Triatoma, Panstrongylus, Rhodnius
(insect: bug)

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. Insects are hexapods with three pairs of uniramous legs, three tagmata (head, thorax, abdomen), ectognathous mouthparts with whole-limb mandibles, and one pair of antennae. Bugs (Hemiptera) are hemipterodeans that undergo gradual metamorphosis where nymphal stages gradually become more like the adults with each moult. All bugs have sucking mouthparts for feeding on the juices mainly of plants, but sometimes on other arthropods or blood from vertebrate hosts. Reduviids are large elongate bugs, usually with wings folded in a concavity on the dorsal abdomen. Most reduviids are known as 'assassin bugs' because they prey on other insects and have a painful bite. However, the subfamily Triatominae feed on animal blood and have relatively painless bites; they are called 'kissing bugs' because they often bite the lips of sleeping persons. Various *Triatoma, Rhodnius* and *Panstrongylus* spp. feeding on humans in South and Central America may transmit Chagas' disease (caused by the kinetoplastid flagellate *Trypanosoma cruzi*).

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:	Hexapoda (three tagmata, three pairs uniramous legs, whole-limb mandibles, Malpighian tubules)
Class:	Insecta (ectognathous mouthparts (bases lie outside head capsule), single pair antennae, many with wings)
Superorder:	Hemipterodea (Exopterygota) (young resemble adults, externally developing wings)
Order:	Hemiptera (true bugs, mouthparts with stylet-like mandibles/maxillae)
Suborder:	Heteroptera (some plant-feeders, some predatory on other arthropods, some blood-feeders on vertebrates)
Family:	Reduviidae (large winged cone-nose/kissing/assassin bugs, incl. triatome bugs, blood feeders on animals)
Genus:	*Triatoma* (parasitic on skin of mammals)
Species:	various species feed on humans and transmit Chagas' disease

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). Various arthropods occur as ectoparasites on other animals, mostly feeding on the blood or skin of vertebrates. Arthropods have small segmented bodies encased in chitinous exoskeletons with articulated limbs. Three main subphyla are recognized: Chelicerata, Crustacea and Hexapoda. Insects are hexapods with six legs, three distinct body parts, two antennae and mouthparts with whole-limb mandibles. Insects are the most biodiverse group on the planet, with millions of species described in numerous taxa. Notorious ectoparasitic species belong to four orders in two superorders: the Hemipterodea (Exopterygota) containing the orders Hemiptera (bugs) and Phthiraptera (lice); and the Holometabola (Endopterygota) containing the orders Siphonaptera (fleas) and Diptera ('true' flies). Bugs are small winged hemipterodeans that undergo gradual (hemimetabolous) metamorphosis. They have stylet-like mouthparts and some prey on other arthropods while others feed on plants or blood from vertebrates.

Major parasitic hemipteran families	No. taxa	Hosts	Parasitic stages	Patho-genesis	Disease transmission
Family: Reduviidae (large winged conenose bugs)	23 subfamilies				
Subfamily: Triatominae (kissing/assassin bugs)	5-6 tribes, 16-19 genera, 132-149 species	mammals, birds	adults	blood-feeding	protozoa (trypanosomes)
Family: Cimicidae (bed bugs, bat bugs, swallow bugs)	6 subfamilies, 24 genera, 110 species	birds, mammals (bats, humans)	nymphs, adults	biting, blood-feeding	-

Members of the family Reduviidae have conical heads and are commonly known as cone-nosed bugs. Most are predatory and feed on other insects (hence being named assassin bugs or ambush bugs), but those of the single subfamily Triatominae are haematophagous and feed on vertebrate blood (known variously as kissing bugs, vampire bugs or barber bugs, as well as barbeiro, benchuca, bicudo, bush chinch, chinchorro, chipo, chirimacha, chupao, iquipito, pito or vinchuca in Latin America). The monophyletic nature of the blood-sucking Triatominae is strongly supported by molecular studies, but subsequent ranks within the subfamily vary with different tribes (and genera) proposed: namely, Alberprosseniini (*Alberprosenia*), Bolboderini (*Belminus, Bolbodera, Microtriatoma, Parabelminus*), Cavernicolini (*Cavernicola*), Linshcosteusini? (*Linshcosteus*), Rhodniini (*Psammolestes, Rhodnius*), and Triatomini (*Dipetalogaster, Eratyrus, Hermanlentia, Mepraia*?, *Meccus*?, *Nesotriatoma*?, *Paratriatoma, Panstrongylus, Triatoma* and the fossil genus *Paleotriatoma*). Most triatomine species occur in tropical and sub-tropical regions of the Americas but some occur in Southeast Asia and Africa. Morphotypic and genotypic studies on triatomines reveal a complex array of characteristics, with many discrepancies. Triatomines display a high degree of morphological plasticity (sometimes referred to as phenetic drift) with considerable pleomorphy within and between groups (particularly in size and color). Experimental studies have also revealed a large degree of inter-specific genetic variation, with evidence of inter-fertility, hybrid formation and chromosomal variation. Karyotyping studies on select American taxa have suggested two clades may exist: a northern clade comprising triatomines of North, Central and northern South America with multiple X chromosomes, and a southern clade comprising triatomines of western and southern South America with single X chromosomes, but more extensive studies are required. It has also become apparent that scientists need to agree on what constitutes a species, as different concepts yield confounding results (discrepancies between morphologic, biogeographic, reproductive and phylogenetic approaches due to pleomorphy, sympatry, inter-fertility, and gene plasticity).

Triatomine bugs spend most of their time free-living in the external environment in vegetation (esp. palm trees), animal nests and human habitations, and only come into temporary contact with vertebrate hosts in order to feed on blood. While bugs may feed on a range of available hosts, most species appear to have preferences for particular hosts (as determined by direct observations, proximity to host habitats (mostly human buildings and chicken coops), experimental feeding studies, and more recently by molecular analyses of ingested bloodmeals). Hosts include mammals (primates, carnivores, rodents, ruminants, insectivores, marsupials), birds (particularly galliforms), reptiles (lizards), and some amphibians. In particular, members of three genera are important with respect to human health, with various *Triatoma*, *Rhodnius* and *Panstrongylus* spp. acting as vectors for the transmission of Chagas' disease (New World or American trypanosomiasis) caused by the protozoan parasite *Trypanosoma cruzi* (stercorarian or contaminative transmission via bug faeces, rather than salivarian or inoculative transmission). While all triatomine species may potentially act as vectors, most transmission is limited to a few species (e.g. *T. infestans, T. brasiliensis, T. dimidiata, R. prolixus, P. megistus*) that have become well adapted to living with humans, particularly in rural areas within rudimentary buildings.

Triatomine species	Hosts	Clinical signs	Distribution
Genus *Triatoma*			
T. amicitiae			Sri Lanka
T. arthurneivai	Rodentia: caviid (Brazilian guinea pig, rock cavy); Sauria: tropidurid (Amazon lava lizard)		Brazil
T. baratai			Brazil
T. barberi	Primates: hominid (human); Carnivora: canid (dog), felid (cat); Rodentia: murid (rats); Artiodactyla: bovid (goat); Galliformes: phasianid (chicken, turkey)	natural vector for *Trypanosoma cruzi*	Mexico
T. bolivari			Mexico
T. boliviana	Insecta: blattid (cockroach)		South America
T. bouvieri			Philippines, Vietnam
T. brailovskyi			Mexico
T. brasiliensis [incl. *T. b. brasiliensis, T. b. macromelasoma, T. b. melanica*] ['brasiliensis' complex]	Primates: hominid (human); Carnivora: canid (dog), felid (cat), mephitid (skunk); Rodentia: caviid (Spix's yellow-toothed cavy, rock cavy, Brazilian guinea pig), murid (rats); Cingulata: dasypodid (armadillo); Artiodactyla: bovid (goat); Galliformes: phasianid (chicken); birds (?); Sauria: tropidurid (calango), teiid (Argentine black and white tegu); Insecta: blaberid (cockroach)	natural vector for *Trypanosoma cruzi*	Brazil
T. breyeri	Rodentia: caviid (?), cricetid (?)		Argentina
T. carcavalloi	Primates: hominid (human)	natural vector for *Trypanosoma cruzi*	Brazil

T. carrioni	Primates: hominid (human); Perissodactyla: equid (horse); wild animals	natural vector for *Trypanosoma cruzi*	South America
T. cavernicola	Primates: hominid (human)		Malaysia
T. circummaculata	Primates: hominid (human)	natural vector for *Trypanosoma cruzi*	Brazil, Argentina?
T. costalimai	Rodentia: caviid (rock cavy)		Brazil
T. deanei (syn. *T. deaneorum*)	Primates: hominid (human)		Brazil
T. delpontei ['infestans' subcomplex]	Psittaciformes: psittacid (monk parakeet); Passeriformes: furnariid (thorn bird); Rodentia: murid (rats); Didelphimorphia: didelphid (opossum)	natural vector for *Trypanosoma cruzi*	Argentina, Paraguay, Uruguay
T. dimidiata [incl. *T. d. dimidiata, T. d. capitata, T. d. maculipennis*]	Primates: hominid (human); Carnivora: canid (dog), felid (cat); Chiroptera: phyllostomid (bat); Cingulata: dasypodid (armadillo); Artiodactyla: bovid (cattle, sheep/goat), suid (pig); Rodentia: murid (rat, mouse); Didelphimorphia: didelphid (opossum); Anseriformes: anatid (duck); Galliformes: phasianid (chicken)	natural vector for *Trypanosoma cruzi*	Central America, Mexico, Venezuela, Peru
T. dispar	Pilosa: choloepodid (Hoffmann's two-toed sloth); Primates: hominid (human)		Central America, Ecuador
T. dominicana [fossil species]	from amber		South America
T. eratyrusiformis (syn. *T. ninoi*)	Primates: hominid (human); Perissodactyla: equid (horse); Rodentia: murid (rat), caviid (southern mountain cavy); Galliformes: phasianid (chicken)	natural vector for *Trypanosoma cruzi*	Argentina
T. flavida	Primates: hominid (human); Rodentia: capromyid (Desmarest's hutia)		Cuba
T. gerstaeckeri	Primates: hominid (human); Rodentia: cricetid (southern plains woodrat); Didelphimorphia: didelphid (common opossum); Artiodactyla: suid (pig), bovid (cattle); Perissodactyla: equid (horse); Passeriformes: corvid (crow); Galliformes: phasianid (chicken); Serpentes: colubrid (indigo snake)	natural vector for *Trypanosoma cruzi*	Mexico, United States
T. gomeznunezi			Mexico
T. guasayana	Primates: hominid (human); Artiodactyla: bovid (goat); Galliformes: phasianid (chicken); Columbiformes: columbid (pigeon); Anura: bufonid (toad)	natural vector for *Trypanosoma cruzi*	Argentina, Bolivia, Paraguay
T. guazu			Paraguay
T. hegneri		natural vector for *Trypanosoma cruzi*	Mexico
T. huehuetenanguensis [*T.* sp. aff *dimidiata* (group 3)]	Primates: hominid (human)	natural vector for *Trypanosoma cruzi*	South America
T. incrassata			Mexico, United States
T. indictiva	Rodentia: cricetid (woodrat)		Mexico, United States
T. infestans (syn. *T. mazzae T. melanosome, T. oswaldoi, T. sordelli*) ['infestans' subcomplex] (winchuka, vinchuca, barbeiro, chipo, kissing bug, barber bug)	Primates: hominid (human); Carnivora: canid (dog), felid (cat); Artiodactyla: suid (pig), bovid (goat, sheep); Perissodactyla: equid (donkey); Rodentia: cricetid (pale leaf-eared mouse, yellow-rumped leaf-eared mouse, Wolffsohn's leaf-eared mouse, South American grass mouse), murid (rat), caviid (guinea pig, common yellow-toothed cavy, southern mountain cavy), chinchillid (southern viscacha), octodontid (mountain degu); Lagomorpha: leporid (rabbit); Didelphimorphia: didelphid (opossum);	natural vector for *Trypanosoma cruzi*	South America

	Galliformes: phasianid (chicken); Columbiformes: columbid (pigeon); Strigiformes: strigid (owl); Passeriformes: tyrranid (southern scrub flycatcher); Sauria: phyllodactylid (naked-toed gecko), tropidurid (neotropical ground lizard)		
T. jatai			Brazil
T. juazeirensis ['brasiliensis' complex]	Primates: hominid (human)	natural vector for *Trypanosoma cruzi*	Brazil
T. jurbergi			Brazil
T. klugi	Rodentia: murid (mouse); Galliformes: phasianid (chicken)	experimental vector for *Trypanosoma cruzi*	Brazil
T. lecticularia (syn. *T. heidemanni, T. occulta*)	Primates: hominid (human); Rodentia: cricetid (southern plains woodrat), sciurid (rock squirrel)	natural vector for *Trypanosoma cruzi*	Mexico, United States
T. lenti (syn. *T. bahiensis, T. pessoai*)	Primates: hominid (human); Artiodactyla: bovid (goat)		Brazil
T. leopoldi (syn. *T. novaeguineae*)			Indonesia, Australia
T. limai	Rodentia: murid (rats)		Argentina
T. longipennis ['phyllosoma' complex]	Didelphimorphia: didelphid (opossum); Artiodactyla: (suid (pig); Rodentia: murid (rat); Galliformes: phasianid (chicken)	natural vector for *Trypanosoma cruzi*	Mexico
T. maculata	Primates: hominid (human), cebid (white-fronted capuchin); Pilosa: choloepodid (Linnaeus's two-toed sloth); Carnivora: canid (dog), felid (cat), procyonid (kinkajou, raccoon); Artiodactyla: bovid (buffalo, cattle, zebu), suid (pig); Perissodactyla: equid (ass), tapirid (South American tapir); Chiroptera: phyllostomid (tailed tailless bat, Seba's short-tailed bat, spectral bat, Tilda's yellow-shouldered bat); Cingulata: chlamyphorid (six-banded armadillo), dasypodid (greater long-nosed armadillo, nine-banded armadillo); Didelphimorphia: didelphid (brown four-eyed opossum, common opossum); Rodentia: erethizontid (black-tailed hairy dwarf porcupine), murid (black rat, brown rat, mouse), sciurid (Brazilian squirrel, North American red squirrel, red-tailed squirrel); Anseriformes: anatid (muscovy duck); Cathartiformes: cathartid (Andean condor); Columbiformes: columbid (rock dove); Galliformes: phasianid (chicken, rufous-throated wood quail, spot-winged woodquail); Passeriformes: furnariid (rufous-throated thornbird); Piciformes: picid (golden-green woodpecker); Psittaciformes: psittaculid (budgerigar); Rheiformes: rheid (Darwin's rhea, greater rhea); Suliformes: fregatid (magnificent frigate bird), phalacrocoracid (neotropic cormorant), sulid (blue-footed booby); Tinamiformes: tinamid (ornate tinamou)	natural vector for *Trypanosoma cruzi*	Brazil, Colombia, Guyana, Surinam, Venezuela
T. matogrossensis			Brazil
T. mazzotti ['phyllosoma' complex]	Primates: hominid (human); Rodentia: cricetid (woodrat); Cingulata: dasypodid (armadillo)	natural vector for *Trypanosoma cruzi*	Mexico
T. melanocephala	Primates: hominid (human); Artiodactyla: bovid (goat)		Brazil
T. mexicana ['phyllosoma' complex]			Mexico
T. migrans			India, South-East

(syn. *T. pallidula*)			Asia
T. mopan [*T.* sp. aff *dimidiata* cave (group 4)]	Primates: hominid (human)	natural vector for *Trypanosoma cruzi*	Central America
T. neotomae	Rodentia: cricetid (southern plains woodrat, white-throated woodrat)	natural vector for *Trypanosoma cruzi*	United States
T. nigromaculata	Primates: hominid (human); Galliformes: phasianid (chicken)	natural vector for *Trypanosoma cruzi*	Venezuela
T. nitida		natural vector for *Trypanosoma cruzi*	Central America
T. obscura	Primates: hominid (human)		Jamaica
T. oliveirai	Rodentia: caviid (Brazilian guinea pig)		Brazil
T. pallidipennis (syn. *T. phyllosoma usingeri*) ['phyllosoma' complex]	Cingulata: dasypodid (nine-banded armadillo); Rodentia: cricetid (Allen's woodrat)		Mexico
T. patagonica	Primates: hominid (human); Lagomorpha: leporid (rabbit); Rodentia: caviid (southern mountain cavy), cricetid (leaf-eared mouse); Galliformes: phasianid (chicken)	natural vector for *Trypanosoma cruzi*	Argentina
T. peninsularis	Rodentia: cricetid (desert woodrat)	natural vector for *Trypanosoma cruzi*	North America
T. petrochiae	Carnivora: canid (dog); Rodentia: caviid (rock cavy), murid (rats); Cingulata: dasypodid (armadillos); birds (?)		Brazil
T. phyllosoma ['phyllosoma' complex]	Primates: hominid (human); Carnivora: canid (dog), felid (cat); Artiodactyla: bovid (sheep), suid (pig); Rodentia: murid (rat); Galliformes: phasianid (chicken); Columbiformes: columbid (pigeon)	natural vector for *Trypanosoma cruzi*	Mexico
T. picturata ['phyllosoma' complex]		natural vector for *Trypanosoma cruzi*	Mexico
T. pintodiasi			Brazil
T. platensis (syn. *T. rosenbuschi*) ['infestans' subcomplex]	Passeriformes: furnariid (firewood gatherer, lark-like brushrunner, brown cacholote); Psittaciformes: psittacid (monk parakeet); Galliformes: phasianid (chicken); Didelphimorphia: didelphid (latrine opossum); Rodentia: cricetid (leaf-eared mouse); Artiodactyla: bovid (goat)	natural vector for *Trypanosoma cruzi*	Argentina, Bolivia, Paraguay
T. protracta (western conenose)	Primates: hominid (human); Carnivora: canid (dog), felid (cat); Artiodactyla: suid (pig); Didelphimorphia: didelphid (opossum); Rodentia: cricetid (white-throated woodrat, dusky-footed woodrat, desert woodrat, southern plains woodrat)	natural vector for *Trypanosoma cruzi*	Mexico, United States
T. pseudomaculata	Primates: hominid (human); Carnivora: canid (dog), mephitid (skunk); Rodentia: murid (rats); Artiodactyla: bovid (goat); birds (?); Insecta: blaberid (cockroach)	natural vector for *Trypanosoma cruzi*	Brazil
T. pugasi			Java
T. recurva (syn. *T. longipes*)	Primates: hominid (human); Didelphimorphia: didelphid (opossum); Rodentia: sciurid (rock squirrel); Carnivora: canid (dog, coyote); Sauria (lizards); Serpentes (snakes); Insecta: blattid (cockroach)	natural vector for *Trypanosoma cruzi*	Mexico, United States
T. rubida (syn. *T. ocellata, T. sonoriana, T. uhleri*)	Primates: hominid (human); Chiroptera: vespertilionid (fish-eating bat); Carnivora: canid (dog, wolf, coyote); Artiodactyla: bovid (sheep, bighorn sheep, goat), suid (pig); Rodentia: murid (rats, mice), cricetid (white-throated woodrat, desert woodrat)	natural vector for *Trypanosoma cruzi*	Mexico, United States, South-East Asia
T. rubrofasciata	Primates: hominid (human); Rodentia: murid (rats, mice); Carnivora: mephitid (skunk);	vector for *Trypanosoma cruzi*,	Indochina, Americas, Africa

	Columbiformes: columbid (pigeon)	*conorhini* and *lewisi*	
T. rubrovaria (syn. *T. bruchi, T. gomesi*)	Primates: hominid (human); Cingulata: dasypodid (armadillo); Sauria (lizards); experimentally Arachnida: mygalomorphid (tarantula); Lepidoptera: bombycid (silkworm)	natural vector for *Trypanosoma cruzi*	Argentina, Brazil, Uruguay, Java?
T. ryckmani			Central America
T. sanguisuga (syn. *T. ambigua, T. pintoi*) (eastern conenose)	Primates: hominid (human); Carnivora: canid (dog), procyonid (raccoon); Perissodactyla: equid (horse); Didelphimorphia: didelphid (opossum); Rodentia: cricetid (eastern woodrat, southern plains woodrat, hispid cotton rat); Galliformes: phasianid (chicken); Anura: hylid (frog)	natural vector for *Trypanosoma cruzi,* and possibly equine encephalitis virus	United States, India
T. sinaloensis	Rodentia: cricetid (sonoran woodrat, white-throated woodrat)	natural vector for *Trypanosoma cruzi*	Mexico
T. sinica			China
T. sordida (syn. *T. garciabesi*)	Primates: hominid (human); Carnivora: canid (dog), felid (cat); Didelphimorphia: didelphid (opossum); Lagomorpha: leporid (rabbit); Rodentia: murid (rats), caviid (guinea pig); Galliformes: phasianid (chicken); Columbiformes: columbid (pigeon); Passeriformes: passerid (sparrow), furnariid (rufous-throated thornbird, firewood gatherer, brown cacholote), troglodytid (thrush-like wren); Psittaciformes: psittacid (monk parakeet)	natural vector for *Trypanosoma cruzi*	South America
T. spinolai (syn. *T. chilena*)	Primates: hominid (human); Carnivora: canid (wolf); Lagomorpha: leporid (rabbit, hare); Rodentia: chinchillid (viscacha), murid (rats); Didelphimorphia: didelphid (mouse opossum); Columbiformes: columbid (pigeon), (guano shorebirds)	natural vector for *Trypanosoma cruzi*	Chile
T. tibiamaculata	Didelphimorphia: didelphid (opossum, mouse opossum); Rodentia: cricetid (marsh rice rat), echimyid (spiny rat)	natural vector for *Trypanosoma cruzi*	Brazil
T. vandae			Brazil
T. venosa	Primates: hominid (human), cebid (white-fronted capuchin); Carnivora: canid (dog), felid (cat); Artiodactyla: bovid (cattle, buffalo), suid (pig); Perissodactyla: equid (ass); Chiroptera: phyllostomid (spectral bat, Tilda's yellow-shouldered bat); Cingulata: chlamyphorid (six-banded armadillo); Pilosa: myrmecophagid (giant anteater, southern tamandua); Didelphimorphia: didelphid (brown four-eyed opossum, common opossum, northern red-sided opossum); Lagomorpha: leporid (rabbit); Rodentia: murid (brown rat, mouse), sciurid (Brazilian squirrel, North American red squirrel, red-tailed squirrel); Anseriformes: anatid (muscovy duck); Columbiformes: columbid (rock dove); Galliformes: phasianid (chicken, common quail, rufous-throated woodquail, spot-winged woodquail, turkey); Piciformes: picid (golden-green woodpecker); Suliformes: fregatid (magnificent frigate bird), phalacrocoracid (neotropic cormorant), sulid (blue-footed booby); Tinamiformes: tinamid (ornate tinamou)	natural vector for *Trypanosoma cruzi*	Central and South America
T. vitticeps (syn. *T. chagasi, T. holmbergi*)	Primates: hominid (human); Didelphimorphia: didelphid (opossum); Rodentia: caviid (rock cavy)	natural vector for *Trypanosoma cruzi*	Brazil
T. williami	Primates: hominid (human)	natural vector for	Brazil

		Trypanosoma cruzi	
T. wygodzinskyi			Brazil
Genus *Panstrongylus*			
P. chinai (syn. *P. turpiali*)	Primates: hominid (human); Rodentia: murid (rats); Galliformes: phasianid (chicken); Columbiformes: columbid (pigeon)	natural vector for *Trypanosoma cruzi*	Ecuador, Peru
P. diasi	Primates: hominid (human)		Brazil, Bolivia
P. geniculatus (syn. *P. parageniculatus, Triatoma fluminensis, tenuis*)	Primates: hominid (human), cebid (white-fronted capuchin); Pilosa: choloepodid (Linnaeus's two-toed sloth), cyclopodid (silky anteater), myrmecophagid (southern tamandua); Carnivora: canid (dog), felid (cat), procyonid (kinkajou, raccoon); Artiodactyla: bovid (zebu, cattle, buffalo), suid (pig); Perissodactyla: equid (ass), tapirid (South American tapir); Chiroptera: phyllostomid (tailed tailless bat, common vampire bat, dwarf little fruit bat, Tilda's yellow-shouldered bat, stripe-headed round-eared bat, spectral bat); Didelphimorphia: didelphid (common opossum, brown four-eyed opossum); Lagomorpha: leporid (rabbit); Rodentia: caviid (guinea pig), murid (mouse, brown rat, black rat), octodontid (common degu), sciurid (Brazilian squirrel, red-tailed squirrel, North American red squirrel); Cingulata: chlamyphorid (southern rocket-tailed armadillo, six-banded armadillo), dasypodid (greater long-nosed armadillo, nine-banded armadillo); Galliformes: phasianid (chicken, turkey, spot-winged woodquail); Anseriformes: anatid (muscovy duck); Cathartiformes: cathartid (Andean condor); Columbiformes: columbid (rock dove); Piciformes: picid (golden-green woodpecker); Psittaciformes: psittaculid (budgerigar); Suliformes: phalacrocoracid (neotropic cormorant), fregatid (magnificent frigate bird), sulid (blue-footed booby); Tinamiformes: tinamid (ornate tinamou)	natural vector for *Trypanosoma cruzi*	South America
P. guentheri (syn. *P. larroussei, seai*)	Primates: hominid (human); Rodentia: murid (rats); Didelphimorphia: didelphid (opossums); birds (?)	natural vector for *Trypanosoma cruzi*	Argentina, Bolivia, Paraguay
P. hispaniolae (fossil species)	from amber		Central America
P. howardi (syn. *Triatoma*)	Primates: hominid (human); Rodentia: murid (rats)	natural vector for *Trypanosoma cruzi*	Ecuador
P. humeralis	Primates: hominid (human)	natural vector for *Trypanosoma cruzi*	Central America
P. lenti	Primates: hominid (human)		Brazil
P. lignarius (syn *P. herreri*)	Primates: hominid (human); Chiroptera: phyllostomid (bats); Didelphimorphia: didelphid (opossums); Lagomorpha: leporid (rabbit); Rodentia: caviid (guinea pig), echimyid (spiny rats), erethizontid (porcupine); Pilosa: cyclopedid (anteater); Galliformes: phasianid (chicken); Columbiformes: columbid (pigeon); Piciformes: ramphastid (toucan)	natural vector for *Trypanosoma cruzi*	Brazil, Guyana, Surinam, Venezuela, Peru
P. lutzi (syn. *P. sherlocki*)	Primates: hominid (human); Carnivora: canid (dog), felid (cat), mephitid (skunk); Artiodactyla: bovid (goat, cattle); Perissodactyla: equid (horse); Rodentia: murid (rats); Cingulata: dasypodid (armadillo); Insecta: blaberid (cockroach); birds (?)	natural vector for *Trypanosoma cruzi*	Brazil
P. martinezorum			Venezuela

P. megistus (syn. *Triatoma africana, wernickei*)	Primates: hominid (human); Chiroptera: phyllostomid (bats); Carnivora: canid (dog), felid (cat), mephitid (skunk); Artiodactyla: bovid (cattle, goat), suid (pig); Didelphimorphia: didelphid (opossums); Rodentia: murid (rats); Galliformes: phasianid (chicken); Insecta: blaberid (cockroach)	natural vector for *Trypanosoma cruzi*	South and Central America
P. mitarakaensis			French Guiana
P. rufotuberculatus	Primates: hominid (human); Chiroptera: phyllostomid (vampire bat); Carnivora: procyonid (kinkajou); Didelphimorphia: didelphis (opossum)	natural vector for *Trypanosoma cruzi*	South and Central America
P. tupynambai	Primates: hominid (human); Carnivora: canid (dog); Rodentia: cricetid (rats), murid (rats); Didelphimorphia: didelphid (opossums); birds (?); Sauria (lizards)	natural vector for *Trypanosoma cruzi*	Brazil
Genus *Rhodnius*			
R. arthuri			South America
R. barretti [‘prolixus-robustus’ group]			South America
R. brethesi [‘pictipes’ group]	Primates: hominid (human)	natural vector for *Trypanosoma cruzi*	Brazil, Venezuela
R. colombiensis [‘pictipes’ group]			South America
R. coreodes			South America
R. dalessandroi [‘prolixus-robustus’ group]			South America
R. domesticus [‘prolixus-robustus’ group]	Primates: hominid (human); Rodentia: murid (rats, mice), echimyid (golden Atlantic tree-rat, drab Atlantic tree-rat); Didelphimorphia: didelphid (opossum, mouse opossum)	natural vector for *Trypanosoma cruzi*	Brazil
R. ecuadoriensis [‘pictipes’ group]	Primates: hominid (human); Rodentia: caviid (guinea pig), murid (rats), sciurid (squirrels); birds (?)	natural vector for *Trypanosoma cruzi, rangeli*	Ecuador, Peru
R. marabaensis (syn. *R. jacundaensis*)			Brazil
R. micki			Bolivia
R. milesi [‘prolixus-robustus’ group]			Brazil
R. montenegrensis [‘prolixus-robustus’ group]			Brazil
R. nasutus (syn. *R. brumpti*) [‘prolixus-robustus’ group]	Primates: hominid (human); Artiodactyla: bovid (goat, sheep); Didelphimorphia: didelphid (opossums); Columbiformes: columbid (pigeon); Galliformes: phasianid (chicken)	natural vector for *Trypanosoma cruzi*	Brazil
R. neglectus [‘prolixus-robustus’ group]	Primates: hominid (human); Passeriformes: furnariid (firewood-gatherer); Columbiformes: columbid (pigeon); Galliformes: phasianid (chicken)	natural vector for *Trypanosoma cruzi*	Brazil
R. neivai [‘prolixus-robustus’ group]	Primates: hominid (human)		Colombia, Venezuela
R. pallescens (syn. *R. dunni*) [‘pictipes’ group]	Primates: hominid (human), cebid (white-fronted capuchin); Pilosa: choloepodid (Linnaeus’s two-toed sloth); cyclopodid (silky anteater), myrmecophagid (giant anteater, southern tamandua); Carnivora: canid (dog), felid (cat), procyonid (kinkajou, raccoon); Chiroptera: phyllostomid (Seba’s short-tailed bat, tailed tailless bat, common vampire bat, dwarf little fruit bat, spectral bat, stripe-headed round-eared bat, Tilda’s yellow-shouldered bat); Artiodactyla: bovid (buffalo, cattle, zebu), suid	natural vector for *Trypanosoma cruzi*	Belize, Colombia, Panama

	(pig); Perissodactyla: equid (ass), tapirid (South American tapir); Cingulata: chlamyphorid (southern rocket-tailed armadillo, six-banded armadillo), dasypodid (greater long-nosed armadillo, nine-banded armadillo); Didelphimorphia: didelphid (brown four-eyed opossum, common opossum, grey four-eyed opossum, white-eared opossum); Rodentia: caviid (guinea pig), erethizontid (black-tailed hairy dwarf porcupine), murid (black rat, brown rat, mouse), octodontid (common degu), sciurid (Brazilian squirrel, North American red squirrel, red-tailed squirrel); Lagomorpha: leporid (rabbit); Anseriformes: anatid (muscovy duck); Cathartiformes: cathartid (Andean condor); Columbiformes: columbid (rock dove); Galliformes: phasianid (chicken, common quail, rufous-throated woodquail, spot-winged woodquail); Pelecaniformes: pelecanid (brown pelican); Piciformes: picid (golden-green woodpecker); Psittaciformes: psittaculid (budgerigar); Rheiformes: rheid (Darwin's rhea, greater rhea); Suliformes: fregatid (magnificent frigate bird), phalacrocoracid (neotropic cormorant), sulid (blue-footed booby); Tinamiformes: tinamid (ornate tinamou); Anura: telmatobiid (Andean frog)		
R. paraensis ['pictipes' group]	Primates: hominid (human); Rodentia: echimyid (white-faced spiny tree-rat); Didelphimorphia: didelphid (opossum)	natural vector for *Trypanosoma cruzi*	Brazil
R. pictipes (syn. *R. amazonicus*) ['pictipes' group]	Primates: hominid (human), Columbiformes: columbid (pigeon)	natural vector for *Trypanosoma cruzi*	Central and South America
R. prolixus ['prolixus-robustus' group]	Primates: hominid (human), cebid (white-fronted capuchin); Pilosa: choloepodid (Linnaeus's two-toed sloth), myrmecophagid (giant anteater, southern tamandua); Carnivora: canid (dog), felid (cat), procyonid (kinkajou, raccoon), ursid (spectacled bear); Artiodactyla: bovid (zebu, cattle, buffalo), suid (pig); Perissodactyla: equid (ass), tapirid (South American tapir); Chiroptera: phyllostomid (tailed tailless bat, common vampire bat, dwarf little fruit bat, Seba's short-tailed bat, spectral bat, stripe-headed round-eared bat, Tilda's yellow-shouldered bat); Cingulata: chlamyphorid (six-banded armadillo, southern rocket-tailed armadillo), dasypodid (greater long-nosed armadillo, nine-banded armadillo); Didelphimorphia: didelphid (brown four-eyed opossum, common opossum, northern red-sided opossum, water opossum); Lagomorpha: leporid (rabbit); Rodentia: caviid (guinea pig), cuniculid (lowland paca), erethizontid (black-tailed hairy dwarf porcupine), murid (black rat, brown rat, mouse), octodontid (common degu), sciurid (Brazilian squirrel, fiery squirrel, North American red squirrel, red-tailed squirrel); Anseriformes: anatid (muscovy duck); Cathartiformes: cathartid (Andean condor); Ciconiiformes: ciconiid (jabiru, wood stork); Columbiformes: columbid (rock dove); Cuculiformes: cuculid (yellow-billed cuckoo);	natural vector for *Trypanosoma cruzi*	South and Central America

	Galliformes: phasianid (chicken, common quail, marbled woodquail, rufous-throated woodquail, spot-winged woodquail, turkey); Pelecaniformes: pelecanid (brown pelican); Piciformes: picid (golden-green woodpecker); Psittaciformes: psittaculid (budgerigar); Rheiformes: rheid (Darwin's rhea, greater rhea); Suliformes: fregatid (magnificent frigate bird), phalacrocoracid (neotropic cormorant), sulid (blue-footed booby); Tinamiformes: tinamid (ornate tinamou)		
R. robustus ['prolixus-robustus' group]	Primates: hominid (human)	natural vector for *Trypanosoma cruzi, rangeli*	Brazil, Bolivia, Colombia, Ecuador, Peru, Venezuela
R. stali ['pictipes' group]	Primates: hominid (human)	natural vector for *Trypanosoma cruzi*	Brazil
R. taquarussuensis			Brazil
R. zeledoni ['prolixus-robustus' group]			Brazil

Parasite morphology: Triatomine bugs form three different types of morphological stages during their development: eggs; nymphs; and adults. The eggs are oval-elliptical and slightly asymmetrical in shape, often developing a lateral flattening on one side (deemed dorsal) after several days (presumably due to drying). They range in size from 1.9-2.5 x 1.0-1.4 mm and have a convex operculum (smooth or ornamented) at one end (mounted on a short neck in the tribe Rhodniini). The eggs are pearly white (sometimes grey) when laid, but they often become brown-pink near hatching. The eggs contain a developing embryo (protonymph) whose eyespots become visible near the operculum in eggs that are > 14 days old. Newly emergent nymphs (first instar) are often pink and may be as small as 2 mm in length. Like all hemipteran bugs, triatomines undergo gradual (incomplete) metamorphosis (hemimetabolous) moulting between 5 nymphal instars (often termed N1-N5) before moulting to adults. All nymphal stages resemble adult bugs but are smaller in size, have smaller eyes, lack ocelli and mature genitalia, and are wingless but have thoracic lobes where the wings will develop. Adult bugs vary in size from 5-45 mm in length depending on species, but the majority range from 20-30 mm in length. They have elongated flattened bodies with three parts (head, thorax, abdomen) and are typically brown-black, but can have bright colouration with contrasting patterns of yellow, brown, orange, or red around the lateral edges of the abdomen. The head is elongate and cone-shaped, but small compared to the rest of the body. It has a conspicuous pair of dark hemispherical compound eyes (with multiple sensory units) at the base just in front of a pair of small ocelli (with single sensory units) located on small elevations. The head is constricted behind the eyes forming a neck without a transverse sulcus. A pair of long filiform antennae, each consisting of four segments, is mounted anterior to the eyes. The length of the anterior portion of the head and the insertion point for the antennae varies between different triatomine genera. *Rhodnius* spp. have long slender heads with the antennae inserted near the apex, *Triatoma* spp. have medium-sized heads with the antennae inserted between the eyes and the anterior apex, and *Panstrongylus* spp. have short heads with the antennae inserted close to eyes. *Panstrongylus* spp. also have large eyes relative to head size, with more and/or larger ommatidia (well adapted to dim illumination). All genera have a long three-segmented proboscis (sometimes called a beak or rostrum) which is folded beneath the head when not in use for feeding. The tip extends to a thoracic groove (the prosternal stridulatory sulcus) in all genera except *Cavernicola* and *Linshcosteus*. In blood-sucking triatomines, the proboscis is slender, straight and has a membranous connection between the second and third rostral segments, while that of predatory reduviids is thick, curved and heavily chitinized. The proboscis contains piercing/sucking mouthparts comprising a basal labrum and an elongate labium which encloses mandibular and maxillary stylets that form feeding and salivary channels. The alimentary tract consists of three sections: the foregut (stomodaeum) including the buccal cavity, pharynx (cibarial pump), oesophagus and saccular crop (stomach); the midgut (mesenteron) with ventriculus (small intestines) connected to excretory Malpighian tubules; and the hindgut (proctodeum) comprising the colon, rectum and anus. Cells in the midgut called mycetomes harbour endosymbiotic (yeast-like) micro-organisms that are involved in the digestion of bloodmeals and the production of essential vitamins. The thorax is usually dark brown and has a rough texture with large tubercles. The dorsal surface has a collar (neck), a triangular pronotum, an elongate scutellum turned down at the posterior margin but lacking lateral prongs, and two pairs of wings. The fore-wings (hemelytra) have a thickened basal section (corium and base of clavus) and an apical membranous section (apical clavus and membrane) which is often dusky, spotted or darkened along the wing veins, while the hindwings are completely membranous. When at rest, the forewings are folded over the hind wings over the dorsal abdomen. The ventral surface of the thorax has a prosternum with the stridulatory groove and gives rise to six long slender legs with simple paired terminal claws (some species also have spongy fossulae with adhesive setae at the apex of tibia on several legs). The abdomen is oval and consists of 11 segments with exposed lateral margins with distinct rims often with varied patterns of brown on a yellow or orange or red background. The abdomen is flat in unfed bugs, but becomes globose in fed bugs as it dilates considerably stretching the intersegmental and connexival membranes. Males are slightly smaller than females and their posterior abdomen is smoothly rounded rather than pointed, lobed or truncate as in females. Both sexes sclerotized external genitalia involved in reproduction. Females have two

ovaries (composed of ovarioles) connected to lateral oviducts that join into a common oviduct together with two lateral spermathecae (blind tubes for sperm storage) and accessory glands (produce proteinaceous cement). The common oviduct opens into the saccular vagina that is supported and framed by external sclerites (gonocoxites, gonapophyses and styloids). Males have two testes connected to a globular ejaculatory bulb by tubular vas deferens, as well as accessory glands connected to the bulb by seminal vesicle ducts. The ejaculatory bulb is connected to the copulatory organ (aedeagus) with a sclerotized articulatory apparatus supporting the intromittent phallus (sac-like phallosome containing an eversible endosome). These organs are contained within a genital capsule (pygophore) with sclerotized external club-shaped appendages (parameres) that hold the female during copulation. Males deposit spermatophores into the female vagina where they burst releasing spermatozoa which migrate to spermathecae.

Site of infection: Triatomine bugs are temporary ectoparasites of vertebrates, with nymphs and adults biting exposed skin and sucking blood before seeking refuge in the immediate vicinity. Various species feed on the face of resting or sleeping humans, especially around the lips (hence the common name of kissing bugs) or around the eyes, and less often on the hands, arms, feet and trunk (they are unable to feed through clothing or bedding). Many species have eclectic feeding habits and are able to feed on locally available mammals, birds, some reptiles and amphibians, although they often demonstrate strong host preferences. Host specificity is difficult to determine as bugs are rarely found on hosts and many host associations have been inferred from epidemiological records of proximity to hosts or host habitats. More recently, molecular sequencing of bloodmeals from bugs has revealed wide variations in sources suggesting broad host ranges. For example, several *Triatoma* spp. showing feeding preferences for primates, bats, rodents and birds, some *Rhodnius* spp. preferred artiodactyls and non-human primates, while some Panstrongylus spp. favoured canids and rodents.

Pathogenesis: All nymph and adult stages are obligate blood feeders and require bloodmeals for growth and development. They use their elongate mouthparts to pierce the skin, inject saliva and suck blood over periods ranging from 3-30 minutes. Despite the size of the bugs, their bites are frequently painless as their saliva contains chemicals with anaesthetic and analgesic properties as well as anticoagulant and vasodilatory activity. However, hosts may then develop immediate and delayed skin reactions to bites, the severity of which depends on the degree of allergic sensitivity. Reactions may range from wheals, papules or nodules around puncture sites to bullous (blister-like) lesions with pruritus (itching), oedema (swelling), and erythema (redness). Wheals may persist for weeks and the pruritus may be intense resulting in secondary traumatic lesions due to scratching. In rare cases, hosts may develop giant urticarial lesions or display systemic hypersensitivity responses such as anaphylaxis. Blood loss from the host may be significant as nymphs may imbibe 6-12 times their body weight and adults 2-3 times their weight in blood every 4-9 days. Heavy infestations in poultry houses may cause chronic blood loss with anaemia, morbidity and even mortality in young birds.

A range of triatomine species have gained notoriety as transmission vectors for the kinetoplastid flagellate *Trypanosoma cruzi*, the causative agent of Chagas' disease in humans in over 20 countries throughout South and Central America. Bugs ingest flagellates with bloodmeals and infective stages develop in the hindgut of the bugs. Subsequent transmission is contaminative (stercorarian) via bug faeces deposited near bite sites and then rubbed into wounds the puncture wounds when the host scratches themselves. Most bugs defaecate shortly after feeding and the interval between feeding and defaecation is one of the critical features determining the effectiveness of that species in disease transmission. Those species that cause pruritic lesions are also good vectors because they cause greater host scratching. The main vectors for Chagas' disease are those 'domestic' species (notably *T. infestans, T. brasiliensis, T. dimidiata, R. prolixus, P. megistus*) that live in close association with humans having invaded and colonized human and domestic animal habitations. However, an increasing number of sylvatic and peri-domestic species have also been shown to be natural and/or experimental vectors for *Trypanosoma cruzi*, and some consider that all triatomine species may be potential vectors. Studies have also shown that *Rhodnius robustus* and *R. ecuadorensis* may act as vectors for the less pathogenic *Trypanosoma rangeli* of mammals, and *T. rubrofasciata* may act as a vector for *Trypanosoma conorhini* and *Trypanosoma lewisi* of rodents. It has also been shown that triatomine bugs can be transiently infected with a range of viruses (including those causing hepatitis and acquired immunodeficiency syndrome in humans, and equine encephalitis), but there is no evidence to suggest that they are involved in disease transmission.

Developmental cycle and mode of transmission: All triatomine species exhibit gradual (incomplete) metamorphosis whereby eggs hatch to release nymphs which moult between five nymphal stages before forming adults. Nymphs and adults are haematophagous and must feed on blood from vertebrate hosts to develop further. They are not transmitted directly or indirectly between hosts, but only make physical contact with a host when feeding. They are nocturnal and feed at night every 2-9 days, although some have occasionally been observed feed during the day under adverse conditions. Rarely, some species have been found to be kleptohaematophagous (sucking blood already ingested by another triatomine), haemolymphagous (sucking haemolymph from other insects, notably cockroaches) or even coprophagous (ingest faeces). When not feeding, they live free in the surrounding environment taking shelter in small enclosed spaces. Many species are nidicolous and aggregate in natural or artificial constructs frequented by hosts, including nests, burrows, caves, animal houses and human habitations. Fertilised females lay 1-2 eggs per day for several weeks, each female producing around 200 eggs in total, although this may range from 50-1,000 eggs depending on

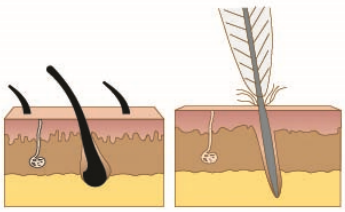
species, lifespan, environment and food supply. Most eggs are oviposited singly or in small clusters free in the environment, although some species secrete an adhesive cement to stick eggs to substrates (sometimes including the feathers of nesting birds). Depending on environmental conditions (temperature and humidity), eggs hatch within 10-37 days releasing small wingless nymphs which begin feeding 2-3 days later. All subsequent nymphal and adult stages must engorge fully to develop, often requiring more than a single bloodmeal (N4 and N5 feed the most). The final moult produces winged adults (males and females) which mature rapidly and mate. Females start laying eggs 10-30 days after mating. The entire life cycle may be completed in 2-3 months, but more usually takes 1-2 years. Development occurs faster at higher ambient temperatures and at low relative humidity, suggesting that incipient global warming may accelerate life-cycles. Many species survive long periods of fasting (months) making them well adapted to nest habitats where hosts may be present intermittently. Adult bugs are good fliers but tend not to fly far from refuges (usually < 200 m although some have been recorded flying up to 1 km). During the night, the adults of several species have been found to be attracted to house lights. Behavioural studies have observed a circadian rhythm with two peak periods of spontaneous locomotory activity: one period around dusk when bugs begin seeking food; and one near dawn when they seek shelter. Host-seeking appears to involve thermoreceptors on antennae to detect heat sources as well as chemoreceptors to detect volatile host odours (carbon dioxide emanating from breath, ammonia, short chain amines and carboxylic acids from skin, hair and exocrine glands). The large compound eyes work well in conditions of dim illumination and vision serves for orientation. Studies have also shown that volatile chemical substances released in bug faeces may act as signals for refuges resulting in gregarious behaviour and aggregated distributions. The majority of triatomines are found in the New World (Americas) between latitudes 42°N and 46°S, although a few species have been found in East Asia and coastal Australia. Three major species groups are recognized on the basis of their habitats: comprising sylvatic species (inhabiting natural settings); peri-domestic species (occurring around shelters for domestic animals and humans); and domestic species (living within human habitations). Most sylvatic species are associated with wild nesting vertebrates in a variety of terrestrial or arboreal habitats, ranging from deserts, savannahs, steppe or thorny brushwood regions to dry, wet, moist and rain forests. Terrestrial habitats include subterranean ground burrows, tree root cavities, fallen logs, rock piles, caves and ruins, often inhabited by rodents (murids and porcupines) and armadillos, while arboreal habitats include hollow trees, tree holes, under tree bark, bird nests, palm-trees crowns and fronds, cactus mandacaru, bromeliads and other epiphytes, occupied by amphibians, lizards, opossums, sloths, bats and birds. *Triatoma* spp. are widespread in most sylvatic habitats while *Rhodnius* spp. primarily inhabit arboreal habitats and *Panstrongylus* spp. prefer terrestrial habitats. Numerous sylvatic species appear to be in the process of domiciliation due to changes in land use (deforestation, agricultural development, and urbanization), with some transiently invading man-made ecotopes and a few colonizing human habitations. Peri-domestic species utilize domestic animals as hosts and live near settlements usually in animal shelters, including chicken coops, aviaries, pens, hutches, sties and stables. A few species (e.g. *T. infestans*) have become truly domestic (domiciliary) and live in cracks and crevices in human dwellings where they depend on humans (and pets) for blood. They are well adapted to living in dilapidated or poorly constructed huts or shacks, especially older dwellings with mud and/or wooden walls, thatched or shingled roofs, earthen or timber floors, crude furniture, elementary furnishings (wall hangings and curtains), woodpiles and stacks of paper, clothing, and other materials. They prefer shaded refuges that provide extensive body contact with rough dry surfaces.

Differential diagnosis: Bugs are rarely captured or even observed feeding on hosts as they are nocturnal, stealthy and have painless bites. Persistent or recurrent feeding, however, may cause skin lesions, especially in allergic individuals, but the lesions are not pathognomic. Infestations in households may generally be indicated by the detection of bug faeces on floors or walls (both whitish streaks/strikes due to excreted uric acid and dark streaks containing heme), exuviae (moulted exoskeletons) or eggs (white-pink intact or empty casings) in nooks and crannies, and occasionally by the presence of nymphs or adults (lethargic after feeding). When disturbed, adults may also produce a pungent odour (secreting isobutyric acid) and they may also 'chirp' using their stridulatory apparatus. Various traps may be used to collect wild triatomines, but light traps only attract adults and live-baited traps only collect starved bugs, so trapping may seriously under-represent bug populations in remote areas with abundant food sources. A variety of genetic techniques have been used to characterize species and infer phylogenetic relationships, ranging from karyotyping (especially X chromosomes) to DNA sequencing (following polymerase chain reaction (PCR) amplification of nuclear (ribosomal RNA) or mitochondrial (cytochrome) genes).

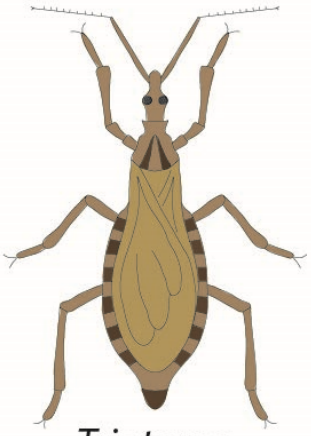
Treatment and control: Given the potential for triatomines to transmit Chagas' disease via their faeces, it is important that bite sites are not rubbed or scratched but washed thoroughly with soap and water. Individuals developing pruritic lesions may seek relief using palliatives or antihistamines while those experiencing acute systemic reactions (anaphylaxis) may require epinephrine and other supportive measures. Several studies have reported some success with immunotherapeutic interventions where multiple measured injections of bug salivary gland extracts have been used to desensitize some individuals. Infestations in domestic animals may be treated or prevented using pour-on formulations of insecticides (notably synthetic pyrethroids) to repel or kill bugs. Effective control programs have been instituted in many countries by reducing bug populations through environmental decontamination and improving living conditions using chemical insecticides and better building methods. Various insecticidal formulations with good residual activity, notably the synthetic pyrethroids (deltamethrin, cyfluthrin, lambdacyhalothron, cypermethrin), may be used to spray inside and outside residences and outbuildings ensuring good coverage of walls, roofs and furniture. Although these chemicals may not be very effective against eggs wedged in cracks and crevices, their residual activity may be enough to kill newly emergent nymphs over longer periods. Alternatively, spray applications may be repeated at regular

intervals, or wettable powders, concentrated suspensions or insecticidal paints may be used. Surface treatments are more effective on non-porous materials, such as hardwood sealed timber, fired bricks, ceramic tiles and plastered walls, than on porous surfaces such as mud adobe and rough dried timber. Homes and shelters constructed with smooth walls and ceilings, tiled or tin roofs, and concrete floors provide fewer refuges for bugs. It is also important that households be kept clear of accumulations of materials (clothing, papers, firewood, vegetation or debris), that furniture and furnishings be solidly constructed, and that domestic animals be kept in separate quarters. Premises should undergo regular or continual surveillance for infestations, sometimes as simple as mounting paper swatches on walls to detect bug faeces. With increasing urbanization and globalization, it is important that luggage, furniture and household goods from endemic areas be treated before translocation. There have been several reports of insecticide resistance emerging in domestic bug species in several South American countries, but it does not appear to be widespread at present (possibly due to the long life-cycles of bugs and their allopatric distributions). Intensive public education programs using print and electronic media (radio, television, internet) have been used to alert communities to the risks associated with bugs and the transmission of Chagas' disease, particularly in schools and health-care facilities.

Reduviid bugs

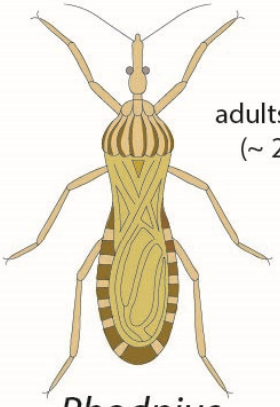


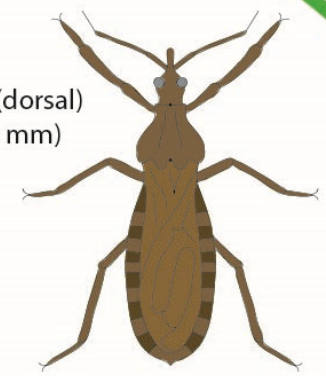
skin, pelage/plumage
(irritation, inflammation,
lesions, allergic reactions,
vector for infectious diseases
[trypanosomiases])



Triatoma

Definitive Hosts
(mammals, birds,
reptiles))

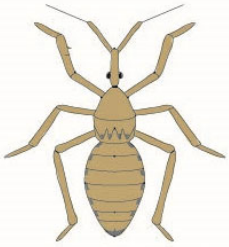




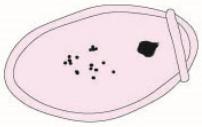
adults (dorsal)
(~ 25 mm)

Rhodnius

Panstrongylus



nymph (dorsal)
(~ 10 mm)

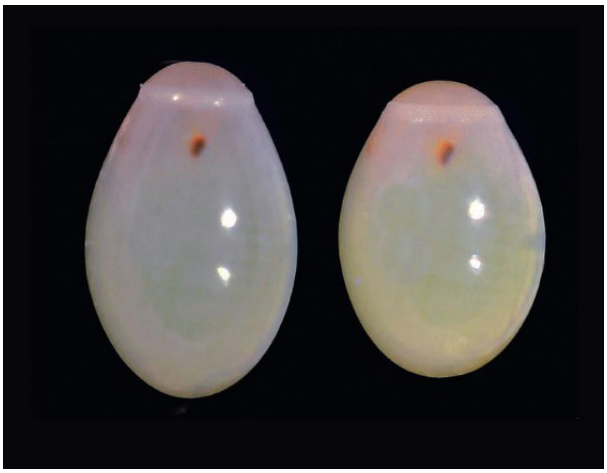


egg
(~ 2 mm)

all stages occur in external environment
(but motile stages are temporary
ectoparasites that feed on blood)

motile stages are nidiculous and
emerge nocturnally to feed on resting hosts

Triatoma adult



Triatoma eggs