A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses of subfamilies and genera, keys to world species, and some new locality records

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Academic editor: Vladimir Pesic | Received 2 April 2014 | Accepted 5 June 2014 | Published 20 June 2014

http://zoobank.org/D71C8A3D-A6CA-40A5-B3A0-34A1FD1C16A0

Citation: Skvarla MJ, Fisher JR, Dowling APG (2014) A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses of subfamilies and genera, keys to world species, and some new locality records. ZooKeys 418: 1–103. doi: 10.3897/zookeys.418.7629

Abstract

Cunaxidae are predaceous mites found in a variety of habitats. This work provides comprehensive keys to world subfamilies, genera, and species. Diagnoses and historical reviews are provided for subfamilies and genera.

Cunaxa boneti, C. denmarki, C. exoterica, C. floridanus, C. lehmanae, C. lukoschusi, C. metzi, C. myabunderensis, C. newyorkensis, C. rackae, C. reevesi, and C. reticulatus are moved to Rubroscirus and C. otiosus, C. valentis, and C. rasile are returned to Rubroscirus. Cunaxoides neopectinatus is moved to Pulaeus. Neocunaxoides pradhani and N. gilbertoi are transferred to Scutopalus. Pulaeus minutus and P. subterraneus are moved to Lupaeus. Pseudobonzia bakari, P. malookensis, and P. shamshadi are transferred to Neobonzia. Dactyloscirus bifidus is transferred to Armascirus.

Scirula papillata is reported from the Western Hemisphere for the first time. Armascirus ozarkensis, A. primigenius, and Dactyloscirus dolichosetosus are reported from new localities.

Keywords

Identification, key, Bdelloidea, Prostigmata, Eupodina
Introduction

Cunaxidae (Fig. 1) are common predatory mites that are present in forest systems, grasslands, agricultural fields, and anthropogenically disturbed areas. Surveys of mites in these habitats often report only family or generic-level identification. This is problematic because little is known about where cunaxid species occur, both regionally and in what habitats, and unfortunate because such reports are potentially very useful collectively if species were identified.

Part of the reason behind the lack of specific identification is the difficulty in reliably identifying cunaxids without extensive knowledge of the primary literature. Keys to cunaxid species are often regional, so of little use to researchers outside of that specific region, and scattered across countless journals. The last comprehensive attempt to present keys to world species was by Smiley (1992). The number of described species since Smiley published his monograph has more than doubled (166 to 400+). Updated keys reflecting known diversity and current taxonomic opinion are therefore imperative if researchers are to identify individuals to the specific rather than generic or family level.

Biology. All cunaxids are thought to be opportunistic predators, though an undescribed *Rubroscirus* was observed to drink drops of honeydew in addition to feeding on live prey (Walter and Proctor 1999). Cunaxids have been reported to feed on active prey such as Collembola (Sellnick 1926, Heryford 1965), bark lice (Zaher et al. 1975a), and thrips (Milne 1977), and relatively inactive prey such as scales (Ewing and Webster 1912, Gerson 1971), nematodes (Taha et al. 1988, Walter and Kaplan 1991), phytophagous mites (Meyer and Ryke 1959, Zaher et al. 1975a, Den Heyer and Ryke 1970, Taha et al. 1988, Smiley 1992, Sathiamma 1995, Arbabi and Singh 2000, Ferla 2001, Lahiri et al. 2004, Castro and Moraes 2010), and paratydeid mites (pers. obs.). They fail to survive when offered only plant material (Zaher et al. 1975a).

Both ambush and active hunting have evolved within the family, sometimes within the same subfamily. Within Cunaxinae, for instance, *Armascirus* and *Dactyloscirus* wait, sometimes for hours, to ambush prey (Walter and Proctor 1999), whereas *Allocunaxa* actively search for prey (Castro and Moraes 2010).

Cunaxids occur in most terrestrial habitats, including soil and leaf litter (Den Heyer 1977a, Luxton 1982; Javan et al. 2012); moss and lichen (Sepasgosarian 1978, Tseng 1980); on vegetation (Miller 1925, Swift and Goff 2001, Ferla and Moraes 2002) including coniferous trees (Lehman 1982), tropical trees (Castro and Moraes 2007) including guava trees (Mallikarjunappa and Nageshchandra 1990), Ferla and Moraes 2002), mango trees (Mohamed et al. 2014), coconut trees (Mariau and Biggins 2001; da Silva et al. 2014), and rubber trees (Hernandes and Feres 2006), ornamental plants (Tagore and Putatunda 2003), invasive weeds (Walter 1999), agricultural plants such as citrus trees (Muma 1960, Olivier 1968, Ramsey et al. 1972a, Soliman and Mahfood 1978, Vacante and Nuñofora 1986, Quilici et al. 1997, Grout and Ueckermann 1999, Ferla and Moraes 2002, Fadamiro et al. 2009), deciduous fruit trees (Nesbitt 1946,
Garman 1948, Lord 1949, Ramsey et al. 1972b, Quilici et al. 1997, Ferla and Moraes 1998, Ferla and Moraes 2002; Shakhsi Zare et al. 2012), cotton (Kuznetsov and Sizova 1978), strawberries (Ferla et al. 2007), grape vineyards (Schruft 1971, Jubb et al. 1985, Molnar 1997), alfalfa fields (Badieritakis et al. 2014), and plants in urban settings (Lahiri et al. 2004); vertebrate nests (Garman 1948, Gupta and Chattopadhyay 1978, Gupta and Paul 1985, Estebanes-Gonzales 1997); caves (Cooreman 1954, Turk 1972, Zacharda 1978); animal debris (Corpuz Raros et al. 1988, Taha et al. 1988); tree holes (Atyeo 1958, Lin and Zhang 2002); house dust (Oliveria and Daemon 2003); and stored food products (Huges 1976, Tseng 1980, Fan 1992). Individual species, however, are thought to be restricted to a particular habitat. For example, Armascirus taurus is reported to be most prevalent on the leaves of citrus trees while Coleoscirus simplex and C. curtipalpus are more common in the leaf litter (Muma 1965) and Parabonzia bdel-liformis is usually collected from treeholes but not nearby litter (Smiley 1992).

**Figure 1.** Examples of cunaxids in ethanol illustrating how they would appear while sorting. 1a Armascirus 1b Cunaxa 1c Pulaeus 1d Parabonzia 1e Coleoscirus 1f Neobonzia.
While cunaxids are often found in agricultural settings, their effect on prey populations is unclear. Ewing and Webster (1912) observed *Cunaxoides parvus* feeding on oyster-shell scales on apple trees and Schruft (1971) reported *C. oliveri* feeding on eriophyid mites on grapes. Sathiamma (1995) reported *Cunaxa setirostris* to be “a very active and efficient predator on all the motile stages of *Oligonychus iseteilemae* [white spider mite]” and that the “predator larva preferred the larval prey; nymphal predator preferred the larvae and early nymphs of the prey and the adult preferred the prey nymphs and adults”. Nucifora and Vacante (1986) reported cunaxids to be auxiliary predators that are useful for crops, but not main predators used in “integrated control techniques”. Rigorous studies investigating the effect of cunaxids on prey populations, however, have not been conducted.

Cunaxids appear to be active year round. Den Heyer (1980a) collected all life stages of *Neocunaxoides* in the Transvaal Highveld during the summer (30 °C+) and winter (minimum 0 °C) months. Zaher et al. (1975b) collected cunaxids throughout the year and demonstrated a positive correlation between abundance and temperature; they also found a slight negative correlation between abundance and relative humidity.

Cunaxids have been reported to be found phoretically on bark beetles, though they were not identified to species (Penttinen et al. 2013).

Both sexual reproduction and thelytokous parthenogenesis have been reported in cunaxids (Walter and Proctor 1999, Castro and Moraes 2010). Within Cunaxinae, Coleoscirinae, and Cunaxoidinae, precopulatory guarding of the quiescent tritonymphal female has been reported (Walter and Kaplan 1991). *Dactyloscirus* males possess a well-developed, sclerotized aedeagus; *Armascirus* and *Rubroscirus* males also possess an aedeagus, though less developed and sclerotized than in *Dactyloscirus* (Den Heyer 1978a, 1979a, 1981a). Castro and Moraes (2010) suggest that *Cunaxatricha tarsospinosa* may be cyclically or facultatively parthenogenetic – one population they studied consisted entirely of females while another population approximately 450 km distant contained males – and that parthenogenesis may be induced by cellular endosymbionts.

Cunaxids spin silk, which is used for a variety of purposes. *Cunaxatricha tarsospinosa* produces a webbing around eggs laid on leaves, but not branches; Castro and Moraes (2010) report that destruction of webbing may reduce viability of the eggs. Nymphal *Armascirus taurus*, *Dactyloscirus inermis*, *Coleoscirus simplex*, and an undescribed *Pulaeus* construct silken molting chambers (Alberti and Ehrnsberger 1977; Walter and Kaplan 1991); the breadth of this behavior suggests it may be widespread among cunaxids. *Cunaxa setirostris* constructs an irregular net of two silk varieties which is used during prey capture (Alberti and Ehrnsberger 1977). It has also been proposed that some species may be venomous, though this has not been confirmed (Den Heyer 1980a, Smiley 1992, Walter and Proctor 1999).

**Biogeography.** Cunaxids have been found on every continent except Antarctica. South Africa and the Philippines have the most well-documented cunaxid diversity – 68 and 57 species respectively – thanks to the efforts of Den Heyer and Corpuz-Raros
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Den Heyer 2011a). South America was little studied until Castro and Den Heyer described 8 genera and 10 species from Brazil between 2008 and 2009. Only two species are known from Australia, both reported by Womersley (1933), though Walter (1999) reported 5 undescribed species in 4 genera and Callan et al. (2011) reported another two species at the family level, suggesting many species await discovery there.

The cunaxid fauna of Europe and North America north of Mexico fall between these extremes. Most reports have been sporadic and span more than a century, beginning with Banks (1894) in the United States and Berlese (1887) in Europe. Robert L. Smiley, a well-known North American worker, never collected material. He instead worked on samples that were sent to him, often intercepted by the USDA at ports of entry, so rather than focusing on North American fauna he more generally worked on world species. This has led to a scattered understanding of the species and genera that occur in North America.

Methods

The diagnoses and keys presented are based on published descriptions and examination of available type specimens. However, for many species the types were not available for examination. The accuracy of the keys is therefore dependent upon the accuracy of the published descriptions. This also influenced which characters were chosen for couplets. Often a character that is potentially useful and informative (such as the presence or absence of a cheliceral seta) was not reported in the original description. Thus, unlike previous keys, characters such as setal counts of leg segments were often preferred. This may prove to be problematic as extra setae are sometimes reported on leg segments; however, examination of multiple specimens in a population should help overcome this.

Den Heyer (2011b, 2013) transferred many species into different genera in the Bdelloidea database that is used by Species 2000 and ITIS Catalogue of Life (CoL). However, nomenclatural acts proposed within these databases are not considered valid under The International Code of Zoological Nomenclature as they do not conform to Article 8.4.2.2. This is intentional for a number of reasons, including avoiding circularity (e.g., a paper that cites CoL about a nomenclatural act, and CoL citing that paper) and time limitations in pursuing a publication that includes all nomenclatural acts proposed within the databases each year (Roskov and Bailly, 2 May 2014, pers. comm.).

Terminology

An effort is made to utilize terminology that is broadly applicable and well-accepted across mite taxa, despite conventions used among bdelloid researchers. Some terms widely used by bdelloid researchers are either inaccurate or outdated, and others are
misleading. Therefore, we follow the suggestions outlined by Fisher et al. (2011), which are elaborated upon below.

**Subcapitulum.** The part of the gnathosoma that bears the palps and chelicerae has been variously termed by researchers of Bdelloidea. One such term – hypostome – more properly refers to the area of the subcapitulum anterior to the oral opening (Evans 1992; Krantz and Walter 2009), and therefore its use in reference to the entire subcapitulum is incorrect. The other term – hypognathum – is synonymous with subcapitulum, and is therefore not inaccurate, but also not broadly used across mite taxa. Thus, we reject the use of hypognathum in favor of subcapitulum and reserve the use of hypostome to the region of the subcapitulum anterior to the oral opening.

**Body segmentation.** The terminology associated with the acariform idiosoma remains controversial. Classically, these regions have been most widely called the propodosoma and hysterosoma. However, Grandjean (1970) proposed an alternate view of acariform idiosomal organization based on a segmentation hypothesis of van der Hammen (1963). Grandjean postulated that the podosoma is dorsally overtaken by the gnathosoma and the opisthosa and termed the outgrowth of the gnathosoma that obscures the propodosoma the ‘aspidosoma’. Under this hypothesis, referring to the antero-dorsal half of the idiosoma as the propodosoma is inaccurate, while referring to posterio-dorsal idiosoma as the hysterosoma (opisthosa + metapodosoma) is more inclusive than necessary and should instead be denoted simply as the opisthosa. This hypothesis has gained popularity and ‘aspidosoma’ is currently used across disparate acariform taxa (e.g., Caeculidae: Coineau 1974; Erythraeidae: Mąkol 2010; Penthalodidae: Jesionowska 2010; Tydeidae: Kazmierski 2008). Contrary to this, Weigmann (2001) pointed out there is neither evidence for the dorsal overgrowth of the gnathosoma obscuring the propodosoma, nor for the overgrowth of the opisthosa obscuring the metapodosoma. Further, he provided good evidence for retaining ‘propodosoma’ and ‘hysterosoma’. Ultimately, this matter will not be resolved without detailed investigation into developmental biology. Barnett and Thomas (2012, 2013) investigated the embryology of an oribatid (*Archegozetes longisetosus* Aoki, 1965) and demonstrated the opisthosa of that mite comprises only two segments. Unfortunately, their investigations are as yet unable to resolve the problem of the dorsal podosoma.

Fisher et al. (2011) proposed avoiding hypothesis-dependent terminology pending further evidence for a given hypothesis. Thus, they retained ‘hysterosoma’ to refer to the idiosoma posterior to the sejugal furrow and implemented ‘proterosoma’ for the anterior idiosoma. Both terms were considered hypothesis-independent, but suffered from being more inclusive than necessary. Regardless, ‘hysterosoma’ is already used by many authors to refer to the dorsum posterior to the sejugal furrow, therefore its implementation is uncontroversial. Conversely, ‘proterosoma’ is not widely used to refer to the anterior idiosoma. Thus, referring to those setae as ‘proterosomal setae’ is novel, and therefore less preferred. However, recent investigations provide some support for implementing ‘proterosoma’ – this is discussed below.
Phylogenetic analyses of large datasets that include molecular data has corroborated previous suspicions of the non-monophyly of “Acari” and provided substantial support for a clade that combines camel spiders with acariforms called Poecilophysidea (Dabert et al. 2010, Pepato et al. 2010). In addition to characteristics of the reproductive system that have been previously noted (Alberti 1980a, b, 2000, Alberti and Peretti 2002, Klann et al. 2009), Dunlop et al. (2012) suggested that the sejugal furrow of Acariformes is homologous to a similar body division in Solifugae, lending another potential synapomorphy for this clade. Because of this, the sejugal furrow was elevated as a key morphological trait among both camel spiders and acariforms, which now makes it possible to construct terminology founded in a well-supported hypothesis. This renders terms that are denoted relative to the sejugal furrow (like ‘proterosoma’ and ‘hysterosoma’) as hypothesis-dependent, which is only preferred over hypothesis-independent terminology when the hypothesis is well-supported.

Therefore, we continue with the suggestions of Fisher et al (2011) in using ‘proterosoma’ and ‘hysterosoma’ for two reasons: 1) they are hypothesis-independent with respect to Grandjean’s ‘aspidosoma’ and Weigmann’s ‘propodosoma’; and 2) since 2011, they have been found to be hypothesis-dependent, but on well-supported hypotheses. Obviously, as future research resolves the issue of the acariform idiosomal dorsum (i.e. Grandjean vs. Weigmann), we suggest that new terminology based on those hypotheses should be adopted.

**Idiosomal setae.** For hysterosomal setae, we follow the notation of Grandjean (1939, 1947) that has been widely adopted by acarologists (e.g., van der Hammen 1970; Lindquist 1976, 1977; Kethley 1990; Swift 1996). However, proterosomal setae remain problematic. Historically, proterosomal chaetotaxy followed Grandjean (1939, 1947), which identified internal/external verticals (vi and ve) and internal/external scapulars (sci and sce). This notation has always been cumbersome for groups like Bdelioidea which have sci always external to sce. Given that homology has not been determined for these setae across mite taxa, some authors suggested simply switching the designations of sci and sce to reflect their position (Den Heyer and Castro 2008a, b, c; Den Heyer 2011c). As a result, frustratingly, the literature now has both sci and sce referring to each set of setae.

Therefore, we reject the suggestion of Den Heyer and Castro (2008) and follow the suggestion of Fisher et al. (2011), which resorts to a modified version of Atyeo (1960) when referring to proterosomal setae: anterior/posterior trichobothria (at/pt), and lateral/median proterosomal setae (lps/mps). Obviously, once homology of these setae can be determined across mite taxa, we suggest revising the terminology accordingly.

**Abbreviations.** The following abbreviations (Fig. 2) are used: attenuate solenidion (asl), blunt rod-like solenidion (bsl), famulus (fam)(=peg organ), microseta (mst), solenidion (s) (this is used only when a description does not specify what type of solenidion and may refer to any solenidion type), spine-like seta (spls), simple tactile seta (sts), trichobothrium (T). When setal types are not specified (e.g., coxae I–IV setal formula 5-5-4-3) it is assumed all setae are simple (sts).

Illustrations were produced using the methods outlined by Fisher and Dowling (2010).
Systematics

Cunaxidae Thor, 1902

Historical review. Linnaeus (1758) described *Acarus* and included all mites therein. Hermann separated three mite species with elongated gnathosomas (i.e., Bdellidae and Cunaxidae) from *Acarus* into *Scirus*. However, Hermann died in 1794 and his papers were not published until after his death by his brother-in-law F. L. Hammer in 1804 (as Hermann 1804). Latreille (1795) had by then separated the same mites into *Bdella*. Von Heyden (1826), recognizing that *Bdella* had priority over *Scirus*, synonymised *Scirus* with *Bdella* and erected *Cyta* and *Cunaxa*. However, many authors, including Dugés (1834a), Kramer (1881), Banks (1894), and Berlese (1904, 1910), continued to describe new species in *Scirus*. Dugés (1834a) erected Bdellidae (Bdelloidea) for *Bdella* and *Scirus*, having apparently not seen Von Heyden’s synonymization of the two genera. Trouessart (1892) moved *Cunaxa* from Bdellidae to Trombidiidae and erected the subfamily Scirinae. Oudemans (1902) used Cunaxinae in the same sense that Trouessart (1892) used Scirinae, that is

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**Figure 2.** Setal types. Relative sizes will vary within a given setal type 2a Attenuate solenidion (asl) 2b Blunt rod-like solenidion (bsl) 2c Elongate, tri-pronged famulus (fam), as seen in *Dactyloscirus* 2d Famulus (fam), as seen in the majority of cunaxids 2e Duplex setae - microseta (mst) and attenuate solenidion 2f Spine-like seta (spls) 2g Simple tactile seta (sts) 2h Trichobothrium (T).
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for those mites in the family Bdellidae (*sensu* Dugés) that have pedipalps with a curved terminal segment and movable chela only (= Cunaxidae *sensu* Thor). Thor (1902) erected Cunaxidae as a family separate from Bdellidae. Oudemans (1906) disregarded Thor's (1902) erection of Cunaxidae and kept Cunaxinae as a subfamily within Bdellidae. Van der Hammens (1972) erected the superfamily Cunaxoidea over Bdelloidea, disregarding the priority of *Bdella* Latreille (1795) over *Cunaxa* Von Heyden (1826). Den Heyer (1977b) erected Bonziinae for *Bonzia* and *Parabonzia*. Den Heyer (1978a) preserved the name Cunaxinae, but limited its concept to those cunaxids possessing 5-segmented pedipalps which extend past the subcapitulum by at least the distal two segments. Den Heyer (1978b) erected Coleoscirinae. Den Heyer (1980c) erected the monobasic Scirulinae and recognized the priority of Bdelloidea over Cunaxoidea. Bu and Li (1987a) erected Orangescirulinae. Smiley (1992) erected Denheyernaxoidinae, Neobonzinae, and Paracunaxoidinae as monotypic subfamilies and monographed and provided keys to known species. Den Heyer and Castro (2009) moved Denheyernaxoidinae and Paracunaxoidinae to Cunaxoidinae, thus disregarding Denheyernaxoidinae and Paracunaxoidinae as valid subfamilies. Lin and Zhang (2010) provided a detailed historical review of Cunaxidae in China and a checklist of species found in that country. Den Heyer (2011) moved *Neobonzia* to Coleoscirinae, effectively disregarding Neobonzinae, and synonymized Coleobonzia with Neobonzia.

**Diagnosis.** *Gnathosoma* (Figs 3–6). **Pedipalps** 3-, 4-, or 5-segmented and end in a strong claw (except in *Pseudobonzia*). They may be shorter than, equal to, or extend beyond the distal end of the subcapitulum. Femora of 5-segmented pedipalps divided into basi- and telofemora, though may be secondarily fused; a dark line often indicates the previous articulation (Fig. 5a, b illustrate a fully divided femur and Fig. 6a, b illustrate a secondarily fused femur. This is for illustration purposes only, i.e., cunaxids with long and short 5-segmented pedipalps may have either fully divided or secondarily fused femora). Telofemora and genua are uniquely fused in *Allocunaxa*, though the basifemoral/telofemoral articulation is present. Apophyses present or not on the telofemora, adjoining the genua and tibiotarsi, or on the tibiotarsi. Subcapitulum wedge-shaped and may be patterned with random dots or papillae, dots or papillae forming lines, a single row of cells on the posterior edge, or reticulations forming polygonal cells. **Subcapitulum** with up to 6 pairs of setae are present: *hg*<sub>1–4</sub> and 2 pairs of adoral setae. Seta *hg*<sub>1</sub> usually straight, but geniculate in Bonziinae and may be curved in *Neoscirula*; *hg*<sub>4</sub> often longest pair of subcapitular setae. **Chelicerae** with or without setae near the cheliceral digit.

**Idiosoma, dorsal** (Fig. 7a). Idiosoma diamond-shaped. Dorsal proterosoma covered with a sclerotized shield that bears 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensilla (*at* and *pt*); rarely one pair of setae or sensillae absent. Dorsal hysterosoma complemented with 0–2 large shields or plates and 0–4 pairs of platelets. These plates and platelets may capture one or more pairs of setae. Up to 8 pairs of dorsal hysterosomal setae present (*c₁–h₁, c₂, f₂, and h₂); *h₂* may occur ventrally. Setae may occur on small platelets that are barely larger than the setal socket. Integument not covered in shields, plates, or
Figures 3–6. a. dorsal. b. ventral. 3 3-segmented pedipalp (Cunaxoidinae) 4 4-segmented pedipalp (Scirulinæ) 5 5-segmented pedipalp that does not extend beyond the subcapitulum by more than the distal half of the genua (Bonziinae, Coleoscirinae, and Orangescirulinae) 6 5-segmented pedipalp that reaches beyond the subcapitulum by at least the distal half of the genua (Cunaxinae).
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Figure 7. Generalized schematic of cunaxid idiosomal morphology. 7a Dorsal. 7b Ventral.

platelets is striated. Cupule $im$ present, usually laterad and slightly posterior to $e_i$. Dorsal idiosomal shields and plates smooth or patterned with random dots or papillae, dots or papillae forming lines, reticulations forming polygonal cells, or cells which form rows.
Idiosoma, ventral (Fig. 7b) Ventral idiosoma may be complemented with 1 or a few small platelets in addition to the coxae. Coxae fused to body and form plates. Coxae I–II are often fused in adults and may coalesce medially to form a sternal shield. Coxae III–IV are often fused in adults and may extend caudally beyond the genital plates. Each coxa complemented with 0–4 setae; in addition, extensive coxae or sternal shields may capture setae normally on the integument and therefore have more. Coxae may be plain or patterned with random dots or papillae, dots or papillae forming lines, or reticulations forming polygonal cells. Genital plates (sometimes called anal valves) present in adults and bear 3 (rarely) or 4 (usually) setae, except in Parabonzia which have up to 9 pairs of setae. 2 pairs of genital papillae visible underneath the plates. Anal plates (sometimes called anal valves) bear 1–2 setae ($p_{s_{1,2}}$). Setae $p_{s_{2}}$ may occur off the anal plates. Legs 6-segmented in larvae, 7-segmented in nymphs and adults. In adults these segments are coxa, trochanter, baifemur, telofemur, genu, tibia, and tarsus, however, the coxae are often treated separately from the other leg articles. Femora undivided in larvae. Trichobothrium present on leg tibia IV. Ambulacral claws present on either side of a 4-rayed empodium.

Key to Subfamilies of Cunaxidae (modified from Smiley 1992)

1 Pedipalpal telofemoral multi-branched seta present (except Parabonzia mindanensis) (Fig. 7a) ................................................................. Bonziinae
   – Pedipalpal telofemoral multi-branched seta absent ...........................................
   2 (1) Pedipalps 3-segmented (Figs 3a,b) ................................................................. Cunaxoidinae
   – Pedipalps 4-segmented (Figs 4a,b) ................................................................. Scirulinae
   – Pedipalps 5-segmented (basi-and telofemora may be partially fused) (Figs 5a, b; 6a, b) .............................................................................
   3 (2) Pedipalps extend beyond the subcapitulum by at most the distal half of the tibiae (Figs 5a, b) ........................................................................  Cunaxinae
   – Pedipalps extend beyond the subcapitulum by at least the distal half of the tibiae (Figs 6a,b) .................................................................
   4 (3) Trichobothrium on tibiae IV present; setae $h_{g_{1}}$ not geniculate; cheliceral seta usually present ............................................................. Colescircirinae
   – Trichobothrium on tibiae IV absent; setae $h_{g_{1}}$ geniculate; cheliceral seta absent ........................................................................................... Orangescirulinae

Bonzinae Oudemans, 1927

Historical review. Oudemans (1927) erected Bonzia within Cunaxidae for B. halacaroides. Smiley (1975) erected Parabonzia for Bonzia bdelliformis. Den Heyer (1975) erected Cunabdella for C. marthae. Den Heyer (1977b) erected Bonzinae for the two genera; he also moved C. marthae to Parabonzia, effectively synonymizing Cunabdella with Parabonzia.
Diagnosis. **Gnathosoma.** Pedipalps 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiae. Apophyses absent. A multi-branched seta present dorsally on the telofemora. Tibiotarsi terminate in a stout claw or two strong setae. 2 pairs of adoral setae present or absent. **Subcapitulum** with 4 pairs of setae (hg1–4) present in *Bonzia*; up to 6 pairs of subcapitular setae (hg1–4 + additional setae) present in *Parabonzia*.

**Idiosoma, dorsal.** Proterosoma bears a shield complemented with 2 pairs of setae (at and pt) and 2 pairs of setose sensillae (lps and mps). Dorsal hysterosoma may bear a shield; if a shield is present it may be complemented with a variable number of setae depending on the extent of the shield. Setae c1–h1, c2, f2 and b2 present and are smooth or spiculate. Cupule im present laterad and caudally of e1. Integument that does not bear shields or plates is striated.

**Idiosoma, ventral.** Coxae I–II fused or not and coxae III–IV fused or not. Genital plates bear 4–9 setae; 2 pairs of genital papillae visible underneath the plates. Up to 4 pairs of setae present on the anal plates. Up to 9 pairs of setae present on the integument between coxae II and the anal plates. **Legs.** Trichobothrium present on leg tibia IV. The ambulacral claws occur on either side of a 4-rayed empodium.

**Key to adult female Bonziinae** (modified from Smiley 1992)

1 Pedipalp tibiotarsal claw present; 2 pedipalp tibiotarsal spine-like tubercles present (Fig. 8b); genital plates with 4 pairs of setae; internal genital setae absent ................................................................. *Bonzia Oudemans, 1927*  
   – Pedipalp tibiotarsal claw absent; 2 pedipalp tibiotarsal spine-like tubercles absent (Fig. 8c); genital plates with 5–9 pairs of setae; internal genital setae present ................................................................. *Parabonzia Smiley, 1975*

**Bonzia Oudemans, 1927**

**Historical review.** Oudemans (1927) erected *Bonzia* for *B. halacaroides*. Willmann (1939) described *B. sphagnicola* from Germany. Willmann (1950) described *B. rufofusca*. *Bonzia brownei* was described by Turk (1972). Den Heyer (1977) provided a detailed redescription of type material of this genus. Kuznetsov and Livshitz (1979) reported *Bonzia* from Russia. Michocka (1987) reported *B. halacaroides* from Poland. Smiley (1992) described *B. woodi* and *B. yunkeri* and synonymized *B. rufofusca* and *B. brownei* with *B. halacaroides*. Skvarla et al. reported *B. yunkeri* from the Ozark Mountains in Arkansas.

**Diagnosis.** **Gnathosoma.** Pedipalps 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiae. Apophyses absent. A dorsal multi-branched seta present on the telofemora. The tibiotarsi terminate in a stout claw. 2 pairs of adoral setae present or absent. **Subcapitulum** with 4 pairs of setae (hg1–4) present. Setae hg1 are geniculate.
Idiosoma, dorsal. Proterosoma bears a shield complemented with 2 pairs of setae (at and pt) and 2 pairs of setose sensillae (lps and mps). The dorsal hysterosoma bears a shield that may be complemented with a variable number of setae depending on the extent of the shield. Setae $c_1-h_1, c_2,f_2$ and $h_2$ present, and are smooth or spiculate. Cupule $im$ present laterad and caudally of $e_1$. Integument that does not bear shields or plates is striated.

Coxae I–II fused and coxae III–IV fused. Genital plates bear 4 setae; 2 pairs of genital papillae visible underneath the plates. 4 pairs of setae present on the anal plates. Trichobothrium on leg tibia IV present. Ambulacral claws occur on either side of a 4-rayed empodium.

**Key to adult female Bonzia** (modified from Smiley 1992)

1  Tibiae IV trichobothrium setose (Fig. 9a).................................................................2
–  Tibiae IV trichobothrium smooth (Fig. 9b).................................................................3
2 (1)  Hysterosomal shield with 2 pairs of setae; Germany ..............................................**B. sphagicola Willmann, 1939**
–  Hysterosomal shield with 3 pairs of setae; N. America, S. America, Europe (possibly cosmopolitan) ...........................................**B. halacaroides Oudemans, 1927**
3 (1)  Dorsal setae spiculate (Figs 10a, 11a); New Zealand ..............................................**B. woodi Smiley, 1992**
–  Dorsal setae smooth (Figs 10b, 11b); USA: Virginia, Ozark Highlands ...........

**Figure 8.** Bonziinae key illustrations. 8a Telofemoral branched seta present in Bonziinae 8b Bonzia 8c Parabonzia.
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

Figures 9–11. Bonzia key illustrations. 9a Setose tibial trichobothrium 9b Smooth tibial trichobothrium 10a Spiculate dorsal setae 10b Smooth dorsal setae 11a Close up of a spiculate seta 11b Close up of a smooth seta.

Parabonzia Smiley, 1975

Historical review. Atyeo (1958) described Bonzia bdelliformis from a tree hole in Tennessee, USA. Smiley (1975) erected Parabonzia for B. bdelliformis. Den Heyer (1975) erected Cunabdella for C. marthae. Den Heyer (1977b) synonymized Cunabdella with Parabonzia and described P. athiasae. Kuznetzov and Livshitz (1979) reported Parabonzia from Russia. Smiley (1992) described P. mumai from Florida, USA. Corpuz-Raros (1996a) described P. mindanensis from the Philippines. Lin and Zhang (1998) described P. trioxys. Later they (Lin and Zhang 2002) described P. zhangi. Skvarla et al. (2013) reported Parabonzia bdelliformis from the Ozark Mountains in Arkansas.
**Diagnosis.** Gnathosoma. Pedipalps 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiae. Apophyses absent. A multi-branched seta present dorsally on the telofemora. Tibiotarsi terminate in two strong setae. 2 pairs of adoral setae present or absent. **Subcapitulum** with up to 8 pairs of setae present.

**Idiosoma, dorsal.** Proterosoma bears a shield complemented with 2 pairs of setae (at and pt) and 2 pairs of setose sensillae (lps and mps). Dorsal hysterosoma may bear a shield; if a shield is present it may be complemented with a variable number of setae depending on the extent of the shield. Setae $c_1-h_1$, $c_2$, $f_2$, and $h_2$ present and smooth. Cupule *im* is present laterad and caudally of $e_1$. Integument that does not bear shields or plates is striated.

**Idiosoma, ventral.** Coxae I–II fused or not and coxae III–IV fused or not. Genital plates with up to 9 pairs of setae; 2 pairs of genital papillae visible underneath the plates. Up to 4 pairs of setae present on the anal plates. Up to 9 pairs of setae on the integument between coxae II and the anal plates. **Legs.** Trichobothrium on leg tibia IV present.

**Key to adult female Parabonzia**

1 8–9 genital setae present.................................2
   – 6–7 genital setae present............................3

2 (1) Pedipalpal telofemoral seta unbranched (Fig. 12a); Philippines, Mindanao
   – Pedipalpal telofemoral seta branched, with 4–5 tines (Fig. 12b); China: Hubei Province.................................P. mindanensis Corpuz-Raros, 1996

3 (1) Hysterosomal shield with 3 pairs of setae..............................4
   – Hysterosomal shield with 4 pairs of setae........................6

4 (3) Pedipalpal tibiotarsal sigmoid setae lightly barbed (Fig. 13); South Africa: West Transvaal.................................P. marthae (Den Heyer, 1975)
   – Pedipalpal tibiotarsal sigmoid setae smooth ......................5
5 (4) Large spur-like process present on femora III (Fig. 14); USA: Florida.................................P. mumai Smiley, 1992
   – Large spur-like process absent on femora III; Ivory Coast..................P. athiasae Den Heyer, 1977

6 (3) Coxae I–IV setal formula 7-5-6-7 sts; basifemora I–IV setal formula 4-7-3-2 sts; China: Fujian.................................P. trioxys Lin & Zhang, 1998
   – Coxae I–IV setal formula 6-6 (sometimes 7)-7-7 sts; basifemora I–IV setal formula 5-8-3-2 sts; USA, Russia........................P. bdelliformis (Atyeo, 1958)

Cunaxoidinae Den Heyer, 1978

**Historical review.** Koch (1838) established *Eupalus* and described the first mite belonging to Cunaxoidinae, *Eupalus croceus*. Baker and Hoffmann (1948) proposed *Cunaxoides* to replace *Eupalus* Koch as the name was preoccupied (a fact that acarolo-
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

Gistl; they also redescribed and reillustrated a number of known species. Radford (1950) proposed Haleupalus to replace Eupalus, though this name is invalid because it is predated by Cunaxoides. Smiley (1975) erected Neocunaxoides and reviewed Cunaxoides. Both genera were assigned to the newly established Cunaxoidinae by Den Heyer (1978c). Pulaeus was established by Den Heyer (1979b); the name is an anagram and nod to Eupalus. Den Heyer (1979c) erected Scutopalus for those cunaxoidines with well-demarcated dorsal and ventral plates. Smiley (1992) synonymized Scutopalus with Neocunaxoides and Haleupalus with Cunaxoides; he also erected Denheyernaxoides and Paracunaxoides as monotypic genera in two new subfamilies, Denheyernaxoidinae and Paracunaxoidinae respectively. Castro and Den Heyer (2009) split a new genus, Lupaeus, from Pulaeus based on the number of setae on basifemora IV (1 and 2, respectively) and the number of pointed processes on the pedipalpal tibiotarsi (2 and 1, respectively). Den Heyer and Castro (2009) split Bunaxella, Dunaxeus, Funaxopsis, and Qunaxella from Cunaxoides; they also moved Denheyernaxoides and Paracunaxoides to Cunaxoidinae, thus disregarding Denheyernaxoidinae and Paracunaxoidinae as valid subfamilies.

**Diagnosis.** *Gnathosoma. Pedipalps* 3-segmented: a trochanter which lacks setae, fused femurogenu (femur + genu) which is complemented with 5 or 6 setae, and tibiotarsus (tibia + tarsus) which is complemented with 5 or 6 setae. Tibiotarsi may be complemented with a bladder- or bulb-like apophysis. Pedipalps do not reach beyond the subcapitulum by more than the distal half of the tibiotarsi. **Chelicera** with or with-
out seta near the cheliceral digit. **Subcapitulum** with 4 pairs of setae \((h_g_{1-4})\) are present; setae \(h_g_4\) is often the longest. 2 pairs of adoral setae are present or absent.

**Idiosoma, dorsal.** Female with proterosomal shield (absent in *Cunaxoides ulcersosus*) which is complemented with two pairs of setae \((lps\text{ and } mps)\) and two pairs of setose sensillae \((at\text{ and } pt)\) and may bear a hysterosomal plate complemented with a varying number of setae; when present the dorsal hysterosomal plate may be fused with the proterosomal shield. Dorsal plates well demarcated or not. Dorsal setae \(c_1-h_1\) are present; \(c_2, f_2\text{ and } h_2\) may also be present. If \(f_2\) is present, \(f_1\) and \(f_2\) may be located together on a small platelet. Setae not on larger plates may be born on small platelets barely larger than the setal socket. Cupule \(im\) present laterad and posterior of \(e_i\). Integument that is not covered in shields or plates is striated.

**Idiosoma, ventral.** **Coxae** of female vary in size, from being restricted to the trochanteral bases to being extensive and nearly forming a holoventral shield. Coxae may or may not be well demarcated. Coxae I–II fused (usually) or not, coxae III–IV fused (usually) or not. Coxae I–II may coalesce medially to form a sternal shield. The genital plates each bear 4 setae \((g_{1-4})\); 2 pairs of genital papillae visible underneath the plates. The anal plates bear one pair of setae \((ps_f)\); one pair of setae is present ventrally on the integument near the anal plates (either \(ps_2\) or \(pa\)). Cupule \(ib\) is present ventrally laterad the integumental setae associated with the anal plates. The integument that is not covered in shields or plates is striated. **Legs.** Tarsi never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Ambulacral claws are rippled and occur on either side of a 4-rayed empodium.

**Key to adult female Cunaxoidinae** (modified from Den Heyer and Castro 2009)

| Key | Description | Notes |
|-----|-------------|-------|
| 1   | Pedipalpal tibiotarsi with 3 sts, 1 spls; New Zealand ................. | *Paracunaxoides Smiley, 1992* |
| 2   | Pedipalpal tibiotarsi with 5 or 6 sts, 0 spls.......................... | |
| 2 (1) | Pedipalpal femurogenu with 5 setae; long setae ending in terminal bulb-like knob (very small) on tarsi III and IV present; telofemoral setal formula not 5-5-4-3; usually 6 setae on pedipalp tibiotarsus Cunaxoidini .......... | *3* |
| 3   | Pedipalpal femurogenu with 6 setae; long setae ending in terminal bulb-like knob (very small) on tarsi III and IV absent; telofemoral setal formula 5-5-4-3; usually 5 setae on pedipalp tibiotarsus Pulaeini ........................................ | *9* |
| 3 (2) | Femora I and II divided; setae \(f_2\) absent; trichobothrium on tibiae IV present or absent ................................................................. | *4* |
| 4   | Femora I and II not divided; setae \(f_2\) present; trichobothrium on tibiae IV absent ................................................................. | *Denheyernaxoides Smiley, 1992* |
| 5   | Dorsum with ill-defined weakly sclerotized dorsal plates (Fig. 15a); subterminal pointed process on pedipalp tibiotarsal claw present (Fig. 16a); small teeth (=serrated edge) on pedipalp tibiotarsal claw present (Fig. 16a); cheliceral setae absent ................................................................. |
Dorsum with well-defined and sclerotized dorsal plates (Fig. 15b); subterminal pointed process on pedipalp tibiotarsal claw absent (Fig. 16b); small teeth on pedipalp tibiotarsal claw absent (Fig. 16b); cheliceral setae present .....

Scutopalus Den Heyer, 1979

- Trichobothrium on tibiae IV present; famulus present, on distal portion of tarsus I

Cunaxoides

- Trichobothrium on tibiae IV absent; famulus present or absent

6 (5) Tibiae III with 1 bsl, 3–5 sts; tibiae IV with 2 or 4 sts

Dunaxeus Den Heyer & Castro, 2009

- Tibiae III with 1 lts, 4 sts; tibiae IV with 1 lsts, 4 sts

Funaxopsis Den Heyer & Castro, 2009

7 (6) Tibiae III with 1 bsl, 3–5 sts; tibiae IV with 1 lst, 2 sts

Qunaxella Den Heyer & Castro, 2009

- Tibiae IV with 1 lst, 4 sts; famulus present

Bunaxella Den Heyer & Castro, 2009

9 (2) Setae f₂ present; basifemora I–IV setal formula 4-6-3-1 or 4-6-3-2

Neocunaxoides Smiley, 1975

- Setae f₂ absent; basifemora I–IV setal formula 3-5-2-0 (rarely with 3-5-2-1)

Pulaeus Den Heyer, 1979

- Basifemora I–IV setal formula 4-6-3-2; pedipalp tibiotarsus with one pointed process (ventral) (Fig. 17a); famulus on proximal half of tarsus I; tibiae I–II with non-striated blunt solenidia

Lupaeus Castro & Den Heyer, 2009

- Basifemora I–IV setal formula 4-6-3-1; pedipalp tibiotarsus with two pointed processes (1 ventral, 1 median) (Fig. 17b); famulus on distal half (subapical) of tarsus I; tibiae I–II with transversely striated blunt solenidia

Bunaxella Den Heyer & Castro, 2009

Historical review. Den Heyer (1981b) described Cunaxoides oribensis, C. quini, and C. zebedielensis. Den Heyer and Castro (2009) erected Bunaxella and transferred Cunaxoides oribensis, C. quini, and C. zebedielensis to the new genus.

Diagnosis. Gnathosoma. Pedipalps 3-segmented. Femurogenua are at least twice as long as wide and complemented with 5 setae. Tibiotarsi at least twice as long as wide and usually complemented with 6 setae. A small apophysis present basally and a pointed process occurs near the terminal tip; a ridge present between the apophysis and pointed process. Subcapitulum with 6 pairs of setae (h₃₁–₄ and 2 pairs of adoral setae) present; setae h₄₄ is often the longest. Chelicera without seta.

Idiosoma, dorsal. Proterosoma bears an ill-defined and weakly sclerotized shield which is complemented with 2 pairs of setae (lps and mps) and 2 pairs of setose sensillae (at and pt). The dorsal hysterosoma may or may not bear a plate; if a plate is present it
is ill-defined and weakly sclerotized, may be complemented with a variable number of setae, and may or may not be fused with the proterosomal shield. Setae $c_1 - h_1$, $c_2$, and $h_2$ are present. Seta $c_2$ plumose or fan-shaped. Cupule $im$ is present laterad and posterior of $e_1$. Integument that is not covered in shields or plates is striated.

**Idiosoma, ventral.** Coxae are weakly sclerotized and ill-defined; they can be recognized by possessing somewhat denser striations than the surrounding integument. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV fused or not. Each coxa complemented with 2–4 setae. Genital plates each bear 4 setae ($g_{1-4}$); 2 pairs of genital papillae visible underneath the plates. Anal plates bear one pair of setae; one pair of setae is present ventrally on the integument near the anal plates. Up to 7 pairs of setae present on the integument between the coxal and genital plates. Cupule $ib$ present ventrally laterad the integumental setae associated with the anal plates. Integument that is not covered in shields or plates is striated. **Legs.** Tarsi are never constricted apically so as to end in lobes. Depression for the famulus on tarsus I is absent. Tibia III complemented with 1 bsl, 5 sts. Tibia IV is complemented with 4 sts and lacks a trichobothrium. Ambulacral claws occur on either side of a 4-rayed empodium.
Key to adult female *Bunaxella* (modified from Den Heyer and Castro 2009)

1 Basifemora I–IV with 3-3-3-0 sts; telofemora IV with 1 sts; dorsal setae fan-shaped, except for smooth $f_2$ .............................. *B. quini* (Den Heyer, 1981)
   – Basifemora I–IV with 4-4-3-1 sts; telofemora IV with 1 sts; dorsal setae plumose, except for $h_2$ which may be plumose or smooth ..............................

2 (1) Setae $h_2$ plumose ........................................ *B. oribensis* (Den Heyer, 1981)
   – Setae $h_2$ smooth ........................................... *B. zebedielsenis* (Den Heyer, 1981)

*Cunaxoides* Baker & Hoffmann, 1948

**Historical review.** Koch (1838) described the first two *Cunaxoides* as *Eupalus croceus* and *E. minutissimus*. Koch (1841) described *E. vitellinus*. Trägårdh (1910) described *E. minima*. Ewing (1917) described *E. parvus* and its feeding on oyster-shell scale in the USA. Thor and Willmann (1941) redescribed and figured *E. croceus*, *E. minutissimus*, and *E. vitellinus*. Nesbitt (1946) described *E. biscutum*. Garman (1948) reported *E. biscutum* from apple trees in Connecticut. Baker and Hoffmann (1948) recognized that the name *Eupalus* was preoccupied and erected *Cunaxoides* to replace it; they transferred all known *Eupalus* to the new genus and figured each species. *Haleupalus oliveri* was described by Schruft (1971). Smiley (1975) synonymized *C. vitellinus* with *C. croceus* and provided a translation of Thor and Willmann’s (1941) description of *C. croceus*. Den Heyer (1978c) placed *Cunaxoides* as the type genus in the newly erected Cunaxoidinae; he also redescribed the genus and redesignated a neotype for *C. croceus*. Kuznetzov and Livshitz (1979) described *C. ulcerosus*, *C. longistriatus*, *C. fidus* and *C. desertus* and reported and figured *C. biscutum*, and *C. parvus* from Russia. Gupta and Ghosh (1980) described *C. nicobarensis*. C. kielczewski was described by Michocka (1982). Smiley (1992) synonymized *Haleupalus oliveri* with *C. biscutum*, effectively synonymizing *Haleupalus* with *Cunaxoides*. Hu (1997) reported *C. croceus* and *C. ulcerosus* from China. Sionti and Papadoulis (2003) described *C. paracrococes* from Greece. Bashir and Afzal (2004a) described *C. trisetosis*. Bashir et al. (2007) described *C. sargodaensis* from Pakistan. Bashir and Afzal (2009) described *C. daskaensis*, *C. neigans*, and *C. sialktotensis* Den Heyer et al. (2013) described *C. decastroae* and *C. lootsi*.

**Diagnosis.** Gnathosoma. Pedipalps 3-segmented. Femurogenua at least twice as long as wide and complemented with 5 setae. Tibiotarsi at least twice as long as wide and usually complemented with 6 setae. A small apophysis present basally and a pointed process present near the terminal tip; a ridge present between the apophysis and pointed process. Subcapitulum with 6 pairs of setae ($h_{g1-4}$ and 2 pairs of adoral setae) are present; setae $h_{g1}$ longest. Chelicera without seta.

Idiosoma, dorsal. Proterosoma bears an ill-defined and weakly sclerotized shield which is complemented with 2 pairs of setae ($lps$ and $mps$) and 2 pairs of setose sensillae ($at$ and $pt$). The dorsal hysterosoma may or may not bear a plate; if a plate is present it is ill-defined and weakly sclerotized, may be complemented with a variable number of
setae, and may or may not be fused with the proterosomal shield. Setae $c_1$–$h_1$, $c_2$, and $b_2$ are present. Cupule im present laterad and posterior of $e_1$. Integument that is not covered in shields or plates is striated.

**Idiosoma, ventral.** Coxae weakly sclerotized and ill-defined; they can be recognized by possessing somewhat denser striations than the surrounding integument. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV may be fused. Each coxa is complemented with 2–4 setae. Genital plates each bear 4 setae ($g_1, \ldots$); 2 pairs of genital papillae visible underneath the plates. Anal plates bear one pair of setae; one pair of setae present ventrally on the integument near the anal plates. Up to 7 pairs of setae present on the integument between the coxal and genital plates. Cupule ih present ventrally laterad the integumental setae associated with the anal plates. Integument that is not covered in shields or plates is striated. **Legs.** Tarsi never constricted apically so as to end in lobes. Trichobothrium present on leg tibia IV. Ambulacral claws are rippled and occur on either side of a 4-rayed empodium.

### Key to adult female *Cunaxoides*

The following species have not been included because the original descriptions and subsequent papers describing them (Thor and Willmann 1941; Baker and Hoffmann 1948) are not in English; known illustrations do not contain enough detail; and the types were not examined: *C. minima* (Trägårdh, 1910), *C. minutissimus* (Koch, 1938), *C. vitellinus* (Koch, 1941).

1. Dorsal hysterosomal median plate present (may be fused with proterosomal shield or only suggested by cuticular pattern) (Figs 18a–c, 19a–d, 20) 。。。 2
   - Dorsal hysterosomal median plate absent (Figs 21a, b, 22) 。。。 9
2. Hysterosomal median plate obvious, sclerotized (Figs 18a–d, 19a–c) 。。。 3
   - Hysterosomal median plate not obvious or sclerotized, may only be suggested by cuticular pattern (Fig. 20) 。。。 8
3. Hysterosomal median plate not complemented with setae; USA 。。。 4
   - Hysterosomal median plate and proterosomal shield separate (Figs 18a–c) 。。。 5
   - Hysterosomal median plate and proterosomal shield fused (Figs 19a–d) 。。。 6
4. Hysterosomal median plate complemented with $c_1, d_1$ (Fig. 18a); Canada, USA 。。。 *C. biscutum* (Nesbitt, 1946)
   - Hysterosomal median plate complemented with $c_1$–$e_1, c_2$ (Fig. 18b); Russia 。。。 *C. longistriatus* Kuznetzov & Livshitz, 1979
5. Hysterosomal median plate complemented with setae $e_1, d_1, c_1$ (Figs 19a, b) 。。。 7
- Hysterosomal shield complemented with setae $c_i$, $e_i$, $e_j$, $c_j$ (Figs 19c) .......................................................... *C. decastroae* Den Heyer, 2013

7 (6) Genna IV with 1 asl, 5 sts; striae between $sci$ and $c_i$ U-shaped (Fig. 19a); Greece ........................................... *C. paracrocatus* Sionti & Papadoulis, 2013

- Genna IV with 2 asl, 5 sts; striae between $sci$ and $c_i$ parallel (Fig. 19b); Europe .......................................................... *C. croceus* (Koch, 1838)

8 (2) Dorsal striae form one “shield-like” area, similar to fused proterosomal and hysterosomal shield (Fig. 23a); Poland............................................

- Dorsal striae form two “shield-like” areas, similar to separate proterosomal and hysterosomal shields (Fig. 23b); Iran........................................... *C. lootsi* Den Heyer, 2013

9 (1) Proterosomal shield present (Figs 21a, b)........................................... 10

- Proterosomal shield absent (Fig. 22); Russia .................................................. *C. ulcerosus* Kuznetzov & Livshitz (1979)

10 (9) Dorsal shield reticulated (Fig. 21a); Russia .................................................. *C. desertus* Kuznetzov & Livshitz (1979)

- Dorsal shield striated (Fig. 21b).......................................................... 11

11 (10) Telofemora I–III setal formula 4-3-3; India.................................................. *C. nicobarensis* Gupta & Ghosh, 1980

- Telofemora I–III setal formula 5-5-4 or 5-5-6 .................................................. 12

12 (11) Telofemur III with 3 sts; Pakistan.......*C. sialkotensis* Bashir & Afzal, 2009

- Telofemur III with 4 sts........................................................................ 13

- Telofemur III with 6 sts; Pakistan........... *C. negans* Bashir & Afzal, 2009

13 (12) Basifemur I with 1 sts ........................................................................ 14

- Basifemur I with 2 sts; Pakistan .........*C. daskaensis* Bashir & Afzal, 2009

14 (13) Basifemora II–IV setal formula 1-1-0; Pakistan.............................................. *C. trisetosis* Bashir & Afzal, 2004

- Basifemora II–IV setal formula 4-2-0; Pakistan.............................................. *C. sargodhaensis* Bashir, Afzal & Raza, 2007

*Denheyernaxoides Smiley, 1992*

**Historical review.** Canestrini (1885) described *Eupalus brevirostris*. Berlese (1894, 1897) redescribed *E. brevirostris* and provided illustrations of the dorsal idiosoma, chelicera, and palp. Baker and Hoffmann (1948) proposed *Cunaxoides* as *nomen novum* as *Eupalus* was preoccupied. Smiley (1992) erected Denheyernaxoidinae and *Denheyernaxoides* for *D. martini*. Lin (2001) moved transferred *C. brevirostris* to *Denheyernaxoides* and redescribed the species based on specimens from China. Den Heyer (2009) considered Denheyernaxoidinae as a junior synonym of Cunaxoidinae. Den Heyer and Castro (2009) considered *Denheyernaxoides* to belong to Cunaxoidini. Sergeyenko (2011) reported *D. brevirostris* from Ukraine and erected Denheyernaxoidini for the genus.
Diagnosis. *Gnathosoma*. Pedipalps 3-segmented. Femurogena at least twice as long as wide, complemented with 5 setae. Tibiotarsi at least twice as long as wide, usually complemented with 6 setae. A small apophysis occurs basally and a pointed process occurs near the terminal tip; a ridge runs between the apophysis and pointed process. **Subcapitulum** with 4 pairs of setae (*hg*$_{1-4}$); setae *hg*$_4$ often the longest. Adoral setae absent. **Chelicera** without seta.

*Idiosoma*, dorsal. Proterosoma lacks a shield, complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Dorsal hysterosoma lacks a
plate. Setae $c_1$, $h_1$, $c_2$, and $f_2$ present. Cupule $im$ present laterad and posterior of $e_1$. Integument not covered in shields or plates is striated.

**Idiosoma, ventral.**

*Coxae* I–II connected by small apodemes. Coxae III–IV fused. Each coxa complemented with 2–4 setae. Genital plates each bear 4 setae ($g_{1-4}$); 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae; 1 pair of setae present ventrally on the integument near the anal plates. 5 pairs of setae present on the integument between the coxal and genital plates. Cupule $ih$ present ventrally laterad the integumental setae associated with the anal plates. Integument not covered in shields or plates is striated.

**Legs.** Femora I and II not divided. Trichobothrium on tibia IV absent. Tarsi never constricted apically so as to end in lobes. Ambulacral claws on either side of a 4-rayed empodium present.

### Key to adult female *Denheyernaxoides*

1. Coxa I with 1 sts; trochanters I–IV setal count 1-1-1-1; femora I-II setal count 2–2; gnathosoma with deep indention posterioventrally ..................

   ........................................................................................................... *D. martini* Smiley, 1992

– Coxa I with 3 sts; trochanters I–IV setal count 0-0-1-0; femora I-II setal count 4–5; gnathosoma with slight indention posterioventrally ..................

   ........................................................................................................... *D. brevirostris* (Canestrini 1885)

### Dunaxeus Den Heyer & Castro, 2009

**Historical review.** Den Heyer (1981b) described *Cunaxoides capensis* and *C. elongatus*. Den Heyer and Castro (2009) erected *Dunaxeus*, transferred *D. capensis* and *D. elongatus* to the genus, and described *D. duosetosus*.

**Diagnosis.**

*Gnathosoma.*

*Pedipalps* 3-segmented. Femurogenae at least twice as long as wide, complemented with 5 setae. Tibiotarsi at least twice as long as wide, usually complemented with 6 setae. A small apophysis occurs basally and a pointed process occurs near the terminal tip; a ridge runs between the apophysis and pointed process. *Subcapitulum* with 4 pairs of setae ($hg_{1-4}$ and 2 pairs of adoral setae); setae $hg_4$ is often the longest. *Chelicera* without seta.

*Idiosoma, dorsal.* Proterosoma bears an ill-defined and weakly sclerotized shield which is complemented with 2 pairs of setae ($lps$ and $mps$) and 2 pairs of setose sensillae ($at$ and $pt$). Dorsal hysterosoma may or may not bear a plate; if a plate is present it is ill-defined and weakly sclerotized, may be complemented with a variable number of setae, and may or may not be fused with the proterosomal shield. Setae $c_1$, $h_1$, $c_2$, and $h_2$ are present. Cupule $im$ is present laterad and posterior of $e_1$. The integument that is not covered in shields or plates is striated.

*Idiosoma, ventral.*

*Coxae* weakly sclerotized and ill-defined; they can be recognized by possessing somewhat denser striations than the surrounding integument. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV fused. Each coxa
complemented with 2–4 setae. Genital plates each bear 4 setae \((g_{1-4})\); 2 pairs of genital papillae visible underneath plates. Anal plates bear 1 pair of setae; 1 pair of setae present ventrally on the integument near the anal plates. Up to 7 pairs of setae present on the integument between the coxal and genital plates. Cupule \(ib\) present ventrally laterad the integumental setae associated with the anal plates. Integument not covered in shields or plates is striated. 

**Legs.** Tarsi never constricted apically so as to end in lobes. Tibia III complemented with 5 sts (4 short, 1 long). Tibia IV complemented with 5 sts (4 short, 1 long), and lacks a trichobothrium. Ambulacral claws on either side of a 4-rayed empodium present.

**Key to adult female Dunaxeus**

1. Basifemora IV with 1 sts...........................................*D. elongatus* (Den Heyer, 1981)
   – Basifemora IV with 2 sts.................................................................2

2 (1). Famulus on tarsus I present ......................... *D. capensis* (Den Heyer, 1981)
   – Famulus on tarsus I absent...........*D. duosetosus* Den Heyer & Castro, 2009

**Funaxopsis** Den Heyer & Castro, 2009

**Historical review.** Den Heyer (1981b) described *Cunaxoides passerinae*, *C. vaneedeni*, and *C. visci*. Den Heyer and Castro (2009) erected *Funaxopsis* and transferred *F. passerinae*, *F. vaneedeni*, and *F. visci* to the genus.

**Diagnosis.** *Gnathosoma.* Pedipalps 3-segmented. Femurogenua at least twice as long as wide, complemented with 5 setae. Tibiotarsi at least twice as long as wide, usually complemented with 6 setae. A small apophysis occurs basally and a pointed process occurs near the terminal tip; a ridge runs between the apophysis and pointed process. *Subcapitulum* with 6 pairs of setae \((hg_{1-4}\text{ and } 2\text{ pairs of adoral setae})\); setae \(hg_{4}\) is often longest. *Chelicera* without seta.

*Idiosoma, dorsal.* Proterosoma bears an ill-defined and weakly sclerotized shield complemented with 2 pairs of setae \((lps\text{ and } mps)\) and 2 pairs of setose sensillae \((at\text{ and } pt)\). Dorsal hysterosoma may or may not bear a plate; if plate present, it is ill-defined and weakly sclerotized, may be complemented with a variable number of setae, and may or may not be fused with the proterosomal shield. Setae \(c_{1-2}\), \(c_{3}\), and \(h_{2}\) present. Cupule \(im\) present laterad and posterior \(e_{1}\). Integument not covered in shields or plates striated.

*Idiosoma, ventral.* *Coxae* weakly sclerotized and ill-defined; they can be recognized by possessing somewhat denser striations than the surrounding integument. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV may be fused. Each coxa complemented with 2–4 setae. Genital plates each bear 4 setae \((g_{1-4})\); 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae; 1 pair of setae present ventrally on the integument near the anal plates. Up to 7 pairs of setae present on the integument between the coxal and genital plates. Cupule \(i b\) present ventrally laterad integumental setae associated with the anal plates. Integument not covered in shields or plates striated. *Legs.* Tibia III complemented with 1 bsl and 3, 4, or 5 sts. Tibia IV complemented with 3 sts (2 short, 1 long) and lacks
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a trichobothrium. Tarsi never constricted apically so as to end in lobes. Ambulacral claws on either side of a 4-rayed empodium present.

**Key to adult female Funaxopsis** (modified from Den Heyer and Castro 2009)

1 Basifemora I–IV setal formula 3-3-3-1 sts; sci smooth................................................................. *F. visci* (Den Heyer, 1981)
   – Basifemora I–IV setal formula 2-2-2-0 sts; sci finely setose.......................... 2

2 (1) Telofemora I–IV setal formula 4-3-1-1 sts; *h*₁ smooth ................................................................. *F. passerinae* (Den Heyer, 1981)
   – Telofemora I–IV setal formula 4-4-3-1 sts; *h*₁ finely setose ............................. *F. vaneedeni* (Den Heyer, 1981)

**Lupaeus** Castro & Den Heyer, 2009

**Historical review.** Berlese (1916) described *Eupalus subterraneus*. Thor and Willmann (1941) redescribed *E. subterraneus*. Baker and Hoffmann (1948) erected *Cunaxoides* in place of *Eupalus* as *Eupalus* was preoccupied; they also described *C. minutus* and redescribed and illustrated *C. subterraneus*. Den Heyer (1979b) erected *Pulaeus*, moving those species with *f*₂ present and setae present on basifemora IV to the new genus from *Cunaxoides*; he also described *P. martini* and *P. clarae* and placed *Pulaeus* into the subfamily Cunaxoidinae. *Pulaeus platygнатhus* was described by Bu and Li (1991). Corpuz-Raros (1996b) described *P. dentatus*, *P. lenis*, *P. longisetus*, *P. villacarlosae*, and *P. filipinus* from the Philippines. Hu (1997) reported *P. platygнатhus* from China. Lin and Zhang (2000) reported *P. platygнатhus* from China. Lin and Zhang (2003) reported *P. minutus* from China. Corpuz-Raros (2007) described *P. polilloensis* and *P. philippinensis* from the Philippines. Castro and Den Heyer (2009) erected *Lupaeus* and moved into it those species of *Pulaeus* that possess two pointed processes on the pedipalp tibiotarsus and 1 simple seta on basifemora IV; they also described *Lupaeus lectus* and *L. lobidorsalis* and provided a key to the Brazilian and South African species. Sergeyenko (2011b) described *L. valentinae*. Den Heyer et al. (2013) described *L. iranensis* and *L. sativae*.

**Diagnosis.** Gnathosoma. Pedipalps 3-segmented. Femurogenua at least twice as long as wide, complemented with 6 setae. Tibiotarsi at least twice as long as wide, usually complemented with 6 setae; they possess 2 or 3 pointed processes and may possess a bladder- or knob-like apophysis (Fig. 24a). Subcapitulum with 6 pairs of setae (*h*₁₋₄ and 2 pairs of adoral setae); setae *h*₄ often the longest. Chelicera with seta present.

Idiosoma, dorsal. Proterosoma bears a well-sclerotized shield complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Dorsal hysterosoma bears a sclerotized plate that is variable in size and fused with the proterosomal shield; it may be complemented with a variable number of setae depending on the size of the plate. Setae *e₁*h₂*, *e₂f₂*, and *h₂* present. Cupule *im* present laterad and posterior of *e₁*. Integument not covered in shields or plates is striated.
Idiosoma, ventral. **Coxae** sclerotized and well-defined. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV may be fused. Each coxa complemented with 2–4 setae. Genital plates each bear 4 setae \( g_{1,2,4} \). Setae \( g_{1,2,4} \) usually occur in a straight line near the midline and setae \( g_{3} \) occur near the edge of the genital plates (Fig. 24b). 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae; 1 pair of setae present ventrally on the integument near the anal plates. Cupule \( ib \) present ventrally laterad; the integumental setae associated with the anal plates. Integument not covered in shields or plates striated. 

**Legs.** Tarsi never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Basifemora setal formula 4-6-3-1. Depression of the famulus occurs on distal half of tarsus I. Tibiae I–II possess striated blunt solenidia. Ambulacral claws rippled and occur on either side of a 4-rayed empodium.

**Key to adult female Lupaeus**

*Lupaeus longisetus* is known only from the male and is not included in the key. It can be recognized by the following characters: small platelet between the edges of a divided sternal shield absent, basifemora I with 3 sts, and setae \( e_{1} \) elongate and barbed (Fig. 25a).

*Lupaeus polilloensis* is only known from the male and is not included in the key. It can be recognized by the following characters: small platelet between the edges of a divided sternal shield absent; basifemora I–II setal formula 4-6; platelets complemented with setae \( f_{1}, f_{2} \) with fused medially into one plate; and the dorsal shield densely granulate (Fig. 25b).

As suggested by Den Heyer (2011b) the following species are moved to *Lupaeus* from *Pulaeus*: *L. minutus* (Baker and Hoffmann) and *L. subterraneus* (Berlese).

1 Small platelet ventromedially between edges of divided sternal plate present (Fig. 26a); South Africa, Brazil ............. **L. martini** (Den Heyer, 1979)
   – Small platelet ventromedially between edges of divided sternal plate absent (Fig. 26b).................................................................................................................2

2 (1) Basifemora I with 4 sts.................................................................3
   – Basifemora I with 5 sts; Philippines ....... **L. filipinus** (Corpuz-Raros, 1996)

3 (2) Basifemora II with 4 sts; USA....... **L. minutus** (Baker & Hoffmann, 1948)
   – Basifemora II with 5 sts ...............................................................4
   – Basifemora II with 6 sts ...............................................................7

4 (3) Setae \( f_{1} \) shorter than \( c_{1} \); Philippines .......... **L. lenis** (Corpuz-Raros, 1996)
   – Setae \( f_{1} \) the same length as \( c_{1} \) ............. **L. lectus** Castro & Den Heyer, 2009
   – Setae \( f_{1} \) longer than \( c_{1} \), usually by at least 1.5 times .......................5

5 (4) Genua I with 9 total simple setae and solenidia; Philippines ............... 
   ............................................................... **L. dentatus** (Corpuz-Raros, 1996)
   – Genua I with 7 total simple setae and solenidia.............................6
6 (5) Setae $c_1$–$e_1$ equal in length; Brazil

- Setae $e_1$ one-fourth longer than $c_1$, $d_1$; Italy, USA

5 (4) Setae $c_2$–$e_2$ equal in length; Argentina

- Setae $e_2$ one-fourth longer than $c_2$, $d_2$; Italy, USA

3 (2) Setae $f_1$, $f_2$ on platelets, which may be separate or fused medially (Fig. 27a).... 8

- Setae $f_1$, $f_2$ on integument (Fig. 27b)....................... 11

7 (3) Tibia II with 1 s, 5 sts

- Tibia II with 2 s (1asl, 1bsl), 5sts; Ukraine... *L. valentinae* Sergeyenko, 2011

9 (8) Pedipalp tibiotarsus with 4 sts; Philippines

- Pedipalp tibiotarsus with 5sts........................................ 10

10 (9) Pedipalp tibiotarsus with 4 sts; Philippines

- Pedipalp tibiotarsus with 5sts; tarsus IV with 14 sts

8 (7) Tibia II with 2 s (1asl, 1bsl), 5sts; Ukraine... *L. sativae* Den Heyer, 2013

- Tibia II with 3 s, 5sts; tarsus IV with 16sts

6 (5) Cheliceral seta not as long as width of cheliceral digit; China

- Cheliceral seta longer than width of cheliceral digit; South Africa, Brazil...

**Figures 24–27.** Lupaeus illustrations. 24a Pedipalp tibiotarsus 24b Genital setae not in a row, $g_3$ out of line 25–27 Lupaeus key illustrations. Setae and cupules removed from figures 25a, b to increase clarity 25a *L. longisetus*, dorsal 25b *L. polilloensis*, dorsal 26a Ventral, small platelet present 26b Ventral, small platelet absent 27a Setae $f_1$, $f_2$ born on small platelets 27b Setae $f_1$, $f_2$ born on integument.
Neocunaxoides Smiley, 1975

Historical review. Baker and Hoffmann (1948) described Cunaxoides andrei. Smiley (1975) erected Neocunaxoides and moved N. andrei to the genus. Gupta and Chat-topadhyay (1978) described N. biswasi from bird nests in Bengal, India. Den Heyer (1978c) placed Neocunaxoides in the subfamily Cunaxoidinae. Kuznetzov and Livshitz (1979) reported C. andrei from Russia, having either disagreed with or been unaware of Smiley’s 1975 publication. Den Heyer (1980a) described N. lajumensis, N. rykei, and N. zuluensis from South Africa. Tseng (1980) reported and figured N. andrei and N. whartoni from Taiwan. Michcka (1987) reported N. andrei from Poland. Inayatullah and Shahid (1989) described N. dilato and N. kalamiensis. N. cerasoides was described by Gupta (1991). Smiley (1992) synonymized Scutopalus with Neocunaxoides and moved Cunaxoides trepidus to Neocunaxoides. Corpuz-Raros (1996c) described N. grandis and N. mahabaeus. Hu (1997) reported N. andrei from China. Lin, Zhang, and Ji (2001) described N. boltoides and N. fani and later (2003) described N. ovatus. Fawzy (2007) described N. metwallyi. Corpuz-Raros and Guèzo (2007) described N. ornatus. Castro and Den Heyer (2009) moved Pulaeus trepidus (=Neocunaxoides trepidus) to Scutopalus.

Diagnosis. Gnathosoma. Pedipalps 3-segmented. Femurogenua at least twice as long as wide, complemented with 6 setae. Tibiotarsi at least twice as long as wide and usually complemented with 6 setae. Tibiotarsi possess two or three knob-like apophyses, a single spur, or sometimes a flange-like seta. Subcapitulum with 6 pairs of setae (hg1–4 and 2 pairs of adoral setae); setae hg4 often the longest. Chelicera with seta present.

Idiosoma, dorsal. Proterosoma bears a well-sclerotized shield which is complemented with 2 pairs of setae (lps and mps) and 2 pairs of setose sensillae (at and pt). Dorsal hysterosoma bears a sclerotized plate which is variable in size and fused with the proterosomal shield; it may be complemented with a variable number of setae depending on the size of the plate. Setae c1, c2, and h2 present. Setae f2 absent. Cupule im present laterad and posterior of e1. The integument not covered in shields or plates is striated.

Idiosoma, ventral. Coxae sclerotized and well-defined. Coxae I–IV may be fused and may coalesce medially for form a sternal shield. Coxae III–IV may be fused. Each coxa complemented with 2–4 setae. Genital plates each bear 4 setae (g1–4), which are usually in a straight row; 2 pairs of genital papillae visible underneath the plates. Anal plates bear one pair of setae; one pair of setae is present ventrally on the integument near the anal plates. Cupule ih present ventrally laterad the integumental setae associated with the anal plates. Integument not covered in shields or plates is striated. Legs. Tarsi never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Basifemora setal formula 3-5-2-0. Ambulacral claws rippled and occur on either side of a 4-rayed empodium.

Key to adult female Neocunaxoides

Cunaxoides philippinensis (Corpuz-Raros, 2007) is regarded as belonging to Neocunaxoides because it has 6 setae on the femurogenu and lacks setae f2. Neocunaxoides makapalus, N. philippinensis (Corpuz-Raros, 1996c), N. unguianalis, and N. rugosus are
regarded as belonging to *Scutopalus* as they possess 5 sts on pedipalp femurogenu and extensive dorsal shields. They have therefore not been included in the following key.

*Neocunaxoides* *biramus* is not included in the key because it is only known from the male. It can be distinguished from all other *Neocunaxoides*, and indeed all de-
scribed cunaxids, by the presence of a branched sci and 4 teeth on the lateral lips of the hypostome.

*Neocunaxoides metwallyi* is not included in the key as, despite the best efforts of the authors and the University of Arkansas Interlibrary Loan Department, the description could not be obtained.

We agree with and follow Castro and Den Heyer (2009) and Den Heyer and Castro (2009) in regarding *Scutopus* as a valid and separate genus.

1  
Coxae I–II fused medially to form sternal shield (Figs 28a–d) ....................... 2

2  
Coxae I–II not fused medially (may be connected anteromedially) (Figs 29a–d) ........................................................................................................ 6

3 (2)  
Posterior edge of coxae IV extending beyond anterior edge of genital plates (Figs 28a, b) ................................................................. 3

4 (3)  
Posterior edge of coxae IV not extending beyond anterior edge of genital plates (Figs 28c, d) ................................................................. 5

5 (2)  
Small platelet anteriomedially of genital plates present (Fig. 28a) ..........  
................................................................. *N. fani* Lin, Zhang & Ji, 2001

6 (1)  
Hysterosomal plate present, fused with proterosomal shield, and bearing c₁–e₁, c₂; small platelet anteriomedially of genital plates present (Fig. 28c) .......

................................................................. *N. philippinensis* Corpuz-Raros, 2007

7 (6)  
Basifemora V with 1 sts ........................................ 8

8 (7)  
Basifemora I with 2 sts ............. *N. biswasi* Gupta & Chattopadhyay, 1978

9 (8)  
All setae on pedipalp of normal length, none extremely long .............. 10

10 (9)  
Basal subcapitular polygonal pattern elongate (Fig. 32a); foveolae on dorsal shield present (Fig. 33a) ............... *N. ornatus* Corpuz-Raros & Gruèzo, 2007

– Basal subcapitular polygonal pattern not elongate (Fig. 32b); foveolae on dorsal shield absent (Fig. 33b) ............ *N. grandis* Corpuz-Raros, 1996
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11 (7) Small platelet anteriomedially of genital plates present (Fig. 29a) ..................

.................................................................................. N. ovatus Lin, Zhang & Ji, 2003

– Small platelet anteriomedially of genital plates absent (Fig. 29b,c) ..........12

12 (11) Coxae I connected anteriomedially (Fig. 29b); mushroom-shaped seta on pedipalp tibiotarsi absent............................ N. rykei Den Heyer, 1980

– Coxae I not connected anteriomedially (Fig. 29c); mushroom-shaped seta on pedipalp tibiotarsi present (Fig. 34) .................. N. andrei (Baker & Hoffmann, 1948)

13 (6) Femora I (basifemora I + telofemora I) with 6 setae ...................

.................................................................................. N. cerasoides Inayatullah & Shahid, 1989

– Femora I (basifemora I + telofemora I) with 9 setae ..................15

14 (13) Coxae I-IV setal formula 2-3-3-1; combined femora (basifemora + telofemora) II-IV setal formula 11-7-5 ............N. dilato Inayatullah & Shahid, 1989

– Coxae I-IV setal formula 2-2-3-2; combined femora (basifemora + telofemora) II-IV setal formula 10-7-4 ..........N. kalamensis Inayatullah & Shahid, 1989

Paracunaxoides Smiley, 1992

Historical review. Smiley (1992) erected Paracunaxoides for a single species, P. newzealandicus. Den Heyer and Castro (2009) state that Paracunaxoides could be synonmous with Cunaxoides but refrained from sinking the genus as they had not examined the type material.

Diagnosis. Gnathosoma. Pedipalps 3-segmented. Femerogenu complemented with 5 setae. Tibiotarsi at least twice as long as wide and complemented with 3 setae. Tibiotarsi possess a stout, spine-like apophysis. Subcapitulum with 4 pairs of setae (hg1–4); setae hg2,4 subequal. Adoral setae absent.

Idiosoma, dorsal. Proterosoma complemented with 2 pairs of setae (lps and mps) and 2 pairs of setose sensillae (at and pt). A pair of oval shields formed by flat, bacillus-like striae present between the sensillae. Setae e1–h1, c2, and h2 present. Setae f2 absent. Integument not covered in shields or plates is striated.

Idiosoma, ventral. Coxae sclerotized and well-defined. Coxae I–II thinly connected. Coxae III–IV more broadly connected. Genital plates each bear 4 setae (g1–4); 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae; 1 pair of setae present ventrally on the integument near the anal plates. Integument not covered in shields or plates is striated. Legs. Trichobothrium on tibia IV present.

Pulaeus Den Heyer, 1978

Historical review. Ewing (1909) described the first species of Pulaeus as Eupalus pectinatus. Berlese (1916) described Eupalus sternalis. Baker and Hoffmann (1948) proposed Cunaxoides to replace Eupalus as the name was preoccupied; described Cunax-
oides patzcuarensis, C. whartoni, and C. americanus; and synonymized C. sternalis with C. pectinatus. They also redrew and illustrated C. pectinellus. Shiba (1978) described C. neopunctatus, C. parapatzcuarensis, and C. pseudominutatus. Chaudhri, Akbar, and Rasool (1979) described Neocunaxoides krama. Kuznetzov and Livshitz (1979) reported C. pectinatus and C. americanus from Russia. Den Heyer (1979b) erected Pulaeus and moved the previously mentioned species into the new genus; he also redescribed and described C. pectinatus. Muma (1960) described C. pectinellus. Shiba (1978) described C. neopectinatus, C. parapatzcuarensis, and C. pseudominutus. Chaudhri, Akbar, and Rasool (1979) described Neocunaxoides cinctus was described by Chaudhri (1980). Den Heyer (1981c) confirmed the synonymy of P. sternalis with P. pectinatus, and synonymized C. pectinellus with P. pectinatus; he also described P. franciscae and placed Pulaeus within Cunaxoidinae, tribe Pulaeini. El-Bishlawy and Rakha (1983) described P. zaherii from Egypt. Liang (1983) recorded P. pseudominutus from China. Pulaeus musci was described by Liang (1985). Zaher and El-Bishlawy (1986) described P. niloticus. Bu and Li (1987b) described P. longignathos and P. chongqingensis. Muhammad and Chaudhri (1990) described P. desitis, P. ferventis, P. osculum, and P. verno from Pakistan. Pulaeus ardeola was described by Barilo (1991). Muhammad and Chaudhri (1991a) described P. camar, P. erinaceus, P. galumna, P. haurio, P. silicula, and P. stultus from Pakistan. Smiley (1992) synonymized P. niloticus with P. subterraneus and provided a key to known world species; he also transferred Cunaxoides neopunctatus to Neocunaxoides. Li et al. (1992) recorded P. glebulentus from Chongqing, China. Corpuz-Raros (1996b) described two species, P. payatopalpus and P. rimandoi, from the Philippines. Lin and Zhang (2000) reported Neocunaxoides neopunctatus, Pulaeus longignathos, P. musci, and P. pseudominutus from China. Lin et al. (2003) reported P. minutus from China. Bashir, Afzal, and Akbar (2005) described P. punctatus. Bashir and Afzal (2006b) described P. anjumi. Corpuz-Raros (2007) also described P. cebuensis, P. palawanensis, and P. samarensis. Castro and Den Heyer (2009) split Lupaeus from Pulaeus and described two new species: P. myrtaeus and P. quadrirolenidius; they also synonymized P. longignathos with Neocunaxoides krama and transferred N. krama to Pulaeus. Bashir and Afzal (2009) described P. akbari, P. banksi, and P. waili. Lin and Zhang (2010) argue that the “original species name longignathos [as in Pulaeus longignathos] is the correct form in Greek. Some authors emended it to the Latinized form longignathus (e.g. Castro and Den Heyer, 2009: 2).” The spelling longignathos is followed here. Sergeyenko (2011b) described P. leonidi, P. maslovi, and P. semistriatus and synonymized P. longignathos and P. chongqingensis with P. krama as he considered them to be male and female of that species, respectively. Den Heyer et al. (2013) described P. razanensis.

**Diagnosis.** Gnathosoma. Pedipalps 3-segmented. Femurogenua at least twice as long as wide, complemented with 6 setae. Tibiotarsi at least twice as long as wide, usually complemented with 6 setae, 1 pointed process, and may possess a bladder- or knob-like apophysis (Fig. 39a–c). Subcapitulum with 6 pairs of setae (hg, and 2 pairs of adoral setae); setae hg often the longest. Chelicera with seta present.

Idiosoma, dorsal. Proterosoma bears a well-sclerotized shield, complemented with 2 pairs of setae (lps and mps) and 2 pairs of setose sensillae (at and pt). Dorsal hysterosoma bears a sclerotized plate which is variable in size and fused with the proterosomal
shield; it may be complemented with a variable number of setae depending on the size of the plate. Setae $c_1$–$h_1$, $e_2$, $f_2$, and $h_2$ and present. Cupule $im$ present laterad and posterior of $e_1$. Integument not covered in shields or plates striated.

**Idiosoma, ventral.** **Coxae** sclerotized and well-defined. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV may be fused. Each coxa complemented with 2–4 setae. Genital plates each bear 4 setae ($g_{1,4}$), which are usually in a straight row; 2 pairs of genital papillae visible underneath the plates. Anal plates bear one pair of setae; 1 pair of setae present ventrally on the integument near the anal plates. Cupule $ih$ present ventrally laterad the integumental setae associated with the anal plates. The integument not covered in shields or plates striated. **Legs.** Tarsi never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Depression of the famulus occurs on proximal half of tarsus I. Tibiae I–II possess non-striated blunt solenidia. Ambulacral claws rippled and occur on either side of a 4-rayed empodium.

**Key to adult female Pulaeus**

*P. ardeola* was not included in the key because the original text is in Cyrillic script and the illustrations do not provide enough characters to differentiate it from other species. *N. cinctus* is moved from *Neocunaxoides* to *Pulaeus* based on features given in the original description, namely that $f_2$ is present and basifemora IV are complemented with 2 sts.

The following were species assigned to *Pulaeus* before *Lupaeus* was erected. The characters that divide the two genera are not given in the original species descriptions and types have not been viewed. These indeterminable species are therefore not included in either generic key, but instead characters are given for each species that will serve to identify them.

*P. parapatzuarensis* (Shiba, 1978) – This species has a divided sternal plate, lacks a sclerotized area anterior to the genital plates, and does not have $f_{1,2}$ located on platelets. In addition it has 6 pairs of setae on the integument between coxal and genital plates.

*P. patzcuarensis* (Baker & Hoffmann, 1948) – This species can be recognized by the sternal plates being connected anteriorly and divided in a v-shape posteriorly.

*P. pseudominutus* (Shiba, 1978) – Setae $e_1$ being 3 times the length of $c_1$ and $d_1$ distinguishes this species.

*P. payatopalpus* (Corpuz-Raros, 1996) – The hypostome is 2/3 the length of the gnathosoma and the pedipalps are extremely long and slender, at least 8 times longer than wide. In addition the tibiotarsus is complemented with a seta that is longer than the segment.

*P. zaherii* (El-Bishlawy & Rakha, 1983) – This species can be recognized by the divided sternal plates, $f_1$ being 4/5 the length of $e_1$, and $f_1$ being ½ the length of $f_2$.

1 Sternal plate divided medially (Fig. 35a, b) .......................................................... 2
– Sternal plate not divided medially (Fig. 36a, b) ....................................................... 23

2 (1) Median platelet between coxae II–III present (Fig. 35a) ......................... 3
– Median platelet between coxae II–III absent (Fig. 35b) .......................... 7
3 (2) Dorsal shield with surface smooth anteriorly and broken striae or lobes posteriorly; Ukraine .................................................. *P. semistriatus* Sergeyenko, 2011

– Dorsal shield with surface patterned (broken striae/lobes or dotted) on entire surface ........................................................................................................4

4 (3) Dorsal shield patterned with dots; Pakistan .......................................................... *P. punctatus* Bashir, Afzal & Akbar, 2005

– Dorsal shield patterned with broken striae/lobes .................................................. 5

5 (4) Genua II with solenidia present ........................................................................... 6

– Genua II with solenidia absent; Pakistan ...................................................................... 6

6 (5) Genua II with 1 asl, 5 sts; genua III with 2 asl, 5 sts; South Africa ....................... *P. glebuletus* Den Heyer, 1979

– Genua II with 2 asl, 4 sts; genua III with 1 asl, 5 sts; Iran ........................................ 7

7 (2) Setae *f*₁ and *f*₂ located on sclerotized platelets or shields ............................. 8

– Setae *f*₁ and *f*₂ not located on sclerotized platelets or shields ............................... 9

8 (7) Pedipalp femurogenu at least 6 times as long as wide; Philippines ....................... *P. rimandoi* Corpuz-Raros, 1996

– Pedipalp femurogenu at most 4 times as long as wide ........................................... 9

9 (8) Genua II with 0 solenidia; Pakistan ...................................................................... 10

– Genua II with 1 solenidion ....................................................................................... 11

– Genua II with 2 solenidia; Philippines .................................................................. 14

– .................................................................................................................. 15

10 (9) Genua I with 2 asl, 6 sts; tibia I with 1 bsl, 6 sts; Pakistan ........................................ *P. ferventis* Muhammad & Chaudhri, 1990

– Genua I with 2 asl, 3 bsl, 3 sts; tibia I with 1 bsl, 7 sts; Pakistan ............................. *P. erinaceus* Muhammad & Chaudhri, 1991

– Genua I with 3 bsl, 6 sts; tibia I with 1 asl, 1 bsl, 6 sts; Pakistan ............................ *P. galumma* Muhammad & Chaudhri, 1991

– Genua I with 4 asl, 4 sts; tibia I with 1 asl, 6 sts; Pakistan .................................... *P. walii* Bashir & Afzal, 2009

– Genua I with 5 bsl, 4 sts; tibia I with 1 bsl, 6 sts; Pakistan ..................................... 11

11 (10) Basifemora I–IV setal formula 5-5-4-3; Pakistan .................................................. *P. silicula* Muhammad & Chaudhri, 1991

– Basifemora I–IV setal formula 4-6-3-1; Pakistan ................................................... *P. stultus* Muhammad & Chaudhri, 1991

12 (9) Basifemora I with solenidion present; telofemora I–IV setal formula 5-5-3-2; Pakistan .......................................................... *P. camar* Muhammad & Chaudhri, 1991

– Basifemora I with solenidion absent; telofemora I–IV setal formula not as above ......................................................................................... 13
13 (12) Basifemora II with 5 (rarely 4) sts; Ukraine.\ldots P. leonidi Sergeyenko, 2011
– Basifemora II with 6 sts ............................................... 14
14 (13) Genua II with solenidia present ................................................................. 15
– Genua II with solenidia absent; Pakistan.\ldots P. akbari Bashir & Afzal, 2009
15 (14) Genua II with 1 asl, 5 sts; Ukraine.\ldots P. maslovi Sergeyenko, 2011
– Genua II with 1 bsl, 6 sts .................................................. 16
16 (15) Genua III–IV setal formula 5 sts–5 sts; Pakistan..............................................
\ldots P. osculum Muhammad & Chaudhri, 1990
– Genua III–IV setal formula 5 sts–6 sts; Pakistan................................................
\ldots P. baurio Muhammad & Chaudhri, 1991
– Genua III–IV setal formula 1 bsl, 4 sts–2 bsl, 4 sts; Pakistan..............................
\ldots P. verno Muhammad & Chaudhri, 1990
17 (9) Setae $f_1$ and $h_1$ approximately equal in length .................................................. 18
– Setae $f_1$ approximately half the length as $h_1$; China.\ldots P. musci Liang, 1985
18 (17) Coxa IV with 2 sts; basifemora IV with 2 sts; Brazil........................................
\ldots P. myrtaceus Castro & Den Heyer, 2009
– Coxa IV with 3 sts; basifemora IV with 1 sts; Pakistan........................................
\ldots P. anjumi Bashir & Afzal, 2006
19 (9) Dorsal shield with punctuations (Fig. 37a); Brazil..............................................
\ldots P. quadrisolenidius Castro & Den Heyer, 2009
– Dorsal shield with flat broken striae (Fig. 37b); USA............................................
\ldots P. whartoni (Baker & Hoffmann, 1948
20 (7) 4 pairs of setae on integument between coxal and genital plates.........................
\ldots P. cinctus (Chaudhri, 1980)
– 5 pairs of setae on integument between coxal and genital plates......................... 21
– 6 pairs of setae on integument between coxal and genital plates........................... 22
21 (20) Coxae II with 2 sts; telofemora II with 5 sts; Pakistan.................................
\ldots P. desitis Muhammad & Chaudhri, 1990
– Coxae II with 2 sts; telofemora II with 4 sts; Philippines........................................
\ldots P. palawanensis Corpuz-Raros, 2007
22 (20) Sensillum at approximately as long as see; setae $f_1$ approximately equal in length to $h_1$.........................................................P. cebuensis Corpuz-Raros, 2007
– Sensillum at longer than see; setae $f_1$ approximately 1.25 the length of $h_1$...........
\ldots P. franciscae Den Heyer, 1981
23 (1) Ventral medial platelet present (Fig. 36a); dorsum punctuate (Fig. 37a); pedipalpal tibiotarsus with truncate, flange-like apophysis (Fig. 38a); USA........
\ldots P. pectinatus Den Heyer, 1979
– Ventral medial platelet absent (Fig. 36b); dorsum striated (Fig. 37b); pedipalpal tibiotarsus with elongate apophysis (Fig. 38b)................................. 24
24 (23) Posterior pedipalpal tibiotarsal seta bifurcate (Fig. 39)........................................
\ldots P. neoplectatus (Shiba, 1978)
– Posterior pedipalpal tibiotarsal seta not bifurcate .................................................. 25
25 (24) Pedipalp femurogenua at most 4 times as long as wide; setae $f_1$ and $f_2$ approximately equal in length; USA.... *P. americanus* (Baker & Hoffmann, 1948) – Pedipalp femurogenua at least 6 times as long as wide; setae $f_1$ ¼ longer than $f_2$; Pakistan.................... *P. krama* (Chaudhri, Akbar & Rasool 1979)

**Qunaxella** Den Heyer & Castro, 2009

**Historical review.** Den Heyer and Castro (2009) erected *Qunaxella* for a single species, *Q. triasetosa*.

**Diagnosis.** **Gnathosoma.** Pedipalps 3-segmented. Femurogenu complimented with 5 sts. Tibiotarsi at least twice as long as wide and complemented with 5 sts, 1 asl. **Subcapitulum** with 6 pairs of setae ($g_{1-4}$) and 2 pairs of adoral setae.

**Idiosoma, dorsal.** Protosporus with weakly defined shield present which is complemented with 2 pairs of setae ($lps$ and $mps$) and 2 pairs of setose sensillae (at and $pt$). Dorsal hysterosoma lacks a plate. Setae $c_i-h, c_2$, and $h_2$ present. Setae $c_i-f_1$ finely setose and $c_2, h_1$, and $h_2$ smooth. Setae $f_2$ absent. Integument not covered in shields or plates striated.

**Idiosoma, ventral.** **Coxae** weakly sclerotized and ill-defined. Coxae I–II fused. Coxae III–IV fused. Genital plates each bear 4 setae ($g_{1-4}$); 2 pairs of genital papillae.
visible underneath the plates. Integument not covered in shields or plates striated.

**Legs.** Basifemora I–IV setal formula 3-4-2-0 sts. Telofemora I–IV setal formula 4-4-3-3. Tibiae III with 1 bsl, 5 sts. Tibiae IV with 5 sts (4 short, 1 long).

### Scutopalus Den Heyer, 1979

**Historical review.** Den Heyer (1979c) erected *Scutopalus* for *S. arboreus* and *S. latisetosus*. Shiba (1978) described *Cunaxoides clavatus*. Kuznetsov and Livshitz (1979) described *Cunaxoides trepidus*. Tseng (1980) described *Neocunaxoides osseus* and *N. unguianalis*. Gupta and Ghosh (1980) described *N. pradhani*. Smiley (1992) synonymized *Scutopalus* with *Neocunaxoides* and transferred *C. trepidus* to *Neocunaxoides*. Corpuz-Raros (1996c) described *N. makapalus*, *N. philippinensis*, and *N. rugosus*. Lin and Zhang (2000) recorded *N. clavatus* from tea in China. Sionti and Papadoulis (2003) described *N. abiesae* and *N. smolikensis*. Bashir and Afzal (2004b) described *Neocunaxoides gilbertoi*. Castro and Den Heyer (2009) transferred *P. trepidus* (=*Neocunaxoides trepidus*) to *Scutopalus*. Rocha et al. (2013) described *S. tomentosus* and transferred *N. makapalus*, *N. philippinensis*, *N. rugosus*, and *N. unguianalis* to *Scutopalus*.

**Diagnosis.** *Gnathosoma. Pedipalps* 3-segmented. Femurogenu complemented with 5 sts. Tibiotarsi at least twice as long as wide and complemented with 5 sts, 1 asl. Subterminal pointed process on pedipalp tibiotarsal claw absent; small teeth on pedipalp tibiotarsal claw absent. *Subcapitulum* with 6 pairs of setae (*hg*1–4 and 2 pairs of adoral setae). **Chelicera** without seta.

**Idiosoma, dorsal.** Proterosoma with a well-defined shield present, complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Dorsal hysterosoma with a well-defined plate fused to the proterosomal plate. Small platelets may be present laterad and posterior to the dorsal shield. Setae *e1–h2* present. Setae *f2* absent. Integument not covered in shields or plates striated.

**Idiosoma, ventral.** *Coxae* well-sclerotized. Coxae I–II fused medially. Coxae III–IV fused. Genital plates each bear 4 setae (*g*1–4); 2 pairs of genital papillae visible underneath the plates. A small platelet may be present laterad the genital plate. Integument not covered in shields or plates striated. **Legs.** Basifemora I–IV setal formula 3-4-2-0 sts. Telofemora I–IV setal formula 4-4-3-3. Tibiae III with 1 bsl, 5 sts. Tibiae IV with 5 sts (4 short, 1 long).

**Key to female Scutopalus** (modified from Rocha et al. 2013).

As suggested by Den Heyer (2011b) *Neocunaxoides pradhani* (Gupta and Ghosh 1980) and *N. gilbertoi* (Bashir and Afzal 2004) are transferred to *Scutopalus* as they posses 5 setae on the femurogenu instead of 6 as in *Neocunaxoides* and have well-demarcated plates.

1. **Coxae I–II faintly or totally divided** (Fig. 40a, b) ........................................ 2

   – **Coxae I–II fused medially** (Fig. 40c) .......................................................... 7

2 (1). **Coxae I–II faintly divided** (Fig. 40a) ......................................................... 3
– Coxae I–II totally divided (Fig. 40b). .......................................................... 4

3 (2) Sternal shield bearing 6 pairs of setae; setae \( c_2 \) and \( mps \) simple; coxae II with 2 setae; basifemora I–IV setal formula 3-3-2-0; Greece ................................................................. 5
– Sternal shield bearing 5 pairs of setae; setae \( c_2 \) and \( mps \) setose; coxae II with 1 setae; basifemora I–IV setal formula 2-2-2-1; South Africa ................................................................. S. abiesae Sionti & Papadoulis, 2003
– S. arboreus Den Heyer, 1979

4 (2) At least 2 pairs of thick rod-like setae on the dorsum (Fig. 41); India ............ S. pradhani (Gupta & Ghosh, 1980)
– Rod-like setae on dorsal shield absent .......................................................... 5

5 (4) Coxae II with 2 sts .............................................................................. 6
– Coxae II with 3 sts; Pakistan ......................................................... S. gilbertoi (Bashir & Afzal, 2004)

6 (4) Setae \( f_1 \) and \( h_1 \) on small platelets; ratio \( c_1: c_2 \) 2:1; genua I with 4 asl, 5 sts; genua II with 2 asl, 5 sts; South Africa ......................................................... S. latisetosus Den Heyer, 1979
– Setae \( f_1 \) and \( h_1 \) on integument; ratio \( c_1: c_2 \) 1:1; genua I with 3 asl, 5 sts; genua II with 1 asl, 5 sts; Greece ................................................................. S. smolikensis Sionti & Papadoulis, 2003

7 (1) Dorsal shield smooth and/or punctate (Fig. 42a) ........................................... 8
– Dorsal shield sparse granulate, rugose, or reticulate (Fig. 42b–d) .............. 12

8 (7) Coxae II and IV with 2 setae .................................................................. 9
– Coxae II and IV with 3 setae .................................................................. 11

9 (8) Setae \( mps, c_1, c_2, d_1, e_1, f_1 \) clavate (Fig. 43); a small subscutum situated posterior to the dorsal shield present; Malaysia ........... S. clavatus (Shiba, 1978)
– Setae \( mps, c_1, c_2, d_1, e_1, f_1 \) setiform; a small subscutum situated posterior to the dorsal shield absent ................................................................. 10

10 (9) Setae \( f_1 \) on dorsal shield; setae \( lps, mps, c_1, c_2, d_1, e_1, f_1 \) set on tubercles (Fig. 44); area between \( pt \) more heavily sclerotized, forming ridges; Taiwan .................. S. osseus (Tseng, 1980)
– Setae \( f_1 \) on integument; setae \( lps, mps, c_1, c_2, d_1, e_1, f_1 \) set normally; area between \( pt \) normally sclerotized, not forming ridges; Ukraine ......................................................... S. trepidus (Kuznetzov & Livshitz, 1979)

11 (8) 4 pairs of hysterosomal setae around genital shield; long slender platelet laterad genital shield present; with a narrow transverse sclerite behind main shield; Philippines .................. S. philippinensis (Corpuz-Raros, 1996)
– 3 pairs of hysterosomal setae around genital shield; long slender platelet laterad genital shield absent; dorsal sclerites absent; Philippines ................................................................. S. makapalus (Corpuz-Raros, 1996)

12 (7) 1 or more dorsal sclerites present (behind or laterad dorsal shield); dorsal shield rugose or reticulate (Fig. 42b, c); basifemora IV with 1 seta; pedipalpal tibiotarsus with 6 setae present and apophysis absent .................. S. unguianalis (Tseng, 1980)
– Dorsal sclerites absent; dorsal shield sparsely granulate; basifemora IV with 2 setae; pedipalpal tibiotarsus with 5 setae and a rod-shaped dorsal apophysis present; Taiwan }
13 (12) Dorsal shield rugose (Fig. 42b); setae $f_1$ and $h_1$ on integument; dorsal setae (except $c_2$ and $h_2$) distally rod-like (slightly clavate), with minute barbs; narrow transverse shield behind main dorsal shield present; Philippines. 

.........................................................................................S. rugosus (Corpuz-Raros, 1996)

Dorsal shield reticulate (Fig. 42c); setae $f_1$ and $h_1$ on small platelets; dorsal setae (except $c_2$ and $h_2$) broad and serrate; sclerites laterad and behind dorsal shield present; Brazil. ..........S. tomentosus Rocha, Skvarla & Ferla, 2013

**Figures 40–44.** Scutopalus key illustrations. 40a Coxae I–II faintly divided 40b Coxae I–II totally divided 41 Coxae I–II fused medially 42 Dorsal shield with thick, rod-like setae present 43 Dorsal shield smooth or punctate 44a Dorsal shield rugose 44b Dorsal shield reticulate 44c Dorsal shield sparsely granulate 45a Setae mps, $c_1$, $c_2$, $d_1$, $e_1$, $f_1$, clavate 45b Setae mps, $c_1$, $c_2$, $d_1$, $e_1$, $f_1$, setiform 46 Setae lps, mps, $c_1$, $c_2$, $d_1$, $e_1$, $f_1$, set on tubercles.
Scirulinae Den Heyer, 1980

Scirula Berlese 1887

Remarks. This is a monobasic subfamily, with the single genus containing two described and one undescribed species. The subfamily and genus are therefore treated together.

Historical review. Berlese (1887) erected Scirula for S. impressa. Thor and Willmann (1941) and Baker and Hoffmann (1948) redescribed and illustrated S. impressa. Den Heyer (1980c) erected Scirulinae for the then monotypic genus. Michocka (1987) reported S. impressa from Poland. Smiley (1992) redescribed and illustrated S. impressa. Lin (1997) described S. papillata from China.

Diagnosis. Gnathosoma. Pedipalps 4-segmented and do not reach beyond the subcapitulum. A flange-like apophysis present on either the genua or tibiotarsi. Pedipalps end in a stout claw. Subcapitulum with 4 pairs of r setae (hg1-4).

Idiosoma, dorsal. Proterosoma covered in a plate which bears 4 pairs of setae: 2 pairs of simple setae (lps and mps) and 2 pairs of setose sensilla (at and pt). Dorsal hysterosoma may or may not be complemented with a plate. 6 dorsal setae, c1–h1, c2 present. Cupule im present.

Idiosoma, ventral. Coxae I–IV fused, resulting in a complete shield covering the ventral idiosoma. Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Cupule ih present. Anal plates bear 2 pairs of setae (ps1 and ps2); 1 pair of setae born on integument next to anal plates.

Key to adult female Scirula

1  Hysterosomal shield present (Fig. 45a); Japan, USA, Denmark, Italy .................. S. impressa Berlese, 1887
   – Hysterosomal shield absent (Fig. 45b); China, USA ........................................
   .......................................................................................................................... S. papillata Lin, 1997

Cunaxinae Den Heyer, 1978

Historical review. Von Heyden (1826) erected Cunaxa for Scirus setirostris. Oudemans (1902) used Cunaxinae in the same sense that Trouessart (1892) used Scirinae, that is for those mites in the family Bdellidae (sensu Koch) that have pedipalps with a curved terminal segment and movable chela only (= Cunaxidae sensu Thor). Oudemans (1906) substituted Cunaxinae for Cunaxidae. Berlese (1916) erected Dactyloscirus as a subgenus of Scirus to accommodate Scirus (Dactyloscirus) eupaloides. Oudemans (1922) erected Rosenhofia to accommodate R. machairodus. Vitzthum (1931) raised Dactyloscirus to full generic status but later (1940–43) treated it as a subgenus. Thor and Willmann (1941) again elevated Dactyloscirus to generic status and designated Dactyloscirus eupaloides as the type specimen. Baker and Hoffmann (1948) regarded Dactyloscirus as a senior syno-
nym of \textit{Cunaxa}. Smiley (1975) synonymized \textit{Rosenhofia} with \textit{Dactyloscirus}. Den Heyer (1978a) preserved the name Cunaxinae, but limited its concept to those cunaxids possessing 5-segmented pedipalps that extend past the subcapitulum by at least the distal two segments; he also erected \textit{Armascirus}. Den Heyer (1979d) erected \textit{Rubroscirus} for \textit{R. africanus}. Gupta and Ghosh (1980) erected \textit{Indocunaxa}. Smiley (1992) synonymized \textit{Rubroscirus} with \textit{Cunaxa} but failed to give his reasoning for doing so. Den Heyer (2006) erected \textit{Riscus} for a species known only from Thailand. Castro and Den Heyer (2008) erected \textit{Cunaxatricha} and provided a key to the genera of Cunaxinae. Den Heyer and Castro (2008) erected \textit{Allocunaxa} for a Neotropical species, synonymized \textit{Indocunaxa} with \textit{Armascirus}, and provided the most up-to-date key to world genera of Cunaxinae.

**Diagnosis.** Gnathosoma. Pedipalps 5-segmented and extend beyond the subcapitulum by at least the distal half of the tibiae. Basifemora and telofemora fused but often dark line remains to indicate the division between the segments; telofemora and genua also fused in this manner in \textit{Allocunaxa}. Apophyses may be present on the telofemora and between the genua and tibiotarsi. Tibiotarsi end in a strong claw. Chelicera with or without seta. Subcapitulum with up to 6 pairs of setae; setae $h_{g1-4}$ always present, 2 pairs of adoral setae present or absent. Setae $h_{g4}$ longest. In species with pedipalpal apophyses, the apophyses of the males shorter.

Idiosoma, dorsal. Female protosoma bears a shield complemented with 2 pairs of setae ($lps$ and $mps$) and 2 pairs of setose sensillae ($at$ and $pt$). Dorsal hysterosoma may bear any combination of a median plate and lateral platelets (i.e., median plate and platelets absent, only median plate present, only lateral platelets present, or both median plate and lateral platelets present). Median plate, if present, may be complemented with 0–6 pairs of dorsal setae; lateral platelets, if present, may bear setae $c_2$. 

**Figures 45.** Scirula key illustrations. 45a \textit{S. impressa} 45b \textit{S. papillata}.
Setae not born on plates or platelets may be born on tiny platelets barely larger than the setal socket. Integument that does not bear plates or platelets striated. Males differ in that the dorsal shields often more extensive and may be holodorsal.

*Idiosoma, ventral.* **Coxae** I–II fused or divided and may coalesce medially to form a sternal shield; coxae III–IV fused or divided and may extend caudally past the genital plates. Coxae each complemented 0–3 setae. Genital plates each bear 4 setae ($g_1$–$g_4$); 2 pairs of genital papillae visible underneath the plates. Anal plates complemented with at least one pair of setae, $p_1$. Setae $p_2$ present or absent, either on the anal plates or on the integument adjacent to the anal plates. Setae $h_2$ present ventrally on the integument adjacent to the anal plates. Cupule $ih$ present laterad of $h_2$. Integument that does not bear plates striated. **Legs.** Tarsi constricted apically so as to end in lobes. A trichobothrium on tibia IV present or absent.

### Key to adult female *Cunaxinae* (modified from Den Heyer and Castro 2008a)

| Option | Description |
|--------|-------------|
| 1      | Anal seta $p_2$ absent; pedipalpal telofemora with dorsal simple seta (Figs 46a–e); tarsal lobes small to medium size (Fig. 47a); dorsal plates reticulated or not (Figs 48a–c) *Cunaxini* | 2 |
| 2 (1)  | Dorsal plates never reticulated (Figs 48a, b); integumental striae smooth or lobed; coxae II–IV setal formula usually 1-3-2 (rarely 2-3-1) | *Cunaxa Von Heyden, 1826* |
| 3 (2)  | Pedipalpal telofemora with one or more apophyses (Fig. 46a); sensillae $at$ and $pt$ not densely pilose | *Rubroscirus Den Heyer, 1979* |
| 4 (3)  | Tibiae IV trichobothrium present | 5 |
| 5      | Tibiae IV trichobothrium absent | *Cunaxatrichia Castro & Den Heyer, 2008* |
| 6 (1)  | Pedipalpal basifemora with simple seta (Fig. 46f); coxae II–IV setal formula usually 1-3-3 (male) or 2-3-3 (female); famulus normal; pedipalpal apophyses (when present) usually long in females and short in males, and with pointed apices (Fig. 46f) | *Armascirus Den Heyer, 1978* |
|        | Pedipalpal basifemora with spine-like seta (Fig. 46g); coxae II–IV setal formula usually 3-3-3; famulus large, broad based with tri-pronged tip; pedipalpal apophyses (when present) usually equal length in females and males, and with bulbous apices (Fig. 46g) | *Dactyloscirus Berlese, 1916* |
**Allocunaxa** Den Heyer & Castro, 2008

**Historical review.** Den Heyer and Castro (2008a) erected *Allocunaxa* for *A. heveae*.

**Diagnosis.** *Gnathosoma.* Pedipalps 5-segmented, end in a strong claw, and extend beyond the subcapitulum by at least the last segment. Pedipalpal apophyses absent. Basifemora complemented with a long simple seta and telofemora with a short simple seta; these two segments fused, although a line remains visible and they can thus be differentiated. Telofemora and genu nearly fused, although a line remains visible and they can thus be differentiated. **Subcapitulum** complemented with 6 pairs of setae (*hg*$_{1-4}$ and 2 pairs of dorsal setae) and covered by integumental papillae.

**Idiosoma, dorsal.** Proterosoma with an ill-defined, weakly sclerotized shield that bears 2 pairs of setose sensillae (*at* and *pt*) and 2 pairs of simple setae (*lps* and *mps*). 7 pairs of setae, *c*$_{1-2}$, *d*$_1$–*h*$_1$, present. Cupule *im* present, usually posteriolateral of *e*$_1$. Integument striated.

**Idiosoma, ventral.** *Coxae* I and II fused. *Coxae* III and IV fused. Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Integument between plates striated and bears 4 pairs of additional setae. **Legs** shorter than the body. Leg 4 longest. Famulus on tarsi I normally shaped. Tarsi constricted apically, resulting in large tarsal lobes. Trichobothrium on leg tibia IV present. Ambulacral claws on either side of a 4-rayed empodium present.

**Armascirus** Den Heyer, 1978

**Historical review.** The first *Armascirus* was described by Kramer (1881) as *Scirus taurus*. Berlese (1888) described *S. taurus* var. *bison*. Banks (1894) described *S. quadripilis*. Thor (1902) transferred *S. taurus* to *Cunaxa*. Banks (1914) described *C. armata*. Miller (1925) reported *S. quadripilis* from Ohio. Womersley (1933) reported *C. taurus* from Australia. Thor and Willmann (1941) transferred *S. taurus* var. *bison* to *Cunaxa* and raised it to full species status, viz. *C. bison* and transferred *S. quadripilis* to *Cunaxa*; they also redescribed and figured *C. armata*, *C. bison*, *C. quadripilis*, and *C. taurus*. Baker and Hoffmann (1948) synonymized *S. quadripilis* and *C. armata* with *C. taurus*; they followed Thor and Willmann (1941) in placing *C. taurus* var. *bison* in *Cunaxa* but declined to recognize it as a species and instead kept it as a variety or subspecies of *C. taurus*. Kuznetzov and Livshitz (1979) redescribed and figured *C. taurus* from Russia, either disagreeing with or being unaware of Den Heyer's 1978 publication. Tseng (1980) reported *A. taurus* from Taiwan. Chaudhri (1980) described *Dactyloscirus fixus* from Pakistan. Den Heyer (1980a) split *Armascirus* from *Dactyloscirus* and *Cunaxa* and raised the subfamily Cunaxinae to accommodate them, thus refining the definitions of all three genera; he transferred *C. taurus* and *C. bison* to the new genus *Armascirus*; and described *A. huysssteeni*, *A. lebowensis*, *A. limpopoensis*, and *A. albiziae*. Kuznetzov and Livshitz (1979) redescribed and figured *C. taurus* and *C. bison* from Russia, either disagreeing with or being unaware of Den Heyer's 1978 publication. Tseng (1980) reported *A. taurus* from Taiwan. Chaudhri (1980) described *Dactyloscirus fixus* from Pakistan. Den Heyer (1980c) erected the tribe Armascirini and...
Figures 46–48. Cunaxinae key illustrations. 46 Pedipalps, dorsal 46a Rubroscirus 46b Riscus 46c Allocunaxa 46d Cunaxatricha 46e Cunaxa 46f Armascirus 46g Dactyloscirus. 47a, b. Distal end of tarsus 47a Armascirini, showing large tarsal lobes 47b Cunaxini, showing small to medium tarsal lobes 48a–c Idiosoma, dorsal. Setae and cupules have been removed for clarity. Shape of proterosomal plate and presence or absence, shape, and extent of hysterosomal plate(s) will differ between species 48a Plates smooth 48b Plates with dot-like pattern 48c Plates with reticulated pattern.
made *Dactyloscirus* and *Armascirus* the sole representatives. Gupta and Ghosh (1980) erected *Indocunaxa*, a monotypic genus with *I. smileyi* as the type species. Liang (1983) reported *A. taurus* from China. Shiba (1986) described *A. hastus* and *A. multiocularus*. Michocka (1987) described *D. rafalskii* from Poland. *A. mactator* and *A. pluri* were described by Muhammad and Chaudhri (1991b). Smiley (1992) described *A. gimplesi*, *A. anastosi*, *A. harrisoni*, *A. herfordi*, *A. virginensis*, *D. bakeri*, and *D. campbellii*; he also transferred *A. bison* to *Dactyloscirus* (which was later returned to *Armascirus* by Den Heyer and Castro 2008a). Cupruz-Raros (1995) described *A. garciai* and *A. makilingensis* from the Philippines. Hu (1997) reported *A. bison* and *A. taurus* from China. Bashir and Afzal (2005) described *A. satianaensis* and *A. asghari*. Cupruz-Raros and Gruèzo (2007) described *A. javanus*. Cupruz-Raros (2008) described *D. bifidus*. Bashir, Afzal, and Khan (2008) described four species from Pakistan: *A. akhtari*, *A. jasmina*, *A. sabrii*, and *A. gojraensis*. Den Heyer and Castro (2008a) synonymized *Indocunaxa* with *Armascirus* and transferred *D. bison*, *D. campbelli*, *D. ebrius*, *D. fixus*, *D. fuscus*, and *D. rafalskii* to *Armascirus*. Corpuz-Raros (2008) described *A. apenesis*. Kalúz (2009) described *A. cyaneus* and *A. cerri* from Central Europe. Skvarla and Dowling (2012) described *A. ozarkensis*, *A. pennsylvanicus*, and *A. primigenius*. Den Heyer and Castro (2012) described *A. brasiliensis* and *A. bahiaensis*. Kalúz and Vrabec (2013) described *A. fendai* and *A. masani*.

**Diagnosis. Gnathosoma. Pedipalps** 5-segmented, end in a strong claw, and extend beyond the subcapitulum by at least the last segment. Apophysis between the genua and tibiotarsi, which tapers to a point, usually present; this apophysis shorter in males than in females. Basifemora complemented with a simple seta; telofemora with a spine-like seta. These two segments fused, although a line remains visible and they can thus be differentiated. **Subcapitulum** complemented with 6 pairs of setae (*hg1–4* and 2 pairs of adoral setae). It can be covered by integumental papillae which are either randomly distributed or form a polygonal, reticulated pattern.

**Idiosoma, dorsal.** Female dorsal idiosoma with at least one sclerotized plate that bears 2 pairs of setose sensillae (*at* and *pt*) and 2 pairs of simple setae (*lps* and *mps*). 0–4 other major plates and platelets may also be present. All plates, if present, covered by integumental papillae that form a reticulated pattern. Integument between the plates is striated. 7 pairs of setae, *c1–2*, *d1–h1*, present. Each seta, when not on a major plate or platelet, surrounded by a minute platelet that is only slightly larger than the setal socket. Cupule *im* present, usually laterad or in the proximity of *e1*. Dorsal idiosoma of males is similar except a single large plate complemented with *c1–2*, *d1–e1* present.

**Idiosoma, ventral.** **Coxae** reticulated in the same manner as the dorsal plates. Coxae I–II often fused; Coxae III–IV often fused. Setal formula of coxae I–IV in males 3-1-3-3 (including the paracoxal seta), in females 3-2-3-3 (including the paracoxal seta). Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae (*psj*). 2 pairs of setae (*psj* and *hj*) associated with but do not occur on the anal plates. Cupule *ih* present in close proximity to *hj*. Integument between plates striated and bears 5–7 pairs of additional setae. The ventral idiosoma
Figures 49–53. Armascirus key illustrations. 49–51 Dorsal idiosoma 49a–e Hysterosomal shield complemented with setae 50a–d Hysterosomal shield small, not complemented with setae 51a–c Hysterosomal shield absent 52a, b Pedipalp tibiotarsal claw 52a Single claw 52b Bifid claw 53a Hysterosomal plate concave on lateral edges 53b Hysterosomal plate not concave on lateral edges.

of males similar except the coxae are much more extensive. A sclerotized aedeagus is often visible in association with the genital plates. Legs comparatively long, at least \( \frac{3}{4} \) the length, and often longer than the body. Famulus on tarsi I normally shaped. Tarsi are constricted apically, resulting in large tarsal lobes. Trichobothrium on leg tibia IV present. Ambulacral claws occur on either side of a 4-rayed empodium.
Key to adult female *Armascirus* (modified from Kalúz and Vrabec 2013)

*Dactyloscirus bifidus* Corpuz-Raros, 2008 is transferred to *Armascirus* as it possess a spine-like seta on the pedipalpal basifemora.

*Armascirus gojraensis* and *A. sabrii* appear to be nymphs based on the leg setal counts given in the original descriptions. Having not seen the type material, however, they are retained within the key. Caution should be exercised if these species are reached.

1 Hysterosomal median shield present (Figs 49a–h, 50a–d) ................... 2
- Hysterosomal median shield absent (Figs 51a–c) ............................... 30

2 (1) Median shield complemented with setae, small or large (Figs 49a–h) .... 3
- Median shield not complemented with setae, small (Figs 50a–d) ........... 22

3 (2) One pair of setae (d) on hysterosomal median shield (Figs 49a–f) .... 4
- Two or more pairs of setae on hysterosomal median shield (Figs 49g–h) ... 18

4 (3) Lateral hysterosomal platelets present (Figs 49a–d) .......................... 5
- Lateral hysterosomal platelets absent (Figs 49e,f) ............................... 15

5 (4) Setae c1 very short, the distance between the bases of c1–c1 20 times the length of c1; venter caudally from coxae II with 5 pairs of simple setae (excluding genital, coxal, and anal setae); Poland ........... *A. rafalskii* (Michocka, 1987)
- Setae c1 longer, the distance between the bases of c1–c1 less than 10 times the length of c1; venter caudally from coxae II with 6 or more pairs of simple setae (excluding genital, coxal, and anal setae) .......................................................... 6

6 (5) The distance between caudal parts of hysterosomal lateral platelets wider than the distance between their frontal parts (Figs 49a,b) ..................... 7
- The distance between caudal parts of hysterosomal lateral platelets shorter than the distance between their frontal parts (Figs 49c,d) ...................... 9

7 (6) Lateral hysterosomal platelets equal to or longer than hysterosomal median shield (Fig 49a); venter caudally from coxae II with 6 pairs of simple setae (excluding genital, coxal, and anal setae); Pakistan .......................................................... *A. jasina* Bashir, Afzal & Khan, 2008
- Lateral hysterosomal platelets shorter than hysterosomal median shield (Fig 49b); venter caudally from coxae II with 7 pairs of simple setae (excluding genital, coxal, and anal setae) .................................................. 8

8 (7) Pedipalpal genua with 3 spls, 1 sts; important leg I–IV sts chaetotaxy: coxae 3-1-3-2, basifemora 4-5-3-1, genua 8-8-6-5, tibiae 5-6-6-6, tarsi 15-12-8-9; Pakistan ............................... *A. akhtari Bashir, Afzal & Khan, 2008*
- Pedipalpal genua with 3 spls; important leg I–IV sts chaetotaxy: coxae 3-2-3-3, basifemora 4-4-3-3, genua 8-4-6-7, tibiae 6-5-6-5, tarsi 11-10-9-7; Pakistan ...... ............................... *A. satianaensis Bashir & Afzal, 2005*

9 (6) Venter caudally from coxae II with 4 pairs of simple setae (excluding genital, coxal, and anal setae); Brazil ............................... *A. babiaensis Den Heyer & Castro, 2012*
- Venter caudally from coxae II with 6 pairs of simple setae (excluding genital, coxal, and anal setae) .................................................. 10
Venter caudally from coxae II with 7 pairs of simple setae (excluding genital, coxal, and anal setae) .................................................. 14
Venter caudally from coxae II with 8 pairs of simple setae (excluding genital, coxal, and anal setae); South Africa ...................... \textit{A. albiziae} Den Heyer, 1978

Tarsus I with more than 27 setae; tarsus II with at least 24 setae .......... 11
Tarsus I with less than 25 setae; tarsus II with less than 23 setae .......... 12

Leg genua I with 4 bsl, 4 sts; genital valve with random dot-like lobes; tarsal sts chaetotaxy I–IV 29-25-23-22; Pakistan ............ \textit{A. pluri} Muhammad & Chaudhri, 1991
Leg genua I with 2 asl, 4 bsl, 3 sts; genital valve longitudinal rows of dot-like lobes; tarsal sts chaetotaxy I–IV 29-24-22-21; Pakistan .................. \textit{A. mactator} Muhammad & Chaudhri, 1991

Pedipalpal telofemora with 1 apophysis, 2 spls; pedipalpal genua with 1 ap, 2 spls, 2 sts; South Africa ...................... \textit{A. buyssteeni} Den Heyer, 1978
Pedipalpal telofemora with 1 apophysis, 1 spls; pedipalpal genua with 1 ap, 3 spls, 1 sts .......................................................... 13

Genua II with 1 asl, 5 sts; genua IV with 2 asl, 5 sts; cosmopolitan .......... \textit{A. Taurus} (Kramer, 1881)
Genua II with 1 asl, 6 sts; genua IV with 1 asl, 4 or 5 sts; USA ........... \textit{A. primigenius} Skvarla & Dowling, 2012

Median shield pointed caudally (Fig. 49c); Pakistan ........................ \textit{A. asghari} Bashir & Afzal, 2005
Median shield truncated caudally (Fig. 49d); Brazil ........................ \textit{A. brasiliensis} Den Heyer & Castro, 2012

Hysterosomal median shield with a straight or concave frontal margin and with very acute anterior lateral corners (angle less than 45°) (Fig. 49e) ..... 16
Hysterosomal median shield with convex frontal margin and with rounded anterior lateral corners (Fig. 49f) ........................................... 17

Pedipalpal genua with 1 ap, 2 spls, 1 sts; legs I–IV sts formulae (excluding solenidia): basifemora 1-2-1-0; telofemora 4-4-4-4; genua 6-7-5-6; $h_4$ 4 times the length of $c_1$; hysterosomal shield width: length = 2.2:1; Pakistan .............. \textit{A. sabrii} Bashir, Afzal & Khan, 2008
Pedipalpal genua with 1 ap, 3 spls, 1 sts; legs I–IV sts formulae (excluding solenidia): basifemora 2-2-1-1; telofemora 4-4-4-3; genua 8-6-6-6; $h_4$ 3 times the length of $c_1$; hysterosomal shield width: length 1.5:1; Pakistan .................. \textit{A. gojraensis} Bashir, Afzal & Khan, 2008

Apophysis adjoining genu and tibiotarsus shorter than pedipalpal tibiotarsus; pedipalpal telofemoral apophyses three times longer than spine-like seta; distance between the bases of \textit{sci}–\textit{sci} 9 times the length of \textit{sci}; Brazil, Mexico .......... \textit{A. bison} (Berlese, 1988)
Apophysis adjoining genu and tibiotarsus longer than pedipalpal tibiotarsus; pedipalpal telofemoral apophyses three times longer than spine-like seta; distance between the bases of \textit{sci}–\textit{sci} 5 times the length of \textit{sci}; Pakistan ............... \textit{A. fixus} (Chaudhri, 1980)
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18 (3) Hysterosomal median shield with 2 pairs of setae ($c_1, d_1$) (Fig. 49g) .......... 19
  – Hysterosomal median shield with more than 3 pairs of setae (Fig. 49h) .......... 20

19 (18) Pedipalpal telofemora with 2 ap, 1 spls; pedipalpal genua with 2 spls, 2 sts;
  venter caudally from coxae II with 6 pairs of simple setae (excluding genital,
  coxal, and anal setae); tarsi I–IV with 21-20-15-13 sts (excluding solenidia);
  the distance between bases of $c_1$–$c_1$ 4 times the distance of $h_1$–$h_1$; distance
  between $c_1$–$c_1$ 5 times the length of $c_1$ .......... \textit{A. anastosi} Smiley, 1992
  – Pedipalpal telofemora with 1 ap, 1 spls; pedipalpal genua with 3 spls, 1 sts;
  venter caudally from coxae II with 5 pairs of simple setae (excluding genital,
  coxal, and anal setae); tarsi I–IV with 19-13-13-13 sts (excluding solenidia);
  the distance between $c_1$–$c_1$ 2 times the distance between $h_1$–$h_1$; the distance
  between $c_1$–$c_1$ 4 times the length of $c_1$ .......... \textit{A. beryfordi} Smiley, 1992

20 (18) Apophysis adjacent to pedipalpal genua and tibiotori present .......... \textit{A. multioculus} Shiba, 1986
  – Apophysis adjacent to pedipalpal genua and tibiotori absent .......... 21

21 (20) 5 pairs of genital setae; pedipalp claw bifid (Fig. 52a); hysterosomal setae not
  serrate; Philippines .......... \textit{A. apoensis} Corpuz-Raros, 2008
  – 4 pairs of genital setae; pedipalp claw entire, not bifid (Fig. 52b); hysteroso-
  mal setae serrate; Pakistan .......... \textit{A. fuscus} (Chaudhri, 1977)

22 (2) Lateral hysterosomal platelets present (Figs 50a–c) .......... 23
  – Lateral hysterosomal platelets absent (Fig. 50d) .......... 27

23 (22) Hysterosomal median shield width: length 1:1; venter caudally from coxae II
  with 6 or 7 pairs of sts (excluding genital and anal setae) .......... 24
  – Hysterosomal median shield width: length 2:1; venter caudally from coxae II
  with 5 or 6 pairs of sts (excluding genital and anal setae) .......... 25

24 (23) Hysterosomal platelets large, as long as median shield (Fig. 50a); venter cau-
  dally from coxae II with 7 sts; pedipalp telofemur with 1 apophysis .......... \textit{A. cerris} Kalúz, 2009
  – Hysterosomal platelets about 1/3 the length of median shield; venter caudally
  from coxae II with 6 sts; pedipalp telofemur with 2 apophysis .......... \textit{A. fendai} Kalúz & Vrabec, 2013

25 (23) Hysterosomal platelets as long as median shield (Fig. 50b) .......... 26
  – Hysterosomal platelets ½ as long as median shield (Fig. 50c); Mexico, USA .......... \textit{A. gimplei}

26 (25) Hysterosomal plate concave on lateral edges (Fig. 53a); USA .......... \textit{A. ozarkensis} Skvarla & Dowling, 2012
  – Hysterosomal plate not concave on lateral edges (Fig. 53b); Japan .......... \textit{A. hastus} Shiba, 1986

27 (22) Apophysis on pedipalp telofemur extends to distal margin of segment; 2 pairs
  of ventral pregenital setae thickened and spiculate; $f_1$ 1/3 length of $h_1$; Philip-
  pines .......... \textit{A. makilingensis} Corpuz-Raros, 1995
  – Apophysis on pedipalp telofemur extends well beyond distal margin of segment;
  ventral pregenital setae not thickened and spiculate; $f_1$ subequal to $h_1$ .......... 28
28 (27) Pedipalpal telofemora with 2 ap, 1 spls; the distance between the bases of $c_1$–$c_i$, two times the distance of $d_1$–$d_i$; South Africa........... *A. limpopoensis* Den Heyer, 1978
– Pedipalp telofemora with 1 ap, 1 spls; the distances between the bases of $c_1$–$c_i$ = $d_1$–$d_i$.................................29

29 (28) Pedipalp tibiotarsus with 1 spls, 4 sts; USA........... *A. harrisoni* Smiley, 1992
– Pedipalp tibiotarsus with 1 spls, 3 sts; Canada .......................................................... *A. bakeri* (Smiley, 1992)

30 (1) Pedipalpal telofemoral apophyses long, reaching apical apophysis on pedipalpal genu; lateral platelets present........................................31
– Pedipalpal telofemoral apophyses short, not reaching apical apophysis on pedipalpal genu; lateral platelets present or absent........................32

31 (30) Pedipalpal basifemora with 1 subrectangular apophysis; pedipalp tibiotarsal spls 3 times the length of terminal claw; hysterosomal platelets small, equal in length to $c_2$ (Fig. 51a); coxal chaetotaxy I–IV 3-2-3-3; South Africa ............... *A. lebowensis* Den Heyer, 1978
– Pedipalpal basifemora without subrectangular apophysis; pedipalp tibiotarsal spls equal in length to terminal claw; hysterosomal platelets long, 2–3 times the length of $c_2$ (Fig. 51b); coxal chaetotaxy I–V 3-1-3-1; USA.......................................................... *A. campbelli* (Smiley, 1992)

32 (30) Coxal setal count I–IV 3-2-3-3..........................................................33
– Coxal setal count I–IV 3-2-3-2..........................................................35
– Coxal setal count I–IV 3-3-3-3.......................................................... *A. bifidus* (Corpuz-Raros, 2008)

33 (32) Pedipalpal telofemora with 1 apophysis, 2 spls, 1 sts; the distance between $d_1$–$d_i$, 9 times the length of $d_j$; pedipalpal genua with 2 spls, 1 sts; Slovakia ......... *A. cyaneus* Kalúz, 2009
– Pedipalpal telofemora with 1 apophysis, 2 spls; the distance between $d_1$–$d_i$, 4 times the length of $d_j$; pedipalpal genua chaetotaxy not as above ..........34

34 (33) Hysterosomal platelets present (Fig 51b); pedipalpal genua with 2 spls, 2 sts; basifemora with 5-5-4-2 sts; USA................................. *A. virginiensis* Smiley, 1992
– Hysterosomal platelets absent (Fig. 51c); pedipalpal genua with 1 spls, 1 sts; basifemora with 6-6-4-2 sts; Philippines .................................................. *A. javanus* Corpuz-Raros & Gruèzo, 2007

35 (32) Pedipalpal telofemoral apophyses as long as width of telofemora; pedipalpal genu with 1 apophysis, 2 spls, 2 sts; USA.......................................................... *A. pennsylvanicus* Skvarla & Dowling, 2012
– Pedipalpal telofemoral apophyses only 1/3 width of telofemora; pedipalpal genu with 1 apophysis, 3 spls, 1 sts; Philippines.......................................................... *A. garciai* Corpuz-Raros, 1995

**Key to adult male Armascirus** (modified from Kalúz and Vrabec 2013)

1 Venter with 5 or fewer pairs of setae, excluding genital, anal, and adanal setae; setal formula of coxae I–IV not as below; setal formula of basifemora I–IV not as below.........................................................2
Venter with 6 pairs of setae, excluding genital, anal, and adanal setae; setal formula of coxae I–IV 3-2-3-3; setal formula of basifemora I–IV 5-5-4-2; cosmopolitan ...................................................... \textit{A. taurus} (Kramer, 1881)

2 (1) Setal formula of basifemora I–IV 5-5-4-1; Pakistan ...................................................... \textit{A. ebrius} (Chaudhri, 1977)

3 (2) Coxae I–IV setal formula 3-1-3-3; papillae on circular region anterior to setae \textit{pt} present; South Africa ......................... \textit{A. buyssteeni} Den Heyer, 1978

4 (3) Setal formula of basifemora I–IV 5-4-3-0; papillae on circular region anterior to setae \textit{pt} present or absent .............................................. \textit{A. limpopoensis} Den Heyer, 1978

5 (4) Genua I with 3 asl, 5 sts; South Africa ............ \textit{A. lebowensis} Den Heyer, 1978

\textit{Cunaxa} Von Heyden, 1826

\textbf{Historical review.} Hermann (1804) erected \textit{Scirus} for \textit{S. setirostris} and placed it with two mites that are now considered to belong to the family Bdelidae. Von Heyden (1826) erected \textit{Cunaxa} for \textit{Scirus setirostris}. Dugés (1834a) described \textit{S. elaphus}. Dugés (1834b) described \textit{S. tenuirostris}. Koch (1836) described \textit{S. stabulicola} and \textit{S. sagax} and later (1838) \textit{S. paludicola}. Gervais (1841) described \textit{S. obisium}. Berlese (1887) described \textit{S. stabulicola} and \textit{S. sagax}, and \textit{S. paludicola} with \textit{S. setirostris}. Thor (1902) erected Cunaxidae and split \textit{Cunaxa} from Bdelidae. Ewing (1913) described \textit{S. laricis}. \textit{S. setirostris} var. \textit{gazella} was described by Berlese (1916). Thor and Willmann (1941) redescribed and figured \textit{S. laricis} after transferring it to \textit{Cunaxa}; they also transferred \textit{S. setirostris} var. \textit{gazella} to \textit{Cunaxa}, though kept it as a subspecies of \textit{C. setirostris} and synonymized \textit{S. tenuirostris} and \textit{S. obisium} with \textit{C. setirostris}. Baker and Hoffmann (1948) redescribed and figured \textit{C. setirostris} var. \textit{gazella} and \textit{C. capreolus} and described \textit{C. womersleyi} and \textit{C. veracruzana}. Zaher et al. (1975b) reported \textit{C. setirostris} and \textit{C. capreolus} from Egypt. Den Heyer (1978a) erected Cunaxinae and assigned \textit{Cunaxa} to the subfamily. Den Heyer (1979e) elevated \textit{C. setirostris} var. \textit{gazella} to full species status, viz. \textit{C. gazella}; described \textit{C. carina}, \textit{C. terrula}, \textit{C. lamberfi}, \textit{C. meirigini}, and \textit{C. groblami} and redescribed and figured \textit{C. capreola} and \textit{C. gazella}. He then (Den Heyer 1979f) described five more species from South Africa: \textit{C. hermanni}, \textit{C. sordwanaensis}, \textit{C. potchensis}, \textit{C. brevircura}, and \textit{C. magoebaensis}. Kuznetzov and Livshitz (1979) redescribed and figured \textit{C. capreolus} and \textit{C. setirostris} from Russia. Chaudhri (1980) described \textit{C. doxa}. Tseng (1980) reported \textit{C. womersleyi} and \textit{C. setirostris} from Taiwan. Gupta and Ghosh (1980) described \textit{C. myabunderensis}. Gupta and Paul (1985) described \textit{C. prinia}. Bu and Li (1987c) reported \textit{C. capreola} from China.
Michocka (1987) reported *C. setirostris* from Poland. Muhammad et al. described *Rubroscirus valentis* from Pakistan. Smiley (1992) described *C. mageei, C. thailandicus, C. evansi,* and *C. neogazella*; he also synonymized *Rubroscirus* with *Cunaxa,* though failed to include his evidence for doing so. Gupta (1992) described *C. anacardae* and *C. magniferae.* Muhammad and Chaudhri (1993) described *Rubroscirus rasile* and *R. otiosus* from Pakistan. Corpuz-Raros and Garcia (1995) described five species from the Philippines: *C. luzonica, C. romblonensis, C. pantabanganensis, C. cogonae,* and *C. mercedesae.* Hu (1997) reported 28 species of *Cunaxidae* from China. Khaustov and Kuznetzov (1998) described *C. heterostriata, C. anomala, C. sudakensis* and *C. bochkovi.* Chinniah and Mohanasundaram (2001) described *C. eupatoria.* Sergeyenko (2003) described *C. dentata.* Sionti and Papadoulis (2003) described *C. thessalica* from Greece. Bei et al. recorded *C. mageei* from China. Bashir, Afzal, and Ali (2005) described *C. reticulatus* and moved *Rubroscirus valentis, R. rasile,* and *R. otiosus* to *Cunaxa.* Bashir and Afzal (2006) described *C. jatotiensis.* Sergeyenko (2009) described *C. guanotoleranta,* *C. maculata, C. papuliphora, C. violaphila* and *C. yaylensis.* Den Heyer and Sergeyenko (2009) redescribed *C. setirostris* and designated a neotype for the species. Bashir and Afzal (2009) described *C. bashiri, C. clusus, C. dotos, C. lodhranensis, C. mahmoodi, C. nankanaensis, C. okaraensis, C. pakpatanensis.* Bashir et al. (2010) described *C. raftaki* and *C. leuros.* Bashir et al. (2011) “described” *C. nankanaensis* as a new species using the same illustrations Bashir and Afzal (2009) used to describe the species originally. Den Heyer et al. (2011a) described the male of *C. capreolus.*

**Diagnosis.** *Gnathosoma. Pedipalps*—5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiae. An apophysis on the telofemora present or absent. Dorsolateral setae on the basi- and telofemora simple. Stout spine-like setae on the genua and tibiotarsi present or absent. Tibiotarsi end in a strong claw. **Subcapitulum** with 6 pairs of setae: 2 pairs of adoral setae and 4 pairs of subcapitular setae (*h_1–4*). Subcapitulum smooth or patterned with random dots, but never reticulated.

**Idiosoma, dorsal.** Proterosoma bears a shield that is complemented with 2 pairs of setae (*at* and *pt*) and 2 pairs of setose sensillae (*lps* and *mps*). Dorsal hysterosoma may bear a shield; if a shield is present, it may bear up to 4 pairs of setae. Dorsal shields may be smooth or patterned with random dots, but never reticulated. Lateral platelets (as in *Armascirus* and *Dactyloscirus*) absent. Setae *c_1–h_1* and *c_2* present. Setae not born on the median plate may be born on small platelets that are barely larger than the setal socket. Cupule *im* present laterad and caudally of *e_3.* Integument not bearing the proterosomal shield and median plate (if present) striated. These striations smooth or lobed but never papillated.

**Idiosoma, ventral.** *Coxae* I–II may be fused and coxae III–IV may be fused. *Coxae* II–IV setal formula 1-3-2. Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae (*ps_1*). 1 pair of setae (*h_2*) associated with, but do not occur on, the anal plates. Cupule *ih* present in close proximity to *h_2.* Integument between plates striated and bears up to 7 pairs of additional setae. **Legs.** Tarsi long and slender. Tarsi constricted distally but the tarsal lobes are small and not conspicuous as in *Armascirus* and *Dactyloscirus.* A trichobothrium on tibia IV present. Ambulacral claws on either side of a 4-rayed empodium present.
Key to adult female Cunaxa

Cunaxa bochkovi is not included in the key because the original description is in Cyrillic and the illustration does not contain enough detail or diagnostic characteristics. Den Heyer (pers. comm., Jan. 13, 2014) indicated that Cunaxa setirostris var. pluriisetosa and C. setirostris var. diversa were described in “Mihelčič, F. 1958” but did not have the entire citation and had not seen the original description. The authors have also not been able to locate such a publication after extensive searching and so have not included the taxa here.

As suggested by Den Heyer (2011b), Cunaxa boneti, C. denmarki, C. exoterica, C. floridanus, C. lehmanae, C. lukoschusi, C. metzi, C. myabunderensis, C. newyorkensis, C. rackae, C. reevesi, and C. reticulatus are moved to Rubroscirus and C. otiosus, C. valentis, and C. rasile returned to Rubroscirus as they possess dorsal plates that are reticulated instead of smooth as in Cunaxa.

Cunaxa nankanaensis Bashir, Afzal, Ashfaq, Raza, Kamran, 2011 is considered a junior synonym and junior homonym of Cunaxa nankanaensis Bashir & Afzal, 2009.

1 Setae lps present (Figs 54a–d) ................................................................. 2
   – Setae lps absent (Fig. 54e) ...... C. anomala Khaustov & Kuznetzov, 1998
2 (1) Setae at normal, nearly as long as pt ................................................ 3
   – Setae at short and stubby, less than half the length of pt ....................... ................................. C. anacardae Gupta, 1992
3 (2) Basifemora I with 1 sts ................................................................. 4
   – Basifemora I with 2 sts ....................................................................... 5
   – Basifemora I with 3 sts ...................................................................... 7
   – Basifemora I with 4 sts ...................................................................... 14
   – Basifemora I with 5 sts ...................................................................... 43
4 (3) Basifemora I–IV setal formula 1-2-3-0; telofemora I–IV setal formula 2-2-4-3; India ................................................................. C. prinia Gupta & Paul, 1985
   – Basifemora I–IV setal formula 1-1-1-2; telofemora I–IV setal formula 2-2-1-1; India .................................................................................. C. magniferae Gupta, 1992
5 (3) Basifemora II–IV setal formula 2-1-0 ........................................................ 6
   – Basifemora II–IV setal formula 3-3-1 ...... C. Dotos Bashir & Afzal, 2009
6 (5) Tibia II with 5 sts; Pakistan .............................................................. C. mahmoodi Bashir & Afzal, 2009
   – Tibia II with 7 sts; Pakistan .............................................................. C. okaraensis
7 (4) Genua I with 3 solenidia .................................................................... 8
   – Genua I with 4 solenidia .................................................................... 9
8 (7) Genua II with 1 solenidion; setae f, h, smooth (Fig. 55a) ............. C. setirostris (Hermann, 1804)
   – Genua II with 2 solenidia; setae f, h, spiculate (Fig. 55b) ................. C. magoebaensis Den Heyer, 1979
9 (7) Coxa I–IV setal formula 3-1-3-2 sts ................................................. 10
   – Coxa I–IV setal formula 3-2-3-1 sts ...................................................... C. eupatoriae Chinniah & Mohanasundaram, 2001
10 (9) Dorsal setae short (c1−f1, c2: 7–10, h1: 17) ........................................................ C. mercedesae Corpuz-Raros & Garcia, 1995

11 (10) Oval area formed by broken striae around setae sci present (Fig. 54a) ................................................................. C. maculata Sergeyenko, 2009

12 (11) Genua II proximal solenidion extremely short, its length subequal to the diameter of its alveolus; ventral surface of the coxal region of hypognathum smooth .............................................. C. guanotoleranta Sergeyenko, 2009

13 (12) Length of setae sci longer than half the distance between their bases; dorsal hysterosomal striae distinctly lobed (= with festoons) (Fig. 56a) ................................................................. C. papuliphora Sergeyenko, 2009

14 (3) Basifemora III with 2 sts .......................................................... C. jatoiensis Bashir & Afzal, 2006

15 (14) Telofemoral apophysis uncinated (e.g., bent, hook-shaped) (Fig. 59a) .......................................................... C. heterostriata Khaustov & Kuznetzov, 1998

16 (14) Basifemora IV with 1 sts; cheliceral longitudinal striations present (Fig. 57a) .............................................................. C. yaylensis Sergeyenko, 2009

17 (14) Basifemora IV with 0 sts .......................................................... C. violaphila Sergeyenko, 2009

18 (17) Median plate present (may be indistinctly defined) (Figs 58a–e) .............. C. meiringi Den Heyer, 1979

19 (18) Telofemoral apophysis uncinated (e.g., bent, hook-shaped) (Fig. 59a) ....... C. leuros Bashir, Afzal, Ashfaq, Akbar & Ali 2010

20 (19) Setae c1 not on hysterosomal shield, on integument .......................................................... C. clusus Bashir & Afzal, 2009

21 (20) Tibiae I with 3 asl, 4 sts; Pakistan ........................................ C. nankanaensis

22 (20) Setae f1 on hysterosomal shield .......................................................... C. leuros Bashir, Afzal, Ashfaq, Akbar & Ali 2010

23 (22) Tibia III with 5 sts........ C. leuros Bashir, Afzal, Ashfaq, Akbar & Ali 2010
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24 (22) Tibia III with 6 sts. .......... *C. rafiqi* Bashir, Afzal, Ashfaq, Akbar & Ali 2010
25 (19) Telofemoral apophysis truncated (Fig. 59b). .......... *C. carina* Den Heyer, 1979
26 (25) Telofemoral apophysis not truncated (Figs 59c–e) .......... *C. bashiri* Bashir & Afzal, 2009
27 (26) Median plate complemented with $c_2$ (Figs 58a–d) .......... *C. terrula* Den Heyer, 1979
28 (27) Median plate indistinctly defined (Fig. 58a) .......... *C. sordwanaensis* Den Heyer, 1979
29 (28) Setae $f_1, h_1$ smooth .......... *C. romblonensis* Corpuz-Raros & Garcia, 1995
30 (28) Median plate complemented with $c_1, d_1, c_2$ (Fig. 58b) .......... *C. sudakensis* Khaustov & Kuznetzov, 1998
31 (30) Coxae IV with 1 sts. .......... *C. womersleyi* Baker & Hoffmann, 1948
32 (31) Broken striae that form cell-like structures on median shield present (Fig. 58c). .......... *C. thailandicus* Smiley, 1992
33 (31) Setae $c_1$ longer than all other dorsal setae. .......... *C. pantabanganensis* Corpuz-Raros & Garcia, 1995
34 (33) Genua I–IV with 4-2-1-1 solenidia .......... *C. lamberti* Den Heyer, 1979
35 (34) Setae $c_i, h_i$ approximately equal in length .......... *C. hermanni* Den Heyer, 1979
36 (18) Telofemoral apophysis uncinated (Fig. 59a) .......... *C. lodhranensis* Bashir & Afzal, 2009
37 (36) Genua I–IV setal formula 1 asl, 6 sts-7-6-6; Philippines .......... *C. lodbrahanensis* Corpuz-Raros & Garcia, 1995
38 (36) Proterosomal shield striated (Fig. 54c) .......... *C. potchensis* Den Heyer, 1979
39 (38) Setae $f_i, h_i$ smooth (Fig. 55a) .......... *C. gazella* (Ewing, 1913)
40 (39) Pedipalp telofemoral apophysis short and cone-like (Fig. 59c) ................................................................. C. mageei Smiley, 1992
– Pedipalp telofemoral apophysis short and finger-like (Fig. 59d) ................................................................. C. neogazella, Smiley, 1992

41 (14) Median plate present (Fig. 58d); basifemora IV with 1 sts ................................................................. C. luzonica Corpuz-Raros & Garcia, 1995
– Median plate absent (Fig. 58f); basifemora IV with 1 or 2 sts ................................................................. 42

42 (41) Basifemora IV with 1 sts ............... C. cogonae Corpuz-Raros & Garcia, 1995
– Basifemora IV with 2 sts .............................................. C. doxa Chaudhri, 1980

43 (3) Basifemora III with 4 sts ............................................. C. evansi Smiley, 1992
– Basifemora III with 6 sts ............................................. C. grobleri Den Heyer, 1979

**Cunaxatricha** Castro & Den Heyer, 2008

**Historical review.** Castro and Den Heyer (2008) erected *Cunaxatricha* for *C. tarsospinosa*.

**Diagnosis.** *Gnathosoma. Pedipalps* 5-segmented and end in a strong claw. They extend beyond the subcapitulum by at least the last segment; apophyses absent. Basifemora complemented with a long simple seta; telofemora complemented with a short simple seta. These two segments fused, although a line remains visible and they can thus be differentiated. Subcapitulum complemented with 6 pairs of setae (h$_{g1-4}$ and 2

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**Figures 54, 55.** *Cunaxa* key illustrations. 54a–e Proterosomal shield, dorsal 54a Proterosomal shield with oval area formed by broken striae around pt present, mps present 54b Proterosomal shield with oval area formed by broken striae around pt absent, mps present 54c Proterosomal shield striated, mps present 54d Proterosomal shield smooth, mps present 54e Proterosomal shield with lps absent 55a Smooth f$_1$, h$_1$ 55b Spiculate f$_1$, h$_1$. 
Figures 56–60. *Cunaxa* key illustrations. 56a, b Integumental striations present 57a Chelicera with longitudinal striations absent 58a–f Examples of variation in the hysterosomal median plate 59a Pedipalp telofemoral apophysis uncinated 59b Pedipalp telofemoral apophysis truncated 59c Pedipalp telofemoral apophysis short and cone-like 59d Pedipalp telofemoral apophysis short and finger-like 59e Pedipalp telofemoral femoral apophysis long 60a Pedipalp tibiotarsus with small teeth present 60b Pedipalp tibiotarsus with small teeth absent.
pairs of adoral setae). Setae $h_g_{4}$ located between $h_g_{2-3}$ instead of in the coxal region. **Chelicera** with seta present.

**Idiosoma, dorsal.** Female dorsal idiosoma bears a sclerotized shield that bears 2 pairs of setose sensillae ($at$ and $pt$) and 2 pairs of simple setae ($lps$ and $mps$). Idiosomal shield reticulated. 7 pairs of setae, $e_1$–$d_1$–$h_1$, present. Cupule *im* present, usually posteriolateral of $e_1$. Integument striated.

**Idiosoma, ventral.** *Coxae* I and II fused, as are coxae III and IV. 6 pairs of setae present between and posterior to the coxae. Genital plates each bear 4 setae; 2 pairs of genital papillae not visible underneath the plates. Integument between plates striated and bears 4 pairs of additional setae. **Legs** shorter than the body. Leg 4 longest. Famulus on tarsi I normally shaped and set in a deep depression. Tarsi slightly constricted apically, resulting in small tarsal lobes. Basifemora and telofemora of legs I and II partially fused. A trichobothrium on leg tibia IV absent. Ambulacral claws on either side of a 4-rayed empodium present.

**Dactyloscirus** *Den Heyer, 1978*

**Historical review.** Trägårdh (1905) described *Scirus inermis*. Berlese (1916) erected *Dactyloscirus* as a subgenus of *Scirus* to accommodate *Scirus (Dactyloscirus) eupaloides*. He also described *Scirus dorcas* but failed to recognize that they were congeneric. Oudemans (1922) described *Rosenhofia machairodus*. Halbert (1923) redescribed and figured *S. inermis* from Ireland. Sellnick (1926) transferred *S. inermis* to *Cunaxa*. Vitzthum (1931) raised *Dactyloscirus* to full generic status but later (1940–43) treated it as a subgenus. Thor and Willmann (1941) again elevated *Dactyloscirus* to generic status and designated *Dactyloscirus eupaloides* as the type specimen; they also transferred *C. inermis* and *S. dorcas* to *Dactyloscirus*. Baker and Hoffmann (1948) regarded *Dactyloscirus* as a senior synonym of *Cunaxa*. Smiley (1975) synonymized *Rosenhofia* with *Dactyloscirus*. Zaher et al. (1975b) reported *Dactyloscirus* from Egypt (though they called it *Cunaxa inermis*). *Den Heyer (1978a)* split *Armascirus* from *Dactyloscirus* and *Cunaxa* and raised the subfamily *Cunaxinae* to accommodate them, thus refining the definitions of all three genera. *Den Heyer (1979a)* described *D. condylus* and *D. dolichosetosus*. *Den Heyer (1980c)* erected the tribe *Armascirini* and made *Dactyloscirus* and *Armascirus* the sole representatives. *Gupta and Ghosh (1980)* described *Cunaxoides nicobarenensis*. *Dactyloscirus pataliputraensis* was described by *Gupta (1981)*. *Liang (1986)* described *D. humuli* from China. *Shiba (1986)* described *D. mesonotus*. *Michocka (1987)* reported *D. inermis* from Poland. *Smiley (1992)* transferred *Cunaxoides nicobarenensis* to *Dactyloscirus* (though see discussion below) and described *D. mansonii*, *D. johnstonii*, and *D. poppi*. *Gupta (1992)* described *D. bengalensis*. *Corpusz-Raros (1995)* described *D. philippinensis*, *D. rosarioae*, and *D. agricolus*. *Inayatullah and Shahid (1996)* described *D. illutus*, *D. minys*, and *D. orsi*. *Swift (1996)* described *D. hoffmannae* and *D. smileyi* from the Hawaiian Islands. *Hu (1997)* reported *D. inermis* and *D. humuli* from China. *Bashir and Afzal (2006a)* described *D. imbecillus* and *D. manzoori*. *Bashir, Afzal, and
Akbar (2005) described *D. kahrrorensis*. Corpuz-Raros (2008) described *D. discocondylus* and *D. trifidus*. Skvarla and Dowling (2012) described *D. pseudophilippinensis*. Den Heyer and Castro (2012) described *D. saopauloensis*.

**Diagnosis.** *Gnathosoma. Pedipalps* 5-segmented, extend beyond the subcapitulum by at least the last segment, and end in a strong claw. An apophysis between the genua and tibiotarsi usually present. This apophysis long or short and generally ends in a bulbous, hyaline tip; it can, however, end in a tapering point as in *Armascirus*. This apophysis approximately equal between males and females or shorter in males. Basifemora and telofemora complemented with spine-like setae; these two segments fused, although a line remains visible and they can thus be differentiated. **Subcapitulum** complemented with 6 pairs of setae (*h*$_{g,1-4}$ and 2 pairs of adoral setae) and covered by integumental papillae that are either randomly distributed or form a polygonal, reticulated pattern.

*Idiosoma, dorsal.* Female dorsal idiosoma has at least one sclerotized plate that bears 2 pairs of setose sensillae (*at and pt*) and 2 pairs of simple setae (*lps* and *mps*). 0–4 other major plates and platelets present. All plates, if present, covered by integumental papillae that form a reticulated pattern. Integument between plates striated. 7 pairs of setae (*c$_{1-2}$, d$_{1-2}$, e$_{1}$, f$_{1}$, g$_{1}$, h$_{1}$, i$_{1}$*) present. Each seta, when not on a major plate or platelet, surrounded by a minute platelet only slightly larger than the setal socket. Cupule *im* present, usually laterad or in the proximity of *e$_{1}$*. Dorsal idiosoma of males similar except a single large plate complemented with *c$_{1-2}$, d$_{1-2}$, e$_{1}$* present.

*Idiosoma, ventral.* Coxae I and II often fused; coxae III and IV often fused. Setal formula for coxae I–IV 3-3-3-3 (including paracoxal seta). Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae (*ps$_{j}$*). 2 pairs of setae (*ps$_{2}$* and *h$_{2}$*) associated with, but do not occur on, anal plates. Cupule *ih* present in close proximity to *h$_{2}$*. Integument between plates striated and bears 5–7 pairs of additional setae. Ventral idiosoma of males similar except the coxae much more extensive. A sclerotized aedeagus often visible in association with the genital plates. **Legs** comparatively short, generally not exceeding $\frac{3}{4}$ the length of the body. Famulus on tarsi I enlarged and ends in a tri-tipped prong. Tarsi constricted apically, resulting in large tarsal lobes. Trichobothrium on leg tibia IV present. Ambulacral claws occur on either side of a 4-rayed empodium.

**Key to adult female Dactyloscirus** (modified from Skvarla and Dowling 2012)

Smiley (1992) transferred *Cunaxoides nicobarensis* to *Dactyloscirus* as *D. nicobarensis* (Gupta & Ghosh, 1980). However, later in the same work he attributes the same holotype (No. 3146/17) and same description (viz. Gupta and Ghosh 1980:191) to *Cunaxoides nicobarensis* Gupta & Ghosh, 1980. The original description and illustration by Gupta and Ghosh clearly state the species in question has three pedipalpal segments, which precludes it from being assigned to *Dactyloscirus*. Smiley illustrated a *Dactyloscirus* with 5-segmented pedipalp “after Gupta and Ghosh 1980” when discussing *D. nicobarensis*, though it looks like nothing in the publication. Because of this *Dactyloscirus nicobarensis* (Gupta and Ghosh 1980) is declared *nomen dubium*. 
1 Pedipalpal tibiotarsi and genua with adjoining apophyses present (Figs 61a–i) ... 2
  Pedipalpal tibiotarsi and genua with adjoining apophyses absent (Figs 62a–d)... 21
2 (1) Dorsal hysterosomal lateral platelets present (Figs 63a–d) ...................... 3
  Dorsal hysterosomal lateral platelets absent (Figs 64a–f) ......................... 15
3 (2) Pedipalp telofemora with one or two apophyses (Figs 65a–c) ............. 4
  Pedipalp telofemora without an apophysis; distribution unknown
  ................................................................................................. \( D. \ poppi \ Smiley, \ 1992 \)
4 (3) Pedipalp telofemora with 1 apophysis (Figs 65a, b) ......................... 5
  Pedipalp telofemora with 2 apophyses: 1 basal, flattened and disc-shaped, 1 apical, short, thick and bulbous (Fig. 65c); South Africa
  ........................................................................................................ \( D. \ condylus \ Den \ Heyer, \ 1979 \)
5 (4) Lateral platelets inconspicuous, length less than 2 times the length of \( c_1 \) or \( c_2 \); cosmopolitan (Fig. 63a) \( D. \ inermis \) (Trägårdh 1905)
  Lateral platelets large, length greater than 2 times the length of \( c_1 \) or \( c_2 \) (Figs 63b–d)
  ........................................................................................................ 6
6 (5) Dorsal setae \( f_1 \) and \( h_1 \) equal in length; median shield present (Figs 63b,c) or absent (Fig. 63d) ................................................................. 7
  Dorsal setae \( f_1 \) shorter than \( h_1 \); median shield absent (Fig. 63d) .......... 11
7 (6) Apophysis adjoining pedipalpal genua and telofemora shorter than length of genu, blunt distally (Fig. 61a); median shield absent (Fig. 63d) ...
  Apophysis adjoining pedipalpal genua and telofemora as long or longer than length of genu, blunt or pointed distally (Fig 61 c); median shield present or absent(Figs 63b, c) ................................................................. 10
8 (7) Median shield present ........................................................................ 9
  Median shield absent; Japan \( D. \ mesonotus \) Shiba, 1986
9 (8) Coxa IV with 2 sts; Pakistan \( D. \ manzoori \ Bashir \ & \ Afzal, \ 2006 \)
  Coxa IV with 3 sts; South Africa \( D. \ dolichosetosus \ Den \ Heyer, \ 1979 \)
10 (7) Apophysis adjoining pedipalpal genua and telofemora pointed distally (Fig 61b); pedipalp tibiotarsi with 4 sts; median shield complimented with setae \( c_1, d_1, e_1 \) on small platelets (Fig. 63b); leg basifemora with 5-5-3-1 sts; Luzon I., Philippines \( D. \ philippinensis \ Corpuz-Raros, \ 1995 \)
  Apophysis adjoining pedipalpal genua and telofemora blunted distally (Fig. 61c); setae \( c_1-e_1 \) on median shield (Fig. 63c); pedipalp tibiotarsi with 5 sts; leg basifemora with 5-5-3-2 sts; Ozark Mountains, USA
  ........................................................................................................ \( D. \ pseudophilippinensis \ Skvarla \ & \ Dowling, \ 2012 \)
11 (6) Apophysis adjoining pedipalpal genua and telofemora inconspicuous: circular, minute and hyaline (Fig. 61d); Oahu I., Hawaiian Islands
  ........................................................................................................ \( D. \ hoffmannae \ Swift, \ 1996 \)
  Apophysis adjoining pedipalpal genua and telofemora conspicuous, blunt apically (Fig. 61e) ................................................................. 12
12 (11) Coxa IV with 2 sts ........................................................................ 13
  Coxae IV with 3 sts ........................................................................... 14
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Figures 61–62. *Dactylosciurus* key illustrations. 61a–h Pedipalp genu and tibiotarsus with adjoining apophysis present. 61i Close up of bifid claw. 62a–d Pedipalp genu and tibiotarsus with adjoining apophysis absent. 62e Close up of trifid claw.

13 (12) Tibiae I with 1 asl, 4 sts; tibiae III with 1 asl, 5 sts.................................*

*D. kabroensis* Bashir, Afzal & Akbar, 2006

– Tibiae I with 2 asl, 4 sts; tibiae III with 2 asl, 4 sts.................................*

*D. imbecillus* Bashir & Afzal, 2006

14 (12) Genital setae *g*₃ longest, 1.5–1.7 times the length of *g*₂ and *g*₄, more than 2 times the length of *g*₁; Kauai I., Hawaiian Islands.....*D. smileyi* Swift, 1996

– Genital setae *g*₄ longest, 2 times the length of *g*₁–₃; Shanghai, China...........

*.................................D. humuli* Liang, 1986

15 (2) Dorsal hysterosomal median shield present (Figs 64a–e).................................16

– Dorsal hysterosomal median shield absent (Fig. 64f).................................18

16 (15) Median shield complemented with *c*₁,*d*₁ (Fig. 64b); apophysis adjacent to pedipalpal genua and tibiotarsi blunt distally (Fig. 61c); Mexico, Philippines...

*.................................D. mansoni* Smiley, 1992

– Median shield complemented with *c*₁–*e*₁ (Figs 64c,d); apophysis adjacent to pedipalpal genua and tibiotarsi blunt or pointed distally.................................18
– Median shield complemented with \( c_i - e_i, c_2 \) (Fig. 64d); apophysis adjacent to pedipalpal genua and tibiotarsi pointed distally.....D. illutus Inayatullah & Shahid, 1996

17 (18) Apophysis adjacent to pedipalpal genua and tibiotarsi blunt distally (Fig. 61e); median shield triangular and nearly as wide as proterosomal shield (Fig. 64c); Bihar, India..........................D. pataliputraensis Gupta, 1981
– Apophysis adjacent to pedipalpal genua and tibiotarsi tapering and pointed distally (Fig. 61f); median shield subrectangular and not as wide as proterosomal shield (Fig. 64d); Mexico..........................D. johnstoni Smiley, 1992

18 (17) Pedipalpal telofemora without apophysis (Fig. 61g); apophysis adjoining pedipalpal genua and telofemora longer than telofemora and tapering to a point; Sumatra, Indonesia..........................D. machairodus (Oudemans, 1922)
– Pedipalpal telofemora with 1 or 2 apophyses (Figs 65a–d); apophysis adjoining pedipalpal genu and telofemur shorter than telofemora and with a bulbous tip (Fig. 61a, d)........................................19

19 (18) Pedipalpal telofemora with 1 apical apophysis (Figs 65a,b); apophysis adjoining genua and tibiotarsi larger (Fig. 61a)..................................................20
– Pedipalpal telofemora inner surface with 2 apophyses: 1 basal, flattened and disc-shaped, 1 apical, short, thick and bulbous (Fig. 65d); apophysis adjoining genua and tibiotarsi small, inconspicuous (Fig. 61d); Luzon I., Philippines.................................D. discocondylus Corpuz-Raros, 2008

20 (19) Basal pair of adoral setae very long, more than 4 times the distal pair; pedipalp telofemoral apophysis about as long as width of segment (Fig. 65a); genital setae \( g_4 \) twice as long as \( g_1 - g_3 \); Luzon I., Philippines.....D. rosarioae Corpuz-Raros, 1995
– Basal pair of adoral setae not unusually long, subequal to distal pair; pedipalp telofemoral apophysis short, less than width of segment (Fig. 65b); genital setae \( g_4 \) only slightly longer than \( g_1 - g_3 \); Luzon I., Philippines..........................D. agricolus, Corpuz-Raros, 1995

21 (1) Median shield present (Figs 64d,e)..........................................................22
– Median shield absent (Fig. 64f).............................................................23

22 (21) Median shield complimented with \( c_i - e_i \) (Fig. 64d); Europe, North and South America..........................D. eupaloides Berlese, 1916

23 (21) Coxa I with 2 sts; Pakistan.............................................D. bengalensis Gupta, 1992
– Coxa I with 3 sts..........................................................24

24 (23) Pedipalp tibiotarsal claw trifid (Fig. 62c,d); coxa II–IV setal formula 3-3-3 sts; Luzon I., Philippines..................D. trifidus Corpus-Raros, 2008
– Pedipalp tibiotarsal claw entire, unbranched (Fig. 62a, b); coxa II–IV setal formula not as above..........................25

25 (24) Coxal setal formula II–IV 1-3-2 sts; Peshawar, Pakistan..............................D. orsi Inayatullah & Shahid, 1996
– Coxal setal formula II–IV 2-3-1 sts; Brazil..................................................D. saopauloensis Den Heyer & Castro, 2012
Riscus Den Heyer, 2006

Historical review. Gupta and Ghosh (1980) described *Cunaxa bambusae*, *C. cynodonae* Den Heyer (2006) erected *Riscus* for *R. thailandensis*. Den Heyer (2011) transferred *C. bambusae* and *C. cynodonae* to *Riscus* based on the redescriptions by Corpuz-Raros (2008). Den Heyer and Castro (2012) described *R. austroamericanus*.

Figures 63–65. *Dactyloccirus* key illustrations. 63a–d Dorsal idiosoma, lateral hysterosomal platelets present 64a–f Dorsal idiosoma, lateral hysterosomal platelet absent 65a Pedipalp telofemur with one apophysis, which is about as long as the width of the telofemur 65b Pedipalp telofemur with one apophysis, which is shorter than the width of the telofemur 65c, d Pedipalp telofemur with two apophyses, one apical and one basal which is flattened and disc-shaped.
Diagnosis. **Gnathosoma. Pedipalps** 5-segmented, extend beyond the subcapitulum by at least the last segment, and end in a strong claw; apophysis absent. Basifemora and telofemora complemented with simple setae; these two segments fused, although a line remains visible and they can thus be differentiated. **Subcapitulum** complemented with 6 pairs of setae ($hg_{3-4}$ and 2 pairs of dorsal setae). Setae $hg_3$ and $hg_4$ both near the coxal bases of the pedipalps.

**Idiosoma, dorsal.** Female dorsal idiosoma has a sclerotized plate that bears 2 pairs of setose sensillae ($at$ and $pt$) and 2 pairs of simple setae ($lps$ and $mps$). Idiosomal shield covered by integumental papillae that form a reticulated pattern. Hysterosoma lacks a plate and bears 7 pairs of setae ($c_{1-2}$, $d_{1-2}$, $b_1$). Cupule $im$ present, usually laterad or in the proximity of $e_1$.

**Idiosoma, ventral.** Coxae ill-defined. Coxae I and II fused; coxae III and IV fused. Coxae I–IV setal formula 3-1-3-1 (including paracoaxal seta). Genital plates each bear 4 setae. Anal plates bear 1 pair of setae ($ps_1$). 2 pairs of setae ($ps_2$ and $h_2$) associated with, but do not occur on, the anal plates. Cupule $ih$ present in close proximity to $h_2$. Integument between plates striated and bears 5 pairs of additional setae. **Legs.** Ambulacral claws on either side of a 4-rayed empodium present.

**Key to adult female Riscus** (modified from Den Heyer and Castro 2012)

1. Five pairs of genital setae .................................................................................................................. $R. austroamericanus$ Den Heyer & Castro, 2008
   - Four pairs of genital setae; tibiae IV with 1 T, 4 sts; tibiae II with {1 asl, 1 sts}, 4 sts ................................................................. 2
2 (1). Pedipalpal genu with 3 sts ............................................................................................................ $R. bambusae$ (Gupta & Ghosh 1980)
   - Pedipalpal genu with 4 sts ................................................................. $R. thailandensis$ Den Heyer, 2006
3 (2). Pedipalpal tibiotarsus with 1 spls, 3 sts, 1 dorsoterminal solenidion ................................................................. $R. cynodonae$ (Gupta & Ghosh, 1980)
   - Pedipalpal tibiotarsus with 5 sts, 1 dorsoterminal solenidion (original description states 6 sts present; one of these is assumed to be a solenidion here) ...... ........................................................................................................ $R. denheyeri$ (Muhammad & Chaudhri, 1993)  

**Rubroscirus** Den Heyer, 1979

**Historical review.** Baker and Hoffmann (1948) described *Cunaxa boneti*. Den Heyer (1979d) erected *Rubroscirus*, described *R. africanus*, *R. rarus*, and *R. vestus*, and transferred *C. boneti* to the *Rubroscirus* genus. Tseng (1980) described *Rubroscirus* with *Cunaxa* and described *C. denmarki*, *C. floridanus*, *C. lehmaniae*, *C. lukoschusi*, *C. metzi*, *C. newyorkensis*, *C. rackae*, and *C. reevesi*. Fan (1992) synonymized *Rubroscirus* with *Cunaxa* and described *C. venusae* and *C. viscayana*. Bashir, Afzal, and Ali (2005) described *Cunaxa reticulatus*
and transferred *R. valentis*, *R. rasile*, and *R. otiosus* to *Cunaxa*. Sergeyenko (2006) recognized *Rubroscirus* as a valid genus and described *R. khaustovi*. Ferla and Rocha (2012) described *R. nidorum*.

**Diagnosis.** *Gnathosoma.* Pedipalps 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiae. An apophysis on the telofemora present. Stout spine-like seta on the genua and tibiotarsi setae present or absent. Tibiotarsi end in a strong claw. **Subcapitulum** with 6 pairs of setae: 2 pairs of adoral setae and 4 pairs of subcapitular setae (*h*<sub>1</sub>–*h*<sub>4</sub>). Subcapitulum is reticulated.

**Idiosoma, dorsal.** Proterosoma bears a shield, complemented with 2 pairs of setose sensillae (*at* and *pt*) and 2 pairs of setae (*lps* and *mps*). Sensillae *at* and *pt* not as densely pilose as in *Allocunaxa*, *Cunaxatricha*, and *Riscus*. Proterosomal shield reticulated. Hysterosomal shield absent in females. Lateral platelets (as in *Armascirus* and *Dactyloscirus*) absent. Setae *c*<sub>1</sub>–*h*<sub>1</sub>, and *c*<sub>2</sub> present. Cupule *im* present laterad and caudally of *e*<sub>1</sub>. Integument not bearing the I shield striated. Striations papillated, not smooth or lobed as in *Cunaxa*.

**Idiosoma, ventral.** Coxae I–II may be fused; coxae III–IV may be fused. Coxae II–IV setal formula 1-3-1. Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae (*ps*<sub>1</sub>). 1 pair of setae (*h*<sub>2</sub>) associated with, but do not occur on, the anal plates. Cupule *ih* present in close proximity to *h*<sub>2</sub>. Integument between plates striated and bears up to 7 pairs of additional setae. **Legs.** Tarsi long and slender, and constricted distally but tarsal lobes small and not conspicuous as in *Armascirus* and *Dactyloscirus*. A trichobothrium on tibia IV present. Ambulacral claws either side of a 4-rayed empodium present.

**Key to adult female Rubroscirus**

*Rubroscirus* is recognized as a valid genus. As suggested by Den Heyer (2011b) *Cunaxa boneti*, *C. denmarki*, *C. exoterica*, *C. floridanus*, *C. lehmanae*, *C. lukoschusi*, *C. metzi*, *C. newyorkensis*, *C. rackae*, *C. reevesi*, *C. reticulatus*, *C. venusae* and *C. viscayana* are transferred to *Rubroscirus* as they possess reticulated proterosomal shields.

1. Basifemora I with 3 sts.................................................................2
   – Basifemora I with 5 sts.........................................................2

2. Basifemora III with 1 sts............................................................3
   – Basifemora III with 2 sts; Pakistan...*R. reticulatus* Bashir, Afzal & Ali, 2006

3. Basifemora IV with 1 sts............................................................4
   – Basifemora IV with 2 sts; Mexico, Central America, USA..........

............................................................*R. boneti* (Baker & Hoffmann, 1948)

4. Coxae I with 2 sts; Taiwan..............................*R. exoterica* (Tseng, 1980)
   – Coxae I with 3 sts.................................................................5

5. Coxae II with 1 sts.................................................................6
   – Coxae II with 2 sts.................................................................6

6. Coxae IV with 1 sts.................................................................7
   – Coxae IV with 2 sts.................................................................12

7. Genua I with 1 asl, 5 sts; Ukraine..................*R. khaustovi* Sergeyenko, 2006
– Genua I with 2 asl, 4 or 6 sts ................................................. 8
– Genua I with 3 asl, 5 or 6 sts .................................................. 10
– Genua I with 3 asl, 1 bsl, 5 sts; Pakistan ..................... R. rasile Chaudhri, 1993
8 (7) Genua I with 2 asl, 4 sts; genua IV with 1 asl, 5 sts...................... 9
– Genua I with 2 asl, 6 sts; genua IV with 2 asl, 5 sts; USA ......................... R. newyorkensis (Smiley, 1992)
9 (8) Genua II with 1 asl, 5 sts; China ............................. R. denbeyeri Fan, 1992
– Genua II with 1 asl, 6 sts; Brazil ....................... R. nidorum Ferla & Rocha, 2012
10 (7) Genua I with 5 sts; genua II with 1 asl, 5 sts; USA ...
.................................................. R. lehmanae (Smiley, 1992)
– Genua I with 6 sts; genua II with 2 asl, 5 or 6 sts ..................... 11
11 (10) Genua II with 2 asl, 5 sts; Pakistan ........................................ R. valentis Muhammad, Chaudhri & Akbar, 1989
– Genua II with 2 asl, 6 sts; Pakistan ........................................ R. otiosus Muhammad & Chaudhri, 1993
12 (6) Genua I with 7 sts; Phillipines ... R. viscayana Corpuz-Raros & Garcia, 1995
– Genua I with 2 asl, 5 or 6 sts ............................................... 13
– Genua I with 3 asl, 4 sts; China ..................... R. sinensis Fan, 1992
– Genua I with 4 asl, 5 sts; USA ..................... R. floridanus (Smiley, 1992)
13 (12) Genua I with 2 asl, 5 sts; genua II with 2 asl, 5 sts; genua IV with 1 asl, 5 sts . 14
– Genua I with 2 asl, 6 sts; genua II with 6 sts; genua IV with 6 sts; Philippines ...................... R. venusae Corpuz-Raros & Garcia, 1995
14 (13) Genua III with 1 asl, 5 sts; setae c1, c2, d1, e1, f1, and h1 smooth .......... 15
– Genua III with 2 asl, 5 sts; setae c1, c2, d1, e1, f1, and h1 spiculate; Costa Rica ................................................ R. ruckae (Smiley, 1992)
15 (14) Minute thorn-like seta adjacent to median spine-like seta on pedipalp tibia-tarsus present; New Zealand .................. R. reevesi (Smiley, 1992)
– Minute thorn-like seta adjacent to median spine-like seta on pedipalp tibia-tarsus absent; USA ................................................................. R. metzi Smiley, 1992
16 (5) Basifemora I with 1 asl, 5 sts; basifemora II with 1 asl, 5 sts; basifemora III with 1 asl, 5 sts; basifemora IV with 1 asl, 5 sts; South Africa .............. R. africanus Den Heyer, 1979
– Basifemora I with 2 asl, 5 sts; basifemora II with 1 asl, 5 sts; basifemora III with 1 asl, 5 sts; basifemora IV with 2 asl, 5 sts .................. 17
– Basifemora I with 3 asl, 5 sts; basifemora II with 1 asl, 5 sts; basifemora III with 1 asl, 5 sts; basifemora IV with 1 asl, 5 sts; South Africa .................. R. vestus Den Heyer, 1979
– Basifemora I with 4 asl, 5 sts; basifemora II with 2 asl, 5 sts; basifemora III with 2 asl, 5 sts; basifemora IV with 1 asl, 5 sts; South Africa .... R. varus Den Heyer, 1979
17 (16) Setae c1, c2, d1, e1, f1, and h1 smooth; India .............. R. myabunderensis (Gupta & Ghosh, 1980)
– Setae c1, c2, d1, e1, f1, and h1 spiculate; Australia, Cominican Republic .... R. lukoschusi (Smiley, 1992)
Coleoscirinae Den Heyer, 1978

**Historical review.** Berlese (1888) described the first Coleoscirinae, *Scirus curtipalpus*, from Argentina. Berlese (1916) then erected *Coleosirus* for two new species, *C. halacaroides* and *C. corniculatus* (*C. corniculatus* was later synonymised with *C. curtipalpus* by Den Heyer 1978b). Smiley (1975) erected *Pseudocunaxa* and *Pseudobonzia*. *Scutascirus* was erected by Den Heyer (1976) for a South African species, *S. polycostatus*. Den Heyer (1977a) erected *Neoscirula* for three South African cunaxids. Den Heyer (1978b) synonymized *Pseudocunaxa* with *Coleosirus* and erected Coleoscirinae for the known genera. Tseng (1980) erected *Lapicunaxa* for two species from Taiwan. Smiley (1992) moved *Neoscirula* from Coleoscirinae to Bonziinae, synonymised *Lapicunaxa* with *Coleosirus*, and erected *Neobonzia* in Neobonzinae. Den Heyer and Castro (2008b) erected *Coleobonzia* for some species previously contained in *Pseudobonzia*. Den Heyer and Castro (2008c) moved *Neoscirula* back to Coleoscirinae. Den Heyer (2011c) moved *Neobonzia* to Coleoscirinae, effectively disregarding Neobonzinae, and synonymized *Coleobonzia* with *Neobonzia*.

**Diagnosis.** *Gnathosoma. Pedipalps* 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiotarsi. Basifemora and telofemora fused but retain a dark line. Tibiotarsi usually complemented with a tubercle and a dorsodistal solenidion. Pedipalps end in a stout claw. *Chelicera* with seta present or absent. *Subcapitulum* bears 6 pairs of setae: 2 pairs of adoral setae and 4 pairs of subcapitular setae (*hg*<sub>1–4</sub>). Setae *hg*<sub>4</sub> often longest.

*Idiosoma, dorsal.* Proterosoma covered in a shield which bears 4 pairs of setae: 2 pairs of simple setae (*lps* and *mps*) and 2 pairs of setose sensilla (*at* and *pt*). Dorsal hysterosoma median plate present or absent; if present this plate separate or fused to the proterosomal shield. Plates and shields smooth or variously covered with papillae that form reticulations. Up to 8 pairs of setae present on the dorsal hysterosoma (*c<sub>1–7</sub>, f<sub>1</sub>, c<sub>2</sub>, f<sub>2</sub>, h<sub>2</sub>); if these setae do not occur on larger plates or shields they may be born on small platelets that are barely larger than the setal socket. Cupule *im* present, usually laterad or in the proximity of *e<sub>1</sub>*. Unsclerotized integument striated.

*Idiosoma, ventral.* *Coxae* I–II fused and may coalesce medially to form a single sternal plate. Each pair of coxae complemented with 3 pairs of setae; if they form an extensive sternal shield, setae normally born on the unsclerotized integument may be located on the shield. Coxae III–IV fused; they may be restricted to the trochanetal bases or extend posteriorly beyond the genital plates. Each pair of coxae complemented with 3 pairs of setae; if the plates are extensive they may bear setae normally born on the unsclerotized integument. The genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. 1–8 pairs of setae present on the integument between coxae III and the genital plates. Analog plates complemented with 2 pairs of setae (*ps<sub>1–2</sub>*, *pa*). Two pairs of setae (*h<sub>2</sub>, *pa*) located on the integument near the anal plates. Cupule *ib* present in close proximity to *h<sub>2</sub>*. *Legs* shorter than idiosoma; they are never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Ambulacral claws on either side of a four-rayed empodium present.
Key to adult female Coleoscirinae (modified from Den Heyer and Castro 2008b)

1  Idiosomal plates well-developed and defined; hysterosomal shield present and fused to proterosomal plate (Fig. 66a, b); females and most males with coxae I–II fused medially into a sternal shield (Fig. 67a); apices of some solenidia, especially on tarsi I, swollen .................................................................2

   – Idiosomal plates poorly developed and sometimes ill-defined; hysterosomal plate absent (Fig. 66c, d); coxae I–II usually not fused medially and restricted to trochanteral bases (Fig. 67b, c); solenidia on tarsi I and II usually cylindrical ........ 3

2 (1) Idiosoma with 15 to 19 plates, including 4 pairs of dorsolateral plates (Fig. 66a); 2 dorsal plates; pedipalp tibiotarsal ventral tubercle often bifurcate (Fig. 68a) ................................................................. Scutascirus

   – Idiosoma with no more than 8 plates; dorsolateral plates absent (Fig. 66b); females with only one dorsal plate but males with up to 3 dorsal plates; pedipalp tibiotarsal ventral tubercle not bifurcate, plain (Fig. 68b) .............................................................. Coleoscirus Berlese, 1916

3 (1) Pedipalp tibiotarsus short and nearly cone-like (Fig. 69a); cheliceral trochanters broad; ambulacral claws smooth .................. Neoscirula Den Heyer, 1977

   – Pedipalp tibiotarsus long and usually narrow and S-shaped (Fig. 69b); cheliceral trochanters narrow; ambulacral claws rippled .................... 4

4 (3) Subcuticular reticulated pattern present on proterosomal, coxal, and genital plates: usually very conspicuous, even proximal leg segments may possess such pattern (Fig. 67c) ........................................ Pseudobonzia Smiley, 1975

   – Subcuticular reticulated pattern absent or restricted to the edge of coxae (Fig. 67d) ............................................................. Neobonzia Smiley, 1992

Coleoscirus Berlese, 1916

Historical review. Berlese (1916) erected Coleoscirus to accommodate two species, the type-species C. halacaroides and C. corniculatus. He had previously described two other species that would be assigned to the genus, Scirus curtipalpus (Berlese, 1888) and Scirus brevicornis (Berlese, 1905), but failed to recognize they belonged to Coleoscirus. Ewing (1917) described Scirus simplex from refuse hog hair in Illinois, USA. Thor and Willmann (1941) transferred S. curtipalpus, S. brevicornis, and S. simplex to Cunaxa and provided redescriptions and illustrations. Baker and Hoffmann (1948) described Cunaxa mexicana, as well as redescribing and illustrating Cunaxa simplex, Coleoscirus curtipalpus, and Coleoscirus brevicornis. Zaher et al. (1975b) reported C. simplex from Egypt. Smiley (1975) provided an English translation of Berlese’s (1916) description of Coleoscirus but failed to include the genus in his key to genera; he also erected Pseudocunaxa for Cunaxa simplex and closely related species. Den Heyer (1978a) erected Coleoscirinae, designating Coleoscirus as the type genus and described Coleoscirus magdalenae and C. tuberculatus; he also synonymized Pseudocunaxa with Coleoscirus and
Coleoscirus corniculatus with C. curtipalpus. Shiba (1978) described Cunaxa mizunoi. Tseng (1980) erected Lapicunaxa horidula and L. monospinosus. Chaudhri (1980) described Pseudocunaxa baptus. Den Heyer (1980b) described Coleoscirus coatesi, C. bre-slauensis, and C. buartsus, and synonymized C. magadalena with C. simplex. Den Heyer (1980c) erected the tribes Coleoscirini for Coleoscirus and Scutascirus and Neoscirulini for Neoscirula and Pseudobonzia. Smiley (1992) synonymized Lapicunaxa with Coleoscirus and transferred Cunaxa mizunoi and Pseudocunaxa baptus to Coleoscirus; he also synonymized Cunaxa mexicanus with Coleoscirus curtipalpus and provided a key to

Figures 66–69. Cunaxidinae key illustrations. 66a–d Idiosoma, dorsal. Position of setae will vary between species. 67a–d Idiosoma, ventral 66a, 67a Generalized Scutascirus. Presence, position, and extent of lateral plates will vary between species 66b, 67b Generalized Coleoscirus 66c, 67c Generalized Pseudobonzia 66d, 67d Generalized Neobonzia 68a Scutascirus pedipalp tibiotarsus, arrow indicates bifurcate tubercle 68b Coleoscirus pedipalp tibiotarsus, arrow indicates plan tubercle 69a Neoscirula pedipalps with short, cone-like tibiotarsus 69b Pseudobonzia and Neobonzia pedipalps with elongate, s-shaped tibiotarsus.
known world species. *Coleoscirus carmus* and *C. disparis* were described by Muhammad and Chaudhri (1992a). Inayatullah and Shahid (1993) described *Pseudocunaxa carex*, *P. mardi*, and *P. kifayat*, apparently unaware or ignoring that Den Heyer (1980) had synonymized *Pseudocunaxa* with *Coleoscirus* thirteen years earlier. Bu and Li (1987c) reported *C. buartsus* from China. Corpuz-Raros (1996d) described six species of *Coleoscirus*: *C. intermedius*, *C. barrioni*, *C. dayamilocus*, *C. bakeri*, *C. leytensis*, and *C. philippinensis*. Hu (1997) reported *C. monospinosus*, *C. horidula*, and *C. buartsus* from China. Bashir, Afzal, and Khan (2006) reaffirmed Den Heyer’s (1980) synonymization of *Pseudocunaxa* and *Coleoscirus* by treating *P. carex*, *P. mardi* and *P. kifayat* as *Coleoscirus* and described *C. trudus*; they also mention a second paper by Muhammad and Chaudhri (1992b) that described two additional species of *Coleoscirus* from Pakistan that I have been unable to obtain. Lin et al. (2003) reported *C. simplex* from China. Fawzy (2007) described *C. zaberi*. Bashir, Afzal, and Khan (2008) described *C. raviensis* and *C. tobaensis*. Bashir and Afzal (2009) described *C. afzali*.

**Diagnosis.** Gnathosoma. Pedipalps 5-segmented; basifemora and telofemora fused but retain a dark line which indicates the presence of the joint. Pedipalps extend beyond the subcapitulum by at most the apical half of the tibiotarsi. Pedipalp tibiotarsal tubercle plain, not bifurcate as in *Scutascirus*. Subcapitulum bears 6 pairs of setae: 2 pairs of dorsal setae and 4 pairs of subcapitular setae (*hg*1–4).

Idiosoma, dorsal. Dorsal idiosoma heavily sclerotized and the plates well-demarcated. A single dorsal shield present; it may range in size from terminating anteriorly to cupule *im* to being holodorsal. No papillated line or other marking indicates the separation of the proterosomal and hysterosomal shields. 2 pairs of setae and 2 pairs of setose sensillae present on the proterosomal. Setae *c*1–*h*1, *c*2, and *f*2 and cupule *im* present dorsally. Dorsolateral plates (such as present in *Scutascirus*) absent.

Idiosoma, ventral. Coxae I–II fused and coalesce medially to form a sternal shield which often has a prominent apex caudally. Sternal plate complemented with 5–7 pairs of setae. Coxae III–IV fused and may extend laterally and caudally past the genital plates. Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Anal plates bear two pairs of setae (*ps*1 and *ps*2). Seta *h*2 located ventrally near the anal plates. Cupule *ih* present in close proximity to *h*2. Legs shorter than the idiosoma, never constricted apically so as to end in lobes. The apices of solenidia, especially on tarsi I, may be swollen. Trichobothrium on leg tibia IV present. Ambulacrual claws on either side of a four-rayed empodium present.

Males similar, except up to three shields or plates may occur on the dorsal idiosoma (that is the proterosomal shield may not be fused to a hysterosomal plate and up to two hysterosomal plates may be present) and coxae I–IV may be fused into a holoventral shield.

**Key to adult female Coleoscirus**

*Coleoscirus brevicornis* (Berlese) has been excluded from the key as the original publication (Berlese 1904) and subsequent publication detailing the species (Thor and Willmann 1941) are in Italian and German and the accompanying illustrations provide
too little detail. Den Heyer (1978b) is the last author to mention the species, but only indicates that it belongs to the genus *Coleoscirus*.

*Coleoscirus carex*, *C. kifayati*, and *C. mardi* have been excluded from the key as the authors did not provide enough information in the original descriptions to include them.

*Coleoscirus zaherii* is not included in the key as, despite the best efforts of the authors and the University of Arkansas Interlibrary Loan Department, the description could not be obtained.

1  Basifemora I with 4 setae ................................................................. 2
   – Basifemora I with 5 setae ............................................................... 4
2 (1) Basifemora II-IV setal formula 5-4-2 ........................................... 3
   – Basifemora II-IV setal formula 6-4-2; Pakistan .................................. *C. trudus* Bashir, Afzal & Khan, 2006
   – Basifemora II-IV setal formula 6-5-2; Pakistan .................................. *C. afzali* Bashir & Afzal, 2009
3 (2) Telofemora I-IV setal formula 4-4-4-3; Pakistan ........................... *C. baptus* (Chaudhri, 1980)
   – Telofemora I-IV setal formula 4-5-4-3; Pakistan ................................ *C. raviensis* Bashir, Afzal & Khan, 2008
4 (1) Basifemora II with 5 setae ........................................................... 5
   – Basifemora II with 6 setae ............................................................. 12
5 (4) Basifemora III with 4 setae ......................................................... 6
   – Basifemora III with 5 setae ............................................................. 8
6 (5) Basifemora IV with 2 setae .......................................................... 7
   – Basifemora IV with 3 setae; Java, South Africa... *C. halacaroides* Berlese, 1916
7 (6) Horizontal reticulations on dorsal shield present (Fig. 70); Taiwan .......................................................... *C. horidula* (Tseng, 1980)
   – Horizontal reticulations on dorsal shield absent; Taiwan ....................... *C. monospinosus* (Tseng, 1980)
8 (5) Basifemora I-IV setal formula 4-5-3-3; Argentina .......................... *C. curtipalpus* (Berlese, 1888)
   – Basifemora I-IV setal formula not as above ........................................ 9
9 (8) Sternal shield bilobed posteriorly; Philippines... *C. barrioni* Corpuz-Raros, 1996
   – Sternal shield not bilobed posteriorly .............................................. 10
10 (9) Extensive reticulations on gnathosoma present (Fig. 71); Philippines ... *C. bakeri* Corpuz-Raros, 1996
   – Extensive reticulations on gnathosoma absent ................................... 11
11 (10) Hysterosomal shield present, complemented with \( c_1 f_1 \), \( c_2 f_2 \); Philippines .... *C. philippinensis* Corpuz-Raros, 1996
   – Hysterosomal shield absent; Philippines .............................................
12 (4) Basifemora III with 4 setae ...................................................... 13
   – Basifemora III with 5 setae ........................................................... 17
   – Basifemora III with 6 setae ........................................................... 20
13 (12) Telofemora I-IV setal formula 4-4-4-3; USA, South Africa, Japan
.................................................................C. simplex (Ewing, 1917)
– Telofemora I-IV setal formula 5-5-4-3

14 (13) Setae \( f_1, f_2 \) born on soft integument
.................................15
– Setae \( f_1, f_2 \) born on dorsal shield; Pakistan
.................................................................C. tobaensis Bashir, Afzal & Khan, 2008

15 (14) Sternal plate rounded posteriomedially (Figs 72a, b); South Africa
.................................................................C. tuberculatus Den Heyer, 1978
– Sternal plate truncated posteriomedially (Fig. 72c) .............................16

16 (15) Light reticulation on dorsal shield present; dorsal shield evenly sclerotized
(Fig. 73a); South Africa ..................................................C. buartsus Den Heyer, 1980
– Light reticulation on dorsal shield absent; dorsal shield unevenly sclerotized
(Fig. 73b); South Africa ..................................................C. coatesi Den Heyer, 1980

17 (12) Sternal shield indented posteriomedially (Fig. 72a); Malaysia
.................................................................C. mizunoi (Shiba, 1978)
– Sternal shield not indented posteriomedially (Fig. 72b) .........................18

18 (17) Setae \( f_2 \) born on soft integument; Pakistan
.................................................................C. disparis Muhammad & Chaudhri, 1992
– Setae \( f_2 \) born on dorsal shield ............................................19

19 (18) Integumental dots on legs I-IV forming rows (Fig. 74a); Pakistan
.................................................................C. carmus Muhammad & Chaudhri, 1992
– Integumental dots on legs I-IV forming random (Fig. 74b); South Africa
.................................................................C. breslauensis Den Heyer, 1980

20 (12) Basifemora IV with 2 setae; Philippines
.................................................................C. leytensis Corpuz-Raros, 1996
– Basifemora IV with 3 setae; Philippines
.................................................................C. dayamilocus Corpuz-Raros, 1996

Neobonzia Smiley, 1992

Historical review. Berlese (1910) described the first species of Neobonzia, Scirus parvirostris. Thor and Willmann (1941) moved S. parvirostris to Cunaxa. Baker and Hoffmann (1948) described Cunaxa snowi. Heryford (1965) described Cunaxa reticulata. Smiley (1975) erected the genus Pseudobonzia, with C. reticulata as the type species. Den Heyer (1977c) redescribed Pseudobonzia, moved C. parvirostris to Pseudobonzia, and described six new species from South Africa: P. argillae, P. nona, P. lootsi, P. themeda, and P. saaymani. Pseudobonzia parilis was described by Chaudhri (1977). Den Heyer (1980b) described P. smileyi and transferred C. snowi to Pseudobonzia. Chaudhri (1980) described P. numida. Luxton (1982) described P. breviscuta from New Zealand peat moss. Liang (1983) reported P. themeda from China. Pseudobonzia shanghaiensis was described by Liang (1984). Smiley (1992) described P. newzealandicus, P. landwehri, and P. summersi; reported P. saaymani from the USA and Canada;
and erected a new monotypic subfamily, Neobonzinae, and genus, *Neobonia*, for *N. moseri*. Corpuz-Raros and Garcia (1996) described two species from the Philippines, *P. gruezoi* and *P. longispina*. Hu (1997) reported *P. shanghaiensis* and *P. themedae* from China. Sergeyenko (2005) described *P. kuznetzovi*. *P. clavata* was described by Corpuz-Raros (2008). Den Heyer and Castro (2008b) split a new genus, *Coleobonzia*, from *Pseudobonzia*; They retained 6 species in *Pseudobonzia* (*P. clathratus, P. delfinadoberkae, P. landwehri, P. neoreticulata, P. reticulata*, and *P. yini*) and transferred all other species to *Coleobonzia* and described *C. clava* and *C. moraesi*. Bashir and Afzal (2009) described *P. bakari, P. malookensis*, and *P. shamshadi*. Den Heyer (2011) synonymized *Coleobonzia* with *Neobonzia* and moved *Neobonzia* to Coleoscirinae, effectively disregarding Neobonzinae.

**Diagnosis.** *Gnathosoma*. *Pedipalps* 5-segmented and reach beyond the subcapitulum by at most the distal half of the last segment. Simple setae present on the basi- and

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![Figures 70–74. Coleoscirus key illustrations.](image)

**Figures 70–74.** *Coleoscirus* key illustrations. 70 Dorsal idiosomal shield with horizontal reticulations present 71 Gnathosoma with extensive reticulations present 72a Sternal plate rounded posteriomedially, indentation absent 72b Sternal plate rounded posteriomedially, indentation present 72c Sternal plate truncated posteriomedially 73a Dorsal idiosomal shield even sclerotized, light reticulation present 73b Dorsal idiosomal shield unevenly sclerotized, light reticulation absent 74a Integumental dots on legs forming rows 74b Integumental dots on legs random.
telofemora. Pedipalp tibiotarsi long and S-shaped (as opposed to short and cylindrical as in *Neoscirula*). **Subcapitulum** with 4 pairs of setae (*h*<sub>g,1–4</sub>). 2 pairs of adoral setae present. **Chelicera** with seta usually present. Extensive reticulated pattern absent from the gnathosoma, though a row of single cells may be present caudally.

**Idiosoma, dorsal.** Plates lightly sclerotized and may not be well defined or demarcated. Proterosomal plate bears 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Extensive reticulated pattern absent, although a pair of rows of up to 6 cells may be present. Proterosomal plate may be covered with random dots or papillae. Hysterosomal plate absent. Setae *c*<sub>1</sub>–*h*<sub>1</sub>, and usually *c*<sub>2</sub> and *f*<sub>2</sub> present dorsally; *h*<sub>2</sub> present or absent. Cupules *im* present laterad and sometimes caudally of *e*<sub>r</sub>. Integument striated.

**Idiosoma, ventral.** **Coxae** usually restricted to the trochanteral bases, though sometimes coxae I–II may nearly touch medially. Coxae I–II fused. Coxae III–IV fused. All coxae lightly sclerotized and may be ill-defined. Extensive reticulated pattern absent from the coxae, though a row of cells or reticulated pattern may be present near the edges. Coxae may be covered with random dots or papillae. Coxae I–IV usually have the simple setal formula 3-3-3-3 (*N. parilis* is the exception with 2-2-3-2). Genital plates each bear 3–4 setae; 2 pairs of genital papillae visible underneath the plates. 2 pairs of setae (*ps*<sub>1–2</sub>) usually occur on the anal plates and 1 pair of setae (*pa*) occurs on the integument near the anal plates. However, at least one species (*N. clavata*) has 3 pairs of setae present on the anal plates and 0 pairs of setae on the integument. Cupules *ih* present ventrally near the anal plates. **Legs.** Tarsi never constricted apically so as to end in lobes. The apices of solenidia cylindrical, not swollen as in *Coleoscirus* and *Scutascirus*. Trichobothrium on leg tibia IV present. Ambulacral claws rippled and occur on either side of a 4-rayed empodium.

**Key to adult female Neobonzia**

As suggested by Den Heyer (2013) *Pseudobonzia bakari*, *P. malookensis*, and *P. shamshadi* are transferred to *Neobonzia*.

*Neobonzia parvirostris* (Berlese, 1910) is known only from the male and so is not included in the key. *N. breviscuta* (Luxton, 1982) is not included in the key as an insufficient number of characters are given in the original description.

1  Sensilla *at* and *pt* clavate (Figs 75a, b) ................................................................. 2
– Sensilla *at* and *pt* not clavate, normal (Fig. 75c).................................................. 3

2 (1) Sensilla *at* and *pt* short, length less than width of proterosomal plate (Fig. 75a); Philippines................................................................. *N. clavata* (Corpuz-Raros, 2008)
– Sensilla *at* and *pt* long, length greater than width of proterosomal plate (Fig. 75b); Brazil................................................................. *N. clavata* (Den Heyer & Castro, 2008)

3 (1) Coxae I–IV setal formula 2-2-3-2 sts; Pakistan...................................................... *N. parilis* (Chaudhri, 1977)
– Coxae I–IV setal formula 3-3-3-3 sts ...................................................................... 4

4 (3) Basifemora I with 2 sts......................................................................................... 5
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A. Basifemora I with 3 sts; Philippines
   N. longispina (Corpuz-Raros & Garcia, 1996)
B. Basifemora I with 4 sts
   N. moseri Smiley, 1992
C. Basifemora I with 5 sts
   N. malookensis (Bashir & Afzal, 2009)
D. Basifemora II–IV setal formula 2-2-1 sts; USA
   N. bakari (Bashir & Afzal, 2009)
E. Basifemora II–IV setal formula 3-3-1 sts
   N. themedae (Den Heyer, 1977)
F. Basifemora II–IV setal formula 4-4-1 sts
   N. lootsi (Den Heyer, 1977)

A. Telofemora I–IV setal formula 4-6-4-2 sts; China
   N. newzealandicus (Smiley, 1992)
B. Telofemora I–IV setal formula 5-5-4-3 sts; South Africa
   N. moraesi (Den Heyer & Castro, 2008)
C. Telofemora I–IV setal formula 6-1 sts; New Zealand
   N. saaymani (Den Heyer, 1977)
D. Telofemora I–IV setal formula 3-0 sts; South Africa
   N. argillae (Den Heyer, 1977)
E. Telofemora I–IV setal formula 3-1 sts; South Africa
   N. nona (Den Heyer, 1977)
F. Telofemora I–IV setal formula 4-2 sts
   N. smileyi (Den Heyer, 1980)

A. Basifemora II with 4 sts
   P. shamshadi (Bashir & Afzal, 2009)
B. Basifemora II with 5 sts
   N. numida (Chaudhri, 1980)
C. Basifemora III–IV setal formula 4-2 sts
   N. gruezoi (Corpuz-Raros & Garcia, 1996)
D. Basifemora III–IV setal formula 3-0 sts; South Africa
   N. snowi (Baker & Hoffmann, 1948)
E. Basifemora III–IV setal formula 3-1 sts
   N. summersi (Smiley, 1992)
F. Basifemora III–IV setal formula 4-2 sts
   N. gruezoi (Corpuz-Raros & Garcia, 1996)

A. Setae l's and m's subequal; South Africa
   N. smileyi (Den Heyer, 1980)
B. Setae l's about half as long as m's; USA
   N. summersi (Smiley, 1992)
C. Basifemora II with 5 sts
   N. numida (Chaudhri, 1980)
D. Basifemora II with 6 sts
   N. numida (Chaudhri, 1980)
E. Basifemora III–IV with 5-2 sts
   N. shanghaiensis (Liang, 1980)
F. Basifemora III–IV with 6-2 sts
   N. kuznetzovi (Sergeyenko, 2005)
**Neoscirula** Den Heyer, 1977

**Historical review.** Den Heyer (1977a) erected *Neoscirula* for three African cunaxids, *N. theroni*, *N. natalensis*, and *N. sevidi*. Shiba (1978) described the first *Neoscirula* outside of Africa, *Coleoscirus ogawai*. Den Heyer (1978b) erected the subfamily *Coleoscirinae*, tribus *Neoscirulini* and assigned *Neoscirula* to it. Den Heyer (1980b) described another African *Neoscirula*, *N. delareyi*. *N. vitulus* was described from Ukraine by Barilo (1991). Smiley (1992) transferred *Neoscirula* from *Coleoscirinae* to *Bonziinae* as he thought setae g1 were geniculate; he also described *N. luxtoni*, *N. proctorae*, *N. kenworthyi*, moved *N. ogawai* from *Coleoscirus*, and provided a key to known world species. *N. abraensis*, *N. aspirasi*, *N. imperata*, *N. makilingica*, *N. puntiglupa* were described by Corpuz-Raros (1996e) from the Philippines. Lin and Zhang (1998) described *N. miaofengensis* and *N. bidens*. *N. saitoi* was described by Lin and Zhang (2002). Corpuz-Raros (2007) described two more Philippine *Neoscirula*: *N. laboensis*, *N. taclobanensis*. Mejía-Recamier and Palacios-Vargas (2007) described *N. aliciae*, *N. baloghi*, and *N. hoffmannae*. Den Heyer and Castro (2008c) described *N. flechtmanni*, *N. oliveirai*, and *N. queirozi*. Skvarla, Fisher, and Dowling (2011) described *N. reticulata*. Den Heyer (2011c) described *N. sepasgosariani*.

**Diagnosis.** Gnatohosoma. Pedipalps 5-segmented and end in a strong claw, which is complemented with a tooth in some species; they extend to the tip of the hypognathum or slightly beyond. Basifemur and telofemur are fused but retain the suture; each has a dorsolateral simple or spine-like seta. Pedipalp tibiotarsus short and cone-like. Subcapitulum with 4 pairs of setae (hg1–4). Seta hg1 longest and in some species bent at 90 degrees, though not geniculate as in *Bonziinae*. Adoral setae present or absent. Chelicera with setae present or absent.

**Idiosoma, dorsal.** Proterosomal shield weakly sclerotized and ill-defined, granulated or papillated; some species possess subcuticular reticulations.

**Idiosoma, ventral.** Coxae I–II separate or fused medially into a single sternal shield. Coxae III–IV contiguous on either side, restricted to area around trochantral bases. Dorsal cupules im present laterad to e1; ventral cupules ih present near h2, anal plates. Legs shorter than body. Tarsi never constricted apically so as to end in lobes. Apices of solenidia cylindrical, not swollen as in *Coleoscirus* and *Scutascirus*. Trichobothrium on leg tibia IV present. Ambulacral claws smooth and occur on either side of a 4-rayed empodium.

**Key to adult female Neoscirula.**

*Neoscirula hoffmannae* Mejía-Recamier & Palacios-Vargas, 2007 is excluded from the following key as it is only known from the male.

1. Coxae I–II fused to form a sternal shield .................................................. 2
   – Coxae I–II separated .................................................................. 6
2 (1) Cheliceral seta present .................................................................. 3
   – Cheliceral seta absent .................................................................... 5
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3 (2) Pedipalp basifemoral dorsal seta spine-like (Fig. 77a); Luzon Is., Philippines.......................... N. makilingica Corpuz-Raros, 1996
– Pedipalp basifemoral dorsal seta simple (Fig. 77b) ................................................. 4

4 (3) Proterosomal shield with polygonal subcuticular sculpturing present (Fig. 78a); posteromedial portion of sternal shield V-shaped, polygonal subcuticular sculpturing absent (Fig. 79a); 6 pairs of setae between coxae III–IV (excluding genital setae); Luzon Is., Philippines...................... N. aspirasi Corpuz-Raros, 1996
– Proterosomal shield with polygonal subcuticular sculpturing absent (Fig. 78b); posteromedial portion of sternal shield rounded, polygonal subcuticular sculpturing present (Fig. 79b); 4 pairs of setae between coxae III–IV (excluding genital setae); Malaysia; Philippines ..................... N. ogawai (Shiba, 1978)

5 (2) ....Chelicerae with dorsomedial reticulations present (Fig. 80a); genua II with 5 setae and 2 solenidia; genua IV with 5 setae and 1 solenidion; Interior Highlands, USA ..................................................... N. reticulata Skvarla, 2011
– Chelicerae dorsomedial reticulations absent (Fig. 80b); genua II with 4 setae and 2 solenidia; genua IV with 4 setae and 1 solenidion; Jalisco, Mexico...... ............................................. N. baloghi Mejía-Recamier & Palacios-Vargas, 2007

6 (1) Pedipalp genua hook-like apophysis present (Fig. 81a); South Africa..................
.......................................................... N. natalensis Den Heyer, 1977
– Pedipalp genua hook-like apophysis absent (Fig. 81b) .............................. 7

7 (6) Pedipalp tibiotarsal claw a tooth present, giving bifid appearance (Fig. 82a) .... 8
Figures 77–87. *Neoscirula* key illustrations

- **77a** Pedipalp basifemoral dorsal seta spine-like
- **77b** Pedipalp basifemoral dorsal seta simple
- **78a** Proterosomal shield with polygonal subcuticular sculpturing present
- **78b** Proterosomal shield with polygonal subcuticular sculpturing absent
- **79a** Sternal shield v-shaped posteriomedially, with polygonal subcuticular sculpturing absent
- **79b** Sternal shield rounded posteriomedially, with polygonal subcuticular sculpturing present
- **80a** Chelicera with dorsomedial reticulations present
- **80b** Chelicera with dorsomedial reticulations absent
- **81a** Pedipalp genua with hook-like apophysis present
- **81b** Pedipalp genua with hook-like apophysis absent
- **82a** Pedipalp tibiotarsal claw with tooth present
- **82b** Pedipalp tibiotarsal claw with tooth absent
- **83a** Pedipalp tibiotarsus with tubercle present
- **83b** Pedipalp tibiotarsus with tubercle absent
- **84a** Hypognathum with ventroapical shield-like process present
- **84b** Hypognathum with ventroapical shield-like process absent
- **85a** Chelicera tapering gradually
- **85b** Chelicera tapering suddenly
- **86a** Proterosomal shield with polygonal subcuticular sculpturing present
- **86b** Proterosomal shield with polygonal subcuticular sculpturing absent
- **87a** Subcapitulum with row of basal subcuticular sculpturing present
- **87b** Subcapitulum with row of basal subcuticular sculpturing absent.
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– Pedipalp tibiotarsal claw a tooth absent (Fig. 82b) ........................................ 13
8 (7) Cheliceral seta present; pedipalp tibiotarsal tubercle present (Fig. 83a) ........ 9
– Cheliceral seta absent; pedipalp tibiotarsal tubercle absent (Fig. 83b); São Paulo, Brazil .................................................. N. oliveirai Den Heyer & Castro, 2008
9 (8) Basifemora II with 4 setae; telofemora I–II 4-4 setae; hypognathum with ventroapical shield-like process present (Fig. 84a); New Zealand; Philippines .......................................................... N. luxtoni Smiley, 1992
– Basifemora II with 5 or 6 setae; telofemora I–II 5-5 setae; hypognathum with ventroapical shield-like process absent (Fig. 84b) ........................................ 10
10 (9) Basifemora II with 5 setae ................................................................. 11
– Basifemora II with 6 setae ................................................................. 12
11 (10) Basifemora I with 4 setae; telofemora III with 4 setae; 7 pairs of setae between coxae III–IV (excluding genital setae); Jalisco, Mexico .......................................................... N. aliciae Mejía-Recamier & Palacios-Vargas, 2007
– Basifemora I with 5 setae; telofemora III with 3 setae; 5 pairs of setae between coxae III–IV (excluding genital setae); Luzon Is., Philippines .......................................................... N. laboensis Corpuz-Raros, 2007
12 (10) Chelicerae tapering gradually (Fig. 85a); Fujian, China .......................................................... N. bidens Lin & Zhang, 1988
– Chelicerae tapering suddenly (Fig. 85b); São Paulo, Brazil .......................................................... N. flechtmanni Den Heyer & Castro, 2008
13 (7) Pedipalp basifemoral dorsal seta spine-like (Fig. 77a) ........................................ 14
– Pedipalp basifemoral dorsal seta simple (Fig. 77b) ........................................ 18
14 (13) Telofemora I–II with 4-4 setae; New Zealand.... N. proctorae Smiley, 1992
– Telofemora I–II with 5-5 setae .......................................................... 15
15 (14) Proterosomal shield with polygonal subcuticular sculpturing present (Fig. 86a); Fujian, China .......................................................... N. saitoi
– Proterosomal shield with polygonal subcuticular sculpturing absent (Fig. 86b) .......................................................... 16
16 (15) Cheliceral seta short, less than half the length of movable digit; South Africa .......................................................... N. sevidi Den Heyer, 1977
– Cheliceral seta long, nearly as long or longer than movable digit .......................... 17
17 (16) Basifemora I–IV setal formula 5-5-4-3; Iran .......................................................... N. sepasgosariani Den Heyer, 2011
– Basifemora I–IV setal formula 4-4-3-1; Brazil .......................................................... N. queirozi Den Heyer & Castro, 2008
18 (13) Coxae I–II with polygonal subcuticular sculpturing present (as in Fig. 79a) .... 19
– Coxae I–II with polygonal subcuticular sculpturing absent (as in Fig. 79b) .... 23
19 (18) Proterosomal shield with polygonal subcuticular sculpturing present (Fig. 78a) .......................................................... 20
– Proterosomal shield with polygonal subcuticular sculpturing absent (Fig. 78b) .......................................................... 21
20 (19) Basifemora II with 4 setae; telofemora I–II 4-4 setae; Maryland, USA .... .......................... N. kenworthyi Smiley, 1992
— Basifemora II with 5 setae; telofemora I–II with 5-5 setae; Leyte Is., Philippines..........................*N. taclobanensis* Corpuz-Raros, 2007

21 (19) Hypognathal setae *hg* 1 more than two times as long as setae *hg* 2-4; coxae II with 4 setae; Fujian, China ..................*N. miaofengensis* Lin & Zhang, 1988

— Hypognathal setae *hg* 1 no more than two times as long as setae *hg* 2-4; coxae II with 3 setae.................................................................22

22 (21) Chelicerae basally narrow, less than three times the width of the distal end; hypognathum narrow, nearly twice as long as wide; Uzbekistan...........................

..........................................................................................*N. vitulus* Barilo, 1991

— Chelicerae basally broad, four times the width of the distal end; hypognathum wide, nearly as wide as long; South Africa...........................

..........................................................................................*N. delareyi* Den Heyer, 1980

23 (18) Proterosomal shield with polygonal subcuticular sculpturing present.......24

— Proterosomal shield with polygonal subcuticular sculpturing absent; Luzon Is., Philippines..............................................*N. imperata* Corpuz-Raros, 1996

24 (23) Subcapitulum with row of basal polygonal subcuticular sculpturing present (Fig. 87a); ventrally with 7 pairs of simple setae between coxae III–IV ....25

— Subcapitulum with row of basal polygonal subcuticular sculpturing absent (Fig. 87b); ventrally with 6 pairs of simple setae between coxae III–IV; Luzon Is., Philippines..............................................*N. abraensis* Corpuz-Raros, 1996

25 (24) Basifemora II with 4 setae; telofemora I–II with 4-4 setae; Western Transvaal, South Africa..............................................*N. theroni* Den Heyer, 1977

— Basifemora II with 5 setae; telofemora I–II with 5-5 setae; Luzon Is., Philippines..............................................*N. puntiglupa* Corpuz-Raros, 1996

### Pseudobonzia Smiley, 1975

**Historical review.** Heryford (1965) described the first *Pseudobonzia*, *Cunaxa reticulata*. Smiley (1975) erected the genus *Pseudobonzia*, with *C. reticulata* as the type species. Den Heyer (1977c) redescribed the genus and described *P. neoreticulata*. Shiba (1978) described *Cunaxoides clathratus*. Smiley (1992) described *P. delfinadobakerae*, *P. landwehri*, and *P. yini* and moved *Cunaxoides clathratus* to *Pseudobonzia*; he also provided a key to known world species. Fuangarown and Lekprayoon (2004) described *P. tangkansingae*. Den Heyer and Castro (2008b) split *Coleobonzia* from *Pseudobonzia*. Bashir, Afzal, and Akbar (2008) described *P. ashfaqi*. Skvarla et al. (2013) reported *P. reticulata* from Arkansas and corrected the description to include setae *f* 2, which were not reported by Heryford (1965).

**Diagnosis.** *Gnathosoma*. Pedipalps 5-segmented and reach beyond the subcapitulum by at most the distal half of the last segment. Simple or spine-like setae on the basi- and telofemora present. Pedipalp tibiotarsi long and S-shaped (as opposed to short and cylindrical as in *Neoscirula*). Subcapitulum with 4 pairs of setae (*hg* 2-4). 2
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Pairs of adoral setae present. **Chelicera** with seta present (usually) or absent. Extensive reticulated pattern present on the gnathosoma.

**Idiosoma, dorsal.** Plates lightly sclerotized and not be well defined or demarcated. The proterosomal plate bears 2 pairs of setae \((lps \text{ and } mps)\) and 2 pairs of setose sensilla \((at \text{ and } pt)\). Extensive reticulated pattern present. Hysterosomal plate absent. Setae \(c_1-b_1\) present; setae \(c_2, f_2, \text{ and } b_2\) present or absent. Cupules \(im\) present laterad and caudally of \(e_1\). Integument striated.

**Idiosoma, ventral.** **Coxae** restricted to the trochantral bases. Coxae I–II fused. Coxae III–IV fused. All coxae lightly sclerotized and may be ill-defined. Coxae with extensive reticulated pattern. Coxae I–IV usually have setal formula 3-3-3-3. Genital plates each bear 3–4 setae; 2 pairs of genital papillae visible underneath the plates. 2 pairs of seta \((ps_{1-2})\) occur on the anal plates and 1 pair of setae \((pa)\) occurs on the integument near the anal plates. Cupules \(ih\) present ventrally near the anal plates. **Legs.** Basal leg podomeres with reticulated pattern present or absent. Tarsi never constricted apically so as to end in lobes. Apices of solenidia cylindrical, not swollen as in **Coleoscirus** and **Scutascirus**. Trichobothrium on leg tibia IV present. Ambulacral claws are rippled and occur on either side of a 4-rayed empodium.

**Key to adult female Pseudobonzia** (modified from Den Heyer and Castro 2008)

| Step | Description | Geographical Location |
|------|-------------|-----------------------|
| 1    | Pedipalp basifemora and telofemora with similar setae, either spine-like or simple (Fig. 88a, b); proterosomal shield conspicuously reticulated | South Africa |
| 2 1  | Pedipalp basifemora with simple seta, pedipalp telofemora with spine-like seta (Fig. 88c); proterosomal shield not conspicuously reticulated | Mexico |
| 2    | Pedipalp basifemora and telofemora with spine-like setae (Fig. 88b); setae \(f_2\) present | Guam |
| 3 2  | Setae \(f_2\) present | South Africa |
| 3    | Proximal leg podomeres reticulated | Malaysia |
| 4 3  | Proterosomal shield convex posteromedially (Fig. 89c); Pakistan | Pakistan |
| 5 3  | Proximal leg podomeres not reticulated | USA |
Scutascirus Den Heyer, 1976

Historical review. Den Heyer (1976) erected Scutascirus for *S. polyscutosus*. Shiba (1978) described *Cunaxa exasperatus*. Den Heyer (1980b) described *S. braziliensis*. Chaudhri (1980) described *S. pigrus*. Smiley (1992) transferred *C. exasperatus* to *Scutascirus*. Corpuz-Raros and Garcia (1996) described *S. contiguus* and *S. pentascutellus*. Lin, Zhang and Ji (2001) described *S. triangulum*.

Diagnosis. Gnathosoma. Pedipalps 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiotarsi. Basifemora and telofemora fused but retain a dark line. The tibiotarsi complemented with a tubercle and a dorsodistal solenidion. Pedipalps end in a stout claw. Chelicera with seta present or absent. Subcapitulum bears 6 pairs of setae: 2 pairs of adoral setae and 4 pairs of subcapitular setae (hg\_1–4). Setae hg\_4 often the longest.

Figures 88, 89. *Pseudobonzia* key illustrations 88a Pedipalp basifemur and telofemur with spine-like setae on both segments 88b Pedipalp basifemur and telofemur with simple setae on both segments 88c Pedipalp with simple seta on basifemur, spine-like seta on telofemur 89a Proterosomal plate convex posteriomedially 89b Proterosomal plate not convex posteriomedially.
**Idiosoma, dorsal.** Proterosoma covered in a shield which bears 4 pairs of setae: 2 pairs of simple setae \((lps \text{ and } mps)\) and 2 pairs of setose sensilla \((at \text{ and } pt)\). Dorsal hysterosoma bears a median plate which is fused with the proterosomal shield and four pairs of lateral platelets. Plates and shields covered with papillae that form reticulations. 8 pairs of setae present on the dorsal hysterosoma \((e_1-f_1, e_2 f_2, h_2)\); these setae occur on the fused dorsal shield. Cupule \(im\) present, usually laterad or in the proximity of \(e_i\). Unsclerotized integument striated.

**Idiosoma, ventral.** Coxae I–II fused and coalesce medially to form a single sternal plate. Each pair of coxae complemented with 3 pairs of setae; if they form an extensive sternal shield setae normally born on the unsclerotized integument may be located on the shield. Coxae III–IV fused and extend posteriorly beyond the genital plates. Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. 1–8 pairs of setae present on the integument between coxae III and the genital plates. Anal plates complemented with 2 pairs of setae \((ps_{1-2})\). Two pairs of setae \((h_2, pa)\) located on the integument near the anal plates. Cupule \(ih\) present in close proximity to \(h_2\). Legs shorter than idiosoma. Tarsi never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Ambulacrual claws on either side of a four-rayed empodium present.

### Key to adult female *Scutascirus*

*Scutascirus tactus* is not included in the following key as it is described only from the male.

| 1 | Tubercle on inner margin of pedipalp tibiotarsus not branched (Fig. 90a) | 2 |
|---|---------------------------------------------------------------|---|
| – | Tubercle on inner margin of pedipalp tibiotarsus bifurcate (Figs 90b,c) | 5 |
| – | Tubercle on inner margin of pedipalp tibiotarsus trifurcate (Fig. 90d); China | *S. triangulum* Lin, Zhang & Ji, 2001 |
| 2 (1) | Telofemora III-IV setal formula 4-3 | 5 |
| – | Telofemora III-IV setal formula 5-2; Philippines | *S. contiguus* Corpuz-Raros & Garcia, 1996 |
| 3 (2) | Genua II with 1 asl, 5 sts; dorsum with lateral scutella absent; Pakistan | *S. pigrus* Chaudhri, 1980 |
| – | Genua II with 2 asl, 1 bsl, 5 sts; dorsum with lateral scutella present; Malaysia | *S. exasperatus* (Shiba, 1978) |
| 4 (1) | Basifemora I–IV setal formula 4-6-4-2; Telofemora I–IV setal formula 5-5-4-3; 4 pairs of dorsolateral hysterosomal plates present (Fig 91a) | 5 |
| – | Basifemora I–IV setal formula 5-5-4-3; Telofemora I–IV setal formula 5-5-5-2; 5 pairs of dorsolateral hysterosomal plates present (Fig. 91b); Luzon Is., Philippines | *S. pentascutellus* Corpuz-Raros & Garcia, 1996 |
| 5 (4) | Pedipalp with entire tibiotarsus projecting past entomalae; bifurcate tubercle positioned halfway along the length of the tibiotarsus (Fig. 90b); Brazil | *S. braziliensis* Den Heyer, 1978 |
| – | Pedipalp with distal 2/3 of tibiotarsus projecting past entomalae; bifurcate tubercle positioned on distal third of tibiotarsus (Fig. 90c); South Africa | *S. polyscutosus* Den Heyer, 1976 |
Orangescirinae Bu & Li, 1987

Orangescirula Bu & Li, 1987

**Historical review.** Bu and Li (1987a) erected Orangescirinae and *Orangescirula* for a new species, *O. yongchuanensis*. Smiley (1992) described *O. kethleyi*. Corpuz-Raros (1996e) described *O. filipina*.

**Diagnosis.** *Gnathosoma.* Pedipalps 5 segmented and reach beyond the subcapitulum by at most the distal half of the tibiotarsi. Basifemoral seta simple or spine-like. Telofemoral seta spine-like. Pedipalps end in a stout claw. *Subcapitulum* bears 6 pairs of setae: 2 pairs of adoral setae and 4 pairs of subcapitular setae (*hg*1–4). Setae *hg*1 long and bent.

*Idiosoma,* dorsal. Proterosoma covered in a shield which bears 4 pairs of setae: 2 pairs of simple setae (*lps* and *mps*) and 2 pairs of setose sensilla (*at* and *pt*). Dorsal hysterosoma median plate present, fused to proterosomal shield; 1 to 5 pairs of dorsolateral plates present. Plates and shields smooth or reticulated. Seven pairs of setae present on the dorsal hysterosoma (*c*1–*f*1, *c*2, *h*2). Unsclerotized integument striated.

*Idiosoma,* ventral. *Coxae* I–II fused, coxae III–IV fused; coxae may coalesce medially for form a sternal shield. Each pair of coxae complemented with 3 pairs of setae. The genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. 4–9 pairs of setae present on the integument between coxae II and the genital plates. Anal plates complemented with 2 pairs of setae (*ps*1, *pa*). Two pairs of setae (*h*2, *pa*) located on the integument near the anal plates. Cupule *ih* present in close proximity to *h*2. *Legs* shorter than idiosoma; they are never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Ambulacral claws on either side of a four-rayed empodium present.

**Key to adult female Orangescirula** (in part modified from Smiley 1992)

1. Pedipalpal basifemora seta simple ................................................................. *O. filipina*
   – Pedipalpal basifemora seta spine-like……………………………………………………………2

2 (1). Dorsal shields with large subcuticular reticulations; 2 pairs of dorsolateral plates present ................................................................. *O. yongchuanensis*
   – Dorsal shield with extremely small subcuticular reticulations; 5 pairs of dorsolateral plates present…………………………………………………………… *O. kethleyi*

**New locality data**

**Scirula papillata**

*Scirula papillata* Lin, 1997: 169, Figs 1–6

**Remarks.** The specimens examined represent the first report of *Scirula papillata* from the Western Hemisphere. The specimens examined correspond to Lin’s (1997) descrip-
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Section except for telofemora I, which have 6 sts instead of 7 sts, and genua I, which have 9 setae (2 asl, 7 sts) instead of 8 setae.

Material examined (2 individuals on slides). 1 female adult (APGD 10-0424-008, #135719), ex deciduous leaf litter, USA, Arkansas, Washington Co, Devil’s Den State Park (35°46.817N, 94°14.750W), 24 April 2010, col. M. J. Skvarla. 1 female adult (APGD 10-0826-003, #135720), ex thick moss by creek near deciduous litter (maple, oak), USA, Pennsylvania, Somerset Co, Laurel Hill State Park, 1985’ elevation (40°00.963 N, 79°14.233 W), 26 August 2010, col. M. J. Skvarla.

Figures 90, 91. Scutascirus key illustrations. 90a (after Corpuz-Raros and Garcia 1996). Pedipalp with tubercle not branched 90b (after Den Heyer 1980b). Pedipalp tibiotarsus with bifurcate tubercle positioned halfway along the length of the segment 90c (after Den Heyer 1980b). Pedipalp tibiotarsus with bifurcate tubercle positioned on distal third of segment 90d (after Lin et al. 2001). Pedipalp tibiotarsus with trifurcate tubercle 90a (after Den Heyer 1980b). Four pairs of dorsolateral hysterosomal plates present 91b (after Corpuz-Raros and Garcia 1996). Five pairs of dorsolateral hysterosomal plates present.
**Armascirus ozarkensis**

*Armascirus ozarkensis* Skvarla & Dowling, 2012: 6, Figs 2–4.

**Remarks.** The specimens examined expand the range of this species within the Interior Highlands and are a new state record for Missouri.

**Material examined** (2 individuals on slides). 1 adult female (APGD 11-1129-002), ex litter, USA, Arkansas, Bradley/Drew Co, Warren Prairie Natural Area, 21 June 2010, col. L. C. Thompson • 1 adult female (APGD 10-0523-004), ex litter, USA, Missouri, Taney Co (36°41′11.98″N, 92°58′16.44″W), 23 May 2010, col. J. R. Fisher, D. M. Keeler.

**Armascirus primigenius**

*Armascirus primigenius* Skvarla & Dowling, 2012: 13, Figs 8–10.

**Remarks.** The specimens examined significantly expand the range of this species within the United States. The Ouachita specimens correspond to Skvarla and Dowling’s (2012) description except for genua IV, which have 1 asl, 5 sts instead of 1 asl, 4 sts.

**Material examined** (3 individuals on slides). 1 adult female (APGD 13-0304-041, #131238), ex. Malaise trap in marsh, USA, Fairfax Co, George Washington Memorial Parkway, Dyke Marsh Wildlife Preserve, 11 April 2009, col. E. M. Barrows • 2 adult females (APGD 12-0706-002, #135716), ex very dry oak.pine litter in small, rocky depression, USA, Arkansas, Polk Co, Ouachita National Forest, Black Fork Mountain Wilderness, Black Fork Trail (34°41.312′N, 94°18.691′W), 6 July 2012, col. M. J. Skvarla.

**Dactyloscirus dolichosetosus**

*Dactyloscirus dolichosetosus* Den Heyer, 1979: 96, figs 71–77; Sepasgosarian 1984: 141; Smiley 1992: 223, Figs 117A, B; Castro 2008: 91; Skvarla and Dowling 2012: 30.

**Remarks.** The specimens examined significantly expand the range of this species within the United States.

**Material examined** (3 individuals on slides). 2 adult females (APGD 12-1020-012, #135721), ex. deciduous litter (maple, sweet gum, poison ivy) in disturbed area, USA, Virginia, Fairfax Co, George Washington Memorial Parkway, Dyke Marsh Wildlife Preserve (38°46′25″N, 77°03′06″W), 22 October 2012, col. A. P. G. Dowling • 1 adult female (JRF 12-1028-010, #135722), ex. dry mixed litter with little tree cover in recently (~5 years) cut pine stand with shrubby oaks, USA, Arkansas, Montgomery Co, Ouachita National Forest (34°23′56″, 93°51′22″), 28 October 2010, col. J. R. Fisher, D. M. Keeler.
References

Alberti G (1980a) Zur Feinstruktur des Hodenepithels und der Spermien von Eusimonia mirabilis Roewer, 1934 (Solfugae, Arachnida). Zoologischer Anzeiger 204: 345–352.
Alberti G (1980b) Zur Feinstruktur der Spermein und Spermocytogenese der Milben (Acari). II. Actinotrichida. Zoologischer Jahrbücher, Anatomie 104: 144–203.
Alberti G (2000) Chelicerata. In: Jamieson BMG (Ed) Progress in male gamete ultrastructure and phylogeny. In: Adiyodi KG, Aditiodi RG (Eds) Reproductive biology of the invertebrates. Vol. 9. p.B. IBH Publishing, New Delhi, India /Wiley, Oxford, New York, United States, 311–388.
Alberti G, Ehrnsberger R (1977) Rasterelektronenmikroskopische untersuchungen zum spin nervein vermogen der Bdelliden und Cunaxiden (Acari, Prostigmata). Acarologia 19(1): 55–61.
Alberti G, Peretti AV (2002) Fine structure of male genital system and sperm in Solifugae does not support a sister-group relationship with Pseudoscorpiones (Arachnida). Journal of Arachnology 30: 268–274. doi: 10.1636/0161-8202(2002)030[0268:FSOMGS]2.0.CO;2
Aoki J (1965) Oribatiden (Acarina) Thailands. I. Nature and Life in Southeast Asia 4: 129–193.
Arbabi M, Singh J (2000) Studies on biological aspects of predacious mite Cunaxa setirostris on Tetranychus ludeni at laboratory conditions in Varanasi, India. Journal of Agriculture and Rural Development 2: 13–23.
Atyeo WT (1958) The genus Bonzia in the New World. Journal of the Kansas Entomological Society 19(1): 55–61.
Atyeo WT (1960) A revision of the mite family Bdellidae in North and Central America (Acari, Prostigmata). The University of Kansas Science Bulletin 40: 345–499.
Badieritakis EG, Fantinou AA, Emmanouel NG (2014) A qualitative and quantitative study of mites in similar alfalfa fields in Greece. Experimental and Applied Acarology 62: 195–214. doi: 10.1007/s10493-013-9729-z
Baker EW, Hoffmann A (1948) Acaros de la familia Cunaxidae. Anales de la Escuela Nacional de Ciencias Biologicas Mexico 5(3–4): 229–273.
Banks N (1894) New American Acarina. Transactions of the American Entomological Society, 21: 209–222.
Banks N (1914) New Acarina. Journal of Entomology and Zoology 6: 55–66.
Barilo AB (1991) Two new species Cunaxidae (Acariformes) from Central Asia. Zoologicheskii Zhurnal 70(9): 131–136.
Barnett AA, Thomas RH (2012) The delineation of the fourth walking leg segment is temporally linked to posterior segmentation in the mite Archegozetes longisetosus (Acari: Oribatida, Trhypochthoniidae). Evolution & Development 14(4): 383–392. doi: 10.1111/j.1525-142X.2012.00556.x
Barnett AA, Thomas RH (2013) Posterior Hox gene reduction in an arthropod: Ultrabithorax and Abdominal-B are expressed in a single segment in the mite Archegozetes longisetosus. EvoDevo 4: 23: 1–12. doi: 10.1186/2041-9139-4-23
Bashir MH, Azal M (2004a) New record of the genus Cunaxoides Baker and Hoffmann (Acari: Cunaxidae) from Pakistan. Pakistan Entomologist 26(2): 25–27.
Bashir MH, Afzal M (2004b) A new species of genus *Neocunaxoides* (Cunaxidae) from Punjab, Pakistan. Pakistan Entomologist 26(2): 29–32.

Bashir MH, Afzal M (2005) New cunaxid mites of the genus *Armascirus* from Punjab-Pakistan. Pakistan Journal of Agricultural Sciences 42(3–4): 117–121.

Bashir MH, Afzal M (2006a) Two new species of the genus *Dactyloscirus* (Acari: Cunaxidae) from Punjab Pakistan. Pakistan Journal of Zoology 38(4): 273–278.

Bashir MH, Afzal M (2006b) A new cunaxid mite of genus *Pulaeus* (Cunaxidae) from Punjab, Pakistan. Pakistan Journal of Zoology 39(1): 17–20.

Bashir MH, Afzal M (2009) Mite fauna of family Cunaxidae (Acari) form Punjab, Pakistan. VDM Verlag Dr. Müller Aktiengesellschaft & Co., Saarbrücken, Germany, 322 pp.

Bashir MH, Afzal M, Akbar S (2005) A new cunaxid mite of genus *Pulaeus* (Cunaxidae) from Punjab-Pakistan. Biologia (Pakistan) 51(2): 163–168.

Bashir MH, Afzal M, Akbar S (2008) A new species of genus *Pseudobonzia* Smiley (Prostigmata: Acari) from Punjab, Pakistan. Biologia (Pakistan) 54(1): 77–82.

Bashir MH, Afzal M, Ali S (2005) Description of a new cunaxid mite *Cunaxa reticulatus* (Acari) from Pakistan. Pakistan Entomologist 27(2): 57–60.

Bashir MH, Afzal M, Ashfaq M, Akbar S, Ali S (2010) Two new species of the genus *Cunaxa* (Acari: Cunaxidae) from District Nankana. Pakistan Journal of Zoology 42(3): 217–222.

Bashir MH, Afzal M, Ashfaq M, Raza ABM, Kamran M (2011) Record of one new species of the genus *Cunaxa* (Acari: Cunaxidae) from rice husk. Pakistan Journal of Zoology 43(1): 37–40.

Bashir MH, Afzal M, Baker A, Raza M (2007) Record of a new species *Cunaxoides sargodhaensis* from leaf debris. Pakistan Entomologist 29(1): 43–48.

Bashir MH, Afzal M, Akbar S (2006) Genus *Dactyloscirus* (Acari: Cunaxidae) from Pakistan. Biologia 52(1): 71–77.

Bashir MH, Afzal M, Khan BS (2006) A new species *Coleoscirus trudus* (Acari: Cunaxidae) from Pakistan. Pakistan Entomologist 28(2): 73–77.

Bashir MH, Afzal M, Khan B (2008) Genus *Armascirus* (Acari: Prostigmata: Cunaxidae) from Pakistan. Belgian journal of Zoology 138 (2):115–127.

Bei NX, Shi CM, Yin SG (2003) *Cunaxa mageei* Smiley, 1992 (Acari: Cunaxidae), a new record from China. Entomotaxonomia 25(1): 34.

Berlese A (1887) Acari Italiani Myriapoda et Scorpiones hucusque in Italia reperta. Redia 14: 78–105.

Berlese A (1888) Acari Austro-Americani quos collegit Aloysius Balzan. Bullettino della Società Entomologica Italiana 20: 171–222.

Berlese A (1894) Acari, Myriapoda et (Pseudo) Scorpiones hucusque in Italia Tratr. Salmin 71: 5.

Berlese A (1897) Gill Acari Agrarii. Revista patologia vegetale: 138–139.

Berlese A (1904) Acari Nuovi. Redia 2: 231–238.

Berlese A (1910) Acari Nuovi. Redia 6: 199–201, pls. 18–19.

Berlese A (1916) Centuria secunda di Acari nuovi. Redia 12(1): 125–177.

Bu G, Li L (1987a) A new cunaxid subfamily with a new genus and new species of *Cunaxidae* from Sichuan, China (Acari: *Acariformes*). Acta Zootaxonomica Sinica 12(2): 160–164.
Bu G, Li L (1987b) Two new species of *Pulaeus* from China (Acariformes: Cunaxidae). Journal of Southwest Agricultural University 9: 22–26.

Bu G, Li L (1987c) List of cunaxids found in Sichuan, China (Acariformes: Cunaxidae). Journal of Southwest Agricultural University 9: 384–387.

Bu G, Li L (1991) A new species of the genus *Pulaeus* from China (Acari: Cunaxidae). Acta Zootaxonomica Sinica 16(1): 70–73.

Callan SK, Majer JD, Edwards K, Moro D (2011) Documenting the terrestrial invertebrate fauna of Barrow Island, Western Australia. Australian Journal of Entomology 50: 323–343. doi: 10.1111/j.1440-6055.2011.00818.x

Castro TMMG (2008) Estudos taxonômicos e biológicos de Cunaxidae (Acari: Prostigmata) do Brasil. Thesis, Jaboticabal, São Paulo, Brazil, 99 pp.

Castro TMMG, Den Heyer J (2008) A new genus, with a new species, from Brazil (Acari: Prostigmata: Cunaxidae). Zootaxa 1771: 54–62.

Castro TMMG, Den Heyer J (2009) A revision of the genus *Pulaeus* Den Heyer, with descriptions of a new genus and four new Brazilian species (Acari: Prostigmata: Cunaxidae). Zootaxa 2141: 20–36.

Castro TMMG, Moraes GJ (2007) Mite diversity on plants on different families found in the Brazilian Atlantic Forest. Neotropical Entomology 36(5): 774–782. doi: 10.1590/S1519-566X2007000500020

Castro TMMG, Moraes GJ (2010) Life cycle and behaviour of the predaceous mite *Cunaxatricha tarsospinosa* (Acari: Prostigmata: Cunaxidae). Experimental and Applied Acarology 50: 133–139. doi: 10.1007/s10493-009-9303-x

Chaudhri WM (1977) Descriptions of the mites of the Family Cunaxidae (Acarina) from Pakistan. Pakistan Journal of Agricultural Science 14(2–3): 41–52.

Chaudhri WM (1980) Studies on the biosystematics and control of mites of field crops, vegetables and fruit plants in Pakistan, second annual report. University of Agriculture Faisalabad, 80.

Chaudhri WM, Akbar S, Rasool A (1979) Studies on the predatory leaf inhabiting mites of Pakistan. University of Agriculture Faisalabad Technical Bulletin 2, 234 pp.

Chinniah C, Mohanasundaram M (2001) New species of acarine fauna (Acarina: Mesostigmata) from Shevroy Range of Eastern Ghats of Tamil Nadu, India. Zoo’s Print Journal 16(7): 523–531. doi: 10.11609/JoTT.ZPJ.16.7.523-31

Coineau Y (1974) Éléments pour une monographie morphologique, écologique et biologique des Caeculidae (Acarines). Memoirs du Museum National d’Histoire Naturelle, Nouvelle Serie, Serie A, Zoologie 81, Muséum national d’Histoire naturelle, Paris, 299 pp.

Cooreman J (1954) Notes sur quelques Acariens de la faune cavernicole. Bulletin de l’Institut Royal des Sciences Naturelles de Belgique Entomologie 35(34): 1–40.

Corpuz-Raros LA (1995) Philippine predatory mites of the family Cunaxidae (Acari). 2. Genera *Armac cirrus* Den Heyer and *Dactyloscir us* Berlese. The Philippine Agriculturist 78(2): 159–173.

Corpuz-Raros LA (1996a) Philippine predatory mites of the family Cunaxidae (acari). 5. Genera *Neoscirula* Den Heyer, *Parabonzia* Smiley, and *Orangescirula* Bu & Li. The Philippine Agriculturist 79(1&2): 15–37.
Corpuz-Raros LA (1996b) Philippine predatory mites of the family Cunaxidae (Acari). Genus *Pulaeus* Den Heyer with records of two species from Central Kalimantan, Borneo and Java, Indonesia. Philippine Entomologist 10(2): 119–138.

Corpuz-Raros LA (1996c) Philippine predatory mites of the family Cunaxidae (Acari). 6. Genus *Neocunaxoides* Smiley with a new species record from Central Kalimantan, Borneo, Indonesia. Asia Life Sciences 5(2): 125–140.

Corpuz-Raros LA (1996d) Philippine predatory mites of the family Cunaxidae (Acari). Genus *Coleoscirus* Berlese. Asia Life Sciences 5(1): 1–25.

Corpuz-Raros LA (1996e) Philippine predatroy mites of the family Cunaxidae (Acari). 5. Genera *Neoscirula* Den Heyer, *Parabonzia* Smiley and *Orangescirula* Bu and Li. Philippine Agriculturist 79: 15–37.

Corpuz-Raros LA (2007) Additional species of Bonziinae and Cunaxoidinae and description of the male of *Coleoscirus horidula* (Tseng) (Coleoscirinae) from the Philippines (Cunaxidae, Acari). Asia Life Science 16(2): 153-173.

Corpuz-Raros LA (2008) Additional species of Cunaxidae and first report of the subfamily Neobonzinae (Cunaxidae, Acari) from the Philippines. Asia Life Sciences 17(1): 71–89.

Corpuz-Raros LA, Garcia RC (1995) Philippine predatory mites of the family Cunaxidae (Acari). 1. Genus Cunaxa Von Heyden. Philippine Entomologist 9(6): 605–624.

Corpuz-Raros LA, Garcia RC (1996) Philippine predatory mites of the family Cunaxidae (Acari). Genera *Pseudobonzia* Smiley and *Scutascirus* Den Heyer. Philippine Entomologist 10(1): 15–28.

Corpuz-Raros LA, Gruezo WS (2007) Two new species of predatory mites of the family Cunaxidae (Acari) from Java, Indonesia. Asia Life Sciences 16(2): 175–181.

Corpuz-Raros LA, Sabio GC, Velasco-Soriano M (1988) Mites associated with stored products, poultry houses and house dust in the Philippines. Philippine Entomologist 7(3): 311–321.

Dabert M, Witalinski W, Kazmierski A, Olszanowski Z, Dabert J (2010) Molecular phylogeny of acariform mites (Acari, Arachnida): strong conflict between phylogenetic signal and long-branch attraction artifacts. Molecular Phylogeny and Evolution 56: 222–241. doi: 10.1016/j.ympev.2009.12.020

da Silva RV, Narita JPZ, Vichitbandha P, Chandrapataya A, Konvipasruang P, Kongchuensin M, de Moraes GJ (2014) Prospection for predatory mites to control coconut pest mites in Thailand, with taxonomic descriptions of collected Mesostigmata (Acari). Journal of Natural History 48(11–12): 699–719. doi: 10.1080/00222933.2013.839842

Den Heyer J (1975) A new genus *Cunabdella* (Prostigmata: Acari) with a description of a new species from the Ethiopian Region. Acarologia 16(4): 664–670.

Den Heyer J (1976) *Scutascirus*, a new cunaxid genus (Prostigmata: Acari) from South Africa. *Wetenskaplike bydraes van die PU vir CHO*, Reeks B: Natuurwetenskappe 92: 1–10.

Den Heyer J (1977a) A new genus *Neoscirula* (Cunaxidae: Prostigmata : Acari) from the Ethiopian Region. Journal of the Entomological Society of South Africa 40(1): 73–86.

Den Heyer J (1977b) Bonziinae, a new subfamily of the Cunaxidae (Prostigmata: Acari). Acarologia 19(4): 601–618.

Den Heyer J (1977c) Six new species of *Pseudobonzia* Smiley, 1975 (Prostigmata: Acari) from the Ethiopian Region. Journal of the Entomological Society of South Africa 40(2): 171–194.
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

Den Heyer J (1978a) Four new species of *Armascirus* gen. nov. (Prostigmata: Acari) from the Ethiopian Region. Journal of the Entomological Society of South Africa 41(2): 217–239.

Den Heyer J (1978b) Coleoscirinae, a new cunaxid subfamily and two new South African species of *Coleosirus* Berlese, 1916 (Prostigmata: Acari). Acarologia 20(4): 522–541.

Den Heyer J (1978c) A new cunaxid subfamily and the neotype designation of *Cunaxoides croceus* (Koch, 1838) (Prostigmata: Acari). Acarologia 20(3): 338–193.

Den Heyer J (1979a) Notes on the cunaxid genus *Dactylolocus* (Actinedida: Acarida) with descriptions of two new species from the Ethiopian Region. Phytophylactica 11: 87–98.

Den Heyer J (1979b) *Pulaeus*, a new cunaxid genus (Prostigmata: Acari). Acarologia 21(1): 18–31.

Den Heyer J (1979c) *Scutopalus*, a new cunaxid genus from the Ethiopian Region (Prostigmata: Acari). Acarologia 21: 187–193.

Den Heyer J (1979d) *Rubroscirus*, a new cunaxid genus (Prostigmata: Acari) with three new species from the Ethiopian Region. Acarologia 20(1): 70–92.

Den Heyer J (1979e) Descriptions of seven African species of *Cunaxa* Von Heyden, 1826 (Actinedida: Acari) with remarks on the genus. Phytophylactica 11(1): 24–42.

Den Heyer J (1979f) Five new African species of *Cunaxa* (Actinedida: Acarida). Phytophylactica 11: 159–171.

Den Heyer J (1980a) Three new Afrotropical species of *Neocunaxoides* Smiley (Actinedida: Acarida). Phytophylactica 12: 129–146.

Den Heyer J (1980b) Six new species of the subfamily Coleoscirinae (Cunaxidae: Actinedida: Acarida). Phytophylactica 12: 105–128.

Den Heyer J (1980c) A new classification system for the family Cunaxidae (Actinedida: Acarida). Publications of the University of the North Series A 23: 1–12.

Den Heyer J (1981a) Systematics of the family Cunaxidae Thor, 1902 (Actinedida: Acarida). Publications of the University of the North, Series A 24: 1–19.

Den Heyer J (1981b) New Afrotropical species of *Cunaxoides* (Actinedida: Acarida). Phytophylactica 13: 63–85.

Den Heyer J (1981c) Three new Afrotropical species of the genus *Pulaeus* (Cunaxidae: Acarida). Phytophylactica 13: 87–99.

Den Heyer J (2006) *Riscus*, a new cunaxid genus from Thailand (Acari: Actinedida: Cunaxidae). Acarologia 46(3–4): 195–201.

Den Heyer J (2009) Order Prostigmata, family Cunaxidae. In: Van Harten A (Ed) Arthropod fauna of the UAE, Vol. 2, 17–25.

Den Heyer J (2011a) Some statistics on the taxonomy of the family Cunaxidae (Acari: Prostigmata). Zoosymposia 6: 34–38. doi: 10.1080/00222933.2011.559602

Den Heyer J (2011b) BdelloideaBase: Bdellid & Cunaxid Databases (version Sep 2011). In: Roskov Y, Kunze T, Paglinawan L, Orrell T, Nicolson D, Culham A, Bailly N, Kirk P, Bourgoin T, Baillargeon G, Hernandez F, De Wever A (Eds) Species 2000 & ITIS Catalogue of Life, 2013 Annual Checklist. DVD; Species 2000: Reading, UK. doi: 10.1080/01647954.2010.495953

Den Heyer J (2011c) The genus *Coleobonzia* declared synonymous with *Neobonzia* Smile, 1992 (Bdelloidea: Cunaxidae: Coleoscirinae). Zootaxa 2817: 59–62.

Den Heyer J (2013) BdelloideaBase: Bdellid & Cunaxid Databases (version Feb 2013). In: Roskov Y, Kunze T, Paglinawan L, Orrell T, Nicolson D, Culham A, Bailly N, Kirk...
Den Heyer J, Castro TMMG (2008a) A new Neotropical genus of the family Cunaxidae (Acari: Prostigmata: Bdelloidea). Zootaxa 1843: 35–46.

Den Heyer J, Castro TMMG (2008b) A new cunaxid genus with descriptions of two new species from Brazil (Acari: Prostigmata: Bdelloidea: Cunaxidae). Zootaxa 1731: 42–50.

Den Heyer J, Castro TMMG (2008c) Subfamilial affiliation of Neoscirula (Acari: Prostigmata: Cunaxidae) and descriptions of three new species of this genus from Brazil. Zootaxa 1731: 51–62.

Den Heyer J, Castro TMMG (2009) Four new cunaxoidine genera (Acari: Prostigmata: Cunaxidae) and the description of two new Neotropical species. Zootaxa 2140:1–15.

Den Heyer J, Castro TMMG (2012) New Neotropical cunaxinæ species (Acari: Prostigmata: Cunaxidae). Zootaxa 3265: 22–42.

Den Heyer J, Ryke PAJ (1970) The mite complex and associated insects on citrus trees at Zebediela Estates. Wetenskaplike bydraes van die P.U. vir C.H.O. Reeks B: Natuurwetenskappe 32: 1–23.

Den Heyer J, Sergeyenko AL (2009) Neotype designation for Cunaxa setirostris (Hermann, 1804) (Acari: Prostigmata: Cunaxidae). Zootaxa 2106: 61–68.

Den Heyer J, Ueckermann EA, Khanjani M (2011a) Iranian Cunaxidae (Acari: Prostigmata: Bdelloidea): Part 2. Subfamily Cunaxinæ. Journal of Natural History 45(27–28): 1667–1678.

Den Heyer J, Ueckermann EA, Khanjani M (2011b) Iranian Cunaxidae (Acari: Prostigmata: Bdelloidea). Part I. Subfamily Coleoscirinæ. International Journal of Acarology 27(2): 143–160.

Den Heyer J, Ueckermann EA, Khanjani M (2013) Iranian Cunaxidae (Acari: Prostigmata: Bdelloidea). Part III. Subfamily Cunaxoidinæ. Journal of Natural History 47(31–32): 2049–2070.

Dugès A (1834a) Recherches sur l’ordre des Acariens en Generale et la Famille des Trombidies en Particulier. Annales des Sciences Naturelles Zoologie et Biologie 2: 42.

Dugès A (1834b) Recherches Sur L’Ordre des Acariens III. Ann. Sci. nat. Sér. 2. 2(2): 2001.1–26.

Dunlop JA, Krüger J, Alberti G (2012) The sejugal furrow in camel spiders and acariform mites. Arachnologische Mitteilungen 43: 8–15. doi: 10.5431/aramit4303

El-Bishlawy SM, Rakha MA (1983) A new cunaxid mite Pulaeus zabrii sp. n. from rat burrows in Egypt (Actinedida: Cunaxidae). Acarologia 24:373–375.

Estebanes-Gonzales ML (1997) Acarofauna en nidos de aves silvestres en Mexico. Acta Zoológica Mexicana 71: 1–15.

Evans GO (1992) Principles of Acarology. CAB International, Cambridge, Massachusetts, USA, 563 pp.

Ewing HE (1909) New species of Acarina. Transactions of the American Entomological Society 35(51): 401–417.

Ewing HE (1913) New Acarina. Part I. General considerations and descriptions of new species from Minnesota, Wisconsin, and Michigan. Bulletin of the American Museum of Natural History 32(5): 93–121.
Ewing HE (1917) New Acarina. Part II. Descriptions of new species and varieties from Iowa, Missouri, Illinois, Indiana, and Ohio. Bulletin of the American Museum of Natural History 37(2): 149–172.

Ewing HE, Webster RL (1912) Mites associated with oyster-shell scale (Lepidosaphes ulmi Linne). Psyche 19: 121–134. doi: 10.1155/1912/73282

Fadamiro HY, Xiao Y, Nesbitt M, Childers CC (2009) Diversity and seasonal abundance of predacious mites in Alabama Satsuma citrus. Annals of the Entomological Society of America 102(4): 617–628. doi: 10.1603/008.102.0406

Fan QH (1992) Two new species of the genus Rubroscirus (Acari: Cunaxidae). In: Fujian Association for Science and Technology (Eds) First Academic Annual Meeting of Youth Proceedings. Fujian Sciences and Technology Press, Fuzhou, 723–726.

Fawzy MMH (2007) Two new species of cunaxid mites on cotton and castor plants from Egypt (Actinedida: Cunaxidae). Egyptian Journal of Agricultural Research 85(6): 2065–2071.

Ferla NJ (2001) Ecologia e controle de acaros (Acari) da seringueira (Hevea brasiliensis Mull. Arg.) no Estado de Mato Grosso. Thesis, ESALQ/USP, Piracicaba, Brazil, 141 pp.

Ferla NJ, Marchetti MM, Gonçalves D (2007) Ácaros predadores (Acari) associados à cultura do morango (Fragaria sp Rosaceae) e plantas próximas no Estado do Rio Grande do Sul. Biota Neotropica 7(2): 1–8. doi: 10.1590/S1676-06032007000200012

Ferla NJ, Moraes GJ (1998) Predaceous mites in apple orchards in Rio Grande do Sul. Anais da Sociedade Entomológica do Brasil 27(4): 649–654. doi: 10.1590/S0301-8059199800400019

Ferla NJ, Moraes GJ (2002) Ácaros predadores (Acari) em plantas nativas e cultivadas do Estado do Rio Grande do Sul, Brasil. Revista Brasileira de Zoologia 19(4): 1011–1031. doi: 10.1590/S0101-81752002000400006

Ferla NJ, Rocha MDS (2012) A new species of Rubroscirus from Brazil (Acari: Bdelloidea: Cunaxidae). Systematic & Applied Acarology 17(4): 435–440. doi: 10.11158/saa.17.4.12

Fisher JR, Dowling APG (2010) Modern methods and technology for doing classical taxonomy. Acarologia 50(3): 395–409. doi: 10.1051/acarologia/20101981

Fisher JR, Skvarla MJ, Bauchan GR, Ochoa R, Dowling APG (2011) Trachymolgus purpureus sp. n., an armored snout mite (Acari, Bdellidae) from the Ozark Highlands: morphology, development, and key to Trachymolgus Berlese. ZooKeys 125: 1–34. doi: 10.3897/zook- eys.125.1875

Garman P (1948) Mite species from apple trees in Connecticut. Connecticut Agricultural Experiment Station, New Haven, Bulletin 520, 27 pp.

Gerson U (1971) The mites associated with armored scale insects. Proceedings of the 3rd International Congress of Acarology, 653–654.

Gervais MP (1841) Note sur quelques species de l’ ordre des Acariens. Annales des Sciences Naturelles - Zoologie et Biologie Animale 15: 6.

Grandjean F (1939) Les segments post-larvaires de l’hysterosoma chez les Oribates (Acariens). Bulletin de la Societe Zoologique de France 64: 273–284.

Grandjean F (1947) Les Enarthronota (Acariens). Premiere Serie. Annales des Sciences Naturelles-Zoologie et Biologie Animale, Série II, 8:213–248.
Grandjean F (1970) Stases. Actinopiline. Rappel de ma classification des Acariens en 3 groupes majeurs. Terminologies en soma. Acarologia 11: 796–827.
Grout TG, Ueckermann EA (1999) Predatory mites (Acari) found under citrus trees in the Southern African Lowveld. International Journal of Acarology 25(3): 235–238. doi: 10.1080/01647959908684158
Gupta SK (1991) Studies on the predatory prostigmatid mites of Northeast with descriptions of new species and new records from India. Records of the Zoological Survey of India 88(1–4): 207–239.
Gupta SK (1992) Arachnida: Plant mites (Acari). In: Saha SK (Ed) State Fauna Series 3, Fauna of West Bengal, Part 3. Zoological Survey of India, Calcutta, India, 61–211.
Gupta SK, Chattopadhyay S (1978) Studies on Acari associated with bird nests in Bengal, India. International Journal of Acarology 2: 77–86.
Gupta SK (1981) Some soil prostigmatid mites (Acarina) from Bihar. Progress in Soil Biology and Ecology in India. USA Technical Series No. 37, 93–99.
Gupta SK, Ghosh SK (1980) Some prostigmatid mites (Acarina) from Andaman and Nicobar Islands. Records of the Zoological Survey of India 77: 189–213.
Gupta SK, Paul K (1985) Some mites associated with birds nests in West Bengal, with descriptions of eleven new species. Bulletin of the Zoological Survey of India 7(1): 1–23.
Halbert JN (1923) Notes on Acari, with descriptions of new species. Journal of the Linnean Society 35: 363–392.
Hermann JF (1804) III. Ciron (Scirus). Mem. Apterologique 60–62; pl. 3; fig. 12; pl. 6; fig. 12.
Hernandes FA, Feres RJF (2006) Review about mites (Acari) on rubber trees (Hevea spp., Euphorbiaceae) in Brazil. Biota Neotropica 6(1). http://www.biotaneotropica.org.br/v6n1/pt/abstract?article=bn00406012006
Heryford N (1965) A new species of Cunaxa (Acari: Cunaxidae). Journal of the Kansas Entomological Society 8: 310–314.
Hu SJ (1997) Cunaxid mites recorded in China. Journal of Ninbo Teachers College 15(1): 56–59.
Huges AM (1976) The mites of stored food and houses. Ministry of Agriculture, Fisheries, and Food, Technical Bulletin 9.
Inayatullah, Shahid M (1989) Two new predatory mites of genus Neocunaxoides Smiley (Acarina: Cunaxidae) from Pakistan. Pakistan Journal of Zoology 21(3): 221–228.
Inayatullah, Shahid M (1993) Three new predatory mites of the genus Pseudocunaxa Smiley (Acarina: Cunaxidae) from Pakistan. Pakistan Journal of Zoology 25(4): 315–320.
Inayatullah, Shahid M (1996) Three new predatory mites of the genus Dactyliscirus Berlese (Acarina: Cunaxidae) from Pakistan. Sarhad Journal of Agriculture 12(5): 547–557.
Javan S, Hosseini SE, Ostovan H, Farzaneh M, Shabani S (2012) Effects of soil solarization on population of Prostigmatic mites (Acari: Trombidiformes). Journal of Entomological Research 4(2): 117–129.
Jesionowska K (2010) A morphological study of the genus Penthalodes (Acari, Prostigmata, Eupodoidea, Penthalodidae) with description of a new species. Zootaxa 2672: 29–49.
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

Jubb GL Jr, Masteller EC, Lehman RD (1985) Survey of Arthropods in vineyards of Erie County, Pennsylvania: Acari. International Journal of Acarology 11(3): 201–207. doi: 10.1080/01647958508683415

Kalúz S (2009) Two new Palearctic mite species of the family Cunaxidae (Acar: Prostigmata). Zootaxa 2198: 27–40.

Kalúz S, Vrabec M (2013) Two new species of Armascirus (Acar: Prostigmata: Cunaxidae) from Slovakia. Zootaxa 3734(2): 141–155. doi: 10.11646/zootaxa.3734.2.3

Kaźmierski A (2008) Tydeidae Kramer, 1877 sensu Andre et Fain 2000 (Acar: Prostigmata). In: Bogdanowicz W, Chudzicka E, Pilipiuk I, Skibinska E (Eds) Fauna of Poland. Zoological Museum and Institute of the Polish Academy of Science (PAN), Warsaw, Poland, 3: 193–196 + 222.

Kethley JB (1990) Acarina: Prostigmata (Actinedida). In: Dindal DL (Ed) Soil Biology Guide. John Wiley and Sons, New York, 667–756.

Khaustov AA, Kuznetsov NN (1998) Four new species of the genus Cunaxa (Acariformes, Cunaxidae). Zoologicheskii Zhurnal 77(11): 1332–1341.

Klann AE, Bird T, Peretti AV, Gromov AV, Alberti G (2009) Ultrastructure of spermatozoa of solifuges (Arachnida, Solifugae): Possible characters for their phylogeny? Tissue and Cell 41: 91–103. doi: 10.1016/j.tice.2008.07.003

Koch CL (1836) Deutschlands Crustaceen, Myriapoden und Arachniden (D.C.M.A.), 1.22.

Koch CL (1838) Deutschlands Crustaceen, Myriapoden und Arachniden (D.C.M.A.), 20.21, 20.22, 20.23 and 20.24.

Koch CL (1841) Deutschlands Crustaceen, Myriapoden und Arachniden (D.C.M.A.), 37.23.

Kramer P (1881) Scirus. Arch. Natura. 81:17, t. 3; fig. 9.

Krantz GW, Walter DE (2009) A Manual of Acarology. Third Edition. Texas Tech University Press, Lubbock, Texas, 807 pp.

Kuznetsov NN, Livshitz IZ (1979) Predatory mites of the Nikita Botanical Gardens (Acariformes: Bdellidae, Cunaxidae Camarobiidae). Trudy Gosudarstvennogo Nikitskogo Botanicheskogo Sada 79: 51–105.

Kuznetsov NN, Sizova IY (1978) The predaceous mite fauna of cotton fields in Uzbekistan. Uzbekskii Biologicheskii Zhurnal 4: 59–64.

Lahiri S, Podder S, Saha GK, Gupta SK (2004) Diversity of phytophagous and predatory mites occurring on medical plants in Kolkata metropolis. Proceedings of the Zoological Society (Calcutta) 57(1): 47–52.

Latreille PA (1795) Observation sur la variete des organs de la boche des Tiques, et distribution methodique des Insectes de cette famille d’apres les characters establish sur la conformation de ces organs. Magasin encyclopedique, ou journal des Sciences, des letters et des Arts redige par Millin. Noel et Warens, Paris, vol. 4: 18.

Lehman RD (1982) Mites (Acar) of Pennsylvania conifers. Transactions of the American Entomological Society 108: 181–286.

Li LS, Xuan JY, Fan QH (1992) Taxonomic investigation of food mites in Sichuan Province. Journal of Southeast Agricultural University 14(1): 23–34.
Liang GW (1983) Notes on four species of mite (Acarina: Cunaxidae) in China. Natural Enemies of Insects 5(3): 104–107.
Liang GW (1984) A new species and a new record of the genus *Pseudobonzia* from China (Acarina: Cunaxidae). Acta Zootaxonomica Sinica 9(1): 49–51.
Liang GW (1985) New species and new records of cunaxid mites from China. Entomotaxonomia 7: 79–81.
Liang GW (1986) A new species and a new record of the genus *Dactyloscirus* from Shanghai, China (Acarina: Cunaxidae). Entomotaxonomia 8(1–2): 159–161.
Lin J (1997) A new species of the genus *Scirula* from Fujian, China (Acari: Cunaxidae). Systematic and Applied Acarology 2: 169–172.
Lin J (2001) New record and new combination of the genus *Denheyernaxoides* from Fujian, China (Acari: Cunaxidae). Wuyi Science Journal 17: 1–5.
Lin LZ, Zhang YZ (1998) Three new species of the Bonziinae from Fujian (Acari: Cunaxidae). Wuyi Science Journal 14: 24–30.
Lin LZ, Zhang YZ (2000) Bdelloidea, 9. In: Huang BK (Ed) Fauna of Insects in Fujian Province of China. Fujian Sciences and Technology Press, Fuzhou, 109–121.
Lin LZ, Zhang YZ (2002) Two new species of the Bonziinae from China (Acari: Cunaxidae). Systematic and Applied Acarology 6: 143–148.
Lin LZ, Zhang YZ (2010) Bdelloidea of China: a review of progress on systematics and biology, with a checklist of species. Zoosymposia, 4: 42–50. In: Zhang ZQ, Hong XY, Fan QH (Eds) Xin Jie-Liu Centenary: Progress in Chinese Acarology. Zoosymposia 4: 1–345.
Lin JZ, Zhang YZ, Ji J (2001) Three new species of Cunaxidae from Fujian, China. Systematic and Applied Acarology 6: 145–153.
Lin JZ, Zhang YZ, Ji J (2003) A new species of *Neocunaxoides* from Fujian, China (Acari: Cunaxidae). Systematic and Applied Acarology 8: 101–106.
Lindquist EE (1976) Transfer of the Tarsocheylidae to the Heterostigmata, and reassignment of the Tarsonemina and Heterostigmata to lower hierarchic status in the Prostigmata (Acari). Canadian Entomologist 108: 23–48. doi: 10.4039/Ent10823-1
Lindquist EE (1977) Homology of dorsal opisthosomal plates, setae, and cupules of heterostigmatic mites with those of other eleutherengone Prostigmata (Acari). Acarologia 19: 97–104.
Linnaeus C (1758) Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata. Impensis Direct, Laurentii Salvii, Holmiæ, [1-4], 1–824.
Lord FT (1949) The influence of spray programs on the fauna of apple orchards in Nova Scotia. III. Mites and their predators. The Canadian Entomologist 81: 202–214. doi: 10.4039/Ent81202-8
Luxton M (1982) Some new species of mites from New Zealand peat soils. New Zealand Journal of Zoology 9: 325–332. doi: 10.1080/03014223.1982.10423864
Mąkol J (2010) A redescription of *Balaustium murorum* (Hermann, 1804) (Acari: Prostigmata: Erythraeidae) with notes on related taxa. Annales Zoologici 60: 439–454. doi: 10.3161/000345410X535424
Mallikarjunappa S, Nageshchandra BK (1990) Observations on predatory mites in association with pecan leaf scorch mite on guava. Current Research - University of Agricultural Sciences (Bangalore) 19(2): 31–33.

Mariau D, Biggins P (2001) The fauna of oil palm and coconut: insect and mite pests and their natural enemies. CIRAD, Montpellier, France, 264 pp.

Mejia-Recamier BE, Palacios-Vargas JG (2007) Three new species of Neoscirula (Prostigmata: Cunaxidae) from a Tropical dry forest in Jalisco, Mexico. Zootaxa 1545: 17–31.

Meyer MKP, Ryke PAJ (1959) Cunaxoidea (Acarina: Prostigmata) occurring on plants in South Africa. Annual Magazine of Natural History 13(2): 369–384.

Michocka S (1982) Two new species of the family Cunaxidae (Acarina: Prostigmata) from Poland. Acarologia 23(4): 327–332.

Michocka S (1987) Mites (Acarina) of the Bdellidae and Cunaxidae families in Poland. Monografia Fauny Polski 14: 1–127.

Miller AE (1925) An introductory study of the Acarina, or mites, of Ohio. Bulletin of the Ohio Agricultural Experiment Station, Number 386, 85–172.

Milne DL (1977) Biological control of citrus thrips, Scirtothrips aurantii: what are the prospects? The Citrus and Subtropical Fruit Journal 528: 14–16.

Mohamed O, Mohamed O, Nabil HA (2014) Survey and biological studies on mite species and scale insects inhabiting mango trees at Sharkia Governorate, Egypt. Journal of Entomology 11(4): 210–217. doi: 10.3923/je.2014.210.217

Molnár JG (1997) The Acarina fauna of vineyards on the highlands, north of the Balaton Lake. Növényvédelem 33(2): 63–68.

Muhammad T, Chaudhri WM (1990) Descriptions of four new species of genus Pulaeus Den Heyer from Pakistan (Acarina: Cunaxidae). Pakistan Entomologist 12(1–2): 18–25.

Muhammad T, Chaudhri WM (1991a) Six new cunaxid mites of the genus Pulaeus Den Heyer (Acarina: Cunaxidae) from Pakistan. Pakistan Entomologist 13(1–2): 9–22.

Muhammad T, Chaudhri WM (1991b) Two new cunaxid mites of the genus Armaciscus (Acarina: Cunaxidae) from Pakistan. Pakistan Entomologist 13(1–2): 50–55.

Muhammad T, Chaudhri WM (1992a) Two new mite species of genus Coleoscirus Berlese (Acarina: Cunaxidae) from Pakistan. Pakistan Journal of Zoology 24(4): 309–311.

Muhammad T, Chaudhri WM (1992b) Genus Coleoscirus Berlese (Cunaxidae: Acarina) from Pakistan. Pakistan Entomologist 14(1–2): 97–103.

Muhammad T, Chaudhri WM (1993) Descriptions of two new species of the genus Rubroscirus Den Heyer (Cunaxidae: Acarina) from Pakistan. Pakistan Journal of Agricultural Sciences 30(1): 108–114.

Muhammad T, Chaudhri WM, Akbar S (1989) New species of genus Rubroscirus (Acarina: Cunaxidae) from Pakistan. Pakistan Entomologist 11(1–2): 1–4.

Muma MH (1960) Predatory mites of the family Cunaxidae associated with citrus in Florida. Annals of the Entomological Society of America 53(3): 321–326.

Muma MH (1965) Populations of common mites in Florida citrus groves. Florida Entomologist 48(1): 35–45. doi: 10.2307/3493522
Nesbitt HHJ (1946) Three new mites from Nova Scotian apple trees. Canadian Entomologist 78:15–22. doi: 10.4039/Ent7815-1

Nucifora A, Vacante V (1986) Some considerations on the role of mites in the biological control of the citrus ecosystem. In: Cavalloro R, Di Martino E (Eds) Integrated pest control in citrus-groves: Proceedings of the experts’ meeting, Acireale (Italy), March 1985. A. A. Balkema, Rotterdam, 369–372.

Oliver AJ, Daemon E (2003) Qualitative and quantitative assessment of mites (Acari) in domiciliat dust in rural dwellings in the “Zona da Mata” region, Minas Gerais, Brazil. Revista Brasileira de Zoologia 20(4): 675–679. doi: 10.1590/S0101-81752003000400020

Oudemans AC (1902) Classificatie der Acari. Tijdschrift voor Entomologie 45: 58–60.

Oudemans AC (1906) Notes on Acari. Tijdschrift voor Entomologie 237–270.

Oudemans AC (1922) Acarologische Aanteekeningen LXVIII (Acari van Sumatra). Entomologische Berichten 1 (Amsterdam): 108–111.

Oudemans AC (1927) Acari van het Eiland Heridia. Acarologische Aanteekeningen LXXXVIII. Entomologische Berichten (Amsterdam) 7(157): 257–268.

Penttinen R, Viiri H, Moser JC (2013) The mites (Acari) associated with bark beetles in the Koli National Park in Finland. Acarologia 53(1): 3–15. doi: 10.1051/acarologia/20132074

Pepato AR, Rocha CEF, Dunlop JA (2010) Phylogenetic position of the actinotrichid mites: sensitivity to homology assessment under total evidence. BMC Evolutionary Biology 10: 235. doi: 10.1186/1471-2148-10-235

Quilici S, Kreiter S, Ueckermann EA, Vincnot D (1997) Predatory mites (Acari) from various crops on Réunion Island. International Journal of Acarology 23(4): 283–291. doi: 10.1080/0167959708683578

Radford CD (1950) Systematic checklist of mite genera and type species. Union internationale des sciences biologiques. Série C. (Section d’entomologie) 1: 1–232.

Ramsey AH, Zaher MA, Albagoury ME (1972a) Mites associated with citrus in the Nile Delta (U.A.R.). Zeitschrift für Angewandte Entomologie 70: 183–186.

Ramsey AH, Zaher MA, Abou-Awad BA (1972b) Mites associated with deciduous fruit trees in U.A.R. Zeitschrift für Angewandte Entomologie 70: 179–183.

Rocha MDS, Skvarla MJ, Ferla NJ (2013) A new species of Scutopalus (Acari: Cunaxidae: Cunaxoidinae) from Rio Grande do Sul State, Brazil with a key to world species. Zootaxa 3734(1): 38–44. doi: 10.11646/zootaxa.3734.1.4

Sathiamma B (1995) Biological suppression of the white spider mite Oligonychus iselemae (Hirst) on coconut foliage. Entomon 20(3-4): 237–243.

Schruff G (1971) Haleupalus oliveri nov.spec., eine Dornpalpenmilbe an Reben (Vitis spec.) (Acari: Cunaxidae). Deutsche entomologische Zeitschrift 18: 377–382.

Sellnick M (1926) Eine parasitische milbe aus dem Balaton-See. Archivum Balatonicum II: 173–177.

Sepasgosarian H (1984) The world genera and species of the family Cunaxidae (Actinedida: Acarida). Zeitschrift für Angewandte Zoologie 71: 135–153.

Sergeyenka AL (2003) A new species of mites of the genus Cunaxa (Acarina: Prostigmata: Cunaxidae) from Crimea (Ukraine). Acarina 11(2): 225–229.
Sergeyenko AL (2005) A new species of the mite genus *Pseudobonzia* Smiley, 1975 (Acarina: Prostigmata: Cunaxidae) from Ukraine. Acarina 13(2): 159–163.

Sergeyenko AL (2006) New species and new record of mites of the genus *Rubroscirus* Den Heyer, 1979 (Acarina: Prostigmata: Cunaxidae) from Ukraine. Acarina 14(1): 103–107.

Sergeyenko AL (2009) New mites species of the genus *Cunaxa* (Acari: Prostigmata: Cunaxidae) from the Crimea, Ukraine. Zootaxa 2161: 1–19.

Sergeyenko AL (2011a) First record and redescriptions of a little known mite species *Denheyerernaxoides brevirostris* (Canestrini, 1886) (Acari: Prostigmata: Cunaxidae) from Ukraine. Systematic and Applied Acarology 16(1): 40–50. doi: 10.11158/saa.16.1.6

Sergeyenko AL (2011b) Mites of the genera *Pulaeus* and *Lupaeus* (Acari: Prostigmata: Cunaxidae) of Crimea, Ukraine. Zootaxa 2088: 54–68. Shakhsi Zare F, Arbabi M, Kmali H, Ghasemzadeh M (2012) Study on faunistic, distribution and host range of Tetranychoida (Arachnida: Acari) on fruit trees in Mashhad region, Iran. Journal of Entomological Research 4(3): 239–248.

Shiba M (1978) Taxonomic investigation on free-living Prostigmata from the Malay Peninsula. Nature and Life in South East Asia 7: 83–229.

Shiba M (1986) The mites of family Cunaxidae (Acarina: Prostigmata) in Japan II. Genera *Armascirus* Den Heyer and *Dactyloscirus* Berlese. Matsuyama Shinonome Tanki Daigaku kenkyû ronsô 17: 151–163.

Sionti PG, Papadoulis GT (2003) Cunaxid mites of Greece (Acari: Cunaxidae). International Journal of Acarology 29(4): 315–325. doi: 10.1080/01647950308684347

Skvarla MJ, Dowling APG (2012) Some New Armascirine Cunaxids (Acari: Prostigmata: Cunaxidae) from the Eastern United States. Zootaxa 3194: 1–34.

Skvarla MJ, Fisher JR, Dowling APG (2011) A new species of *Neosciurula* (Acari: Cunaxidae: Coleoscirinae) from the Ozark Highlands (USA), with notes on biogeography. Acarologia 51(3): 283–293. doi: 10.1051/acarologia/20112013

Skvarla MJ, Fisher JR, Dowling APG (2013) On some mites (Acari: Prostigmata) from the Interior Highlands: descriptions of the male, immature stages, and female reproductive system of *Pseudocheylus americanus* (Ewing, 1909) and some new state records for Arkansas. Zootaxa 3641(4): 401–419. doi: 10.11646/zootaxa.3641.4.7

Smiley R (1975) A generic revision of the mites of the family Cunaxidae (Acarina). Annals of the Entomological Society of America 68(2): 227–244.

Smiley RL (1992) The predatory mite family Cunaxidae (Acari) of the world with a new classification. Indira Publishing House, West Bloomington, Michigan, 356 pp.

Soliman ZR, Mahfood SA (1978) Phytophagous and predaceous mites of People’s Republic of Southern Yemen. Bulletin of the Zoological Society of Egypt 27: 78–84.

Swift SF (1996) Two new species of *Dactyloscirus* (Acari: Prostigmata: Cunaxidae) in the Hawaiian Islands. Anales del Instituto de Biologia Universidad Nacional Autonoma de Mexico, Series Zoologia 67(2): 225–237.

Swift SF, Goff ML (2001) Mite (Acari) communities associated with ‘Ôhi’a, Metrosideros polymorpha (Myrtaceae), at Hono O Nā Pali and Kui’a Natural Area Reserves on Kaua’I Island, Hawaiin Islands. Pacific Science 55(1): 23–40. doi: 10.1353/psc.2001.0008

Tagore A, Putatunda BN (2003) Mites associated with some ornamental plants at Hisar, Haryana. Pest Management and Economic Zoology 11(1): 37–44.
Taha HA, El-Naggar MEE, Abou-El-Ngaga MM, Soliman SM (1988) Effect of different prey species on the development and fecundity of the predaceous mite, *Neocunaxoides andrei* Baker and Hoff. (Acari: Cunaxidae). Agricultural Research Review 66(1): 129–135.

Thor S (1902) Zur Systematik der Acarinenfamilien Bdellidae Koch, 1842, Grube 1859, Eu- podidae Koch, 1842 und Cunaxidae Sig Thor, 1902. Verhandlungen der kaiserlich-königlichen zoologish-botanischen Gesellschaft in Wien, 159–165.

Thor S, Willmann C (1941) Eupodidae, Penthalodidae, Penthaeleidae, Rhagidiidae, Pachyg- nathidae, Cunaxidae. In: Thor S, Willmann C (Eds) Das Tierreich, Eine Zusammenstel- lung und Kennzeichung der rezenten Tierformen. Lieferung 71a. Walter De Gruyter and Co, Leipzig, 164–175.

Trägårdh I (1905) Acariden aus Ägypten und dem Sudan. Results of the Swedish Zoological Expedition to Egypt and the White Nile, 1901, Part II: 5–8.

Trägårdh I (1910) Acariden aus dem Sarekgebirge. Naturwissenschaftliche untersuchungen des Sarekgebirges in Schwedisch-Lappland 4: 1–207.

Trouessart E (1892) Considerations generales sur la classification des Acariens, suivies s’un essai de classification nouvelle. Revue des Sciences Naturelles de l’Ouest 2: 330–331.

Tseng YH (1980) Taxonomical study of the mite family Cunaxidae from Taiwan (Acarina: Tromoidiformes). Quarterly Journal of the Taiwan Museum 33 (3-4): 253–277.

Turk FA (1972) Biological notes on Acari recently recorded from British caves and mites with descriptions of three new species. Transactions of the Cave Research Group of Great Brit- ain 14(4): 187–194.

Vacante V, Nucifora A (1986) A first list of mites in citrus orchards in Italy. In: Cavalloro R, Di Martino E (Eds) Integrated pest control in citrus-groves: Proceedings of the experts’ meeting, Acireale (Italy), March 1985. A. A. Balkema, Rotterdam, 177–188.

van der Hammen (1963) The addition of segments during the postembryonic ontogenesis of the Actinotrichida (Acarida) and its importance for the recognition of the primary subdivi- sion of the body and the original segmentation. Acarologia 5: 443–454.

van der Hammen (1970) Tarsonemoides limbatus nov. spec., and the systematic position of the Tarsonemida (Acarida). Zoologische Verhandelingen, Leiden 108: 1–35.

van der Hammen L (1972) A revised classification of the mites (Arachnidea, Acarida) with diagnoses, a key, and notes on phylogeny. Zoologische Mededelingen 47: 273–292.

Vitzthum HG (1931) Familie 13: Cunaxidae. In: Kukenthal W, Krumbach T (Eds) Handbuch der Zoologie, band 3. Walter De Gruyter and Co, Leipzig, 140–146.

Von Heyden C (1826) Versuch einer systematischen Eintheilung der Acariden. “Isis” von Oken 18(6): 19.

Walter DE (1999) Cryptic inhabitants of a noxious weed: Mites (Arachnida: Acari) on Lantana camara L. invading forests in Queensland. Australian Journal of Entomology 38: 197–200. doi: 10.1046/j.1440-6055.1999.00101.x

Walter DE, Kaplan DT (1991) Observations on *Coleosculus simplex* (Acarina: Prostigmata), a predatory mite that colonizes greenhouse cultures of rootknot nematode (*Meloidogyne* spp.), and a review of feeding behavior in the Cunaxidae. Experimental and Applied Acarology 12: 47–59. doi: 10.1007/BF01204399
Walter DE (1999) Cryptic inhabitants of a noxious weed: Mites (Arachnida: Acari) on Lantana camara L. invading forests in Queensland. Australian Journal of Entomology 38: 197–200. doi: 10.1046/j.1440-6055.1999.00101.x
Walter DE, Proctor HC (1999) Mites: ecology, evolution, and behaviour. CABI Publishing, Wallingford, 322 pp.
Weigmann G (2001) The body segmentation of oribatid mites from a phylogenetic perspective. In: Halliday RB, Walter DE, Proctor HC, Norton RA, Colloff MJ (Eds) Acarology: Proceedings of the 10th International Congress. CSIRO Publishing, Melbourne, Australia, 43–49.
Willmann C (1939) Die Moorfauna des Glatzer Schneeberges. 3. Die milben des Schneebergmoore. Beiträge zur Biologie des Glatzer Schneeberges, Breslau, 5: 427–458.
Willmann C (1950) Milben aus Mineral quellen. Zoologischer Anzeiger 145(7–8): 188–190.
Womersley H (1933) On some Acarina from Australia and South Africa. Transactions of the Royal Society of South Australia, Trans. 57: 108–112.
Zacharda M (1978) Terrestrial prostigmatic mites from the Amateurs’ Cave, The Moravian Kars, Czechoslovakia. Věstník Československé společnosti zoologické 42(3): 215–240.
Zaher MA, El-Bishlawy SM (1986) In: Zaher MA (1986) Survey and ecological studies on phytophagous, predaceous and nonphytophagous mites (Nile Valley and Delta.) Faculty of Agriculture, Cairo University, 567 pp.
Zaher MA, Soliman ZR, El-Bishlawy SM (1975a) Feeding habits of the predaceous mite, Cunaxa capreolus [Acarina Cunaxidae]. Entomophaga 20(2): 209–212.
Zaher MA, Soliman ZR, El-Bishlawy SM (1975b) Studies on population dynamics of soil predaceous prostigmatid mites in Giza, Egypt. Zeitschrift für angewandte entomologie 79: 440–443.