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

Michael J. Skvarla¹, J. Ray Fisher¹, Ashley P. G. Dowling¹

Department of Entomology, 319 AGRI Building, University of Arkansas, Fayetteville, Arkansas, 72701, USA

Corresponding author: Michael J. Skvarla (mskvarla36@gmail.com)

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


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 neopecticatus 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).

A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

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 (Kuznetzov 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 bdeliformis is usually collected from treeholes but not nearby litter (Smiley 1992).
While cunaxids are often often found on plants 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 isleilemae* [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 Ehnsberger 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 Ehnsberger 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.
(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 anterio-dorsal half of the idiosoma as the propodosoma is inaccurate, while referring to posterio-dorsal idiosoma as the hysterosoma (opisthosoma + metapodosma) is more inclusive than necessary and should instead be denoted simply as the opisthosoma. 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 opisthosoma 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 (*Ar-chegozetes longisetosus* Aoki, 1965) and demonstrated the opisthosoma 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 Bdeelloidea 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 (atl/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 _Scirius_. 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 _Scirius_, synonymised _Scirius_ with _Bdella_ and erected _Cyta_ and _Cunaxa_. However, many authors, including Dugès (1834a), Kramer (1881, Banks (1894), and Berlese (1904, 1910), continued to describe new species in _Scirius_. Dugès (1834a) erected Bdellidae (Bdelloidea) for _Bdella_ and _Scirius_, 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...
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...


**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: \( hg_1-4 \) and 2 pairs of adoral setae. Seta \( hg_1 \) usually straight, but geniculate in Bonziinae and may be curved in Neoscirula; \( hg_4 \) 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 (\( c_1-h_1, c_2-f_2, c_2-h_2 \)); \( h_2 \) 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 (Scirulinae) 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).
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

Figure 7. Generalized schematic of cunaxid idiosomal morphology. 7a Dorsal. 7b Ventral.

platelets is striated. Cupule im present, usually laterad and slightly posterior to e₁. 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 ($ps_{2}$). Setae $ps_{2}$ 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

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

3 (2) Pedipalps extend beyond the subcapitulum by at most the distal half of the tibiae (Figs 5a, b) .............................................................. 4
   – Pedipalps extend beyond the subcapitulum by at least the distal half of the tibiae (Figs 6a,b) ...................................................................... Cunaxinae

4 (3) Trichobothrium on tibiae IV present; setae hg1 not geniculate; cheliceral seta usually present .............................................................. Coleoscirulinae
   – Trichobothrium on tibiae IV absent; setae hg1 geniculate; cheliceral seta absent .............................................................. Orangescirulinae

**Bonzinae Oudemans, 1927**

**Historical review.** Oudemans (1927) erected *Bonzia* within Cunaxidae for *B. halacaroidei*. 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 ($h_{g1-4}$) present in *Bonzia*; up to 6 pairs of subcapitular setae ($h_{g1-4}$ + 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 $c_{1-2}$, $f_2$ 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.

**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 tibiotalar claw present; 2 pedipalp tibiotalar spine-like tubercles present (Fig. 8b); genital plates with 4 pairs of setae; internal genital setae absent ............................................................ *Bonzia Oudemans, 1927*

1. Pedipalp tibiotalar claw absent; 2 pedipalp tibiotalar 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. Kuznetzov and Livshitz (1979) reported *Bonzi* 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 ($h_{g1-4}$) present. Setae $h_{g1}$ 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 .......................................................... \( B. \ sphagnicola \) 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 ........
     ........................................................................................................................................ \( B. \ yunkeri \) Smiley, 1992
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

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 $c_1$, $b_1$, $c_2$, $f_2$, 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. The ambulacral claws occur on either side of a 4-rayed empodium.

**Key to adult female Parabonzia**

1. 8–9 genital setae present ........................................................................................................... 2  
   – 7–6 genital setae present ........................................................................................................... 3
2 (1) Pedipalpal telofemoral seta unbranched (Fig. 12a); Philippines, Mindanao Is. .............................................. P. mindanensis Corpuz-Raros, 1996  
   – Pedipalpal telofemoral seta branched, with 4–5 tines (Fig. 12b); China: Hubei Province .............................................. P. zhangi Lin & Zhang, 2002
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...

gists had missed for 100 years) by *Eupalus* 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-

---

**Figures 12–14. Parabonzia** key illustrations. **12a** Unbranched pedipalp telofemoral seta **12b** Multi-branched pedipalp telofemoral seta **13** Lightly barbed pedipalp tibiotarsal sigmoid seta **14** Spur-like process on femora III.
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 ulcerosus*) which is complemented with two pairs of setae \((lps\) and \(mpsls\)) and two pairs of setose sensillae \((at\) 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; \(c_{2}, f_{2}\) 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 \(e_{1}\). 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 \((ps_{j})\); one pair of setae is present ventrally on the integument near the anal plates (either \(ps_{2}\) or \(pa_{1}\)). 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)

1 Pedipalpal tibiotarsi with 3 sts, 1 spls; New Zealand.................................................................\textbf{Paracunaxoides Smiley, 1992}

   – Pedipalpal tibiotarsi with 5 or 6 sts, 0 spls.................................\textbf{2}

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.................................\textbf{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.................................\textbf{9}

3 (2) Femora I and II divided; setae \(f_{2}\) absent; trichobothrium on tibiae IV present or absent ...........................................................................................................\textbf{4}

   – Femora I and II not divided; setae \(f_{2}\) present; trichobothrium on tibiae IV absent ...........................................................................................................\textbf{Denheyernaxoides Smiley, 1992}

4 (3) 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.......................................................................................\textbf{5}
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

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

5 (4) Trichobothrium on tibiae IV present; famulus present, on distal portion of tarsus I..............................

.................................................................................. *Cunaxoides*

– Trichobothrium on tibiae IV absent; famulus present or absent..............6

6 (5) Tibiae III with 1 bsl, 3–5 sts; tibiae IV with 2 or 4 sts .................7

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

.................................................................................. *Dunaxeus* Den Heyer & Castro, 2009

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

.................................................................................. *Funaxopsis* Den Heyer & Castro, 2009

– Tibiae III with 1 bsl, 5 sts; tibiae IV setal formula not as above ..........8

8 (7) Tibiae IV with 1 lsts, 4 sts; famulus present........... *Qunaxella* Den Heyer & Castro, 2009

– Tibiae IV with 4 sts; famulus absent.... *Bunaxella* Den Heyer & Castro, 2009

9 (2) Setae $f_1$ present; basifemora I–IV setal formula 4-6-3-1 or 4-6-3-2........10

– Setae $f_2$ absent; basifemora I–IV setal formula 3-5-2-0 (rarely with 3-5-2-1)....

.................................................................................. *Neocunaxoides* Smiley, 1975

10 (9) 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.............. *Pulaeus* Den Heyer, 1979

– 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.............. *Lupaeus* Castro & Den Heyer, 2009

**Bunaxella** Den Heyer & Castro, 2009


**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 ($h_{g1-4}$ and 2 pairs of adoral setae) present; setae $h_g$ 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 ($l_p$ and $m_p$) and 2 pairs of setose sensillae ($a_t$ and $p_t$). 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.

_Figures 15–17._ Cunaxoidinae key illustrations. Setae are removed from figures 16–17 for clarity.  

15a Idiosoma with poorly demarcated dorsal plates 15b Idiosoma with well demarcated dorsal plates  

16a Pedipalp tibiotarsus with subapical process and small teeth present 16b Pedipalp tibiotarsus with subapical process and small teeth absent  

17a Pedipalp tibiotarsus with a single pointed process 17b Pedipalp tibiotarsus with two pointed processes.
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

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 2 sts; dorsal setae plumeose, except for $h_2$ which may be plumeose or smooth .........................2

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

   – Setae $h_2$ smooth ...................................*B. zebedieleniensis* (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 redescribed and designated a neotype for *C. croceus*. Kuznetzov and Livshitz (1979) described *C. ulcerosus*, *C. longistriatus*, *C. fidas* and *C. desertus* and reported and figured *C. biscutum*, and *C. parvus* from Russia. Gupta and Ghosh (1980) described *C. nicobarenensis*. *C. kielczewskii* 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. paracroceus* from Greece. Bashir and Afzal (2004a) described *C. trisetosis*. Bashir et al. (2007) described *C. sargodhaensis* from Pakistan. Bashir and Afzal (2009) described *C. daskaensis*, *C. negans*, and *C. sialkotensis* 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 ($hg_{1-4}$ and 2 pairs of adoral setae) are present; setae $hg_4$ 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 $c_1$–$d_1$, $e_2$, and $h_2$ 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 ($g_1$–$g_4$); 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 (1) Hysterosomal median plate obvious, sclerotized (Figs 18a–d, 19a–c) ........3
– Hysterosomal median plate not be obvious or sclerotized, may only be suggested by cuticular pattern (Fig. 20) ................................................................. 8
3 (2) Hysterosomal median plate not complemented with setae; USA..................
.......................................................................... C. parvus (Ewing, 1917)
– Hysterosomal median plate complemented with setae .............................. 4
4 (3) Hysterosomal median plate and proterosomal shield separate (Figs 18a–c) ... 5
– Hysterosomal median plate and proterosomal shield fused (Figs 19a–d) .... 6
5 (4) Hysterosomal median plate complemented with $c_1$–$d_1$ (Fig. 18a): Canada, USA .................................................................................. C. biscutum (Nesbitt, 1946)
– Hysterosomal median plate complemented with $c_1$–$d_1$ (Fig. 18b): Russia ...
.................................................................................. C. fidus Kuznetzov & Livshitz, 1979
– Hysterosomal median plate complemented with $e_1$–$e_2$, $c_1$ (Fig. 18c): Russia ...
.................................................................................. C. longistriatus Kuznetzov & Livshitz (1979)
6 (4) Hysterosomal shield complemented with setae $e_1$, $d_1$, $e_2$ (Figs 19a, b) ....... 7
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

- Hysterosomal shield complemented with setae $c_1$ and $e_1$ (Figs 19c) .  
  ................................................................. C. decastroae Den Heyer, 2013

7 (6) Genua IV with 1 asl, 5 sts; striae between $sci$ and $c_1$ U-shaped (Fig. 19a); Greece ........................................ C. paracroceus Sionti & Papadoulis, 2013

- Genua IV with 2 asl, 5 sts; striae between $sci$ and $c_1$ 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 ................................................................. C. kieleczewskii Gupta & Ghosh, 1980

- 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

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 \( h_{g,1-4} \); setae \( h_{g,4} \) 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 $f_2$, $h_2$ present. Cupule $im$ present laterad and posterior of $e_r$. 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


**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 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 $e_r$. 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 $ih$ presents ventrally laterad 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


**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 ($hg_{1-4}$ and 2 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 ($lps$ and $mps$) and 2 pairs of setose sensillae ($at$ 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 $c_1–h_1$, $c_2$, 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 $ib$ 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
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...........................................\textit{F. visci} (Den Heyer, 1981)

\textit{–} 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...........................................\textit{F. passerinae} (Den Heyer, 1981)

\textit{–} Telofemora I–IV setal formula 4-4-3-1 sts; \(h_1\) finely setose .........................\textit{F. vaneedeni} (Den Heyer, 1981)

**Lupaeus** Castro & Den Heyer, 2009


**Diagnosis.** \textit{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). \textit{Subcapitulum} with 6 pairs of setae (\(h_{g_{1-4}}\) and 2 pairs of adoral setae); setae \(h_{g_4}\) often the longest. \textit{Chelicera} with seta present.

\textit{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 \(e_1\), \(h_1\), \(e_2\), \(f_2\), and \(h_2\) present. Cupule \(im\) present laterad and posterior of \(e_1\). 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 ($g_{1,4}$). 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 $c_i$; Philippines ............. L. lenis (Corpuz-Raros, 1996)
   – Setae $f_1$ the same length as $c_i$ ....................... L. lectus Castro & Den Heyer, 2009
   – Setae $f_1$ longer than $c_i$, 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 ................................................................. 
   \textit{L. lobidorsalis} Castro & Den Heyer, 2009
- Setae $e_1$ one-fourth longer than $c_1$; Italy, USA .................................................... 
   \textit{L. subterraneus} (Berlese, 1916)
7 (3) 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
8 (7) Tibia II with 1 s, 5 sts ...................................................................................... 9
- Tibia II with 2 s (1 asl, 1 bsl), 5 sts; Ukraine. \textit{L. valentinae} Sergeyenko, 2011
9 (8) Pedipalp tibiotarsus with 4 sts; Philippines ........................................................ 
   \textit{L. villacarlosae} (Corpuz-Raros, 1996)
- Pedipalp tibiotarsus with 5 sts ............................................................................. 10
10 (9) Tarsus I with 3 asl, 2 terminal solenidion, 1 fam, 20 or 21 sts; tarsus IV with 
   14 sts .................................................................................................................. L. iranensis Den Heyer, 2013
- Tarsus I with 3 asl, 1 dorsodistal solenidion, 1 terminal solenidion, 1 fam, 22 
   sts; tarsus IV with 16 sts ................................................................................ L. sativae Den Heyer, 2013
11 (7) Cheliceral seta not as long as width of cheliceral digit; China ........................
   \textit{L. platygnathus} (Bu & Li, 1991)
- Cheliceral seta longer than width of cheliceral digit; South Africa, Brazil ....
   \textit{L. clarae} (Den Heyer, 1979)

\textbf{Figures 24–27.} \textit{Lupaeus} illustrations. 24a Pedipalp tibiotarsus 24b Genital setae not in a row, $g_3$ out of 
line 25–27 \textit{Lupaeus} key illustrations. Setae and cupules removed from figures 25a, b to increase clarity 
25a \textit{L. longisetus}, dorsal 25b \textit{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**


**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 (*hg*1–4 and 2 pairs of adoral setae); setae *hg*4 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 *c*1–*h*1, *c*2, and *h*2 present. Setae *f*2 absent. Cupule *im* present laterad and posterior of *e*1. The 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 for 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; 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 *f*2. *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-

Figures 28–34. *Neocunaxoides* key illustrations. See key for explanations of figures.
scribed cunaxids, by the presence of a branched sci and 4 teeth on the lateral lips of the hypostome.

\textit{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 \textit{Scutopalus} as a valid and separate genus.

1. Coxae I–II fused medially to form sternal shield (Figs 28a–d) .................. 2
   – Coxae I–II not fused medially (may be connected anteromedially) (Figs 29a–d) ......................................................... 6

2. (1) ..... Posterior edge of coxae IV extending beyond anterior edge of genital plates (Figs 28a, b) ......................................................... 3
   – Posterior edge of coxae IV not extending beyond anterior edge of genital plates (Figs 28c, d) ......................................................... 5

3. (2) Small platelet anteriomedially of genital plates present (Fig. 28a) ............. 4
   – Small platelet anteriomedially of genital plates absent (Fig. 28b) .............. 3

4. (3) Solid or broken band of papillae on ventral subcapitulum present (Fig. 30a); subcapitulum longer, length: width 1.75:1 ........................................ 6
   – Solid or broken band of papillae on ventral subcapitulum absent (Fig. 30b); subcapitulum shorter, length: width 1.25:1 ........................................ 9

5. (2) Hysterosomal plate present, fused with proterosomal shield, and bearing $c_1$, $c_2$; small platelet anteriomedially of genital plates present (Fig. 28c) ........ 8
   – Hysterosomal plate absent; small platelet anteriomedially of genital plates absent (Fig. 28d) .......................... \textit{N. philippinensis} (Corpuz-Raros, 2007)

6. (1) Median platelet between coxae II present (Figs 29a–c) ............................... 7
   – Median platelet between coxae II absent (Fig. 29d) ............................... 13

7. (6) Basifemora V with 1 sts ........................................... \textit{N. biswasi} Gupta & Chattopadhyay, 1978
   – Basifemora V with 0 sts ................................................... 11

8. (7) Basifemora I with 2 sts.............. \textit{N. mahabaeus} Corpusz-Raros, 1996
   – Basifemora I with 3 sts........................................................... 8

9. (8) All setae on pedipalp of normal length, none extremely long ................. 10
   – 2 setae on pedipalp femurogenu extremely long, nearly as long as segment; 1 distal pedipalp tibiotarsal setalong, longer than segment (Fig. 31) ........ 6

10. (9) Basal subcapitular polygonal pattern elongate (Fig. 32a); foveolae on dorsal shield present (Fig. 33a) ........... \textit{N. ornatus} Corpusz-Raros & Gruèzo, 2007
   – Basal subcapitular polygonal pattern not elongate (Fig. 32b); foveolae on dorsal shield absent (Fig. 33b) ............... \textit{N. grandis} Corpusz-Raros, 1996
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

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 synomymous with Cunaxoides but refrained from sinking the genus as they had not examined the type material.

Diagnosis. Gnathosoma. Pedipalps 3-segmented. Femerogenu complimented 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 ($h_g_{1-4}$); setae $h_g_{2,4}$ subequal. Adoral setae absent.

Idiosoma, dorsal. Proterosoma complemented with 2 pairs of setae ($l_p$s and $m_p$s) and 2 pairs of setose sensillae ($a_t$ and $p_t$). A pair of oval shields formed by flat, bacillus-like striae present between the sensillae. Setae $c_1$, $h_1$, $c_2$, and $h_2$ present. Setae $f_2$ absent. Integument not covered in shields or plates is striated.

Idiosoma, ventral. Coxae sclerotized and well-defined. Coxae I–II thinly connectd. Coxae III–IV more broadly connected. 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. 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-

**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 (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, 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 $e_1 - h_1$, $e_2$, $f_2$, 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 $f_1$ 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.

$P. parapatzaurenensis$ (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.

$P. patzcuarenensis$ (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 tibiotalus 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 ................................................ 9
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 ........................................ 20
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 ............................................................................................. 12
- Genua II with 2 solenidia; Philippines ............................................................................. 17
10 (9) Basifemora I–IV setal formula 5-5-4-3; 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) Genua II with 0 solenidia; Pakistan ......................................................................... 12
- Genua II with 1 solenidion ............................................................................................. 12
- Genua II with 2 solenidia; Philippines ............................................................................. 12
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
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

13 (12) Basifemora II with 5 (rarely 4) sts; Ukraine. P. leonidi Sergeyenko, 2011
- Basifemora II with 6 sts .............................. 14
14 (13) Genua II with solenidia present ................................................................. 15
- Genua II with solenidia absent; Pakistan. P. akbari Bashir & Afzal, 2009
15 (14) Genua II with 1 asl, 5 sts; Ukraine. P. maslovi Sergeyenko, 2011
- Genua II with 1 bsl, 6 sts ........................................... 16
16(15) Genua III–IV setal formula 5 sts–5 sts; Pakistan ..........................................
- Genua III–IV setal formula 5 sts–6 sts; Pakistan ........................................
- Genua III–IV setal formula 1 bsl, 4 sts–2 bsl, 4 sts; Pakistan .................................
- P. osculum Muhammad & Chaudhri, 1990
- P. baurio Muhammad & Chaudhri, 1991
- P. verno Muhammad & Chaudhri, 1990
17 (9) Setae f₁ and h₁ approximately equal in length ............................................. 18
- Setae f₁ approximately half the length as h₁; China. P. musci Liang, 1985
18 (17) Coxa IV with 2 sts; basifemora IV with 2 sts; Brazil ...................................
- Coxa IV with 3 sts; basifemora IV with 1 sts; Pakistan ...........................................
- P. myrtaceus Castro & Den Heyer, 2009
- P. anjumi Bashir & Afzal, 2006
19 (9) Dorsal shield with punctuations (Fig. 37a); Brazil .......................................
- Dorsal shield with flat broken striae (Fig. 37b); USA ........................................
- P. quadrisolenidius Castro & Den Heyer, 2009
- P. whartoni (Baker & Hoffmann, 1948
20 (7) 4 pairs of setae on integument between coxal and genital plates ................
- 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 ...............................
- Coxae II with 2 sts; telofemora II with 4 sts; Philippines ....................................
- P. desitis Muhammad & Chaudhri, 1990
22 (20) Sensillum at approximately as long as see; setae f₁ approximately equal in
length to h₁ ......................................................... P. cebuensis Corpusz-Raros, 2007
- Sensillum at longer than see; setae f₁ approximately 1.25 the length of h₁ ......
- P. franciscæ 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 .........................
- 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) .............................
- 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


**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 ($h_{g_1-d}$ and 2 pairs of adoral setae).

**Idiosoma, dorsal.** Proterosoma 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*). Dor- sal hysterosoma lacks a plate. Setae $c_1-h_1, c_2,$ and $b_2$ present. Setae $c_1-f_1$ finely setose and $c_2, b_1,$ and $h_1$ smooth. Setae $f_2$ absent. Integument not covered in shields or plates striated.

**Idiosoma, ventral.** **Coxae** weakly scleritized 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.
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses

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


**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. Subterminal pointed process on pedipalp tibiotarsal claw absent; small teeth on pedipalp tibiotarsal claw absent. **Subcapitulum** with 6 pairs of setae (*hg1–4* and 2 pairs of adoral setae). **Chelicera** without setae.

**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–h1, e2*, and *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 (*g1–4*); 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 5-5-4-3. 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 |
3 (2) Sternal shield bearing 6 pairs of setae; setae c₁ and mps simple; coxae II with 2 setae; basifemora I–IV setal formula 3-3-2-0; Greece .......................................................... S. abiesae Sioni & Papadoulis, 2003

3 (2) Sternal shield bearing 5 pairs of setae; setae c₁ and mps setose; coxae II with 1 setae; basifemora I–IV setal formula 2-2-2-1; South Africa .......................................................... S. arboresus 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)

5 (4) Coxae II with 2 sts.................................................. 5

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

6 (4) Setae f₁ and h₁ on small platelets; ratio c₁:c₂ 2:1; genua I with 4 asl, 5 sts; genua II with 2 asl, 5 sts; South Africa .......................................................... S. latisetosus Den Heyer, 1979

6 (4) Setae f₁ and h₁ on integument; ratio c₁:c₂ 1:1; genua I with 3 asl, 5 sts; genua II with 1 asl, 5 sts; Greece .......................................................... S. smolikensis Sioni & Papadoulis, 2003

7 (1) Dorsal shield smooth and/or punctate (Fig. 42a) .......................................................... 8

7 (1) Dorsal shield sparse granulate, rugose, or reticulate (Fig. 42b–d) .......................................................... 12

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

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

9 (8) Setae mps, c₁, c₂, d₁, e₁, f₁ clavate (Fig. 43); a small subscutum situated posterior to the dorsal shield present; Malaysia .......................................................... S. clavatus (Shiba, 1978)

9 (8) Setae mps, c₁, c₂, d₁, e₁, f₁ setiform; a small subscutum situated posterior to the dorsal shield absent .......................................................... S. osseus (Tseng, 1980)

10 (9) Setae f₁ on dorsal shield; setae lps, mps, c₁, c₂, d₁, e₁, f₁ set on tubercles (Fig. 44); area between pt more heavily sclerotized, forming ridges; Taiwan .......................................................... S. trepidus (Kuznetzov & Livshitz, 1979)

10 (9) Setae f₁ on integument; setae lps, mps, c₁, c₂, d₁, e₁, f₁ set normally; area between pt normally sclerotized, not forming ridges; Ukraine .......................................................... S. makapalus (Corpusz-Raros, 1996)

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 (Corpusz-Raros, 1996)

11 (8) 3 pairs of hysterosomal setae around genital shield; long slender platelet laterad genital shield absent; dorsal sclerites absent; Philippines .......................................................... S. makapalus (Corpusz-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)

12 (7) 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 .......................................................... S. unguianalis (Tseng, 1980)
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, $e_1$, $c_2$, $d_1$, $e_1$, $f_1$ clavate 45b Setae mps, $e_1$, $c_2$, $d_1$, $e_1$, $f_1$ setiform 46 Setae lps, mps, $e_1$, $c_2$, $d_1$, $e_1$, $f_1$ 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.


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 (h,g,1-4).

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, c,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-

**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 *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 *hg*$_{1-4}$ always present, 2 pairs of adoral setae present or absent. Setae *hg*$_4$ longest. In species with pedipalpal apophyses, the apophyses of the males shorter.

*Idiosoma, dorsal.* Female proterosoma 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*$_2$.
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.** Coxa 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. Coxa each complemented 0–3 setae. Genital plates each bear 4 setae (g); 2 pairs of genital papillae visible underneath the plates. Anal plates complemented with at least one pair of setae, ps. Setae ps present or absent, either on the anal plates or on the integument adjacent to the anal plates. Setae h present ventrally on the integument adjacent to the anal plates. Cupule ih present laterad of h. 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)

1. Anal seta ps absent; pedipalp 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. Anal seta ps present; pedipalp telofemora with dorsal spine-like seta (Figs 46f,g); tarsal lobes medium to large size (Fig. 47b); dorsal plates always reticulated (Fig. 48c) Armascirini

   6. (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. Dorsal plates usually reticulated (Fig. 48c); integumental striae usually papil-lated; coxae II–IV setal formula usually 1-3-1 Rubroscirus Den Heyer, 1979

   4. Pedipalpal telofemora with one or more apophyses (Fig. 46a); sensillae at and pt not densely pilose

   5. Pedipalpal telofemora without apophyses (Figs 46b–e); sensillae at and pt densely pilose

   2. Tibiae IV trichobothrium present


   4. Articulation joint between pedipalpal telofemora and genua functional (Fig. 46b) Riscus Den Heyer, 2006

   6. Articulation joint between pedipalpal telofemora and genua fused/non-functional (Fig. 46c) Allocunaxa Den Heyer & Castro, 2008

   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

   4. 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 (*h*$_{1-4}$ 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*$_{1-8}$, present. Cupule *im* present, usually posteriolaterad 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*. Zaher et al. (1975b) collected *C. taurus* in Egypt. Chaudhri (1977) described *Dactyloscirus ebrius* and *D. fuscus* from Pakistan. 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; 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 *D. 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.

**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 (*hg*<sub>1–4</sub> 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, *c*<sub>1–2</sub>, *d*<sub>1–h</sub>, 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 *e*.<sub>1</sub>. Dorsal idiosoma of males is similar except a single large plate complemented with *c*<sub>1–2</sub>, *d*<sub>1–e</sub>, 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 (*ps*<sub>1</sub>). 2 pairs of setae (*ps*<sub>2</sub> and *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 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 ¾ 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 possesses 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
2. (1) Median shield complemented with setae, small or large (Figs 49a–h)........................................ 3
3. (2) One pair of setae (d') on hysterosomal median shield (Figs 49a–f) ........................................ 4
4. (3) Lateral hysterosomal platelets present (Figs 49a–d) ........................................................................ 5
5. (4) Setae c₁ very short, the distance between the bases of c₁–c₂ 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)
6. (5). The distance between caudal parts of hysterosomal lateral platelets wider than the distance between their frontal parts (Figs 49a,b) ......................................................... 7
7. (6) . The distance between caudal parts of hysterosomal lateral platelets shorter than the distance between their frontal parts (Figs 49c,d) ......................................................... 9
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. akhtiari Bashir, Afzal & Khan, 2008*
9. (6) Venter caudally from coxae II with 4 pairs of simple setae (excluding genital, coxal, and anal setae); Brazil. .................................................................................. *A. bahiaensis Den Heyer & Castro, 2012*
- Venter caudally from coxae II with 6 pairs of simple setae (excluding genital, coxal, and anal setae) ........................................................................................................ 10
Michael J. Skvarla et al. / ZooKeys 418: 1–104 (2014)

– 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 .................. *A. albiziae* Den Heyer, 1978

10 (9) 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

11 (10) Leg genua I with 4 bsl, 4sts; genital valve with random dot-like lobes; tarsal sts chaetotaxy I–IV 29-25-23-22; Pakistan .......... *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 ..................

.................................................................................. *A. mactator* Muhammad & Chaudhri, 1991

12 (10) Pedipalpal telofemora with 1 apophysis, 2 spls; pedipalpal genua with 1 ap, 2 spls, 2 sts; South Africa ...................... *A. buyssteeni* Den Heyer, 1978
– Pedipalpal telofemora with 1 apophysis, 1 spls; pedipalpal genua with 1 ap, 3 spls, 1 sts .................................................................

13 (12) Genua II with 1 asl, 5 sts; genua IV with 2 asl, 5 sts; cosmopolitan ........
– Genua II with 1 asl, 6 sts; genua IV with 1 asl, 4 or 5 sts; USA ................
........................................................................ *A. Taurus* (Kramer, 1881)

– Genua II with 1 asl, 6 sts; genua IV with 1 asl, 4 or 5 sts; USA ................
........................................................................ *A. primigenius* Skvarla & Dowling, 2012

14 (9) Median shield pointed caudally (Fig. 49c); Pakistan ..................
– Median shield truncated caudally (Fig. 49d); Brazil ............................... *A. asghari* Bashir & Afzal, 2005

15 (4) 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

16 (15) 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; \( b_2 \) 4 times the length of \( c_1 \); hysterosomal shield width: length = 2.2:1; Pakistan ........

.................................................................................. *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; \( b_2 \) 3 times the length of \( c_1 \); hysterosomal shield width: length 1.5:1; Pakistan ........

........................................................................ *A. gojraensis* Bashir, Afzal & Khan, 2008

17 (15) Apophysis adjoining genu and tibiotarsus shorter than pedipalpal tibiotarsus; pedipalpal telofemoral apophyses three times longer than spine-like seta; distance between the bases of sci–sci 9 times the length of sci; Brazil, Mexico ....

.................................................................................. *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 sci–sci 5 times the length of sci; Pakistan ........

........................................................................ *A. fixus* (Chaudhri, 1980)
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 $c_1$..............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 $c_1$..............A. heryfordi Smiley, 1992

20 (18)  Apophysis adjacent to pedipalpal genua and tibiotarsi present .............A. multioculus Shiba, 1986

–  Apophysis adjacent to pedipalpal genua and tibiotarsi absent..................21

21 (20)  5 pairs of genital setae; pedipalp claw bifid (Fig. 52a); hysterosomal setae not serrate; Philippines..................A. apoensis Corpuz-Raros, 2008

–  4 pairs of genital setae; pedipalp claw entire, not bifid (Fig. 52b); hysterosomal setae serrate; Pakistan..................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 caudally from coxae II with 7 sts; pedipalp telofemur with 1 apophysis..............................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..............................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 . A. gimplei ..........................28

26 (25)  Hysterosomal plate concave on lateral edges (Fig. 53a); USA..................A. ozarkensis Skvarla & Dowling, 2012

–  Hysterosomal plate not concave on lateral edges (Fig. 53b); Japan..................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 $h_1$; Philippines..........................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 \( c_1-c_2 \), two times the distance of \( d_1-d_2 \); South Africa........... *A. limpopoensis* Den Heyer, 1978
– Pedipalp telofemora with 1 ap, 1 spls; the distances between the bases of \( c_1-c_2 \) = \( d_1-d_2 \),........................................................................................................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 \( d_1-d_2 \), 9 times the length of \( d_1 \); pedipalpal genua with 2 spls, 1 sts; Slovakia ..
........................................................................................................................................A. cyaneus Kalúz, 2009
– Pedipalpal telofemora with 1 apophysis, 2 spls; the distance between \( d_1-d_2 \), 4 times the length of \( d_1 \); 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 ...................................................... *A. taurus* (Kramer, 1881)

2 (1) Setal formula of basifemora I–IV 5-5-4-1; Pakistan ..............................................

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

4 (3) Setal formula of basifemora I–IV 5-4-3-0; papillae on circular region anterior to setae *pt* present or absent ..............................................................

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

**Cunaxa** Von Heyden, 1826

**Historical review.** Hermann (1804) erected *Scirus* for *S. setirostris* and placed it with two mites that are now considered to belong to the family Bdellidae. Von Heyden (1826) erected *Cunaxa* for *Scirus setirostris*. Dugés (1834a) described *S. elaphus*. Dugés (1834b) described *S. tenuirostris*. Koch (1836) described *S. capreolus*. Berlese (1888) synonymized *S. elaphus*, *S. tenuirostris*, *S. sagax*, and *S. paludicola* with *S. setirostris*. Thor (1902) erected Cunaxidae and split *Cunaxa* from Bdellidae. Ewing (1913) described *S. laricis*. *S. setirostris var. gazella* was described by Berlese (1916). Thor and Willmann (1941) redescribed and figured *S. laricis* after transferring it to *Cunaxa*; they also transferred *S. setirostris* var. *gazella* to *Cunaxa*, though kept it as a subspecies of *C. setirostris* and synonymized *S. tenuirostris* and *S. obisium* with *C. setirostris*. Baker and Hoffmann (1948) redescribed and figured *C. setirostris* var. *gazella* and *C. capreolus* and described *C. womersleyi* and *C. veracruzena*. Zaher et al. (1975b) reported *C. setirostris* and *C. capreolus* from Egypt. Den Heyer (1978a) erected Cunaxinae and assigned *Cunaxa* to the subfamily. Den Heyer (1979e) elevated *C. setirostris* var. *gazella* to full species status, viz. *C. gazella*; described *C. carina*, *C. terrula*, *C. lamberi*, *C. meiringi*, and *C. grobleri* and redescribed and figured *C. capreola* and *C. gazella*. He then (Den Heyer 1979f) described five more species from South Africa: *C. hermanni*, *C. sordwanaensis*, *C. potchensis*, *C. brevicrura*, and *C. magoebaensis*. Kuznetzov and Livshitz (1979) redescribed and figured *C. capreolus* and *C. setirostris* from Russia. Chaudhri (1980) described *C. doxa*. Tseng (1980) reported *C. womersleyi* and *C. setirostris* from Taiwan. Gupta and Ghosh (1980) described *C. myabunderensis*. Gupta and Paul (1985) described *C. prinia*. Bu and Li (1987c) reported *C. capreola* from China.

**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 (*hg*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 *Armacrus* and *Dactyloscus*) absent. Setae *c1–h3*, and *c3* 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 *e1*. 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 pair of setae (*h2*) associated with, but do not occur on, the anal plates. Cupule *ib* present in close proximity to *h2*. 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 *Armacrus* and *Dactyloscus*. 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. *plurisetosa* 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.

<table>
<thead>
<tr>
<th>1</th>
<th>Setae <em>lps</em> present (Figs 54a–d)</th>
<th>...............................................................</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Setae <em>lps</em> absent (Fig. 54e)</td>
<td><em>C. anomala</em> Khaustov &amp; Kuznetzov, 1998</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Basifemora I with 1 sts</td>
<td>........................................................................</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Basifemora I with 2 sts</td>
<td>........................................................................</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Basifemora I with 3 sts</td>
<td>........................................................................</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Basifemora I with 4 sts</td>
<td>......................................................................</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Basifemora I with 5 sts</td>
<td>......................................................................</td>
<td>43</td>
</tr>
<tr>
<td>4</td>
<td>Basifemora I–IV setal formula 1-2-3-0; telofemora I–IV setal formula 2-2-4-3; India .......................................................</td>
<td><em>C. prinia</em> Gupta &amp; Paul, 1985</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basifemora I–IV setal formula 1-1-1-2; telofemora I–IV setal formula 2-2-1-1; India .......................................................</td>
<td><em>C. magniferae</em> Gupta, 1992</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Basifemora II–IV setal formula 2-1-0</td>
<td>.......................................................................</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Basifemora II–IV setal formula 3-3-1</td>
<td>.......................................................................</td>
<td><em>C. Dotos</em> Bashir &amp; Afzal, 2009</td>
</tr>
<tr>
<td>6</td>
<td>Tibia II with 5 sts; Pakistan ..................................................................................</td>
<td><em>C. mahmoodi</em> Bashir &amp; Afzal, 2009</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tibia II with 7 sts; Pakistan ..................................................................................</td>
<td><em>C. okaraensis</em></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Genua I with 3 solenidia ........................................................</td>
<td>.......................................................................</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Genua I with 4 solenidia ........................................................</td>
<td>.......................................................................</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>Genua II with 1 solenidion; setae <em>f</em>; <em>h</em>, smooth (Fig. 55a) ........................................................</td>
<td>.......................................................................</td>
<td><em>C. setirostris</em> (Hermann, 1804)</td>
</tr>
<tr>
<td></td>
<td>Genua II with 2 solenidia; setae <em>f</em>; <em>h</em>, spiculate (Fig. 55b) ........................................................</td>
<td>.......................................................................</td>
<td><em>C. magoebaensis</em> Den Heyer, 1979</td>
</tr>
<tr>
<td>9</td>
<td>Coxae I–IV setal formula 3-1-3-2 sts ........................................................</td>
<td>.......................................................................</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Coxae I–IV setal formula 3-2-3-1 sts ........................................................</td>
<td>.......................................................................</td>
<td><em>C. eupatoriae</em> Chinniah &amp; Mohanasundaram, 2001</td>
</tr>
</tbody>
</table>
10 (9) Dorsal setae short ($c_1$, $f_1$, $c_2$: 7-10, $h$; 17) ............................................................... .............................. \textit{C. mercedesae} Corpuz-Raros & Garcia, 1995
– Dorsal setae longer (19-40) ............................................................... \textit{C. maculata} Sergeyenko, 2009
11 (10) Oval area formed by broken striae around setae $sci$ present (Fig. 54a) .................................
– Oval area formed by broken striae around setae $sci$ absent (Fig. 54b) ........................................ 12
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 ........................................ \textit{C. guanotoleranta} Sergeyenko, 2009
– Genua II proximal solenidion long, its length several times longer than the diameter of its alveolus; ventral surface of the coxal region of the hypognathum with numerous papillae ......................................................... \textit{C. papuliphora} 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) ............................................................... \textit{C. jatoiensis} Bashir & Afzal, 2006
– Length of setae $sci$ shorter or equal to half the distance between their bases; dorsal hysterosomal striae smooth (Fig. 56b) \textit{C. gordeevae} Sergeyenko, 2009
14 (3) Basifemora III with 2 sts ......................................................... 15
– Basifemora III with 3 sts ............................................................... 17
– Basifemora III with 4 sts ......................................................... 41
15 (14) Telofemoral apophysis uncinated (e.g., bent, hook-shaped) (Fig. 59a) ............................. \textit{C. jatoiensis} Bashir & Afzal, 2006
– Telofemoral apophysis straight, not uncinated ........................................................................ 16
16 (14) Basifemora IV with 1 sts; cheliceral longitudinal striations present (Fig. 57a) ........ \textit{C. heterostriata} Khaustov & Kuznetzov, 1998
– Basifemora IV with 0 sts; cheliceral longitudinal striations absent (Fig. 57b) ................ \textit{C. yaylensis} Sergeyenko, 2009
17 (14) Basifemora IV with 0 sts ......................................................... \textit{C. violaphila} Sergeyenko, 2009
– Basifemora IV with 1 sts ......................................................... 18
– Basifemora IV with 2 sts ......................................................... \textit{C. brevicrura} Den Heyer, 1979
– Basifemora IV with 5 sts ......................................................... \textit{C. meiringi} Den Heyer, 1979
18 (17) Median plate present (may be indistinctly defined) (Figs 58a–e) ........................................ 19
– Median plate absent (Fig. 58f) ............................................................... 36
19 (18) Telofemoral apophysis uncinated (e.g., bent, hook-shaped) (Fig. 59a) .................. \textit{C. jatoiensis} Bashir & Afzal, 2006
– Telofemoral apophysis present or absent; if present, not uncinated (Figs 59b–e) ........ 20
20 (19) Setae $c$, not on hysterosomal shield, on integument ............................................................... 21
– Setae $c$, on hysterosomal shield ........................................................................ 22
21 (20) Tibiae I with 3 asl, 4 sts; Pakistan ........................................ \textit{C. clusus} Bashir & Afzal, 2009
– Tibiae I with 2 asl, 4 sts; Pakistan ......................................................... \textit{C. nankanaensis}
22 (20) Setae $f_1$ on hysterosomal shield ............................................................... \textit{C. leuros} Bashir, Afzal, Ashfaq, Akbar & Ali 2010
– Setae $f_1$, not on hysterosomal shield, on integument ......................................................... 23
23 (22) Tibia III with 5 sts ........ \textit{C. leuros} Bashir, Afzal, Ashfaq, Akbar & Ali 2010
Tibia III with 6 sts: \textit{C. rafiqi} Bashir, Afzal, Ashfaq, Akbar & Ali 2010

24 (22) Genua I with 2 asl, 5 sts: \textit{C. capreolus} (Berlese, 1887)
– Genua I with 3 asl, 3 sts; tibia I with 2 asl, 4 sts; Pakistan: \textit{C. pakpatanensis}
– Genua I with 3 asl, 4 sts; tibia I with 2 asl, 4 sts; Pakistan: \textit{C. bashiri} Bashir & Afzal, 2009

25 (19) Telofemoral apophysis truncated (Fig. 59b): \textit{C. carina} Den Heyer, 1979
– Telofemoral apophysis not truncated (Figs 59c–e): 26

26 (25) Line of small sharp spines on pedipalp tibiotarsi present (Fig. 60a):
– Line of small sharp spines on pedipalp tibiotarsi absent (Fig. 60b): 27

27 (26) Median plate complemented with \(c_2\) (Figs 58a–d): 28
– Median plate not complemented with \(c_2\) (Fig. 58e): \textit{C. terrula} Den Heyer, 1979

28 (27) Median plate indistinctly defined (Fig. 58a): 29
– Median plate distinctly defined (Fig. 58b–d): 30

29 (28) Setae \(f_1, h_1\) smooth: \textit{C. romblonensis} Corpuz-Raros & Garcia, 1995
– Setae \(f_1, h_1\) finely setose: \textit{C. sordwanaensis} Den Heyer, 1979

30 (28) Median shield complemented with \(c_1, d_1, c_2\) (Fig. 58b):
– Median shield complemented with \(c_1–e_1, c_2\) (Fig. 58c, d): 31

31 (30) Coxae IV with 1 sts: 32
– Coxae IV with 2 sts: 33

32 (31) Broken striae that form cell-like structures on median shield present (Fig. 58c):
– Broken striae that form cell-like structures on median shield absent (Fig. 58d): \textit{C. veracruzana} Baker & Hoffmann, 1948

33 (31) Setae \(c_1\) longer than all other dorsal setae:
– Setae \(c_1\) not longer than all other dorsal setae: \textit{C. womersleyi} Baker & Hoffmann, 1948

34 (33) Genua I–IV with 4-2-1-1 solenidia: \textit{C. lamberti} Den Heyer, 1979
– Genua I–IV with 3-1-1-1 solenidia: 35

35 (34) Setae \(c_1–h_1\) approximately equal in length: \textit{C. hermanni} Den Heyer, 1979
– Setae \(c_1–e_1\) half as long as \(f_1, h_1\): \textit{C. thessalica} Sionti & Papadoulis, 2003

36 (18) Telofemoral apophysis uncinated (Fig. 59a):
– Telofemoral apophysis not uncinated (Fig. 59b–e): 38

37 (36) Genua I–IV setal formula 1 asl, 6 sts-7-6-6; Philippines:
– Genua I–IV setal formula 1 asl, 4 sts-5-6-6; Pakistan:

38 (36) Proterosomal shield striated (Fig. 54c):
– Proterosomal shield smooth (Fig. 54d): \textit{C. potchensis} Den Heyer, 1979

39 (38) Setae \(f_1, h_1\) smooth (Fig. 55a):
– Setae \(f_1, h_1\) spiculate (Fig. 55b): \textit{C. gazella} (Ewing, 1913)

40 (39) Proterosomal shield striated (Fig. 54c):
– Proterosomal shield smooth (Fig. 54d): \textit{C. potchensis} Den Heyer, 1979

41 (40) Proterosomal shield striated (Fig. 54c):
– Proterosomal shield smooth (Fig. 54d): \textit{C. potchensis} Den Heyer, 1979
40 (39) Pedipalp telofemoral apophysis short and cone-like (Fig. 59c) …………………
- Pedipalp telofemoral apophysis short and finger-like (Fig. 59d) …………………
.......................................................................................... C. mageei Smiley, 1992
- Pedipalp telofemoral apophysis short and cone-like (Fig. 59c) …………………
- 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 (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 (*hg*<sub>1–4</sub> and 2

---

**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 f₁, h₁ 55b Spiculate f₂, h₁
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 \( h_g \) 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, \( e_{1-2}, d_{1-4}, h_1 \), present. Cupule \( im \) present, usually posteriolarad 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 dolcas* 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 *D. inermis* from Egypt (though they called it *Cu- naxa 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 nicobarensis*. *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 nicobarensis* to *Dactyloscirus* (though see discussion below) and described *D. mansonii*, *D. johnstonii*, and *D. poppi*. Gupta (1992) described *D. bengalensis*. Corpuz-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. manzoouri*. Bashir, Afzal, and

**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, e_2, d_1–h_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, d_1–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 ¾ 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 c₁ or c₂; cosmopolitan (Fig. 63a) ... D. inermis (Trägårdh 1905)
   – Lateral platelets large, length greater than 2 times the length of c₁ or c₂ (Figs 63b–d) ...

6 (5) Dorsal setae f₁ and h₁ equal in length; median shield present (Figs 63b,c) or absent (Fig. 63d) ... 7
   – Dorsal setae f₁ shorter than h₁; 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 61c); median shield present or absent(Figs 63b, c) ...

D. philippinensis Corpuz-Raros, 1995

8 (7) Median shield present ...
   – 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 c₁, d₁, e₁ 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 c₁–e₁ 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 (11) Coxa IV with 2 sts ...
   – Coxae IV with 3 sts ...

13

14
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

Figures 61–62. Dactyloscirus 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. kabrorensis 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 $e_1$, $d_1$ (Fig. 64b); apophysis adjacent to pedipalpal genua and tibiotarsi blunt distally (Fig. 61c); Mexico, Philippines...
   D. mansoni Smiley, 1992
– Median shield complemented with $e_1$–$e_4$ (Figs 64c,d); apophysis adjacent to pedipalpal genua and tibiotarsi blunt or pointed distally.............................18
Median shield complemented with $c_1$–$e_1$, $c_2$ (Fig. 64c); 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)..............................*D. discocondylus* Corpuz-Raros, 2008

– 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...............................

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 $c_1$–$e_1$ (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. tridicus* Corpuz-Raros, 2008

– Pedipalp tibiotarsal claw entire, unbranched (Fig. 62a, b); coxa II–IV setal formula not as above..........................25


– Coxa setal formula II–IV 2–3–1 sts; Brazil..................................................*D. saopauloensis* Den Heyer & Castro, 2012
**Riscus** Den Heyer, 2006


---

**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, 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 ($h_{g_{1-4}}$ and 2 pairs of adoral setae). Setae $h_{g_3}$ and $h_{g_4}$ 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 ($c_{i-2}$, $d_{i-1}$). Cupule $im$ present, usually laterad or in the proximity of $e_i$.

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 paracoxal seta). Genital plates each bear 4 setae. Anal plates bear 1 pair of setae ($p_s_{j}$). 2 pairs of setae ($p_s_j$ and $h_j$) associated with, but do not occur on, the anal plates. Cupule $ih$ present in close proximity to $h_j$. Integument between plates striated and bears 5 pairs of additional setae. Legs. Ambulacrual 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) ......

Rubroscirus Den Heyer, 1979


**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 (*hg*<sub>1–4</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>j</sub>*) 1 pair of setae (*h<sub>j</sub>*) associated with, but do not occur on, the anal plates. Cupule *ih* present in close proximity to *h<sub>j</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 ................................................................. | *R. denmarki* (Smiley, 1992) |
| 2 (1) | Basifemora III with 1 sts .................................................................. | 3 |
| – | Basifemora III with 2 sts; Pakistan ...... *R. reticulatus* Bashir, Afzal & Ali, 2006 |
| 3 (2) | Basifemora IV with 1 sts .................................................................. | 4 |
| – | Basifemora IV with 2 sts; Mexico, Central America, USA .................. |
| .......................................................... | .......................................................... | *R. boneti* (Baker & Hoffmann, 1948) |
| 4 (3) | Coxae I with 2 sts; Taiwan ......................................................... *R. exoterica* (Tseng, 1980) |
| – | Coxae I with 3 sts .......................................................................... | 5 |
| 5 (4) | Coxae II with 1 sts ......................................................................... | 6 |
| – | Coxae II with 2 sts ....................................................................... | 16 |
| 6 (5) | Coxae IV with 1 sts ..................................................................... | 7 |
| – | Coxae IV with 2 sts ...................................................................... | 12 |
| 7 (6) | Genua I with 1 asl, 5 sts; Ukraine ........................................ *R. khaustovi* Sergeyenko, 2006 |
68

– 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 ......................... \textit{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 ................................................................. \textit{R. newyorkensis} (Smiley, 1992)
9 (8) Genua II with 1 asl, 5 sts; China................................. \textit{R. denheyeri} Fan, 1992
– Genua II with 1 asl, 6 sts; Brazil ......................... \textit{R. nidorum} Ferla & Rocha, 2012
10 (7) Genua I with 5 sts; genua II with 1 asl, 5 sts; USA ................................................................. \textit{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 ........................................ \textit{R. valentis} Muhammad, Chaudhri & Akbar, 1989
– Genua II with 2 asl, 6 sts; Pakistan ........................................ \textit{R. otiosus} Muhammad & Chaudhri, 1993
12 (6) Genua I with 7 sts; Phillipines .... \textit{R. viscayana} Corpuz-Raros & Garcia, 1995
– Genua I with 2 asl, 5 or 6 sts .................................................................13
– Genua I with 3 asl, 4 sts; China .................................................. \textit{R. sinensis} Fan, 1992
– Genua I with 4 asl, 5 sts; USA ................................................ \textit{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 ... \textit{R. venusae} Corpuz-Raros & Garcia, 1995
– Genua I with 2 asl, 6 sts; genua II with 6 sts; genua IV with 6 sts; Philippines ........................................ \textit{R. rackae} (Smiley, 1992)
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 ................................................ \textit{R. myabunderensis} (Gupta & Ghosh, 1980)
15 (14) Minute thorn-like seta adjacent to median spine-like seta on pedipalp tibiotarsus present; New Zealand ......................... \textit{R. reevesi} (Smiley, 1992)
– Minute thorn-like seta adjacent to median spine-like seta on pedipalp tibiotarsus absent; USA ........................................ \textit{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 ................................................................. \textit{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 ................................................................. \textit{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... \textit{R. rarus} Den Heyer, 1979
17 (16) Setae c1, c2, d1, e1, f1, and h1 smooth; India ................................................................. \textit{R. myabunderensis} (Gupta & Ghosh, 1980)
– Setae c1, c2, d1, e1, f1, and h1 spiculate; Australia, Cominican Republic... \textit{R. lukoschusi} (Smiley, 1992)
Coleoscirinae Den Heyer, 1978


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. Chelicerae with seta present or absent. Subcapitulum bears 6 pairs of setae: 2 pairs of adoral setae and 4 pairs of subcapitular setae ($h_{g1-4}$). Setae $h_{g4}$ 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 ($c_{1-7}, c_{2}, f_{1}, h_{2}$); 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 $e_{r}$. 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 trochantral 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. 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; 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 ................................................................. Scutascirus
   – 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 .......... Coleoscirus Berlese, 1916

2. 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
   – Idiosomal 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. 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 ................................................................. Neobonzia Smiley, 1992

4. 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

Figures 66–69. Cunaxoidinae 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 Pseu-dobonzia 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. kifayati,* 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. kifayati* 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. zaherii.* 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 adoral 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 sensilla 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. Ambulacral 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 $e_1 f_1$, $e_2 f_2$; Philippines ........................................ *C. philippinensis* Corpuz-Raros, 1996
– Hysterosomal shield absent; Philippines ........................................ 13
12 (4) Basifemora III with 4 setae ........................................ 14
– 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
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. carnis 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. themedae*, 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. themedae* 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;

**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

---

**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 (*hgs*). 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 (1ps and 1mps) and 2 pairs of setose sensillae (1at and 1pt). 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 c1–h1, and usually c2 and f2 present dorsally; h2 present or absent. Cupules im present laterad and sometimes caudally of e1. 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 (1ps) usually occur on the anal plates and 1 pair of setae (1pa) 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*.

*N. 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. clava* (Den Heyer & Castro, 2008)
3  (1) Coxa I–IV setal formula 2-2-3-2 sts; Pakistan ......................................................... *N. parilis* (Chaudhri, 1977)
   – Coxa I–IV setal formula 3-3-3-3 sts ................................................................. 4
4  (3) Basifemora I with 2 sts ....................................................................................... 5
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

<table>
<thead>
<tr>
<th>Basifemora I with 3 sts; Philippines</th>
<th>N. longispina (Corpuz-Raros &amp; Garcia, 1996)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basifemora I with 4 sts</td>
<td></td>
</tr>
<tr>
<td>Basifemora I with 5 sts</td>
<td></td>
</tr>
<tr>
<td>5 (4) Basifemora II–IV setal formula 2-2-1 sts; USA</td>
<td>N. moseri Smiley, 1992</td>
</tr>
<tr>
<td>Basifemora II–IV setal formula 2-1-0 sts; Pakistan</td>
<td>N. malookensis (Bashir &amp; Afzal, 2009)</td>
</tr>
<tr>
<td>Basifemora II–IV setal formula 3-3-1 sts</td>
<td>N. bakari (Bashir &amp; Afzal, 2009)</td>
</tr>
<tr>
<td>Basifemora II–IV setal formula 4-4-1 sts</td>
<td></td>
</tr>
<tr>
<td>6 (5) Telofemora I–IV setal formula 4-6-4-2 sts; China</td>
<td>N. themedae (Den Heyer, 1977)</td>
</tr>
<tr>
<td>Telofemora I–IV setal formula 5-5-4-3 sts; South Africa</td>
<td>N. lootsi (Den Heyer, 1977)</td>
</tr>
<tr>
<td>7 (4) Basifemora II with 4 sts</td>
<td>N. moraesii (Den Heyer &amp; Castro, 2008)</td>
</tr>
<tr>
<td>Basifemora II with 5 sts</td>
<td>P. shamsbadi (Bashir &amp; Afzal, 2009)</td>
</tr>
<tr>
<td>Basifemora II with 6 sts</td>
<td>N. saaymani (Den Heyer, 1977)</td>
</tr>
<tr>
<td>8 (7) Basifemora III–IV setal formula 4-2 sts</td>
<td>N. argillae (Den Heyer, 1977)</td>
</tr>
<tr>
<td>Basifemora III–IV setal formula 6-1 sts; New Zealand</td>
<td>N. newzealandicus (Smiley, 1992)</td>
</tr>
<tr>
<td>9 (8) Pedipalp tibiotarsal tubercle present; Brazil</td>
<td>N. moraesii (Den Heyer &amp; Castro, 2008)</td>
</tr>
<tr>
<td>Pedipalp tibiotarsal tubercle absent; South Africa</td>
<td>N. saaymani (Den Heyer, 1977)</td>
</tr>
<tr>
<td>10 (7) Basifemora III–IV setal formula 3-0 sts; South Africa</td>
<td>N. argillae (Den Heyer, 1977)</td>
</tr>
<tr>
<td>Basifemora III–IV setal formula 3-1 sts; South Africa</td>
<td>N. newzealandicus (Smiley, 1992)</td>
</tr>
<tr>
<td>Basifemora III–IV setal formula 4-2 sts</td>
<td>N. argillae (Den Heyer, 1977)</td>
</tr>
<tr>
<td>11 (10) Setae lps and mps subequal; South Africa</td>
<td>N. smileyi (Den Heyer, 1980)</td>
</tr>
<tr>
<td>Setae lps about half as long as mps; USA</td>
<td>N. summersi (Smiley, 1992)</td>
</tr>
<tr>
<td>12 (4) Basifemora II with 5 sts</td>
<td>N. argillae (Den Heyer, 1977)</td>
</tr>
<tr>
<td>Basifemora II with 6 sts</td>
<td>N. argillae (Den Heyer, 1977)</td>
</tr>
<tr>
<td>13 (12) Coxae I–II nearly touching medially (Fig. 76a); USA, Austria</td>
<td>N. snowi (Baker &amp; Hoffmann, 1948)</td>
</tr>
<tr>
<td>Coxae I–II widely separated medially (Fig. 76b); Philippines</td>
<td>N. gruezoi (Corpuz-Raros &amp; Garcia, 1996)</td>
</tr>
<tr>
<td>14 (12) Basifemora III–IV with 5-2 sts</td>
<td>N. gruezoi (Corpuz-Raros &amp; Garcia, 1996)</td>
</tr>
<tr>
<td>Basifemora III–IV with 6-2 sts; Pakistan</td>
<td>N. numida (Chaudhri, 1980)</td>
</tr>
<tr>
<td>15 (14) Setae g3 longest; posterior corners of proterosomal shield angled; China</td>
<td>N. shanghaiensis (Liang, 1980)</td>
</tr>
<tr>
<td>Setae g3 longest; posterior corners of proterosomal shield rounded; Russia</td>
<td>N. kuznetzovi (Sergeyenko, 2005)</td>
</tr>
</tbody>
</table>
Neoscirula Den Heyer, 1977


**Diagnosis.** Gnathosoma. 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 (*hg*1–4). Seta *hg*1 longest and in some species bent at 90 degrees, though not geniculate as in Bonziinae. Adoral setae present or absent. Chelicera with seta present or absent. Idiosoma, dorsal. Protersosomal shield weakly sclerotized and ill-defined, granulated or papilllated; 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 *e*; ventral cupules *ih* present near *h*2, 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
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

3 (2) Pedipalp basifemoral dorsal seta spine-like (Fig. 77a); Luzon Is., Philippines...
............................................................... \textit{N. makilingica} Corpuz-Raros, 1996
– Pedipalp basifemoral dorsal seta simple (Fig. 77b) ........................................ 4

4 (3) Proterosomal shield with polygonal subcuticular sculpturing present (Fig. 78a); posteromedia l 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............... \textit{N. aspirasi} Corpuz-Raros, 1996
– Proterosomal shield with polygonal subcuticular sculpturing absent (Fig. 78b); posteromedia l portion of sternal shield rounded, polygonal subcuticular sculpturing present (Fig. 79b); 4 pairs of setae between coxae III–IV (excluding genital setae); Malaysia; Philippines ............. \textit{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 ................................. \textit{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...... ............................................................... \textit{N. baloghi} Mejía-Recamier & Palacios-Vargas, 2007

6 (1) Pedipalp genua hook-like apophysis present (Fig. 81a); South Africa...........
............................................................... \textit{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.
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...

81 – 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
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 ($h_{3,4}$). 2
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* and *mps*) and 2 pairs of setose sensilae (*at* and *pt*). Extensive reticulated pattern present. Hysterosomal plate absent. Setae *c₁–b₁* present; setae *c₂*, *f₂*, and *h₂* present or absent. Cupules *im* present laterad and caudally of *e₁*. 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 setae (*ps₁–₂*) 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)

<table>
<thead>
<tr>
<th>1</th>
<th>Pedipalp basifemora and telofemora with similar setae, either spine-like or simple (Fig. 88a, b); proterosomal shield conspicuously reticulated</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pedipalp basifemora with simple seta, pedipalp telofemora with spine-like seta (Fig. 88c); proterosomal shield not conspicuously reticulated; Mexico</td>
<td></td>
</tr>
<tr>
<td>2 (1)</td>
<td>Pedipalp basifemora and telofemora with simple setae (Fig. 88a); setae <em>f₂</em> present or absent</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Pedipalp basifemora and telofemora with spine-like setae (Fig. 88b); setae <em>f₂</em> present; Guam</td>
<td></td>
</tr>
<tr>
<td>3 (2)</td>
<td>Setae <em>f₂</em> present</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Setae <em>f₂</em> absent</td>
<td>5</td>
</tr>
<tr>
<td>4 (3)</td>
<td>Proterosomal shield concave posteromedially (Fig. 89a); South Africa</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proterosomal shield straight posteromedially (Fig. 89b); USA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proterosomal shield convex posteromedially (Fig. 89c); Pakistan</td>
<td></td>
</tr>
<tr>
<td>5 (3)</td>
<td>Proximal leg podomeres reticulated; Malaysia</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proximal leg podomeres not reticulated; USA</td>
<td></td>
</tr>
</tbody>
</table>

---

*P. delfinadobakerae* Smiley, 1992

*P. yini* Smiley, 1992

*P. neoreticulata* Den Heyer, 1977

*P. landwehri* Smiley, 1992

*P. ashfaqi* Bashir, Afzal & Akbar, 2008

*P. clathratus* (Shiba, 1978)

*P. reticulata* (Heryford, 1965)
**Scutascirus** Den Heyer, 1976


**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 (*hg₁–₄*). Setae *hg₄* 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 and mps) and 2 pairs of setose sensilla (at 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 (c1–f1, c2, f2, h2); these setae occur on the fused dorsal shield. Cupule im present, usually laterad or in the proximity of e'. Un sclerotized 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 (ps1–2). Two pairs of setae (h2, pa) located on the integument near the anal plates. Cupule ih present in close proximity to h2. Legs shorter than idiosoma. Tarsi 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 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
Orangescirlinae Bu & Li, 1987

Orangescirula Bu & Li, 1987


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 (hg₁–₄). Setae hg₁ 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 (c₁–f₁, c₂, h₂). 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 (ps₁,₂). Two pairs of setae (h₂, pa) located on the integument near the anal plates. Cupule ih present in close proximity to h₂. 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-
A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...


tion 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.

Armascirus ozarkensis


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


Armascirus primigenius


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.


Dactyloscirus dolichosetosus


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

References


A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...


Hermann JF (1804) III. Ciron (Scirus). Mem. Apterologique 60–62; pl. 3; fig. 12; pl. 6; fig. 12.


A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...


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


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.


A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses...


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.


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 subdivision of the body and the original segmentation. Acarologia 5: 443–454.


