, leopard); Primates: hominid (human); Struthioniformes: struthionid (ostrich) (3-host cycle)	(vector for rickettsiosis)	Africa
H. (*Hyalomma*) *anatolicum* (syn. *H. depressum, grossum*, *pusillum*) (bont-legged tick)	Artiodactyla: bovid (cattle, zebu, buffalo, water buffalo, sheep, karakul sheep, argali, goat, alpine ibex, antelope), camelid (camel, dromedary), cervid (red deer), suid (pig); Perissodactyla: equid (horse, donkey, mule, onager); Eulipotyphla: erinaceid (long-eared hedgehog, Egyptian hedgehog); Lagomorpha: leporid (European rabbit, desert hare, tolai hare, European hare, Cape hare), ochotonid (pika); Rodentia: cricetid (northern mole vole), dipodid (small five-toed jerboa, lesser Egyptian jerboa), hystricid (Indian crested porcupine), murid (short-tailed bandicoot rat, fat sand rat, Turkestan rat, house mouse, wood mouse, golden spiny mouse, great gerbil, Mongolian gerbil, lesser Egyptian gerbil, midday jird, Libyan jird, Sundevall's jird, Tamarisk jird), sciurid (yellow ground squirrel, long-clawed ground squirrel); Carnivora: canid (dog, golden jackal, fox), felid (cat), mustelid (marbled polecat, least weasel); Primates: hominid (human); Charadriiformes: burhinid (European stone curlew); Galliformes: phasianid (chicken, common quail, turkey); Passeriformes: acrocephalid (Eurasian reed warbler), corvid (hooded crow), hirundinid (barn swallow), motacillid (tree pipit), muscicapid (flycatcher), passerid (Spanish sparrow), turdid (Eurasian blackbird); Sauria: lacertid (wall lizard); Crocodilia: crocodylid (crocodile); Testudines: testudinid (Russian tortoise) (2- or 3-host cycle)	trauma, irritation, toxicosis, sweating sickness (vector for theileriosis, anaplasmosis, Crimean-Congo haemorrhagic fever, arboviruses)	Asia, Middle East, Africa
H. (*Hyalommina*) *arabica*	Artiodactyla: bovid (sheep, goat); Rodentia: murid (spiny mouse) (3-host cycle)		Arabia
H. asiaticum (syn. *H. amurense*)	Artiodactyla: bovid (cattle, buffalo, water buffalo, sheep, karakul sheep, goat, wild goat, argali, urial, saiga, goitered gazelle),	(vector for theileriosis, Q	Indo-China

(incl. subspp. *asiaticum, caucasicum, kozlovi*)	camelid (Bactrian camel, dromedary), cervid (red deer, Bactrian deer), suid (pig, wild boar); Perissodactyla: equid (horse, donkey, mule, onager), Eulipotyphla: erinaceid (long-eared hedgehog, European hedgehog, Brandt's hedgehog), soricid (tundra shrew, lesser white-toothed shrew, piebald shrew); Lagomorpha: leporid (rabbit, tolai hare, European hare), ochotonid (Afghan pika); Rodentia: cricetid (desert hamster, golden hamster, grey dwarf hamster, northern mole vole, steppe lemming), dipodid (Gobi jerboa, small five-toed jerboa, northern three-toed jerboa, hairy-footed gerboa, long-eared gerboa, dwarf fat-tailed jerboa, thick-tailed three-toed jerboa, lesser Egyptian jerboa, William's jerboa), hystricid (Indian crested porcupine), murid (house mouse, wood mouse, short-tailed bandicoot rat, brown rat, great gerbil, midday jird, Libyan jird, Persian jird, Tamarisk jird, Tristram's jird, Vinogradov's jird), sciurid (long-tailed ground squirrel, long-clawed ground squirrel, yellow ground squirrel, yellow suslik, little ground squirrel, European ground squirrel); Carnivora: canid (dog, wolf, jackal, red fox, Karaganka fox), felid (sand cat), mustelid (steppe polecat, marbled polecat, least weasel); Chiroptera (unspecified bat); Primates: hominid (human); Accipitriformes: accipitrid (long-legged buzzard); Bucerotiformes: upupid (European hoopoe); Columbiformes: columbid (rock pigeon); Coraciiformes: coraciid (European roller); Galliformes: phasianid (chicken); Passeriformes: corvid (European magpie), emberizid (red-headed bunting), laniid (red-tailed shrike), motacillid (pied wagtail, white wagtail, western yellow wagtail), muscicapid (pied wheatear), sturnid (common starling), sylviid (common whitethroat, lesser whitethroat); Strigiformes: strigid (Eurasian eagle-owl); Sauria: gekkonid (Przewalski's wonder gecko), lacertid (Strauch's racerunner), scincid (Berber skink); Serpentes: colubrid (dotted dwarf racer, smooth snake), viperid (Halys pit viper); Testudines: testudinid (Greek tortoise, Russian tortoise) (3-host cycle)	fever, rickettsiosis (Siberian tick typhus) and possibly Crimean-Congo haemorrhagic fever, Tamdy and Wad Medani viruses)	
H. (*Hyalommina*) *brevipunctatum*	Artiodactyla: bovid (cattle, buffalo, sheep, goat, nilgai), camelid (camel), cervid (spotted deer, sambar); Perissodactyla: equid (horse); Eulipotyphla: soricid (Asian house shrew); Rodentia: murid (mouse, little Indian field mouse, flat-haired mouse, Asiatic long-tailed climbing mouse, black rat, soft-furred rat, Blanford's rat), sciurid (jungle palm squirrel); Carnivora: canid (dog), felid (cat, cheetah); Primates: hominid (human); Cuculiformes: cuculid (cuckoo) (3-host cycle)	(vector for Kyasanur forest disease)	India, Pakistan
H. bubi (nymphs) *nomen nudum*	Strigiformes: strigid (Eurasian eagle-owl)		India
H. dromedarii (syn. *H. delpyi, yakimovi*) (camel tick)	Artiodactyla: bovid (cattle, zebu, buffalo, sheep, goat, oryx, Arabian antelope), camelid (dromedary), suid (pig, warthog); Perissodactyla: equid (horse, donkey); Eulipotyphla: erinaceid (long-eared hedgehog, desert hedgehog); Lagomorpha: leporid (tolai hare, Egyptian hare, Cape hare); Rodentia: dipodid (lesser Egyptian jerboa), geomyid (gopher), murid (black rat, fat sand rat, short-tailed bandicoot rat, Libyan jird, Shaw's jird, Sundevall's jird, four-spotted gerbil, Cheesman's gerbil, lesser Egyptian gerbil, great gerbil, greater Egyptian gerbil, North African gerbil), sciurid (long-clawed ground squirrel); Carnivora: canid (dog, red fox, Ruppell's fox), felid (cat), hyaenid (hyena); Primates: hominid (human); Charadriiformes: charadriid (Egyptian plover); Falconiformes: falconid (common kestrel); Galliformes: phasianid (common quail); Struthioniformes: struthionid (ostrich); Sauria: lacertid (Bosc's fringe-toed lizard), scincid (long-tailed skink) (1-, 2- or 3-host cycle)	trauma, irritation, toxicosis, sweating sickness (vector for theileriosis, hepatozoonosis, Q fever, rickettsiosis, Crimean-Congo haemorrhagic fever, Kadam, Dera Ghazi Khan, Sindbis and Dhori viruses)	Eurasia, Africa
H. excavatum	Artiodactyla: bovid (cattle, buffalo, water buffalo, sheep, Asiatic	trauma, irritation,	Africa,

(syn. *I. algeriensis, savignyi*) (brown ear tick)	mouflon, goat, eland, unspecified gazelle), camelid (dromedary), cervid (deer), suid (pig, desert warthog); Perissodactyla: equid (horse, donkey); Eulipotyphla: erinaceid (European hedgehog); Lagomorpha: leporid (rabbit, mountain hare, European hare, Cape hare), ochotonid (pika); Rodentia: dipodid (lesser Egyptian jerboa), murid (eastern broad-toothed field mouse, Cairo spiny mouse, fat sand rat, bushy-tailed gerbil, lesser Egyptian gerbil, greater Egyptian gerbil, Wagner's gerbil, Sundevall's jird, Shaw's jird, Tristram's jird), sciurid (ground squirrel); Carnivora: canid (dog), mustelid (tayra); Primates: hominid (human); Galliformes: phasianid (partridge); Passeriformes: motacillid (grey wagtail), muscicapid (common redstart, black redstart), oriolid (Eurasian golden oriole); Sauria: lacertid (Bosc's fringe-toed lizard) (2- or 3-host cycle)	toxicosis (vector for theileriosis and possibly rickettsiosis and borreliosis)	Eurasia
H. franchinii	Artiodactyla: bovid (cattle, sheep), camelid (camel); Perissodactyla: equid (donkey); Rodentia: murid (golden spiny mouse); Primates: hominid (human); Sauria: agamid (desert agama), lacertid (Bosc's fringe-toed lizard, Nidua fringe-toed lizard, Schreiber's fringe-toed lizard); Testudines: testudinid (Greek tortoise) (3-host cycle)		Europe
H. glabrum (syn. *H. marginatum turanicum*) (enameled bont-legged tick, pale-legged bont-legged tick)	Artiodactyla: bovid (cattle, sheep, goat, gemsbok, eland); Perissodactyla: equid (horse, Cape mountain zebra), rhinocerotid (black rhinoceros); Lagomorpha: leporid (scrub hare); Hyracoidea: procaviid (hyrax); Rodentia: pedetid (springhare); Carnivora: canid (dog); Primates: hominid (human); Galliformes: numidid (guineafowl); Passeriformes: emberizid (cinnamon-breasted bunting), ploceid (red-billed quelea); Strigiformes: strigid (Eurasian eagle-owl) (3-host cycle)	(vector for Crimean-Congo fever)	Africa
H. (*Hyalommina*) *hussaini*	Artiodactyla: bovid (cattle, zebu, buffalo, sheep, goat, nilgai), camelid (dromedary), cervid (chital, sambar deer), suid (pig); Perissodactyla: equid (horse); Eulipotyphla: soricid (shrew); Rodentia: murid (black rat); Carnivora: canid (dog), felid (tiger), ursid (sloth bear); Primates: hominid (human) (3-host cycle)		India, Pakistan, Burma
H. (*Hyalommina*) *hystricis*	Artiodactyla: bovid (cattle, buffalo), cervid (reeve's muntjac), suid (pig, wild boar); Perissodactyla: equid (horse); Scandentia: tupaiid (tree shrew); Rodentia: hystricid (Indian crested porcupine, Bengal porcupine), murid (Southeast Asian house rat, chesnut-bellied white rat); Carnivora: canid (dog), felid (tiger), mephitid (stink badger), mustelid (hog badger), ursid (Himalayan black bear); Primates: hominid (human); Passeriformes: timaliid (large scimitar babbler); Testudines: geoemydid (spiny tortoise)		India
H. impeltatum (syn. *H. brumpti, erythraeum, sinaii, somalicum*)	Artiodactyla: bovid (cattle, zebu, sheep, goat, gazelle, blue wildebeest, gemsbok, eland, Arabian oryx, unspecified gazelle), camelid (dromedary, camel), suid (pig); Perissodactyla: equid (horse, donkey, zebra), rhinocerotid (black rhinoceros); Eulipotyphla: erinaceid (European hedgehog); Lagomorpha: leporid (Cape hare); Rodentia: caviid (guinea pig), dipodid (lesser Egyptian jerboa), murid (fat sand rat, eastern spiny mouse, bushy-tailed gerbil, greater Egyptian gerbil, lesser Egyptian gerbil); Carnivora: canid (dog), felid (caracal); Primates: hominid (human); Passeriformes: muscicapid (northern wheatear, isabelline wheatear, common redstart, black redstart); Struthioniformes: struthionid (ostrich); Sauria: lacertid (Bosc's fringe-toed lizard) (2 or 3-host cycle)	(vector for theileriosis, rickettsiosis, Crimean-Congo haemorrhagic fever)	Africa, South Central Asia
H. impressum (syn. *H. transiens*) (bont-legged tick)	Artiodactyla: bovid (cattle, zebu, buffalo, forest buffalo, sheep, goat, gemsbok, eland, nyala, waterbuck, greater kudu, blue wildebeest, Lichtenstein's hartebeest, sable antelope, roan antelope), camelid (dromedary, camel), giraffid (giraffe), suid	trauma, irritation (vector for Crimean-Congo haemorrhagic	Africa

	(boar, bushpig, red river hog, common warthog, desert warthog); Perissodactyla: equid (horse, donkey, plains zebra), rhinocerotid (black rhinoceros); Lagomorpha: leporid (savannah hare); Eulipotyphla: erinaceid (four-toed hedgehog, South African hedgehog); Tubulidentata: orycteropodid (aardvark); Rodentia: murid (mouse); Carnivora: canid (dog), felid (cat, lion, Indian leopard); Primates: hominid (human); Bucerotiformes: bucerotid (eastern yellow-billed hornbill); Struthioniformes: struthionid (ostrich) (3-host cycle)	fever)	
H. isaaci	Artiodactyla: bovid (cattle, buffalo, sheep, goat), camelid (camel), cervid (Central Asian red deer); Perissodactyla: equid (horse, donkey); Lagomorpha: leporid (Indian hare, rabbit); Rodentia: caviid (guinea pig); Carnivora: canid (dog), herpestid (mongoose); Primates: hominid (human); Cuculiformes: cuculid (coucal); Passeriformes: muscicapid (blue rock thrush), passerid (house sparrow) (2-host cycle)	trauma, irritation (vector for Crimean-Congo haemorrhagic fever, rickettsioses, piroplasmosis, anaplasmosis, trypanosomiasis)	Eurasia
H. (*Hyalommina*) *kumari*	Artiodactyla: bovid (cattle, zebu, buffalo, sheep, goat, Nilgiri tahr), camelid (camel), cervid (unspecified deer); Perissodactyla: equid (horse); Eulipotyphla: soricid (shrew); Rodentia: murid (black rat); Carnivora: canid (dog), felid (tiger); Passeriformes: estrildid (munia) (3-host cycle)		India, Pakistan, South Central Asia
H. (*Hyalomma*) *lusitanicum*	Artiodactyla: bovid (cattle, sheep, goat), camelid (camel), cervid (red deer, roe deer, European fallow deer), suid (pig, boar); Perissodactyla: equid (horse); Eulipotyphla: erinaceid (hedgehog); Lagomorpha: leporid (European rabbit, hare); Rodentia: glirid (garden dormouse), murid (mouse, black rat); Carnivora: canid (dog, red fox), herpestid (mongoose), mustelid (European polecat, least weasel); Otidiformes: otidid (bustard); Primates: hominid (human); Galliformes: phasianid (red partridge); Passeriformes: fringillid (finch), turdid (blackbird); Strigiformes: strigid (eagle-owl); Struthioniformes: struthionid (ostrich) (3-host cycle)	(vector for theileriosis, babesiosis and possibly anaplasmosis, ehrlichiosis, tularemia, borreliosis, Q fever and Crimean-Congo haemorrhagic fever)	Europe
H. (*Hyalomma*) *marginatum* (syn. *H. cypriacum, dentatum, plumbeum*) (bont-legged tick, Mediterranean hyalomma)	Artiodactyla: bovid (cattle, zebu, buffalo, water buffalo, sheep, argali, goat, eland, saiga antelope, goitered gazelle, springbok, black wildebeest), camelid (camel), cervid (red deer, roe deer), giraffid (giraffe), suid (pig, wild boar); Perissodactyla: equid (horse, donkey, mule, plains zebra, mountain zebra, onager); Eulipotyphla: erinaceid (long-eared hedgehog, desert hedgehog, European hedgehog); Lagomorpha: leporid (rabbit, scrub hare, tolai hare, Smith's red rock hare, Cape hare, Indian hare, European hare); Rodentia: caviid (guinea pig), cricetid (common vole, social vole, Major's pine vole), didpodid (small five-toed jerboa), erethizontid (porcupine), murid (house mouse, striped field mouse, wood mouse, fat sand rat, Libyan jird, Shaw's jird, Sundevall's jird, Tamarisk jird, Tristram's jird, great gerbil, lesser Egyptian gerbil), pedetid (springhare), sciurid (red squirrel, little ground squirrel, European ground squirrel); Carnivora: canid (dog, red fox), felid (cat, leopard), herpestid (Indian brown mongoose), mustelid (steppe polecat, marbled polecat, least weasel); Primates: hominid (human); Accipitriformes: accipitrid (great spotted eagle, booted eagle, tawny eagle, western marsh harrier, hen harrier, pallid harrier, common buzzard, Himalayan buzzard, dark chanting goshawk, Egyptian vulture); Anseriformes: anatid (mallard, goose); Bucerotiformes: upupid (Eurasian hoopoe); Caprimulgiformes: caprimulgid (European nightjar); Charadriiformes: burhinid (Eurasian stone curlew), charadriid (northern lapwing, European golden plover, little ringed plover), scolopacid (common snipe); Columbiformes: columbid (common wood pigeon, yellow-eyed pigeon, rock dove,	trauma, irritation, paralysis (vector for theileriosis, babesiosis, anaplasmosis, rickettsiosis, Q fever, Crimean-Congo haemorrhagic fever and possibly West Nile virus)	Africa, Asia, Europe

	laughing dove, European turtle dove); Coraciiformes: coraciid (European roller), meropid (European bee-eater, blue-cheeked bee-eater); Cuculiformes: cuculid (common cuckoo); Falconiformes: falconid (common kestrel, lesser kestrel, saker falcon); Galliformes: phasianid (chicken, common partridge, Daurian partridge, grey partridge, rock partridge, chukar partridge, see-see partridge, mountain partridge, common quail, black francolin, ring-necked pheasant, turkey); Gruiformes: gruid (common crane, Demoiselle crane), rallid (spotted crake); Otidiformes: otidid (great bustard, little bustard); Passeriformes: acrocephalid (marsh warbler, sedge warbler, melodius warbler, Eurasian reed warbler), alaudid (woodlark, crested lark, red-capped lark, bimaculated lark, Calandra lark, lesser short-toed lark, Hume's short-toed lark, Eurasian skylark, Oriental skylark), corvid (common raven, carrion crow, rook, western jackdaw, Eurasian magpie, Eurasian jay, Turkestan ground jay), emberizid (red-headed bunting, grey-necked bunting, corn bunting, eastern meadow bunting, white-capped bunting, Cretzschmar's bunting, Ortolan bunting, yellowhammer), fringillid (hawfinch, common chaffinch, desert finch, grey-crowned goldfinch, European goldfinch, European greenfinch, common linnet, white-winged snowfinch), laniid (red-backed shrike, brown shrike, lesser grey shrike, masked shrike, long-tailed shrike, woodchat shrike), leiothrichid (yellow-billed babbler), locustellid (Savi's warbler), motacillid (tawny pipit, tree pipit, white wagtail, grey wagtail, citrine wagtail, western yellow wagtail), muscicapid (common rock thrush, blue rock thrush, blue whistling thrush, common nightingale, thrush nightingale, common redstart, black redstart, Guldenstadt's redstart, rufous-tailed scrub robin, European robin, European pied flycatcher, whinchat, pied bush chat, African stonechat, northern wheatear, isabelline wheatear, variable wheatear, western black-eared wheatear, pied wheatear, common nightingale, thrush nightingale, collared flycatcher, spotted flycatcher, European pied flycatcher), oriolid (Eurasian golden oriole), parid (great tit), passerid (house sparrow, tree sparrow, rock sparrow, Spanish sparrow), phylloscopid (greenish warbler, willow warbler, sulphur-bellied warbler), scotocercid (streaked scrub warbler), sittid (western rock nuthatch, eastern rock nuthatch), sturnid (common starling, rosy starling, Brahminy starling, Tristram's starling, common mynah), sylviid (common whitethroat, lesser whitethroat, Hume's whitethroat, garden warbler, western subalpine warbler, Eurasian blackcap), turdid (common blackbird, song thrush, red-throated thrush, mistle thrush); Pterocliformes: pteroclid (black-bellied sandgrouse); Strigiformes: strigid (little owl, boreal owl, short-eared owl, Eurasian scops owl, Eurasian eagle-owl); Sauria: agamid (Caucasian agama), lacertid (sand lizard, Caucasus emerald lizard, European green lizard, Bosc's fringe-toed lizard); Testudines: testudinid (Greek tortoise) (2-host cycle)		
H. marinatum	Struthioniformes: struthionid (ostrich)		
H. monstrosum	Artiodactyla: suid (Indian boar); Perissodactyla: equid (horse)		India
H. (*Euhyalomma*) *nitidum*	Artiodactyla: bovid (cattle, buffalo, goat, gemsbok, eland, roan antelope, waterbuck, kob), camelid (camel), suid (red river hog, warthog); Perissodactyla: equid (horse, zebra); Lagomorpha: leporid (African savannah hare); Rodentia: murid (striped grass mouse); Carnivora: canid (golden jackal); Primates: hominid (human) (3-host cycle)	(possible vector for Crimean-Congo haemorrhagic fever)	Africa
H. (*Hyalommina*) *punt*	Artiodactyla: bovid (cattle, sheep, goat, antelope, gazelle), camelid (camel) (3-host cycle)		Somalia, Ethiopia
H. puta	Charadriiformes: chionid (black-faced sheathbill);		Kerguelen

	Procellariiformes: diomodeid (sooty albatross); Spheniscifformes: spheniscid (Gentoo penguin)		Islands
H. (Hyalommina) rhipicephaloides	Artiodactyla: bovid (sheep, goat, alpine ibex, Nubian ibex, Arabian gazelle); Lagomorpha: leporid (Cape hare); Rodentia: murid (eastern spiny mouse, golden spiny mouse, Cairo spiny mouse); Carnivora: canid (Ruppell's fox) (3-host cycle)		Middle-East
H. rufipes (coarse bont-legged tick)	Artiodactyla: bovid (cattle, buffalo, sheep, goat, eland, common duiker, hartebeest, blue wildebeest, gemsbok, springbok, blesbok, bushbuck, greater kudu, roan antelope, sable antelope), camelid (camel), giraffid (giraffe, Masai giraffe); Perissodactyla: equid (horse, Burchell's zebra, Grant's zebra, Hartmann's mountain zebra), rhinocerotid (black rhinoceros), suid (desert warthog); Eulipotyphla: erinaceid (four-toed hedgehog, South African hedgehog); Macroscelidea: macroscelidid (elephant shrew, bushveld elephant shrew); Lagomorpha: leporid (Jameson's red rock hare, scrub hare, Egyptian hare, Cape hare); Rodentia: caviid (guinea pig), murid (striped grass mouse, four-striped grass mouse, eastern spiny mouse, African grass rat, Namaqua rock rat, Woosnam's brush-furred rat, Cape short-eared gerbil); Carnivora: canid (dog, black-backed jackal), felid (cat, leopard), herpestid (yellow mongoose); Primates: hominid (human); Accipitriformes: accipitrid (black kite, yellow-billed kite, martial eagle, common buzzard); Bucerotiformes: bucerotid (African grey hornbill), phoeniculid (green wood hoopoe, common scimitarbill); Charadriiformes: burhinid (spotted thick-knee); Coliiformes: coliid (red-faced mousebird); Columbiformes: columbid (laughing dove, Namaqua dove); Coraciiformes: alcedinid (striped kingfisher), meropid (little bee-eater); Cuculiformes: cuculid (common cuckoo, Senegal coucal); Falconiformes: falconid (common kestrel); Galliformes: numidid (helmeted guineafowl, tiara'd guineafowl), phasianid (chicken, red-billed spurfowl, yellow-necked spurfowl, crested francolin); Gruiformes: gruid (black-crowned crane); Otidiformes: otidid (southern black korhaan, black bustard, white-bellied bustard); Passeriformes: alaudid (greater short-toed lark, large-billed lark, spike-heeled lark, monotonous lark, Sabota lark), cisticolid (black-chested prinia), dicrurid (fork-tailed drongo), estrildid (blue waxbill), fringillid (white-throated canary, black-throated canary, streaky-headed seedeater), hirundinid (barn swallow), laniid (magpie shrike, southern fiscal shrike, masked shrike, woodchat shrike), malaconotid (southern boubou, brown-crowned tchagra, crimson-breasted shrike, black-headed puffback), motacillid (tawny pipit, Cape longclaw), muscicapid (fiscal flycatcher, southern black flycatcher, Marico flycatcher, mocking cliff chat, Cape robin chat, anteater chat, northern wheatear, black-eared wheatear, isabelline wheatear, rufous-tailed scrub-robin, common rock thrush, spotted flycatcher, common redstart), oriolid (black-headed oriole), parid (coal tit, grey tit, cinereous tit, southern black tit, ashy tit), passerid (northern grey-headed sparrow), ploceid (lesser masked weaver, southern masked weaver, white-browed sparrow-weaver, village weaver, red-billed quelea), pycnonotid (common bulbul, white-spectacled bulbul, dark-capped bulbul), scotocercid (streaked scrub warbler), sturnid (wattled starling, black-bellied starling, Meve's starling), sturnid (red-winged starling), turdid (olive thrush, Cape thrush, Karoo thrush, Kurrichane thrush, Namaqua thrush), vangid (white-crested helmetshrike), viduid (pin-tailed whydah); Strigiformes: strigid (Cape barn owl, Verreaux's eagle-owl); Struthioniformes: struthionid (ostrich); Suliformes: phalacrocoracid (bank cormorant) (2-host cycle)	irritation, abscesses (vector for babesiosis, theileriosis, anaplasmosis, rickettsioses, Crimean-Congo haemorrhagic fever, fowl aegyptianellosis, trypanosomiasis)	Africa
H. schulzei	Artiodactyla: bovid (cattle, sheep, goat), camelid (camel);		Arabia

	Perissodactyla: equid (horse, donkey, mule); Eulipotyphla: erinaceid (hedgehog); Lagomorpha: leporid (Cape hare); Rodentia: murid (fat sand rat, bushy-tailed jird, Sundevall's jird), sciurid (red-cheeked ground squirrel); Carnivora: canid (dog); Primates: hominid (human); Sauria: agamid (unspecified agama) (2-host cycle)		
H. scupense (syn. *H. detritum, mauritanicum, sharifi, steineri, uralense, volgense*) (bont-legged tick, shiny hyalomma)	Artiodactyla: bovid (cattle, zebu, buffalo, water buffalo, sheep, argali, arkhar, goat, argali, antelope, goitered gazelle), camelid (camel), cervid (red deer, Bactrian deer, roe deer), suid (pig, wild boar); Perissodactyla: equid (horse, donkey, mule, onager); Eulipotyphla: erinaceid (hedgehog); Lagomorpha: leporid (rabbit, desert hare, tolai hare, European hare); Rodentia: hystricid (Indian crested porcupine), murid (great gerbil, Libyan jird, Tamarisk jird); Carnivora: canid (dog, golden jackal, true fox), hyaenid (striped hyena), mustelid (marbled polecat); Primates: hominid (human); Accipitriformes: accipitrid (golden eagle); Bucerotiformes: upupid (Eurasian hoopoe); Galliformes: phasianid (chicken, common quail); Gruiformes: gruid (Demoiselle crane), rallid (corn crake); Passeriformes: corvid (black-billed magpie, European jay), passerid (tree sparrow), turdid (common blackbird, true thrush, song thrush); Sauria: lacertid (common wall lizard, European green lizard) (1 or 2-host cycle)	trauma, irritation, toxicosis, sweating sickness (vector for theileriosis, babesiosis, rickettsiosis, Q fever, Bhanja virus and possibly Crimean-Congo haemorrhagic fever, tularemia and brucellosis)	Eurasia, Africa
H. (Euhyalomma) truncatum (syn. *H. lewisi, planum, rhinocerotis, zambesianum, Hyalommina lewisi*) (small smooth bont-legged tick)	Artiodactyla: bovid (cattle, zebu, buffalo, forest buffalo, sheep, goat, roan antelope, sable antelope, black wildebeest, blue wildebeest, hartebeest, red hartebeest, Lichtenstein's hartebeest, brindled gnu, sassaby, tiang, eland, greater kudu, harnessed bushbuck, waterbuck, gemsbok, kob, impala, springbok, blesbok, korrigum, oryx, duiker, nyala), camelid (camel), giraffid (giraffe), suid (pig, Egyptian wild boar, bush pig, red river hog, desert warthog); Perissodactyla: equid (horse, donkey, mule, plains zebra, Hartmann's mountain zebra, Cape mountain zebra, Burchell's zebra), rhinocerotid (black rhinoceros, white rhinoceros); Lagomorpha: leporid (scrub hare, savannah hare, Cape hare, Smith's red rock hare); Macroscelidea: macroscelidid (elephant shrew); Eulipotyphla: erinaceid (four-toed hedgehog); Tubulidentata: orycteropodid (aardvark); Rodentia: hystricid (African porcupine, Cape porcupine), murid (four-striped grass mouse, African grass rat, bush vlei rat, Namaqua rock rat, Brown's whistling rat, bushveld gerbil, Cape gerbil); Carnivora: canid (dog, jackal), felid (cat, African wildcat, cheetah, lion, leopard), herpestid (white-tailed mongoose); Primates: cercopithecid (Chacma baboon), hominid (human); Accipitriformes: sagittarid (secretary bird); Bucerotiformes: bucerotid (yellow-billed hornbill, eastern yellow-billed hornbill, African gray hornbill); Charadriiformes: burhinid (spotted thick-knee); Columbiformes: columbid (laughing dove); Coraciiformes: coraciid (lilac-breasted roller); Galliformes: phasianid (Natal spurfowl, Swainson's spurfowl); Otidiformes: otidid (Denham's bustard, Kori bustard); Passeriformes: alaudid (crested lark), corvid (pied crow), sturnid (wattled starling); Strigiformes: strigid (barn owl); Struthioniformes: struthionid (ostrich); Sauria: agamid (black-necked agama), chamaeleonid (flap-necked chameleon); Testudines: testudinid (leopard tortoise, geometric tortoise, Bell's hinge-back tortoise) (2-host cycle)	trauma, irritation, toxicosis, sweating sickness, paralysis (vector for piroplasmosis, rickettsioses, Q fever, Crimean-Congo haemorrhagic fever)	Africa
H. tunesiacum	Artiodactyla: bovid (cattle, sheep, goat), camelid (camel); Perissodactyla: equid (horse, donkey, mule); Eulipotyphla: erinaceid (hedgehog); Carnivora: canid (dog); Primates: hominid (human); Sauria: agamid (unspecified agama)		Africa
H. turanicum	Artiodactyla: bovid (cattle, sheep), camelid (camel), suid (pig); Perissodactyla: equid (horse); Lagomorpha: leporid (hare); Eulipotyphla: erinaceid (hedgehog); Primates: hominid (human);	trauma, irritation (vector for Crimean-Congo	South Central Asia, Africa

	Accipitriformes: accipitrid (Egyptian vulture); Bucerotiformes: upupid (Eurasian hoopoe); Columbiformes: columbid (rock dove, eastern stock pigeon, yellow-eyed pigeon, European turtle dove); Coraciiformes: coraciid (European roller), meropid (blue-cheeked bee-eater); Galliformes: phasianid (chukar partridge, common pheasant, ringneck pheasant); Passeriformes: alaudid (Calandra lark, Oriental skylark, Oriental short-toed lark, Hume's lark), emberizid (corn bunting, white-capped bunting, grey-necked bunting, red-headed bunting), fringillid (European goldfinch), laniid (lesser grey shrike, red-backed shrike), motacillid (tawny pipit), muscicapid (variable wheatear, African stonechat, white-headed chat, Strickland's chat, black redstart), passerid (house sparrow, tree sparrow), phylloscopid (green warbler), sittid (eastern rock nuthatch), sturnid (common starling, rosy starling), sylviid (lesser whitethroat, Hume's whitethroat) (2-host cycle)	haemorrhagic fever, rickettsioses, piroplasmosis, anaplasmosis, trypanosomiasis)	
H. verae	Artiodactyla: bovid (goitered gazelle)		China

Parasite morphology: *Hyalomma* spp. form 4 different types of morphological stages; namely, eggs, larvae, nymphs, and adults. Eggs are small brown oval stages measuring 0.4-0.5 x 0.3-0.4 mm and usually clustered together in large batches. Larvae have dorso-ventrally flattened oval-pyriform bodies measuring from 0.5-1.0 mm in length. They range in colour from pale yellow to reddish-brown and have a small anterodorsal dorsal shield (scutum) without coloured enamel ornamentation but with lateral eyes. The small anterior capitulum (head) bears long mouthparts while the large posterior idiosoma (body) has poorly developed indentations (festoons) along the posterior margin. Larvae have 3 pairs of long pale legs arising ventrally, but they lack respiratory openings (stigmata). Nymphs are similar in shape and colouration but are larger measuring from 1-4 mm in length. They have 4 pairs of long ventral legs, a pair of lateral stigmata with round plates, and the anus has a posterior anal groove. Adult ticks have ovate-ellipsoidal bodies that are ventrally flattened but dorsally convex (slightly when unfed but strongly when engorged). Unfed ticks are light-yellow to red-brown in colour and range in length from 4-7 mm, while engorged females are often blue-grey in colour and are grossly distended up to 10-20 mm in length. The anterior capitulum is small and visible from above (whereas that of argasids is ventral and not visible from above) and consists of a basis capitulum (basal ring encircling mouthparts) and projecting gnathosoma (bearing mouthparts). The basis capitulum is rectangular (not triangular, hexagonal or pentagonal) with angular lateral margins, and the dorsal surface of females has 2 porose areas (clusters of pores) involved in waterproofing eggs during oviposition. The mouthparts are longer than, but as wide as, the basis capitulum, and bears 2 lateral sensory palps and a central hypostome flanked by 2 cutting chelicerae. The palps are elongate (especially the second segment) and they do not enter the skin when feeding but move laterally. The chelicerae have long curved tubular shafts terminating in cutting digits with recurved teeth. They are used cut skin with a horizontal action tearing flesh to form small pools of blood. The barbed hypostome is inserted into the pools to facilitate feeding and help anchor the tick to the host. A feeding tube (buccal canal) is formed between the chelicerae and hypostome to suck blood and inject saliva from long paired salivary glands. The alimentary tract consists of a muscular pharynx (with pharyngeal valve), a short oesophagus, a large saccular midgut (ventriculus) with lateral diverticula (caeca), a short intestine (with excretory Malpighian tubules), a rectal sac, and a subterminal ventral anus. The anus has a posterior (metastriate) anal groove, unlike Ixodes which has an anterior (prostriate) groove. The posterior idiosoma is large and bears a sclerotized dorsal plate (scutum) which nearly covers the dorsal surface of males (= conscutum), but is restricted to a small anterior shield in females. The scutum is inornate (without coloured enamel ornamentation) but may have longitudinal striations, several ridges and depressions and a few shallow scattered punctuations. The lateral margins of the scutum contain 2 simple orbited convex eyes. The posterior margin of the idiosoma has a series of indented grooves (festoons) which are irregular and partly coalesced (indistinct on engorged females). The ventral idiosoma gives rise to 4 pairs of long legs, which are very distinctive in most species as they have conspicuous pale rings around the distal portions of most segments. While *Hyalomma* spp. are often known as bont-legged (banded legged) ticks, some species actually do not have bands (e.g. *H. anatolicum, H. scupense*). Each leg contains 6 segments (coxae, trochanter, femur, patella (genu), tibia, and tarsus) and ends in a pair of claws with a pad-like pulvillus (argasids do not have pulvilli). Coxae I possess a pair of large and equal spurs in both sexes, tarsi I have a unique sensory structure (Haller's organ) used to detect host odours, heat and vibrations, and a pair of lateral respiratory stigmata with large spiracular plates are located behind coxae IV (the stigmata on argasids are located between coxae III). Adult ticks display marked sexual dimorphism, with external differences mainly involving body size (females are larger), scutal plates (larger in males), and glands (females with porose areas). Male *Hyalomma* also have sclerotized ventral plates (adanal, subanal and accessory plates) like *Ixodes* and *Rhipicephalus* (incl. *Boophilus*). Mature males have 2 tubular testes with vas efferentia joining to form a common vas deferens (with accessory gland) leading to the ejaculatory duct and genital aperture (gonopore) situated anteroventrally behind a sclerotized flap (genital apron). Mature females have a single saccular ovary with paired tubular oviducts joining to a common uterus (with lateral accessory glands). The vagina has 2 regions with the cervical region acting as a receptaculum seminis to store spermatophores and the vestibular vagina prolapsing during oviposition. The gonopore may be V- or U-shaped and is located anteroventrally behind a genital apron and adjacent to a special secretory structure (Gene's organ) which produces waxy coating for eggs.

Site of infection: All motile developmental stages are transient ectoparasites on the skin of vertebrate hosts. Infestations have been recorded on mammals belonging to 36 families in 12 orders (including ungulates, insectivores, lagomorphs, rodents, carnivores and primates), birds belonging to 31 passerine families and 29 non-passerine families in 20 orders (including shore birds, sea birds, terrestrial birds, fowl, doves and birds of prey), reptiles belonging to 6 lizard families, 3 snake families, 3 tortoise families and one crocodile family. Most species exhibit variable host specificities (or host preferences), as smaller stages (larvae and nymphs) tend to occur on smaller animals (mammals (especially rodents), ground-dwelling birds and reptiles) while adult ticks occur on larger animals (mainly ungulates but also including carnivores, lagomorphs, passeriform and galliform birds, and some nocturnal birds of prey). Their favoured feeding sites also vary greatly but are often regions with sparse hair/feathers that are difficult for the host to groom. Feeding stages on birds and reptiles are often found around the head (face, eyes, ears), neck and foreleg axillae. On mammals, they are usually found around the ears, eyes, belly, inner thighs, scrotum, udders, perineum and between the toes (depending on host species). In heavy infestations, however, ticks may occur over the whole body.

Pathogenesis: Larvae, nymphs and adult ticks are haematophagous parasites that attach to vertebrate hosts to feed using their cutting mouthparts to form pools of blood from which they suck up blood (feeding process known as telmophagy). Their attachment to the host is aided by the secretion of a salivary cement which helps create a feeding lesion in the dermis. During feeding, they inject saliva containing many haemodynamic compounds, including those with cytolytic, analgesic, anticoagulatory and vasodilatory properties. When replete with blood, they detach to digest their bloodmeals before undergoing further development. Despite their transient feeding, heavy infestations may cause blood loss severe enough to manifest as anaemia (females shown to engorge with blood volumes up to 8 ml). Tick bites cause local tissue trauma with irritation, pruritus, inflammation (erythema, oedema), focal necrosis and granuloma formation. Animals may aggressively groom infested regions (biting, scratching, rubbing) resulting in self-trauma and predisposing conditions for secondary infections, abscess formation, pyaemia and even myiasis. Infestations of the ear may cause otoacariasis, with ear pain, inflammation, exudates and frequent head-shaking. Livestock may exhibit considerable biting stress (tick worry) with interrupted feeding, weakness, poor growth and reduced meat and/or milk production. These effects may be exacerbated in animals where ticks have infested interdigital clefts resulting in reduced mobility and lameness. Saliva from engorging females of several species has also been associated with toxicosis in certain hosts, producing a sweating sickness with profuse moist eczema and hyperaemia of mucous membranes in pigs and ruminants, ascending flaccid paralysis with unsteady gait, lameness and recumbency in camels and lambs, and even facial nerve paralysis in humans. Feeding stages may also act as vectors for the transmission of several infectious microbial diseases. Some microbes may undergo massive amplification in tick tissues, most survive tick moults (trans-stadial transmission) and some are even transferred vertically to tick eggs (trans-ovarian transmission). Hosts may become infected when ticks feed (via saliva), regulate fluids (via regurgitation) or eliminate wastes (via defaecation). Various *Hyalomma* spp. have been shown to transmit haemoprotozoa causing babesiosis, theileriosis and trypanosomiasis, rickettsial bacteria causing spotted fevers, anaplasmosis, Siberian tick typhus, Boutonneuse fever and canine ehrlichiosis, proteobacteria causing coxiellosis (Q fever) and brucellosis, and viruses causing African horse sickness and Crimean-Congo haemorrhagic fever. Screening studies have also detected a range of arthropod-borne (arbo-) viruses in ticks, including Bhanja, Chick Ross, Dhori, Kadam, Sindbis, Thogoto and West Nile viruses, but their involvement in the transmission of disease remains to be established.

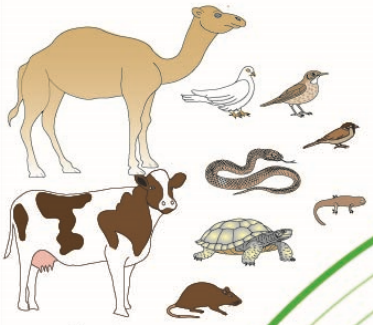
Developmental cycle and mode of transmission: *Hyalomma* spp. undergo incomplete (hemimetabolous) metamorphosis whereby eggs hatch larvae which moult to nymphs and then adults. Most species have 3-host life-cycles (all stages on separate hosts) although some have 2-host cycles (larvae and nymphs on one host, adults on another) and a few have one-host cycles (all stages on the same host). Some 3-host species can adopt one- or 2-host cycles, a facultative ability unique to this genus. Each developmental stage feeds once to repletion, with larvae and nymphs feeding for several days and adults for a few weeks. Gravid female ticks lay eggs in ground litter where they hatch after 21-43 days, sometimes up to 60 days depending on prevailing conditions. The emergent 6-legged larvae then seek hosts on which to feed, preferring small mammals, ground-dwelling birds or reptiles. Many species actively hunt for hosts by scuttling along the ground after sensing nearby vibrations, body heat or chemical odours (especially exhaled carbon dioxide, but also including pheromones produced by ticks already resident on hosts). Some ticks may also adopt an ambush strategy by climbing onto vegetation and questing for passing hosts. Larvae may survive without feeding for several weeks to months as they appear to be quite resistant to cold and dry conditions. Having located a host, the larvae crawl onto the skin and attach to feed for 2-5 days (rarely up to 21 days). When replete, the larvae detach and those species with 3-host cycles drop to the ground while those with 1- or 2-host cycles stay on the host. After 4-18 days to digest their bloodmeals, the larvae moult to form 8-legged nymphs (only one nymphal instar is formed, while argasids form 2-7 nymphal instars). Free nymphs then seek small animal hosts either by hunting or questing and they may survive unfed for several weeks. Nymphs attach to their hosts and feed for 6-8 days, sometimes up to 23 days. Those attached to migratory birds have been shown to undergo widespread dispersal. When replete, nymphs detach and those species with 2- or 3-host cycles drop to the ground while those with 1-host cycles stay on the host. Fed nymphs take several days to digest their bloodmeals before moulting to adult ticks. Both male and female ticks seek hosts by hunting or questing, preferentially infesting larger animals, particularly ungulates. Adult ticks may survive unfed for several weeks depending on environmental conditions (longer in moist conditions). Having located a suitable host, both males and females begin feeding as they require bloodmeals to become sexually mature. Males take small meals and move about the host seeking attached females presumably following pheromone cues. Mating takes place on hosts when males transfer spermatophores to receptive females. Once fertilized, attached females continue feeding for 5-14 days until engorgement, sometimes up to 52 days in a few species. When replete, they drop off the host onto the ground and after 3-12 days begin to lay large batches of eggs (totaling 4,000-

15,500) over 8-12 days (sometimes up to 40 days) before becoming spent and dying. The duration of the entire life-cycle depends on the tick species, whether 1, 2 or 3 hosts are required and their availability, and the geographic location and climate. Experimental and epidemiological studies have shown that the life cycle may be completed in as little as 70-180 days, but it often takes longer when hosts are sparsely distributed or only seasonally available. Species with 1-host cycles complete one generation each year, those with 2-host cycles generally take 1-2 years while those with 3-host cycles take 2-3 years. *Hyalomma* ticks are most abundant in warm arid and semiarid regions with long dry seasons. Nymphs and unfed adults survive the dry winter seasons in cracks and crevices in rocks, stone walls and stables, or amongst the litter in weedy or fallow fields.

Differential diagnosis: Infestations are rarely diagnosed on clinical grounds as symptoms and signs (skin lesions, anaemia, illthrift) are nonspecific and could be attributed to a number of causes (including other ectoparasites). Diagnoses are made by direct detection of feeding stages attached to hosts which are subsequently collected for microscopic examination and identification on the basis of their morphological characteristics (e.g. inornate ticks with festoons and eyes, banded legs, rectangular basis capituli, long mouthparts, long palps, males with ventral plates). Specimens may be preserved by freezing or fixation for molecular characterization, with phylogenetic analyses usually conducted following 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, nicotinamide adenine dinucleotide dehydrogenase subunit 5) gene sequences.

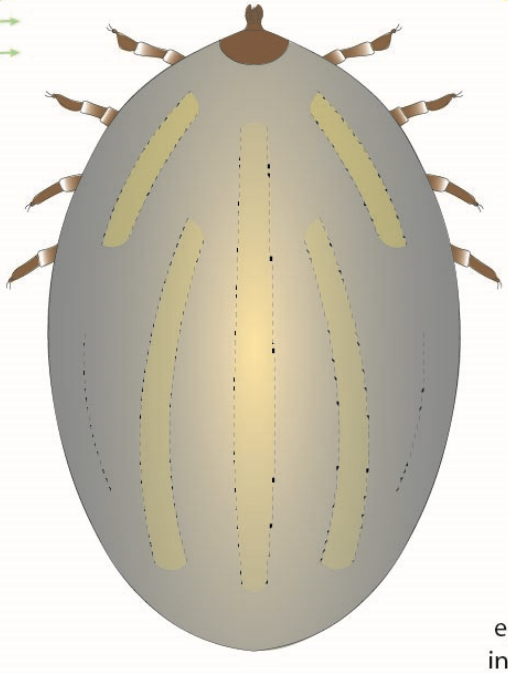
Treatment and control: Individual ticks may be removed from compliant hosts using fine forceps, special tick removal devices (keys, lassos, twists) and even spearing with sharp thorns. Care should be taken not to squeeze or break ticks as fluids and fragments may cause further inflammation or systemic reactions. Caution should also be exercised if using folklore remedies that include applying freezing agents, solvents or volatile fluids to the backs of ticks as they may release potentially toxic compounds when dying. Bite sites should be treated with disinfectants and symptomatic relief may be provided using analgesics, antipuritics, antihistamines or even antibiotics to forestall secondary bacterial infections. Infestations on livestock and companion animals are more usually treated using chemical acaricides applied as topical or systemic sprays/showers, dips/baths, dusts, emulsions, pour-ons, spot-ons, collars, eartags, tailtags, drenches, tablets or injections. Successful treatments have been reported using arsenical preparations, organochlorines (dichloro-diphenyl-trichloroethane (DDT), lindane), organophosphates (coumaphos, malathion, chlorpyrifos, fenthion, dichlorvos, diazinon, phosmet, chlorfenvinphos, dioxathion, fenchlorvos, trichlorfon), carbamates (carbaryl), pyrethroids (permethrin, flumethrin, deltamethrin, decamethrin, cypermethrin, cyprothrin), formamidines (amitraz), macrocyclic lactones (ivermectin, selamectin), phenylpyrazoles (fipronil), chloronicotinyls (imidacloprid), isoxazolines (afoxolaner, fluralaner), some natural products (rotenone) and insect growth regulators (methoprene, pyriproxyfen). Animals may require periodic treatments as they may become re-infested, although the use of slow-release formulations or those with long residual activities reduces treatment frequency. Unfortunately, tick populations have developed resistance to many acaricides, including organochlorines, organophosphates and some pyrethroids and formamidines. Recommendations to combat the development of resistance include avoiding under-dosing, periodic cycling between major acaricide classes, and testing for resistance (by *in situ* or *in vitro* egg hatch, larval development or adult survival assays). A range of preventive measures may be used to minimize transmission cycles through strategic health management (screening, quarantine, treatment, culling), grazing management (pasture rotation, spelling, cultivation, avoiding overstocking), environmental management (clearing vegetation, cleaning holding facilities, treating with residual acaricides) and wildlife control (vermin control through hunting or trapping, excluding wildlife using barriers, diverting migration routes, treating using medicated supplementary feeds or installing self-medicating devices such as rollers and rubbing posts). People at risk should improve their personal protection by wearing better clothing (boots, socks, trousers with gathered cuffs, long-sleeved shirts), applying repellents to skin or clothing (such as diethyltoluamide (DEET), permethrin, picaridin, oil of eucalyptus), or by avoiding tick-infested grassy habitats. Preliminary vaccination studies using *H. anatolicum* gut antigens have demonstrated some success in protecting cattle against subsequent tick challenge.

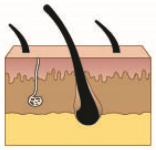
Hyalomma



Hosts
(mammals,
birds,
reptiles)

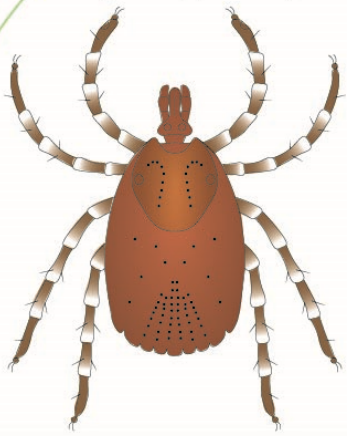
engorged female
(dorsal) (~ 15 mm)



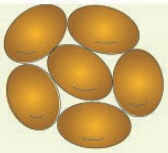


skin
(blood loss,
lesions,
toxicosis)
(vectors for
infectious
microbial
diseases)

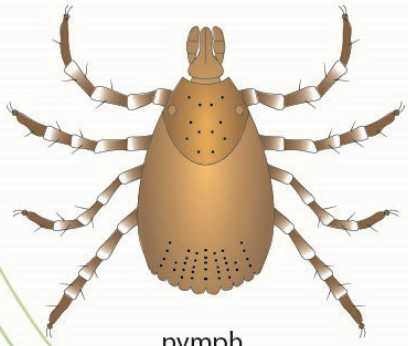
adult female
(dorsal) (~ 4 mm)



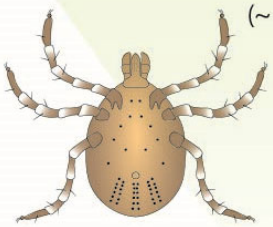
eggs laid
in soil/litter



eggs
(~ 0.5 mm)



nymph
(dorsal)
(~ 2 mm)



larva
(ventral)
(~ 1 mm)

hatch

some quest,
most actively
seek hosts

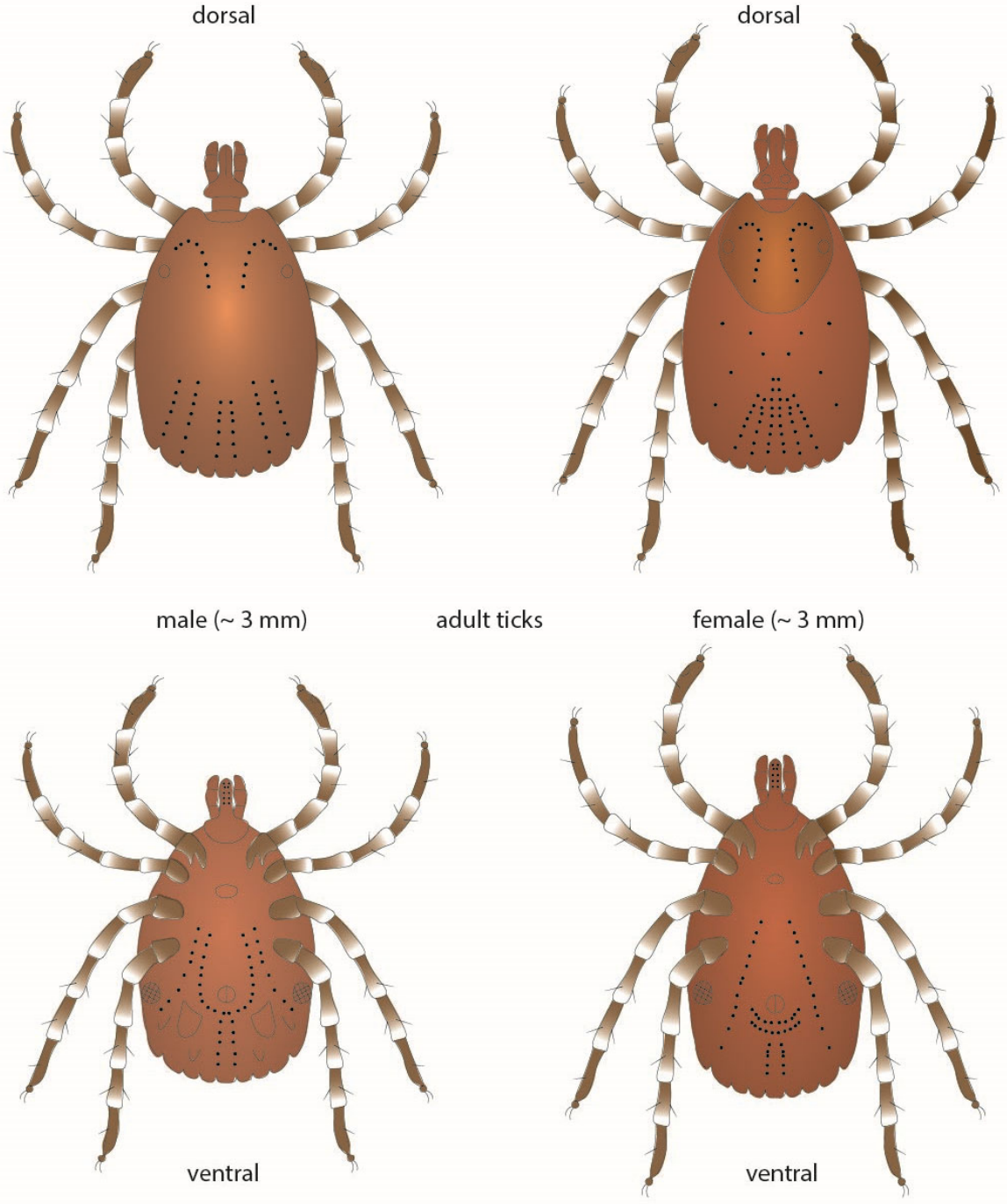
all motile stages
(i.e. larvae (L), nymphs (N)
and adults (A)) are transient
ectoparasites on vertebrates
(feed on blood)

1
2
3

most *Hyalomma* spp. have 2-host cycles,
some have 3-host cycles, but
a few have 1-host cycles

{ 1-host cycle (LNA on same host)
2-host cycle (L-NA on successive hosts)
3-host cycle (L-N-A on separate hosts)

Hyalomma


dorsal
dorsal
male (~ 3 mm)
adult ticks
female (~ 3 mm)
ventral
ventral

Hyalomma adult

Hyalomma larva