

**University of São Paulo  
“Luiz de Queiroz” College of Agriculture**

**Taxonomic studies of Macrochelidae mites (Acari: Mesostigmata) and their potential use to control *Stomoxys calcitrans* and *Musca domestica* (Diptera: Muscidae)**

**Letícia Henrique de Azevedo**

Thesis presented to obtain the degree of Doctor in  
Science. Area: Entomology

**Piracicaba  
2017**

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**This work is especially dedicated**

**To GOD**

My mother

**Maria Paula Henrique da Silva Azevedo**

My husband

**Diego Luis Prado**

My brother

**Matheus Henrique de Azevedo**

**For all the love and support offered to me**

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“Work gives you meaning and purpose and life is empty without it.”

– **Stephen Hawking**

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## RESUMO

### **Estudos taxonômicos de ácaros Macrochelidae (Acari: Mesostigmata) e o potencial de uso destes para o controle de *Stomoxys calcitrans* e *Musca domestica* (Diptera: Muscidae)**

Macrochelidae Vitzthum é um dos mais abundantes e diversos grupos de ácaros predadores que encontrados em excrementos ou em carcaças de animais em decomposição. Algumas espécies dessa família tem mostrado potencial como agentes de controle biológico. *Stomoxys calcitrans* L. tem sido um problema sério enfrentado por pecuaristas em alguns estados brasileiros e tem causado perdas significativas no setor pecuarista. Já *Musca domestica* L. pode ser vetora de várias patógenos de seres humanos e de animais. Os objetivos do estudo relatado neste documento foram a elaboração de um catálogo taxonômico de espécies de Macrochelidae do mundo, determinar as espécies de macroquelídeos encontradas em microhabitats em que a mosca-dos-estábulo é geralmente encontrada nas fazendas do Estado de São Paulo, e avaliar o efeito de diferentes espécies de macroquelídeos como possíveis agentes de controle de moscas nocivas. Um total de 520 espécies de 23 gêneros são relatadas no catálogo. No total, 1359 espécimes foram coletados de esterco de gado e serapilheira em diferentes regiões do Estado de São Paulo. Estes representaram dez espécies de três gêneros e uma nova espécie, que foi descrita. Nos testes em laboratório, *Macrocheles* n. sp. apresentou maiores taxas de predação e oviposição alimentando-se de larvas de *S. calcitrans* (23,8 larvas predadas e oviposição de cerca de 4 ovos por dia, respectivamente). Para *Macrocheles* n. sp., o desenvolvimento da fase imatura (ovo-adulto) foi concluído em  $1,3 \pm 0,01$ ,  $1,3 \pm 0,01$  e  $1,5 \pm 0,03$  dias alimentando-se de ovos de *S. calcitrans*, *M. domestica* e de *Protorhabditis* sp., respectivamente. A fecundidade foi maior quando alimentado com *Protorhabditis* sp. ( $77,2 \pm 5,1$  ovos / fêmea) do que com *S. calcitrans* ( $58,0 \pm 5,9$ ) e *M. domestica* ( $55,0 \pm 5,3$ ). Os resultados deste estudo sugerem que *Macrocheles* n. sp. é um promissor agente de controle biológico de *S. calcitrans* e *M. domestica* e que poderia ser criado de forma massal com o uso de *Protorhabditis* sp. ou ovos de *M. domestica*.

Palavras-chave: Controle biológico; Catálogo; Ácaros predadores; Mosca-dos-estábulo

## ABSTRACT

### **Taxonomic studies of Macrochelidae mites (Acari: Mesostigmata) and their potential use to control *Stomoxys calcitrans* and *Musca domestica* (Diptera: Muscidae)**

The family Macrochelidae Vitzthum is one of the most abundant and diverse groups of predatory mites living in excrements or decomposing animals. Some species of this family have shown good potential as biological control agents. *Stomoxys calcitrans* L. is a serious problem that has been faced by cattle raisers in some Brazilian states, causing significant losses. *Musca domestica* L. may vector several pathogens that affect humans and animals. The aims of the study reported in this document were the preparation of a taxonomic catalog of the world macrochelid species, to determine the macrochelid species in microhabitats where the stable fly is usually found in commercial cow raising farms in São Paulo State, and to evaluate of the effect of different macrochelid species as control agents of harmful muscid flies. A total of 520 species of 23 genera are reported in the catalog. In total, 1359 specimens were collected from cow manure and litter in different regions of São Paulo State. These represented ten species of three genera and one new species, which was described. In laboratory tests, *Macrocheles* n. sp. presented higher predation and oviposition rates on larvae of *S. calcitrans* (23.8 larvae consumed and laid about 4 eggs per day, respectively). For *Macrocheles* n. sp., total immature development (egg-adult) was completed in  $1.3 \pm 0.01$ ,  $1.3 \pm 0.01$  and  $1.5 \pm 0.03$  days on eggs of *S. calcitrans* and *M. domestica* and on *Protorhabditis* sp., respectively. Fecundity was higher on *Protorhabditis* sp. ( $77.2 \pm 5.1$  eggs/female) than on *S. calcitrans* ( $58.0 \pm 5.9$ ) and *M. domestica* ( $55.0 \pm 5.3$ ). Results of this study suggest that *Macrocheles* n. sp. is a promising biological control agent of *S. calcitrans* and *M. domestica*, and that it could be mass reared with the use of *Protorhabditis* sp. or eggs of *M. domestica*.

Keywords: Biological control; Catalog; Predatory mite; Stable fly

## 1. INTRODUCTION

### Macrochelid mites (Mesostigmata: Macrochelidae) as biological control agents

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Biological control of plant pests using predatory mites has been extensively practiced in many countries, especially in protected crops. The predators most often used for that purpose belong to the Phytoseiidae (Gerson et al. 2003; Beaulieu and Weeks 2007), especially because these are usually by far the most common plant inhabiting group of predatory mites.

The family Macrochelidae Vitzthum (Figure 1), of the order Mesostigmata, is one of the most abundant and diverse groups of predatory mites living in excrements or decomposing animals (Vitzthum 1930; Koehler 1999; Behan-Pelletier 2003; Gerson et al. 2003; Braig and Perotti 2009; Lindquist et al. 2009; Perotti and Braig 2009). Filipponi (1964) divided the macrochelids into three main groups, fimicolous, humicolous and insecticolous, referring to their association with excrements, humus or insects (mainly as carriers of these mites). They have also been found in nests or galleries of mammals, birds and social insects, as summarized by Lindquist et al. (2009), where they find an ample assortment of food sources, represented by different organisms found in those microhabitats (Krantz and Whitaker 1988).

Macrochelids have a potential as biological control agents of organisms with which they have been found in association, including different species of flies, and other groups of organisms.



**Figure 1.** Adult female of *Glyptholaspis* sp. (Macrochelidae) preying larvae of *Musca domestica*

### 1.1. Morphological characterization

In addition to the original descriptions, morphological characterizations of Macrochelidae were provided by several authors, including Evans (1956), Evans and Browning (1956), Krantz (1962), Krauss (1970), Bregetova (1977), Hyatt and Emberson (1988), Mašán (2003) and Lindquist et al. (2009).

Within the Mesostigmata, diagnostic characteristics of females of this family are as follows: most frequently well sclerotized, with undivided dorsal shield bearing at least 28 pairs of setae (sometimes with additional unpaired, or asymmetrically inserted setae); sternal shield with three pairs of setae; genital shield with one pair of setae and with a pair of conspicuous accessory sclerites beneath lateral margins; ventrianal shield with 1 – 5 pairs of setae in addition to circumanal setae (except in *Neopodocinum* Oudemans and *Reductholaspis* Emberson, with a small anal shield only); peritreme generally looped around the stigma (except in some species of *Neopodocinum*). Arthrodistal membrane at base of movable cheliceral digit with an elongate fimbriate or brush-like process; palp apotele 3-tined; tarsus I usually without pretarsus (except in some species of *Neopodocinum*); paired paradactyli of pretarsi II-IV usually broad, extending to apex of claws and distally divided or serrated (not always distinct because of position in mounted specimens). Males with a holovenral shield or separate sternigenital and ventrianal shields.

### 1.2. Trends in understanding the morphology, taxonomy, and biology of macrochelids

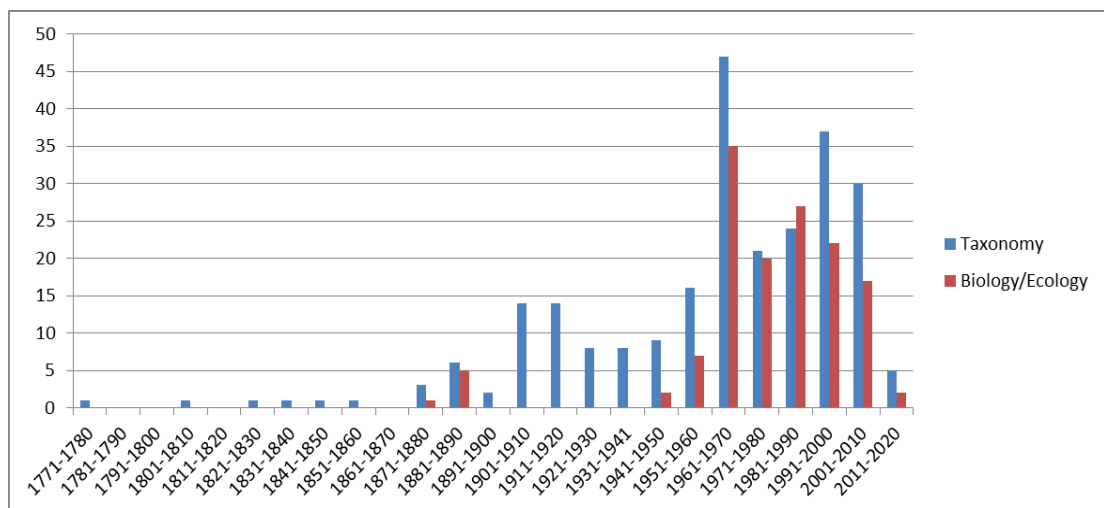
Knowledge about the morphology and taxonomy of macrochelids has increased greatly in the last 60 years. Most important contributions include the detailed study of *Glyptholaspis confusa* (Foà) by Van der Hammen (1964), body chaetotaxy (Lindquist and Evans 1965; Halliday 1986, 1987), leg chaetotaxy (Evans 1963; Evans and Hyatt 1963), cribrum (Krantz and Redmond 1989), dorsal porotaxy (Van der Hammen 1964; Krantz and Redmond 1987; Moraza 2004), comparative studies of the female reproductive tract (Petrova 1960; Costa 1966, 1967; Athias-Henriot 1968), etc.

Filipponi (1959) was the first author to study the effect of environmental conditions on the morphology of macrochelids. A few years later, he (Filipponi 1964) proposed the use of experimental studies to separate closely related macrochelid species, including biological information and phenotypic and genotypic variation resulting from the variation of

environmental factors. This initiative, and the detailed conduct of these studies, represent an important contribution to the taxonomy of mites in general, not only of macrochelids.

A comprehensive work to pull together information and references on the taxonomy of the macrochelids, in the form of a catalog, was initiated by R. M. Emberson in the early 2000's. Other collaborators have joined with him since then, but the work is still on going. Until now, almost 250 papers related to the taxonomy of this group have been detected. This work already allows some interpretation of the trends in the taxonomic knowledge of the family.

It seems that the first paper dealing with the taxonomy of this group was published almost 250 years ago (Figure 2), by Scopoli (1772) in describing *Acarus muscaedomesticae*. For about 100 years after that description, the number of publications on macrochelid taxonomy remained very low. Between 1880 and 2000, the number of new publications increased, with outlyingly higher numbers between 1901 and 1920, and between 1961 and 1970, probably reflecting contributions of A. Berlese in Italy and G.W. Krantz in the USA, respectively. However, a reduction in the number of published papers has been noticed since 2003.



**Figure 2.** Number of publications on taxonomy and biology/ ecology of macrochelids per decade.

Quite a different progression was observed in relation to knowledge about the biology and ecology of the macrochelids (Figure 2). The first study was published about 135 years ago, and apparently very little was published in the subsequent 70 years (until the early 1950's). The first publication concerning the predatory behavior of these mites was published only about 70 year ago (Pereira and Castro 1945). Soon after that, the number of publications

increased considerably up to the mid 1970's, mainly due to the efforts by A. Filliponi and R.C. Axtel. The number of publications then reduced considerably. We have been unable to determine the cause of this lack of interest in the study of the macrochelids in the last decades, but it could be related to the fact that not enough effort has been dedicated to the promotion of the practical use of these mites and to the general lack of funding sources for basic science.

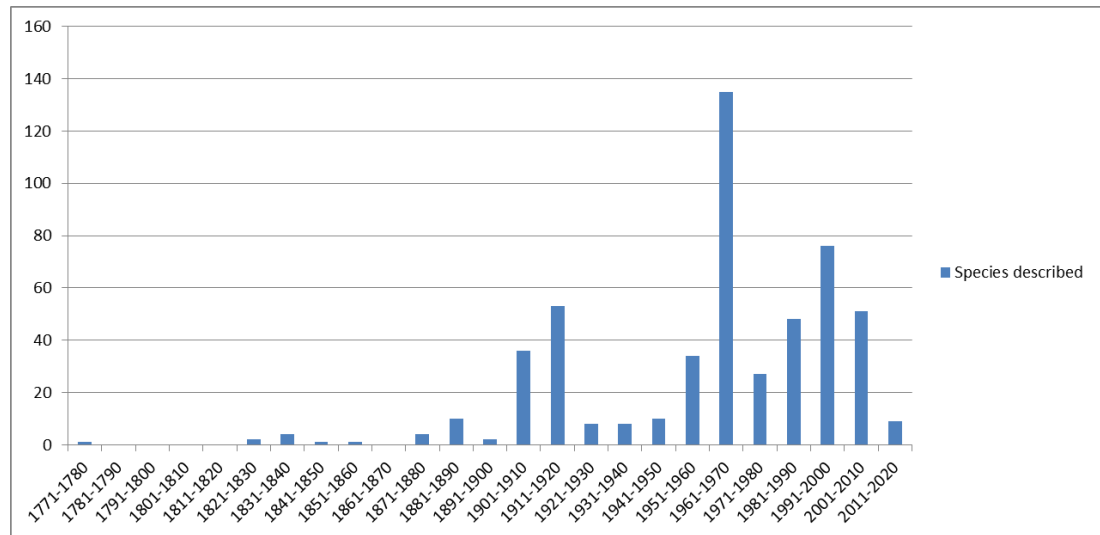
### 1.3. Diversity of the Macrochelidae

The current concept of this family is largely based on the work of Evans (1956), who divided Vitzthum's (1930) concept of the family into the subfamilies Macrochelinae and Parholaspiinae, and Krantz (1960), who raised those subfamilies to the family level. The Macrochelidae is in need of a thorough revision because of insufficient detail provided in many of the original species descriptions. This situation has led to the creation of many synonyms, a number of homonyms and problems in ascertaining the correct name and authority for many species.

The first revision of the family at the generic level was conducted by Krantz (1962), who considered it to include ten genera. He mentioned that *Macrocheles* Latreille was by far the largest genus, with more than 100 species. He also provided keys to the species of *Geholaspis* Berlese, *Grafiia* Krantz and *Lordocheles* Krantz, and listed relevant publications which included taxonomic keys: Valle (1953) for *Geholaspis* species; Balogh (1958) for European species of *Longicheles*; Evans and Browning (1956) for British macrochelids; and Bregetova and Koroleva (1960) for Russian macrochelids. Other important regional taxonomic papers providing keys to genera and species are those of Krauss (1970) and Karg (1993) for Europe; Bregetova (1977) for the former Soviet Union; Krantz and Ainscough (1990) for North America; Halliday (2000) for Australia; and Mašán (2003) for Slovakia. More recently, Emberson (2010) provided a reappraisal of some basal macrochelid groups, providing a key to the genera and subgenera of *Geholaspini*, a newly proposed tribe.

According to data gathered by one of the authors of this chapter (R. M. Emberson, unpublished), about 550 named mite species have been assigned to Macrochelidae, only about 470 of which seem to be valid; these are currently arranged in 23 genera. He observed that the largest diversity is found in *Macrocheles*, followed by *Holocelaeno* Berlese, *Holostaspella* Berlese, *Neopodocinum*, *Nothrolaspis* Berlese, *Macrholaspis* Oudemans and *Glyphtholaspis* Filipponi & Pagazzano (about 320, 41, 37, 33, 20, 18 and 15 species, respectively). Ten other

genera are monospecific, and the remaining genera contain between two and eleven species each.



**Figure 3.** Number of macrochelid species described per decade.

The first macrochelid species to be described (Scopoli 1772) was named *Acarus muscaedomesticae* Scopoli. The second species was described only almost fifty years later. The number of species described along the years (Figure 3) has the same pattern of variation reported for the number of taxonomic papers published.

#### 1.4. Associations with other organisms

The association of mesostigmatid mites with other arthropods seems to have evolved several times, with the development of a wide range of attachment mechanisms that facilitate mite phoretic dispersal, as summarized by Hunter and Rosario (1988). According to those authors, the complexity of these associations, particularly with insects, indicates a long history of evolution. Phoresy is usually necessary for mite species specialized in living in patchy habitats, which become periodically inadequate for their survival, as in the case of animal excreta or decomposing animal cadavers.

Much has been published about the phoretic behavior of macrochelids because of their common occurrence in patchy habitats. A comprehensive discussion of phoresy in macrochelids was published by Krantz (1998). This process may be facultative or obligatory, but in some cases phoretic specificity in macrochelids has evolved to a degree as intimate as in true parasitism (Krantz 1967). A close association between three macrochelid species,



*Aethosoma burchellestes* Krantz, *Macrocheles rettenmeyeri* Krantz and *Macrocheles dibamos* Krantz, and species of army ants (*Eciton* spp.) was reported by Rettenmeyer (1962). He presumed all three species to be ectoparasites, as opposed to other macrochelid species also associated with ants acting as coprophages or scavengers in ant colonies, or by using ants to disperse (phoresy).

Mated macrochelid females are the usual dispersants, attaching to insects when the habitat becomes unfavorable and detaching when the insects visit suitable new mite habitat, to feed or oviposit (Farish and Axtell 1971). Based on the literature taken into account in the preparation of this chapter, most of the reports refer to *Macrocheles* species, but all species of *Holocelaeno* and *Neopodocinum*, and many species of *Holostaspella*, together with species of some of the smaller macrochelid genera, are also known to be phoretic. As carriers, most reports refer to Coleoptera species, mainly those whose larvae feed on dung (the dung beetles, or Scarabaeinae, as well as Aphodiinae, the small dung beetles), but also to Diptera. Krantz (1983a) reported that about 280 macrochelid species have been found in association with dung beetles. Most reports do not specify the family of the dipteran carrier, but most of those that do, refer to Muscidae, especially *Musca domestica* L.

There are also reports of the association of these mites with small mammals (Womersley 1955; Krantz 1983b; Whitaker and Spicka 1976; Whitaker 1977; Adis and Krantz 1985; Krantz and Whitaker 1988; Estebanes-Gonzales and Cervantes 2009). Krantz and Whitaker (1988) summarized reports of *Macrocheles* species associated with small mammals in North America and added new records of this type of association. Altogether, 32 *Macrocheles* species were reported in association with 53 mammal species. It is thought that the mites attach to the host mammals when the latter visit the substrate where the mites live, in search of food. A curious example of this type of association is of *Macrocheles lukoschusi* Krantz, known to live in the rectum of the sloth *Bradypus tridactylus* L., apparently feeding on nematodes (Krantz 1983b; Adis and Krantz 1985).

Facultative parasitism has been reported by *Macrocheles muscaedomesticae* on adult houseflies (*Musca domestica* L.) and by *Macrocheles subbadius* (Berlese) on adult *Drosophila nigrospiracula* Patterson and Wheeler, by Jalil and Rodriguez (1970) and Polak (1996), respectively.

Phoresy in *Glyphtholaspis* Filipponi and Pegazzano is less common, usually involving a beetle as carrier (Krantz 1983a). It has been reported for *G. americana* and *G. confusa* on stable fly (*Stomoxys calcitrans* L.) (Axtell 1961), some species of Scarabaeidae (Halliday 1986; Glida et al. 2003) and the housefly (Axtell 1964; Niogret et al. 2006).

According to Krantz (1998), a phylogenetic analysis of selected phoretic and non-phoretic macrochelid taxa has shown a strong correlation between phoresy and evolutionary position, indicating that an increasing commitment to phoresy is correlated with an advance from early derivative to more evolved taxa.

Some studies support the hypothesis that the phoretic behavior in *Macrocheles* is closely related with the stage of decomposition, temperature and relative humidity (Singh et al. 1967; Jalil and Rodriguez 1970; Farish and Axtell 1971; Stafford and Bay 1987; Ho 1990; Rodrigueiro and Prado 2004). According to Farish and Axtell (1971), the decomposition stage of the substrate interferes with moisture content. With humidity loss at increasing temperatures, the substrate becomes progressively less suitable for mite development, leading to dispersal by phoresy. Mite tolerance to temperature and relative humidity may have an indirect effect on the phoretic rate. Singh et al. (1967) reported *M. muscaedomesticae* to be more sensitive to fluctuation of temperature than of relative humidity. As ambient temperature rises above their preferred range, mites leave for more favourable niches (Ho 1990).

As discussed by Hunter and Rosario (1988) for mites in general, Krantz (1998) considered that phoresy, as a survival mechanism, offered many macrochelids ample reason for development of special structures to assure their successful transfer to new habitats. According to that author, most phoretic *Macrocheles*, and species of other phoretic macrochelid genera (for example *Holocelaeno*, *Holostaspella* and *Neopodocinum*), have a special mechanism to grasp an individual seta of their beetle or fly carrier. This mechanism involves the use of a set of two closely associated teeth [referred to by Krantz (1998) as the subterminal bidentate tooth] located near the middle of the inner edge of the movable cheliceral digit and an opposing ribbed section of the the inner edge of the fixed digit. A different specialized structure is found in *M. rettenmeyeri*, which has a close association with the army ant *Eciton dulcis crassinode* Borgmeier (Rettemnmeyer 1962). Legs IV of this mite are greatly enlarged, serving as functional claws for the ant worker, by the attachment of the mite to the pulvillus of the ant hind leg.

### **1.5. Predation potential and life cycle**

Experimental data on predation potential and life cycle have only been published for species of two macrochelid genera. By far, most detailed information is available for *Macrocheles* species, with a few studies conducted on *Glyphtholaspis* species.

Several macrochelid species have been reported as predators of eggs and first instar larvae of the housefly, as first noted by Pereira and Castro (1945). However, they are also known to feed on other fly species, nematodes, collembola and other small arthropods, as subsequently described.

An important aspect interfering with the predation ability of macrochelids refers to the location of their prey in the substrate. Perotti (2001) evaluated the effect of prey (housefly eggs) location on the predatory ability of *M. muscaedomesticae* and *G. confusa*. This author showed that *M. muscaedomesticae* was an effective predator and located both hidden and exposed eggs of *M. domestica*, while *G. confusa* only showed a significant predation on hidden eggs.

### 1.5.1. *Macrocheles*

Most studies on the life cycle and prey consumption of species of this genus used fly and nematode species as prey (Table 1). Many studies refer to predation of housefly without providing details about the process (Pereira and Castro 1945; 1947; Filipponi 1959; Filipponi and Petrelli 1967; Ito 1973; Filipponi et al. 1971; Manning and Halliday 1994).

Table 1. Studies on the life cycle and prey consumption by *Macrocheles* species and respective food source.

<b><i>Macrocheles</i> species</b>	<b>Food source</b>	<b>Reference</b>
<i>M. boudreauxi</i>	Nematodes: Rhabditidae	Kinn and Witcosky (1977)
<i>M. glaber</i>	Flies: <i>Lucilia</i> sp., <i>Musca domestica</i> , <i>Musca vetustissima</i>	Filipponi (1959), Manning and Halliday (1994), Al-Dulaimi (2002)
	Nematodes: <i>Panagrellus</i> sp., Rhabditidae	Filipponi and Delupis (1963), Manning and Halliday (1994)
	Other soil invertebrates: <i>Enchytraeus albidus</i> (Enchytraeidae) and Poduromorpha Collembola	Filipponi and Delupis (1963)
<i>M. insignitus</i>	Unidentified flies	Filipponi and Ilardi (1959)
<i>M. matrius</i>	Fly: <i>M. domestica</i>	Filipponi and Cicolani (1974), Cicolani (1978), Soliman et al. (1978)
	Nematodes: Rhabditidae	Filipponi and Cicolani (1974), Cicolani (1978).
<i>M. merdarius</i>	Flies: <i>Lucilia</i> sp., <i>M. domestica</i> , <i>M. vetustissima</i>	Filipponi and Francaviglia (1964), Manning and

		Halliday (1994)
	Nematodes: <i>Panagrellus</i> sp., Rhabditidae	Filipponi and Francaviglia (1964), Manning and Halliday (1994)
<i>M. muscaedomesticae</i>	<i>M. domestica</i>	Pereira and Castro (1945, 1947), Filipponi (1959), Wade and Rodriguez (1961), Rodriguez et al. (1962), Filipponi and Delupis (1963), Wallwork and Rodriguez (1963), Filipponi and Francaviglia (1964), O'Donnel and Axtell (1964), Kinn (1966), Singh et al. (1966), Filipponi and Petrelli (1967), Willis and Axtell (1968), Filipponi (1971), Filipponi et al. (1971), Ito (1971, 1973, 1977), Al-Dulaimi (1986), Ho (1989), Geden and Axtell (1988), Geden et al. (1988, 1990), Almeida (1994), Perotti (2001), Guanilo and Cordero (2003)
	Other flies: <i>Fannia canicularis</i> , <i>Haematobia irritans</i> , <i>Musca autumnalis</i> , <i>Phormia regina</i> , <i>Stomoxys calcitrans</i>	Kinn (1966), Singh et al. (1966), O'Donel and Nelson (1967), Perotti (2001)
	Nematodes: <i>Aphelenchus avenae</i> , <i>Aphelenchoides composticora</i> , <i>Diplogasteroides</i> sp., <i>Diplogaster</i> sp., <i>Panagrellus redivivus</i> , <i>Panagrolaimus</i> sp., <i>Rhabditella</i> sp., Rhabditidae, <i>Rhabditis (Rhabditella) axei</i> ,	Rodriguez et al. (1962,) Filipponi and Delupis (1963), Filipponi and Francaviglia (1964), Filipponi and Petreli (1967), Filipponi (1971), Filipponi et al. (1971), Ito (1971, 1973, 1977), Geden and Axtell (1988), Royce and Krantz (1991)

	<i>Rhabditis elongata</i> , <i>R. teres</i> , <i>Rhitis inermiformis</i>	
	Other invertebrates: <i>Enchytraeus albidus</i> (Enchytraeidae), <i>Phthorimaea operculella</i> , Poduromorpha Collembola	Filipponi and Delupis (1963), Filipponi and Petrelli (1967), Hassan et al. (2002)
<i>M. mycotrupetes</i>	Flies: <i>M. domestica</i>	Krantz and Royce (1994)
	Nematode: <i>Rhitis inermiformis</i>	Royce and Krantz (1991), Krantz and Royce (1994)
<i>M. parapisentii</i>	Nematodes: Rhabditidae	Costa (1967)
<i>M. penicilliger</i>	Flies: <i>Lucilia</i> sp., <i>M. domestica</i> , <i>M. vetustissima</i>	Filipponi (1971), Manning and Halliday (1994)
	Nematodes: <i>Panagrellus</i> sp., Rhabditidae	Filipponi (1971), Manning and Halliday (1994)
<i>M. peniculatus</i>	Flies: <i>Lucilia</i> sp., <i>M. domestica</i> , <i>Musca vetustissima</i>	Filipponi and Delupis (1963), Filipponi and Francaviglia (1964), Filipponi (1971), Manning and Halliday (1994)
	Nematodes: <i>Panagrellus</i> sp., Rhabditidae	Filipponi and Delupis (1963), Filipponi (1971), Manning and Halliday (1994)
	Other invertebrates: <i>Enchytraeus albidus</i> , Poduromorpha Collembola	Filipponi and Delupis (1963), Filipponi and Francaviglia (1964)
<i>M. peregrinus</i>	Flies: <i>Haematobia irritans exigua</i> , <i>Haematobia thirouxi potans</i>	Doube et al. (1986), Roth et al. (1988)
<i>M. perglaber</i>	Flies: <i>M. domestica</i>	Filipponi and Delupis (1963), Filipponi and Francaviglia (1964), Filipponi and Petreli (1969)
	Nematodes: Rhabditidae, <i>Rhitis inermiformis</i>	Filipponi and Delupis (1963), Filipponi and Francaviglia (1964), Filipponi and Petreli (1969), Royce and Krantz (1991)
	Other invertebrates: <i>Enchytraeus albidus</i>	Filipponi and Delupis (1963), Filipponi and

	(Enchytraeidae) and Poduromorpha Collembola	Petrel (1969)
<i>M. pisentii</i>	Nematode: <i>Rhitis inermiformis</i>	Royce and Krantz (1991)
<i>M. robustulus</i>	Flies: <i>Bradysia</i> spp., <i>Lucilia</i> sp., <i>M. domestica</i> , <i>Musca vetustissima</i>	Filipponi and Delupis (1963), Filipponi and Mosna (1968), Manning and Halliday (1994), Grosman et al. (2011)
	Nematodes: <i>Panagrellus</i> sp., Rhabditidae.	Filipponi and Delupis (1963), Costa (1966), Manning and Halliday (1994)
	Other invertebrates: <i>Enchytraeus albidus</i> (Enchytraeidae), <i>Frankliniella occidentalis</i> , Poduromorpha Collembola	Filipponi and Delupis (1963), Messelink and Holstein-Saj (2008)
<i>M. rodriguezii</i>	Acarid mites (Acaridae)	Oliver and Krantz (1963)
<i>M. saceri</i>	Nematode: <i>Rhitis inermiformes</i>	Royce and Krantz (1991)
<i>M. scutatus</i>	Fly: <i>M. domestica</i>	Filipponi and Delupis (1963)
	Nematodes: Rhabditidae	Filipponi and Delupis (1963)
	Other invertebrates: <i>Enchytraeus albidus</i> (Enchytraeidae) and Poduromorpha Collembola	Filipponi and Delupis (1963)
<i>M. similis</i>	<i>Tyrophagus similis</i>	Saito and Takaku (2013)
<i>M. subbadius</i>	Flies: <i>Lucilia</i> sp., <i>M. domestica</i> , <i>M. vetustissima</i>	Filipponi and Francaviglia (1964), Filipponi (1971), Cicolani et al. (1977), Manning and Halliday (1994)
	Nematodes: <i>Panagrellus</i> sp., Rhabditidae, <i>Rhitis inermiformis</i>	Filipponi and Francaviglia (1964), Filipponi (1971), Royce and Krantz (1991), Manning and Halliday (1994)
<i>M. superbus</i>	Flies: Diptera	Blaszak et al. (1990)
	Other invertebrates:	Blaszak et al. (1990)

	Enchytraeidae, Poduromorpha Collembola	
<i>M. vernalis</i>	Nematode: <i>Rhitis inermiformis</i>	Royce and Krantz (1991)
<i>M. virgo</i>	Flies: <i>Lucilia</i> sp., <i>Musca vetustissima</i>	Manning and Halliday (1994)
	Nematodes: <i>Panagrellus</i> sp.	Manning and Halliday (1994)

Predation rates were reported for *M. muscaedomesticae* on housefly (Filipponi and Delupis 1963; Wallwork and Rodriguez 1963; O'Donnell and Axtell 1964; Kinn 1966; Singh et al. 1966; Willis and Axtell 1968; Ito 1977; Soliman et al. 1978; Al-Dulaimi 1986; Geden et al. 1988, 1990; Geden and Axtell 1988; Almeida 1994; Perotti 2001; Guanilo and Cordero 2003), little housefly (*Fannia canicularis* L.) (Singh et al. 1966; O'Donnell and Nelson 1967), face fly (*Musca autumnalis* De Geer) (Singh et al. 1966), black blow fly (*Phormia regina* Meigen) (Kinn 1966), stable fly (Kinn 1966) and horn fly (*Haematobia irritans* L.) (Perotti 2001). Predation rates were also reported for *Macrocheles peregrinus* Krantz on buffalo fly (*Haematobia irritans exigua* de Meijere) (Doube et al. 1986; Roth et al. 1988) and the African buffalo fly (*Haematobia thirouxi potans* Bezzi) (Doube et al. 1986), as well as for *Macrocheles glaber* (Müller) on housefly (Al-Dulaimi 2002).

Adult *M. muscaedomesticae* have a marked preference for housefly eggs over first instar larvae (Filipponi 1955; Ito 1977; Almeida 1994; Perotti 2001; Al-Dulaimi 2002), while protonymphs and deutonymphs have a preference for nematodes (Rodriguez et al. 1962; Filipponi and Delupis 1963; Ito 1977).

Development and reproduction on housefly were reported for *Macrocheles insignitus* Berlese (Filipponi and Ilardi 1959); *M. muscaedomesticae* (Wade and Rodriguez 1961; Filipponi and Francaviglia 1964; Filipponi and Petrelli 1967; Filipponi et al. 1971; Soliman et al. 1978; Al-Dulaimi 1986; Ho 1989; Geden et al. 1990; Almeida 1994); *Macrocheles merdarius* (Berlese), *Macrocheles peniculatus* Berlese and *M. subbadius* (Filipponi and Francaviglia 1964); *Macrocheles perglaber* Filipponi and Pegazzano (Filipponi and Francaviglia 1964; Filipponi and Petrelli 1969), *Macrocheles matrius* Hull (Cicolani 1978) and *M. glaber* (Al-Dulaimi 2002).

Development and reproduction of *M. muscaedomesticae* on a lepidopteran species (*Phthorimaea operculella* Zeller, Gelechiidae, the potato tuber moth) was also reported by

Hassan et al. (2002), who found a considerable number of these mites associated with *P. operculella* on stored potatoes.

Macrochelid predation on mites has been reported less frequently, and always involving species of Astigmatina, which usually require high levels of environmental humidity to develop. The life cycle of *Macrocheles rodriguezii* Oliver and Krantz on an unidentified astigmatine of the family Acaridae was studied by Oliver and Krantz (1963). The predator was able to develop and oviposit on that prey, but not on an unidentified astigmatine of the family Histiostomatidae (cited as Anoetidae). Predation of *Macrocheles robustulus* (Berlese) on *Carpoglyphus lactis* (L.) was reported by Grosman et al. (2011), while Saito and Takaku (2013) investigated the predation capacity of *Macrocheles similis* Krantz and Filipponi on *Tyrophagus similis* Volgin.

Consumption of nematodes by *Macrocheles* species has also been widely observed. It was reported for *M. muscaedomesticae* on an unidentified nematode (Filipponi and Delupis 1963), on *Rhabditis elongata* Schneider (Ito 1971, 1973, 1977), on *Rhabditella axei* (Cobbold) (Filipponi and Petrelli 1967), and on *Rhabditis teres* (Schneider), *Panagrellus redivivus* L., *Aphelenchus avenae* Bastian and *Aphelenchoides composticola* Franklin (Ito 1971). Predation has also been reported for *Macrocheles glaber*, *M. peniculatus*, *M. perglaber*, *M. robustulus* and *M. scutatus* (Berlese) on an unidentified nematode (Filipponi and Delupis 1963).

In addition, nematodes have been shown to allow development and reproduction of *Macrocheles*. Available reports include *M. merdarius*, *M. muscaedomesticae*, *M. peniculatus*, *M. perglaber* and *M. subbadius* on unidentified free living nematodes (Filipponi and Francaviglia 1964); *M. robustulus* and *Macrocheles parapisentii* Costa on *Panagrellus* sp. (Costa 1966, 1967, respectively); *M. muscaedomesticae*, *M. boudreauxi* Krantz and *M. matrius* on rhabditoid nematodes (Filipponi et al. 1971, Kinn and Witcosky, 1977 and Cicolani, 1978, respectively); *M. matrius* on *Rhabditella axei* (Filipponi and Cicolani, 1974); *Macrocheles mycotrupetes* Krantz and Mellot on *Rhitis inermiformis* (Osche) (Krantz and Royce 1994); and *M. glaber*, *M. merdarius*, *M. penicilinger* (Berlese), *M. peniculatus*, *M. subbadius* and *M. virgo* Halliday on *Panagrellus* sp. (Manning and Halliday 1994).

The available information has demonstrated the ability of *Macrocheles* species to prey and reproduce on a range of other food items, demonstrating their polyphagous behavior. A few studies have reported several collembolan (Arthropoda: Entognatha) and *Enchytraeus* (Annelida: Oligochaeta) species to allow development and reproduction of different species of *Macrocheles*. Predation on collembolans of the order Poduromorpha and on *Enchytraeus*



*albidus* Henle was reported by Filipponi and Delupis (1963) and Filipponi and Petrelli (1967) for *M. muscaedomesticae*, and by Filipponi and Petrelli (1967) for *M. peniculatus*, *M. robustulus*, *M. perglaber*, *M. glaber* and *M. scutatus*. Feeding on wounded or dead enchytraeid, larvae of house cricket (*Acheta domesticus* (L.)) and housefly by *M. glaber* was reported by Ignatowicz (1974).

Aspects of food ingestion have been studied by different authors. Filipponi and Delupis (1963) observed that the food preferred by a species was not always the same as that ensuring its greatest reproductive rate. This has also been reported by other authors for other groups of Mesostigmata (Cavalcante 2014). Filipponi and Delupis (1963) also observed that the food preferred by immatures did not always coincide with that preferred by adults. Studies have also been conducted on the interference of a food item on the ingestion of other food items. Ito (1973) noted that although the availability of nematodes to *M. muscaedomesticae* reduced its predation rate on little housefly eggs, its reproduction rate was remarkably enhanced when nematodes were also available as food.

Several studies have been conducted on the effect of temperature on the biology of different *Macrocheles* species, including *M. glaber* (Filipponi 1959), *M. muscaedomesticae* (Wallwork and Rodriguez 1963; Filipponi 1971; Filipponi et al. 1971; Geden and Axtell 1988; Almeida 1994; Hassan et al. 2002), *M. matrius* (Filipponi and Cicolani 1974; Cicolani 1978), *M. penicilliger*, *M. peniculatus* and *M. subbadius* (Filipponi 1971). Biological parameters obtained by different authors under different temperature regimes were summarized by Cicolani (1979). She reported development of *Macrocheles* species from egg to adult to be completed in periods ranging from 1.4 (*M. robustulus*) to 4.6 (*M. penicilliger*) days; the fecundity to range from 53.3 (*M. penicilliger*) to 163.2 (*M. matrius*) adult offspring per female; and the intrinsic rate of population increase to range from about 0.323 (*M. penicilliger*) to 0.906 (*M. muscaedomesticae*). These values are significantly higher than those reported for other groups of Mesostigmata. For instance, the highest values of intrinsic rate of population increase reported for Phytoseiidae mites correspond to the lowest levels determined for those *Macrocheles* species (Sabelis 1985). The duration of immature development at temperatures ranging from 15 to 35 °C has been observed to vary between two and five days, while fecundity ranged between 0.2 and 8 eggs per female per day.

A simulation model for *M. muscaedomesticae* population dynamics and predation rates on immature housefly, taking into account temperature as well as other environmental factors, was first proposed by Geden et al. (1990). The authors reported close agreement between mite populations predicted by the model with actual populations from validation

experiments. Simulations models may be helpful in describing interactions of biotic factors and thus aid decision making in fly management.

### 1.5.2. *Glyphtholaspis*

Predation rates were reported for *G. confusa* on housefly (Axtell 1961; Geden et al. 1988), horn fly (Halliday and Holm 1987; Perotti 2001), and Australian bush fly (*Musca vetustissima* Walker) (Halliday and Holm 1987). Only one study has been published on the development and reproduction of *Glyphtholaspis*. Afifi (1989) reported that *Glyphtholaspis americana* (Berlese) can complete immature development on housefly eggs and larvae. Adult female longevity and fecundity of *G. americana* were determined to be higher than those observed for *M. robustulus* and *M. carinatus*. Immature development of *G. americana* was completed in 6.5 days, females lived for an average of 71.4 days, while average fecundity was 14.3 eggs per female when feeding on housefly eggs. The average total number of housefly eggs consumed during the adult female stage by this species was 247.

Studies on the feeding behavior of some manure-inhabiting mesostigmatids mites on free-living nematodes concluded that *G. confusa* was not attracted to nematodes (Ito 1971). However, Afifi (1989) reported successful development and reproduction of *G. americana* feeding on free-living nematodes, although oviposition rates and longevities were lower on mites fed upon nematodes.

## 1.6. Reproduction

Apparently one of the first reports concerning the modes of reproduction of macrochelids was published by Kramer (1876), who referred to the scarcity of males in *M. muscaedomesticae*. Canestrini (1881) interpreted this as an indication of the occurrence of parthenogenesis in this species. Almost 70 years later, Pereira and Castro (1947) demonstrated experimentally the occurrence of arrhenotoky in *M. muscaedomesticae*.

Norton et al. (1993) summarized the published information regarding the modes of reproduction of macrochelids and presented a list of species undergoing thelytoky (species of *Geholaspis* and *Macrocheles*) and arrhenotoky (species of *Glyphtholaspis*, *Holostaspella* and *Macrocheles*). Thelytoky was also reported by Halliday (1993) and Manning and Halliday (1994) (*Macrocheles*), while arrhenotoky was also reported by Cicolani (1983) and Manning and Halliday (1994) (*Glyphtholaspis* and *Macrocheles*).

The role of pheromones has been investigated in macrochelid reproduction. Krantz and Redmond (1989) suggested the opening of the cribral glands of *M. perglaber* (localized in the posterior portion of female ventrianal shield) to be sites of sex pheromone release, the cribrum (on the posterior end of the ventrianal or anal shield) functioning as a dispersal platform for these substances. Adult males of *M. muscaedomesticae* were observed to mount on pharate female deutonymphs, preventing other males from approaching them, mating soon after emergence of the adult (Yasui, 1988, 1992). According to Yasui (1996) males are able to assess the insemination status of other males, adjusting duration of copulation according to the probability of fertilizing eggs with their own sperm. Males were able to assess the value of their mates according to the age and reproductive status of the latter (Yasui 1996).

Krantz and Wernz (1979) studied the mechanism of sperm transfer and various aspects of pre-mating and mating behavior in *G. americana*. They observed that the oozing sperm droplet is taken up by one of the male chelicerae, which then remain closely appressed to each other throughout the transfer process, allowing uninterrupted sperm flow from the droplet to the spermadactyl of the opposing chelicera, which ultimately does the actual insemination.

The relationship between distribution of macrochelid species and type of reproduction was examined by Manning and Halliday (1994). Not needing to mate before reproduction, thelytokous species should have an advantage in colonising patchy and temporary habitats over sexually reproducing species. However, Manning and Halliday (1994) concluded that thelytokous species (*M. penicilliger*, *M. peniculatus* and *M. virgo*) were usually found in temporarily stable, physically continuous habitats such as leaf litter and compost. They also observed that arrhenotokous species (*M. glaber*, *M. merdarius*, *M. robustulus*, *M. subbadius* and *G. americana*) were found in a variety of habitats, but especially in ephemeral scattered habitats. This occurs because arrhenotokous macrochelid females can mate with their own sons (Manning and Halliday 1994), producing fertilized eggs to establish a new population even when males are not available beforehand in the newly reached habitat.

## 1.7. Behaviour

Laboratory and field observations have confirmed the importance of semiochemicals in the relation between macrochelids and other organisms serving as their carriers or their prey (Krantz 1998). Strong positive responses of *Macrocheles pisentii* (Berlese), *Macrocheles*

*saceri* Costa and *M. mycotrupetes* were reported to be elicited by surface extracts of their scarab carriers (Krantz 1991, 1998). The effect of those chemicals may be remarkably strong in some cases. Krantz and Royce (1994) reported the ability of *M. mycotrupetes* to commute between underground galleries of its beetle hosts by moving through a sandy substrate for up to 80 mm, stimulated by chemicals produced by beetles in a different gallery.

Specialized receptors present on tarsus I are presumed to play a major role in the perception of volatile compounds. Farish and Axtell (1966) demonstrated that the removal of tarsi I of *M. muscaedomesticae* resulted in lack of attraction of the mite to housefly eggs, pupae or adults. This result led the authors to conclude that receptors of olfactory stimuli are present on tarsi I. Jalil and Rodriguez (1970) concluded that among the several setae of tarsi I, the longer, terminal setae were the most important in odor perception. This was later corrected by Coons and Axtell (1973), who reported that the setae involved in odor perception were the neighboring (also terminal) peg-like setae. Jalil and Rodriguez (1970) and Wicht et al. (1971) demonstrated the attraction of *M. muscaedomesticae* to water-soluble compound(s) released by adult houseflies. Wicht et al. (1971) pointed out that water extracts from adult houseflies could contain an amino sugar or a polysaccharide present on both males and females.

Jalil and Rodriguez (1970) showed preference of *M. muscaedomesticae* for odors of housefly adults over housefly eggs. Borden (1989) reported higher olfactory attraction of the same predator to the little housefly adults, followed by the attraction to eggs, larvae and pupae. This author concluded that the predators would benefit from choosing adults, to assure dispersal to new breeding sites.

Adults of *M. muscaedomesticae* have been shown to congregate around the anterior end of stable fly pupae, attaching to the adults as they emerge (Greenberg and Carpenter 1960). The predator often attaches to abdomen of adult housefly (Jalil and Rodriguez 1970), especially on the ventral surface (Ho, 1990; Rodrigueiro and Prado 2004).

Perception of non-volatile compounds was assumed to be determined by different sensors located on the palpi of *M. muscaedomesticae* (Farish and Axtell 1966; Coons and Axtell 1973).

Other chemicals seem to affect other types of behavior of macrochelids. In laboratory experiments, addition of ammonia to the substrate was observed to increase the predation rate of *M. muscaedomesticae* (Rodriguez and Wade 1961; Wallwork and Rodriguez 1963). This is not surprising, given that its main prey, the housefly, is attracted to ammonia, naturally released from the nitrogenous compounds in bovine manure (Wallwork and Rodriguez 1963). Attraction of *M. muscaedomesticae* to ammonia and to skatole was also demonstrated (Jalil

and Rodriguez 1970). These observations might be important in the implementation of applied biological control programs.

### **1.8. Potential for the practical use of macrochelids in biological control**

Soil mesostigmatid mites have the potential to control plant pests that spend part of their lives in the soil or litter, or that attack underground plant parts (Eickwort 1983; Lesna et al. 1995; Gerson et al. 2003). Some of them, including the macrochelids, also have the potential to reduce population levels of noxious flies associated with animal excreta or decomposing animal cadavers (Wallace et al. 1979; Krantz 1983a). Given the ability of macrochelids to feed on a variety of soil invertebrates, it is certainly conceivable that they could be used for applied biological control (Walter and Ikonen 1989).

Pereira and Castro (1945) were the first to claim that a macrochelid species had a definitive role as a biological control agent, referring to the predation of the housefly by *M. muscaedomesticae*. The first thorough appraisal of macrochelids as biological control agents was done by Axtell (1969), centering his discussion on the potential of augmentative release of these mites to control synanthropic flies. He highlighted positive and negative aspects of macrochelid biology and ecology in relation to their potential as control agents of the housefly and other manure inhabiting synanthropic flies. He emphasized the need for the development of means to mass produce macrochelids at low cost, making their field releases possible early in the fly breeding season. In addition, Axtell (1969) suggested that better control might be achieved by the concurrent use of one or more macrochelid species in association with other types of natural enemies. He was quite positive about the potential use of macrochelids for fly control, especially within the scope of integrated management programs.

The second comprehensive appraisal of the potential use of macrochelids as control agents was by Krantz (1983a), who summarized the differences between the mite fauna found in what he termed domestic and pastoral settings, referring to dung accumulations and to individual dung pads, respectively. He placed special importance on understanding these differences when proposing biological control programs, due to the lower diversity of insect groups that could serve as carriers for macrochelids in domestic rather than in pastoral settings. According to this author, dung beetles tend to favor isolated dung pads, so that synanthropic flies are the only common potential carriers for the macrochelids of domestic settings (where synanthropic flies predominate). He listed a series of factors considered necessary to allow the widespread use of macrochelids as biological control agents in both

settings, within the concept of integrated pest management programs. In relation to pastoral settings, Krantz (1983a) emphasized the importance of considering the introduction of prospective macrochelids and their carriers from other regions in a classical biological control approach.

Beaulieu and Weeks (2007) reviewed the role of free-living mesostigmatid mites as biological control agents in Australia. They mentioned the following traits as making some macrochelids suitable as fly control agents: (i) aggressive behaviour and feeding preference for fly eggs and larvae; (ii) high rate of population increase; (iii) efficient dispersal on a variety of dung-inhabiting beetles; and (iv) the ease with which they can be reared on flies or nematodes (Krantz 1983a).

A discussion is presented below on the potential of macrochelid species as biological control agents of specific groups of harmful organisms.

### **1.8.1. Housefly**

Applied biological control activities are usually classified in three general tactics, conservation, augmentation and classical biological control. While considering the conclusion of Pereira and Castro (1945) on the potential for the use of *M. muscaedomesticae* for housefly control, Axtell (1969) listed eleven attributes that in his view made this species a prospective control agent of that prey. These essentially referred to the preference of the predator to inhabit sites also preferred by the fly, to its phoretic behavior on the fly, and to the biological characteristics that enable it to survive under unfavorable environmental conditions.

Practical use of *M. muscaedomesticae* could benefit from the results of the work of Wallwork and Rodriguez (1963), which suggested that the addition of ammonia to the substrate may increase predation. Gerson et al. (2003) concluded that the ability of *M. muscaedomesticae* to bring about satisfactory housefly control also depended on the presence of alternate prey. According to these authors, the alternative prey (e.g. acarid mites, nematodes and larvae of other flies) helped to maintain predator fecundity and longevity when housefly numbers declined. From the previous sections of this chapter, it is clear that this predator has the ability to feed on several other organisms in addition to housefly. The release of nematodes to increase the population of macrochelids has also been proposed by different authors (Axtell 1969; Wicht and Rodriguez 1970; Ito 1973).

Effective control of housefly by *M. muscaedomesticae* and *G. confusa* was also reported by Axtell (1963a, b) in calf and poultry manure. Significant reductions in fly

populations by these predators were observed under natural conditions, but the reduction was much more significant, reaching up to 85.5%, when the predators were augmented (Axtell 1963a; Singh et al. 1966). Effective control of houseflies in poultry houses, with up to 99% reduction in population level, was obtained by Rodriguez et al. (1970). Krantz (1983a) commented that despite this positive evidence, widespread use of the macrochelids for fly control in calf and poultry manure had not occurred due to several factors, including the total removal of manure, lack of understanding about the interactions between and among biotic and abiotic components of the system, and lack of efficient rearing methods.

### 1.8.2. Other flies

Given the demonstrated ability of macrochelids to feed on the housefly, an obvious question to be asked is what is their potential use as control agents of other important flies.

Works conducted so far do not show a clear potential of macrochelid species as biocontrol agents, suggesting that further studies are necessary. Several studies highlight the importance of the early arrival of the mites, on their dung beetle carriers, for maximum predation to take place. Wallace et al. (1979) suggested that the native Australian macrochelids, *M. glaber* and *M. perglaber* (according to Beaulieu and Weeks 2007, both referred to as *M. glaber*) could control the Australian bush fly, provided the predators could be brought to the dung pad soon after the flies laid their eggs. They concluded that significant improvement in Australian bush fly control could be achieved in southeastern Australia by introducing a dung beetle that could carry the mites. The dung beetles should have high flight activity in the afternoon and/or evening, coinciding as close as possible with the flight activity of the fly.

*Macrocheles peregrinus* was introduced from South Africa to Australia for control of the Australian bush fly and the buffalo fly (Wallace and Holm 1983). Roth et al. (1988) considered it had a significant effect on the Australian bush fly, which oviposites in parts of the dung pad accessible to the mite, i.e. on the surface. However, they considered the predator to be ineffective in the control of the buffalo fly, providing an estimated suppression of 33% of the population under field conditions.

Another promising result was obtained by Singh et al. (1966). The authors reported 92% control of little housefly in an experiment conducted under semi-field condition, with the release of *M. muscaedomesticae* at a ratio of one mite to five muscid eggs. Further studies to confirm that efficiency are necessary.

### 1.8.3. Other arthropods

Regardless of the most common occurrence of macrochelids in association with patchy habitats, some inhabit more uniform environments. *Macrocheles robustulus* has often been found in greenhouse soils (Messelink and van Holstein-Saj 2008), where it arrives with the introduction of compost (Messelink and Kogel 2005). This species performed better as predator of the thrips (Thripidae) *Frankliniella occidentalis* (Pergande) (Messelink and van Holstein-Saj 2008) and of fungus gnats *Bradysia* spp. (family Sciaridae) (Grosman et al. 2011), than the predatory mite *Gaeolaelaps aculeifer* (Canestrini) (Laelapidae). In the case of the sciarids, the predator's population increased with the addition of mulch containing an astigmatid mite that served as an alternative prey, on which the predators were previously reared. *Macrocheles robustulus* is presently commercially available for the control of pre-pupae and pupae of thrips as well as larvae of *Lyprauta* sp. (Keroplastidae) sciarids.

### 1.9. Rearing techniques

Efforts to develop rearing techniques for macrochelid mites under laboratory conditions started long ago. Pereira and Castro (1946, 1947) were apparently the first to rear *M. muscaedomesticae* for experimental purposes, using porous clay substrates to prevent water condensation, and allowing humidity retention and air exchange.

The effect of environmental factors that could interfere with the mass production of *M. muscaedomesticae* was discussed by Rodriguez and Wade (1961), based on laboratory and semi-field observations. The type of substrate, livestock feed additives, pH, temperature and relative humidity had an effect on the reproduction of *M. muscaedomesticae*. They proposed a substrate for the production of macrochelids, which included housefly eggs and nematodes as food. Filipponi (1964) presented a series of recommendations for rearing macrochelid mites for experimental taxonomic studies, including a substrate, food items (housefly eggs and nematodes), and the containers to be used. He also mentioned the procedure used for the production of the nematodes.

Singh and Rodriguez (1966) reported successful results in their efforts to mass rear *M. merdarius*, *M. muscaedomesticae* and *M. subbadius* on the nematode *Rhabditella leptura* (Cobb). They also standardized a method for rearing the nematode species in the laboratory. Ho et al. (1990) developed a mass-production method for *M. muscaedomesticae*, involving the use of spent housefly media, frozen housefly eggs, and the nematode *Protorhabditis* sp..



At about the same time, Royce and Krantz (1991) developed a rearing method that was successfully used for the production of several macrochelid species including, *M. muscaedomesticae*, *M. mycotrupetes*, *M. perglaber*, *M. pisentii*, *M. saceri*, *M. subbadius*, *M. vernalis* and *G. confusa*. It consisted of the production of nematodes in a fly rearing medium, which was then periodically supplied to the mite colonies in jars lined with plaster-of-paris/charcoal.

An important aspect to consider is the common cannibalistic behavior of the macrochelids (Wade and Rodriguez 1961; Ignatowicz 1974). Almeida (1994) proposed the use of pieces of ceramics at the bottom of the rearing units to reduce the rate of cannibalism.

More recently, Grosman et al. (2011) reported the use of the astigmatid mite *C. lactis* for the mass production of *M. robustulus*. Details about the rearing process were not provided, except that the prey was reared on bran. Astigmatine mites have long been widely used for the mass production of other predatory mites (Ramakers and van Lieburg 1982). However, the use of astigmatines for the production of macrochelids is interesting for the fact that, as mentioned previously in this chapter, relatively few studies have reported predation by macrochelids on astigmatids.

### **1.10. Integrated Management**

The natural occurrence of macrochelids in animal excreta under different ecological conditions was known before the widespread use of chemical insecticides became common for fly control. The deleterious effect of insecticides on those predators soon became evident to researchers (Axtell 1963a, 1966, 1968, 1970; Axtell and Rultz 1986; Rodriguez et al. 1970; Anderson 1983; Axtell and Arends 1990; Mattos 1992). It was then concluded that conservation of predators could improve fly control, especially implementing techniques to reduce the humidity in dung piles, judicious removal of manure, and use of selective pesticides (Axtell 1986, 1999).

Axtell (1991) constructed simulation models to evaluate the effect of different densities of *M. muscaedomesticae*, application of different insecticides, presence or absence of alternative prey and manure-removal on housefly population. Maintaining the manure as dry as possible through proper air ventilation, drainage and phased manure removal, were considered essential for the success of fly control. Stafford and Bay (1987) determined that *M. muscaedomesticae* preferred slightly drier areas than the third instar larvae of the housefly; most of the mites were found in the manure cones, where fly eggs were also more abundant.

Deleterious effect of bi-weekly and monthly manure removal on predatory mites, mainly macrochelids, was shown by Peck and Anderson (1970), Erőss and Mahunka (1971), Wills et al. (1990) and Mullens et al. (1996; 2001). The first authors noticed that at least 4 weeks were required before *M. muscaedomesticae* population could reach the densities found in older, unremoved manure. The authors suggested different manure management schedules to allow more effective predation of the housefly by macrochelids.

### 1.11. Possible limitations

Axtell (1969) listed six aspects he considered as possible limitations in relation to the use of macrochelids for fly control. Among these were humidity requirements, population increase and predation rates, limited prey stages attacked (mostly eggs and first instar larvae) and susceptibility of macrochelid immatures to predation by other organisms.

Some studies suggest that egg structure may have an important bearing on the predation potential of macrochelids. The limited ability of *M. muscaedomesticae* to feed on stable fly eggs was attributed to their thicker chorion in comparison with housefly eggs (Kinn 1966).

All nine macrochelid species studied by Halliday and Holm (1987) were observed to consume eggs of the Australian bush fly, but only the larger species were able to feed on the eggs of the buffalo fly, probably due to the thicker chorion of the latter. In a subsequent experiment, the ineffective control of the buffalo fly in Australia by the introduced *M. peregrinus* was attributed mostly to its preference for fly species that had softer egg chorion (Roth et al. 1988). Before any effort is initiated for the mass production of macrochelids for practical use, adequate selection of predators is essential.

Success in biological control of a particular species of unwanted organism cannot be immediately deduced from laboratory tests, most often conducted under artificial conditions. This is exemplified by the observations by Kinn (1966), who reported effective predation of eggs and first instar larvae of black blow fly by *M. muscaedomesticae* under laboratory condition, but concluded that it was unlikely that it played an important role in the control of that insect, as *M. muscadomesticata* is seldom found on carrion, the preferred habitat of the black blow fly.

Still another limitation to predation of fly eggs relates to macrochelid oviposition behavior and fly biological traits. *Musca sorbens* Wiedemann deposits clusters of several hundred eggs into fresh dung. These hatch quickly enough to escape predation by *M.*

*muscaedomesticae*, which cannot colonise the droppings in time to attack most eggs. The most exposed eggs of the cluster can be attacked, but these become hard and dry, forming a barrier that protects the inner eggs of the cluster from predation (Toyama and Ikeda 1976).

In relation to the use of macrochelids for nematode control, possible limitations refer mainly to the relatively large size of these mites, physically preventing their movement deep into the soil. Most plant parasitic nematodes are found in association with roots, at least several centimeters below the soil surface. Parasitic nematodes are found on aerial parts of some low growing plants, but macrochelids have rarely been found on aerial plant parts (a *Macrocheles* species was recently found by T. Ranielle in the state of Pernambuco, in northeast Brazil, in flowers of *Heliconia bihai* L.), and their use in this type of habitat seems improbable.

Predation of macrochelids on annelids of the family Enchytraeidae could be seen as a limitation in the use of these predators, given that enchytraeids are considered beneficials for their natural role in the decomposition process of organic matter. However, the alternative control of pest species with agrochemicals may cause considerable mortality of enchytraeids. In addition, most macrochelids considered for practical use are found in patchy habitats, implying that they do not seem to have a close association with enchytraeids, of seemingly more uniform distribution in the environment.

The introduction of a macrochelid from a different region of the world warrants a careful evaluation of benefits and potential problems that could result from the introduction. However, the use of macrochelid species naturally occurring in the area where the pest is present, is not expected to cause major impact on enchytraeid population, especially in areas of traditional agriculture, where other factors (as the use of fertilizer) is already expected to reduce enchytraeid populations.

### **1.12. Suggested complementary studies**

It is widely known that the success in biological control efforts of unwanted organisms is dependent upon adequate taxonomic and ecological knowledge of the species to be controlled as well as of the prospective biological control agent. Macrochelids have received limited attention in most countries, and their potential should still be considered to be limited (Krantz 1983a). However, researchers involved in the biological control of organisms that spend part of their life in discontinuous habitats, where these mites are most

commonly found (especially fly species), might consider macrochelids to deserve special attention. The initial effort in these countries should concentrate on faunistic studies to enable correct determination of the species present, their population dynamics, and their relationships with other organisms.

A series of other more applied topics for research could then be established, involving the evaluation of groups of organisms to be targeted for control. One of these special cases refers to nematodes that are intestinal parasites of farm animals. These are periodically eliminated in the faeces of their hosts. The potential role of macrochelids in the control of these organisms has not been adequately explored. Given the reported suitability of many soil nematodes as food for macrochelids, it seems likely that these predators could have some effect on those nematodes, which have free-living stages that are taken up by new hosts as part of their biological cycle.

Another seemingly important topic for research refers to a possible limitation to the use of macrochelids due to intra-guild predation. Intra-guild predation involving organisms of the same genus has been mentioned in the literature. In the laboratory, competition between *M. robustulus* (Berlese) and *M. glaber* resulted in reduced densities of the latter when both were placed together in cow dung (Wallace and Holm 1984), despite its larger size. Such competition however, is not expected to occur in the field, given that while *M. robustulus* favors domestic settings, *M. glaber* favors pastoral settings. There are also cases of intra-guild predation involving macrochelids and other species of Mesostigmata. Axtell (1969) mentioned the predation of macrochelid larvae and protonymphs by species of Parasitidae. Preliminary experimental evidence supporting that statement was presented by Ignatowicz (1974), who observed predation of *M. glaber* immatures by all mobile stages of *Parasitus coleopratorum* (L.). Thus, the presence of parasitids in the substrate might inhibit colonization by macrochelids.

However, it has also been suggested (Axtell 1962, 1963a) that the usual pattern of succession of mite groups in aging manure is characterized by the pioneer colonization by parasitids, followed by macrochelids and then other mite groups. While this assumed pattern seems to be the opposite of what was observed by Axtell (1969) and Ignatowicz (1974), additional studies on this subject are warranted, to determine the possible limitation of macrochelids by high abundance of parasitids.

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## 2. CATALOGUE OF THE FAMILY MACROCHELIDAE VITZTHUM (ACARI: MESOSTIGMATA)

### ABSTRACT

Mites of the family Macrochelidae are very abundant in excrements or decomposing animals. They are also found in nests or galleries of mammals, birds and social insects. Much has been published about the facultative or obligatory phoretic behavior of macrochelids, because of their common occurrence in patchy habitats. Several macrochelid species have been reported as predators of eggs and first instar larvae of the housefly. However, they are also known to feed on other fly species, nematodes, collembola and other small arthropods. The family includes a total of 519 species arranged in 23 genera. The largest diversity is found in *Macrocheles* Latreille (314 species), followed by *Holostaspella* Berlese, *Holocelaeno* Berlese, *Neopodocinum* Oudemans, *Nothrolaspis* Berlese, *Glypholaspis* Filipponi & Pegazzano and *Macrholaspis* Oudemans (41, 40, 38, 16, 15 and 12 species, respectively). Ten genera are monotypic. New combinations are proposed for 5 species.

Keywords: Excrements mites; Predatory mites; Fauna list

### 2.1. Introduction

Macrochelidae was originally described by Vitzthum's (1930) to contain an array of different mite groups. The current concept of this family is largely based on the works of Evans (1956), who divided that group into two subfamilies, Macrochelinae and Parholaspiniae, and of Krantz (1960), who raised those subfamilies to the family level. The taxonomic concept and nomenclatural status of the family have a complicated history because of insufficient detail provided in many of the original species descriptions. This situation has led to the creation of many synonyms, a number of homonyms and problems in ascertaining the correct name and authority for many species. The catalogue attempts to list all the original names that have been applied to species of Macrochelidae, *sensu* Krantz (1960).

The first revision of the family at the generic level was conducted by Krantz (1962b), who considered it to include ten genera. He mentioned that *Macrocheles* Latreille was by far the largest genus, with more than 100 species. He also provided keys to the species of *Geholaspis* Berlese, *Grafia* Krantz and *Lordocheles* Krantz, and listed relevant publications which included taxonomic keys, namely Valle (1953) for *Geholaspis* species; Balogh (1958)

for European species of *Longicheles*; Evans & Browning (1956) for British macrochelids; and Bregetova & Koroleva (1960) for Russian macrochelids. Since then, other important regional taxonomic papers providing keys to genera and species were published, including those of Krauss (1970) and Karg (1993) for Europe; Bregetova (1977) for the former Soviet Union; Krantz & Ainscough (1990) for North America; Halliday (2000) for Australia; and Mašán (2003) for Slovakia. More recently, Emberson (2010) provided a reappraisal of some basal macrochelid groups, providing a key to the genera and subgenera of Geholaspini, a newly proposed tribe.

Macrochelidae species are divided into three main groups, fimicolous, humicolous and insecticolous, referring to their association with excrements, humus or insects (mainly as carriers of these mites) (Filipponi, 1964). They have also been found in nests or galleries of mammals, birds and social insects, as summarized by Lindquist *et al.* (2009), where they find an ample assortment of potential food sources, represented by different organisms found in those microhabitats (Krantz & Whitaker, 1988). Macrochelids have a potential as biological control agents of organisms with which they have are commonly associated, including different species of flies, and other groups of organisms.

The aim of this work is to bring together the presently available taxonomic information about the family, providing a resource that future researchers can use when preparing more detailed studies of the group.

## **2.2. Material and Methods**

This work includes papers published up to December 2016. The search for information was initiated through a list containing all species of the family provided by Emberson in 2013 (R. M. Emberson, unpublished). New references were detected by a search of electronic databases and by the evaluation of references listed in each paper available to the authors. The catalogue proper then includes a list of species of Macrochelidae, presented in alphabetical order of genera and of species within each genus.

We have not considered intermediate categories such as subfamily, subgenus, or species groups, because too many species are not described in enough detail to allow these decisions to be done. For each genus, the following information is provided:

- Name and author;
- Original designation of the genus, author, year of the original description, page on which the description begins, family in which the genus was initially placed, type species, and further references to descriptions or re-descriptions of the genus;
- Synonyms, each followed by its author, page on which the corresponding original description started, family in which the genus was initially placed, type species, reference to the paper in which each corresponding synonymy was established, type species, and further references providing descriptive information about the junior synonym.
- The type species.

For each species, the following information is provided:

- Current generic combination of the species, with its author and date of description;
- Name of the species in its original combination, with reference to the author, date, and the page on which the description started;
- References to subsequent literature on the species, including different combinations or variations of the name, and including publications that provide information on the morphology of the species, other than the original description;
- Synonyms, each followed by its author, date, and page number, and the reference in which the synonymy was established;
- Type depository, the institution where the name-bearing type specimens are deposited;
- Type locality, mentioning first the country and then other geographic information (from the most specific to the most general), and habitat from which the species were collected, using the original description in the paper, followed in square brackets by the new name of the locality and/or host if applicable. For animal hosts, we added the names of the order and family; for plants we list the names of the family;
- Occasionally, a note was added after the details of a genus or species, to explain an unusual or complicated taxonomic or nomenclatural problem.

### 2.3. Results

#### Catalogue of word species of Macrochelidae Vitzthum, 1930

##### Genus *Aethosoma* Krantz, 1962

*Aethosoma* Krantz, 1962a: 349.

Type species: *Aethosoma burchellestes* Krantz, 1962, by monotypy.

*Aethosoma*.— Krantz, 1998: 100.

##### 001. *Aethosoma burchellestes* Krantz, 1962

*Aethosoma burchellestes* Krantz, 1962a: 349.

*Aethosoma burchellestes*.— Krantz, 1998: 100.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Trinidad and Tobago, Northern Range, Saint Augustine, June 1935, on *Eciton burchelli urichi* Forel [Hymenoptera: Formicidae].

##### Genus *Ancistrocheles* Krantz, 1962

*Ancistrocheles* Krantz, 1962b: 165.

Type species: *Ancistrocheles bregetovae* Krantz, 1962, by original designation.

*Ancistrocheles*.— Krantz, 1998: 105.

##### 002. *Ancistrocheles bregetovae* Krantz, 1962

*Ancistrocheles bregetovae* Krantz, 1962b: 165.

*Ancistrocheles bregetovae*.— Krantz, 1998: 103.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Canon, Arizona, 2 January 1937, on *Cochliomyia macellaria* F. [Diptera: Caliphoridae].

##### Genus *Bellatocheles* Van Driel & Loots, 1975

*Bellatocheles* Van Driel & Loots, 1975: 594.

Type species: *Bellatocheles variatus* Van Driel & Loots, 1975, by original designation.

**003. *Bellatocheles variatus* Van Driel & Loots, 1975**

*Bellatocheles variatus* Van Driel & Loots, 1975: 595.

**Type depository.** Royal Museum for Central Africa, Tervuren, Belgium.

**Type locality and habitat.** Democratic Republic of the Congo, Nioka, Ituri, August 1953, from unspecified host/substrate.

**Genus *Dissoloncha* Falconer, 1923**

*Macrocheles (Dissoloncha)* Falconer, 1923: 151.

Type species: *Macrocheles superbus* Hull, 1918, by original designation.

*Dissoloncha*.— Hyatt & Emberson, 1988: 76; Emberson, 2010: 40.

**004. *Dissoloncha superbus* (Hull, 1918)**

*Macrocheles superbus* Hull, 1918: 71.

*Macrocheles (Dissoloncha) superbus*.— Falconer, 1923: 151.

*Macrocheles superbus*.— Evans & Browning, 1956: 38; Bregetova & Koroleva, 1960: 89; Hirschmann, 1970d: 49; Krantz, 1972: 271; Bregetova, 1977: 368.

*Macrocheles (Macrocheles) superbus*.— Krauss, 1970: 11.

*Dissoloncha superbus*.— Hyatt & Emberson, 1988: 78; Takaku, 1997b: 19.

**Type depository.** Natural History Museum, London, England.

**Type locality and habitat.** England, Lancashire, Yorkshire, date of collection and host/substrate unspecified.

**Genus *Geholaspis* Berlese, 1918**

*Macrocheles (Geholaspis)* Berlese, 1918: 145.

Type species: *Gamasus longispinosus* Kramer, 1876, by original designation.

*Geholaspis*.— Oudemans, 1931: 273; Valle, 1953: 319; Evans, 1956: 351; Evans & Browning, 1956: 41; Bregetova & Koroleva, 1960: 62; Krantz, 1962b: 157; Krauss, 1970: 34; Hirschmann, 1970a: 44; Karg, 1971: 130; Hyatt & Emberson, 1988: 69; Karg, 1993: 99; Mašán, 2003: 46; Emberson, 2010: 40; Ösbek & Bal, 2014: 469.

*Geholaspis (Geholaspis)*.— Valle, 1953: 323; Evans & Browning, 1956: 42; Krantz, 1962b: 157; Athias-Henriot, 1968: 241; Krauss, 1970: 34; Hyatt & Emberson, 1988: 70; Karg, 1993: 100; Mašán, 2003: 46.

*Geholaspis (Cyrtocheles)* Valle, 1953: 340.

Type species: *Holostaspis longispinosus asper* Berlese, 1904a, by original designation.

*Geholaspis (Cyrtocheles)*.— Krantz, 1962b: 157; Krauss, 1970: 34; Karg, 1993: 100.

#### **005. *Geholaspis aeneus* Krauss, 1970**

*Geholaspis (Geholaspis) aeneus* Krauss, 1970: 38.

*Geholaspis aeneus*.— Hirschmann, 1970d: 49.

*Geholaspis (Geholaspis) aeneus*.— Hyatt & Emberson, 1988: 71; Karg, 1993: 100.

**Type depository.** Unspecified.

**Type locality and habitat.** Spain, “Valle de Lozera, Puento de Lozera (alt. 600 m)” [sic], Province of Lugo, date of collection unspecified, under of an old tree of *Castanea sativa* Mill. [Fagaceae] and a tree of oak *Quercus pyrenaica* Willd. [cited as *Quercus toza* – junior synonymy] [Fagaceae] from a dry creek bed.

#### **006. *Geholaspis alpinus* (Berlese, 1887)**

*Holostaspis alpinus* Berlese, 1887a: 10.

*Holostaspis alpinus*.— Berlese, 1892: 70.

*Macrocheles (Geholaspis) alpinus*.— Berlese, 1918: 145.

*Geholaspis alpina*.— Sellnick, 1931: 760.

*Geholaspis alpinus*.— Wilmann, 1938: 149; Willmann, 1941: 26; Hirschmann, 1970d: 49; Karg, 1971: 131.

*Geholaspis (Geholaspis) alpinus*.— Valle, 1953: 335; Krantz, 1962b: 171; Krauss, 1970: 37; Bregetova, 1977: 398; Karg, 1993: 101.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Italy, in field of the Florentine hills, Vallombrosa, Reggello, Tuscany, date of collection unspecified, on flies.

**007. *Geholaspis asper* (Berlese, 1904)**

*Holostaspis longispinosus* var. *asper* Berlese, 1904a: 264.

*Geholaspis* (*Cyrtocheles asper*) [sic].— Valle, 1953: 340.

*Geholaspis* (*Cyrtocheles*) *asper*.— Krantz, 1962b: 170; Bregetova, 1977: 396.

*Geholaspis* (*Geholaspis*) *asper*.— Krauss, 1970: 37.

*Geholaspis asper*.— Hirschmann, 1970d: 49.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Greece, Corfu, date and host/substrate unspecified.

**008. *Geholaspis berlesei* Valle, 1953**

*Geholaspis* (*Geholaspis*) *berlesei* Valle, 1953: 332.

*Geholaspis* (*Geholaspis*) *berlesei*.— Krantz, 1962b: 171; Krauss, 1970: 36; Bregetova, 1977: 398; Karg, 1993: 101.

*Geholaspis berlesei*.— Hirschmann, 1970d: 49; Mašán, 2003: 51; Ács & Kontschán, 2014: 110.

**Type depository.** Museo di Scienze Naturali di Bergamo, Bergamo, Italy.

**Type locality and habitat.** Italy, Vals (alt. 600 m), Ovaro, [Province of Udine], 8 August 1950, on moss in fir (*Abies* sp.) forest [Pinaceae]; Italy, Bosco Lonza (alt. 600 m), Ovaro, [Province of Udine], 24 August 1950, on moss in the forest of firs *Abies* sp. [Pinaceae]; Italy, Monte Cucasit (alt. 1800 m), 30 September 1950, in litter of *Alnus glutinosa* [Betulaceae] forest.

**009. *Geholaspis biperforatus* Krauss, 1970**

*Geholaspis* (*Geholaspis*) *biperforatus* Krauss, 1970: 39.

*Geholaspis biperforatus*.— Hirschmann, 1970a: 44, 970b: 45, 1970c: 46.

*Geholaspis* (*Geholaspis*) *biperforatus*.— Bregetova, 1977: 397; Karg, 1993: 101.

**Type depository.** Unspecified.

**Type locality and habitat.** Spain, “Villaverde de Pontes” [sic], Santander, Cantabria, date of collection unspecified, in litter of an oak [*Quercus* sp; Fagaceae] forest.

**010. *Geholaspis comelicensis* Lombardini, 1962**

*Geholaspis comelicensis* Lombardini, 1962: 197.

*Geholaspis* (*Geholaspis*) *comelicensis*.— Emberson, 2010: 41.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.



**Type locality and habitat.** Italy, Malga Coltrondo (alt. 1900 m), Comelico Superiore, Province of Belluno, 25 August 1952, in soil.

**011. *Geholaspis foroliviensis* Lombardini, 1943**

*Geholaspis foroliviensis* Lombardini, 1943: 18.

*Geholaspis* (*Geholaspis*) *longispinosus forolivensis* [sic].— Valle, 1953: 325.

*Geholaspis* (*Geholaspis*) *forolivensis* [sic].— Emberson, 2010: 41.

*Holostaspis longispinosus*.— Canestrini & Canestrini, 1882: 31; G. Canestrini, 1885: 63; Berlese, 1887b: 1 [Misidentifications, according to Valle, 1953: 325].

*Macrocheles longispinosus*.— Oudemans, 1902a: 42 [Misidentification, according to Valle, 1953: 325].

*Geholaspis* (*Geholaspis*) *longispinosus*.— Valle, 1953: 324 [Misidentification, according to Evans & Browning, 1956: 42].

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Italy, Ladino, Forlì, [Forlì-Cesena], 26 December 1932, in soil of oak [Fagaceae] forest.

**Note.** Suspected junior synonym of *Geholaspis longispinosus* (Kramer) by Krauss (1970: 37) and Mašán (2003: 48).

**012. *Geholaspis longispinosus* (Kramer, 1876)**

*Gamasus longispinosus* Kramer, 1876: 100.

*Gamasus* (*Holostaspis*) *longispinosus*.— Berlese, 1882b: 637.

*Holostaspis longispinosus*.— Berlese, 1892: 70.

*Macrocheles longispinosus*.— Berlese, 1906: 282.

*Macrocheles* (*Geholaspis*) *longispinosus*.— Berlese, 1918: 145.

*Geholaspis longispinosus*.— Wilmann, 1938: 149; Karg, 1971: 130; Hirschmann, 1970b: 45, 1970c: 46, 1970d: 49, 1987: 110; Emberson, 1973a: 120; Mašán, 2003: 48; Ács & Kontschán, 2014: 110; Ösbek & Bal, 2014: 469.

*Geholaspis* (*Geholaspis*) *longispinosus*.— Valle, 1953: 324; Evans & Browning, 1956: 42; Bregetova & Koroleva, 1960: 68; Krantz, 1962b: 171, 1972: 268; Athias-Henriot, 1968: 269; Krauss, 1970: 37; Bregetova, 1977: 397; Hyatt & Emberson, 1988: 70; Karg, 1993: 100.

*Macrocheles tridentinus* [protonymph].— Oudemans, 1902a: 42 [Misidentification, according to Oudemans, 1904: 107].

*Macrocheles longulus*.— Hull, 1918: 73 [Misidentification, according to Hyatt & Emberson, 1988: 74].

*Macrocheles (Geholaspis) castaneus* Hull, 1925: 211 [Synonymy by Valle, 1953: 355].

*Geholaspis castaneus*.— Valle, 1953: 355.

**Type depository.** *G. longispinosus*: Unspecified; *M. (G.) castaneus*: Natural History Museum, London, England.

**Type locality and habitat.** *G. longispinosus*: unspecified; *M. (G.) castaneus*: England, Allendale (cited as West Allendale), date of collection unspecified, among dead leaves.

**Note<sup>1</sup>.** Specimens reported by Canestrini & Canestrini, 1882: 31; G. Canestrini, 1885: 63; Berlese, 1887b: 1 as *Holostaspis longispinosus* (Kramer) were identified as *Geholaspis (Geholaspis) longispinosus forolivensis* [sic] Lombardini by Valle, 1953: 325.

**Note<sup>2</sup>.** Specimen reported by Oudemans (1902a: 42) as *Macrocheles longispinosus* (Kramer) were identified as *Geholaspis (Geholaspis) longispinosus forolivensis* [sic] Lombardini by Valle (1953: 325).

**Note<sup>2</sup>.** Figures of specimen reported by Valle (1953: 324) as *Geholaspis (Geholaspis) longispinosus* (Kramer) were identified as *Geholaspis forolivensis* Lombardini by Evans & Browning (1956: 42).

**Note<sup>3</sup>.** Suspected senior synonym of *Geholaspis forolivensis* Lombardini by Valle (1953: 324) and Mašán (2003: 48).

### **013. *Geholaspis pauperior* (Berlese, 1918)**

*Macrocheles (Geholaspis) alpinus* var. *pauperior* Berlese, 1918: 145.

*Geholaspis (Geholaspis) pauperior*.— Valle, 1953: 339; Krantz, 1962b: 171; Krauss, 1970: 38; Bregetova, 1977: 398; Karg, 1993: 101.

*Geholaspis pauperior*.— Hirschmann, 1970a: 44, 1970b: 45, 1970d: 49; Mašán, 2003: 53; Ács & Kontschán, 2014: 110.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Italy, Tiarno, Trentino, date of collection unspecified, on flies; Italy, Bergamo, Lombardy; Padola, Comelico Superiore, Blluno; Desenzano del Garda, Brescia; and Pontedera, Pisa, date of collection unspecified, on flies.

**014. *Geholaspis ponticus* Bregetova & Koroleva, 1960**

*Geholaspis (Cyrtocheles) ponticus* Bregetova & Koroleva, 1960: 63.

*Geholaspis (Cyrtocheles) ponticus*.— Krantz, 1962b: 170; Bregetova, 1977: 396; Karg, 1993: 100.

*Geholaspis ponticus*.— Hirschmann, 1970c: 46, 1970d: 49; Karg, 1971: 130.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Georgia, Sukhumi, Caucasus, Black Sea coast, 31 October 1957, in litter under *Rubus* sp. [Rosaceae]; Russia, Mount Akhun, Sochi, Black Sea coast, 4 November 1958, in litter in a beech [Fagaceae] forest.

**015. *Geholaspis terrestris* (Berlese, 1889)**

*Holostaspis terrestris* Berlese, 1889: 7.

*Geholaspis (Geholaspis) terrestris*.— Emberson, 2010: 41.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Unspecified.

**Genus *Geotrupacarus* Krantz, 2009**

*Geotrupacarus* Krantz, 2009: 48.

Type species: *Macrocheles mycotrupetes* Krantz & Mellott, 1968, by original designation.

**016. *Geotrupacarus mycotrupetes* (Krantz & Mellot, 1968).**

*Macrocheles mycotrupetes* Krantz & Mellott, 1968: 52.

*Macrocheles mycotrupetes*.— Krantz & Royce, 1992: 305.

*Geotrupacarus mycotrupetes*.— Krantz, 2009: 48.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Levy, Florida, 19-21 February 1959, on *Peltotrupes profundus* Howden [Coleoptera: Geotrupidae].

**017. *Geotrupacarus peltotrupes* (Krantz & Mellot, 1968)**

*Macrocheles peltotrupes* Krantz & Mellott, 1968: 54.

*Macrocheles peltotrumpetes*.— Hirschmann, 1970d: 51.

*Geotrumpacus peltotrumpetes*.— Krantz, 2009: 48.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Levy, Florida, 19-21 February 1959, on *Peltotrumpes profundus* Howden [Coleoptera: Geotrupidae].

### **Genus *Glypholaspis* Filipponi & Pegazzano, 1960**

*Macrocheles (Macrocheles)*.— Berlese, 1918: 172, *in part*.

*Glypholaspis* Filipponi & Pegazzano, 1960: 136.

Type species: *Nothrolaspis fimicola* Sellnick, 1931, by original designation [= *Macrocheles (Macrocheles) marginatus* (Hermann) *sensu* Berlese, 1918: 172].

*Glypholaspis*.— Krantz, 1962b: 152; Filipponi & Pegazzano, 1962a: 186; Hyatt & Emberson, 1988: 114; Mašán, 2003: 122.

*Macrocheles (Glypholaspis)*.— Bregetova, 1977: 384; Karg, 1993: 101.

### **018. *Glypholaspis americana* (Berlese, 1888)**

*Holostaspis marginatus* var. *americanus* Berlese, 1888: 195<sup>Note1</sup>.

*Macrocheles (Macrocheles) americanus*.— Berlese, 1918: 172.

*Glypholaspis americana*.— Filipponi & Pegazzano, 1960: 148; Filipponi & Pegazzano, 1962a: 192; Petrova, 1967a: 25; Krantz, 1972: 270; Emberson, 1973a: 121; Halliday, 1986c: 73; Hyatt & Emberson, 1988: 116; Roy, 1989b: 345; Mašán, 2003: 124; Faraji *et al.*, 2008: 234; Özbek *et al.*, 2014: 2.

*Macrocheles americanus*.— Sheals, 1962: 97.

*Macrocheles (Glypholaspis) americana*.— Bregetova, 1977: 387; Karg, 1993: 102.

*Macrocheles americana*.— Karg, 1994: 180.

*Nothrolaspis ? montivagus* [sic].— Womersley, 1942: 168 [Misidentification, according to Krantz & Filipponi, 1964: 52].

*Macrocheles (Macrocheles) tardus*.— Krauss, 1970: 20 [Misidentification, according to Hyatt & Emberson, 1988: 116].

*Holostaspis vagabundus* Berlese, 1889: 8 [Synonymy by Filipponi & Pegazzano, 1960: 148].

*Holostaspis vagabundus*.— Berlese, 1892: 70; Foà, 1900: 139.

*Macrocheles (Macrocheles) vagabundus*.— Berlese, 1918: 172; Filipponi & Ilardi, 1958: 118; Krauss, 1970: 20; Karg, 1971: 137.

*Macrocheles vagabundus*.— Halbert, 1923: 366; Balogh, 1958: 251; Bregetova & Koroleva, 1960: 76; Schweizer, 1961: 77; Hirschmann, 1970a: 44, 1970b: 45, 1970c: 46, 1970d: 52.

*Coprholaspis vagabundus*.— Turk, 1945: 793.

*Holostaspella spectabilis* Berlese, 1916b: 155 [Synonymy by Filipponi & Pegazzano 1962a: 192].

*Macrocheles (Macrocheles) vagabundus* var. *neotropicus* Berlese, 1918: 173 [Synonymy by Filipponi & Pegazzano, 1960: 154]<sup>Note2</sup>.

*Macrocheles (Monoplites) tardior* Hull, 1925: 216 [Synonymy by Hyatt & Emberson, 1988: 116]<sup>Note3</sup>.

**Type depository.** *G. americana*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *H. vagabundus*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. vagabundus insulanus*: Not stated, but presumably Swedish Museum of Natural History, Stockholm, Sweden; *M. (M.) tardior*: Natural History Museum, London, England; *H. spectabilis*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. (M.) vagabundus* var. *neotropicus*: Istituto Sperimentale per la Zoologia Agraria, Firenze, Italy.

**Type locality and habitat.** *G. americana*: Brazil, Matto-grosso [= Mato Grosso? or Mato Grosso do Sul?]; Argentina (cited as Paraguay), Buenos Aires and Resistencia; Paraguay, Asunción and Apa River; date of collect not mentioned; under tree bark, carcass and stones, on Scarabaeidae [Coleoptera] and on *Syrphus* spp. [Diptera: Syrphidae]; *H. vagabundus*: Italy, Padua, Veneto, date of collect not mentioned, on flies; *M. vagabundus insulanus*: Denmark, Thorshavn, Faroe Islands, 1926, from unspecified host/substrate; *M. (M.) tardior*: England, “Oxfordshire”, date of collect and host/substrate not mentioned; *H. spectabilis*: Argentina, La Plata, Buenos Aires, date of collect not mentioned, in nest of *Acromyrmex lundii* (Guérin-Méneville) [Hymenoptera: Formicidae]; *M. (M.) vagabundus* var. *neotropicus*: Uruguay, Montevideo, date of collect not mentioned, under rocks; Argentina, La Plata, date of collect not mentioned, in nest of *Acromyrmex lundii* [sic] (Guérin-Méneville)

[Hymenoptera: Formicidae]; South Africa, Cape of Good Hope, date of collect not mentioned, in flies [Diptera].

- Note<sup>1</sup>**. Only adults according Berlese, 1918: 289; specimen reported by Berlese, 1888: 195 as tritonymph of *Holostaspis marginatus* var. *americanus* Berlese was described as *Macrocheles (Coprholaspis) mundus* Berlese by Berlese, 1918: 157; specimen reported by Berlese, 1888: 195 as protonymph of *Holostaspis marginatus* var. *americanus* Berlese was identified as *Macrocheles (Coprholaspis) perparvulus* Berlese by Berlese, 1918: 157.
- Note<sup>2</sup>**. Adult males and part of adult females; other part of adult females were synonymized as *Glyphtholaspis confusa* (Foà) by Filipponi & Pegazzano, 1960: 154.
- Note<sup>3</sup>**. *Macrocheles (Monoplites) tardior* Hull was considered species *incertae sedis* by Evans & Browning (1956: 41).
- Note<sup>4</sup>**. Specimens reported by Oudemans (1902a: 43) as *Macrocheles vagabundus* (Berlese) were described as *Holostaspis (Holostaspella) ornatus* Berlese by Berlese (1904a: 277).
- Note<sup>5</sup>**. Specimens reported by Trägårdh (1912: 555) as *Holostaspis vagabundus* Berlese were identified as *Macrocheles (Macrocheles) penicilliger* (Berlese) by Krauss, 1970: 18.
- Note<sup>6</sup>**. Suspected senior synonym of *Glyphtholaspis confusa* (Foà) by Berlese, 1918: 289.
- Note<sup>7</sup>**. Suspected senior synonym of *Macrocheles plumipes* Hull by Filipponi & Pegazzano, 1960: 148.

**019. *Glyphtholaspis asperrima* (Berlese, 1905)**

*Holostaspis asperrimus* Berlese, 1905: 163.

*Macrocheles (Macrocheles) asperrimus*.— Berlese, 1918: 172.

*Macrocheles asperrimus*.— Hirschmann, 1970d: 52.

*Macrocheles (Glyphtholaspis) asperrima*.— Bregetova, 1977: 390.

*Glyphtholaspis asperrima*.— Filipponi & Pegazzano, 1960: 166, 1962: 202; Petrova, 1967a: 25; Roy, 1989b: 346; Hartini *et al.*, 2007: 92; Takaku *et al.*, 2012: 102.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Indonesia, Tjampea [cited as Tjiompea], Java, date of collection and host unspecified.

**020. *Glyphtholaspis baichengensis* Ma, 1997**

*Glyphtholaspis baichengensis* Ma, 1997a: 41.

**Type depository.** National Base of Plague and Brucellosis Control, Baicheng, China.

**Type locality and habitat.** China, Baicheng City (45°37'N; 122°49'E), Jilin, May – September 1992, in decomposed nest of rodent.

**021. *Glyphtholaspis cariasoi* Jesus & Rueda, 1990**

*Glyphtholaspis cariasoi* Jesus & Rueda, 1990: 715.

*Glyphtholaspis cariasoi*.— Takaku *et al.*, 2012: 102.

**Type depository.** Entomology Musum, UPLB Museum of Natural History, Los Baños, Philippines.

**Type locality and habitat.** Philippines, Los Baños, Laguna, 15 September 1987, on carabao *Bubalus bubalis* (L.) [Mammalia: Bovidae] manure.

**022. *Glyphtholaspis confusa* (Foà, 1900)**

*Holostaspis confusus* Foà, 1900: 137.

*Macrocheles (Macrocheles) confusus*.— Filipponi & Ilardi, 1958: 118.

*Glyphtholaspis confusa*.— Filipponi & Pegazzano, 1960: 154; Filipponi & Pegazzano, 1962a: 197; Axtell, 1963a: 632; Van Der Hammen, 1964: 4; Petrova, 1967a: 25; Krantz, 1972: 270; Emberson, 1973a: 121; Halliday, 1986c: 73; Hyatt & Emberson, 1988: 116; Jesus & Rueda, 1990: 714; Maśán, 2003: 122; Faraji *et al.*, 2008: 234; Takaku *et al.*, 2012: 104; Özbek *et al.*, 2014: 1.

*Macrocheles (Glyphtholaspis) confusa*.— Bregetova, 1977: 387; Karg, 1993: 101.

*Macrocheles marginatus* [adult].— Oudemans, 1900a: 129 [Misidentification, according to Evans & Browning 1956: 16].

*Nothrolaspis fimicola*.— Filipponi, 1955: 145 [Misidentification, according to Filipponi & Pegazzano, 1960: 154].

*Macrocheles (Macrocheles) vagabundus* var. *neotropicus* Berlese, 1918: 173 [Synonymy by Filipponi & Pegazzano, 1960: 154]<sup>Note1</sup>.

*Macrocheles (Macrocheles) vagabundus* var. *australis* Berlese, 1918: 173 [Synonymy by Filipponi & Pegazzano, 1960: 154].

*Macrocheles plumiventris* Hull, 1925: 216 [Synonymy by Filipponi & Pegazzano, 1960: 154].

*Macrocheles plumiventris*.— Evans & Browning, 1956: 36<sup>Note2</sup>; Filipponi & Seganti, 1957: 27; Balogh, 1958: 253; Bregetova & Koroleva, 1960: 76; Schweizer, 1961: 80.

*Macrocheles (Monoplitis) oudemansii* Hull, 1925: 215 [Synonymy of *Macrocheles plumiventris* by Evans & Browning, 1956: 16]<sup>Note3</sup>.

**Type depository.** *G. confusa*: Museo Dell'Istituto Superiore di Sanità, Rome, Italy

[Neotype]; *M. (M.) vagabundus* var. *neotropicus*: Istituto Sperimentale per la Zoologia Agraria, Firenze, Italy; *M. (M.) vagabundus* var. *australis*: Istituto Sperimentale per la Zoologia Agraria, Firenze, Italy; *M. plumiventris*: Natural History Museum, London, England; *M. (M.) oudemansii*: Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands.

**Type locality and habitat.** *G. confusa*: Holotype not designated; Italy, Roma, 14 March 1957, in horse manure [Neotype designated by Filipponi & Pegazzano, 1960: 154]; *M. (M.) vagabundus* var. *neotropicus*: Uruguay, Montevideo, date of collect not mentioned, under rocks; Argentina, La Plata, date of collect not mentioned, in nest of *Acromyrmex lundii* [sic] (Guérin-Méneville) [Hymenoptera: Formicidae]; South Africa, Cape of Good Hope, on flies [Diptera]; *M. (M.) vagabundus* var. *australis*: Australia, Sidney, date of collect not mentioned, on *Onthophagus australis* Guérin-Méneville [Coleoptera: Scarabaeidae]; *M. plumiventris*: England, Allendale (cited as West Allendale), date of collect not mentioned, in a manure-heap; *M. (M.) oudemansii*: Italy, San Remo, date of collect and host/substrate not mentioned.

**Note<sup>1</sup>.** Only part of adult females; adult males and part of adult females were synonymized as *Glyphtholaspis americana* (Berlese) by Filipponi & Pegazzano, 1960: 140.

**Note<sup>2</sup>.** Only adult female; adult male was identified as *Glyphtholaspis fimicola* (Berlese) [sic] by Filipponi & Pegazzano, 1960: 139.

**Note<sup>3</sup>.** Hull proposed this name for specimens described by Oudemans, 1900a: 129 as *Macrocheles marginatus*. According Evans & Browning 1956: 16, these specimens, however, is a complex of at least two distinct species, the tritonymph is *Macrocheles glaber* (Müller) and the adult is *Macrocheles plumiventris* Hull [= *Glyphtholaspis confusa* (Foà)].

**Note<sup>4</sup>.** Specimen reported by Womersley, 1942: 166 as *Macrocheles vagabundus* var. *australis* (Berlese) was identified as *Macrocheles muscaedomesticae* (Scopoli) by Halliday, 2000: 302.

**Note<sup>5</sup>.** Suspected junior synonym of *Glyphtholaspis americana* (Berlese) by Berlese, 1918: 289.

**Note<sup>6</sup>.** *Macrocheles plumiventris* Hull was considered suspect senior synonym of *Glyphtholaspis fimicola* (Sellnick) by Filipponi & Pegazzano, 1960: 139.

### 023. *Glyphtholaspis depuncta* Petrova, 1967



*Glyphtholaspis depuncta* Petrova, 1967a: 22.

*Macrocheles (Glyphtholaspis) depuncta*.— Bregetova, 1977: 387.

**Type depository.** Department of Entomology, Moscow State University, Moscow, Russia.

**Type locality and habitat.** Russia, south of Sakhalin, 11 September 1964, on *Apodemus speciosus* (Temminck) [Mammalia: Rodentia: Muridae] found in a bamboo thicket.

#### 024. *Glyphtholaspis filiponni* Roy, 1989

*Glyphtholaspis filiponni* Roy, 1989b: 348.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Dibrugarh, Assam, 10 May 1976, in litter of banana plantation.

#### 025. *Glyphtholaspis fimicola* (Sellnick, 1931)

*Holostaspis marginatus*.— Berlese 1889: 4; Berlese 1889: 5 [Misidentifications, according to Sellnick, 1931: 765].

*Nothrholaspis fimicola* Sellnick, 1931: 765<sup>Note1</sup>.

*Glyphtholaspis fimicola*.— Filipponi & Pegazzano, 1960: 139; Filipponi & Pegazzano, 1962a: 190; Petrova, 1967a: 24; Hyatt & Emberson, 1988: 117; Hartini *et al.*, 2007: 74, 2009: 417; Takaku *et al.*, 2012: 104.

*Macrocheles (Glyphtholaspis) fimicola*.— Bregetova, 1977: 387; Karg, 1993: 101.

*Gamasus tardus*.— Berlese, 1882a: 108 [Misidentification, according to Filipponi & Pegazzano, 1960: 139].

*Holostaspis marginatus*.— Canestrini & Canestrini, 1882: 26 [plates II and III]; Foà, 1900: 139; Berlese, 1913b: 98 [Misidentifications, according to Filipponi & Pegazzano, 1960: 139].

*Macrocheles (Macrocheles) marginatus*.— Berlese, 1918: 172; Filipponi & Iardi, 1958: 118 [Misidentifications, according to Filipponi & Pegazzano, 1960: 139].

*Macrocheles plumiventris*.— Evans & Browning, 1956: 36 [Misidentification, according to Filipponi & Pegazzano, 1960: 139].

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Holotype – not designated; Italy, Bevagna, Perugia, date of collection unspecified, in dunghill [Neotype female designated by Filipponi & Pegazzano, 1960: 139]; Italy, Padua, Veneto, 1882, in dunghill [Neotype male designated by Filipponi & Pegazzano, 1960: 139].

**Note<sup>1</sup>.** Described on the basis of specimens reported by Berlese (1889: 4 and 5) as *Holostaspis marginatus* (Hermann).

**Note<sup>2</sup>.** Specimen reported by Filipponi (1955: 145) as *Nothrolaspis fimicola* Sellnick was identified as *Glypholaspis confusa* (Foà) by Filipponi & Pegazzano (1960: 154).

**Note<sup>3</sup>.** Suspected junior synonym of *Macrocheles gladiator* Hull by Filipponi & Pegazzano (1960: 139).

**Note<sup>4</sup>.** Suspected junior synonym of *Macrocheles plumiventris* Hull [= *Glypholaspis confusa* (Foà)] by Filipponi & Pegazzano (1960: 139).

**026. *Glypholaspis gressitti* Krantz, 1967**

*Glypholaspis gressitti* Krantz, 1967a: 151.

*Macrocheles gressitti* [sic].— Hirschmann, 1970d: 52.

*Glypholaspis gressitti*.— Hartini *et al.*, 2007: 91.

**Type depository.** Bernice Pauahi Bishop Museum, Hawaii, USA.

**Type locality and habitat.** Indonesia, Kampong Landbouw, Biak Island, Schouten Islands, Papua, 28 May 1959, on decayed leaves.

**027. *Glypholaspis indica* Roy, 1989**

*Glypholaspis indica* Roy, 1989b: 350.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Lumding Reserve Forest, Nowgong, Assam, 9 December 1973, in leaf litter.

**028. *Glypholaspis merapiensis* Hartini, Dwibadra & Takaku, 2009**

*Glypholaspis merapiensis* Hartini, Dwibadra & Takaku, 2009: 417.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Mount Merapi National Park, Turgo, Purwobinangun, Pakem, Sleman, Yogyakarta, 13-15 July 2005, on *Catharsius molossus* (L.) [Coleoptera: Scarabaeidae].

**029. *Glypholaspis neglecta* (Bregetova, 1977)**

*Macrocheles (Glypholaspis) neglectus* Bregetova, 1977: 391.

*Glypholaspis neglecta*.— Halliday, 1986c: 71.

*Macrocheles (Glypholaspis) neglectus*.— Karg, 1993: 102.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Russia, Promyslovka Village, Primorye, 10 September 1959, under wild apple.

**030. *Glyphtholaspis pontina* Filipponi & Pegazzano, 1960**

*Glyphtholaspis pontina* Filipponi & Pegazzano, 1960: 161.

*Glyphtholaspis pontina*.— Petrova, 1967a: 24; Mašán, 2003: 128.

*Macrocheles pontinus*.— Hirschmann, 1970d: 52.

*Macrocheles (Glyphtholaspis) pontina*.— Bregetova, 1977: 389; Karg, 1993: 102.

**Type depository.** Museo Dell'Istituto Superiore di Sanità, Rome, Italy.

**Type locality and habitat.** Italy, Parco Nazionale del Circeo, Lazio, 28 January 1958, from laboratory colony originated from specimens collected on oak [*Quercus* sp.; Fagaceae] rotten wood.

**031. *Glyphtholaspis saprophila* Mašán, 2003**

*Glyphtholaspis saprophila* Mašán, 2003: 125.

*Glyphtholaspis saprophila*.— Özbek *et al.*, 2014: 3; Ács & Kontschán, 2014: 111.

**Type depository.** Institute of Zoology, Slovak Academy of Sciences, in author's private collection.

**Type locality and habitat.** Slovakia, Zoological Garden, Bratislava, 31 May 1994, in organic substrates.

**032. *Glyphtholaspis thorri* Van Driel, Loots & Marais, 1977**

*Glyphtholaspis thorri* Van Driel, Loots & Marais, 1977: 309.

**Type depository.** Central African Museum, Tervuren, Belgium.

**Type locality and habitat.** Saint Helena [South Atlantic island], Fisher's Valley, 1965, from unspecified host/substrate.

**033. *Glyphtholaspis wuhouyongi* Ma, 1997**

*Glyphtholaspis wuhouyongi* Ma, 1977b: 263.

**Type depository.** National Base of Plague and Brucellosis Control, Baicheng, China.

**Type locality and habitat.** China, Baicheng (45°37'N; 122°49'E), Jilin, May – June 1992, in soil.

**Genus *Gonatothrix* Krantz, 1988**

*Gonatothrix* Krantz, 1988: 1318.

Type species: *Gonatothrix carinata* Krantz, 1988, by original designation.

**034. *Gonatothrix carinata* Krantz, 1988.**

*Gonatothrix carinata* Krantz, 1988b: 1318.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Panama, Barro Colorado Island, Canal Zone, 8 December 1985, on *Phanaeus pyrois* Bates [Coleoptera: Scarabaeidae].

**Genus *Holocelaeno* Berlese, 1910**

*Holocelaeno* Berlese, 1910: 249.

Type species: *Holocelaeno mitis* Berlese, 1910, by subsequent designation.

*Holocelaeno*.— Krantz, 1962b: 153, 1967: 15; Hirschmann, 1970d: 47.

*Holocelaeno* (*Evholocelaeno*) Berlese, 1918: 176.

Type species: *Holocaeleno* [sic] *bursiformis* Berlese, 1910, by original designation.

*Euholocelaeno* [sic].— Evans, 1956: 351; Krantz, 1962b: 155.

*Holocelaeno* (*Tricholocelaeno*) Berlese, 1918: 176.

Type species: *Holocaeleno* [sic] *lengicomma* [sic] Berlese, 1910, by original designation.

*Neoholaspis* Turk, 1948: 99 [Junior synonymy by Krantz, 1962b:153].

Type species: *Neoholaspis coprophilus* Turk, 1948, by original designation.

*Neholaspis* [sic].— Evans, 1956: 351; Evans & Hyatt, 1963: 327.

**035. *Holocelaeno acinothrix* Krantz, 1967**

*Holocelaeno acinothrix* Krantz, 1967: 19.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Suriname, April 1927, on *Megathopa astyanax* Olivier [Coleoptera: Scarabaeidae].

**036. *Holocelaeno amygdaligera* Berlese, 1918**

*Holocaeleno* [sic] *amygdaligera* Berlese, 1918: 177.

*Macrocheles amygdaligera*.— Evans & Hyatt, 1963: 378.

*Holocelaeno amygdaligera*.— Krantz, 1967: 16.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, Buenos Aires, date of collection unspecified, on *Phanaeus (Notiophanaeus) splendidulus* (F.) [Coleoptera: Scarabaeidae].

**037. *Holocelaeno anogmos* Krantz, 1967**

*Holocelaeno anogmos* Krantz, 1967b: 20.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Brazil, date of collection unspecified, on *Phanaeus bellicosus* Olivier [Coleoptera: Scarabaeidae].

**038. *Holocelaeno axtelli* Krantz, 1967**

*Holocelaeno axtelli* Krantz, 1967b: 23.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, North Carolina, date of collection unspecified, on *Phanaeus igneus* M'Leay [Coleoptera: Scarabaeidae]; USA, Florida, Lake Alfred, 4 February 1940, "on dung beetle"; USA, Pennsylvania, Jeanette, on *Phaneus vindex* M'Leay [Coleoptera: Scarabaeidae]; USA, Georgia, Tifton, August 1957, on *Onthophagus pennsylvanicus* Harold [Coleoptera: Scarabaeidae].

**039. *Holocelaeno berlesei* Krantz, 1967**

*Holocelaeno berlesei* Krantz, 1967b: 24.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Ecuador, date of collection unspecified, on *Dichotomius satanus* (Harold) [Coleoptera: Scarabaeidae]; Panama, Barro Colorado Island, 22 March 1955, "on beetle" [sic].

**040. *Holocelaeno brachychaeta* Krantz, 1967**

*Holocelaeno brachychaeta* Krantz, 1967b: 26.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** North America, date of collection unspecified, on *Dichotomius carolinus* L. [Coleoptera: Scarabaeidae].

**041. *Holocelaeno bursiformis* Berlese, 1910**

*Holocelaeno bursiformis* Berlese, 1910: 250.

*Holocelaeno (Evholocelaeno) bursiformis*.— Berlese, 1918: 176.

*Euholocelaeno* [sic] *bursiformis*.— Krantz, 1962b: 155.

*Holocelaeno bursiformis*.— Krantz, 1967b: 27; Hirschmann, 1970d: 47.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** North America, date of collection unspecified, on *Dichotomius carolinus* (L.) [cited as *Copris carolina*] [Coleoptera: Scarabaeidae].

**042. *Holocelaeno condyla* Krantz, 1967**

*Holocelaeno condyla* Krantz, 1967b: 30.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Brownsville, 30 May 1903, on *Megathopa yucateca* Harold [Coleoptera: Scarabaeidae]; Mexico, 1937, on *Megathopa yucateca* Harold [Coleoptera: Scarabaeidae].

**043. *Holocelaeno coprophilus* (Turk, 1948)**

*Neoholaspis coprophilus* Turk, 1948: 99.

*Holocelaeno corpophilus* [sic].— Krantz, 1962b: 153.

*Holocelaeno coprophilus*.— Krantz, 1967b: 32.

*Neoholaspis coprophilus* var. *elongatus* Turk, 1948: 101 [Synonymy by Krantz, 1967b: 32].

**Type depository.** Unspecified.

**Type locality and habitat.** Trinidad & Tobago, Saint Augustine, 13 October 1945, from scarabaeid beetle.

**044. *Holocelaeno cosmothorax* Krantz, 1967**

*Holocelaeno cosmothorax* Krantz, 1967b: 32.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** North America, on *Dichotomius carolinus* (L.) [Coleoptera: Scarabaeidae]; Bolivia, Tumupaso, 1921, on *Phanaeus faunus* F. [Coleoptera: Scarabaeidae].

**045. *Holocelaeno costai* Krantz, 1967**

*Holocelaeno costai* Krantz, 1967b: 34.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Brazil, date of collection unspecified, on *Phanaeus bellicosus* (Olivier) [Coleoptera: Scarabaeidae].

**046. *Holocelaeno dubius* (Evans & Hyatt, 1963)**

*Macrocheles dubius* Evans & Hyatt, 1963: 381.

*Holocelaeno dubius*.— Krantz, 1967b: 37.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Argentina, date of collection unspecified, on *Phanaeus (Notiophanaeus) splendidulus* (F.) [Coleoptera: Scarabaeidae].

**047. *Holocelaeno expolita* Berlese, 1918**

*Holocaeleno* [sic] *expolita* Berlese, 1918: 176.

*Holocelaeno expolita*.— Krantz, 1967b: 27.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Brazil, “Alto Paraná”, date of collection unspecified, on *Coprophanaeus (Coprophanaeus) milon* (Blanchard) [cited as *Phanaeus milo*] [Coleoptera: Scarabaeidae].

**048. *Holocelaeno floridanus* (Evans & Hyatt, 1963)**

*Macrocheles floridanus* Evans & Hyatt, 1963: 382.

*Holocelaeno floridanus*.— Krantz, 1967b: 40.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** USA, Columbia, Florida, 1931, on *Deltochilum orbiculare* Lansberge [Coleoptera: Scarabaeidae].

**049. *Holocelaeno fuscata* Berlese, 1916**

*Halocaeleno* [sic] *mitis* var. *fuscata* Berlese, 1916b: 154.

*Holocaeleno* [sic] *fuscata*.— Berlese, 1918: 189.

*Holocelaeno fuscata*.— Krantz, 1967b: 41.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection unspecified, on *Ateuchus* sp. [Coleoptera: Scarabaeidae].

**050. *Holocelaeno grandis* (Evans & Hyatt, 1963)**

*Macrocheles grandis* Evans & Hyatt, 1963: 382.

*Holocelaeno grandis*.— Krantz, 1967b: 43.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Honduras, date of collection unspecified, on *Deltochilum* (*Hybomidium*) *lobipes* Bates [Coleoptera: Scarabaeidae].

**051. *Holocelaeno hadrosoma* Krantz, 1967**

*Holocelaeno hadrosoma* Krantz, 1967b: 43.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Venezuela, date of collection unspecified, on *Dichotomius protectus* Harold [Coleoptera: Scarabaeidae].

**052. *Holocelaeno hanselli* Krantz, 1967**

*Holocelaeno hanselli* Krantz, 1967b: 45.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Brazil, date of collection unspecified, on *Phanaeus ensifer* (Germar) [Coleoptera: Scarabaeidae].

**053. *Holocelaeno hypocrita* Berlese, 1916**

*Holocaeleno* [sic] *magna* var. *hypocrita* Berlese, 1916b: 153.

*Macrocheles* (*Coprholaspis*) *hypocrita*.— Berlese, 1918: 146.

*Macrocheles hypocrita*.— Berlese, 1918: 189.

*Holocelaeno hypocrita*.— Krantz, 1967b: 46.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection unspecified, under elytron of *Phanaeus* sp. [cited as *Phanaei*] [Coleoptera: Scarabaeidae].

**054. *Holocelaeno interrupta* Berlese, 1918**

*Holocaeleno* [sic] *amygdaligera* var. *interrupta* Berlese, 1918: 178.

*Holocelaeno amygdaligera* f. *interrupta*.— Hyatt, 1964: 467.

*Holocelaeno interrupta*.— Krantz, 1967b: 48.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.



**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection unspecified, on *Sulcophanaeus batesi* (Harold) [cited as *Phanaeus bathesi*] [Coleoptera: Scarabaeidae].

**055. *Holocelaeno iota* Krantz, 1967**

*Holocelaeno iota* Krantz, 1967b: 49.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Brazil, date of collection unspecified, on *Phanaeus bellicosus* (Olivier) [Coleoptera: Scarabaeidae].

**056. *Holocelaeno jasius* Krantz, 1967**

*Holocelaeno jasius* Krantz, 1967b: 51.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Paraguay, date of collection unspecified, on *Coprophanaeus jasius* Olivier [Coleoptera: Scarabaeidae].

**057. *Holocelaeno jugulans* Berlese, 1916**

*Holocaeleno* [sic] *magna* var. *jugulans* Berlese, 1916b: 153.

*Macrocheles (Coprholaspis) jugulans*.— Berlese, 1918: 146.

*Macrocheles jugulans*.— Berlese, 1918: 189.

*Holocelaeno jugulans*.— Krantz, 1967b: 53.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection unspecified, on *Phanaeus* sp. [cited as *Phanaei*] [Coleoptera: Scarabaeidae].

**058. *Holocelaeno longicoma* Berlese, 1910**

*Holocelaeno longicoma* Berlese, 1910: 250.

*Holocelaeno (Tricholocelaeno) longicoma* [sic].— Berlese, 1918: 176.

*Holocelaeno longicoma*.— Krantz, 1967b: 56; Hirschmann, 1970d: 47.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** North America, date of collection unspecified, on *Dichotomius carolinus* (L.) [cited as *Copris carolina*] [Coleoptera: Scarabaeidae].

**059. *Holocelaeno magna* Berlese, 1910**

*Holocelaeno magna* Berlese, 1910: 250.

*Holocelaeno magna*.— Krantz, 1967b: 56.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Ecuador, date of collection unspecified, on *Paussus* (*Cochliopaussus*) *inexpectatus* Fairmaire [cited as *Phanaeus perspicillatus*<sup>Note</sup>] [Coleoptera: Carabidae].

**Note.** *Phanaeus perspicillatus* does not seem to exist, the author may have mistaken *Paussus* for *Phanaeus* ; *Paussus perspicillatus* is a junior synonym of *Paussus* (*Cochliopaussus*) *inexpectatus*.

**060. *Holocelaeno melisi* Krantz, 1967**

*Holocelaeno melisi* Krantz, 1967b: 60.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Brazil, date of collection unspecified, on *Phanaeus bonariensis* (Gory), *Diabroctis mimas* L. and *Diabroctis cadmus* Harold [Coleoptera: Scarabaeidae].

**061. *Holocelaeno mitis* Berlese, 1910**

*Holocelaeno mitis* Berlese, 1910: 249.

*Holocaeleno* [sic] *mitis*.— Berlese, 1916b: 154.

*Holocelaeno mitis*.— Krantz, 1967b: 62.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** USA, Texas, date of collection unspecified, on *Deltotichilum gibbosum* (F.) [Coleoptera: Scarabaeidae].

**062. *Holocelaeno neophanei* Krantz, 1967**

*Holocelaeno neophanei* Krantz, 1967b: 63.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Brazil, date of collection unspecified, on *Phanaeus dardanus* MacLeay [Coleoptera: Scarabaeidae].

**063. *Holocelaeno palaeno* Krantz, 1967**

*Holocelaeno palaeno* Krantz, 1967b: 65.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Paraguay, Villarrica, Guairá, date of collection unspecified, on *Phanaeus palaeno* Blanch [Coleoptera: Scarabaeidae].

**064. *Holocelaeno phanaei* Berlese, 1916**

*Holocelaeno mitis* var. *phanaei* Berlese, 1916b: 154.

*Holocaeleno* [sic] *phanaei*.— Berlese, 1918: 189.

*Macrocheles phanaei*.— Evans & Hyatt, 1963: 385.

*Holocelaeno phanaei*.— Krantz, 1967b: 67.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Ecuador, date of collection unspecified, on *Paussus* (*Cochliopaussus*) *inexpectatus* Fairmaire [cited as *Phanaeus perspicillatus*<sup>Note</sup>] [Coleoptera: Carabidae].

**Note.** *Phanaeus perspicillatus* does not seem to exist, the author may have mistaken *Paussus* for *Phanaeus* ; *Paussus perspicillatus* is a junior synonym of *Paussus* (*Cochliopaussus*) *inexpectatus*.

**065. *Holocelaeno pontigera* Berlese, 1918**

*Holocaeleno* [sic] *pontigera* Berlese, 1918: 176.

*Holocelaeno pontigera*.— Krantz, 1967b: 68.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection unspecified, on *Deltochilum* sp. [Coleoptera: Scarabaeidae].

**066. *Holocelaeno ritcheri* Krantz, 1967**

*Holocelaeno ritcheri* Krantz, 1967b: 70.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Mexico, date of collection unspecified, on *Phanaeus endymion* Harold [Coleoptera: Scarabaeidae]; Panama, date of collection unspecified, on *Phanaeus velutinus* Murray [Coleoptera: Scarabaeidae].

**067. *Holocelaeno rotunda* Berlese, 1910**

*Holocelaeno rotunda* Berlese, 1910: 249.

*Holocelaeno rotunda*.— Krantz, 1967b: 72; Hirschmann, 1970d: 47.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** USA, Texas, date of collection unspecified, on *Onthophagus* (*Palaeonthophagus*) *verticicornis* (Laicharting) [cited as *Copris bituberculatus*] [Coleoptera: Scarabaeidae]; North America, date of collection unspecified, on *Dichotomius carolinus* (L.) [cited as *Copris carolina*] [Coleoptera: Scarabaeidae].

**068. *Holocelaeno scapularis* (Evans & Hyatt, 1963)**

*Macrocheles scapularis* Evans & Hyatt, 1963: 385.

*Holocelaeno scapularis*.— Krantz, 1967b: 74.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** North America, date of collection unspecified, on *Deltochilum* (*Hybomidium*) *lobipes* Bates [Coleoptera: Scarabaeidae].

**069. *Holocelaeno shoemakei* Krantz, 1967**

*Holocelaeno shoemakei* Krantz, 1967b: 75.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Peru, date of collection unspecified, on *Oxysternon conspicillatum* (Weber) [Coleoptera: Scarabaeidae].

**070. *Holocelaeno singeri* Krantz, 1967**

*Holocelaeno singeri* Krantz, 1967b: 77.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** South America, date of collection unspecified, on *Phanaeus lancifer* (L.) [Coleoptera: Scarabaeidae]; British Guiana, date of collection unspecified, on *Phanaeus lancifer* (L.) [Coleoptera: Scarabaeidae].

**071. *Holocelaeno thyreos* Krantz, 1967**

*Holocelaeno thyreos* Krantz, 1967b: 79.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Brazil, date of collection unspecified, on *Deltochilum brasiliense* Castelnau [Coleoptera: Scarabaeidae].

**072. *Holocelaeno trochantalis* Berlese, 1910**

*Holocelaeno trochantalis* Berlese, 1910: 250.

*Holocelaeno trochantalis*.— Krantz, 1967b: 79.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Brazil, date of collection unspecified, on *Dichotomius mormon* (Ljungh) [cited as *Copris ephialtes*<sup>Note</sup>] [Coleoptera: Scarabaeidae].

**Note.** Krantz (1967b) mentioned *Dichotomius mormon* as host of *H. trochantalis* and synonymy of *Copris ephialtes*.

**073. *Holocelaeno turki* (Evans & Hyatt, 1963)**

*Macrocheles turki* Evans & Hyatt, 1963: 386.

*Holocelaeno turki*.— Krantz, 1967b: 80.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Panama, Volcan de Chiriquí, Bugaba, date of collection unspecified, on *Coprophanaeus telemon* Erichson [Coleoptera: Scarabaeidae].

**074. *Holocelaeno veracruzensis* (Méndez Olivo, 1968) New combination**

*Macrocheles veracruzensis* Méndez Olivo, 1968: 166.

**Type depository.** Escuela Nacional de Ciencias Biológicas, Mexico city, Mexico.

**Type locality and habitat.** Mexico, Tlapacoyan, Veracruz, 29 July 1953, on *Dichotomius carolinus* (L.) [Coleoptera: Scarabaeidae].

**075. *Holocelaeno wenzeli* Krantz, 1967**

*Holocelaeno wenzeli* Krantz, 1967b: 82.

**Type depository.** Field Museum of Natural History, Illinois, USA.

**Type locality and habitat.** Ecuador, date of collection unspecified, on *Phanaeus haroldi* Kirsch [Coleoptera: Scarabaeidae].

**Genus *Holostaspella* Berlese, 1903**

*Holostaspis* (*Holostaspella*) Berlese, 1903: 241.

Type species: *Holostaspis* (*Holostaspella*) *sculpta* Berlese, 1903, by original designation.

*Holostaspella*.— Berlese, 1910: 248; Oudemans, 1931: 273; Evans, 1956: 351; Evans & Browning, 1956: 51; Ryke & Meyer, 1958: 150; Bregetova & Koroleva, 1960: 56; Krantz, 1962b: 156, 1967c: 102; Petrova & Tascava, 1964: 60; Filipponi &

Pegazzano, 1967: 220; Hirschmann, 1970d: 47; Bregetova, 1977: 399; Halliday, 1988: 149; Hyatt & Emberson, 1988: 118; Roy, 1989a: 329; Karg, 1993: 98.

*Holostaspella (Holostaspella)*.— Vitzthum, 1925: 16.

*Nolostaspella* [sic].— Bregetova & Koroleva, 1960: 56.

*Macrocheles (Holostaspella)*.— Krauss, 1970: 6; Karg, 1971: 131.

*Holostaspella (Prholaspina)* Berlese, 1918: 175.

Type species: *Holostaspella micrarrhena* Berlese, 1916, by original designation.

*Prholaspina*.— Evans, 1956: 351 [Considered junior synonymy of *Macrocheles (Macrocheles)* by Krauss, 1970: 6].

*Areolaspis* Trägårdh, 1952: 60 [Synonymy by Krantz, 1967c: 102].

Type species: *Areolaspis bifoliatum* Trägårdh, 1952, by monotypy.

*Areolaspis*.— Evans, 1956: 351; Krantz, 1962b: 155.

*Aethiolaspis* Van Driel & Loots, 1975: 587 [Synonymy by Halliday, 1988: 149]

Type species: *Aethiolaspis congoensis* Van Driel & Loots, 1975, by original designation.

**076. *Holostaspella ainscoughi* Krantz, 1967**

*Holostaspella ainscoughi* Krantz, 1967c: 104.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Sutton Lake, 5.6 miles north of Florence, Oregon, 12 July 1959, in duff.

**077. *Holostaspella ancylothrix* Krantz, 1967**

*Holostaspella ancylothrix* Krantz, 1967c: 107.

*Holostaspella ancylothrix*.— Takaku *et al.*, 2012: 97.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Dominica, date of collection unspecified, from unspecified host/substrate.

**078. *Holostaspella aplodontiae* Krantz, 1967**

*Holostaspella aplodontiae* Krantz, 1967c: 109.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, near Blodgett, Benton, Oregon, 4 August 1966, in nest of *Aplodontia rufa pacifica* Rafinisque [Mammalia: Rodentia: Aplodontiidae].

**079. *Holostaspella ateucha* Halliday, 1988**

*Holostaspella ateucha* Halliday, 1988: 151.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Australia, Armidale, New South Wales, 21 January 1971, in sheep pasture.

**080. *Holostaspella berlesei* Krantz, 1967**

*Holostaspella berlesei* Krantz, 1967c: 112.

*Holostaspella berlesei*.— Takaku, 2001: 505; Hartini *et al.*, 2007: 91; Hartini & Takaku, 2010: 108.

**Type depository.** Institut des Parcs Nationaux, Brussels, Belgium.

**Type locality and habitat.** Congo, Mission H. De Saeger, Garamba National Park, 8 August 1952, on a saprophagous insect in a grassland.

**081. *Holostaspella bifoliata* (Trägårdh, 1952)**

*Areolaspis bifoliatus* Trägårdh, 1952: 61.

*Macrocheles (Holostaspella) bifoliatus*.— Hirschmann, 1970b: 45, 1970c: 46, 1970d: 47.

*Holostaspella bifoliata*.— Filipponi & Pegazzano, 1967: 243; Krantz, 1967c: 113; Halliday, 1988: 151; Roy, 1989a: 337; Karg, 1993: 98; Hartini *et al.*, 2007: 91; Faraji *et al.*, 2008: 233; Hartini & Takaku, 2010: 114; Takaku *et al.*, 2012: 99.

**Type depository.** Bishop Museum, Honolulu, Hawaii.

**Type locality and habitat.** French Polynesia, Society Islands, Tahiti, Pare, Arihiri, 16 March 1934, from unspecified host/substrate.

**Note.** Suspected junior synonym of *Holostaspella fonsecai* (Fox) by Krantz, 1967c: 113.

**082. *Holostaspella caelata* Berlese, 1910**

*Holostaspella caelata* Berlese, 1910: 248.

*Holostaspella caelata*.— Filipponi & Pegazzano, 1967: 235; Krantz, 1967c: 118; Costa, 1974: 487.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Firenze, Italy.

**Type locality and habitat.** South Africa, Cape of Good Hope, date of collect not mentioned, on *Heliocopris hamadryas* (F.) [cited as *Copris hamadryas*] [Coleoptera: Scarabaeidae].

**Note.** Specimen reported by Ryke & Meyer (1958: 150) as *Holostaspella caelata* Berlese was described as *Holostaspella similis* by Krantz, 1967c: 137.

**083. *Holostaspella congoensis* (Van Driel & Loots, 1975)**

*Aethiolaspis congoensis* Van Driel & Loots, 1975: 588.

*Holostaspella congoensis*.— Halliday, 1988: 149.

**Type depository.** Central African Museum, Tervuren, Belgium.

**Type locality and habitat.** Rwanda, Rugege forest (alt. 2200 m), April 1951, from unspecified host/substrate.

**084. *Holostaspella crenulata* Krantz, 1967**

*Holostaspella crenulata* Krantz, 1967a: 151.

*Holostaspella crenulata*.— Krantz, 1967c: 121; Halliday, 1988: 153; Takaku *et al.*, 2012: 99.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Caroline Islands [Micronesia], hill behind Yaptown, Yap Island, 29 November 1952, in light trap.

**085. *Holostaspella exornata* Filipponi & Pegazzano, 1967**

*Holostaspella exornata* Filipponi & Pegazzano, 1967: 230.

*Holostaspella exornata*.— Bregetova, 1977: 404; Halliday, 1988: 153; Hyatt & Emberson, 1988: 120; Karg, 1993: 99; Mašán, 2003: 135.

*Holostaspella ornata*.— Evans & Browning, 1956: 51 [Misidentification, according to Hyatt & Emberson, 1988: 120].

*Holostaspella ornata*.— Bregetova & Koroleva, 1960: 58 [Misidentification, according to Filipponi & Pegazzano, 1967: 230].

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Italy, Bosco di Paglione, L'Agro Pontino, Lazio, 20 March 1956, from laboratory colony originated from soil under cow manure.

**086. *Holostaspella fatimahae* Hartini & Takaku, 2006**

*Holostaspella fatimahae* Hartini & Takaku, 2006b: 169.



*Holostaspella fatimahaе*.— Hartini *et al.*, 2007: 91; Hartini & Takaku, 2010: 108.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, site of Freeport Indonesia Company, Tembagapura, Timika, Fakfak, Papua, 11 March 1977, on *Onthophagus* sp. [Coleoptera: Scarabaeidae] deposited in the Museum Zoologicum Bogoriense, Bogor, Indonesia.

**087. *Holostaspella foai* Berlese, 1910**

*Holostaspella foai* Berlese, 1910: 248.

*Holostaspella foai*.— Filipponi & Pegazzano, 1967: 236; Krantz, 1967c: 124; Hartini *et al.*, 2007: 91; Hartini & Takaku, 2010: 109.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Indonesia, Java, date of collection unspecified, on *Catharsius molossus* (L.) [cited as *Copris molossus*] [Coleoptera: Scarabaeidae].

**088. *Holostaspella fonsecai* (Fox, 1946) New combination**

*Macrocheles fonsecai* Fox, 1946a: 451.

**Type depository.** Department of Medical Zoology, School of Tropical Medicine, San Juan, Puerto Rico.

**Type locality and habitat.** Puerto Rico, San Juan, 16 February 1946, on *Rattus norvegicus* Berkenhout [Mammalia: Rodentia: Muridae].

**Note.** Suspected senior synonym of *Holostaspella bifoliata* (Trägårdh, 1952) by Krantz, 1967c: 113.

**089. *Holostaspella halawanyii* Ibrahim, 1992**

*Holostaspella halawanyii* Ibrahim, 1992: 191.

**Type depository.** Collection of Plant Protection Research Institute, Dokki, Cairo, Egypt.

**Type locality and habitat.** Egypt, Giza Governorate, date of collection unspecified, in debris under mango trees, associated with species of nematodes, insects and mites.

**090. *Holostaspella katakurai* Hartini & Takaku, 2003**

*Holostaspella katakurai* Hartini & Takaku, 2003b: 348.

*Holostaspella katakurai*.— Hartini *et al.*, 2007: 91; Hartini & Takaku, 2010: 109.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Bukit Suharto, Samarinda, East Kalimantan, 21–23 May 1993, on *Paragymnopleurus maurus* Sharp [Coleoptera: Scarabaeidae].

**091. *Holostaspella krantzi* Roy, 1989**

*Holostaspella krantzi* Roy, 1989a: 336.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Zoo Garden, Manipur, Imphal, 2 January 1979, in soil under grass.

**092. *Holostaspella macula* Karg, 1979**

*Holostaspella macula* Karg, 1979: 301.

**Type depository.** Ungarischen Naturwissenschaftliches Museum, Budapest, Hungary.

**Type locality and habitat.** Argentina, El Bolsón, Rio Negro, 7 September 1961, in litter on the bank of Rio Azul river.

**093. *Holostaspella micrarrhena* Berlese, 1916**

*Holostaspella micrarrhena* Berlese, 1916b: 155.

*Holostaspella (Prholaspina) micrarrhena*.— Berlese, 1918: 175.

*Holostaspella micrarrhena*.— Filipponi & Pegazzano, 1967: 239; Krantz, 1967c: 126.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection unspecified, in nest of *Acromyrmex lundii* (Guérin-Ménéville) [Hymenoptera: Formicidae].

**094. *Holostaspella mirabilis* Petrova & Tascava, 1964**

*Holostaspella mirabilis* Petrova & Tascava, 1964: 55.

*Holostaspella mirabilis*.— Filipponi & Pegazzano, 1967: 249; Krantz, 1967c: 127.

**Type depository.** Department of Entomology, Moscow State University, Moscow, Russia.

**Type locality and habitat.** China, Western Mountains (alt. 2100 m), near Kunming, Yunnan, 2 October 1958, on scarab beetle [Coleoptera: Scarabaeidae].

**095. *Holostaspella moderata* Berlese, 1920**

*Holostaspella moderata* Berlese, 1920: 188.

*Holostaspella moderata*.— Filipponi & Pegazzano, 1967: 224; Krantz, 1967c: 130; Halliday, 1988: 154; Roy, 1989a: 334; Hartini *et al.*, 2007: 91; Hartini & Takaku, 2010: 109; Takaku *et al.*, 2012: 100.

*Holostaspella (Holostaspella) egregia* Vitzthum, 1925: 16 [Synonymy by Krantz, 1967c: 130].

**Type depository.** *H. moderata*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *H. (H.) egregia*: Arachnologische Sammlung des Museums für Naturkunde, Berlin, Germany.

**Type locality and habitat.** *H. moderata*: Indonesia, Java, date of collection and host/substrate unspecified; *H. (H.) egregia*: Indonesia, Sumatra, date of collection unspecified, in litter.

**096. *Holostaspella neglecta* (Krauss, 1970)**

*Macrocheles (Holostaspella) neglectus* Krauss, 1970: 26.

*Holostaspella neglectus*.— Karg, 1993: 99.

*Holostaspella neglecta*.— Mašán, 2003: 131.

**Type depository.** Unspecified.

**Type locality and habitat.** Germany, Erlangen, Bavaria, date of collection unspecified, in nest of *Chroicocephalus ridibundus* (L.) [Aves: Laridae].

**097. *Holostaspella oblonga* Hartini & Takaku, 2010**

*Holostaspella oblonga* Hartini & Takaku, 2010: 111.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Mount Merapi National Park, Java, Central Java, 13–15 July 2005, on *Microcopris hidakai* Ochi & Kon [Coleoptera: Scarabaeidae].

**098. *Holostaspella ornata* (Berlese, 1904)**

*Macrocheles vagabundus*.— Oudemans, 1902a: 43 [Misidentification, according to Berlese, 1904a: 277].

*Holostaspis (Holostaspella) ornatus* Berlese, 1904a: 277.

*Holostaspella ornata*.— Oudemans, 1931: 273; Bregetova & Koroleva, 1960: 58 (part); Filipponi & Pegazzano, 1967: 227; Krantz, 1967c: 131, 1972: 266; Bregetova, 1977: 404; Hyatt & Emberson, 1988: 120; Roy, 1989a: 330, 1991a: 706; Karg, 1993: 99; Ma, 1999: 117; Mašán, 2003: 132.

*Macrocheles (Holostaspella) ornatus*.— Krauss, 1970: 22; Hirschmann, 1970c: 46, 1970d: 47; Karg, 1971: 131.

**Type depository.** National Museum of Natural History – Naturalis, Leiden, Netherlands.

**Type locality and habitat.** Netherlands, date of collection and host/substrate not mentioned.

**Note<sup>1</sup>.** Specimen reported by Evans & Browning (1956: 51) as *Holostaspella ornata* (Berlese) identified as *Holostaspella exornata* Filipponi & Pegazzano by Hyatt & Emberson (1988: 120).

**Note<sup>2</sup>.** Part of specimens reported by Bregetova & Koroleva (1960: 58) as *Holostaspella ornata* (Berlese) identified as *Holostaspella exornata* Filipponi & Pegazzano by Filipponi & Pegazzano (1967: 230).

### **099. *Holostaspella orientalis* Roy, 1989**

*Holostaspella orientalis* Roy, 1989a: 339.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Lumding, Nowgong, Assam, 7 December 1984, on *Heliocopriss* sp. [Coleoptera: Scarabaeidae].

### **100. *Holostaspella paraornata* Bhattacharyya, 1972**

*Holostaspella paraornata* Bhattacharyya, 1972: 129.

*Holostaspella paraornata*.— Roy, 1991a: 706.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Shitala, Sonarpur, West Bengal, 20 June 1963, in grassy soil.

### **101. *Holostaspella pentalineata* (Krauss, 1970)**

*Macrocheles (Holostaspella) pentalineata* Krauss, 1970: 27.

*Macrocheles (Holostaspella) pentalineatus*.— Hirschmann, 1970b: 45, 1970d: 47.

*Holostaspella pentalineatus*.— Karg, 1993: 98.

**Type depository.** Unspecified.

**Type locality and habitat.** Germany, Erlangen, Bavaria, date of collection unspecified, in rotting fruits of *Prunus domestica* (L.) [Rosaceae]; in rotting grass, compost with rotting apple *Malus pumila* Miller [Rosaceae], soil with plants of mangelwurzel *Beta vulgaris* L. [Amaranthaceae] and on *Hister stercorarius* Hoffmann [Coleoptera: Histeridae] in a dunghill.

**102. *Holostaspella polytrema* Krantz, 1967**

*Holostaspella polytrema* Krantz, 1967c: 133.

*Macrocheles (Holostaspella) polytrema*.— Hirschmann, 1970d: 47.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Mexico, date of collection unspecified, on *Oniticellus* sp. [Coleoptera: Scarabaeidae] and on *Megathopa* sp. [Coleoptera: Scarabaeidae]; Panama, Barro Colorado Island, 29 May 1956, on refuse deposit of nest of *Eciton burchelli* Westwood [Hymenoptera: Formicidae].

**103. *Holostaspella pulchella* Mašán, 2003**

*Holostaspella pulchella* Mašán, 2003: 133.

*Holostaspella pulchella*.— Hartini & Takaku, 2010: 109; Takaku *et al.*, 2012: 100.

**Type depository.** Institute of Zoology, Slovak Academy of Sciences, in author's private collection.

**Type locality and habitat.** Slovakia, Muránska Planina Plateau, Muráň, Studňa, 28 August 2002, in compost-excrement substrate and in horse dung.

**104. *Holostaspella punctata* Krantz, 1972**

*Holostaspella punctata* Krantz, 1972: 266.

**Type depository.** Zoologisches Museum Hamburg, Hamburg, Germany.

**Type locality and habitat.** Germany, Ahrensburg, [Stormarn, Schleswig-Holstein], 9 September 1965, in rotten stumps with moss in a mire.

**105. *Holostaspella rosichoni* Hartini & Takaku, 2006**

*Holostaspella rosichoni* Hartini & Takaku, 2006: 171.

*Holostaspella rosichoni*.— Hartini *et al.*, 2007: 91; Hartini & Takaku, 2010: 111.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, site of Freeport Indonesia Company, Tembagapura, Timika, Fakfak, Papua, 11 March 1977, on *Onthophagus* sp. [Coleoptera: Scarabaeidae] deposited in the Museum Zoologicum Bogoriense, Bogor, Indonesia.

**106. *Holostaspella scatophila* Takaku, 1994**

*Holostaspella scatophila* Takaku, 1994: 296.

**Type depository.** National Science Museum, Tokyo, Japan.

**Type locality and habitat.** Japan, Hokkaido Agriculture Experimental Station, Sapporo, Hokkaido, 7 August 1988, from the body surface of adults of *Copris ochus* Motschulsky [Coleoptera: Scarabaeidae].

**107. *Holostaspella sculpta* (Berlese, 1903)**

*Holostaspis* (*Holostaspella*) *sculpta* Berlese, 1903: 241.

*Holostaspella sculpta*.— Berlese, 1910: 248; Filipponi & Pegazzano, 1967: 222; Krantz, 1967c: 135.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** South Africa, Cape of Good Hope, date of collection unspecified, in nest of *Termes tubicola* Wasmann [cited as *Termitidis tubicolae*] [Junior synonym of *Odontotermes transvaalensis* (Sjostedt), Isoptera: Termitidae].

**108. *Holostaspella shereefi* Afifi, Hassan & Nawar, 1986**

*Holostaspella shereefi* Afifi, Hassan & Nawar, 1986: 237.

**Type depository.** Faculty of Agriculture, Cairo University, Cairo, Egypt.

**Type locality and habitat.** Egypt, El-Sheikh Zewaid, [Arish], North Sinai, 1983, from organic manure.

**109. *Holostaspella similiornata* Roy, 1989**

*Holostaspella similiornata* Roy, 1989a: 332.

*Holostaspella similiornata*.— Roy, 1991a: 705; Hartini & Takaku, 2010: 111.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Zoo Garden, Manipur, Imphal, 31 December 1978, in grassy soil.

**110. *Holostaspella similis* Krantz, 1967**

*Holostaspella caelata*.— Ryke & Meyer, 1958: 150 [Misidentification, according to Krantz, 1967c: 137].

*Holostaspella similis* Krantz, 1967c: 137<sup>Note</sup>.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** South Africa, Wolfischbai, date of collection unspecified, on *Heliocopris faunus* Boheman [Coleoptera: Scarabaeidae]; South Africa, Potchefstroom, April 1963, on *Heliocopris gigas* L. [Coleoptera: Scarabaeidae].

**Note.** Described on the basis of specimens reported by Ryke & Meyer (1958: 150) as *Holostaspella caelata* Berlese.

**111. *Holostaspella sklari* Bregetova, 1977**

*Holostaspella sklari* Bregetova, 1977: 402.

*Holostaspella sklari*.— Karg, 1993: 98.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Ukraine, Donets Basin, 25 October 1967, in nest of wood mouse.

**112. *Holostaspella solimani* Afifi, Hassan & Nawar, 1986**

*Holostaspella solimani* Afifi, Hassan & Nawar, 1986: 238.

**Type depository.** Collection of Faculty of Agriculture, Cairo University, Cairo, Egypt.

**Type locality and habitat.** Egypt, Janaklees, Beheira, 1983, from organic manure.

**113. *Holostaspella stenaspis* Krantz, 1967**

*Holostaspella stenaspis* Krantz, 1967c: 139.

**Type depository.** Chicago Natural History Museum, Chicago, Illinois, USA.

**Type locality and habitat.** Philippine Islands, Mindanao, date of collection unspecified, on *Catharsius molossus* (L.) [Coleoptera: Scarabaeidae].

**114. *Holostaspella subornata* Bregetova & Koroleva, 1960**

*Holostaspella subornata* Bregetova & Koroleva, 1960: 60.

*Holostaspella subornata*.— Krantz, 1967c: 140; Bregetova, 1977: 404; Hyatt & Emberson, 1988: 122; Karg, 1993: 99; Maśán, 2003: 130; Faraji *et al.*, 2008: 233.

*Macrocheles (Holostaspella) subornatus*.— Hirschmann, 1970d: 47; Karg, 1971: 131.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Russia, Old Petergof, [Petrodvortsovy District], Saint Petersburg, 21 August 1955, on rotten tree stump; Russia, New Petergof, [Petrodvortsovy District], Saint Petersburg, 28 August 1956, on fallen leaves under trees; Russia, Gatchina, [Gatchinsky District, Leningrad Oblast], 21 July 1957, in forest litter; Russia, Tyukalinsk, Omsk region, 12 August 1955, from nest of *Ondatra zibethicus*

(L.) [Mammalia: Rodentia: Cricetidae]; Russia, Sargatsky District, Omsk region, 10 June 1955, from nest of *O. zibethicus*.

**115. *Holostaspella tropicalis* Roy, 1991**

*Holostaspella tropicalis* Roy, 1991a: 703.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Botanical Garden, Darjeeling, West Bengal, 14 November 1973, in leaf litter.

**116. *Holostaspella tuberilinea* Karg, 1994**

*Holostaspella tuberilinea* Karg, 1994a: 126.

**Type depository.** Arachnologische Sammlung des Museums für Naturkunde, Berlin, Germany.

**Type locality and habitat.** Galapagos Islands, El Chato Tortoise Reserve, Santa Cruz Island, 27 February 1985, in grass hay and moist decaying wood.

**117. *Holostaspella villosa* Hartini & Takaku, 2010**

*Holostaspella villosa* Hartini & Takaku, 2010: 113.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Mount Gede Pangrango National Park, Java, West Java, 24-25 May 2006, on *Onthophagus malangensis* Boucomont [Coleoptera: Scarabaeidae].

**Genus *Longicheles* Valle, 1953**

*Geholaspis* (*Longicheles*) Valle, 1953: 343.

Type species: *Holostaspis mandibularis* Berlese, 1904.

*Geholaspis* (*Longicheles*).— Evans & Browning, 1956: 44; Krantz, 1962b: 157; Valle & Mazzoleni, 1967: 402; Krauss, 1970: 34; Hyatt & Emberson, 1988: 70; Karg, 1993: 99; Mašán, 2003: 55.

*Longicheles*.— Athias-Henriot, 1968: 241; Emberson, 2010: 41; Özbek & Bal, 2012: 259.

**118. *Longicheles bianchii* (Valle & Mazzoleni, 1967)**

*Geholaspis* (*Longicheles*) *bianchii* Valle & Mazzoleni, 1967: 392.



*Longicheles bianchii*.— Emberson, 2010: 45.

**Type depository.** Museo di Scienze Naturali di Bergamo, Bergamo, Italy.

**Type locality and habitat.** Italy, Calamita hill, Elba Island, Tuscany, 4 January 1963, on moss of gullies; Italy, Mola, Porto Azzurro, Livorno, Elba Island, Tuscany, 9 January 1963, in cow dung in a swamp near the sea.

### 119. *Longicheles bulgaricus* (Balogh, 1958)

*Geholaspis* (*Longicheles*) *bulgaricus* Balogh, 1958: 248.

*Geholaspis* (*Longicheles*) *bulgaricus*.— Krantz, 1962b: 170; Bregetova, 1977: 395; Karg, 1993: 100.

*Longicheles bulgaricus*.— Athias-Henriot, 1968: 269; Emberson, 2010: 45; Ács & Kontschán, 2014: 111.

*Geholaspis* (*Longicheles*) cf. *bulgaricus*.— Johnston, 1970: 149.

*Geholaspis bulgaricus*.— Hirschmann, 1970d: 49.

**Type depository.** In author's private collection, Budapest, Hungary.

**Type locality and habitat.** Bulgaria, Vitocha Mountain (alt. 1600 m), 1 June 1956, on needles and humus of spruce, *Picea* sp. [Pinaceae], forest.

### 120. *Longicheles hortorum* (Berlese, 1904)

*Holostaspis longulus* var. *hortorum* Berlese, 1904a: 265.

*Macrocheles* (*Geholaspis*) *hortorum*.— Berlese, 1918: 145.

*Geholaspis* (*Longicheles*) *mandibularis hortorum*.— Valle, 1953: 349; Krantz, 1962b: 171; Valle & Mazzoleni, 1967: 402.

*Geholaspis* (*Longicheles*) *hortorum*.— Balogh, 1958: 251; Bregetova, 1977: 394; Hyatt & Emberson, 1988: 74; Karg, 1993: 100; Mašán, 2003: 57.

*Longicheles hortorum*.— Athias-Henriot, 1968: 269; Emberson, 2010: 45; Özbek & Bal, 2012: 260; Ács & Kontschán, 2014: 111.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Italy, Boboli Gardens, Florence, date of collection unspecified, on decaying leaves.

**Note.** Suspected junior synonymy of *Longicheles mandibularis* (Berlese) by Krauss (1970: 38).

### 121. *Longicheles ilvana* (Valle & Mazzoleni, 1967)

*Geholaspis (Longicheles) ilvana* Valle & Mazzoleni, 1967: 396.

*Longicheles ilvana*.— Emberson, 2010: 45.

**Type depository.** Museo di Scienze Naturali di Bergamo, Bergamo, Italy.

**Type locality and habitat.** Italy, Calamita Hill, Elba Island, Tuscany, 4 January 1963, on moss of gullies; Italy, Mola, Porto Azzurro, Livorno, Elba Island, Tuscany, 9 January 1963, on cow dung in a swamp near the sea; Greece, Mount Ida (alt. 900 m), Anogeia, Crete, 1965, in soil.

### 122. *Longicheles lagrecai* (Valle, 1963)

*Geholaspis (Longicheles) lagrecai* Valle, 1963: 419.

*Geholaspis (Longicheles) lagrecai*.— Valle & Mazzoleni, 1967: 402.

*Longicheles lagrecai*.— Emberson, 2010: 45.

**Type depository.** Museo di Scienze Naturali di Bergamo, Bergamo, Italy.

**Type locality and habitat.** Italy, Monte Manfrè (alt. 1450 m), Etna, Sicily, 16 July 1961, in soil of volcanic zone; Italy, Monte Rossi (alt. 900 m), Etna, Sicily, 3 April 1962, in soil of volcanic zone; Italy, Rifugio Marini, Madonie (alt. 1700 m), Palermo, Sicily, 1 April, 1963, in litter of a deciduous grove.

### 123. *Longicheles longisetosus* (Balogh, 1958)

*Geholaspis (Longicheles) longisetosus* Balogh, 1958: 250.

*Geholaspis (Longicheles) longisetosus*.— Krantz, 1962b: 171; Bregetova, 1977: 396; Karg, 1993: 100.

*Geholaspis longisetosus*.— Hirschmann, 1970d: 49; Kontschán, 2007: 103.

*Geholaspis* cf. *longisetosus*.— Mašán, 2003: 60.

*Longicheles longisetosus*.— Emberson, 2010: 45; Özbek & Bal, 2012: 263.

**Type depository.** In author's private collection, Budapest, Hungary.

**Type locality and habitat.** Bulgaria, Borovec, Rila Mountain (alt. 1360 m), 27 August 1956, on decaying leaves and moss.

### 124. *Longicheles longulus* (Berlese, 1887)

*Holostaspis longulus* Berlese, 1887a: 9.

*Macrocheles longulus*.— Oudemans, 1902a: 42.

*Macrocheles (Geholaspis) longulus*.— Berlese, 1918: 145.

*Geholaspis (Longicheles) longulus*.— Valle, 1953: 351; Evans & Browning, 1956: 44; Balogh, 1958: 251; Krantz, 1962b: 171; Krauss, 1970: 38; Bregetova, 1977: 395; Karg, 1993: 100; Mašán, 2003: 58.

*Geholaspis (Longicheles) longula*.— Valle, 1963: 425; Valle & Mazzoleni, 1967: 402.

*Geholaspis longulus*.— Hirschmann, 1970d: 49.

*Longicheles longulus*.— Emberson, 2010: 45; Ács & Kontschán, 2014: 112.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Italy, Acireale, Sicilia, date of collection unspecified, on flies.

**Note**<sup>1</sup>. Specimens reported by Halbert (1915: 66) as *Holostaspis longulus* Berlese identified as *Geholaspis (Longicheles) mandibularis* (Berlese) by Hyatt & Emberson (1988: 74).

**Note**<sup>2</sup>. Specimen reported by Hull (1918: 73) as *Macrocheles longulus* Berlese identified as *Geholaspis longispinosus* (Kramer) by Hyatt & Emberson (1988: 74).

## 125. *Longicheles mandibularis* (Berlese, 1904)

*Holostaspis mandibularis* Berlese, 1904a: 263.

*Macrocheles (Geholaspis) mandibularis*.— Berlese, 1918: 145; Schweizer, 1922: 37; Cooreman, 1943: 22.

*Geholaspis mandibularis*.— Hirschmann, 1970a: 44, 1970b: 45, 1970c: 46, 1970d: 49; Karg, 1971: 130; Mašán, 2003: 55.

*Geholaspis (Longicheles) mandibularis*.— Valle, 1953: 344; Evans & Browning, 1956: 44; Balogh, 1958: 251; Bregetova & Koroleva, 1960: 67; Krantz, 1962b: 171, 1972: 268; Valle & Mazzoleni, 1967: 402; Krauss, 1970: 38; Van Driel *et al.*, 1977: 308; Bregetova, 1977: 394; Hyatt & Emberson, 1988: 74; Karg, 1993: 99.

*Longicheles mandibularis*.— Emberson, 2010: 45; Özbek & Bal, 2012: 259; Ács & Kontschán, 2014: 112.

*Holostaspis longulus*.— Halbert, 1915: 66 [Misidentification, according to Hyatt & Emberson, 1988: 74].

**Type depository.** *H. mandibularis*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** *H. mandibularis*: Italy, Cansiglio, date of collection unspecified, on wood flies.

**Note.** Suspected senior synonymy of *Holostaspis longulus* var. *hortorum* Berlese by Krauss (1970: 38).

**Note.** Suspected senior synonymy of *Macrocheles minimus* Hull by Evans & Browning (1956: 44).

**126. *Longicheles ranzii* (Valle & Mazzoleni, 1967)**

*Geholaspis* (*Longicheles*) *ranzii* Valle & Mazzoleni, 1967: 386.

*Longicheles ranzii*.— Emberson, 2010: 45.

**Type depository.** Museo di Scienze Naturali di Bergamo, Bergamo, Italy.

**Type locality and habitat.** Greece, Leuka Ore (alt. 1000 m), Omalos, Crete, 1965, in soil.

**Genus *Lordocheles* Krantz, 1961**

*Lordocheles* Krantz, 1961: 3.

*Lordocheles*.— Krantz, 1962b: 159; Krantz, 1998: 96.

Type species: *Lordocheles desaegeri* Krantz, 1961, by original designation.

**127. *Lordocheles desaegeri* Krantz, 1961**

*Lordocheles desaegeri* Krantz, 1961: 5.

*Lordocheles desaegeri*.— Krantz, 1962b: 171, 1998: 96.

**Type depository.** Central African Museum, Tervuren, Belgium.

**Type locality and habitat.** Congo, Garamba National Park, Orientale, 6 November 1951/ 6 February 1952, on insects collected in grassy savannah and on other arthropods from marshy area in sparsely forested habitat.

**128. *Lordocheles rykei* Krantz, 1961**

*Lordocheles rykei* Krantz, 1961: 8.

*Lordocheles rykei*.— Krantz, 1962b: 171.

**Type depository.** Central African Museum, Tervuren, Belgium.

**Type locality and habitat.** Congo, Garamba National Park, Orientale, 6 November 1951, on insects collected in grassy savannah.

**Genus *Macrholaspis* Oudemans, 1931**

*Macrholaspis* Oudemans, 1931: 272.

Type species: *Gamasus opacus* Koch, 1839, by original designation.

*Macrholaspis*.— Evans, 1956: 351; Evans & Browning, 1956: 46; Bregetova & Koroleva, 1960: 71; Emberson, 2010: 48.

*Macrocheles (Macrholaspis)*.— Karg, 1971: 131; Bregetova, 1977: 380; Karg, 1993: 102.

*Macrocheles opacus* species group.— Johnston, 1970: 148; Hyatt & Emberson, 1988: 95.

**Note.** Considered junior synonymy of *Macrocheles* by Krantz (1962b: 146).

**129. *Macrholaspis beieri* (Johnston, 1970)**

*Macrocheles beieri* Johnston, 1970: 146.

*Macrocheles (Macrholaspis) beieri*.— Bregetova, 1977: 384; Karg, 1993: 104.

*Macrholaspis beieri*.— Emberson, 2010: 49.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Austria, Waschnigg (alt. 700 m), Carinthia, 16 July 1962, from leaf litter and moss under a crystalline slate in a mixed forest of beech [Fagaceae] and fir [Pinaceae].

**130. *Macrholaspis carpathicus* (Mašán, 2003)**

*Macrocheles (Macrholaspis) carpathicus* Mašán, 2003: 75.

*Macrholaspis carpathicus*.— Emberson, 2010: 49.

**Type depository.** Institute of Zoology, Slovak Academy of Sciences, in author's private collection.

**Type locality and habitat.** Slovakia, Revúcka Vrchovina Highland, 8 August 1997, in edaphic sylvicolous detriticole.

**131. *Macrholaspis dentatus* Evans & Browning, 1956**

*Macrholaspis dentatus* Evans & Browning, 1956: 48.

*Macrholaspis dentatus*.— Balogh, 1958: 248; Bregetova & Koroleva, 1960: 71; Emberson, 2010: 49.

*Macrocheles (Macrholaspis) dentatus*.— Bregetova, 1977: 382; Karg, 1993: 102; Mašán, 2003: 73.

*Macrocheles dentatus*.— Hirschmann, 1970d: 52; Hyatt & Emberson, 1988: 101.

*Macrocheles (Macrocheles) multisetosus* Götz, in Krauss, 1970: 29 [Synonymy by Hyatt & Emberson 1988: 101].

*Macrocheles multisetosus*.— Hirschmann, 1970c: 46, 1970d: 52.

*Macrocheles (Nothrolaspis) pannosus*.— Hull, 1925: 211 [In part – misidentification, according to Hyatt & Emberson, 1988: 101].

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** *M. dentatus*: Wales, Leri Valley, [Dôl-y-Bont], Cardigan [cited as North Cardiganshire], [Ceredigion], 1955, in humus under bracken; *M. (M.) multisetosus*: Germany, Hetzles, Bavaria, date of collection unspecified, on moss; Germany, Erlangen, Bavaria, date of collection unspecified, in compost heaps; Germany, Hersbrucker Schweiz, Bavaria, date of collection unspecified, on *Fontinalis antipyretica* Hedw. [Fontinalaceae].

### 131a. *Macrholaspis dentatus franzi* (Krauss, 1970)

*Macrocheles (Macrholaspis) dentatus* var. *franzi* Krauss, 1970: 26.

*Macrocheles dentatus* var. *franzi*.— Hirschmann, 1970a: 44.

*Macrocheles (Macrholaspis) dentatus franzi*.— Karg, 1993: 103.

*Macrholaspis dentatus franzi*.— Emberson, 2010: 49.

**Type depository.** Unspecified.

**Type locality and habitat.** Spain, Castiñeiras, Galicia, date of collection unspecified, in litter and moss at the foot of old chestnut trees from a flat valley with sphagnum.

**Note.** This subspecies was considered as *Macrholaspis* when Emberson, 2010: 49 considered *Macrholaspis dentatus* Evans & Browning in that genus.

### 132. *Macrholaspis evansi* Balogh, 1958

*Macrholaspis evansi* Balogh, 1958: 247.

*Macrocheles (Macrholaspis) evansi*.— Bregetova, 1977: 382; Karg, 1993: 103.

*Macrocheles evansi*.— Hirschmann, 1970d: 51.

*Macrholaspis evansi*.— Emberson, 2010: 49.

**Type depository.** In author's private collection, Budapest, Hungary.

**Type locality and habitat.** Bulgaria, Karlovo (alt. 1400 m), Balkan Mountains, 10 June 1956, in litter and humus from a beech, *Fagus* sp. [Fagaceae], forest.

### 133. *Macrholaspis georgicus* (Bregetova, 1977)

*Macrocheles (Macrholaspis) georgicus* Bregetova, 1977: 381.

*Macrocheles (Macrholaspis) georgicus*.— Karg, 1993: 102.

*Macrholaspis georgicus*.— Emberson, 2010: 49.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Georgia, Chakvistskhali River, 8 October 1961, from unspecified host/substrate.

**134. *Macrholaspis morikawai* (Ishikawa, 1969)**

*Macrocheles morikawai* Ishikawa, 1969: 60.

*Macrocheles morikawai*.— Hirschmann, 1970d: 51; Bregetova, 1977: 359.

*Macrholaspis morikawai*.— Emberson, 2010: 49.

**Type depository.** Biological Laboratory, Matsuyama Shinonome Junior College, Matsuyama, Japan.

**Type locality and habitat.** Japan, Otanomosu-no-taira, Mount Shiga, Shigakogen, October 1967, in soil and litter.

**135. *Macrholaspis opacus* (Koch, 1839)**

*Gamasus opacus* Koch, 1839b: 24.

*Gamasus opacus*.— Canestrini & Fanzago, 1877: 116; Berlese, 1892: 66.

*Macrocheles opacus*.— Oudemans, 1916: 250; Hirschmann, 1970b: 45, 1970c: 46, 1970d: 51; Krantz, 1972: 270; Hyatt & Emberson, 1988: 96; Faraji *et al.*, 2008: 234.

*Macrholaspis opacus*.— Oudemans, 1931: 272, 1936: 184; Evans & Browning, 1956: 48; Balogh, 1958: 248; Bregetova & Koroleva, 1960: 71; Athias-Henriot, 1968: 269; Emberson, 2010: 49.

*Macrocheles (Macrholaspis) opacus*.— Karg, 1971: 131, 1993: 104; Bregetova, 1977: 384; Mašán, 2003: 69.

*Macrocheles (Nothrholaspis) aciculatus* Berlese, 1918: 169 [Synonymy by Evans & Browning, 1956: 48].

*Macrocheles (Macrocheles) opacus* var. *aciculatus*.— Krauss, 1970: 23.

*Macrocheles (Macrholaspis) opacus aciculatus*.— Bregetova, 1977: 382; Karg, 1993: 102.

**Type depository.** *G. opacus*: Unspecified; *M. (N.) aciculatus*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. (M.) opacus aciculatus*: Unspecified.

**Type locality and habitat.** *G. opacus*: Germany, date of collection and host/substrate unspecified; *M. (N.) aciculatus*: France, Meudon Forest, Paris, date of collection unspecified, on flies; *M. (M.) opacus aciculatus*: Spain, date of collection and host/substrate unspecified.

**Note.** Specimens identified as *Macrocheles (Macrocheles) opacus* (Koch) by Krauss, 1970: 22 considered as *Macrocheles terreus* by Krantz (1972: 270).

**136. *Macrholaspis recki* (Bregetova & Koroleva, 1960)**

*Macrocheles recki* Bregetova & Koroleva, 1960: 104.

*Macrocheles (Macrocheles) recki*.— Karg, 1971: 137.

*Macrocheles (Macrholaspis) recki*.— Bregetova, 1977: 383; Karg, 1993: 103; Mašán, 2003: 78.

*Macrocheles recki*.— Hirschmann, 1970d: 51; Faraji *et al.*, 2008: 234.

*Macrholaspis recki*.— Emberson, 2010: 49.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Georgia, Lagodekhi Nature Reserve, Lagodekhi, 18 July 1938, from litter and soil.

**Note.** Suspected junior synonym of *Macrholaspis terreus* (Bregetova & Koroleva) by Mašán, 2003: 79.

**137. *Macrholaspis reductus* (Petrova, 1966)**

*Macrocheles reductus* Petrova, 1966: 20.

*Macrocheles reductus*.— Bregetova, 1977: 359; Ma *et al.*, 2002: 113.

*Macrholaspis reductus*.— Emberson, 2010: 49.

**Type depository.** Department of Entomology, Moscow State University, Moscow, Russia.

**Type locality and habitat.** Russia, Kedrovaya Pad Nature Reserve, Khasansky District, Primorsky Krai, June 1962, in soil and litter from a deciduous forest.

**138. *Macrholaspis similiopacus* (Mašán, 2003)**

*Macrocheles (Macrholaspis) similiopacus* Mašán, 2003: 71.

*Macrholaspis similiopacus*.— Emberson, 2010: 49; Ács & Kontschán, 2014: 112.

**Type depository.** Institute of Zoology, Slovak Academy of Sciences, in author's private collection, Slovakia.

**Type locality and habitat.** Slovakia, Vepor Mountains [cited as Veporské Vrchy Hills], 9 April 1999, in edaphic detriticole.

**139. *Macrholaspis stammeri* (Krauss, 1970)**



*Macrocheles (Macrocheles) stammeri* Krauss, 1970: 25.

*Macrocheles stammeri*.— Hirschmann, 1970c: 46, 1970d: 51.

*Macrholaspis stammeri*.— Emberson, 2010: 49.

**Type depository.** Unspecified.

**Type locality and habitat.** Spain, Pontevedra, Galicia, date of collection unspecified, in soil from a fragment of a *Quercus pedunculata* Hoffm. [Fagaceae] forest; in litter under old blackberry [*Rubus* sp.; Rosaceae] bushes; Spain, Castiñeiras, Galicia, date of collection unspecified, on moss.

**139a. *Macrholaspis stammeri angustatus* (Krauss, 1970)**

*Macrocheles (Macrocheles) stammeri* var. *angustatus* Krauss, 1970: 26.

**Type depository.** Unspecified.

**Type locality and habitat.** Spain, Pontevedra, Galicia, date of collection unspecified, in soil from a rest of a forest of *Quercus pedunculata* Hoffm. [Fagaceae]; in litter under old blackberry bushes; Spain, Castiñeiras, Galicia, date of collection unspecified, on moss.

**Note.** This subspecies was considered as *Macrholaspis* when Emberson (2010: 49) considered *Macrholaspis stammeri* (Krauss) in that genus.

**140. *Macrholaspis terreus* (Canestrini & Fanzago, 1877)**

*Gamasus terreus* Canestrini & Fanzago, 1877: 116.

*Gamasus tardus* var. *terreus*.— Berlese, 1882a: 112.

*Gamasus (Holostaspis) terreus*.— Berlese, 1882b: 637.

*Holostaspis terreus*.— Canestrini & Canestrini, 1882: 29; G. Canestrini, 1885: 62; Berlese, 1892: 69; Halbert, 1915: 66.

*Holostaspis alpinus* var. *terreus*.— Berlese, 1889: 7<sup>Note1</sup>.

*Macrocheles terreus*.— Oudemans, 1902a: 43; Berlese, 1906: 289; Hyatt & Emberson, 1988: 103.

*Macrocheles (Nothrholaspis) terreus*.— Berlese, 1918: 169; Cooreman, 1943: 21.

*Nothrholaspis terreus*.— Willmann, 1951: 104.

*Macrocheles (Macrholaspis) terreus*.— Bregetova, 1977: 382; Karg, 1993: 103; Mašán, 2003: 79<sup>Note2</sup>.

*Macrholaspis terreus*.— Emberson, 2010: 49.

*Macrocheles (Macrocheles) opacus*.— Krauss, 1970: 22 [Misidentification, according to Krantz, 1972: 270].

*Gamasus arcticus* Kramer & Neumann, 1883: 528 [Synonymy by Berlese, 1892: 63].

*Holostaspis echinatus* Berlese, 1904b: 20 [Synonymy by Berlese, 1918: 189].

**Type depository.** *M. terreus*: Holotype apparently lost; neotype designated by Hyatt & Emberson, 1988: 103 – Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *G. arcticus*: unknown; *M. echinatus*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** *M. terreus*: Italy, Padua, Veneto, date of collection unspecified, in soil [original description]; neotype designated by Hyatt & Emberson (1988: 103): Italy, Boboli Gardens, Florence, date of collection unspecified, on rotting palm leaves; *G. arcticus*: Russia, Bering Island, date of collection and host unspecified; *M. echinatus* lectotype designated by Hyatt & Emberson (1988: 103): Italy, Boboli Gardens, Florence, date of collection unspecified, on rotting palm leaves.

**Note<sup>1</sup>.** The species cited by Berlese (1889: 7) as *Holostaspis alpinus* var. *terreus* is probably *Holostaspis longispinosus* var. *terreus* as mentioned in the figure and as used in the explanation about the name of the species.

**Note<sup>2</sup>.** Reported as “near” *Macrocheles terreus* (Canestrini & Fanzago).

**Note<sup>3</sup>.** Suspected senior synonym of *Macrocheles recki* Bregetova & Koroleva by Mašán (2003: 79).

#### **141. *Macrholaspis tianschanicus* (Bregetova, 1977)**

*Macrocheles (Macrholaspis) tianschanicus* Bregetova, 1977: 382.

*Macrholaspis tianschanicus*.— Emberson, 2010: 49.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** China, Tian Shan, Dzhilandy Scenic Point (alt. 2150 m), 24 May 1959, under mountain ash [Oleaceae].

#### **Genus *Macrocheles* Latreille, 1829**

*Macrocheles* Latreille, 1829: 282.

Type species: *Acarus marginatus* Hermann, 1804 (= *Acarus muscae domesticae* Scopoli, 1772), by original designation.

*Macrocheles (Macrocheles)*.— Berlese, 1918: 172; Krauss, 1970: 6; Karg, 1971: 131; Karg, 1993: 105.

*Macrocheles*.— Oudemans, 1931: 273; Oudemans, 1942: 166; Evans, 1956: 351; Bregetova & Koroleva, 1960: 72; Krantz, 1962b: 146; Athias-Henriot, 1968: 241; Krauss, 1970: 3; Hirschmann, 1970a: 44; Hyatt & Emberson, 1988: 78; Mašán, 2003: 61.

*Macrocheles (Coprholaspis)* Berlese, 1918: 146.

Type species: *Holostaspis glabra* Müller, 1860, by original designation.

*Coprholaspis*.— Lombardini, 1941: 184.

*Macrocheles (Monoplites)* Hull, 1925: 215.

Type species: *Macrocheles (Monoplites) oudemansii* Hull, 1925: 215 [= *Macrocheles glaber* (Müller, 1860)], by original designation.

*Holostaspis*.— Berlese, 1887b: 2.

*Andrholaspis* Turk, 1948: 103 [Junior synonymy by Krantz, 1962b: 146].

Type species: *Andrholaspis trinitatis* Turk, 1948, by original designation.

*Andrholaspis*.— Evans, 1956: 351.

#### **142. *Macrocheles abbreviatus* Berlese, 1918**

*Macrocheles (Coprholaspis) abbreviatus* Berlese, 1918: 151.

*Macrocheles abbreviatus*.— Evans & Hyatt, 1963: 332; Hirschmann, 1970d: 48.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Somalia, date of collection unspecified, on *Atheucus* sp. [possibly *Ateuchetus* sp.] [Coleoptera: Scarabaeidae].

#### **143. *Macrocheles adenostictus* Krantz & Whitaker, 1988**

*Macrocheles adenostictus* Krantz & Whitaker, 1988: 229.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Suver, Polk, 23 March 1980, in fecal chamber of *Neotoma fuscipes* Baird [Mammalia: Rodentia: Cricetidae].

#### **144. *Macrocheles aemulans* (Berlese, 1905)**

*Holostaspis aemulans* Berlese, 1905: 163.

*Macrocheles (Coprholaspis) aemulans*.— Berlese, 1918: 146.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Indonesia, Bogor [cited as Buitenzorg], Java, date of collection and host unspecified.

**145. *Macrocheles aestivus* Halliday, 1986**

*Macrocheles aestivus* Halliday, 1986a: 734.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Raleigh, New South Wales, 15 January 1980, in dung and on dung beetles.

**146. *Macrocheles agilis* Halliday, 2000**

*Macrocheles agilis* Halliday, 2000: 278.

*Macrocheles agilis*.— Hartini *et al.*, 2007: 93.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Allyn River (32°08'S; 151°27'E), New South Wales, 1 February 1986, of a laboratory colony originated from females collected on *Ptomaphila lacrymosa* (Schreibers) [Coleoptera: Silphidae].

**147. *Macrocheles agnosticus* Walter & Krantz, 1992**

*Macrocheles agnosticus* Walter & Krantz, 1992: 245.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** South Africa, date of collection unspecified, on *Scarabaeus savignyi* MacLeay [Coleoptera: Scarabaeidae].

**148. *Macrocheles alatus* (Fox, 1946)**

*Macrocheles alatus* Fox, 1946b: 174.

**Type depository.** Department of Medical Zoology, School of Tropical Medicine, San Juan, Puerto Rico.

**Type locality and habitat.** Puerto Rico, Santurce, San Juan, 9 February 1946, on *Rattus norvegicus* Berkenhout [Mammalia: Rodentia: Muridae].

**149. *Macrocheles amaliae* Hartini, 2008**

*Macrocheles amaliae* Hartini, 2008: 15.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Wai Bayon, Lopintol, Raja Ampat, Waigeo Island, West Papua, 6–9 June 2007, on *Onthophagus* sp. [Coleoptera: Scarabaeidae].

**150. *Macrocheles amamiensis* Takaku, 2000**

*Macrocheles amamiensis* Takaku, 2000: 121.

**Type depository.** Natural History Museum, London, England.

**Type locality and habitat.** Japan, Mount Yuwan, Uken-son, Amami-Oshima Island, 26 April 1998, on *Trox sugayai* Masumoto & Kiuchi [Coleoptera: Trogidae].

**151. *Macrocheles ancyleus* Krauss, 1970**

*Macrocheles (Macrocheles) ancyleus* Krauss, 1970: 24.

*Macrocheles ancyleus*.— Hirschmann, 1970d: 50; Mašán, 2003: 97.

*Macrocheles minervae* Cicolani, 1982: 153 [Synonymy by Mašán & Zubáčová, 2001: 577].

**Type depository.** *M. (M.) ancyleus*: unspecified; *M. minervae*: Museum of Natural History of Verona, Italy.

**Type locality and habitat.** *M. (M.) ancyleus*: Germany, Erlangen, Bavaria, date of collection unspecified, in litter from a fallen poplar, *Populus tremula* L. [Salicaceae], tree; *M. minervae*: Italy, Castro, Grotta Zinzulusa, 20 July 1981, in guano.

**152. *Macrocheles angustus* Halliday, 2000**

*Macrocheles angustus* Halliday, 2000: 280.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Bule Pool Trail (28°13'S; 153°08'E), Lamington National Park, 22 May 1996, in samples of rotting polypore fungus.

**153. *Macrocheles arabaesc* Takaku & Hartini, 2001**

*Macrocheles scarabae* Chinniah & Mohanasundaram, 1995: 220 [Junior homonym of *Macrocheles scarabae* Vishnupriya & Mohanasundaram, 1988].

*Macrocheles arabaesc* Takaku & Hartini, 2001: 329 [Replacement name].

**Type depository.** Department of Agricultural Entomology, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, India.

**Type locality and habitat.** India, Coimbatore, Tamil Nadu, 17 March 1988, on *Onitis philemon* F. [Coleoptera: Scarabaeidae].

**154. *Macrocheles arcuatus* (Trägårdh, 1931)**

*Coprhoslaspis arcuatus* Trägårdh, 1931a: 609.

*Macrocheles arcuatus*.— Hirschmann, 1970d: 51.

**Type depository.** Not stated, but presumably Swedish Museum of Natural History, Stockholm.

**Type locality and habitat.** Juan Fernández Islands [South Pacific Ocean], Robinson Crusoe Island [cited as Masatierra], 16 August 1917, among dry leaves.

**155. *Macrocheles areolatus* Krantz & Whitaker, 1988**

*Macrocheles areolatus* Krantz & Whitaker, 1988: 234.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Patuxent Wildlife Refuge, Maryland, 7 June 1955, in nest of *Peromyscus* sp. [Mammalia: Rodentia: Cricetidae].

**156. *Macrocheles argentinus* Evans & Hyatt, 1963**

*Macrocheles argentinus* Evans & Hyatt, 1963: 332.

*Macrocheles argentinus*.— Hirschmann, 1970d: 47.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Argentina, Villa Valeria, date of collection unspecified, on *Eudinopus dytisoides* (Schreiberg) [Coleoptera: Scarabaeidae].

**157. *Macrocheles assamensis* Roy, 1996**

*Macrocheles assamensis* Roy, 1996a: 68.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Rajabhetta, Dibrugarh University Campus, Dibrugarh, Assam, 10 July 1976, on *Scarabaeus* sp. [Coleoptera: Scarabaeidae].

**158. *Macrocheles austroamericanus* Evans & Hyatt, 1963**

*Macrocheles austroamericanus* Evans & Hyatt, 1963: 389.

*Macrocheles austroamericanus*.— Méndez Olivo, 1968: 160; Hirschmann, 1970d: 50.

*Macrocheles (dimidiatus) austroamericanus*.— Arriaga-Jimenez *et al.*, 2014: 374.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Paraguay, Nanahua, Paraguayan Chaco, date of collection unspecified, on *Sulcophanaeus imperator* Chevrolat [Coleoptera: Scarabaeidae].

**159. *Macrocheles bacchusi* Evans & Hyatt, 1963**

*Macrocheles bacchusi* Evans & Hyatt, 1963: 335.

*Macrocheles bacchusi*.— Hirschmann, 1970d: 50.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Africa, date of collection unspecified, on *Circellium bacchus* (F.) [Coleoptera: Scarabaeidae].

**160. *Macrocheles badernus* Lizaso, Mendes & Santos, 1992**

*Macrocheles badernus* Lizaso, Mendes & Santos, 1992: 598.

**Type depository.** Instituto Butantan, São Paulo, Brasil.

**Type locality and habitat.** Brazil, Itapetininga, São Paulo, 26 January 1987, in accumulated dung under cages of laying hens in industrial farms.

**161. *Macrocheles badius* Koch, 1839**

*Gamasus badius* Koch, 1839c: 9.

*Holostaspis badius*.—Berlese, 1892: 70.

*Gamasus badius*.— Oudemans, 1929b: 13.

*Gamasus curtus* Koch, 1839c: 10 [Suspect synonymy by Berlese, 1892: 64].

*Hypoaspis ? curtus* [sic].— Oudemans, 1936: 207.

**Type depository.** *G. badius*: Unspecified; *G. curtus*: Unspecified;

**Type locality and habitat.** *G. badius*: Germany, “Feldholzern”, date of collect not mentioned; *G. curtus*: Germany, Thalern, Pfaffenhofen, Bavaria, date of collect not mentioned, on the banks of the river Bache;

**Note<sup>1</sup>.** Specimen reported by Oudemans (1904a: 105) as *Macrocheles badius* (Koch) identified as *Macrocheles glaber* (Müller) by Filipponi & Pegazzano (1962b: 215).

**Note<sup>2</sup>.** Specimen reported by Berlese (1913b: 195) as *Holostaspis badius* (Koch) described as *Macrocheles veterrimus* Sellnick, 1940 [junior synonymy of *Macrocheles glaber* (Müller) by Evans & Browning (1956: 16)].

**Note<sup>3</sup>.** Suspected senior synonym of *Holostaspis glabra* Müller by Berlese (1892: 71).

**162. *Macrocheles baliensis* Takaku & Hartini, 2001**

*Macrocheles baliensis* Takaku & Hartini, 2001: 327.

*Macrocheles baliensis*.— Hartini *et al.*, 2007: 74.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Bali Barat National Park, Bali, 4 December 1999, on *Aphodiini* sp. [Coleoptera: Scarabaeidae].

**163. *Macrocheles baramensis* Evans & Hyatt, 1963**

*Macrocheles baramensis* Evans & Hyatt, 1963: 335.

*Macrocheles baramensis*.— Hirschmann, 1970d: 50; Hartini *et al.*, 2007: 93.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Indonesia, Baram, Northwest Borneo, date of collection unspecified, on *Paragymnopleurus maurus* Sharp [Coleoptera: Scarabaeidae].

**164. *Macrocheles bengalensis* Roy, 1996**

*Macrocheles bengalensis* Roy, 1996a: 71.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Narendrapur, 24 Parganas (South), West Bengal, 24 December 1979, in poultry bed litter.

**165. *Macrocheles berlesei* Hennessey & Farrier, 1988**

*Macrocheles (Coprholaspis) spinipes* Berlese, 1918: 160 [Junior homonymy of *Macrocheles spinipes* (Say, 1821)].

*Coprholaspis spinipes*.— Turk, 1948: 101.

*Macrocheles berlesei* Hennessey & Farrier, 1988: 22 [Replacement name].

*Macrocheles spinipes*.— Krantz, 1988: 977.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection unspecified, on *Diloboderus abderus* (Sturm) [Coleoptera: Scarabaeidae].

**166. *Macrocheles bertrandi* Niogret & Nicot, 2008**

*Macrocheles bertrandi* Niogret & Nicot, 2008: 43.

**Type depository.** Muséum National d'Histoire Naturelle de Paris, Paris, France.

**Type locality and habitat.** Gabon, Bakoumba (01°79'S; 13°04'E; alt. 623 m), June 2006, on *Stomoxys calcitrans* L. [Diptera: Muscidae].

**167. *Macrocheles bilacunatus* Krantz, 1970**

*Macrocheles bilacunatus* Krantz, 1970: 21.



**Type depository.** Cited as SSAE.

**Type locality and habitat.** South Africa, Kleinmond, Western Cape, 20 December 1950, on scarabaeid [Coleoptera: Scarabaeidae].

**168. *Macrocheles bisignata* (Berlese, 1918)**

*Holostaspella (Prholaspina) bisignata* Berlese, 1918: 175.

*Macrocheles bisignata*.— Filipponi & Pegazzano, 1967: 220; Krantz, 1967c: 143; Hirschmann, 1970d: 47.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection and host/substrate unspecified.

**169. *Macrocheles bolivari* Iavorschi, 1987**

*Macrocheles bolivari* Iavorschi, 1987: 147.

**Type depository.** Institut Spéologie “Émile Racovitza”, Bucharest, Romania.

**Type locality and habitat.** Venezuela, date of collection unspecified, in soil.

**170. *Macrocheles bombycis* Kishida, 1940**

*Macrocheles bombycis* Kishida, 1940: 113.

**Type depository.** Unspecified.

**Type locality and habitat.** Japan, Kyoto, date of collection unspecified, on *Bombyx mori* (L.) [Lepidoptera: Bombycidae].

**171. *Macrocheles boneti* Méndez Olivo, 1968**

*Macrocheles boneti* Méndez Olivo, 1968: 146.

**Type depository.** Escuela Nacional de Ciencias Biológicas, Mexico city, Mexico.

**Type locality and habitat.** Mexico, Playa Azul, Calemaco, Veracruz, August 1965, on *Dichotomius carolinus* (L.) [Coleoptera: Scarabaeidae].

**172. *Macrocheles bordoni* Iavorschi, 1987**

*Macrocheles bordoni* Iavorschi, 1987: 147.

**Type depository.** Institut Spéologie “Émile Racovitza”, Bucharest, Romania.

**Type locality and habitat.** Venezuela, date of collection unspecified, in soil.

**173. *Macrocheles borealis* Halliday, 2000**

*Macrocheles borealis* Halliday, 2000: 284.

*Macrocheles borealis*.— Hartini *et al.*, 2007: 94.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Bamaga, Queensland, 26 March 1964, on *Onthophagus tricavicollis* Lea [Coleoptera: Scarabaeidae].

**174. *Macrocheles boudreauxi* Krantz, 1965**

*Macrocheles boudreauxi* Krantz, 1965b: 145.

*Macrocheles boudreauxi*.— McGraw & Farrier, 1969: 27; Hirschmann, 1970b: 45, 1970c: 45, 1970d: 48; Kinn & Witcosky, 1977: 136.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Louisiana, 1964, in colony derived from specimens in galleries of *Ips calligraphus* De Geer [Coleoptera: Curculionidae].

**175. *Macrocheles boxi* Evans & Hyatt, 1963**

*Macrocheles boxi* Evans & Hyatt, 1963: 338.

*Macrocheles boxi*.— Hirschmann, 1970d: 47

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Argentina, Tucuman, date of collection unspecified, on *Canthon principalis* (Burmeister) [Coleoptera: Scarabaeidae].

**176. *Macrocheles brasiliensis* Evans & Hyatt, 1963**

*Macrocheles brasiliensis* Evans & Hyatt, 1963: 391.

*Macrocheles brasiliensis*.— Hirschmann, 1970d: 50.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Brazil, Santa Catarina, date of collection unspecified, on *Phanaeus bellicosus* Olivier [Coleoptera: Scarabaeidae].

**177. *Macrocheles bregetovae* Evans & Hyatt, 1963**

*Macrocheles bregetovae* Evans & Hyatt, 1963: 392.

*Macrocheles bregetovae*.— Hirschmann, 1970d: 51.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Venezuela, El Zumbador, date of collection unspecified, on *Dichotomius carolinus* (L.) [Coleoptera: Scarabaeidae].

**178. *Macrocheles browningi* Evans & Hyatt, 1963**

*Macrocheles browningi* Evans & Hyatt, 1963: 338.

*Macrocheles browningi*.— Hirschmann, 1970d: 49.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Brazil, Rio de Janeiro, date of collection unspecified, on *Eurysternus deplanatus* (Germar) [Coleoptera: Scarabaeidae].

**179. *Macrocheles bruneti* (Turk, 1948)**

*Coprholaspis bruneti* Turk, 1948: 102.

*Macrocheles bruneti*.— Farrier & Hennessey, 1993: 93.

**Type depository.** Unspecified.

**Type locality and habitat.** Trinidad & Tobago, Piarco, 1 December 1941, from large ground beetle.

**180. *Macrocheles bryanti* Evans & Hyatt, 1963**

*Macrocheles bryanti* Evans & Hyatt, 1963: 338.

*Macrocheles bryanti*.— Hirschmann, 1970d: 51.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Brazil, Ilha de Santo Amaro, near Santos, São Paulo, date of collection unspecified, on *Eurysternus calligrammus* Dalman [Coleoptera: Scarabaeidae].

**181. *Macrocheles bucephali* Roy, 1996**

*Macrocheles bucephali* Roy, 1996c: 576.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Jabalpur, Madhya Pradesh, 6 April 1985, on *Heliocopriss bucephalus* (F.) [Coleoptera: Scarabaeidae].

**182. *Macrocheles buruensis* (Oudemans, 1927)**

*Macrocheles* (*Coprholaspis*) *buruensis* Oudemans, 1927: 225.

*Macrocheles (Coprholaspis) buruensis*.— Oudemans, 1928: 39.

*Macrocheles buruensis*.— Hirschmann, 1970d: 51.

**Type depository.** National Museum of Natural History – Naturalis, Leiden, Netherlands.

**Type locality and habitat.** Indonesia, Buru Island, Maluku Islands, 6 January, 1921, on *Lucilia* sp. [Diptera: Calliphoridae].

### **183. *Macrocheles caelatus* Berlese, 1918**

*Macrocheles (Coprholaspis) caelatus* Berlese, 1918: 157.

*Macrocheles caelatus*.— Walter & Krantz, 1986b: 283.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** “Africa Oriental” [sic], date of collection and host/substrate unspecified.

**Note.** Specimens reported by Ramsay (1970: 91) and Emberson (1973a: 119) as *Macrocheles caelatus* Berlese were identified as *Macrocheles peniculatus* Berlese by Emberson (1980: 138).

### **184. *Macrocheles caligynius* (Berlese, 1910)**

*Holostaspis caligynius* Berlese, 1910: 250.

*Macrocheles caligynus* [sic].— Walter & Krantz 1986b: 281.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Indonesia, Java, date of collection unspecified, on *Copris* spp. [Coleoptera: Scarabaeidae].

### **185. *Macrocheles capensis* Walter & Krantz, 1986**

*Macrocheles capensis* Walter & Krantz, 1986b: 291.

**Type depository.** Central African Museum, Tervuren, Belgium.

**Type locality and habitat.** Zaire, Garamba National Park, Orientale, 23 April 1951, in samples of elephant dung.

### **186. *Macrocheles cardiatus* Fox, 1947**

*Macrocheles cardiatus* Fox, 1947: 602.

**Type depository.** Entomological collection of the Department of Medical Zoology, School of Tropical Medicine, San Juan, Puerto Rico.

**Type locality and habitat.** Puerto Rico, Santurce, San Juan, 3 January 1947, on *Rattus norvegicus* Berkenhout [Mammalia: Rodentia: Muridae].

**187. *Macrocheles carolinensis* Banks, 1906**

*Macrocheles carolinensis* Banks, 1906: 137.

**Type depository.** Museum of Comparative Zoology, Harvard University, Cambridge, USA.

**Type locality and habitat.** USA, Black Mountains, North Carolina, date of collection and host/substrate unspecified.

**188. *Macrocheles carteri* Evans & Hyatt, 1963**

*Macrocheles carteri* Evans & Hyatt, 1963: 341.

*Macrocheles carteri*.— Hirschmann, 1970d: 47.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Paraguay, Nanahua, Paraguayan Chaco, date of collection unspecified, on *Sulcophanaeus imperator* (Chevrolat) [Coleoptera: Scarabaeidae].

**189. *Macrocheles centrognus* Berlese, 1918**

*Macrocheles (Coprholaspis) centrognus* Berlese, 1918: 168.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection unspecified, in litter.

**190. *Macrocheles ceylonicus* Evans & Hyatt, 1963**

*Macrocheles ceylonicus* Evans & Hyatt, 1963: 341.

*Macrocheles ceylonicus*.— Hirschmann, 1970d: 48.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Sri Lanka, Colombo, date of collection unspecified, on *Kheper erichsoni* (Harold) [cited as *Scarabaeus erichsoni*] [Coleoptera: Scarabaeidae].

**191. *Macrocheles chaetopus* Petrova, 1967**

*Macrocheles chaetopus* Petrova, 1967c: 1044.

*Macrocheles chaetopus*.— Hirschmann, 1970d: 51; Bregetova, 1977: 359.

**Type depository.** Department of Entomology, Moscow State University, Moscow, Russia.

**Type locality and habitat.** Southeastern of Turkmenistan, 28 April 1956, on carrion beetle; Turkmenistan, Mary District, May 1960, on carrion beetle; Russia, Adamovsky District, Orenburg Oblast, 20 May 1955, on *Spermophilus pygmaeus* (Pallas) [cited as *Citellus pygmaeus*] [Mammalia: Rodentia: Sciuridae] collected in the steppes.

**192. *Macrocheles citricariosus* Nawar, Abou-Setta & Childers, 1992**

*Macrocheles citricariosus* Nawar, Abou-Setta & Childers, 1992: 37.

**Type depository.** National Museum of Natural History, Beltsville, USA.

**Type locality and habitat.** USA, Citrus Resarch and Education Center, Lake Alfred, Polk, Florida, 9 May 1990, from decaying citrus fruit under unsprayed ‘Hamlin’ orange trees.

**193. *Macrocheles clavisetosus* Ewing, 1909**

*Macrocheles clavisetosus* Ewing, 1909: 64.

*Macrocheles clavisetosa*.— Ewing, 1909: 63; Hennessey & Farrier, 1988: 21.

*Macrocheles rodriguezii* Oliver & Krantz, 1963: 519 [Synonymy by Hennessey & Farrier, 1988: 21].

*Macrocheles rodriguezii*.— Krantz & Whitaker, 1988: 251.

**Type depository.** *M. clavisetosus*: Department of Entomology of the Smithsonian Institution National Museum of Natural History, Washington, USA; *M. rodriguezii*: United States Nacional Museum, Washington, USA.

**Type locality and habitat.** *M. clavisetosus*: USA, Galesburg, Knox, Illinois, date of collection unspecified, under logs and in trash; USA, Arcola, Douglas, Illinois, date of collection unspecified, under logs and in trash; USA, Urbana, Champaign, Illinois, date of collection unspecified, under logs and in trash [original designation]; USA, Arcola, Douglas, Illinois, 21 June 1906, under logs and in trash [lectotype designated by Hennessey & Farrier, 1988: 21]; *M. rodriguezii*: USA, Lawrence, Kansas, January 1958, from laboratory colony started from mites collected.

**194. *Macrocheles cognatus* Berlese, 1918**

*Macrocheles (Coprholaspis) cognatus* Berlese, 1918: 159.

*Coprholaspis cognatus*.— Turk, 1948: 103.

*Macrocheles cognatus*.— Evans & Hyatt, 1963: 344; Hirschmann, 1970d: 47.

*Macrocheles cognatus* Falconer, 1923 [Junior homonym]<sup>Note</sup>.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection unspecified, on *Phanaeus* sp. [cited as *Phanaei* sp.] [Coleoptera: Scarabaeidae]; Brazil, Pará, date of collection and host/substrate unspecified.

**Note.** *Nothrolaspis submotus* (Falconer) is a replacement name for *Macrocheles cognatus* Falconer [Junior homonym of *Macrocheles cognatus* Berlese].

**194a. *Macrocheles cognatus hypogaeus* Berlese, 1918**

*Macrocheles (Coprholaspis) cognatus* var. *hypogaeus* Berlese, 1918: 159.

*Coprholaspis cognatus* var. *hypogaeus*.— Turk, 1948: 101.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection not mentioned, on *Bombus* sp. [Hymenoptera: Apidae].

**195. *Macrocheles collocliae* Ma & Liu, 2003**

*Macrocheles collocliae* Ma & Liu, 2003: 657

**Type depository.** Institute of Microbiology and Epidemiology, Academy of Military Medical Science, Beijing, China.

**Type locality and habitat.** China, Houhe Natural Reserve (30°07'N; 110°54'E), Wufeng, Hubei and Hupingshan Natural Reserve (alt. 1700 m), Shimen, Hunan, 16 April 2000, in nest of *Collocalia brevirostris* Deignan [Aves: Apodidae].

**196. *Macrocheles convexus* Hartini, Dwibadra & Takaku, 2007**

*Macrocheles convexus* Hartini, Dwibadra & Takaku, 2007: 78.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Lore Lindu National Park, Saluki, Central Sulawesi, 19 October 2002, on *Copris* sp. [Coleoptera: Scarabaeidae].

**197. *Macrocheles cooremani* (Turk, 1948)**

*Macrocheles (Coprholaspis)* sp.— Cooreman, 1943: 24.

*Neoholaspis cooremani* Cooreman, in Turk, 1948: 101.

*Macrocheles cooremani*.— Krantz, 1962b: 153.

**Type depository.** Unspecified.

**Type locality and habitat.** Belgium, Hockai, Liège, 2 June 1939, on *Nicrophorus vespilloides*

Herbst, *Nicrophorus vespillo* L., *Nicrophorus investigator* Zetterstadt, *Nicrophorus humator* Gleditsch [Coleoptera: Silphidae] and *Pterostichus oblongopunctatus* (F.) [Coleoptera: Carabidae].

**198. *Macrocheles coprephorae* Chinniah & Mohanasundaram, 1995**

*Macrocheles coprephorae* Chinniah & Mohanasundaram, 1995: 215.

**Type depository.** Department of Agricultural Entomology, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, India.

**Type locality and habitat.** India, Coimbatore, Tamil Nadu, 10 May 1988, on *Copris* sp. [Coleoptera: Scarabaeidae].

**199. *Macrocheles copridis* Mašán, 2003**

*Macrocheles copridis* Mašán, 2003: 109.

**Type depository.** Institute of Zoology, Slovak Academy of Sciences, in author's private collection.

**Type locality and habitat.** Slovakia, Brunovce, Trnavská Pahorkatina, 24 June 1991, on *Copris lunaris* (L.) [Coleoptera: Scarabaeidae].

**200. *Macrocheles cordiger* (Berlese, 1888)**

*Holostaspis cordiger* Berlese, 1888: 195.

*Macrocheles* (*Coprholaspis*) *cordiger*.— Berlese, 1918: 146.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Paraguay, Apa River, date of collection unspecified, in litter.

**201. *Macrocheles craspedochetes* Glida & Bertrand, 2003**

*Macrocheles craspedochetes* Glida & Bertrand, 2003: 18, 19.

**Type depository.** Muséum National d'Histoire Naturelle, Paris, France.

**Type locality and habitat.** France, Réserve Naturelle de l'Estagnol, Montpellier, date of collection unspecified, in horse manure (Camargue race).

**202. *Macrocheles crenulatus* Roy, 1996**

*Macrocheles crenulatus* Roy, 1996a: 72.



**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Botanical Garden, Darjeeling, West Bengal, 14 November 1973, in leaf litter.

**203. *Macrocheles crista* (Berlese, 1910)**

*Holocelaeno crista* Berlese, 1910: 249.

*Macrocheles crista*.— Krantz, 1967b: 35; Hirschmann, 1970d: 48; Hartini *et al.*, 2007: 92.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Indonesia, Java, date of collection unspecified, on *Copris* sp. and related genera [Coleoptera: Scarabaeidae].

**204. *Macrocheles cristati* Costa, 1967**

*Macrocheles cristati* Costa, 1967: 313.

*Macrocheles cristati*.— Hirschmann, 1970d: 47.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Israel, Na'aman Dunes, 12 July 1965, on *Scarabaeus cristatus* F. [Coleoptera: Scarabaeidae].

**205. *Macrocheles cubanicus* Iavorschi, 1980**

*Macrocheles cubanicus* Iavorschi, 1980: 147.

**Type depository.** Unknown.

**Type locality and habitat.** Cuba, Cueva de las Majaes, Oriente, 23 March 1969, in guano.

**206. *Macrocheles dayaci* Dwibadra & Takaku, 2014**

*Macrocheles dayacus* Dwibadra & Takaku, in Dwibadra *et al.*, 2014: 48.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Hutan Lindung Sungai Wain, Balikpapan, Kalimantan, 20 December 2006, on *Catharsius dayacus* Lansberg [Coleoptera: Scarabaeidae].

**207. *Macrocheles deccanensis* Roy, 1991**

*Macrocheles deccanensis* Roy, 1991b: 707.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Kodaikanal (alt. 2400 m), Dindigul, Tamil Nadu, 10 March 1980, in forest leaf litter.

**208. *Macrocheles decoloratus* (Koch, 1839)**

*Gamasus decoloratus* Koch, 1839b: 14.

*Gamasus decoloratus*.— Berlese, 1892: 64; Berlese, 1906: 277.

*Macrocheles decoloratus*.— Oudemans, 1913: 5, 1936: 172; Evans & Browning, 1956: 32; Bregetova & Koroleva, 1960: 105; Hirschmann, 1970d: 51; Bregetova, 1977: 358; Hyatt & Emberson, 1988: 88; Mašán, 2003: 90.

*Macrocheles decoloratus decoloratus*.— Petrova, 1967b: 29.

*Macrocheles (Macrocheles) decoloratus*.— Krauss, 1970: 18; Karg, 1971: 135, 1993: 112.

**Type depository.** Unspecified.

**Type locality and habitat.** Germany, date of collection unspecified, in moist meadows in an old town square.

**208a. *Macrocheles decoloratus orientalis* Petrova, 1967**

*Macrocheles decoloratus orientalis* Petrova, 1967b: 29.

**Type depository.** Department of Entomology, Moscow State University, Moscow, Russia.

**Type locality and habitat.** Tien Shan mountains [China, Kazakhstan, Kyrgyzstan and Uzbekistan]; Russia, Siberia; Far East; date of collection and host/substrate unspecified.

**209. *Macrocheles decoratus* Berlese, 1918**

*Macrocheles (Coprholaspis) decoratus* Berlese, 1918: 167.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Indonesia, Java, date of collection and host/substrate unspecified.

**210. *Macrocheles decui* Iavorschi, 1995**

*Macrocheles decui* Iavorschi, 1995: 57.

**Type depository.** Institut Spéologie “Émile Racovitza”, Bucharest, Romania.

**Type locality and habitat.** Israel, Shemurat haMasreq (near Bet Me'ir), 12 May 1990, in litter and soil.

**211. *Macrocheles delamarei* Sheals, 1962**

*Macrocheles delamarei* Sheals, 1962: 95.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Argentina, San Miguel de Tucumán, Tucumán, 19 April 1959, from unspecified host/substrate.

**212. *Macrocheles denhamensis* Halliday, 2000**

*Macrocheles denhamensis* Halliday, 2000: 285.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, 15 km south of Denham, 28 September 1986, on *Coproecus hemisphaericus* Guérin-Meneville [Coleoptera: Scarabaeidae].

**213. *Macrocheles dibamos* Krantz, 1962**

*Macrocheles dibamos* Krantz, 1962a: 356.

*Macrocheles dibamos*.— Hirschmann, 1970d: 52.

**Type depository.** United States National Museum of Natural History, Washington, USA.

**Type locality and habitat.** Panama, Barro Colorado Island, Canal Zone, 4 Julho 1956, on *Eciton dulcius* Forel [Hymenoptera: Formicidae].

**214. *Macrocheles dimidiatus* Berlese, 1918**

*Macrocheles (Coprholaspis) dimidiatus* Berlese, 1918: 163.

*Macrocheles dimidiatus*.— Evans & Hyatt, 1963: 344; Méndez Olivo, 1968: 148; Hirschmann, 1970d: 51.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection unspecified, on *Phanaeus (Notiophanaeus) splendidulus* (F.) [Coleoptera: Scarabaeidae]; Argentina, Buenos Aires, date of collection unspecified, on *Bombus* sp. [Hymenoptera: Apidae].

**214a. *Macrocheles dimidiatus difficilis* Berlese, 1918**

*Holostaspis pisentii*.— Berlese & Leonardi, 1901: 13 [Misidentification, according to Berlese, 1918: 164].

*Macrocheles (Coprholaspis) dimidiatus* var. *difficilis* Berlese, 1918: 164.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Chile, Santiago, date of collection and host/substrate unspecified.

**Note.** Described on the basis of specimens reported by Berlese & Leonardi, 1901: 13 as *Holostaspis pisentii* (Berlese).

**215. *Macrocheles disjunctus* Delfinado & Baker, 1975**

*Macrocheles disjunctus* Delfinado & Baker, 1975: 55.

**Type depository.** New York State Museum and Science Service, Albany, USA.

**Type locality and habitat.** USA, Duncan Falls, Ohio, 18 June 1916, on *Popilius disjunctus* (Illiger) [Coleoptera: Passalidae].

**216. *Macrocheles disneyi* Fain & Greenwood, 1991**

*Macrocheles disneyi* Fain & Greenwood, 1991: 193.

*Macrocheles disneyi*.— Mašán, 2003: 101; Ács & Kontschán, 2014: 112.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** England, Kitchen Garden Wood, Malham Tarn, Malham, 26 July 1983, on *Diplonevra nitidula* (Meigen) [Diptera: Phoridae].

**217. *Macrocheles dispar* (Berlese, 1910)**

*Holostaspis dispar* Berlese, 1910: 251.

*Macrocheles* (*Coprholaspis*) *dispar*.— Berlese, 1918: 151; Vitzthum, 1925: 13.

*Macrocheles dispar*.— Walter & Krantz, 1992: 244; Hartini & Takaku, 2003: 1262; Hartini *et al.*, 2007: 75, 2009: 419; Takaku *et al.*, 2012: 105.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Indonesia, Java, date of collection unspecified, on *Copris* sp. [Coleoptera: Scarabaeidae].

**218. *Macrocheles distanti* Evans & Hyatt, 1963**

*Macrocheles distanti* Evans & Hyatt, 1963: 348.

*Macrocheles distanti*.— Hirschmann, 1970d: 50.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** South Africa, Nieuwoudtville, Cape, date of collection unspecified, on *Scarabaeus bonellii* McLeay [Coleoptera: Scarabaeidae].

**219. *Macrocheles dolichosternus* Krantz & Whitaker, 1988**

*Macrocheles dolichosternus* Krantz & Whitaker, 1988: 234.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Melrose, Nacogdoches, Texas, 31 December 1964, on *Geomys bursarius* (Shaw) [Mammalia: Rodentia: Geomyidae].

**220. *Macrocheles donggalensis* Hartini, Dwibadra & Takaku, 2007**

*Macrocheles donggalensis* Hartini, Dwibadra & Takaku, 2007: 80.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Lore Lindu National Park, Donggala, Kulawi Salua, Central Sulawesi, 12 May 2002, on *Onthophagus* sp. [Coleoptera: Scarabaeidae].

**221. *Macrocheles elgonensis* André, 1945**

*Macrocheles elgonensis* André, 1945: 199.

*Macrocheles elgonensis*.— Hirschmann, 1970d: 50.

**Type depository.** Muséum National d'Histoire Naturelle, Paris, France.

**Type locality and habitat.** Kenya, camp II of Mount Elgon (alt. 2470 m), 30 December 1932, in nest of *Tachyoryctes splendens* (Rüppell) [Mammalia: Rodentia: Spalacidae]; Kenya, camp III of Mount Elgon (alt. 3500 m), 5 January 1933, in nest of *Tachyoryctes splendens* (Rüppell) [Mammalia: Rodentia: Spalacidae]; Kenya, camp Cherangani (alt. 3000 m), Elgeyo-Marakwet, 13 March 1933, in nest of *Tachyoryctes splendens* (Rüppell) [Mammalia: Rodentia: Spalacidae].

**222. *Macrocheles elimatus* Berlese, 1918**

*Macrocheles (Coprholaspis) elimatus* Berlese, 1918: 148.

*Macrocheles elimatus*.— Krantz 1988a: 968.

*Macrocheles inornatus* Evans & Hyatt, 1963: 348 [Synonymy by Krantz 1988a: 968].

*Macrocheles inornatus*.— Hirschmann, 1970d: 46.

**Type depository.** *M. elimatus*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. inornatus*: British Museum (Natural History), London, England.

**Type locality and habitat.** *M. elimatus*: Argentina, Alto Pecosos [cited as Alto Pecosos], San Luis, date of collection unspecified, on *Ennearabdus lobocephalus* (Harold) [Coleoptera: Scarabaeidae]; *M. inornatus*: Argentina, Patquia, La Rioja, date of collection unspecified, on *Anomiopsis heteroclytum* Blanchard [Coleoptera: Scarabaeidae].

**223. *Macrocheles entetiensis* Hartini & Takaku, 2005**

*Macrocheles entetiensis* Hartini & Takaku, in Hartini *et al.*, 2005: 204.

*Macrocheles entetiensis*.— Hartini *et al.*, 2007: 94; Hartini *et al.*, 2009: 419.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Kampa Jawa, Kota Waingapu, East Sumba, Sumba Island, 30 January 2003, on beetle of the family Scarabaeidae [Coleoptera].

**224. *Macrocheles erniae* Hartini & Takaku, 2006**

*Macrocheles erniae* Hartini & Takaku, 2006a: 33.

*Macrocheles erniae*.— Hartini *et al.*, 2007: 92.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Tamrau Reserve (alt. 180 m), Saukarem, Auejou, Auberbalun, Manokwari, Papua, 13 June 2001, on Scarabaeidae [Coleoptera].

**225. *Macrocheles erichsoni* Roy, 1996**

*Macrocheles erichsoni* Roy, 1996b: 269.

**Type depository.** Author's private collection.

**Type locality and habitat.** India, Arku Valley, Andhra Pradesh, 20 March 1980, on *Kheper* [cited as *Scarabaeus*]??? *erichsoni* (Harold) [Coleoptera: Scarabaeidae].

**226. *Macrocheles eta* Halliday, 2000**

*Macrocheles eta* Halliday, 2000: 286.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, 4 km west of Mount Baird, Queensland, 11 May 1986, in trap baited with pig dung.

**227. *Macrocheles falsiglaber* Glida & Bertrand, 2003**

*Macrocheles falsiglaber* Glida & Bertrand, 2003: 16.

**Type depository.** Muséum National d'Histoire Naturelle, Paris, France.

**Type locality and habitat.** France, Réserve Naturelle de l'Estagnol, Montpellier, date of collection unspecified, in horse manure (Camargue race).

**228. *Macrocheles faveolus* Halliday, 1993**

*Macrocheles faveolus* Halliday, 1993: 99.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Mount Tiptree (alt. 840 m), Queensland, 29 June 1971, in rainforest leaf litter.

**229. *Macrocheles feehani* Halliday, 1990**

*Macrocheles feehani* Halliday, 1990: 409.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, 4 Km W of Mount Baird, Queensland, 11 May 1986, in trap baited with pig dung.

**230. *Macrocheles fenestella* Karg, 1994**

*Macrocheles fenestella* Karg, 1994a: 129.

**Type depository.** Arachnologische Sammlung des Museums für Naturkunde, Berlin, Germany.

**Type locality and habitat.** Galapagos Islands, Santa Cruz Island, 28 Juny 1985, in *Scalesia* [Asteraceae] forest and in horse and cattle feces.

**231. *Macrocheles filipponii* Evans & Hyatt, 1963**

*Macrocheles filipponii* Evans & Hyatt, 1963: 392.

*Macrocheles filipponi* [sic].— Hirschmann, 1970d: 51.

*Macrocheles (dimidiatus) filipponii*.— Arriaga-Jimenez *et al.*, 2014: 373.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Costa Rica, date of collection unspecified, on *Dichotomius carolinus* (L.) [Coleoptera: Scarabaeidae].

**232. *Macrocheles forceps* Halliday, 2000**

*Macrocheles forceps* Halliday, 2000: 289.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Babinda (Palms), Queensland, 15 July 1993, on *Drosophila* sp. [Diptera: Drosophilidae].

**233. *Macrocheles friggi* Walter & Krantz, 1986**

*Macrocheles friggi* Walter & Krantz, 1986b: 287.

**Type depository.** United States Nacional Museum, Washington, USA.

**Type locality and habitat.** Zaire, Stanley Pool, 1936, on *Heteronitis castelnaudi* Harold [Coleoptera: Scarabaeidae].

**234. *Macrocheles fungicolus* Halliday, 2000**

*Macrocheles fungicolus* Halliday, 2000: 290.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Blue Pool Trail (28°13'S; 153°08'E), Lamington National Park, Queensland, 22 May 1996, in a rotting agaric.

**235. *Macrocheles gama* Halliday, 2000**

*Macrocheles gama* Halliday, 2000: 291.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Hazelmere Station, 24 km northwest Cooktown (15°24'S; 145°03'E), Queensland, 08 May 1981, on *Onthophagus bicavicolis* Lea [Coleoptera: Scarabaeidae].

**236. *Macrocheles garciai* Takaku, Hartini, Dwibadra & Corpuz-Raros, 2012**

*Macrocheles garciai* Takaku, Hartini, Dwibadra & Corpuz-Raros, 2012: 115.

**Type depository.** Zoological Collections of the Graduate School of Science, Hokkaido University, Sapporo, Japan.

**Type locality and habitat.** Philippines, Mount Makiling, Bagong Silang, Los Baños, Laguna, Luzon Island, 18 May 1994, in decomposing *Ficus* [Moraceae] fruit.

**237. *Macrocheles glaber* (Müller, 1860)**

*Holostaspis glabra* Müller, 1860: 178.

*Macrocheles (Coprholaspis) glaber*.— Berlese, 1918: 146.

*Macrocheles glaber*.— Evans & Browning, 1956: 16; Bregetova & Koroleva, 1960: 134; Filipponi & Pegazzano, 1962b: 215; Axtell, 1963: 629; Hirschmann, 1970a: 44; Hirschmann, 1970b: 45; Hirschmann, 1970c: 46; Hirschmann, 1970d: 48; Krantz, 1972: 273; Emberson, 1973a: 121; Bregetova, 1977: 375; Emberson, 1980: 137; Halliday, 1986a: 739; Hyatt & Emberson, 1988: 107; Mašán, 2003: 105; Faraji *et al.*, 2008: 235; Ács & Kontschán, 2014: 114.

*Macrocheles (Macrocheles) glaber*.— Karg, 1971, 135; Karg, 1993: 111.

*Gamasus tardus* ["tritonympha foemina"].— Berlese, 1882a: 107 [Misidentification, according to Filipponi & Pegazzano, 1962b: 215].

*Holostaspis marginatus* ["seconda forma giovanile"].— Canestrini & Canestrini, 1882: 26 [Misidentification, according to Filipponi & Pegazzano, 1962b: 215].



- Holostaspis badius*.— Berlese, 1889: 3 [Misidentification, according to Berlese, 1918: 146]; Foà, 1900: 134 [Misidentification, according to Filipponi & Pegazzano, 1962b: 215]; Oudemans, 1904a: 105 [Misidentification, according to Filipponi & Pegazzano, 1962b: 215]; Berlese, 1906: 275, 288 [Misidentifications, according to Berlese, 1918: 146].
- Macrocheles marginatus* ["tritonymph"].— Oudemans, 1900a: 129 [Misidentification, according to Evans & Browning 1956: 16].
- Macrocheles pisentii*.— Hull, 1918: 72 [Misidentification, according to Hyatt & Emberson, 1988: 105].
- Gamasus latus* Koch, 1844: 16 [Synonymy of *Gamasus badius* Koch by Berlese, 1892: 65; 1906: 282].
- Macrocheles latus*.— Oudemans, 1914a: 67, 1915a: 182.
- Gamasus stercorarius* Kramer, 1876: 95 [Synonymy by Berlese, 1918: 146]<sup>Note1</sup>.
- Macrocheles stercorarius*.— Sellnick, 1955: 62; Hirschmann, 1970d: 48.
- Macrocheles (Macrocheles) stercorarius*.— Krauss, 1970: 16.
- Macrocheles vulgaris* Oudemans, in MacGillavry, 1914: 91<sup>Note2</sup> [Synonymy of *Macrocheles latus* (Koch) by Oudemans, 1915a: 182].
- Macrocheles marginatus* var. *littoralis* Halbert, 1915: 67 [Synonymy by Evans & Browning, 1956: 16].
- Macrocheles (Coprholaspis) alecto* Berlese, 1918: 153 [Synonymy by Filipponi & Pegazzano, 1962b: 215]<sup>Note3</sup>.
- Macrocheles (Macrocheles) alecto*.— Krauss, 1970: 31.
- Macrocheles alecto*.— Hirschmann, 1970d: 48.
- Macrocheles (Coprholaspis) alecto* var. *aegyptius* Berlese, 1918: 155 [Synonymy by Filipponi & Pegazzano 1962b: 215].
- Macrocheles (Coprholaspis) alecto* var. *aethiopicus* Berlese, 1918: 155 [Synonymy by Filipponi & Pegazzano, 1962b: 215].
- Macrocheles (Coprholaspis) alecto* var. *australis* Berlese, 1918: 155 [Synonymy by Filipponi & Pegazzano, 1962b: 216].
- Macrocheles (Monoplites) oudemansii* Hull, 1925: 215<sup>Note4</sup> [Synonymy by Evans & Browning, 1956: 16].
- Macrocheles veterrimus* Sellnick, 1940: 80<sup>Note5</sup> [Synonymy by Evans & Browning, 1956: 16].
- Coprholaspis anglicus* Turk, 1945: 791 [Synonymy by Evans & Browning, 1956: 16].

*Macrocheles subglaber* Filipponi, 1959: 210 [Synonymy by Filipponi & Pegazzano, 1962b: 215]<sup>Note6</sup>.

*Macrocheles subglaber*.— Filipponi, 1960: 168; Filipponi, 1962: 129.

**Type depository.** *M. glaber*: Holotype – lost; Neotype – Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *G. latus*: unspecified; *G. stercorarius*, *M. vulgaris* and *C. anglicus*: unspecified; *M. marginatus* var. *littoralis*: National Museum of Ireland, Dublin, Ireland; *M. (C.) alecto*, *M. (C.) alecto* var. *aegyptius*, *M. (C.) alecto* var. *aethiopicus*, *M. (C.) alecto* var. *australis*, *M. veterrimus* and *M. subglaber*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. (M.) oudemansii*: Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands.

**Type locality and habitat.** *M. glaber*: Czech Republic, near Brno, date of collection unspecified, on *Geotrupes stercorarius* (L.) [Coleoptera: Geotrupidae], *Anoplotrupes stercorosus* (Scriba) [cited as *Geotrupes sylvaticus* Panzer] [Coleoptera: Geotrupidae] and *Musca domestica* L. [Diptera: Muscidae]; Austria, Vienna, date of collection unspecified, on *G. stercorarius*, *A. stercorosus* and *M. domestica* [original designation]; former Czechoslovakia, date of collection unspecified, on *Geotrupes stercorarius* (L.) [Coleoptera: Geotrupidae] [Neotype designated by Filipponi & Pegazzano, 1962b: 215]; *G. latus*: Germany, date of collection unspecified, on *Creophilus maxillosus* (L.) [cited as *Staphylinus maxillosus*] [Coleoptera: Staphylinidae]; *G. stercorarius*: Locality and date of collection unspecified, on dung beetle; *M. vulgaris*: Netherlands, Terschelling, August 1912, host/substrate unspecified; *M. marginatus* var. *littoralis*: Ireland, Westport, Mayo, July 1910, on seashore [Lectotype designated by Hyatt & Emberson, 1988: 107]; *M. (C.) alecto*: Italy, Florence, date of collection unspecified, in litter; Italy, Vittorio Veneto, Treviso, date of collection unspecified, in litter of a pine forest; France, Longny, Orne, date of collection and host/substrate unspecified; Norway, date of collection and host/substrate unspecified; *M. (C.) alecto* var. *aegyptius*: Egypt, date of collection unspecified, on *Onitis sphinx* F. [Coleoptera: Scarabaeidae]; *M. (C.) alecto* var. *aethiopicus*: “Africa Oriental” [sic], date of collection and host/substrate unspecified; *M. (C.) alecto* var. *australis*: New Guinea, date of collection unspecified, on “*Celeius*” and *Gonatus* sp. [Mollusca: Gonatidae]; *M. (M.) oudemansii*: Italy, San Remo, date of collection and host/substrate unspecified; *M. veterrimus*: Europe, date of collect unspecified, on beetles, flies and manure; *C. anglicus*: England, Reskadinnick,

Camborne, Cornwall, 10 June 1941, under wet wood; *M. subglaber*: Italy, L'Agro Pontino, Lazio, date of collection and host/substrate unspecified.

- Note<sup>1</sup>**. Berlese (1892: 67) considered *Gamasus stercorarius* Kramer as junior synonymy of specimens identified as *Holostaspis badius* (Koch) by Berlese (1889: 3).
- Note<sup>2</sup>**. New name for specimens reported by some authors as *Gamasus badius* Koch or *Gamasus carinatus* Koch, after 1880.
- Note<sup>3</sup>**. Suspected senior synonym of *Macrocheles alecto* var. *aethiopicus* according to Krantz (1988: 976).
- Note<sup>4</sup>**. Hull proposed this name for specimens identified by Oudemans (1900a: 129) as *Macrocheles marginatus* (Hermann). According Evans & Browning (1956: 16), these specimens represent a complex of at least two distinct species, the tritonymph being *Macrocheles glaber* (Müller) and the adult *Macrocheles plumiventris* Hull [= *Glypholaspis confusa* (Foà)].
- Note<sup>5</sup>**. Described on the basis of specimens reported by Berlese (1913b: 195) as *Holostaspis badius* (Koch).
- Note<sup>6</sup>**. Filipponi & Pegazzano (1962b: 215) considered *Macrocheles subglaber* as *nomina nuda*.
- Note<sup>7</sup>**. Suspected junior synonym of *Holostaspis badius* (Koch) by Berlese (1892: 71).
- Note<sup>8</sup>**. Specimens reported by Evans & Browning (1956: 16) (male), Filipponi & Cervone (1957: 25), Filipponi (1959: 199, 1960: 168, 1962: 129) as *Macrocheles glaber* (Müller) were identified as *Macrocheles perglaber* Filipponi & Pegazzano by Filipponi & Pegazzano (1962b: 222).
- Note<sup>9</sup>**. Specimen reported by Krauss (1970: 15) as *Macrocheles (Macrocheles) glaber* (Müller) identified as *Macrocheles perglaber* Filipponi & Pegazzano by Halliday (1986a: 747).

**237a. *Macrocheles glaber tsaii* Samšičák, 1962**

*Macrocheles glaber tsaii* Samšičák, 1962: 200.

*Macrocheles glaber* ssp. *tsaii*.— Hirschmann, 1970d: 48.

**Type depository.** Author's personal collection, possibly Prague, Czech Republic.

**Type locality and habitat.** China, Guangdong, December 1960, *Oniticellus cinctus* (F.) [Coleoptera: Scarabaeidae].

**238. *Macrocheles gladiator* Hull, 1918**

*Macrocheles gladiator* Hull, 1918: 71.

*Macrocheles (Dissoloncha) gladiator*.— Falconer, 1923: 151.

**Type depository.** Natural History Museum, London, England.

**Type locality and habitat.** England, Ninebanks, Northumberland, date of collection unspecified, in manure.

**Note.** Suspected senior synonym of *Glyphtholaspis fimicola* (Sellnick) by Filipponi & Pegazzano. (1960: 139).

**239. *Macrocheles goncharovae* Bregetova, 1977**

*Macrocheles bregetovae* Bujakova & Goncharova, 1964: 771 [Junior homonym of *Macrocheles bregetovae* Evans & Hyatt, 1963: 392]

*Macrocheles goncharovae* Bregetova, 1977: 370 [Replacement name].

**Type depository.** Department of Biology, The Medical Institute, Chita, Zabaykalsky Krai, Russia.

**Type locality and habitat.** Russia, Karasny, Zabaykalsky District, Zabaykalsky Krai, 21 July 1956, on *Spermophilus* [cited as *Citellus*] *dauricus* (Brandt) [Mammalia: Rodentia: Sciuridae].

**240. *Macrocheles gracilipes* Berlese, 1918**

*Macrocheles (Coprholaspis) gracilipes* Berlese, 1918: 149.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection unspecified, on *Eucranium* spp. [Coleoptera: Scarabaeidae].

**241. *Macrocheles grossipes* Berlese, 1918**

*Macrocheles (Coprholaspis) grossipes* Berlese, 1918: 161.

*Coprholaspis grossipes*.— Turk, 1948: 101.

*Macrocheles grossipes*.— Krantz, 1988a: 978.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection and host/substrate unspecified.

**242. *Macrocheles guttatus* Halliday, 2000**

*Macrocheles guttatus* Halliday, 2000: 292.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Mulyie (near Goldsworthy), 9 May 1983, host/substrate unspecified.

**243. *Macrocheles halffteri* Machado-Allison, 1964**

*Macrocheles halffteri* Machado-Allison, 1964: 154.

*Macrocheles halffteri*.— Méndez Olivo, 1968: 161.

**Type depository.** Escuela Nacional de Ciencias Biológicas, Mexico city, Mexico.

**Type locality and habitat.** Mexico, Cuernavaca, Morelos, 24 September 1962, on *Phanaeus mexicanus* Harold [Coleoptera: Scarabaeidae].

**244. *Macrocheles halli* Halliday, 2000**

*Macrocheles halli* Halliday, 2000: 293.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Dardanup, South West, 31 May 1979, in dung baited trap.

**245. *Macrocheles hallidayi* Walter & Krantz, 1986**

*Macrocheles hallidayi* Walter & Krantz, 1986a: 214.

*Macrocheles hallidayi*.— Takaku, 1998: 30, 2001: 501; Hartini *et al.*, 2007: 75, 2009: 420; Takaku *et al.*, 2012: 106.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** India, 467 m at Coimbatore, Madras State, South India, October 1977, on *Onitis philemon* F. [Coleoptera: Scarabaeidae].

**246. *Macrocheles hamadryadis* (Berlese, 1910)**

*Holostaspis hamadryadis* Berlese, 1910: 251.

*Macrocheles* (*Coprholaspis*) *hamadryadis*.— Berlese, 1918: 146.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** South Africa, Cape of Good Hope, date of collection unspecified, on *Heliocopris* [cited as *Copris*] *hamadryas* (F.) [Coleoptera: Scarabaeidae].

**247. *Macrocheles hamatus* Oudemans, 1915**

*Macrocheles marginatus* [protonymph].— Oudemans, 1900a: 129 [Misidentification, according to Oudemans, 1915a: 182].

*Macrocheles hamatus* Oudemans, 1915a: 182.

**Type depository.** Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands.

**Type locality and habitat.** Italy, San Remo, date of collection and host/substrate unspecified.

**Note.** Described on the basis of specimens reported by Oudemans (1900a: 129) as protonymph of *Macrocheles marginatus* (Hermann).

**248. *Macrocheles hastatus* Ewing, 1910**

*Macrocheles hastatus* Ewing, 1910: 114.

**Type depository.** Unspecified.

**Type locality and habitat.** India, Nilgiri Hills, date of collection unspecified, on moss.

**249. *Macrocheles hechti* Machado-Allison, 1964**

*Macrocheles hechti* Machado-Allison, 1964: 156.

*Macrocheles hechti*.— Méndez Olivo, 1968: 149.

**Type depository.** Escuela Nacional de Ciencias Biológicas, Mexico city, Mexico.

**Type locality and habitat.** Mexico, Cuernavaca, Morelos, 24 September 1962, on *Phanaeus mexicanus* Harold [Coleoptera: Scarabaeidae].

**250. *Macrocheles helenaensis* Van Driel, Loots & Marais, 1977**

*Macrocheles helenaensis* Van Driel, Loots & Marais, 1977: 306.

**Type depository.** Central African Museum, Tervuren, Belgium.

**Type locality and habitat.** Saint Helena Island [South Atlantic], Fisher's Valley, 1965, from unspecified host/substrate.

**000. *Macrocheles himalayensis* Roy, 1988**

*Macrocheles himalayensis* Roy, 1988: 151.

**Type depository.** Zoological Survey of India, Calcutta, India.

**Type locality and habitat.** India, Chitoli Reserve Forest, Almora (alt. 1,646 m), Uttarakhand, 9 October 1976, in soil under grass.

**252. *Macrocheles hirsutissima* (Berlese, 1910)**

*Holostaspella hirsutissima* Berlese, 1910: 248.

*Macrocheles hirsutissima*.— Filipponi & Pegazzano, 1967: 220; Hirschmann, 1970d: 51; Krantz, 1988a: 969.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** USA, Texas, date of collection unspecified, on *Onthophagus* (*Palaeonthophagus*) *verticicornis* (Laicharting) [cited as *Copris bituberculatus*] [Coleoptera: Scarabaeidae]; North America, date of collection unspecified, on *Dichotomius carolinus* (L.) [cited as *Copris carolina*] [Coleoptera: Scarabaeidae].

**Note.** Specimens reported by Evans & Hyatt (1963: 395) as *Macrocheles hirsutissima* (Berlese) described as *Macrocheles laciniatus* by Krantz (1988a: 970).

**253. *Macrocheles hoffmannae* Méndez Olivo, 1968**

*Macrocheles hoffmannae* Méndez Olivo, 1968: 152.

**Type depository.** Escuela Nacional de Ciencias Biológicas, Mexico city, Mexico.

**Type depository.** Mexico, Tepeji del Rio, Querétaro, 19 September 1966, on *Canthon humectus humectus* (Say) [Coleoptera: Scarabaeidae].

**254. *Macrocheles holmi* Halliday, 2000**

*Macrocheles holmi* Halliday, 2000: 294.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Coorong National Park, 14 km north of Kingston, 16 November 1976, in cow dung.

**255. *Macrocheles howdenorum* Halliday, 2000**

*Macrocheles howdenorum* Halliday, 2000: 296.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Leyburn (40 miles southwest of Toowoomba), Queensland, 23 March 1975, on *Blackbolbus furcaticollis* Howden [Coleoptera: Geotrupidae].

**256. *Macrocheles hyatti* Krantz & Filipponi, 1964**

*Macrocheles hyatti* Krantz & Filipponi, 1964: 43.

*Macrocheles hyatti*.— Hirschmann, 1970d: 48; Emberson, 1973b: 295, 1980: 137.

**Type depository.** South Australian Museum, Adelaide, Australia.

**Type locality and habitat.** New Zealand, Wellington, 14 January 1958, from litter on waste land (type locality originally mentioned as ‘Wellington [sic], Sydney St., N.S.W.’, corrected by Emberson, 1973b: 295 as here stated).

**257. *Macrocheles imeldae* Arriaga & Bertrand, 2014**

*Macrocheles (dimidiatus) imeldae* Arriaga & Bertrand, in Arriaga-Jimenez *et al.*, 2014: 368.

**Type depository.** Colección Nacional de Acaros, Instituto de Biología, Departamento de Zoología, Universidad Nacional Autónoma de México (UNAM), Mexico city, Mexico.

**Type locality and habitat.** Mexico, Pico Orizaba (19°02’14.0’’N, 97°10’15.3’’W; alt. 2709 m), Cuiyachapa, Veracruz, July 2012, on *Onthotrupes nebularum* Howden [Coleoptera: Geotrupidae] collected in a *Pinus* [Pinaceae] and *Alnus* [Betulaceae] forest.

**258. *Macrocheles immundus* Berlese, 1918**

*Macrocheles (Coprholaspis) immundus* Berlese, 1918: 165.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection and host/substrate unspecified.

**259. *Macrocheles indicus* Bhattacharyya, 1972**

*Macrocheles indicus* Bhattacharyya, 1972a: 272.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Elephant Flat, Bhalukpong, West Kameng, Arunachal Pradesh, 23 December 1965, under bark of a dead tree.

**260. *Macrocheles inpaie* Krantz, 1983**

*Macrocheles inpaie* Krantz, 1983: 8.

**Type depository.** Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil.

**Type locality and habitat.** Brazil, Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Amazonas, 28 May 1978, on *Uroxys besti* Ratcliffe [Coleoptera: Scarabaeidae] collected on *Bradypus tridactylus* L. [Mammalia: Pilosa: Bradypodidae].



**261. *Macrocheles insignitus* Berlese, 1918**

*Macrocheles (Coprholaspis) insignitus* Berlese, 1918: 158.

*Macrocheles insignitus*.— Evans & Browning, 1956: 21; Filipponi & Ilardi, 1959: 79; Filipponi & Pegazzano, 1963: 78; Hirschmann, 1970c: 45, 1970d: 46; Bregetova, 1977: 355; Hyatt & Emberson, 1988: 113; Krantz & Whitaker, 1988: 236; Mašán, 2003: 116; Faraji *et al.*, 2008: 234; Ács & Kontschán, 2014: 114.

*Macrocheles (Macrocheles) insignitus*.— Krauss, 1970: 17; Karg, 1971: 134, 1993: 110.

*Macrocheles whartoni* Delfinado & Baker, 1975: 55 [Synonymy by Krantz & Whitaker, 1988: 236].

**Type depository.** *M. insignitus*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. whartoni*: New York State Museum and Science Service, Albany, USA.

**Type locality and habitat.** *M. insignitus*: France, Longny, Orne, date of collection unspecified, on moss; *M. whartoni*: USA, Duncan Falls, Ohio, 18 June 1916, on *Popilius disjunctus* (Illiger) [Coleoptera: Passalidae].

**262. *Macrocheles insulicola* Hartini & Takaku, 2012**

*Macrocheles insulicola* Hartini & Takaku, 2012: 8.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Sempu Island, Sendang Biru, Desa Tambak rejo, Sumber Manjing Wetan, Malang, East Java, 28 June 2006, on *Paragymnopleurus maurus* Sharp [Coleoptera: Scarabaeidae].

**263. *Macrocheles isidis* (Berlese, 1910)**

*Holostaspis isidis* Berlese, 1910: 252.

*Macrocheles (Coprholaspis) isidis*.— Berlese, 1918: 146.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Egypt, date of collection unspecified, on *Heliocopris andersoni* Bates [cited as *Copris isidis* Boheman] [Coleoptera: Scarabaeidae].

**264. *Macrocheles ivanovi* Bregetova & Koroleva, 1960**

*Macrocheles ivanovi* Bregetova & Koroleva, 1960: 124.

*Macrocheles ivanovi*.— Hirschmann, 1970d: 52; Bregetova, 1977: 358.

*Macrocheles (Macrocheles) ivanovi*.— Karg, 1993: 113.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Russia, Ussuriysk, 14 August 1955, from nest of *Apodemus agrarius* (Pallas) [Mammalia: Rodentia: Muridae].

**Note.** Suspected senior synonym of *Macrocheles papillosus* Götz by Karg (1993: 113).

**265. *Macrocheles jabarensis* Hartini & Takaku, 2003**

*Macrocheles jabarensis* Hartini & Takaku, 2003c: 1266.

*Macrocheles jabarensis*.— Hartini *et al.*, 2007: 76, 2009: 420.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Mount Halimun National Park (alt. 950 m), Cikaniki, Bogor, West Java, 27-28 September 2000, on *Onthophagus* sp. [Coleoptera: Scarabaeidae].

**266. *Macrocheles jalisciensis* Méndez Olivo, 1968**

*Macrocheles jalisciensis* Méndez Olivo, 1968: 155.

**Type depository.** Escuela Nacional de Ciencias Biológicas, Mexico city, Mexico.

**Type locality and habitat.** Mexico, Guadalajara, Jalisco, 5 November 1965, on *Dichotomius carolinus* (L.) [Coleoptera: Scarabaeidae].

**267. *Macrocheles japonicus* Evans & Hyatt, 1963**

*Macrocheles japonicus* Evans & Hyatt, 1963: 351.

*Macrocheles japonicus*.— Hirschmann, 1970d: 50.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Japan, date of collection unspecified, on *Paragymnopleurus sinuatus* (Olivier) [Coleoptera: Scarabaeidae].

**267a. *Macrocheles japonicus* Ishikawa, 1967**

*Macrocheles punctatus* Ishikawa, 1967: 154<sup>Note</sup>.

**Type depository.** Collection of the Biological Laboratory, Matsuyama Shinonome Junior College, Matsuyama, Japan.

**Type locality and habitat.** Japan, Kume, Matsuyama, Ehime Prefecture, Island of Shikoku, 9 March 1966, in litter from the pine-wood grove.

**Note.** Junior homonymy of *M. japonicus* Evans & Hyatt.

**268. *Macrocheles jiangsuensis* Meng & Sun, 1990**

*Macrocheles jiangsuensis* Meng & Sun, 1990: 61.

**Type depository.** Department of Parasitology, Suzhou Medical College, Suzhou, Jiangsu Province, China.

**Type locality and habitat.** China, Danyang County (32°N; 119.5°E), Zhenjiang, Jiangsu Province, May 1984, in nest of *Apodemus agrarius* (Pallas) [Mammalia: Rodentia: Muridae].

**269. *Macrocheles jocosus* Lizaso, Mendes & Santos, 1992**

*Macrocheles jocosus* Lizaso, Mendes & Santos, 1992: 598.

**Type depository.** Instituto Butantan, São Paulo, Brasil.

**Type locality and habitat.** Brazil, Cotia, São Paulo, 16 March 1988, in accumulated dung under cages of laying hens in industrial farms.

**270. *Macrocheles jonggolensis* Hartini & Takaku, 2003**

*Macrocheles jonggolensis* Hartini & Takaku, 2003c: 1266.

*Macrocheles jonggolensis*.— Hartini *et al.*, 2007: 93.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Sukadamai (alt. 600 m), Sukamakmur, Jonggol, Bogor, West Java, 25 October 2000, on *Gymnopleurus* sp. [Coleoptera: Scarabaeidae].

**271. *Macrocheles kalimantanensis* Hartini & Takaku, 2003**

*Macrocheles kalimantanensis* Hartini & Takaku, in Hartini *et al.*, 2003: 310.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Kereng Bangkirai, Pahandut, Palangkaraya, Kalimantan, 18 – 20 June 2001, on *Paragymnopleurus maurus* Sharp [Coleoptera: Scarabaeidae].

**272. *Macrocheles kamengensis* Roy, 1988**

*Macrocheles kamengensis* Roy, 1988: 152.

**Type depository.** Zoological Survey of India, Calcutta, India.

**Type locality and habitat.** India, Nuranang Falls, Tawang district, Arunachal Pradesh, 6 November 1977, on moss.

**273. *Macrocheles kappa* Halliday, 1990**

*Macrocheles kappa* Halliday, 1990: 415.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, 25 km north of Bulahdelah, Wootton, New South Wales, 06 November 1986, on unknown insect at light.

**274. *Macrocheles kojimai* Hartini & Takaku, 2006**

*Macrocheles kojimai* Hartini & Takaku, 2006a: 35.

*Macrocheles kojimai*.— Hartini *et al.*, 2007: 94.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, site of Freeport Indonesia Company, Tembagapura, Timika, Fakfak, Papua, 17 – 20 March 1977, on *Onthophagus* sp. [Coleoptera: Scarabaeidae] deposited in the Museum Zoologicum Bogoriense, Bogor, Indonesia.

**000. *Macrocheles kolpakovae* Bregetova & Koroleva, 1960**

*Macrocheles kolpakovae* Bregetova & Koroleva, 1960: 101.

*Macrocheles kolpakovae*.— Hirschmann, 1970d: 51; Bregetova, 1977: 355.

*Macrocheles (Macrocheles) kolpakovae*.— Karg, 1993: 113.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Russia, Astrakhan Oblast, 11 September 1945, in nest of *Mus musculus* L. [Mammalia: Rodentia: Muridae]; Russia, Karagalinsk Reservoir, 28 July 1958, in nests of *Apodemus sylvaticus* (L.) [Mammalia: Rodentia: Muridae] and *Microtus socialis* (Pallas) [Mammalia: Rodentia: Cricetidae].

**275. *Macrocheles kraepelini* (Berlese, 1905)**

*Holostaspis kraepelini* Berlese, 1905: 164.

*Macrocheles (Coprholaspis) kraepelini*.— Berlese, 1918: 146; Vitzthum, 1926: 34.

*Coprholaspis kraepelini*.— Vitzthum, 1931b: 66.

*Macrocheles kraepelini*.— Krantz & Filipponi, 1964: 40; Hirschmann, 1970d: 50; Halliday, 1986a: 743; Wallace, 1986: 8; Walter & Krantz, 1986a: 212; Jesus & Rueda, 1990: 714; Takaku, 2001: 500; Hartini *et al.*, 2007: 76; Takaku *et al.*, 2012: 106.

*Macrocheles (Coprholaspis) multihamatus* Vitzthum, 1926: 29 [Synonymy by Krantz & Filipponi 1964: 40].

**Type depository.** *M. kraepelini*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. multihamatus*: author's private collection.

**Type locality and habitat.** *M. kraepelini*: Indonesia, Tjibodas, West Java, date of collection and host unspecified; *M. multihamatus*: Indonesia, Tjibodas, West Java, May 1922, in soil.

**276. *Macrocheles krantzi* Evans & Hyatt, 1963**

*Macrocheles krantzi* Evans & Hyatt, 1963: 351.

*Macrocheles* ? *krantzi* [sic].— Krantz & Filipponi, 1964: 44.

*Macrocheles krantzi*.— Hirschmann, 1970d: 46; Wallace, 1986: 12; Hartini *et al.*, 2007: 92.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** India, Salem, Namakal, date of collection unspecified, on *Escarabaeus brahminus* (Castelnau) [cited as *Scarabaeus*] [Coleoptera: Scarabaeidae].

**277. *Macrocheles kurosai* Takaku, 1997**

*Macrocheles kurosai* Takaku, 1997a: 118.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Japan, Mount Yuwan, Uken-son, Amami-Oshima Island, 22 September 1996, on *Eusilpha kurosawai* Nishikawa [Coleoptera: Silphidae].

**278. *Macrocheles laciniatus* Krantz, 1988**

*Macrocheles hirsutissima*.— Evans & Hyatt, 1963: 395 [Misidentification, according to Krantz, 1988a: 970].

*Macrocheles laciniatus* Krantz, 1988a: 970<sup>Note</sup>.

**Type depository.** United States National Museum of Natural History, Washington, USA.

**Type locality and habitat.** Venezuela, Jota, 18 December 1952, on *Oxysternon festivum* L. [Coleoptera: Scarabaeidae].

**Note.** Described on the basis of specimens reported by Evans & Hyatt (1963: 395) as *Macrocheles hirsutissima* (Berlese).

**279. *Macrocheles lagodekhensis* Bregetova & Koroleva, 1960**

*Macrocheles lagodekhensis* Bregetova & Koroleva, 1960: 85.

*Macrocheles lagodekhensis*.— Hirschmann, 1970d: 47; Bregetova, 1977: 369.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Georgia, Lagodekhi Nature Reserve, Lagodekhi, 8 August 1938, in litter under trees.

**280. *Macrocheles lama* Halliday, 2000**

*Macrocheles lama* Halliday, 2000: 299.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Moorlands, South Australia, 13 October 1983, on *Ontophagus pentacanthus* Harold [Coleoptera: Scarabaeidae].

**281. *Macrocheles lambda* Halliday, 2000**

*Macrocheles lambda* Halliday, 2000: 300.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, base of Mount Cook, road to Walker Bay, Cooktown, Queensland, 12 May 1986, in trap baited with pig dung.

**282. *Macrocheles latisternus* Ryke & Meyer, 1958**

*Macrocheles latisternus* Ryke & Meyer, 1958: 148.

**Type depository.** Institute for Zoological Research of the Potchefstroom University, Potchefstroom, South Africa.

**Type locality and habitat.** South Africa, Fochville, February 1953, on *Onitis* sp. [Coleoptera: Scarabaeidae].

**283. *Macrocheles liguizhenae* Ma, 1996**

*Macrocheles liguizhenae* Ma, 1996: 89.

**Type depository.** National Base of Plague and Brucellosis Control, Baicheng, China.

**Type locality and habitat.** China, Qianguoerluosi Mongolian Autonomous County (45°N;125°E), Jilin, 02 August 1976, in horse dung.

**284. *Macrocheles limue* Samšičák, 1962**

*Macrocheles limue* Samšičák, 1962: 202.

*Macrocheles limue*.— Hirschmann, 1970d: 48; Walter & Krantz, 1986b: 283; Jesus & Rueda, 1990: 713; Takaku, 2001: 501; Hartini & Takaku, 2006: 31; Hartini *et al.*, 2007: 76; Takaku *et al.*, 2012: 107.

*Macrocheles eurygaster* Krantz, 1981: 3 [Synonymy by Walter & Krantz, 1986b: 283].

**Type depository.** *M. limue*: author's personal collection, possibly Prague, Czech Republic; *M. eurygaster*: United States National Museum, Washington, USA.

**Type locality and habitat.** *M. limue*: China, Guangdong, December 1960, *Oniticellus cinctus* (F.) [Coleoptera: Scarabaeidae].; *M. eurygaster*: South Africa, Dung Beetle Research Unit (CSIRO), Pretoria, Gauteng, from laboratory colony initiated with females collected from *Onitis* spp. [Coleoptera: Scarabaeidae] at Hluhluwe, KwaZulu-Natal and at Pretoria, Gauteng, South Africa, in December 1979 and March 1980.

### 285. *Macrocheles lisae* Niogret & Nicot, 2007

*Macrocheles lisae* Niogret & Nicot, in Niogret *et al.*, 2007: 116.

**Type depository.** Muséum National d'Histoire Naturelle de Paris, Paris, France.

**Type locality and habitat.** France, Languedoc-Roussillon, Le Caylar (03°10'E; 43°51'N), December 2005, on *Aphodius scybalarius* F. [Coleoptera: Scarabaeidae].

### 286. *Macrocheles longipes* (Berlese, 1910)

*Holostaspis longipes* Berlese, 1910: 251.

*Macrocheles* (*Coprholaspis*) *longipes*.— Berlese, 1918: 162.

*Macrocheles longipes*.— Krantz, 1988a: 972.

*Macrocheles nemontanus* Ryke & Meyer, 1958: 139 [Synonymy by Krantz, 1988a: 972].

*Macrocheles nemontanus*.— Hirschmann, 1970d: 51; Costa, 1974: 485.

**Type depository.** *M. longipes*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. nemontanus*: Institute for Zoological Research of the Potchefstroom University, Potchefstroom, South Africa.

**Type locality and habitat.** *M. longipes*: Egypt, date of collection unspecified, on *Heliocopris andersoni* Bates [cited as *Copris isidis* Boheman] [Coleoptera: Scarabaeidae]; *M. nemontanus*: South Africa, Potchefstroom, February 1953, on *Heliocopris gigas* L. [Coleoptera: Scarabaeidae].

### 287. *Macrocheles longipilis* Willmann, 1941

*Macrocheles vagabundus longipilis* Willmann, 1941: 26.

*Macrocheles (Macrocheles) longipilis*.— Krauss, 1970: 20.

*Macrocheles longipilis*.— Hirschmann, 1970d: 50.

**Type depository.** Zoologische Staatssammlung München, Munich, Germany.

**Type locality and habitat.** Bosnia and Herzegovina, Dubrava, 23 June 1923, from unspecified host/substrate.

**288. *Macrocheles longisetis* Evans & Hyatt, 1963**

*Macrocheles longisetis* Evans & Hyatt, 1963: 351.

*Macrocheles longisetis*.— Hirschmann, 1970d: 49.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** South Africa, Kaffra, date of collection unspecified, on *Mnematium marginatum* Péringuey [Coleoptera: Scarabaeidae].

**289. *Macrocheles lukoschusi* Krantz, 1983**

*Macrocheles lukoschusi* Krantz, 1983: 4.

**Type depository.** Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil.

**Type locality and habitat.** Brazil, Ilha de Curarí (Rio Solimões), Amazonas, 24 June 1977, in feces at anal region of *Bradypus variegatus* Schinz [Mammalia: Pilosa: Bradypodidae].

**290. *Macrocheles lumareti* Niogret & Nicot, 2008**

*Macrocheles lumareti* Niogret & Nicot, 2008: 41.

**Type depository.** Muséum National d'Histoire Naturelle de Paris, Paris, France.

**Type locality and habitat.** France, St Germain-Les-Buxy (46°42'N, 4°46'E; alt. 206 m), May 2006, on *Copris lunaris* (L.) [Coleoptera: Scarabaeidae].

**291. *Macrocheles lundae* Krantz, 1970**

*Macrocheles lundae* Krantz, 1970: 19.

**Type depository.** Cited as SSAE.

**Type locality and habitat.** South Africa, Kleinmond, Western Cape, 20 December 1950, on scarabaeid [Coleoptera: Scarabaeidae].

**292. *Macrocheles luzonensis* Takaku, Hartini, Dwibadra & Corpuz-Raros, 2012**

*Macrocheles luzonensis* Takaku, Hartini, Dwibadra & Corpuz-Raros, 2012: 116.



**Type depository.** Zoological Collections of the Graduate School of Science, Hokkaido University, Sapporo, Japan.

**Type locality and habitat.** Philippines, University of the Philippines Los Baños (UPLB), Laguna, Luzon Island, 5 February 1972, in decomposing bark of *Araucaria* [Araucariaceae].

**293. *Macrocheles lyallpurensis* Halliday, 2000**

*Macrocheles krantzi* Anwarullah & Irshad, 1971: 146 [Junior homonym of *Macrocheles krantzi* Evans & Hyatt].

*Macrocheles lyallpurensis* Halliday, 2000: 299 [Replacement name].

**Type depository.** Collection of the Acarology Section, PCSIR (Pakistan Council of Scientific and Industrial Research) Laboratories, Karachi, Pakistan.

**Type locality and habitat.** Pakistan, Lyallpur, Punjab, 10 November 1968, from soil in a wheat *Triticum* spp. [Poaceae] field.

**294. *Macrocheles lyratus* Fox, 1947**

*Macrocheles lyratus* Fox, 1947: 602.

**Type depository.** Entomological collection of the Department of Medical Zoology, School of Tropical Medicine, San Juan, Puerto Rico.

**Type locality and habitat.** Puerto Rico, Santurce, San Juan, 02 May 1947, on *Rattus norvegicus* Berkenhout [Mammalia: Rodentia: Muridae].

**295. *Macrocheles macroscatophilus* Walter & Krantz, 1986**

*Macrocheles macroscatophilus* Walter & Krantz, 1986b: 291.

**Type depository.** Central African Museum, Tervuren, Belgium.

**Type locality and habitat.** Zaire, Garamba National Park, Orientale, 26 August 1952, on unidentified coprophagic insect in grassy savanna.

**296. *Macrocheles maharashtraensis* Roy, 1991**

*Macrocheles maharashtraensis* Roy, 1991b: 711.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Mahabaleshwar (alt. 1650 m), Satara District, Maharashtra, 27 May 1970, in forest litter.

**297. *Macrocheles malabaricus* Evans & Hyatt, 1963**

*Macrocheles malabaricus* Evans & Hyatt, 1963: 354.

*Macrocheles malabricus* [sic].— Hirschmann, 1970d: 47.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** India, Malabar, date of collection unspecified, on *Allogymnopleurus maculosus* McLeay [Coleoptera: Scarabaeidae].

**298. *Macrocheles mammifer* Berlese, 1918**

*Macrocheles (Nothrholaspis) mammifer* Berlese, 1918: 171.

*Macrocheles mammifer*.— Krantz, 1967c: 150; Bregetova, 1977: 365; Wallace, 1986: 11; Krantz & Whitaker, 1988: 236; Mašán, 2003: 94; Takaku *et al.*, 2012: 108.

*Macrocheles (Macrocheles) mammifer*.— Karg, 1993: 113; Ahadiyat *et al.*, 2014: 236.

*Macrocheles tridentatus*.— Delfinado & Baker, 1975: 53 [Misidentification, according to Krantz & Whitaker, 1988: 236].

*Holostaspella polyornata* Turk, 1948: 105 [Synonymy by Krantz, 1967c: 143].

*Macrocheles pavlovskii* Bregetova & Koroleva, 1960: 83 [Synonymy by Krantz, 1967a: 150].

*Macrocheles (Macrocheles) pavlovskii*.— Karg, 1971: 138.

*Macrocheles pavlovskii*.— Hirschmann, 1970d: 49.

*Macrocheles (Macrocheles) postneri* Götz, in Krauss, 1970: 28 [Synonymy by Krantz & Whitaker, 1988: 236].

*Macrocheles postneri*.— Hirschmann, 1970c: 45; Hirschmann, 1970d: 49.

*Glyphtholaspis orientalis* Iavorschi, 1980: 149 [Synonymy by Krantz & Whitaker, 1988: 236].

**Type depository.** *M. mammifer*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *G. orientalis*, *H. polyornata* and *M. postneri*: unspecified; *M. pavlovskii*: Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** *M. mammifer*: Argentina, La Plata, Buenos Aires, date of collection and host/substrate not specified; *H. polyornata*: Trinidad & Tobago, San Rafael, 18 September 1945, in nest of *Melipona fasciata* Latreille [Hymenoptera: Apidae]; *M. pavlovskii*: Georgia, Eshera, Sukhumi, Abkhazia, 14 August 1958, dry litter under *Rubus fruticosus* L. [Rosaceae]; Russia, Primorsky, date and host/substrate unspecified; *M. postneri*: Germany, Erlangen, Bavaria, date of collection unspecified, in in dunghill and litter; Spain, El Escorial, date of collection unspecified, in litter of *Quercus pyrenaica* Will. [cited as *Quercus toza*] [Fagaceae] and in nest of *Bombus*

*terrestris* (L.) [Hymenoptera: Apidae]; *G. orientalis*: Cuba, Cueva Bariay, Oriente, 2 March 1973, in guano; Cuba, Cueva Bariay, Oriente, 2 March 1973, in guano; Cuba, Quemado de Pineda, Pinar el Río, 22 April 1973, in soil.

**299. *Macrocheles manokwariensis* Hartini & Takaku, 2006**

*Macrocheles manokwariensis* Hartini & Takaku, 2006a: 37.

*Macrocheles manokwariensis*.— Hartini *et al.*, 2007: 93.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Tamrau Reserve (alt. 180m), Saukarem, Auejou, Auberbalun, Manokwari, Papua, 13 June 2001, on *Onthophagus* sp. [Coleoptera: Scarabaeidae] deposited in the Museum Zoologicum Bogoriense.

**300. *Macrocheles margaritoideus* Karg, 1994**

*Macrocheles margaritoideus* Karg, 1994b: 180.

**Type depository.** Arachnologischen Sammlung des Museums für Naturkunde, Berlin, Germany.

**Type locality and habitat.** Galapagos Islands, Isabela, 1/2 km of Saint Tomas, 7 July 1985, in burned litter of trees.

**301. *Macrocheles marshalli* Evans & Hyatt, 1963**

*Macrocheles marshalli* Evans & Hyatt, 1963: 354.

*Macrocheles marshalli*.— Hirschmann, 1970d: 50.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Zimbabwe, Umfuli River and Umtali, Mashonaland, date of collection unspecified, on *Sceliages adamastor* LePeletier & Serville [Coleoptera: Scarabaeidae].

**302. *Macrocheles maseri* Krantz & Whitaker, 1988**

*Macrocheles maseri* Krantz & Whitaker, 1988: 238.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, 7 miles southeast of Vale, Malheur, Oregon, 20 March 1975, on *Urocitellus townsendi* (Bachman) [Mammalia: Rodentia: Sciuridae].

**303. *Macrocheles matrius* Hull, 1925**

*Macrocheles (Nothrolaspis) matrius* Hull, 1925: 212.

*Macrocheles matrius*.— Evans & Browning, 1956: 34; Bregetova & Koroleva, 1960: 109; Axtell, 1963: 630; Hirschmann, 1970b: 45, 1970d: 50; Krantz, 1972: 271; Emberson, 1973a: 121, 1980: 137; Bregetova, 1977: 374; Hyatt & Emberson, 1988: 85; Mašán, 2003: 94.

*Macrocheles (Macrocheles) matrius*.— Krauss, 1970: 17; Karg, 1971: 135, 1993: 112.

*Holostaspis subbadius* var. *rubustulus*.— Sellnick, 1940: 84 [Misidentification, according to Evans & Browning, 1956: 34].

*Macrocheles carinatus*.— Hughes, 1948: 126 [Misidentification, according to Evans & Browning, 1956: 34].

**Type depository.** *M. matrius*: Natural History Museum, London, England.

**Type locality and habitat.** *M. matrius*: England, Allendale (cited as West Allendale), date of collection unspecified, in poultry manure [lectotype designated by Hyatt & Emberson, 1988: 85].

### **303a. *Macrocheles matrius violovictsi* Bregetova & Koroleva, 1960**

*Macrocheles matrius violovictsi* Bregetova & Koroleva, 1960: 114.

*Macrocheles matrius violovictsi*.— Bregetova, 1977: 376.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Russia, Sakhalin Island and Ariadne, 9 October 1946, from nest of *Sciurus vulgaris* L. and *Pteromys volans* L. [Mammalia: Rodentia: Sciuridae].

### **304. *Macrocheles matrius pratensis* Bregetova & Koroleva, 1960**

*Macrocheles matrius pratensis* Bregetova & Koroleva, 1960: 112.

*Macrocheles matrius pratensis*.— Bregetova, 1977: 375.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Georgia, 15 November 1950, from soil around a nest of *Prometheomys schaposchnikowi* Satunin [Mammalia: Rodentia: Muridae].

### **305. *Macrocheles medialis* Berlese, 1918**

*Macrocheles (Coprholaspis) medialis* Berlese, 1918: 156.

*Macrocheles medialis*.— Walter & Krantz, 1992: 244.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Africa Oriental, date of collection and host/substrate unspecified.

**306. *Macrocheles merdarius* (Berlese, 1889)**

*Gamasus tardus* [protonymph].— Berlese, 1882a: 103 [Misidentification, according to Berlese, 1889: 1].

*Holostaspis marginatus* [“prima forma giovanile”].— Canestrini & Canestrini, 1882: 25 [Misidentification, according to Berlese, 1889: 1].

*Holostaspis merdarius* Berlese, 1889: 1<sup>Note</sup>.

*Holostaspis merdarius*.— Berlese, 1892: 70.

*Macrocheles (Coprholaspis) merdarius*.— Berlese, 1918: 146.

*Macrocheles merdarius*.— Sellnick, 1940: 86; Evans and Browning, 1956: 21; Bregetova & Koroleva, 1960: 145; Filipponi & Pegazzano, 1963: 83; Axtell, 1963: 631; Krantz & Filipponi, 1964: 36; Hirschmann, 1970a: 44, 1970b: 44, 1970c: 45, 1970d: 46; Emberson, 1973a: 121, 1980: 137; Bregetova, 1977: 355; Wallace, 1986: 9; Hyatt & Emberson, 1988: 113; Krantz & Whitaker, 1988: 228; Jesus & Rueda, 1990: 712; Mašán, 2003: 117; Hartini *et al.*, 2007: 77, 2009: 420; Faraji *et al.*, 2008: 234; Takaku *et al.*, 2012: 108.

*Macrocheles medarius* [sic].— Axtell, 1961: 748.

*Macrocheles (Macrocheles) merdarius*.— Krauss, 1970: 17; Karg, 1971: 134, 1993: 110.

*Holostaspis adulescens* Berlese, 1910: 252 [Synonymy by Filipponi & Pegazzano, 1963: 83].

*Macrocheles (Coprholaspis) adulescens*.— Berlese, 1918: 146.

**Type depository.** *H. adulescens* and *M. merdarius*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** *M. merdarius*: holotype – not designated; Italy, Vittorio Veneto, Treviso, date of collection unspecified, in dunghill [neotype designated by Filipponi & Pegazzano, 1963: 83]; *H. adulescens*: Brazil, Pernambuco, date of collection unspecified, on *Isocopris inhiatus* (Germar) [cited as *Copris hypocrita* Lucas – junior synonymy] [Coleoptera: Scarabaeidae].

**Note.** Specimens reported by Berlese, 1882a: 103 as protonymph of *Gamasus tardus* Koch and by Canestrini & Canestrini, 1882: 26 as “prima forma giovanile” of *Holostaspis marginatus* (Hermann) described as *Holostaspis merdarius* Berlese by Berlese, 1889: 1.

**307. *Macrocheles mesochthonius* Krantz & Whitaker, 1988**

*Macrocheles mesochthonius* Krantz & Whitaker, 1988: 242.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Terre Haute, Vigo, Indiana, 20 September 1969, on *Ictidomys tridecemlineatus* (Mitchill) [Mammalia: Rodentia: Sciuridae].

**308. *Macrocheles mexicanus* Evans & Hyatt, 1963**

*Macrocheles mexicanus* Evans & Hyatt, 1963: 358.

*Macrocheles mexicanus*.— Méndez Olivo, 1968: 157; Hirschmann, 1970d: 47.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Mexico, Jalapa, date of collection unspecified, on *Phanaeus palliatus* Sturm [Coleoptera: Scarabaeidae].

**309. *Macrocheles minimus* Hull, 1918**

*Macrocheles minimus* Hull, 1918: 73.

**Type depository.** Natural History Museum, London, England.

**Type locality and habitat.** *M. minimus*: England, Leicestershire, unspecified date and host.

**Note.** Suspected junior synonymy of *Longicheles mandibularis* Berlese by Evans & Browning, 1956: 44].

**310. *Macrocheles monchadskii* Bregetova & Koroleva, 1960**

*Macrocheles monchadskii* Bregetova & Koroleva, 1960: 118.

*Macrocheles monchadskii*.— Hirschmann, 1970d: 48; Bregetova, 1977: 374.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Georgia, Batumi Botanical Garden, Batumi, 8 October 1956, from litter under *Cupressus arizonica* [Cupressaceae].

**311. *Macrocheles moneronicus* Bregetova & Koroleva, 1960**

*Macrocheles moneronicus* Bregetova & Koroleva, 1960: 143.

*Macrocheles moneronicus*.— Hirschmann, 1970d: 46; Bregetova, 1977: 378.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Russia, Moneron Island, Sakhalin Island, 24 August 1956, in bird colonies.

**312. *Macrocheles monticola* Takaku & Hartini, 2001**

*Macrocheles monticola* Takaku & Hartini, 2001: 329.

*Macrocheles monticola*.— Hartini *et al.*, 2007: 93; Takaku *et al.*, 2012: 113.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Pancasari, Sukasada, Bali, 3 December 1999, on *Catharsius* sp. [Coleoptera: Scarabaeidae].

**313. *Macrocheles montivagus* (Berlese, 1887)**

*Holostaspis montivagus* Berlese, 1887b: 4.

*Holostaspis montivagus*.— Berlese, 1892: 70.

*Macrocheles* (*Nothrholaspis*) *montivagus*.— Berlese, 1918: 169.

*Macrocheles* (*Macrocheles*) *montivagus*.— Krauss, 1970: 22.

*Macrocheles montivagus*.— Hirschmann, 1970b: 45, 1970c: 46, 1970d: 49.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Italy, in field of the Florentine hills, Vallombrosa, Reggello, Tuscany, date of collection unspecified, on flies.

**Note<sup>1</sup>.** Specimens reported by Womersley (1942: 168) as *Nothrholaspis* ? *montivagus* (Berlese) identified as *Glypholaspis americana* (Berlese) by Krantz & Filipponi (1964: 52).

**Note<sup>2</sup>.** Specimens reported by Womersley (1955: 413) as *Macrocheles* (*Nothrholaspis*) ? *montivagus* (Berlese) described as *Macrocheles tenuirostris* by Krantz & Filipponi (1964: 46).

**Note<sup>3</sup>.** Specimens reported by Krauss (1970: 22) as *Macrocheles* (*Macrocheles*) *montivagus* (Berlese) were identified as *Macrocheles montanus* (Willmann) by Masan (2003: 85).

**Note<sup>4</sup>.** Suspected senior synonym of *Nothrholaspis montanus* Willmann by Krauss (1970: 22) and Bregetova (1977: 369).

**313a. *Macrocheles montivagus transoceanicus* Berlese, 1918**

*Macrocheles* (*Nothrholaspis*) *montivagus* var. *transoceanicus* Berlese, 1918: 171.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection unspecified, in nest of *Acromyrmex lundii* [sic] (Guérin-Méneville) [Hymenoptera: Formicidae].

**314. *Macrocheles mundus* Berlese, 1918**

*Holostaspis marginatus* var. *americanus* [tritonymph].— [Misidentification, according to Berlese, 1918: 157].

*Macrocheles (Coprholaspis) mundus* Berlese, 1918: 157<sup>Note</sup>.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection not mentioned, under rocks and in nest of *Acromyrmex lundii* (Guérin-Méneville) [Hymenoptera: Formicidae].

**Note.** Species described based on specimens reported by Berlese (1888: 195) as tritonymph of *Holostaspis marginatus* var. *americanus* Berlese.

**315. *Macrocheles muscaedomesticae* (Scopoli, 1772)**

*Acarus muscae domesticae* Scopoli, 1772: 125.

*Macrocheles muscaedomesticae*.— Pereira & de Castro, 1945: 161; Evans & Browning, 1956: 12; Axtell, 1963: 629; Krantz & Filipponi, 1964: 36; Bregetova & Koroleva, 1960: 131; Méndez Olivo, 1968: 142; Hirschmann, 1970a: 44, 1970d: 50; Krantz, 1972: 273; Emberson, 1973a: 121, 1980: 137; Bregetova, 1977: 378; Hyatt & Emberson, 1988: 105; Hennessey & Farrier, 1988: 20; Halliday, 1990: 417; Jesus & Rueda, 1990: 711; Mašán, 2003: 114; Hartini *et al.*, 2007: 93, 2009: 421; Faraji *et al.*, 2008: 234; Takaku *et al.*, 2012: 113.

*Macrocheles muscae domesticae* [sic].— Oudemans, 1936: 174; Sellnick 1940: 78.

*Macrocheles (Macrocheles) muscaedomesticae*.— Krauss, 1970: 14; Karg, 1971: 138, 1993: 114.

*Macrocheles vagabundus* var. *australis*.— Womersley, 1942: 166 [Misidentification, according to Halliday, 2000: 302].

*Acarus marginatus* Hermann, 1804: 76 [Synonymy by Pereira & de Castro, 1945: 161].

*Macrocheles marginatus*.— Latreille, 1829: 282; Oudemans, 1902a: 44; Hull, 1925: 215.

*Gamasus marginatus*.— Lamarck, 1839: 290; Berlese, 1906: 282.

*Gamasus (Holostaspis) marginatus*.— Berlese, 1882b: 636.

*Holostaspis marginatus*.— Canestrini & Canestrini, 1882: 26; G. Canestrini, 1885: 61; Berlese, 1892: 70, 1913b: 98.



*Macrocheles (Macrocheles) marginatus*.— Schweizer, 1922: 39

*Holostaspis submarginatus* Foà, 1900: 135 [Synonymy by Krantz & Filipponi, 1964: 36].

*Holostaspis posteroarmatus* Berlese, 1904a: 263 [Synonymy by Filipponi & Pegazzano 1962a: 204].

*Macrocheles (Coprholaspis) posteroarmatus*.— Berlese, 1918: 146.

*Macrocheles (Coprholaspis) posteroarmatus* var. *novimundi* Berlese, 1918: 155.

*Macrocheles canadensis* Banks, 1912: 98 [Synonymy by Hennessey & Farrier, 1988: 20].

*Macrocheles muscae* Ewing, 1913a: 454 [Synonymy by Pereira & de Castro, 1945: 162].

**Type depository.** *A. marginatus*, *M. muscaedomesticae* and *H. submarginatus*: unspecified;

*H. posteroarmatus* and *M. (C.) posteroarmatus novimundi*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. canadensis*: Museum of Comparative Zoology, Harvard University, Cambridge, USA; *M. muscae*: Systematic Entomology Laboratory, United States National Museum of Natural History, USDA-SEA-IIBIII, Beltsville, Maryland, USA.

**Type locality and habitat.** *A. muscaedomesticae*: Austria, Tyrol, date of collection

unspecified, on *Musca domestica* L. [Diptera: Muscidae]; *A. marginatus*: unspecified;

*H. submarginatus*: unspecified; *H. posteroarmatus*: Italy, Veneto, date of collection

unspecified, in dunghills; *M. (C.) posteroarmatus novimundi*: Argentina, La Plata,

Buenos Aires, date of collection unspecified, under rocks and in nest of *Acromyrmex*

*lundii* (Guérin-Méneville) [Hymenoptera: Formicidae]; *M. canadensis*: Canada,

Ottawa, date of collection unspecified, on guinea pig [Mammalia: Rodentia:

Caviidae]. *M. muscae*: USA, Ithaca, New York, 5 October 1910, on *Musca* sp.

{Díptera: Muscidae}.

**Note<sup>1</sup>.** Specimens reported by Canestrini & Canestrini (1882: 26) as “seconda forma giovanile” of *Holostaspis marginatus* (Hermann) were identified as *Macrocheles glaber* (Müller) by Filipponi & Pegazzano (1962b: 215).

**Note<sup>2</sup>.** Specimen reported by Canestrini & Canestrini (1882: 26) as deutonymph of *Holostaspis marginatus* (Hermann) identified as *Macrocheles perglaber* Filipponi & Pegazzano, 1962 by Filipponi & Pegazzano (1962b: 221).

**Note<sup>3</sup>.** Specimens reported by Canestrini & Canestrini, 1882: 27 [plates II and III], Foà, 1900: 139 and Berlese, 1913b: 98 as *Holostaspis marginatus* (Hermann); by Berlese, 1918: 172 and Filipponi & Ilardi, 1958: 118 as *Macrocheles (Macrocheles) marginatus*

(Hermann) were identified as *Glypholaspis fimicola* (Berlese) [sic] by Filipponi & Pegazzano, 1960: 139.

**Note**<sup>4</sup>. Specimens reported by Berlese, 1889: 4 and 5 as *Holostaspis marginatus* (Hermann) described as *Nothrolaspis fimicola* Sellnick by Sellnick, 1931: 765 [actually *Glypholaspis fimicola* (Sellnick)].

**Note**<sup>5</sup>. Specimens reported by Berlese (1889: 6) as *Holostaspis marginatus* (Hermann) were described as *Holostaspis subbadius* by Berlese (1904a: 264).

**Note**<sup>6</sup>. Specimen reported by Berlese (1889: 6) as tritonymph of *Holostaspis marginatus* (Hermann) identified as *Macrocheles perglaber* Filipponi & Pegazzano by Filipponi & Pegazzano (1962b: 221).

**Note**<sup>7</sup>. Specimens reported by Oudemans (1900a: 129) as *Macrocheles marginatus* (Hermann) described as *Macrocheles (Monoplites) oudemansii* Hull [part] and identified as *Macrocheles glaber* (Müller) [tritonymph] and *Macrocheles plumiventris* Hull [= *Glypholaspis confusa* (Foà)] [adult] by Evans & Browning (1956: 16).

**Note**<sup>8</sup>. Specimen reported by Oudemans (1900a: 129) as protonymph of *Macrocheles marginatus* (Hermann) described as *Macrocheles hamatus* by Oudemans (1915a: 182).

**Note**<sup>9</sup>. Suspected senior synonymy of *Gamasus tardus* Koch by Berlese (1913b: 98).

### **316. *Macrocheles mykytowyczi* Womersley, 1956**

*Macrocheles (Coprholaspis) mykytowyczi* Womersley, 1956: 516.

*Macrocheles mykytowyczi*.— Krantz & Filipponi, 1964: 50; Hirschmann, 1970d: 47.

**Type depository.** South Australian Museum, Adelaide, Australia

**Type locality and habitat.** Australia, Canberra, December 1952, on tangle-foot paper in the field.

### **317. *Macrocheles nalani* Walter & Krantz, 1986**

*Macrocheles nalani* Walter & Krantz, 1986b: 288.

*Macrocheles nalani*.— Hartini *et al.*, 2007: 94.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Thailand, Khorat Plateau, Tenasserim, January 1924, on *Heliocopriss tyrannus* Thomson [Coleoptera: Scarabaeidae].

### **318. *Macrocheles natalensis* Evans & Hyatt, 1963**

*Macrocheles natalensis* Evans & Hyatt, 1963: 358.

*Macrocheles natalensis*.— Hirschmann, 1970d: 48; Walter & Krantz, 1992: 247.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** South Africa, Natal, date of collection unspecified, on *Scarabaeus cuvieri* MacLeay [Coleoptera: Scarabaeidae].

### 319. *Macrocheles nataliae* Bregetova & Koroleva, 1960

*Macrocheles nataliae* Bregetova & Koroleva, 1960: 140.

*Macrocheles nataliae*.— Hirschmann, 1970d: 48; Bregetova, 1977: 378; Hyatt & Emberson, 1988: 109; Mašán, 2003: 104.

*Macrocheles (Macrocheles) nataliae*.— Karg, 1971: 135, 1993: 111.

*Macrocheles (Macrocheles) melisii* Krauss, 1970: 24 [Synonymy by Hyatt & Emberson, 1988: 109].

*Macrocheles melisii*.— Hirschmann, 1970a: 44, 1970d: 48.

**Type depository.** *M. nataliae*: Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia; *M. (M.) melisii*: unspecified.

**Type locality and habitat.** *M. nataliae*: Republic of Lithuania (mentioned as Lithuanian Soviet Socialist Republic), Plunge, 11 July 1954, on the corpses of *Microtus arvalis*; Russia, Kuibyshev, Tatarstan (mentioned as Tatar Autonomous Soviet Socialist Republic), 11 June 1957, in soil at experiment station, under grass; *M. (M.) melisii*: Germany, Erlangen, Bavaria, date of collection unspecified, in the lower layer of a dunghill.

### 320. *Macrocheles nemerdarius* Krantz & Whitaker, 1988

*Macrocheles nemerdarius* Krantz & Whitaker, 1988: 244.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Patuxent Wildlife Refuge, Maryland, 6 July 1955, in nest of *Peromyscus* sp. [Mammalia: Rodentia: Cricetidae].

### 321. *Macrocheles neomexicanus* Arriaga & Bertrand, 2014

*Macrocheles neomexicanus* Arriaga & Bertrand, in Arriaga-Jimenez *et al.*, 2014: 376.

**Type depository.** Colección Nacional de Acaros, Instituto de Biología, Departamento de Zoología, Universidad Nacional Autónoma de México (UNAM), Mexico City, Mexico.

**Type locality and habitat.** Mexico, Xalapa (19°31'32"N; 96°55'23"W; 1400 m), Veracruz, June 2012, on *Onthophagus incensus* Say [Coleoptera: Scarabaeidae] collected in an urban vegetation.

**322. *Macrocheles neoscutatus* Krantz, 1972**

*Macrocheles neoscutatus* Krantz, 1972: 273.

*Macrocheles neoscutatus*.— Walter & Krantz, 1992: 244.

**Type depository.** Zoologisches Museum Hamburg, Hamburg, Germany.

**Type locality and habitat.** Germany, Volksdorfer Florest, Volksdorfer, Hamburg, 11 August 1965, under ferns.

**323. *Macrocheles neovernalis* Ryke & Meyer, 1958**

*Macrocheles neovernalis* Ryke & Meyer, 1958: 144.

*Macrocheles neovernalis*.— Hirschmann, 1970d: 48; Walter & Krantz, 1992: 244.

**Type depository.** Institute for Zoological Research of the Potchefstroom University, Potchefstroom, South Africa.

**Type locality and habitat.** South Africa, Potchefstroom, February 1953, on *Heliocopris hamadryas* F. [Coleoptera: Scarabaeidae].

**Note.** Specimen reported by Costa (1975a: 124) as *Macrocheles neovernalis* Ryke & Meyer identified as *Macrocheles pumiliosternus* Walter & Krantz by Walter & Krantz (1986b: 287).

**324. *Macrocheles nevernalis* Evans & Hyatt, 1963**

*Macrocheles nevernalis* Evans & Hyatt, 1963: 361.

*Macrocheles nevernalis*.— Hirschmann, 1970d: 48.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** India, Namakal, Salem, date of collection unspecified, on *Escarabaeus* [cited as *Scarabaeus*] *brahminus* (Castelnau) [Coleoptera: Scarabaeidae].

**325. *Macrocheles nevinsoni* Evans & Hyatt, 1963**

*Macrocheles nevinsoni* Evans & Hyatt, 1963: 361.

*Macrocheles nevinsoni*.— Hirschmann, 1970d: 51.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Argentina, Rio Salado, date of collection unspecified, on *Melagoniella argentina* Gillet [Coleoptera: Scarabaeidae].

**326. *Macrocheles nidus* Hartini, Kahono & Takaku, 2013**

*Macrocheles nidus* Hartini, Kahono & Takaku, 2013: 48.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Bogor Botanical Garden, Bogor, West Java, 30 January 2004, in nest of *Apis dorsata dorsata* F. [Hymenoptera: Apidae].

**327. *Macrocheles novaezelandiae* Emberson, 1973**

*Macrocheles novaezelandiae* Emberson, 1973b: 295.

*Macrocheles novaezelandiae*.— Emberson, 1980: 137; Wallace, 1986: 12; Halliday, 1990a: 418.

**Type depository.** New Zealand Arthropod Collection, Landcare Research, Auckland, New Zealand.

**Type locality and habitat.** New Zealand, Highway 73, Paddy's Lookout, 11 July 1971, in tree fern litter.

**328. *Macrocheles novaodessensis* Mendes & Lizaso, 1992**

*Macrochelis* [sic] *novaodessensis* Mendes & Lizaso, 1992: 357.

**Type depository.** Instituto Butantan, São Paulo, Brazil.

**Type locality and habitat.** Brazil, Nova Odessa, São Paulo, 12 March 1990, in cattle manure.

**329. *Macrocheles oigru* Walter & Krantz, 1986**

*Macrocheles oigru* Walter & Krantz, 1986b: 281.

*Macrocheles oigru*.— Takaku, 2001: 500; Hartini *et al.*, 2007: 77, 2009: 421.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** India, Coimbatore (alt. 430 m), Madras State, 1977, on *Onitis philemon* F. [Coleoptera: Scarabaeidae].

**330. *Macrocheles omicron* Halliday, 2000**

*Macrocheles omicron* Halliday, 2000: 303.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Mount Tiptree, Queensland, 13 July 1984, on dung baited trap.

**331. *Macrocheles onitissae* Chinniah & Mohanasundaram, 1995**

*Macrocheles onitissae* Chinniah & Mohanasundaram, 1995: 216.

**Type depository.** Department of Agricultural Entomology, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, India.

**Type locality and habitat.** India, Coimbatore, Tamil Nadu, 30 May 1988, on *Onitis* sp. [Coleoptera: Scarabaeidae].

**332. *Macrocheles ontariensis* Norton, 1973**

*Macrocheles ontariensis* Norton, 1973: 101.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Lake Ontario, Jefferson, New York, summer and fall 1970, from decaying beach debris on the shore.

**333. *Macrocheles orientalis* Bhattacharyya, 1972**

*Macrocheles orientalis* Bhattacharyya, 1972a: 275.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Elephant Flat, Bhalukpong, West Kameng, Arunachal Pradesh, 23 December 1965, under bark of a dead tree.

**334. *Macrocheles ovoidalis* Niogret & Nicot, 2008**

*Macrocheles ovoidalis* Niogret & Nicot, 2008: 44.

**Type depository.** Muséum National d'Histoire Naturelle de Paris, Paris, France.

**Type locality and habitat.** Gabon, Bakoumba (01°79'S , 13°04'E; alt. 623 m), June 2006, on *Stomoxys calcitrans* L.. [Diptera: Muscidae].

**335. *Macrocheles ovoideus* Ishikawa, 1980**

*Macrocheles ovoideus* Ishikawa, 1980: 43.

**Type depository.** Biological Laboratory of Matsuyama Shinonome Junior College, Matsuyama, Japan.

**Type locality and habitat.** Japan, Kawashimo-kô, Kawashimo, Tobe, Ehime Prefecture, Island of Shikoku, 17 August 1979, from abandoned mine adits.

**336. *Macrocheles paganus* Berlese, 1918**

*Macrocheles (Coprholaspis) paganus* Berlese, 1918: 153.

*Macrocheles paganus*.— Walter & Krantz, 1992: 247.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Angola, Benguela, date of collection unspecified, on *Kheper* [cited as *Scaraboeus*] *paganus* (Harold) [Coleoptera: Scarabaeidae].

**337. *Macrocheles palniensis* Roy, 1991**

*Macrocheles palniensis* Roy, 1991b: 711.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Kodaikanal (alt. 2450 m), Dindigul, Tamil Nadu, 10 March 1980, in forest leaf litter.

**338. *Macrocheles papillosus* Götze, 1970**

*Macrocheles (Macrocheles) papillosus* Götze, in Krauss, 1970: 30.

*Macrocheles papillosus*.— Hirschmann, 1970b: 45, 1970c: 46, 1970d: 52.

**Type depository.** Unspecified.

**Type locality and habitat.** Germany, Fischbach, Nuremberg, date of collection unspecified, in galleries of *Ips* sp. [Coleoptera: Curculionidae] in a pine *Pinus* sp. [Pinaceae] stock.

**Note.** Suspected junior synonym of *Macrocheles ivanovi* Bregetova & Koroleva by Karg (1993: 113).

**339. *Macrocheles paralius* Halliday, 1990**

*Macrocheles paralius* Halliday, 1990: 421.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, near Binalong Bay, Skeleton Bay, Tasmania, 1 February 1980, in rotting seaweed on the beach.

**340. *Macrocheles parapisentii* Costa, 1967**

*Macrocheles parapisentii* Costa, 1967: 305.

*Macrocheles parapisentii*.— Hirschmann, 1970a: 44, 1970b: 45, 1970c: 45, 1970d: 47.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Israel, Na'aman Dunes, 29 October 1963, on *Scarabaeus puncticollis* (Latreille) [Coleoptera: Scarabaeidae].

**341. *Macrocheles paucipectinatus* Niogret & Nicot, 2007**

*Macrocheles paucipectinatus* Niogret & Nicot, in Niogret *et al.*, 2007: 118.

**Type depository.** Muséum National d'Histoire Naturelle de Paris, Paris, France.

**Type locality and habitat.** France, Languedoc-Roussillon, Le Caylar (03°10'E; 43°51'N), December 2005, on *Aphodius scybalarius* F. [Coleoptera: Scarabaeidae].

**342. *Macrocheles peckorum* Halliday, 2000**

*Macrocheles peckorum* Halliday, 2000: 304.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Stirling Range National Park, Western Australia, 16–26 December 1989, on *Onthophagus haagi* Harold in pit trap [Coleoptera: Scarabaeidae].

**343. *Macrocheles pegazzanae* Evans & Hyatt, 1963**

*Macrocheles pegazzanae* Evans & Hyatt, 1963: 395.

*Macrocheles pegazzanae*.— Hirschmann, 1970d: 50.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Brazil, Santa Catarina, date of collection unspecified, on *Phanaeus bellicosus* Olivier [Coleoptera: Scarabaeidae].

**344. *Macrocheles pelaezi* Méndez Olivo, 1968**

*Macrocheles pelaezi* Méndez Olivo, 1968: 158.

**Type depository.** Escuela Nacional de Ciencias Biológicas, Mexico city, Mexico.

**Type locality and habitat.** Mexico, Guadalajara, Jalisco, 5 November 1965, on *Dichotomius carolinus* (L.) [Coleoptera: Scarabaeidae].

**345. *Macrocheles penicilliger* (Berlese, 1904)**

*Holostaspis penicilliger* Berlese, 1904a: 264.

*Macrocheles (Coprholaspis) penicilliger*.— Berlese, 1918: 146.

*Macrocheles penicilliger*.— Sellnick, 1940: 82; Evans & Browning, 1956: 27; Bregetova & Koroleva, 1960: 86; Hirschmann, 1970d: 50; Emberson, 1973a: 121; Bregetova, 1977: 369; Hyatt & Emberson, 1988: 86; Krantz & Whitaker, 1988: 249; Roy, 1998: 296; Takaku, 2000: 120; Mašán, 2003: 96; Faraji *et al.*, 2008: 235; Ács & Kontschán, 2014: 114.

*Macrocheles (Macrocheles) penicilliger*.— Krauss, 1970: 18; Karg, 1971: 138, 1993: 113.



*Macrocheles pencilliger* [sic].— Emberson, 1980: 137.

*Holostaspis vagabundus*.— Trägårdh, 1912: 555 [Misidentification, according to Krauss, 1970: 18].

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Italy, Cison di Valmarino, Treviso, date of collection unspecified, under decomposing wood; Italy, Boboli Gardens, Florence, date of collection unspecified, under decomposing wood.

### 346. *Macrocheles peniculatus* Berlese, 1918

*Macrocheles (Coprholaspis) peniculatus* Berlese, 1918: 166.

*Macrocheles peniculatus*.— Bregetova & Koroleva, 1960: 81; Krantz & Filipponi, 1964: 40; Krantz, 1970: 19; Hirschmann, 1970c: 46, 1970d: 49, 1977: 367; Emberson, 1980: 138; Wallace, 1986: 11; Roy, 1998: 295; Faraji *et al.*, 2008: 234.

*Macrocheles (Macrocheles) peniculatus*.— Karg, 1971: 138, 1993: 113.

*Macrocheles caelatus*.— Ramsay, 1970: 91; Emberson, 1973a: 119 [Misidentifications, according to Emberson, 1980: 138].

*Macrocheles (Coprholaspis) vicarius* Berlese, 1918: 167 [Synonymy by Krantz & Filipponi, 1964: 40].

**Type depository.** *M. peniculatus*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. (C.) vicarius*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** *M. peniculatus*: Argentina, La Plata, Buenos Aires, date of collection unspecified, in nest of *Acromyrmex lundii* [sic] (Guérin-Méneville) [Hymenoptera: Formicidae]; *M. (C.) vicarius*: Argentina, La Plata, Buenos Aires, date of collection and host/substrate unspecified.

### 347. *Macrocheles perciliatus* Arriaga & Bertrand, 2014

*Macrocheles perciliatus* Arriaga & Bertrand, in Arriaga-Jimenez *et al.*, 2014: 377.

**Type depository.** Colección Nacional de Acaros, Instituto de Biología, Departamento de Zoología, Universidad Nacional Autónoma de México, Mexico City, Mexico.

**Type locality and habitat.** Mexico, Sierra Negra (18°59'25.9''N, 97°24.26'W; alt. 2766 m), Ciudad Serdan, Puebla, June 2012, on *Copris armatus* Harold [Coleoptera: Scarabaeidae] collected in a *Pinus* [Pinaceae] and *Cupressus* [Cupressaceae] forest.

### 348. *Macrocheles peregrinus* Krantz, 1981

*Macrocheles peregrinus* Krantz, 1981: 7.

*Macrocheles peregrinus*.— Halliday, 1986a: 747; Wallace, 1986: 8; Krantz, 1988a: 976.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** South Africa, Dung Beetle Research Unit (CSIRO), Pretoria, Gauteng, from laboratory colonies initiated with females collected from *Sisyphus spinipes* Thunberg [Coleoptera: Scarabaeidae] and other unidentified scarab species at Hluhluwe, KwaZulu-Natal, South Africa, in November and December 1979 and August 1980.

**Note.** Suspected junior synonym of *Macrocheles alecto* var. *aethiopicus* by Krantz (1988a: 976).

### 349. *Macrocheles perglaber* Filipponi & Pegazzano, 1962

*Macrocheles perglaber* Filipponi & Pegazzano, 1962b: 221.

*Macrocheles perglaber*.— Hirschmann, 1970d: 48; Bregetova, 1977: 374; Emberson, 1980: 137; Halliday, 1986a: 747; Krantz & Redmond, 1987; 1989; Mašán, 2003: 106; Faraji *et al.*, 2008: 235.

*Gamasus stercorarius* [“tritonymph”].— Berlese, 1882a: 106 [Misidentification, according to Filipponi & Pegazzano, 1962b: 221].

*Gamasus tardus* [“tritonymph”].— Berlese, 1882a: 106 [Misidentification, according to Filipponi & Pegazzano, 1962b: 221].

*Holostaspis marginatus* [deutonymph].— Canestrini & Canestrini, 1882: 26 [Misidentification, according to Filipponi & Pegazzano, 1962b: 221].

*Holostaspis marginatus* [“tritonymph”].— Berlese, 1889: 6 [Misidentification, according to Filipponi & Pegazzano, 1962b: 221].

*Holostaspis badius* [part].— Foà, 1900: 134 [Misidentification, according to Filipponi & Pegazzano, 1962b: 221].

*Macrocheles (Coprholaspis) glaber*.— Berlese, 1918: 146 [Misidentification, according to Filipponi & Pegazzano, 1962b: 221].

*Macrocheles glaber*.— Evans & Browning, 1956: 16; Filipponi & Cervone, 1957: 25; Filipponi, 1959: 199, 1960: 168, 1962: 129 [Misidentifications, according to Filipponi & Pegazzano, 1962b: 221].

*Macrocheles (Macrocheles) glaber*.— Krauss, 1970: 15 [Misidentification, according to Halliday, 1986a: 747].

*Macrocheles* (near) *glaber* [part].— Wallace, 1986: 4.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Italy, L'Agro Pontino, Lazio, date of collection unspecified, from laboratory colony initiated with specimens collected in horse manure.

**350. *Macrocheles perparvulus* Berlese, 1918**

*Macrocheles (Coprholaspis) perparvulus* Berlese, 1918: 161.

*Holostaspis marginatus* var. *americanus* [protonymph].— [Misidentification, according to Berlese, 1918: 157].

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, Río Cuarto, Córdoba, date of collection unspecified, on Scarabaeidae [Coleoptera].

**351. *Macrocheles persimilis* Hartini, Dwibadra & Takaku, 2007**

*Macrocheles persimilis* Hartini, Dwibadra & Takaku, 2007: 82.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Lore Lindu National Park (alt. 1140 m), Poso, Lore Utara, Malewuko, Central Sulawesi, 17 May 2002, on *Onthophagus* sp. [Coleoptera: Scarabaeidae].

**352. *Macrocheles pharaonius* Berlese, 1918**

*Macrocheles (Coprholaspis) pharaonius* Berlese, 1918: 150.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Egypt, date of collection unspecified, on *Ateuchetus puncticollis* (Latreille)[cited as *Atheucum puncticollem*] [Coleoptera: Scarabaeidae].

**353. *Macrocheles philemonae* Chinniah & Mohanasundaram, 1995**

*Macrocheles philemonae* Chinniah & Mohanasundaram, 1995: 218.

**Type depository.** Department of Agricultural Entomology, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, India.

**Type locality and habitat.** India, Coimbatore, Tamil Nadu, 17 March 1988, on *Onitis philemon* F. [Coleoptera: Scarabaeidae].

**354. *Macrocheles pilosellus* Hartini, Dwibadra & Takaku, 2007**

*Macrocheles pilosellus* Hartini, Dwibadra & Takaku, 2007: 85.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Lore Lindu National Park (alt. 1140 m), Poso, Lore Utara, Malewuko, Central Sulawesi, 17 May 2002, on *Onthophagus* sp. [Coleoptera: Scarabaeidae].

### 355. *Macrocheles pipientii* (Berlese, 1882)

*Gamasus tardus* var. *pipientii* Berlese, 1882a: 112.

*Gamasus (Holostaspis) pipientii*.— Berlese, 1882b: 637.

*Holostaspis pipientii*.— Berlese, 1887c: 1, 1892: 70, 1904a: 279 Foà, 1900: 144.

*Macrocheles pipientii*.— Oudemans, 1902a: 44, 1905b: 6; Berlese, 1906: 288; Evans & Browning, 1956: 13; Bregetova & Koroleva, 1960: 138; Evans & Hyatt, 1963: 361; Hirschmann, 1970d: 47; Iavorschi, 1995: 54.

*Macrocheles (Coprholaspis) pipientii*.— Berlese, 1918: 146.

*Coprholaspis pipientii*.— Turk, 1945: 793.

*Macrocheles (Macrocheles) pipientii*.— Krauss, 1970: 17; Karg, 1971: 132, 1993: 106.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Italy, Lido di Venezia, Veneto, date of collection unspecified, on *Scarabaeus (Ateuchetus) semipunctatus* F. [cited as *Atheucus (A. semipunctatus)*] [Coleoptera: Scarabaeidae].

**Note**<sup>1</sup>. Specimen reported by Berlese & Leonardi (1901: 13) as *Holostaspis pipientii* (Berlese) described as *Macrocheles (Coprholaspis) dimidiatus* var. *difficilis* by Berlese (1918: 164).

**Note**<sup>2</sup>. Specimen reported by Hull (1918: 72) as *Macrocheles pipientii* (Berlese) identified as *Macrocheles glaber* (Müller) by Hyatt & Emberson (1988: 105).

### 356. *Macrocheles plateculus* Ma & Wang, 1998

*Macrocheles plateculus* Ma & Wang, 1998: 90.

**Type depository.** National Base of Plague and Brucellosis Control, Baicheng, Jilin, China.

**Type locality and habitat.** China, Taoan (45°46'N; 121°49'E), Jilin, September 1987, in cow dung.

### 357. *Macrocheles plumipes* Hull, 1918

*Macrocheles plumipes* Hull, 1918: 72.

**Type depository.** Natural History Museum, London, England.

**Type locality and habitat.** England, Ninebanks, Northumberland, date of collection unspecified, in manure.

**Note.** Suspected junior synonym of *Glypholaspis americana* (Berlese) by Filipponi & Pegazzano (1960: 148).

**358. *Macrocheles plumosus* Evans & Hyatt, 1963**

*Macrocheles plumosus* Evans & Hyatt, 1963: 364.

*Macrocheles plumosus*.— Hirschmann, 1970d: 51; Hartini *et al.*, 2007: 92.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Malaysian, Sarawak, 28 October 1932, on “Beetle F240” deposited in the collection of coprid beetles of the Department of Entomology, British Museum, London, England.

**359. *Macrocheles podophorae* Chinniah & Mohanasundaram, 1995**

*Macrocheles podophorae* Chinniah & Mohanasundaram, 1995: 219.

**Type depository.** Department of Agricultural Entomology, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, India.

**Type locality and habitat.** India, Coimbatore, Tamil Nadu, 17 March 1988, on *Onitis philemon* F. [Coleoptera: Scarabaeidae].

**360. *Macrocheles polypunctatus* Krantz & Whitaker, 1988**

*Macrocheles polypunctatus* Krantz & Whitaker, 1988: 249.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Lane, Oregon, 22 September 1968, on *Scapanus townsendii* (Bachman) [Mammalia: Eulipotyphla: Talpidae].

**361. *Macrocheles polystichus* Krantz & Whitaker, 1988**

*Macrocheles polystichus* Krantz & Whitaker, 1988: 251.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** USA, Klamath, Oregon, 14 August 1972, on *Thomomys talpoides* Richardson [Mammalia: Rodentia: Geomyidae].

**362. *Macrocheles pori* Iavorschi, 1995**

*Macrocheles pori* Iavorschi, 1995: 55.

**Type depository.** Institut Spéologie “Émile Racovitza”, Bucharest, Romania.

**Type locality and habitat.** Israel, Nahal Betzet (near Eilon), Upper Galilee, 6 June 1990, in litter.

**363. *Macrocheles praedafimetorum* Richards & Richards, 1977**

*Macrocheles praedafimetorum* Richards & Richards, 1977: 711.

*Macrocheles praedafimetorum*.— Krantz & Whitaker, 1988: 251.

**Type depository.** Canadian National Collection, Biosystematics Research Centre, Ottawa, Canada.

**Type locality and habitat.** Canada, Alberta Province (49°20'N, 114°06'W; alt. 1585 m), 16 August 1971, in nest of *Bombus flavifrons* Cresson [Hymenoptera: Apidae].

**364. *Macrocheles propinquus* Halliday, 2005**

*Macrocheles propinquus* Halliday, 2005: 37.

**Type depository.** National Collection of Mites, ARC Plant Protection Research Institute, Pretoria, South Africa.

**Type locality and habitat.** South Africa, Plettenberg Bay (roadside picnic area), 18 August 1994, on clover, grass, capweed.

**365. *Macrocheles pulcher* Berlese, 1918**

*Macrocheles (Coprholaspis) pulcher* Berlese, 1918: 163.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, La Plata, Buenos Aires, date of collection and host/substrate unspecified.

**366. *Macrocheles pumiliosternus* Walter & Krantz, 1986**

*Macrocheles neovernalis*.— Costa, 1975a: 124 [Misidentification, according to Walter & Krantz, 1986b: 287].

*Macrocheles pumiliosternus* Walter & Krantz, 1986b: 287.

**Type depository.** Central African Museum, Tervuren, Belgium.

**Type locality and habitat.** Zaire, Zambezi River, Zaire, December 1929, on *Onitis inversidens* Lansberge [Coleoptera: Scarabaeidae].

**367. *Macrocheles pumilus* Hartini, Dwibadra & Takaku, 2009**

*Macrocheles pumilus* Hartini, Dwibadra & Takaku, 2009: 423.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Mount Merapi National Park, Turgo, Purwobinangun, Pakem, Sleman, Jogjakarta, 13–15 July 2005, on *Onthophagus javanensis* Balthasar [cited as *Onthophagus javensis*] [Coleoptera: Scarabaeidae].

### 368. *Macrocheles punctatissimus* Berlese, 1918

*Macrocheles (Nothrholaspis) punctatissimus* Berlese, 1918: 170.

*Macrocheles (Macrocheles) punctatissimus*.— Krauss, 1970: 20; Karg, 1993: 112.

*Macrocheles punctatissimus*.— Hirschmann, 1970d: 52; Bregetova, 1977: 358; Hyatt & Emberson, 1988: 101; Mašán, 2003: 89; Ács & Kontschán, 2014: 114.

*Nothrholaspis pulcherrimus* Willmann, 1951b: 104 [Synonymy by Krauss, 1970: 20].

*Macrocheles (Macrocheles) pulcherrimus*.— Karg, 1971: 135.

**Type depository.** *M. (N.) punctatissimus*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *N. pulcherrimus*: author's personal collection.

**Type locality and habitat.** *M. (N.) punctatissimus*: Italy, Castions di Strada, Udine, date of collection unspecified, in soil; *N. pulcherrimus*: Austria, Moosbrunn, Bruck an der Leitha, Lower Austria, 7 May 1939, on moss and lawn poppies in a swamp meadow.

### 369. *Macrocheles punctatus* Ishikawa, 1967

*Macrocheles punctatus* Ishikawa, 1967: 151.

**Type depository.** Collection of the Biological Laboratory, Matsuyama Shinonome Junior College, Matsuyama, Japan.

**Type locality and habitat.** Japan, Sugitate, Matsuyama, Ehime Prefecture, Island of Shikoku, 3 July 1966, in litter under the mixed forest.

### 370. *Macrocheles punctoscutatus* Evans & Browning, 1956

*Macrocheles punctoscutatus* Evans & Browning, 1956: 18.

*Macrocheles punctoscutatus*.— Bregetova & Koroleva, 1960: 119; Bregetova, 1977: 374; Hyatt & Emberson, 1988: 88; Mašán, 2003: 100.

*Macrocheles (Macrocheles) punctoscutatus*.— Krauss, 1970: 12; Karg, 1971: 135, 1993: 111.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** England, Churcham, Gloucestershire, 16 May 1954, in nest of mole *Talpa europaea* L. [Mammalia: Eulipotyphla: Talpidae].

**371. *Macrocheles punctosternalis* Roy, 1996**

*Macrocheles punctosternalis* Roy, 1996a: 69.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Luming, Nowgong District, Assam, 28 December 1973, in nest of *Passer domesticus* (L.) [Passeriformes: Passeridae].

**372. *Macrocheles punctovariata* Roy, 1994**

*Macrocheles punctovariata* Roy, 1994: 112.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Karnataka, Bangalore, date of collection unspecified, on *Heliocepris* sp. [Coleoptera: Scarabaeidae].

**373. *Macrocheles punctulatus* (Berlese, 1910)**

*Holostaspis punctulatus* Berlese, 1910: 250.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Indonesia, Java, date of collection unspecified, on *Catharsius* [cited as *Copris*] *molossus* (L.) [Coleoptera: Scarabaeidae].

**374. *Macrocheles pusillus* Berlese, 1918**

*Macrocheles (Coprholaspis) pusillus* Berlese, 1918: 162.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Africa Oriental, date of collection and host/substrate unspecified.

**375. *Macrocheles pustulae* Karg, 1978**

*Macrocheles pustulae* Karg, 1978: 361.

**Type depository.** Museum für Naturkunde, Berlin, Germany.

**Type locality and habitat.** Chile, Azapa Valley, Arica y Parinacota Region, 19 November 1965, in leaf litter.

**376. *Macrocheles pyriformis* Evans & Hyatt, 1963**

*Macrocheles pyriformis* Evans & Hyatt, 1963: 365.

*Macrocheles pyriformis*.— Hirschmann, 1970d: 47.

**Type depository.** British Museum (Natural History), London, England.



**Type locality and habitat.** Lybia, Tripolitania, 1899, on *Mnematium ritchiei* MacLeay [Coleoptera: Scarabaeidae].

**377. *Macrocheles quadriareolatus* Berlese, 1918**

*Macrocheles (Coprholaspis) quadriareolatus* Berlese, 1918: 152.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Brazil, date of collection unspecified, on *Dichotomius mormon* (Ljungh) [cited as *Copris ephialtes* – junior synonym] [Coleoptera: Scarabaeidae].

**378. *Macrocheles quadrilineatus* Roy, 1996**

*Macrocheles quadrilineatus* Roy, 1996b: 271.

**Type depository.** Author's personal collection.

**Type locality and habitat.** India, Zoo Garden, Mysore, Karnataka, 16 March 1980, on *Escarabaeus brahminus* (Castelnau) [cited as *Scarabaeus*] [Coleoptera: Scarabaeidae].

**379. *Macrocheles rettenmeyeri* Krantz, 1962a**

*Macrocheles rettenmeyeri* Krantz, 1962a: 354.

*Macrocheles rettenmeyeri*.— Hirschmann, 1970d: 51.

**Type depository.** United States National Museum of Natural History, Washington, USA.

**Type locality and habitat.** Panama, Barro Colorado Island, Canal Zone, 4 July 1956, on *Eciton dulcius* Forel [Hymenoptera: Formicidae].

**380. *Macrocheles rhodesi* Evans & Hyatt, 1963**

*Macrocheles rhodesi* Evans & Hyatt, 1963: 365.

*Macrocheles rhodesi*.— Hirschmann, 1970d: 48; Walter & Krantz, 1992: 247.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Zimbabwe, Serenje District, 1907, on *Garreta nitens* (Olivier) [Coleoptera: Scarabaeidae].

**381. *Macrocheles rimbija* Halliday, 2000**

*Macrocheles rimbija* Halliday, 2000: 309.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Rimbija Island, Wessel Islands Group, Northern Territory, 14 February 1977, on *Coptodactyla glabricollis* (Hope) [Coleoptera: Scarabaeidae].

### 382. *Macrocheles riparius* Dwibadra & Takaku, 2014

*Macrocheles riparius* Dwibadra & Takaku, in Dwibadra *et al.*, 2014: 50.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Hutan Lindung Sungai Wain, Balikpapan, Kalimantan, 20 December 2006, in residue in vial.

### 383. *Macrocheles robustulus* (Berlese, 1904)

*Holostaspis subbadius* var. *robustus* Berlese, 1904a: 264<sup>Note1</sup>.

*Macrocheles robustulus*.— Axtell, 1961: 748; Filipponi & Pegazzano, 1962b: 230; Axtell, 1963: 631; Krantz & Filipponi, 1964: 40; Costa, 1966b: 533; Hirschmann, 1970a: 44, 1970b: 45, 1970c: 45, 1970d: 48; Krantz, 1972: 271; Bregetova, 1977: 376; Emberson, 1980: 137; Wallace, 1986: 11; Hyatt & Emberson, 1988: 106; Faraji *et al.*, 2008: 235.

*Macrocheles (Macrocheles) robustulus*.— Krauss, 1970: 18; Karg, 1971: 132, 1993: 109.

*Holostapis humeratus* Berlese, 1908: 13 [Synonymy by Filipponi & Pegazzano, 1962b: 234].

*Nothrholaspis punctillatus* Willmann, 1939: 176 [Synonymy by Filipponi, 1959: 210].

*Macrocheles punctillatus*.— Bregetova & Koroleva, 1960: 126.

*Macrocheles coprophila* Womersley, 1942: 167 [Synonymy by Filipponi & Pegazzano 1962b: 234].

*Macrocheles rothamstedensis* Evans & Browning, 1956: 15 [Synonymy by Filipponi, 1959: 210].

*Macrocheles rothamstedensis*.— Balogh, 1958: 256.

**Type depository.** *H. humeratus* and *M. robustulus*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *N. punctillatus*: Institute for Environmental Research, Hamburg, Germany; *M. coprophila*: South Australian Museum, Adelaide, Australia; *M. rothamstedensis*: British Museum (Natural History), London, England.

**Type locality and habitat.** *M. robustulus*: Italy, Imperia [cited as Porto Maurizio], Liguria, date of collection unspecified, in dunghills; *H. humeratus*: South Africa, Cape of Good Hope, date of collection and host/substrate unspecified; *N. punctillatus*: Germany, Hamburg, October 1937, on a rearing of Enchytraeidae [Annelida]; *M.*

*coprophila*: Australia, Bathurst, New South Wales, May 1932, in manure heap; *M. rothamstedensis*: England, Rothamsted Experimental Station, Harpenden, Herts, 1955, from bullock manure.

**Note**<sup>1</sup>. According ICZN Opinion 1638, *rubustulus* is incorrect original spelling of *robustulus*.

**Note**<sup>2</sup>. Specimen reported by Sellnick (1940: 84) as *Holostaspis subbadius* var. *rubustulus* Berlese was identified as *Macrocheles matrius* Hull by Evans & Browning (1956: 34).

#### **384. *Macrocheles roquensis* Mendes & Lizaso, 1992**

*Macrocheles roquensis* Mendes & Lizaso, 1992: 359.

**Type depository.** Instituto Butantan, São Paulo, Brazil.

**Type locality and habitat.** Brazil, São Roque, São Paulo, 1 February 1989, in cattle manure.

#### **385. *Macrocheles rotundiscutis* Bregetova & Koroleva, 1960**

*Macrocheles rotundiscutis* Bregetova & Koroleva, 1960: 116.

*Macrocheles (Macrocheles) rotundiscutis*.— Karg, 1971: 135, 1993: 112.

*Macrocheles rotundiscutis*.— Hirschmann, 1970d: 48; Bregetova, 1977: 373; Krantz & Whitaker, 1988: 255; Hyatt & Emberson, 1988: 88; Mašán, 2003: 99; Kontschán, 2005: 78.

*Macrocheles (Macrocheles) bombophilus* Götz, in Krauss, 1970: 28 [Synonymy by Hyatt & Emberson, 1988: 88].

*Macrocheles bombophilus*.— Hirschmann, 1970d: 48.

**Type depository.** *M. rotundiscutis*: Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia; *M. (M.) bombophilus*: Unspecified.

**Type locality and habitat.** *M. rotundiscutis*: Russia, Saint Petersburg, 8 June 1957, from compost heap; *M. (M.) bombophilus*: Germany, Erlangen, Bavaria, date of collection unspecified, in rotten potatoes and in nest of *Bombus terrestris* (L.) [Hymenoptera: Apidae].

#### **386. *Macrocheles rykei* Evans & Hyatt, 1963**

*Macrocheles rykei* Evans & Hyatt, 1963: 369.

*Macrocheles rykei*.— Hirschmann, 1970d: 48.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** South Africa, Cape Town, date of collection unspecified, on *Kheper bonellii* MacLeay [Coleoptera: Scarabaeidae].

**387. *Macrocheles saceri* Costa, 1967**

*Macrocheles saceri* Costa, 1967: 315.

*Macrocheles saceri*.— Hirschmann, 1970d: 47; Bregetova, 1977: 371; Iavorschi, 1995: 55.

*Macrocheles (Macrocheles) saceri*.— Karg, 1993: 106.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Israel, Na'aman Dunes, 13 July 1962, on *Scarabaeus sacer* L. [Coleoptera: Scarabaeidae].

**388. *Macrocheles samarensis* Takaku, Hartini, Dwibadra & Corpuz-Raros, 2012**

*Macrocheles samarensis* Takaku, Hartini, Dwibadra & Corpuz-Raros, 2012: 118.

**Type depository.** Zoological Collections of the Graduate School of Science, Hokkaido University, Sapporo, Japan.

**Type locality and habitat.** Philippines, north of Libungon Creek, San Rafael, Taft, Samar Island, 29 October 2001, on moss from lowland dipterocarp forest [Dipterocarpaceae].

**389. *Macrocheles scarabae* Vishnupriya & Mohanasundaram, 1988**

*Macrocheles scarabae* Vishnupriya & Mohanasundaram, 1988: 248.

**Type depository.** Department of Agricultural Entomology, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, India.

**Type locality and habitat.** India, Coimbatore, Tamil Nadu, 20 October 1984, on *Catharsius pithecius* (F.) [Coleoptera: Scarabaeidae].

**Note.** Senior homonym of *Macrocheles scarabae* Chinniah & Mohanasundaram, 1995 [now *Macrocheles arabaesc* Takaku & Hartini, 2001].

**390. *Macrocheles schaeferi* Walter, 1988**

*Macrocheles schaeferi* Walter, 1988: 386.

**Type depository.** United States National Museum of Natural History, Washington, USA.

**Type locality and habitat.** USA, above Gordon Creek (alt. 2100m), north of Poudre Park, Colorado, 03 June 1987, in sod on an open grassy hillside.

**391. *Macrocheles scutatiformis* Petrova, 1967**

*Macrocheles scutatiformis* Petrova, 1967c: 1041.

*Macrocheles scutatiformis*.— Hirschmann, 1970d: 49; Bregetova, 1977: 364.

**Type depository.** Department of Entomology, Moscow State University, Moscow, Russia.

**Type locality and habitat.** South of Turkmenistan, date of collection unspecified, in old rhizomes of *Ferula* sp. [Apiaceae].

**392. *Macrocheles scutatus* (Berlese, 1904)**

*Holostaspis subbadius* var. *scutatus* Berlese, 1904a: 264.

? *Macrocheles scutatus* [sic].— Filipponi, 1959: 212.

*Macrocheles scutatus*.— Filipponi, 1962: 129; Filipponi & Pegazzano, 1962b: 228; Petrova, 1967c: 1037; Hirschmann, 1970d: 48; Emberson, 1973a: 121, 1980: 137; Bregetova, 1977: 379; Hyatt & Emberson, 1988: 110; Walter & Krantz, 1992: 243; Mašán, 2003: 113; Faraji *et al.*, 2008: 235; Takaku *et al.*, 2012: 114.

*Macrocheles (Macrocheles) scutatus*.— Karg, 1993: 111.

*Macrocheles subbadius*.— Evans & Browning, 1956: 19; Bregetova & Koroleva, 1960: 132 [Misidentifications, according to Filipponi & Pegazzano, 1962b: 228].

*Macrocheles subbadius*.— Petrova, 1960: 399, 1964: 553 [Misidentifications, according to Petrova, 1967c: 1037].

*Macrocheles (Macrocheles) subbadius*.— Krauss, 1970: 16; Karg, 1971: 134 [Misidentifications, according to Halliday, 2000: 315].

*Macrocheles (Macrocheles) willmanni* Krauss, 1970: 23 [Synonymy by Bregetova, 1977: 379].

*Macrocheles willmanni*.— Hirschmann, 1970d: 48.

**Type depository.** *M. scutatus*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. willmanni*: unspecified.

**Type locality and habitat.** *M. scutatus*: Italy, Udine, date of collection unspecified, in dunghills; *M. willmanni*: “Bill Heller West” [sic], date of collection and host/substrate unspecified.

**Note.** Suspected senior synonym of *Macrocheles vicinus* Leitner by Filipponi & Pegazzano, 1962b: 228.

**393. *Macrocheles seraphim* Niogret & Nicot, 2007**

*Macrocheles seraphim* Niogret & Nicot, *in* Niogret *et al.* 2007: 22.

**Type depository.** Muséum National d’Histoire Naturelle de Paris, Paris, France.

**Type locality and habitat.** France, Trucy l’Orgueilleux (47°45’N, 3°41’E; alt. 160 m), April 2006, on *Geotrupes mutator* (Marsham) [Coleoptera: Geotrupidae].

**394. *Macrocheles serratus* Ishikawa, 1968**

*Macrocheles serratus* Ishikawa, 1968: 201.

*Macrocheles serratus*.— Hirschmann, 1970d: 48.

**Type depository.** Collection of the Biological Laboratory, Matsuyama Shinonome Junior College, Matsuyama, Japan.

**Type locality and habitat.** Japan, Oonogahara, Shikoku, 6 August 1952, on *Phelotrupes* [cited as *Geotrupes*] *laevistriatus* (Motschulsky) [Coleoptera: Geotrupidae].

**395. *Macrocheles siderolophus* Halliday, 2000**

*Macrocheles siderolophus* Halliday, 2000: 311.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, 14 km east-northeast of Mount Tozer, Iron Range, Queensland, June 1986, in trap baited with human faeces.

**396. *Macrocheles sikkimensis* Roy, 1996**

*Macrocheles sikkimensis* Roy, 1996a: 70.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Gangtok, Sikkim, 10 November 1977, on *Kheper* [cited as *Scarabaeus*] *erichsoni* (Harold) [Coleoptera: Scarabaeidae].

**397. *Macrocheles similis* Krantz & Filipponi, 1964**

*Macrocheles similis* Krantz & Filipponi, 1964: 37.

*Macrocheles similis*.— Hirschmann, 1970d: 48; Halliday, 1990a: 422.

**Type depository.** South Australian Museum, Adelaide, Australia.

**Type locality and habitat.** Australia, Rockhampton, Queensland, 1951, from unspecified host/substrate.

**398. *Macrocheles simplisetosus* Arriaga & Bertrand, 2014**

*Macrocheles simplisetosus* Arriaga & Bertrand, in Arriaga-Jimenez *et al.*, 2014: 374.

**Type depository.** Colección Nacional de Acaros, Instituto de Biología, Departamento de Zoología, Universidad Nacional Autónoma de México (UNAM), Mexico city, Mexico.

**Type locality and habitat.** Mexico, Xalapa (19°31'32"N, 96°55'23"W; alt. 1400 m), Veracruz, June 2012, on *Onthophagus incensus* Say [Coleoptera: Scarabaeidae] collected in an urban vegetation.

**399. *Macrocheles simplissimus* Arriaga & Bertrand, 2014**

*Macrocheles (dimidiatus) simplissimus* Arriaga & Bertrand, in Arriaga-Jimenez *et al.*, 2014: 372.

**Type depository.** Colección Nacional de Acaros, Instituto de Biología, Departamento de Zoología, Universidad Nacional Autónoma de México (UNAM), Mexico City, Mexico.

**Type locality and habitat.** Mexico, Cofre de Perote (18°59'25.9"N, 97°24.26'W; alt. 3237 m), near Carabinas, Xico, Veracruz, July 2012, on *Halffterius rufoclavatus* (Jekel) [Coleoptera: Geotrupidae] collected in a shrubland surrounded by *Pinus teocote* [Pinaceae].

**400. *Macrocheles simulans* Hartini, Dwibadra & Takaku, 2007**

*Macrocheles simulans* Hartini, Dwibadra & Takaku, 2007: 87.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Lore Lindu National Park (alt. 560 m), Donggala, Kulawi, Bulu Momi, Central Sulawesi, 11 May 2002, on *Onthophagus* sp. [Coleoptera: Scarabaeidae].

**401. *Macrocheles sisiri* Roy, 1994**

*Macrocheles sisiri* Roy, 1994: 116.

**Type depository.** Zoological Survey of India, Kolkata, India.

**Type locality and habitat.** India, Karnataka, Bangalore, date of collection unspecified, on *Copris* sp. [Coleoptera: Scarabaeidae] deposited in the collection of the Entomology Department, University of Agricultural Sciences, Bangalore, Karnataka, India.

**402. *Macrocheles slovacus* Mašán & Fenda, 2003**

*Macrocheles slovacus* Mašán & Fenda, in Mašán, 2003: 119.

**Type depository.** Institute of Zoology, Slovak Academy of Sciences, in author's personal collection.

**Type locality and habitat.** Slovakia, Podunajská Rovina Flatland, Svätý Jur, 10 June 1998, in nest of *Fulica atra* (L.) [Aves: Rallidae].

**403. *Macrocheles somalicus* Berlese, 1918**

*Macrocheles (Coprholaspis) somalicus* Berlese, 1918: 148.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Somalia, Mogadiscio, date of collection unspecified, on *Copris* sp. [Coleoptera: Scarabaeidae].

**404. *Macrocheles spatei* Halliday, 2000**

*Macrocheles spatei* Halliday, 2000: 312.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Deua National Park, Deua Cave, New South Wales, 5 May 1986, in bat guano.

**405. *Macrocheles spectandus* Berlese, 1918**

*Macrocheles (Coprholaspis) spectandus* Berlese, 1918: 151.

*Macrocheles spectandus*.— Evans & Hyatt, 1963: 398; Hirschmann, 1970d: 49.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, Alto Pencoso, Province of San Luis [cited as S. Louis], date of collection unspecified, on *Eudinopus dytiscoides* (Schreibers) [Coleoptera: Scarabaeidae].

**406. *Macrocheles spickai* Krantz & Whitaker, 1988**

*Macrocheles spickai* Krantz & Whitaker, 1988: 255.

**Type depository.** United States Nacional Museum, Washington, USA.

**Type locality and habitat.** USA, Orchard Farm, Saint Charles, Missouri, 24 May 1973, on *Geomys bursarius* (Shaw) [Mammalia: Rodentia: Geomyidae].

**407. *Macrocheles spiculatus* Halliday, 2000**

*Macrocheles spiculatus* Halliday, 2000: 313.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Lamington National Park, Queensland, 13 January 1995, in litter of *Asplenium australicum* [Aspleniaceae].



**408. *Macrocheles spinipes* (Say, 1821)**

*Gamasus spinipes* Say, 1821: 71.

*Nothrolaspis spinipes*.— Oudemans, 1936: 186.

*Macrocheles spinipes*.— Hennessey & Farrier, 1988: 22.

**Type depository.** Unspecified.

**Type locality and habitat.** USA, date of collection and host/substrate unspecified.

**Note.** Senior homonym of *Macrocheles (Coprholaspis) spinipes* Berlese, 1918: 160 [now *Macrocheles berlesei* Hennessey & Farrier, 1988].

**409. *Macrocheles spinosissima* (Berlese, 1916)**

*Holostaspella spinosissima* Berlese, 1916b: 154.

*Macrocheles spinosissima*.— Filipponi & Pegazzano, 1967: 220; Krantz, 1967c: 143; Hirschmann, 1970d: 51.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Argentina, Río Cuarto, Cordoba, date of collection unspecified, on Scarabaeidae [Coleoptera].

**410. *Macrocheles spinosus* Berlese, 1918**

*Macrocheles (Coprholaspis) spinosus* Berlese, 1918: 162.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Brazil, “Alto Paraná”, date of collection unspecified, on *Coprophanaeus (Coprophanaeus) milon* (Blanchard) [cited as *Phanaeus milo*] [Coleoptera: Scarabaeidae].

**411. *Macrocheles sternalis* Evans & Hyatt, 1963**

*Macrocheles sternalis* Evans & Hyatt, 1963: 369.

*Macrocheles sternalis*.— Hirschmann, 1970d: 52.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Zimbabwe, date of collection unspecified, on *Sceliages augias* Gillet [Coleoptera: Scarabaeidae].

**412. *Macrocheles subbadius* (Berlese, 1904)**

*Gamasus tardus*.— Berlese, 1882a: 105.

*Holostaspis marginatus*.— Berlese, 1889: 6<sup>Note1</sup>.

*Holostaspis subbadius* Berlese, 1904a: 264<sup>Note2</sup>.

*Macrocheles subbadius*.— Filipponi & Seganti, 1957: 27; Axtell, 1961: 748; Filipponi & Pegazzano, 1963: 73; Axtell, 1963a: 630; Petrova, 1967b, 1039; Athias-Henriot, 1968: 269; Hirschmann, 1970d: 46; Bregetova, 1977: 354; Emberson, 1980: 137; Wallace, 1986: 12; Hyatt & Emberson, 1988: 111; Mašán, 2003: 115; Hartini *et al.*, 2007: 92; Faraji *et al.*, 2008: 234.

*Macrocheles (Macrocheles) subbadius*.— Karg, 1993: 109.

*Macrocheles situs* Karg, 1978: 364<sup>Note3</sup> [Synonymy by Krantz & Whitaker, 1988: 257].

**Type depository.** *M. subbadius*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. situs*: Ungarischen Naturwissenschaftliches Museum, Budapest, Hungary.

**Type locality and habitat.** *M. subbadius*: Italy, Padua, 1882, in dunghill [lectotype designated by Filipponi & Pegazzano, 1963: 73]; *M. situs*: Germany, Manschnow, Küstriner Vorland, Märkisch-Oderland, Brandenburg, 9 June 1962, in dunghill of the Cooperative of horticultural production "Oderbruch".

**Note<sup>1</sup>.** Identified on the basis of specimens reported by Berlese (1882a: 105) as "ninfabontomorfa femmina" of *Gamasus tardus* Koch.

**Note<sup>2</sup>.** Described on the basis of specimens reported by Berlese (1889: 6) as *Holostaspis marginatus* (Hermann).

**Note<sup>3</sup>.** Described on the basis of specimens reported by Schweizer (1961) and Karg (1971: 172) as *Macrocheles (Macrocheles) vernalis* (Berlese).

**Note<sup>4</sup>.** Specimens reported by Evans & Browning (1956: 19) and Bregetova & Koroleva (1960: 132) as *Macrocheles subbadius* (Berlese) identified as *Macrocheles scutatus* (Berlese) by Filipponi & Pegazzano (1962b: 228).

**Note<sup>5</sup>.** Specimens reported by Krauss (1970: 16) and Karg (1971: 134) as *Macrocheles (Macrocheles) subbadius* (Berlese) were identified as *Macrocheles scutatus* (Berlese) by Halliday (2000: 315).

**Note<sup>6</sup>.** Lombardini (1960: 255) described *Macrocheles subbadius* var. *evorensis* n. var. This name similarly has no nomenclatural status and is not listed in the catalogue.

#### **413. *Macrocheles sublaevis* Banks, 1914**

*Macrocheles sublaevis* Banks, 1914: 59.

*Macrocheles sublaevis*.— Hennessey & Farrier, 1988: 21.

**Type depository.** Museum of Comparative Zoology, Harvard University, Cambridge, USA.

**Type locality and habitat.** USA, Cedar Point, Sandusky, Ohio, June 1912, on *Tomarus* [cited as *Ligyris*] *relictus* (Say) [Coleoptera: Dynastidae] and on *Bolitotherus* [cited as *Boletotherus*] *bifurcus* (F.) [Coleoptera: Tenebrionidae] [Lectotype designated by Hennessey & Farrier, 1988: 21].

**414. *Macrocheles subscutatus* Walter & Krantz, 1992**

*Macrocheles subscutatus* Walter & Krantz, 1992: 244.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** South Africa, Potchefstroom, Transvaal, January 1953, on *Onthophagus gazella* Heyden [Coleoptera: Scarabaeidae].

**415. *Macrocheles substitutus* Berlese, 1920**

*Macrocheles (Coprholaspis) substitutus* Berlese, 1920: 189.

*Coprholaspis substitutus*.— Vitzthum, 1931b: 65.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Asia? [sic], date of collection unspecified, on *Catharsius* [cited as *Copris*] *molossus* (L.) [Coleoptera: Scarabaeidae].

**416. *Macrocheles subterraneus* Ishikawa, 1980**

*Macrocheles subterraneus* Ishikawa, 1980: 45.

**Type depository.** Biological Laboratory of Matsuyama Shinonome Junior College, Matsuyama, Japan.

**Type locality and habitat.** Japan, Ganigoé-no-kanauo, Okuôdô, Towa, Kôchi Prefecture, Island of Shikoku, 18 July 1978, from abandoned mine adits.

**417. *Macrocheles sukabumiensis* Hartini & Takaku, 2003**

*Macrocheles sukabumiensis* Hartini & Takaku, 2003c: 1269.

*Macrocheles sukabumiensis*.— Hartini *et al.*, 2007: 92.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Mount Gede Pangrango National Park (alt. 900 m), Bodogol, Cicurug, Sukabumi, Bogor, West Java, 7–9 July 2001, on *Onthophagus* sp. [Coleoptera: Scarabaeidae].

**418. *Macrocheles sukaramiensis* Takaku, 2001**

*Macrocheles sukaramiensis* Takaku, 2001: 502.

*Macrocheles sukaramiensis*.— Hartini *et al.*, 2007: 78; Hartini *et al.*, 2009: 421.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Indonesia, Sukarami, Sumatera Barat, 14 November 1996, on *Catharsius molossus* (L.) [Coleoptera: Scarabaeidae].

**419. *Macrocheles sumbaensis* Hartini & Takaku, 2005**

*Macrocheles sumbaensis* Hartini & Takaku, *in* Hartini *et al.*, 2005: 206.

*Macrocheles sumbaensis*.— Hartini *et al.*, 2007: 93.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Watumbaka, Pandawai, East Sumba, Sumba Island, 30 January 2003, on *Aphodius* sp. [Coleoptera: Aphodiidae].

**420. *Macrocheles tantalus* Walter & Krantz, 1986**

*Macrocheles tantalus* Walter & Krantz, 1986: 213.

**Type depository.** United States National Museum of Natural History, Washington, USA.

**Type locality and habitat.** Hawaii, Mount Tantalus, Honolulu, 5 October 1963, under a rotting avocado, *Persea americana* Mill [Lauraceae].

**421. *Macrocheles telamoni* Evans & Hyatt, 1963**

*Macrocheles telamoni* Evans & Hyatt, 1963: 372.

*Macrocheles telamoni*.— Hirschmann, 1970d: 51.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Panama, Volcan de Chiriquí, date of collection unspecified, on *Coprophanaeus telemon* Erichson [Coleoptera: Scarabaeidae].

**422. *Macrocheles tenuirostris* Krantz & Filipponi, 1964**

*Macrocheles (Nothrholaspis) ? montivagus*.— Womersley, 1955: 413

*Macrocheles tenuirostris* Krantz & Filipponi, 1964: 46.

*Macrocheles tenuirostris*.— Hirschmann, 1970d: 51.

**Type depository.** South Australian Museum, Adelaide, Australia.

**Type locality and habitat.** Australia, Fisher Island, Bass Strait, 2 February 1953, in burrows and nests of *Ardenna* [cited as *Puffinus*] *tenuirostris* (Temminck) [Aves: Procellariidae].

**Note<sup>1</sup>.** Described on the basis of specimens reported by Womersley (1955: 413) as *Macrocheles (Nothrholaspis) ? montivagus* (Berlese).

**Note<sup>2</sup>.** Specimens reported by Costa (1975b: 263) and Monteith & Storey (1981: 267) as *Macrocheles tenuirostris* Krantz & Filipponi identified as *Macrocheles tessellatus* Halliday by Halliday (2000: 315).

**423. *Macrocheles tessellatus* Halliday, 2000**

*Macrocheles tenuirostris*.— Costa, 1975b: 263 and Monteith & Storey, 1981: 267  
[Misidentifications, according to Halliday, 2000: 316].

*Macrocheles tessellatus* Halliday, 2000: 316.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Mount Tiptree, Queensland, 13 July 1984, in dung baited trap.

**424. *Macrocheles thomasseti* Evans & Hyatt, 1963**

*Macrocheles thomasseti* Evans & Hyatt, 1963: 372.

*Macrocheles thomasseti*.— Hirschmann, 1970d: 47.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** South Africa, Sterkfontein, Transvaal, date of collection unspecified, on *Scarabaeus gangeticus* Castelnau [Coleoptera: Scarabaeidae].

**425. *Macrocheles timikaensis* Hartini & Takaku, 2006**

*Macrocheles timikaensis* Hartini & Takaku, 2006a: 39.

*Macrocheles timikaensis*.— Hartini *et al.*, 2007: 94; Hartini, 2008: 13.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, site of Freeport Indonesia Company, Tembagapura, Timika, Fakfak, Papua, 11 March 1977, on *Onthophagus* sp. [Coleoptera: Scarabaeidae] deposited in the Museum Zoologicum Bogoriense.

**426. *Macrocheles transbaicalicus* Bregetova & Koroleva, 1960**

*Macrocheles transbaicalicus* Bregetova & Koroleva, 1960: 128.

*Macrocheles transbaicalicus*.— Bregetova, 1977: 377.

*Macrocheles tranbaicalicus* [sic].— Hirschmann, 1970d: 50.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Russia, Baikal, 1956, on carrion beetle and on *Ochotona dauurica* (Pallas) [Mammalia: Lagomorpha: Ochotonidae].

**427. *Macrocheles transmigrans* Petrova & Tascava, 1964**

*Macrocheles transmigrans* Petrova & Tascava, 1964: 52.

**Type depository.** Department of Entomology, Moscow State University, Moscow, Russia.

**Type locality and habitat.** China, Western Mountains (alt. 2100 m), near Kunming, Yunnan, 2 October 1958, on scarab beetle [Coleoptera: Scarabaeidae].

**428. *Macrocheles transvaalensis* Ryke & Meyer, 1958**

*Macrocheles transvaalensis* Ryke & Meyer, 1958: 142.

**Type depository.** Institute for Zoological Research of the Potchefstroom University, Potchefstroom, South Africa.

**Type locality and habitat.** South Africa, Potchefstroom, March 1953, on *Heliocopris hamadryas* F. [Coleoptera: Scarabaeidae].

**429. *Macrocheles transversus* Evans & Hyatt, 1963**

*Macrocheles transversus* Evans & Hyatt, 1963: 375.

*Macrocheles transversus*.— Hirschmann, 1970d: 48.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Uganda, Entebbe, date of collection unspecified, on *Garreta unicolor* Fahraeus [Coleoptera: Scarabaeidae].

**430. *Macrocheles tridentatus* Pearse & Wharton, 1936**

*Macrocheles tridentatus* Pearse & Wharton, in Pearse *et al.*, 1936: 473.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** England, Duke Forest, Durham, 7 June and 17 September 1933, on *Passalus cornutus* F. [Coleoptera: Passalidae].

**Note.** Specimen reported by Delfinado & Baker (1975: 53) as *Macrocheles tridentatus* Pearse & Wharton, 1936 identified as *Macrocheles mammifer* Berlese, 1918 by Krantz & Whitaker (1988: 236).

**431. *Macrocheles trinitatis* (Turk, 1948)**

*Andrholaspis trinitatis* Turk, 1948: 103.

*Macrocheles trinitatis*.— Krantz, 1962b: 146.

**Type depository.** Unspecified.

**Type locality and habitat.** Trinidad & Tobago, Saint Augustine, 13 October 1945, from a scarabaeid beetle.

**432. *Macrocheles trogicolis* Mašán, 1994**

*Macrocheles trogicolis* Mašán, 1994: 349.

*Macrocheles trogicolis*.— Mašán, 2003: 92.

**Type depository.** Institute of Zoology and Ecosozology of the Slovak Academy of Sciences, Bratislava, Slovakia.

**Type locality and habitat.** Slovakia, Jakubov (Záhorská nizina lowland), Malacky, 21 July 1992, on *Trox sabulosus* (L.) [Coleoptera: Trogidae] in decaying felt.

**433. *Macrocheles turgoensis* Hartini, Dwibadra & Takaku, 2009**

*Macrocheles turgoensis* Hartini, Dwibadra & Takaku, 2009: 421.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Mount Merapi National Park, Turgo, Purwobinangun, Pakem, Sleman, Jogjakarta, 13-15 July 2005, on *Onthophagus javanensis* Balthasar [cited as *Onthophagus javensis*] [Coleoptera: Scarabaeidae].

**434. *Macrocheles undoolya* Halliday, 2000**

*Macrocheles undoolya* Halliday, 2000: 317.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, 30 km east of Alice Springs, Undoolya Station, Northern Territory, 4 March 1982, in dung baited pitfall trap.

**435. *Macrocheles upsilon* Halliday, 2000**

*Macrocheles upsilon* Halliday, 2000: 319.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, 22 km southwest of Merriwa, New South Wales, 6 January 1977, in cattle dung.

**436. *Macrocheles uroxys* Krantz, 1983**

*Macrocheles uroxys* Krantz, 1983: 8.

**Type depository.** Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil.

**Type locality and habitat.** Brazil, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, 28 May 1978, on *Uroxys besti* Ratcliffe [Coleoptera: Scarabaeidae] collected on *Bradypus tridactylus* L. [Mammalia: Pilosa: Bradypodidae].

**437. *Macrocheles validus* Berlese, 1918**

*Macrocheles (Coprholaspis) validus* Berlese, 1918: 150.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Ethiopia, date of collection unspecified, on *Copris cornifrons* Boheman [cited as *Copris achates* Péringuey – junior synonymy] [Coleoptera: Scarabaeidae].

**438. *Macrocheles variodecoratus* Hartini, Dwibadra & Takaku, 2007**

*Macrocheles variodecoratus* Hartini, Dwibadra & Takaku, 2007: 87.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Lore Lindu National Park, Saluku, Central Sulawesi, 19 October 2002, on *Copris* sp. [Coleoptera: Scarabaeidae].

**439. *Macrocheles vernalis* (Berlese, 1887)**

*Holostaspis vernalis* Berlese, 1887c: 1.

*Holostaspis vernalis*.— Berlese, 1892: 70.

*Macrocheles vernalis*.— Oudemans, 1905b: 6; Evans & Hyatt, 1963: 375; Petrova & Tascava, 1968: 1179; Hirschmann, 1970d: 48; Bregetova, 1977: 377; Faraji *et al.*, 2008: 235.

*Macrocheles (Coprholaspis) vernalis*.— Berlese, 1918: 146.

*Macrocheles (Macrocheles) vernalis*.— Krauss, 1970: 16; Karg, 1993: 111.

*Macrocheles siculus* Oudemans, 1905b: 7 [Synonymy by Berlese, 1916a: 67].

*Macrocheles siculus*.— Oudemans, 1915b: 125.

**Type depository.** *M. vernalis*: Istituto Sperimentale per la Zoologia Agraria, Florence, Italy; *M. siculus*: National Museum of Natural History - Naturalis, Leiden, Netherlands.

**Type locality and habitat.** *M. vernalis*: Italy, Veneto, date of collection unspecified, on *Scarabaeus semipunctatus* F. [cited as *Atheuci semipunctati*] [Coleoptera:



Scarabaeidae]; Italy, Calabria, date of collection unspecified, on *Scarabaeus semipunctatus* F. [cited as *Atheuci semipunctati*] [Coleoptera: Scarabaeidae]; *M. siculus*: Italy, Catania, Sicily, October 1901, on *S. semipunctatus*.

**Note.** Specimens reported by Schweizer (1961: 80) and Karg (1971: 172) as *Macrocheles* (*Macrocheles*) *vernalis* (Berlese) described as *Macrocheles situs* by Karg (1978: 364).

**440. *Macrocheles verticalis* Evans & Hyatt, 1963**

*Macrocheles verticalis* Evans & Hyatt, 1963: 378.

*Macrocheles verticalis*.— Hirschmann, 1970d: 49.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Venezuela, El Zumbador, date of collection unspecified, on *Dichotomius carolinus* (L.) [Coleoptera: Scarabaeidae].

**441. *Macrocheles vespillo* Berlese, 1918**

*Macrocheles* (*Copropholaspis*) *vespillo* Berlese, 1918: 164.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** North America, date of collection unspecified, on *Nicrophorus carolinus* L. [cited as *Nicrophorus mediatum* F. – junior synonym] [Coleoptera: Silphidae].

**442. *Macrocheles vicinus* Leitner, 1946**

*Macrocheles vicinus* Leitner, 1946: 148.

*Macrocheles* (*Macrocheles*) *vicinus*.— Krauss, 1970: 16.

**Type depository.** Unspecified.

**Type locality and habitat.** Austria, Grosser Bösenstein (alt. 2,448 m), Lower Tauern, Styria, date of collection unspecified, on compost.

**Note.** Suspected junior synonym of *Macrocheles scutatus* (Berlese, 1904) by Filipponi & Pegazzano (1962b: 228).

**443. *Macrocheles violetae* Arriaga & Bertrand, 2014**

*Macrocheles* (*dimidiatus*) *violetae* Arriaga & Bertrand, in Arriaga-Jimenez *et al.*, 2014: 371.

**Type depository.** Colección Nacional de Acaros, Instituto de Biología, Departamento de Zoología, Universidad Nacional Autónoma de México (UNAM), Mexico city, Mexico.

**Type locality and habitat.** Mexico, Sierra Negra (18°59'25.9''N, 97°24.26'W; alt. 2766 m), Ciudad Serdan, Puebla, June 2012, on *Copris armatus* Harold [Coleoptera: Scarabaeidae] collected from a *Pinus* [Pinaceae] and *Cupressus* [Cupressaceae] forest.

**444. *Macrocheles virgo* Halliday, 1993**

*Macrocheles virgo* Halliday, 1993: 104.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, 45 km north of Cairns, Cook Highway, Queensland, 13 January 1991, in sandy littoral rainforest litter.

**445. *Macrocheles voigtsi* Oudemans, 1905**

*Macrocheles voigtsi* Oudemans, 1905a: 236.

*Macrocheles voigtsi*.— Oudemans, 1915b: 128.

**Type depository.** unspecified.

**Type locality and habitat.** Togo, date of collection unspecified, on *Zonabris* sp. [Coleoptera: Meloidae].

**446. *Macrocheles vulgaris* Petrova & Tascava, 1968**

*Macrocheles vulgaris* Petrova & Tascava, 1968: 1181.

*Macrocheles vulgaris*.— Hirschmann, 1970d: 48.

**Type depository.** Department of Entomology, Moscow State University, Moscow, Russia.

**Type locality and habitat.** China, Simao, Pu'er Prefecture, Yunnan, 7 November 1958, on dungbeetle [Coleoptera: Scarabaeidae].

**447. *Macrocheles waigeoensis* Hartini, 2008**

*Macrocheles waigeoensis* Hartini, 2008: 17.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Wai Rabi, Lopintol, Raja Ampat, Waigeo Island, West Papua, 1–2 June 2007, on *Onthophagus* sp. [Coleoptera: Scarabaeidae].

**448. *Macrocheles wainensis* Dwibadra & Takaku, 2014**

*Macrocheles wainensis* Dwibadra & Takaku, in Dwibadra *et al.*, 2014: 50.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Hutan Lindung Sungai Wain, Balikpapan, Kalimantan, 20 December 2006, on *Proagoderus dives* Harold [cited as *Onthophagus semicupreus* - junior synonymy] [Coleoptera: Scarabaeidae].

**449. *Macrocheles waitei* Halliday, 2000**

*Macrocheles waitei* Halliday, 2000: 320.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Cawarral, Queensland, 13 September 1992, on rotting banana.

**450. *Macrocheles wallacei* Halliday, 2000**

*Macrocheles wallacei* Halliday, 2000: 320.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, near Batemans Bay, Tomakin, New South Wales, 17 December 1986, in wallaby dung [Mammalia: Diprotodontia].

**451. *Macrocheles wenpingi* Samšičák, 1964**

*Macrocheles wenpingi* Samšičák, 1964: 33.

*Macrocheles wenpingi*.— Hirschmann, 1970d: 50.

**Type depository.** Institute of Zoology Chinese Academic of Sciences, Beijing, China.

**Type locality and habitat.** China, Kao-Ho, Guangdong, 1963, in nest of *Coptotermes formosanus* Shiraki [Isoptera: Rhinotermitidae], associated with phorid [Diptera] species.

**452. *Macrocheles witcoskyanus* Walter & Krantz, 1986**

*Macrocheles witcoskyanus* Walter & Krantz, 1986b: 284.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Cameroons, Sanaga River, April 1974, on *Goliathus goliathus* Drury [Coleoptera: Scarabaeidae: Cetoninae].

**453. *Macrocheles woroae* Hartini & Takaku, 2006**

*Macrocheles woroae* Hartini & Takaku, 2006a: 43.

*Macrocheles woroae*.— Hartini *et al.*, 2007: 94.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, site of Freeport Indonesia Company, Tembagapura, Timika, Fakfak, Papua, 11 March 1977, on *Onthophagus* sp. [Coleoptera: Scarabaeidae].

**454. *Macrocheles zaheri* Nawar, 1995**

*Macrocheles zaheri* Nawar, 1995: 98.

**Type depository.** Faculty of Agriculture, Cairo University Collection, Giza, Egypt.

**Type locality and habitat.** Egypt, Faculty of Agriculture, Cairo University, Giza, date of collection unspecified, in compost on the farm of the Faculty of Agriculture.

**455. *Macrocheles zeta* Halliday, 2000**

*Macrocheles zeta* Halliday, 2000: 322.

**Type depository.** Australian National Insect Collection, Canberra, Australia.

**Type locality and habitat.** Australia, Burdekin Rural Education Centre, 6 km northwest of Clare, Queensland, 7 December 1985, in dung.

**456. *Macrocheles zumpti* Ryke, 1959**

*Macrocheles zumpti* Ryke, 1959: 14.

**Type depository.** Museu Dr. Alvaro de Castro, Maputo, Mozambique.

**Type locality and habitat.** Mozambique, Tinonganine, Maputo, March 1958, on *Catharsius tricornutus* (DeGeer) [Coleoptera: Scarabaeidae].

**Genus *Neopodocinum* Oudemans, 1902**

*Neopodocinum* Oudemans, 1902a: 24.

Type species: *Neopodocinum jaspersi* Oudemans, 1902, by monotypy.

*Neopodocinum*.— Oudemans, 1903: 100, 1904b: 115; Berlese, 1922: 98; Evans, 1956: 351; Krantz, 1962b: 157, 1965a: 149; Hirschmann, 1970a: 44; Karg, 1971: 130, 1993: 98; Mašán, 2003: 41.

*Coprolaelaps* Berlese, 1908: 13 [Junior synonymy by Krantz, 1965a: 149].

Type species: *Coprolaelaps caputmedusae* Berlese, 1908, by original designation.

*Cosmiphis* Vitzthum, 1925: 33 [Junior synonymy by Hartini & Takaku, 2004: 78].

Type species: *Emeus bosschai* Oudemans, 1902, by monotypy.

*Beaurieuia* Oudemans, 1929a: 476 [Junior synonymy by Bregetova, 1977: 405].

Type species: *Neopodocinum nederveeni* Oudemans, 1903, by original designation.

**457. *Neopodocinum afrum* Berlese, 1916**

*Neopodocinum afrum* Berlese, 1916b: 153.

*Neopodocinum afrum*.— Berlese, 1922: 153; Krantz, 1965a: 153; Costa, 1975a: 126.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Kenya [cited as Africa orientali Anglica], Rendilé [cited as Lesammise Rendilé], date of collection and host/substrate unspecified.

**458. *Neopodocinum bartkei* Micherdzinski, 1964**

*Neopodocinum bartkei* Micherdzinski, 1964: 229.

*Neopodocinum bartkei*.— Krantz, 1965a: 158.

**Type depository.** Zoological Museum of the Jagiellonian University, Kraków, Poland.

**Type locality and habitat.** Vietnam, surroundings of the Geophysical Station, Sa Pa, 2–19 March 1961, on *Copris* sp. [Coleoptera: Scarabaeidae].

**459. *Neopodocinum benoiti* Krantz, 1965**

*Neopodocinum benoiti* Krantz, 1965a: 160.

**Type depository.** Royal Museum for Central Africa, Tervuren, Belgium.

**Type locality and habitat.** Democratic Republic of Congo [cited as Belgian Congo], date of collection unspecified, on *Catharsius dux* Harold [Coleoptera: Scarabaeidae].

**460. *Neopodocinum bosschai* (Oudemans, 1902)**

*Emeus bosschai* Oudemans, 1902b: 290.

*Cosmiphis bosschai*.— Vitzthum, 1925: 33; Krantz, 1965a: 206.

*Neopodocinum bosschai*.— Hartini & Takaku, 2004: 78; Hartini *et al.*, 2007: 91.

**Type depository.** National Museum of Natural History - Naturalis, Leiden, Netherlands.

**Type locality and habitat.** Indonesia, Sambas, West Kalimantan, Borneo, date of collection unspecified, with beetles among decaying leaves.

**461. *Neopodocinum caputmedusae* (Berlese, 1908)**

*Coprotaelaps caputmedusae* Berlese, 1908: 14.

*Coprotaelaps caputmedusae*.— Berlese, 1913a: 82; Costa, 1963: 35.

*Neopodocinum caputmedusae*.— Krantz, 1965a: 158; Hirschmann, 1970a: 44; Bregetova, 1977: 408; Faraji *et al.*, 2008: 233; Karg, 1993: 98; Ács *et al.*, 2016: 68.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Italy, Rosignano Marittimo [cited as Rosignano], Livorno, Tuscany, date of collection unspecified, on *Copris hispanus* (L.) [Coleoptera: Scarabaeidae].

**462. *Neopodocinum coprophilum* Vitzthum, 1926**

*Neopodocinum coprophilum* Vitzthum, 1926: 40.

*Neopodocinum coprophilum*.— Vitzthum, 1925: 20.

**Type depository.** Author's personal collection.

**Type locality and habitat.** Indonesia, Lake Toba, Sumatra, 22 March 1922, on *Heliocopris* sp. [Coleoptera: Scarabaeidae].

**Note.** Suspected junior synonym of *Neopodocinum maius* Berlese by Krantz, 1965a: 185.

**463. *Neopodocinum dehongense* Li & Chang, 1979**

*Neopodocinum dehongense* Li & Chang, 1979: 357.

**Type depository.** Kunming Medical University, Yunnan, China.

**Type locality and habitat.** China, July 1974, on “beetle”.

**464. *Neopodocinum emodi* Krantz, 1965**

*Neopodocinum emodi* Krantz, 1965a: 172.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Nepal, Rangoon (alt. 4297 m), 7 October 1960, on venter of *Geotrupes* sp. [Coleoptera: Geotrupidae].

**465. *Neopodocinum emodioides* Krantz, 1965**

*Neopodocinum emodioides* Krantz, 1965a: 173.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** China, Tibet (alt. 1500 m), 1923, on *Geotrupes genestieri* Boucomont [Coleoptera: Geotrupidae].

**466. *Neopodocinum galfyi* Samšičák & Daniel, 1978**

*Neopodocinum galfyi* Samšičák & Daniel, 1978: 98.

**Type depository.** Institute of Parasitology, Czechoslovak Academy of Sciences, České Budějovice, Czech Republic.

**Type locality and habitat.** Nepal, Shipton Pass (alt.  $\pm$  4000 m) (a kettle with a lake between the passes Turu La and Keke La), 1 June 1973, on *Phelotrupes jekeli* (Harold) [Coleoptera: Geotrupidae].

**467. *Neopodocinum giganteum* Gu & Li, 1987**

*Neopodocinum giganteum* Gu & Li, 1987: 165.

**Type depository.** Department of Parasitology, Guiyang Medical College, Suzhou, Guiyang, Guizhou Province, China.

**Type locality and habitat.** China, Binchuan County (26°20'N; 100°21'E), Dali Bai Autonomous Prefecture, Yunnan Province, 1 November 1983, on scarabaeid beetle [Coleoptera: Scarabaeidae].

**468. *Neopodocinum halimunensis* Hartini & Takaku, 2003**

*Neopodocinum halimunensis* Hartini & Takaku, 2003a: 49.

*Neopodocinum halimunense* [sic].— Hartini *et al.*, 2007: 90.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia

**Type locality and habitat.** Indonesia, Halimun National Park (alt. 950 m), Cikaniki, Bogor, 25–

26 February 2001, on *Onthophagus* sp. [Coleoptera: Scarabaeidae].

**469. *Neopodocinum ilincae* Iavorschi, 1975**

*Neopodocinum ilincae* Iavorschi, 1975: 99.

*Neopodocinum mrciaki*.— Petrova, 1969: 12; Bregetova, 1977: 411; Ambros, 1984: 43.

**Type depository.** Institut Spéologie “Émile Racovitza”, Bucharest, Romania.

**Type locality and habitat.** Romania, Buşteni, Prahova, 8 September 1973, in a beech and conifer forest.

**Note.** Suspected junior synonym of *Neopodocinum mrciaki* Sellnick by Mašán (2003: 42).

**470. *Neopodocinum jaspersi* Oudemans, 1902**

*Neopodocinum jaspersi* Oudemans, 1902a: 25.

*Neopodocinum jaspersi*.— Oudemans, 1904b: 119; Berlese, 1911: 431; Krantz, 1962b: 159, 1965a: 176; Hartini *et al.*, 2007: 91; Ács *et al.*, 2016: 68.

**Type depository.** National Museum of Natural History - Naturalis, Leiden, Netherlands.

**Type locality and habitat.** Netherlands, Amsterdam, date of collection and host/substrate unspecified.

**471. *Neopodocinum javensis* Krantz, 1965**

*Neopodocinum javensis* Krantz, 1965a: 179.

*Neopodocinum javense*.— Hartini *et al.*, 2007: 91.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Indonesia, Bogor, Java, 1909, on *Heliocopris bucephalus* F. [Coleoptera: Scarabaeidae].

**472. *Neopodocinum kalimantanense* Hartini & Takaku, 2004**

*Neopodocinum kalimantanense* Hartini & Takaku, 2004: 87.

*Neopodocinum kalimantanense*.— Hartini *et al.*, 2007: 91.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, East Kalimantan, Pujungan, Kayan Mentarang (alt. 890 m), 01 June 1993, on *Catharsius molossus* (L.) [Coleoptera: Scarabaeidae].

**473. *Neopodocinum longisetum* Ács, Suták & Kontschán, 2016**

*Neopodocinum longisetum* Ács *et al.*, 2016: 67.

**Type depository.** Soil Zoology Collections, Hungarian Natural History Museum, Budapest, Hungary.

**Type locality and habitat.** Greece, garden of a cafe bar along the road towards Louros, west of the village (39°13.026'N 20°42.823'E; 130 m a.s.l.), Ano Kotsanopoulo, Preveza peripheral unit, Epirus, 5 May 2011, from *Oryctes nasicornis* (L.) [Coleoptera: Scarabaeidae: Dynastinae].

**474. *Neopodocinum magna* Krantz, 1965**

*Neopodocinum magna* Krantz, 1965a: 181.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Bambesa, Central Africa, July 1938, on *Heliocopris haroldi* Kolbe [Coleoptera: Scarabaeidae]; Bambesa, September 1937, on *H. haroldi*; Territory of Gemena (Karewa) [sic], Central Africa, 5 December 1938, on *H. haroldi*; Democratic Republic of the Congo, Kalina, 25 December 1933, on *Heliocopris* sp.



[Coleoptera: Scarabaeidae]; Democratic Republic of the Congo, Lubumbashi (Elisabethville), on *H. haroldi*; Bambesa; 3 June 1938, on *H. haroldi*; Bambesa, October 1937, on *H. haroldi*; Democratic Republic of the Congo, Barumbu, January 1921, on *H. haroldi*; Bambesa, 2 October 1937, on *Onitis artuosus* Gillet [Coleoptera: Scarabaeidae].

**475. *Neopodocinum maius* Berlese, 1911**

*Neopodocinum maius* Berlese, 1911: 431.

*Neopodocinum maius*.— Krantz, 1965a: 185; Hartini *et al.*, 2007: 90.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Indonesia, Sumatra, date of collection and host unspecified.

**Note.** Suspected senior synonym of *Neopodocinum coprophilum* Vitzthum by Krantz (1965a: 185).

**476. *Neopodocinum meridionalis* (Sellnick, 1931)**

*Coprolaelaps* (?) *meridionalis* [sic] Sellnick, 1931: 767.

*Coprolaelaps meridionalis*.— Götz & Hirschmann, 1957: 115.

*Neopodocinum meridionalis*.— Krantz, 1965a: 187; Karg, 1971: 130, 1993: 98; Bregetova, 1977: 409; Mašán, 2003: 45; Ács & Kontschán, 2014: 115; Ács *et al.*, 2016: 68.

**Type depository.** Author's personal collection.

**Type locality and habitat.** Greece, Aghios Mattheos (alt. 300 m), Corfu, 6 April 1929, in soil.

**477. *Neopodocinum mrciaki* Sellnick, 1968**

*Neopodocinum mrciaki* Sellnick, 1968: 253.

*Neopodocinum mrciaki*.— Karg, 1971: 130; Bregetova, 1977: 410; Karg, 1993: 98; Mašán, 2003: 42; Ács & Kontschán, 2014: 115; Ács *et al.*, 2016: 68.

**Type depository.** Author's personal collection.

**Type locality and habitat.** Slovakia, banks of River Váh, Liptovská Mara, 15 May 1963, on *Apodemus agrarius* (Pallas) [Mammalia: Rodentia: Muridae].

**Note.** Suspected senior synonym of *Neopodocinum ilincae* Iavorschi by Mašán (2003: 42).

**478. *Neopodocinum nederveeni* Oudemans, 1903**

*Neopodocinum nederveeni* Oudemans, 1903: 100.

*Neopodocinum nederveeni*.— Oudemans, 1904b: 118.

*Beaurieuia nederveeni*.— Oudemans, 1929a: 476.

**Type depository.** National Museum of Natural History - Naturalis, Leiden, Netherlands.

**Type locality and habitat.** Indonesia, Sumatra, date of collection unspecified, on *Catharsius molossus* (L.) [Coleoptera: Scarabaeidae].

**479. *Neopodocinum petrovae* Davydova, 1979**

*Neopodocinum petrovae* Davydova, 1979: 13.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Russia, Kedrovaya Pad Nature Reserve, Khasansky District, Primorsky Krai, 20 June 1968, on *Geotrupes* sp. [Coleoptera: Geotrupidae].

**480. *Neopodocinum rhinolophi* Oudemans, 1914**

*Neopodocinum rhinolophi* Oudemans, 1914a: 67.

*Neopodocinum rhinolophi*.— Oudemans, 1915b: 122.

**Type depository.** Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands.

**Type locality and habitat.** India, Khandala, Maharashtra, 25 October 1911, on *Rhinolophus* sp. [Mammalia: Chiroptera: Rhinolophidae].

**481. *Neopodocinum serrochaetae* (Ramaraju & Mohanasundaram, 1996) New combination**

*Alliphis serrochaetae* Ramaraju & Mohanasundaram, 1996: 166.

**Type depository.** Department of Agricultural Entomology, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, India.

**Type locality and habitat.** India, Madurai, Tamil Nadu, 28 October 1992, on *Catharsius molossus* (L.) [Coleoptera: Scarabaeidae].

**482. *Neopodocinum setosum* Krantz, 1965**

*Neopodocinum setosum* Krantz, 1965a: 190.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** India, date of collection unspecified, on *Catharsius capucinus* F. and *Catharsius pithecius* F. [Coleoptera: Scarabaeidae] deposited in the Chicago Natural History Museum Collection, Chicago, USA; India, Shimoga, Mysore (alt.

1865 m), date of collection unspecified, on *Catharsius capucinus* F. deposited in the U.S. National Museum Collection, USA.

**483. *Neopodocinum sinicum* Li & Gu, 1987** *apud* Hartini *et al.*, 2007: 91.

**484. *Neopodocinum spinirostris* (Berlese, 1910)**

*Megalolaelaps spinirostris* Berlese, 1910: 258.

*Megalolaelaps spinirostris*.— Berlese, 1913a: 82; Bregetova, 1958: 176.

*Neopodocinum spinirostris*.— Krantz, 1965a: 191; Takaku & Hartini, 2001: 333; Hartini *et al.*, 2007: 91, 2009: 419.

**Type depository.** Istituto Sperimentale per la Zoologia Agraria, Florence, Italy.

**Type locality and habitat.** Indonesia, Java, date of collection unspecified, on *Copris* sp. [Coleoptera: Scarabaeidae].

**485. *Neopodocinum subjaspersi* Hartini & Takaku, 2003**

*Neopodocinum subjaspersi* Hartini & Takaku, 2003a: 56.

*Neopodocinum subjaspersi*.— Hartini *et al.*, 2007: 91.

**Type depository.** Museum Zoologicum Bogoriense, Bogor, Indonesia.

**Type locality and habitat.** Indonesia, Halimun National Park (alt. 950 m), Cikaniki, Bogor, 1 April 2001, on *Onthophagus* sp. [Coleoptera: Scarabaeidae].

**486. *Neopodocinum tianschanicus* Petrova, 1969** *apud* Bregetova, 1977: 411.

**487. *Neopodocinum tshambi* Krantz, 1965**

*Neopodocinum tshambi* Krantz, 1965a: 193.

**Type depository.** United States National Museum, Washington, USA.

**Type locality and habitat.** Democratic Republic of the Congo, Kasenyi, Lake Albert, May 1935, on *Scarabaeus gangeticus* Castelnau [Coleoptera: Scarabaeidae]; Democratic Republic of the Congo, Tshambi, Kabasha, October 1933, on *S. gangeticus*; Lonami, Kambaye, September 1950, on *S. gangeticus*; Ruanda, Kibungu (alt. 1500 m), on *S. gangeticus*.

**488. *Neopodocinum turcomonarum* Petrova, 1970** *apud* Bregetova, 1977: 411.

**489. *Neopodocinum vanderhammeni* Krantz, 1965**

*Neopodocinum vanderhammeni* Krantz, 1965a: 196.

**Type depository.** National Museum of Natural History - Naturalis, Leiden, Netherlands.

**Type locality and habitat.** China, Futsjan [sic], Province of Fujian, 1905; host/substrate unspecified; Vietnam, around Geophysical Station, Cha-Pa [sic], 27 October 1960, on *Copris* sp. [Coleoptera: Scarabaeidae].

**490. *Neopodocinum vanstraeleni* Krantz, 1965**

*Neopodocinum vanstraeleni* Krantz, 1965a: 199.

**Type depository.** Institute of National Parks, Congo and Ruanda-Urundi, Brussels, Belgium.

**Type locality and habitat.** Democratic Republic of the Congo, 22 August 1951, host/substrate unspecified.

**491. *Neopodocinum verschureni* Krantz, 1965**

*Neopodocinum verschureni* Krantz, 1965a: 201.

**Type depository.** Institute of National Parks, Congo and Ruanda-Urundi, Brussels, Belgium.

**Type locality and habitat.** Democratic Republic of the Congo, date of collection unspecified, in sheep pasture.

**492. *Neopodocinum vosi* Oudemans, 1903**

*Neopodocinum vosi* Oudemans, 1903: 100.

*Neopodocinum vosi*.— Oudemans, 1904b: 117, 1915: 124.

**Type depository.** National Museum of Natural History – Naturalis, Leiden, Netherlands.

**Type locality and habitat.** Indonesia, Sumatra, date of collection unspecified, on *Catharsius molossus* (L.) [Coleoptera: Scarabaeidae].

**Note.** Described from the protonymph.

**493. *Neopodocinum wainsteini* Arutunjan, 1993**

*Neopodocinum wainsteini* Arutunjan, 1993: 178.

**Type depository.** Laboratory Acarology, Institute of Zoology, National Academy of Sciences of Armenia, Yerevan, Armenia.

**Type locality and habitat.** Uzbekistan, Fergana, 1925-1930, on *Geotrupes impressus* Gebler [Coleoptera: Geotrupidae].

**494. *Neopodocinum wenzeli* Krantz, 1965**

*Neopodocinum wenzeli* Krantz, 1965a: 204.

*Megalolaelaps synapsidis* Bregetova, 1958: 176 [Synonymy by Bregetova, 1977: 410].

**Type depository.** *N. wenzeli*: United States National Museum, Washington, USA; *M.*

*synapsidis*: Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** *N. wenzeli*: Turkestan, date of collect not mentioned, on *Synapsis tmolus* (Fischer von Waldheim) [cited as *Homalocopriss tmolus*] [Coleoptera: Scarabaeidae]; *M. synapsidis*: Tajikistan, Dushanbe [cited as Stalinabad], 10 May 1945, on *Synapsis tmolus* Fisher [Coleoptera: Scarabaeidae].

**495. *Neopodocinum yunnanense* Li & Gu, 1987** *apud* Hartini *et al.*, 2007: 91.***Nothrolaspis* Berlese, 1918**

*Macrocheles* (*Nothrolaspis*) Berlese, 1918: 169.

Type species: *Holostaspis tridentinus* Canestrini & Canestrini, 1882 (= *Gamasus tardus* Koch, 1841), by original designation.

*Nothrolaspis*.— Falconer, 1923: 153; Oudemans, 1931: 273; Womersley, 1942: 168; Emberson, 2010: 47; Özbek & Bal, 2013: 43; Babaeian *et al.*, 2014: 586.

*Macrocheles* (*Scleritholaspis*) Mašán, 2003: 80 [Synonymy by Emberson, 2010: 47].

Type species: *Gamasus carinatus* Koch, 1839, by original designation.

*Macrocheles carinatus* species group.— Hyatt & Emberson, 1988: 90.

**496. *Nothrolaspis anatolicus* Özbek & Bal, 2013**

*Nothrolaspis anatolicus* Özbek & Bal, 2013: 43.

*Nothrolaspis anatolicus*.— Babaeian *et al.*, 2014: 589.

**Type depository.** Erzincan University's Acarology Laboratory, Erzincan, Turkey.

**Type locality and habitat.** Turkey, Köse mountain (40°16'N, 39°37'E; alt. 1862 m) Gümüşhane, 26 June 2011, in nest of ant [Hymenoptera].

**497. *Nothrolaspis banaticus* (Iavorschi, 1977)**

*Macrocheles banaticus* Iavorschi, 1977: 47.

*Nothrolaspis banaticus*.— Emberson, 2010: 48; Özbek & Bal, 2013: 48; Babaeian *et al.*, 2014: 589.

**Type depository.** Institut Spéologie “Émile Racovitza”, Bucharest, Romania.

**Type locality and habitat.** Romania, upstream of the cave Liliecilor, Semenic Mountain, Semenic Mountain, Banat Mountains, Caraş-Severin, 3 October 1969, in litter.

**Note.** Suspected junior synonymy of *Macrocheles tardus* (Koch) [presently *Nothrolaspis tardus*] by Mašán (2003: 83).

#### **498. *Nothrolaspis biharicus* (Iavorschi, 1977) new combination**

*Macrocheles biharicus* Iavorschi, 1977: 52.

**Type depository.** Institut Spéologie “Émile Racovitza”, Bucharest, Romania.

**Type locality and habitat.** Romania, near Bihor, Sighistel Valley, 14 July 1969, in litter from a beech, *Fagus* sp. [Fagaceae], forest.

**Note.** Suspected junior synonymy of *Macrocheles montanus* (Willmann) [presently *Nothrolaspis montanus*] by Mašán (2003: 85).

#### **499. *Nothrolaspis carinatus* (Koch, 1839)**

*Gamasus carinatus* Koch, 1839a: 16.

*Macrocheles carinatus*.— Oudemans, 1914a: 66, 1915a: 182; Evans & Browning, 1956: 25; Athias-Henriot, 1968: 269; Hirschmann, 1970d: 50; Krantz, 1972: 271; Bregetova, 1977: 368; Hyatt & Emberson, 1988: 90; Faraji *et al.*, 2008: 234.

*Nothrolaspis carinata*.— Sellnick, 1931: 764; Wilmann, 1938: 149, 1941: 26.

*Nothrolaspis carinatus*.— Oudemans, 1936: 185; Emberson, 2010: 48; Özbek & Bal, 2013: 48; Ács & Kontschán, 2014: 115; Babaeian *et al.*, 2014: 589.

*Macrocheles* (*Macrocheles*) *carinatus*.— Krauss, 1970: 18; Karg, 1971: 138, 1993: 113.

*Macrocheles* (*Scleritholaspis*) *carinatus*.— Mašán, 2003: 81.

*Nothrolaspis hullii* Falconer, 1923: 153 [Synonymy by Evans & Browning, 1956: 25].

*Macrocheles hypochthonius* Oudemans, 1913: 6 [Synonymy of Oudemans, 1915a: 182]<sup>Note1</sup>.

*Coprhospis hypochthonius*.— Oudemans, 1929b: 12.

**Type depository.** *G. carinatus*: unspecified; *N. hullii*: Natural History Museum, London, England; *M. hypochthonius*: National Museum of Natural History - Naturalis, Leiden, Netherlands.

**Type locality and habitat.** *G. carinatus*: Germany, date of collect and host/substrate unspecified; *N. hullii*: England, Winterset, Wakefield, West Yorkshire, May 1919, in

vegetable debris on a sloping bank; *M. hypochthonius*: Netherlands, Limburg, date of collection unspecified, in mole [Mammalia: Eulipotyphla: Talpidae] nest.

**Note<sup>1</sup>**. Berlese (1918: 289) stated *Macrocheles hypochthonius* Oudemans as junior synonymy of *Macrocheles (Nothrolaspis) tridentinus* (Canestrini & Canestrini) [Junior synonymy of *Nothrolaspis tardus* (Koch)].

**Note<sup>2</sup>**. Suspected junior synonym of *Macrocheles badius* (Koch) by Berlese (1892: 63).

**Note<sup>3</sup>**. Specimens reported by Hughes (1948: 126) as *Macrocheles carinatus* (Koch) were identified as *Macrocheles matrius* (Hull) by Evans & Browning (1956: 34).

#### **500. *Nothrolaspis caucasicus* (Bregetova & Koroleva, 1960)**

*Macrocheles caucasicus* Bregetova & Koroleva, 1960: 95.

*Macrocheles caucasicus*.— Hirschmann, 1970d: 49; Bregetova, 1977: 369.

*Macrocheles (Scleritholaspis) caucasicus*.— Mašán, 2003: 80.

*Nothrolaspis caucasicus*.— Emberson, 2010: 48; Özbek & Bal, 2013: 48; Babaeian *et al.*, 2014: 589.

**Type depository.** Museum of the Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

**Type locality and habitat.** Russia, Kislovodsk, Stavropol Krai, 31 October 1957/ 23 November 1958, On needles under a pine [Pinaceae] tree; Russia, Kislovodsk, Stavropol Krai, 3 November 1957, under hay in a tree nursery (alt. 960 m); Georgia, Lagodekhi Nature Reserve, Lagodekhi, 28 August 1937/ 27 June 1938, in litter and soil; Russia, Mount Akhun, Sochi, 8–9 November 1958, in litter; Russia, Mount Akhun, 4 November 1958, litter in beech forest; Georgia, Batumi Botanical Garden, Batumi, 27/30 September 1956, in litter.

#### **501. *Nothrolaspis coenosus* (Takaku, 1996)**

*Macrocheles coenosus* Takaku, 1996: 7.

*Macrocheles (Scleritholaspis) coenosus*.— Mašán, 2003: 80.

*Nothrolaspis coenosus*.— Emberson, 2010: 48; Özbek & Bal, 2013: 48; Babaeian *et al.*, 2014: 589.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Japan, foot of Mount Hakken, Sapporo, Hokkaido, 14 September 1992, in larch forest.

**502. *Nothrolaspis dogani* Özbek & Bal, 2013**

*Nothrolaspis dogani* Özbek & Bal, 2013: 45.

*Nothrolaspis dogani*.— Babaeian *et al.*, 2014: 589.

**Type depository.** Erzincan University's Acarology Laboratory, Erzincan, Turkey.

**Type locality and habitat.** Turkey, Kürtün (Spider forest) (40°39'N, 39°01' E; alt. 1375 m), Gümüşhane, 29 October 2007, from rotting wood, moss and lichen.

**503. *Nothrolaspis margaretae* (Iavorschi, 1977) New combination**

*Macrocheles margaretae* Iavorschi, 1977: 53.

**Type depository.** Institut Spéologie "Émile Racovitza", Bucharest, Romania.

**Type locality and habitat.** Romania, Mehedinți, September 1976, from litter of deciduous forest.

**Note.** Suspected junior synonymy of *Macrocheles montanus* (Willmann) [presently *Nothrolaspis montanus*] by Mašán (2003: 85).

**504. *Nothrolaspis montanus* Willmann, 1951**

*Nothrolaspis montana* Willmann, 1951a: 157.

*Macrocheles montanus*.— Evans & Browning, 1956: 23; Krantz, 1972: 270; Bregetova, 1977: 369; Hyatt & Emberson, 1988: 92; Faraji *et al.*, 2008: 234.

*acrocheles montanus* [sic].— Bregetova & Koroleva, 1960: 99.

*Macrocheles (Macrocheles) montanus*.— Karg, 1971: 138, 1993: 114.

*Macrocheles (Scleritholaspis) montanus*.— Mašán, 2003: 85.

*Nothrolaspis montanus*.— Emberson, 2010: 48; Özbek & Bal, 2013: 48; Ács & Kontschán, 2014: 115; Babaeian *et al.*, 2014: 589.

*Macrocheles (Macrocheles) montivagus*.— Krauss, 1970: 22 [Misidentification, according to Masan, 2003: 85].

**Type depository.** Unspecified.

**Type locality and habitat.** Austria, brook gorge of the Hirzbaches (alt. 1,300 m), Fuscher Ache, Glogner Group, date of collection unspecified, in leaf litter.

**Note**<sup>1</sup>. Suspected junior synonym of *Macrocheles montivagus* (Berlese) by Krauss (1970: 22) and by Bregetova (1977: 369).

**Note**<sup>2</sup>. Suspected senior synonymy of *Macrocheles biharicus* Iavorschi [presently *Nothrolaspis biharicus*] and *Macrocheles margaretae* Iavorschi [presently *Nothrolaspis margaretae*] by Mašán (2003: 85).



**505. *Nothrolaspis saboorii* Babaeian & Joharchi, 2014**

*Nothrolaspis saboorii* Babaeian & Joharchi, in Babaeian *et al.*, 2014: 586.

**Type depository.** Acarological Collection, Jalal Afshar Zoological Museum, Faculty of Agriculture, University of Tehran, Karaj, Iran.

**Type locality and habitat.** Iran, Shahrestanak (35°56' N, 51°22' E; alt. 2330 m), Karaj, 18 September 2009, in soil.

**506. *Nothrolaspis shennongjiaensis* (Ma & Liu, 2003)**

*Macrocheles shennongjiaensis* Ma & Liu, 2003: 657.

*Nothrolaspis shennongjianensis* [sic].— Emberson, 2010: 48.

*Nothrolaspis shennongjiaensis*.— Özbek & Bal, 2013: 48; Babaeian *et al.*, 2014: 589.

**Type depository.** Institute of Microbiology and Epidemiology, Academy of Military Medical Science, Beijing, China.

**Type locality and habitat.** China, Shennongjia (31°15'N, 109°56'E; alt. 2900 m), Hubei, 25 June 1990, on *Ochotona thibetana* (Milne-Edwards) [Mammalia: Lagomorpha: Ochotonidae].

**507. *Nothrolaspis sinicus* (Ye, Ma & Chen, 1994)**

*Macrocheles sinicus* Ye, Ma & Chen, 1994: 309.

*Macrocheles (Scleritholaspis) sinicus*.— Mašán, 2003: 80.

*Nothrolaspis sinicus*.— Özbek & Bal, 2013: 48; Babaeian *et al.*, 2014: 589.

**Type depository.** Xinjiang Institute for Endemic Disease Control and Research, Ürümqi, Xinjiang, China.

**Type locality and habitat.** China, Xinyuan County (43°20'N; 83°30'E), Xinjiang, 29 August 1982, on *Dryomys nitedula* (Pallas) [Mammalia: Rodentia: Gliridae].

**508. *Nothrolaspis subcoenosus* (Takaku, 1996)**

*Macrocheles subcoenosus* Takaku, 1996: 11.

*Macrocheles (Scleritholaspis) subcoenosus*.— Mašán, 2003: 80.

*Nothrolaspis subcoenosus*.— Emberson, 2010: 48; Özbek & Bal, 2013: 48; Babaeian *et al.*, 2014: 589.

**Type depository.** British Museum (Natural History), London, England.

**Type locality and habitat.** Japan, foot of Mount Hakken, Sapporo, Hokkaido, 02 June 1993, in larch forest.

**509. *Nothrolaspis submotus* (Falconer, 1924)**

*Macrocheles cognatus* Falconer, 1923: 152 [Junior homonym of *Macrocheles cognatus* Berlese, 1918]

*Macrocheles submotus* Falconer, 1924: 363 [Replacement name].

*Macrocheles submotus*.— Evans & Browning, 1956: 28; Van Driel *et al.*, 1977: 308; Bregetova, 1977: 368; Hyatt & Emberson, 1988: 92.

*Macrocheles (Macrocheles) submotus*.— Karg, 1993: 111.

*Macrocheles (Scleritholaspis) submotus*.— Mašán, 2003: 80.

*Nothrolaspis submotus*.— Emberson, 2010: 48; Özbek & Bal, 2013: 48; Babaeian *et al.*, 2014: 589.

*Macrocheles (Nothrolaspis) occidentalis* Hull, 1925: 213 [Synonymy by Evans & Browning, 1956: 28].

*Macrocheles (? Nothrolaspis) gloriosus* [sic] Hull, 1925: 214 [Synonymy by Evans & Browning, 1956: 28].

**Type depository.** *N. submotus*: Natural History Museum, London, England; *M. (N.) occidentalis*: Natural History Museum, London, England; *M. (? N.) gloriosus*: Natural History Museum, London, England.

**Type locality and habitat.** *N. submotus*: England, Slaithwaite, West Yorkshire, May 1919, on dead leaves, sphagnum and heap of cut grass [lectotype designated by Hyatt & Emberson, 1988: 92]; *M. (N.) occidentalis*: England, Penrith, Cumbria, date of collection unspecified, among dead leaves; *M. (? N.) gloriosus*: England, Allendale (cited as West Allendale), date of collection unspecified, on moss.

**Note.** Suspected junior synonymy of *Macrocheles tridentinus* (Canestrini & Canestrini) by Krauss (1970: 19).

**510. *Nothrolaspis tardus* (Koch, 1841)**

*Gamasus tardus* Koch, 1841: 14.

*Gamasus tardus*.— Canestrini & Fanzago, 1877: 117; Berlese, 1882a: 101, 1882c: 120, 1892: 67; Oudemans, 1929b: 13.

*Nothrolaspis tarda*.— Sellnick, 1931: 766.

*Nothrolaspis tardus*.— Oudemans, 1936: 187; Emberson, 2010: 48; Özbek & Bal, 2013: 48; Ács & Kontschán, 2014: 116; Babaeian *et al.*, 2014: 589.

*Macrocheles (Nothrolaspis) tarda*.— Cooreman, 1943: 24.

*Macrocheles tardus*.— Evans & Browning, 1956: 30; Bregetova & Koroleva, 1960: 91; Athias-Henriot, 1968: 269; Hirschmann, 1970a: 44, 1970b: 45, 1970c: 46, 1970d: 52; Krantz, 1972: 271; Hyatt & Emberson, 1988: 94.

*Macrocheles (Macrocheles) tardus*.— Karg, 1971: 138.

*Macrocheles (Scleritholaspis) tardus*.— Mašán, 2003: 83.

*Holostaspis tridentinus* Canestrini & Canestrini, 1882: 30<sup>Note1</sup> [Synonymy by Hyatt & Emberson, 1988: 94].

*Holostaspis tridentinus*.— G. Canestrini, 1885: 63; Berlese, 1887a: 7, 1887a: 8, 1892: 70.

*Macrocheles tridentinus*.— Oudemans, 1902a: 42<sup>Notes2 and 3</sup>, 1904a: 277; Hull, 1918: 72; Hirschmann, 1970a: 44, 1970b: 45, 1970c: 46, 1970d: 50; Bregetova, 1977: 368

*Macrocheles (Nothrholaspis) tridentinus*.— Berlese, 1918: 169.

*Macrocheles (Macrocheles) tridentinus*.— Krauss, 1970: 19; Karg, 1971: 138, 1993: 114.

**Type depository.** *G. tardus*: unspecified; *G. tridentinus*: specimen probably destroyed [original description]; Istituto Sperimentale per la Zoologia Agraria, Florence, Italy [neotype designated by Hyatt & Emberson, 1988: 94].

**Type locality and habitat.** *G. tardus*: Germany, Regensburg, Bavaria, date of collection unspecified, between grasses; *G. tridentinus*: Italy, Trentino, date of collection unspecified, on rotting leaves [original description]; Italy, Tiarno, Trentino, date of collection unspecified, on moss [neotype designated by Hyatt & Emberson, 1988: 94].

**Note<sup>1</sup>.** Suspected senior synonymy of *Macrocheles hypochthonius* Oudemans by Berlese (1918: 289).

**Note<sup>2</sup>.** Only deutonymph; specimen reported by Oudemans (1902a: 42) as protonymph of *Macrocheles tridentinus* (Canestrini & Canestrini) was identified as *Macrocheles longispinosus* (Kramer) by Oudemans (1904a: 107).

**Note<sup>3</sup>.** Berlese (1904a: 277) stated that specimens reported by Oudemans (1902a: 42) as *Macrocheles tridentinus* (Canestrini & Canestrini) are not of the genera *Macrocheles* and *Holostaspis*.

**Note<sup>4</sup>.** Specimens reported by Berlese (1882a: 105) as “ninja ibontomorfa femmina” of *Gamasus tardus* (Koch) were identified as *Holostaspis marginatus* (Hermann) by Berlese (1889: 6) and later described as *Holostaspis subbadius* Berlese (1904a: 264).

**Note<sup>5</sup>.** Specimens reported by Berlese (1882a: 106) as tritonymph of *Gamasus tardus* Koch were identified as *Macrocheles perglaber* Filipponi & Pegazzano by Filipponi & Pegazzano (1962b: 221).

**Note**<sup>6</sup>. Specimens reported by Berlese (1882a: 107) as “tritonympha foemina” of *Gamasus tardus* Koch were identified as *Macrocheles glaber* (Müller) by Filipponi & Pegazzano (1962b: 215).

**Note**<sup>7</sup>. Specimens reported by Berlese (1882a: 108) as “adulto femmina” of *Gamasus tardus* Koch identified as *Glyphtholaspis fimicola* (Berlese) [sic] by Filipponi & Pegazzano (1960: 139).

**Note**<sup>8</sup>. Specimens reported by Krauss (1970: 20) as *Macrocheles (Macrocheles) tardus* (Koch) were identified as *Glyphtholaspis americana* (Berlese) by Hyatt & Emberson (1988: 116).

**Note**<sup>9</sup>. Suspected junior synonymy of *Holostaspis marginatus* (Hermann) by Berlese (1913b: 98).

**Note**<sup>10</sup>. *Nothrholaspis tardus* is suspected to be the senior synonymy of *Macrocheles banaticus* Iavorschi [presently *Nothrholaspis banaticus*] by Mašán (2003: 83).

### **511. *Nothrholaspis turcicus* Özbek & Bal, 2013**

*Nothrholaspis turcicus* Özbek & Bal, 2013: 41.

*Nothrholaspis turcicus*.— Babaeian *et al.*, 2014: 589.

**Type depository.** Erzincan University’s Acarology Laboratory, Erzincan, Turkey.

**Type locality and habitat.** Turkey, Şiran (40°09’N, 38°57’E; alt. 1457 m), Gümüşhane, 29 May 2011, from debris under *Pyrus* sp. [Rosaceae].

### **Genus *Odontocheles* Krantz & Moser, 2012**

*Odontocheles* Krantz & Moser, 2012: 577.

Type species: *Odontocheles attaphilus* Krantz & Moser, 2012, by original designation.

### **512. *Odontocheles attaphilus* Krantz & Moser, 2012**

*Odontocheles attaphilus* Krantz & Moser, 2012: 577.

**Type depository.** United States National Museum of Natural History, Washington, USA.

**Type locality and habitat.** USA, Kisatchie National Forest, Natchitoches Parish, Louisiana, 4 August 2004, in fresh detritus from fungus garden cavity 2.5 metres below the nest cavity of *Atta texana* Buckley [Hymenoptera: Formicidae].

**Genus *Reductholaspis* Emberson, 2010**

*Reductholaspis* Emberson, 2010: 45.

Type species: *Macrocheles analis* Hyatt & Emberson, 1988, by original designation.

**513. *Reductholaspis analis* (Hyatt & Emberson, 1988)**

*Macrocheles analis* Hyatt & Emberson, 1988: 96.

*Macrocheles analis*.— Faraji *et al.*, 2008: 234.

*Reductholaspis analis*.— Emberson, 2010: 46.

**Type depository.** British Museum (Natural History), London, England

**Type locality and habitat.** England, Berks, Silwood Park, 23 November 1963, in light sandy loam with winter wheat.

**Genus *Synaphaspis* Krantz, 1961**

*Synaphaspis* Krantz, 1961: 10.

Type species: *Synaphaspis congoensis* Krantz, 1961, by monotypy.

*Synaphaspis*.— Krantz, 1962b: 163; Krantz, 1998: 100.

**514. *Synaphaspis congoensis* Krantz, 1961**

*Synaphaspis congoensis* Krantz, 1961: 10.

*Synaphaspis congoensis*.— Krantz, 1992: 163; 1998: 100.

**Type depository.** Central African Museum, Tervuren, Belgium.

**Type locality and habitat.** Congo, Garamba National Park, Orientale, 26 August 1952/ 06 November 1951, on coprophagous and insects taken in grassy savannah.

**Genus *Trigonholaspis* Vitzthum, 1930**

*Trigonholaspis* Vitzthum, 1930: 300.

Type species: *Trigonholaspis salti* Vitzthum, 1930, by original designation.

*Trigonholaspis*.— Evans, 1956: 351; Krantz, 1962b: 161, 1998: 105.

*Grafia* Krantz, 1962b: 163 [junior synonymy by Krantz, 1998: 105].

Type species: *Trigonholaspis trigonarum* Vitzthum, 1930, by original designation.

**515. *Trigonholaspis amaltheae* Vitzthum, 1930**

*Trigonholaspis amaltheae* Vitzthum, 1930: 311.

*Grafia amaltheae*.— Krantz, 1962b: 171.

**Type depository.** Author's personal collection.

**Type locality and habitat.** Colombia, Rio Frio, Magdalena, 25 September 1927, in nest of  
*Trigona amalthea* (Olivier) [Hymenoptera: Apidae].

**516. *Trigonholaspis columbiana* Vitzthum, 1930**

*Trigonholaspis columbiana* Vitzthum, 1930: 305.

*Grafia columbiana*.— Krantz, 1962b: 171.

**Type depository.** Author's personal collection.

**Type locality and habitat.** Colombia, Rio Frio, Magdalena, 25 September 1927, in nest of  
*Trigona amalthea* (Olivier) [Hymenoptera: Apidae].

**517. *Trigonholaspis salti* Vitzthum, 1930**

*Trigonholaspis salti* Vitzthum, 1930: 301.

*Trigonholaspis salti*.— Krantz, 1998: 105.

**Type depository.** Author's personal collection.

**Type locality and habitat.** Colombia, Rio Frio, Magdalena, 25 September 1927, in nest of  
*Trigona amalthea* (Olivier) [Hymenoptera: Apidae].

**518. *Trigonholaspis trigonarum* Vitzthum, 1930**

*Trigonholaspis trigonarum* Vitzthum, 1930: 308.

*Grafia trigonarum*.— Krantz, 1962b: 171.

**Type depository.** Author's personal collection.

**Type locality and habitat.** Colombia, Rio Frio, Magdalena, 25 September 1927, in nest of  
*Trigona amalthea* (Olivier) [Hymenoptera: Apidae].

**Genus *Venatiolaspis* Van Driel & Loots, 1975**

*Venatiolaspis* Van Driel & Loots, 1975: 591.

Type species: *Venatiolaspis pilosus* Van Driel & Loots, 1975, by original designation.

**519. *Venatiolaspis pilosus* Van Driel & Loots, 1975.**

*Venatiolaspis pilosus* Van Driel & Loots, 1975: 592.

**Type depository.** Royal Museum for Central Africa, Tervuren, Belgium.

**Type locality and habitat.** Democratic Republic of the Congo, Kasongo, Maniema, September 1959, from unspecified host/substrate.

**Species incertae sedis**

**001. *Eviphis spatulaesetae* Ramaraju & Mohanasundaram, 1996**

*Eviphis spatulaesetae* Ramaraju & Mohanasundaram, 1996: 171.

**002. *Geholaspis subspinosus* Vitzthum, 1931**

*Geholaspis subspinosus* Vitzthum, 1931: 14.

**003. *Macrocheles akbari* Khan, 1967**

*Macrocheles akbari* Khan, 1967: 395.

**004. *Macrocheles albicans* (Koch, 1839)**

*Gamasus albicans* Koch, 1839b: 17.

*Macrocheles albicans* [sic].— Oudemans, 1936: 169.

**005. *Macrocheles appendiculatus* (Gervais, 1849)**

*Gamasus appendiculatus* Gervais, 1849: 43.

*Macrocheles appendiculatus*.— Oudemans, 1936: 170.

**006. *Macrocheles brevior* Berlese, 1923**

*Macrocheles* (*Coprholaspis*) *pharaonius* var. *brevior* Berlese, 1923: 249.

**007. *Macrocheles bihastatus* Ewing, 1920**

*Macrocheles bihastatus* Ewing, 1920: 286.

**008. *Macrocheles cerinus* (Koch, 1839)**

*Gamasus cerinus* Koch, 1839a: 21.

*Macrocheles cerinus*.— Oudemans, 1936: 171.

**009. *Macrocheles dorsalis* (Koch, 1839)**

*Gamasus dorsalis* Koch, 1839b: 7.

*Macrocheles dorsalis*.— Oudemans, 1936: 171.

**010. *Macrocheles fuscus* Berlese, 1918**

*Macrocheles (Coprholaspis) fuscus* Berlese, 1918: 160.

*Coprholaspis fuscus*.— Turk, 1948: 101.

*Macrocheles fuscus*.— Krantz, 1967b: 83.

**011. *Macrocheles spinatus* Banks, 1904**

*Macrocheles spinatus* Banks, 1904: 60.

*Macrocheles spinatus*.— Hennessey & Farrier, 1988: 22.

**012. *Macrocheles sulcatus* (Gervais, 1849)**

*Gamasus sulcatus* Gervais, 1849: 41.

*Macrocheles sulcatus*.— Oudemans, 1936: 182.

**013. *Macrocheles (Coprholaspis) appalachicus* Jacot, 1939**

*Macrocheles (Coprholaspis) appalachicus* Jacot, 1939: 201.

**014. *Macrocheles (Nothrholaspis) nemoralis* Hull, 1925**

*Macrocheles (Nothrholaspis) nemoralis* Hull, 1925: 213.

**015. *Macrocheles (Nothrholaspis) pannosus* Hull, 1925**

*Macrocheles (Nothrholaspis) pannosus* Hull, 1925: 211.

**016. *Macrocheles (Nothrholaspis) parmulatus* Hull, 1925**

*Macrocheles (Nothrholaspis) parmulatus* Hull, 1925: 214.

**017. *Macrocheles (Monoplites) palustris* Hull, 1925**



*Macrocheles (Monoplites) palustris* Hull, 1925: 216.

**Unavailable names**

**018. *Macrocheles elongatum* Glida, Latifi, Bertrand & Saboori, 2003**

*Macrocheles elongatum* Glida, Latifi, Bertrand & Saboori, 2003: 347.

*Macrocheles elongatum*.— Faraji *et al.*, 2008: 234.

**Type locality and habitat.** Iran, Sahrabad, date of collect and host/substrate unspecified.

**Note.** Name unavailable because no reference was made in the description about the place of deposition of the type specimens (International Code of Zoological Nomenclature).

**019. *Macrocheles kamalii* Glida, Latifi, Bertrand & Saboori, 2003**

*Macrocheles kamalii* Glida, Latifi, Bertrand & Saboori, 2003: 346.

*Macrocheles kamalii*.— Faraji *et al.*, 2008: 235.

**Type locality and habitat.** Iran, Karaj, date of collect and host/substrate unspecified.

**Note.** Name unavailable because no reference was made in the description about the place of deposition of the type specimens (International Code of Zoological Nomenclature).

**020. *Macrocheles kermani* Glida, Latifi, Bertrand & Saboori, 2003**

*Macrocheles kermani* Glida, Latifi, Bertrand & Saboori, 2003: 346.

*Macrocheles kermani*.— Faraji *et al.*, 2008: 234.

**Type locality and habitat.** Iran, Karaj, date of collect and host/substrate unspecified.

**Note.** Name unavailable because no reference was made in the description about the place of deposition of the type specimens (International Code of Zoological Nomenclature).

**021. *Macrocheles minutum* Seifoori, Glida, Saboori & Bertrand, 2008**

*Macrocheles minutum* Seifoori, Glida, Saboori & Bertrand, 2008: 42.

**Type locality and habitat.** Iran, Nare Satan, 19 June 2005, in soil and dung.

**Note.** Name unavailable because no reference was made in the description about the place of deposition of the type specimens (International Code of Zoological Nomenclature).

**022. *Macrocheles paucipunctatum* Seifoori, Glida, Saboori & Bertrand, 2008**

*Macrocheles paucipunctatum* Seifoori, Glida, Saboori & Bertrand, 2008: 42.

**Type locality and habitat.** Iran, Malekabad, 01 September 2004, in soil core.

**Note.** Name unavailable because no reference was made in the description about the place of deposition of the type specimens (International Code of Zoological Nomenclature).

**023. *Macrocheles similiscutatus* Seifoori, Glida, Saboori & Bertrand, 2008**

*Macrocheles similiscutatus* Seifoori, Glida, Saboori & Bertrand, 2008: 42.

**Type locality and habitat.** Iran, Hossein Abaj, date of collect unspecified, in soil and dung.

**Note.** Name unavailable because no reference was made in the description about the place of deposition of the type specimens (International Code of Zoological Nomenclature).

**024. *Macrocheles simplex* Seifoori, Glida, Saboori & Bertrand, 2008**

*Macrocheles simplex* Seifoori, Glida, Saboori & Bertrand, 2008: 44.

**Type locality and habitat.** Iran, Baghdady, 30 October 2004, in soil and dung

**Note.** Name unavailable because no reference was made in the description about the place of deposition of the type specimens (International Code of Zoological Nomenclature).

## **2.4. Discussion**

A total of 519 species belonging to 23 genera are reported in this paper. The genus *Macrocheles* contains the largest number of species (519 species). Ten of the genera are monotypic. A large number (24 species) are of uncertain taxonomic placement (*incertae sedis*), because of the insufficient details known about them until now. This suggests that a large number of species of this family is in need of adequate revision. The preparation of the catalog represents a significant step towards the proper knowledge of the taxonomy of Macrochelidae, making relevant information and a list of references available to taxonomists interested on this group.

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### 3. MACROCHELID MITES (MESOSTIGMATA: MACROCHELIDAE) FROM SÃO PAULO STATE, BRAZIL, AND DESCRIPTION OF A NEW SPECIES OF *Macrocheles*

#### ABSTRACT

Macrochelid mites have been reported in several papers about mites of different habitats in Brazil, but this is the first work specifically conducted to determine the macrochelids from that country. The main goal was to determine macrochelid species in microhabitats where the stable fly is usually found in commercial cow raising farms. In total, 1359 specimens were collected from cow manure and litter in different regions of São Paulo state. These represented ten species of three genera. One of these, *Macrocheles* n. sp. is here described as new to science. Other macrochelid species are expected to be found in the study area, when other types of microhabitats are explored.

Keywords: Macrochelids; Animal manure; Litter; Taxonomy

#### 3.1. Introduction

Excrements, decomposing animals and litter are ideal habitats for abundant and diverse arthropod fauna (Braig & Perotti, 2009). Macrochelidae is one of the most abundant and diverse groups of predatory mites in these habitats (Gerson *et al.*, 2003; Azevedo *et al.* 2015). Filipponi (1964) divided the macrochelids into three main groups, fimicolous, humicolous and insecticolous, referring to their respective association with excrements, humus or insects.

About 550 species have been assigned to Macrochelidae, of which about 470 seem to be valid names; these are currently arranged in 23 genera (Azevedo *et al.*, 2015). However there is little information about macrochelids in Brazil. About 36 species of four genera have been reported from Brazil (Azevedo *et al.*, catalogue of Macrochelidae in construction): *Macrocheles* (21 species), *Holocelaeno* (13 species), *Mesocheles* (one species) and *Glyptholaspis* (one species). This number can be considered small in the case of Brazil, which has a great diversity of ecosystems.

Macrochelids have been mentioned to have the potential as biological control agents of organisms with which they have been found in association, including different fly species (Azevedo *et al.*, 2015). One of these species, *Macrocheles robustulus* (Berlese), has been commercialized for the control of sciarid flies (Sciaridae), thrips and a species of *Lyprauta* sp. flies (Keroplastidae).

The stable fly [*Stomoxys calcitrans* (L.) (Diptera: Muscidae)] is a serious problem that has been faced by cow farmers in central and southeastern Brazilian states (Koller *et al.*, 2009; Cançado *et al.*, 2013; Dominghetti *et al.*, 2015). The problem is so serious that the Secretary of Agriculture of the São Paulo state decided to intervene creating a research group dedicated to the solution of that problem. Thus, an effort was initiated to determine prospective macrochelid mites to control *S. calcitrans*.

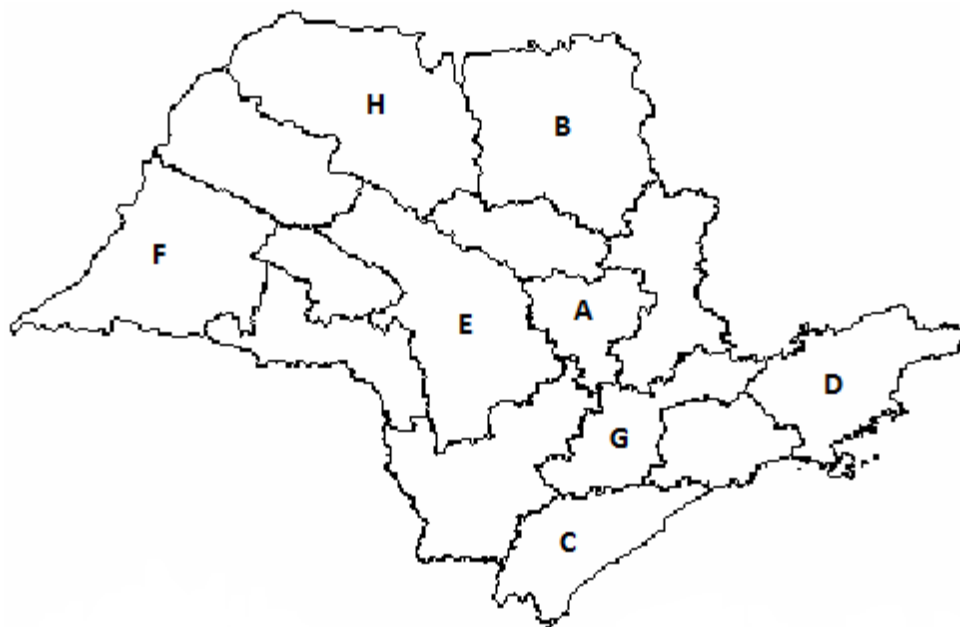
In the development of a biological control strategy, one of the first recommended steps is the determination of the fauna in the area where the pest or parasite is intended to be controlled. This not only is a pre-requisite for latter evaluation of the result of any control effort then initiated, but can also indicate local prospective natural enemies to be evaluated. The aims of this publication are to present a list of the macrochelid species found in this study in different regions of São Paulo state and to described the new macrochelid species reported in the previous paragraph.

## 3.2. Material and Methods

### 3.2.1. Collection sites

Main emphasis was given in this study to the discovery of macrochelid species inhabiting microhabitats where the stable fly is usually found in commercial cow raising farms. Manure and litter samples were collected in 2014 in two farms from each of the following sites (Figure 1): Piracicaba (22°42'25.7"S, 47°38'30.4"W and 22°70'50.2"S, 47°62'16.4"W); Cajuru (21°12'28.5"S, 47°19'35.2"W and 21°17'30"S, 47°17'05"W); Pariquera-Açu (24°42'54"S, 47°52'52"W); Registro (24°29'16"S, 47°50'38"W); São Luis do Paraitinga (23°27'08" S, 45°18'30"W); Paraibuna (23°10'22"S, 45°19'59"W); Piratininga (22°24'46"S, 49°08'05"W); Cabrália Paulista (22°27'20"S, 49°20'15"W); Pirapozinho (22°16'31"S, 51°30'00"W); Narandiba (22°24'26" S, 51°31'28"W), Araçoiaba da Serra (23°31'20,46"S, 47°38'24,05"W and 23°31'18,07"S, 47°36'26,34"W); and Nipoã (20°54'48" S, 49°46'40"W and 20°40'20"S, 49°10'22"W). Twenty samples were collected from each farm,

each samples consisting of approximately 1000 g of cow manure and litter collects randomly at the farms.



**Figure 1.** Homogeneous mesoregions of the State of São Paulo indicating the collection points A. Region of Piracicaba (Piracicaba), B. Region of Ribeirão Preto (Cajuru); C. South coast region (Pariquera-Açu and Registro); D. Region of Vale do Paraíba (São Luis do Paraitinga and Paraibuna); E. Region of Bauru (Piratininga and Cabrália Paulista); F. Region of Presidente Prudente (Pirapozinho and Narandiba); G. Region of Sorocaba (Araçoiaba da Serra); H. Region of São José do Rio Preto (Nipoã).

### 3.2.2. Sample processing and mite identification

Mites were extracted from the samples with the use of a modified Berlese-Tullgren apparatus (Oliveira *et al.*, 2001), for seven days. The most sclerotised specimens were cleared in Nesbitt medium before mounting. The mesostigmatid mites collected were mounted in Hoyer's medium and later separated into families. Macrochelids were separated into morphospecies and examined under phase contrast microscopy for species identification, using the world taxonomic literature. Mites of other families were reserved for later studies.

A list of the species found is presented according to the following order: concerning taxonomic literature, specimens collected, diagnosis (including measurements of dorsal shield determined in the present study), countries in which the species was reported and eventual notes. Upon the determination that the one *Macrocheles* species was new to science, this was described in accordance with some of the most recent taxonomic descriptions of species of this family (ex. Babaein *et al.*, 2015 and Ozbek & Halliday, 2015). Taxonomically relevant

structures of this new species were illustrated with the use of a digital camera connected to an interference contrast microscope; photos were processed with a digital tablet, using the Adobe Illustrator® program. Dorsal chaetotaxy is based on Halliday (1987), leg chaetotaxy on Evans (1963), spermathecal apparatus on Costa (1966) and other terminology on Walter & Krantz (1986). For each structure, the mean and the corresponding range (for variable measurements) are given in micrometers.

Abbreviations used in the diagnosis and description of the new species are:

*l.ang.*: linea angulata; anterior paired lines on the sternal shield.

*l.m.t.*: linea media transversa; transverse line on sternal shield connecting insertions of *st2*.

*l.o.a.*: linea obliqua anterior; paired lines on sternal shield extending anterolaterally from insertion of *st2*.

*l.o.p.*: linea obliqua posterior; paired lines extending posteriorly from *l.m.t.*.

*a.p.p.*: area punctate; along posterior margin of sternal shield.

### 3.3. Results

In total, 3195 mites were collected, in 80% of the samples. The mesostigmatids accounted 1950 of the mites collected, and 1362 of these were macrochelids. These corresponded to 1306 females of *Macrocheles* species, 49 females of *Glyphtholaspis*, 7 females of *Holostaspella*, 95 males and 413 immatures. Males and immatures were not identified by the absence of adequate information in the literature.

#### 3.3.1. Taxonomic groups collected

##### ***Glyphtholaspis* Filipponi & Pegazzano, 1960**

##### ***Glyphtholaspis confusa* (Foà, 1900)**

*Holostaspis confusus* Foà, 1900: 137.

*Macrocheles* (*Macrocheles*) *confusus*.— Filipponi & Ilardi, 1958: 118.

*Glyphtholaspis confusa*.— Filipponi & Pegazzano, 1960: 154; Filipponi & Pegazzano, 1962: 197; Van Der Hammen, 1964: 4; Krantz, 1972: 270; Halliday, 1986c: 73; Hyatt &

Emberson, 1988: 116; Jesus & Rueda, 1990: 714; Mašán, 2003: 122; Faraji *et al.*, 2008: 234; Takaku *et al.*, 2012: 104; Özbek *et al.*, 2014: 1.

*Macrocheles (Glypholaspis) confusa*.— Bregetova, 1977: 387; Karg, 1993: 101.

*Nothrolaspis fimicola*.— Filipponi, 1955: 145 [Misidentification, according to Filipponi & Pegazzano, 1960: 154].

*Macrocheles (Macrocheles) vagabundus* var. *neotropicus* Berlese, 1918: 173 [Synonymy by Filipponi & Pegazzano, 1960: 154].

*Macrocheles (Macrocheles) vagabundus* var. *australis* Berlese, 1918: 173 [Synonymy by Filipponi & Pegazzano, 1960: 154].

*Macrocheles plumiventris* Hull, 1925: 216 [Synonymy by Filipponi & Pegazzano, 1960: 154].

*Macrocheles plumiventris*.— Evans & Browning, 1956: 36; Filipponi & Seganti, 1957: 27; Balogh, 1958: 253; Bregetova & Koroleva, 1960: 76; Schweizer, 1961: 80.

*Macrocheles (Monoplites) oudemansii* Hull, 1925: 215 [Synonymy of *Macrocheles plumiventris* by Evans & Browning, 1956: 16].

**Material examined.** Three females from Piracicaba (22°42'25.7"S, 47°38'30.4"W), 13 March 2014; two females from Cajuru (21°12'28.5"S, 47°19'35.2"W) and two females from Cajuru (21°17'30"S, 47°17'05"W), 18 February 2014; one female from Registro, 24 February 2014; one female from São Luis do Paraitinga and 13 females from Paraibuna, 10 March 2014; 24 females from Pirapozinho, 25 March 2014; three females from Nipoã (20°54'48" S, 49°46'40"W), 31 March 2014.

**Diagnosis of female.** Dorsal shield large [1,237 (1,175–1,310) long and 833 (790–875) wide at level of coxa III (n=6)], oval and with punctate-reticulate pattern. Posterior margin of dorsal shield with large denticles and numerous microdenticles. Most dorsal setae brush-shaped and long; *j*<sub>6</sub>, *z*<sub>5</sub> and 1–2 unpaired median setae (between *j*<sub>6</sub> and *J*<sub>2</sub>) smooth and short; *j*<sub>5</sub> longer than *z*<sub>6</sub>; bases of *Z*<sub>5</sub> not adjacent to each other; *J*<sub>5</sub> short, approximately half as long as *Z*<sub>4</sub>. Sternal and ventrianal shields with polygonal pattern. Ventrianal shield with anterior margin truncate. Preanal setae relatively short and brush-shaped.

**Previous records.** Argentina, Australia, Austria, Azerbaijan, Bulgaria, Caucasus, England, Germany, Greece, Indonesia, Iran, Israel, Italy, Japan, Morocco, New Zealand, Philippines, Russia, Slovakia, Switzerland, Tajikistan, Turkey, Turkmenistan, USA, Uzbekistan, Wales.

**Note.** First record in Brazil.

***Holostaspella* Berlese, 1903*****Holostaspella bifoliata* (Trägårdh, 1952)**

*Areolaspis bifoliatus* Trägårdh, 1952: 61.

*Holostaspella bifoliata*.— Filipponi & Pegazzano, 1967: 243; Krantz, 1967b: 113; Ishikawa, 1968: 201; Halliday, 1988: 151; Roy, 1989a: 337; Karg, 1993: 98; Hartini *et al.*, 2005: 202; Faraji *et al.*, 2008: 233; Takaku *et al.*, 2012: 99.

**Material examined.** Two females from Cajuru (21°17'30"S, 47°17'05"W), 18 February 2014; five females from Pirapozinho, 25 March 2014.

**Diagnosis of female.** Dorsal shield relatively small [586 (580–600) long and 356 (350–380) wide at level of coxa III (n=5)], with strong punctate pattern interspersed with finely punctate areas, laterally with a series of strongly punctate rounded depressions; *j1* broadly plumose, inserted on an anterior protuberance of the shield, longer than *z1*; *J5* pectinate, other dorsal shield setae aciculate. Sternal shield strongly punctate, with *l.o.p* and *l.m.t* forming an arch, the anterior edge of which nearly reaching the level of insertion of *st2*. Epigynial shield punctate to various degrees, truncate posteriorly. Ventrianal shield rounded, wider than long, with three pairs of aciculate preanal setae.

**Previous records.** Argentina, Australia, Congo, Costa Rica, India, Indonesia, Iran, Israel, Italy, Japan, Papua New Guinea, Peru, Philippines, Singapore, South Africa, Tahiti, USA.

**Note.** First record in Brazil.

***Macrocheles* Latreille, 1829*****Macrocheles* n. sp.**

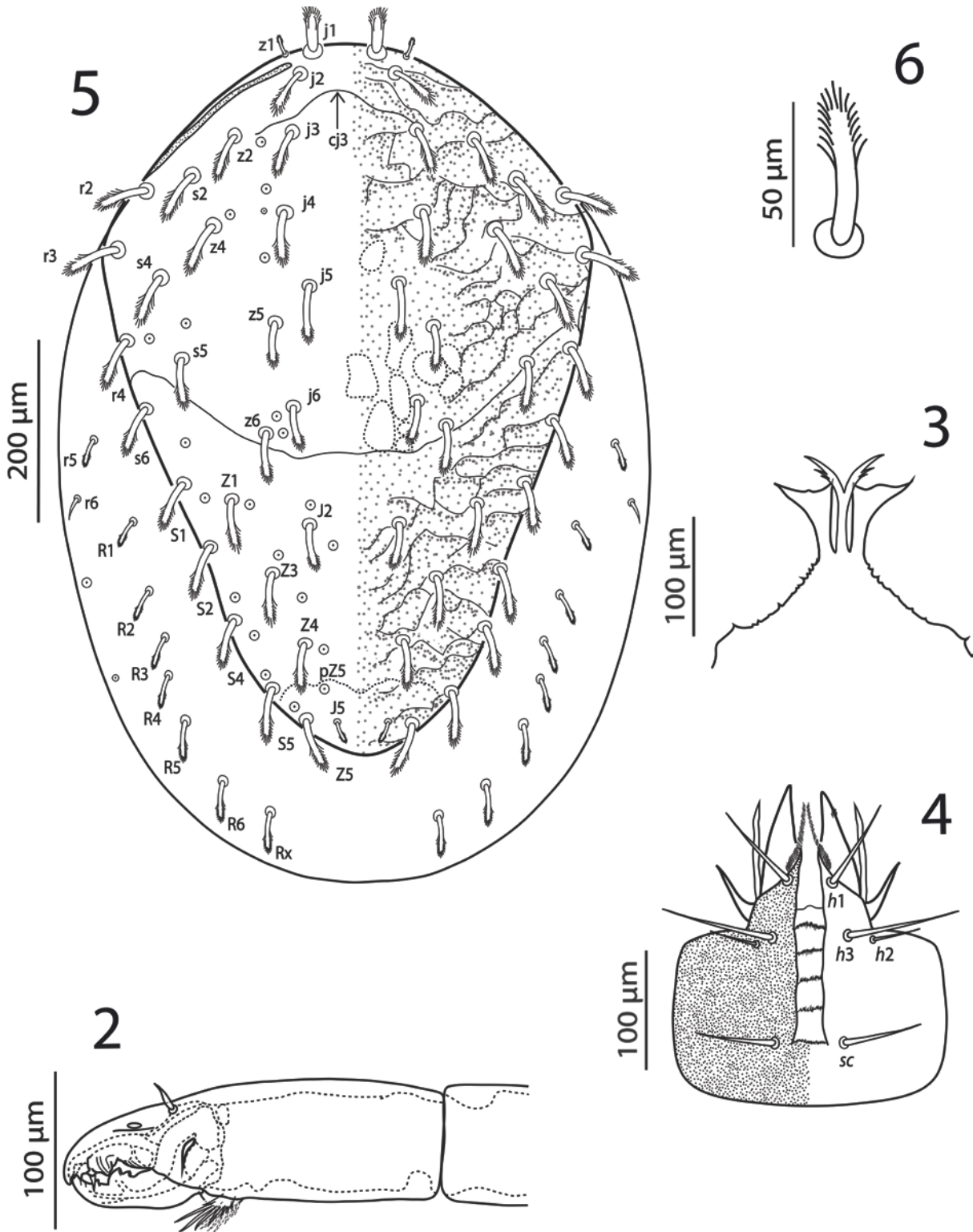
**Adult female** (Figure 2-11) – Five specimens measured.

**Gnathosoma.** Fixed cheliceral digit 105 (100–110) long, with three teeth in addition to apical tooth and a setiform *pilus dentilis* (Figure 2); movable digit 92 (90–95) long, with three teeth in addition to apical tooth; antiaxial and dorsal lyrifissures as well as dorsal seta distinct. Arthrodistal process of chelicera double brush-shaped. Numbers of setae on palp trochanter, femur and genu 2–5–6; all setiform; apotele three-tined. Epistome with a distally bifurcate anteromedian extension flanked by a pair of shorter distally expanded anterolateral extensions (Figure 3). Hypostome microtuberculate; deutosternum with six roughly transverse lines, the

most distal smooth, others multidenticulate (Figure 4). Internal malae fused with external margin fimbriate. Corniculus horn-shaped, about twice as long as its basal width. Seta *h3* about in longitudinal line with *h1*, mesad of and slightly anterior of *h2*. Measurements of setae: *h1* 68 (60–73), *h2* 36 (28–43), *h3* 95 (88–100), *sc* 37 (33–43); all aciculate and smooth.

**Dorsal idiosoma** (Figure 5). Idiosoma 900 (870–950) long and 600 (570–650) wide at widest level. Dorsal shield reticulate (except in central region of podonotal region, smooth) and punctate; 815 (735–830) long and 520 (483–542) wide at level of coxa III, attenuate posteriorly; with 28 pairs of setae (*j1–j6*, *z1*, *z2*, *z5*, *z6*, *s2–s6*, *r2–r4*, *J2*, *J5*, *Z1*, *Z3–Z5*, *S1*, *S2*, *S4* and *S5*) and 22 pairs of distinguishable pores; with a cell-like depression (*cj3*) between *j2* and *j3*; with procurved line well developed posterior of *j6*, *z6*, *s5* and *r4*; with a posterior depression encompassing pore *pZ5* and insertions of *J5* and *Z5*. Unsclerotised cuticle laterad of dorsal shield with nine pairs of setae (*r5*, *r6*, *R1–6* and *Rx*). Measurements of setae: *j1* 44 (41–48); *j2* 57 (50–65); *j3* 63 (58–64); *j4* 65 (60–70); *j5* 67 (63–70); *j6* 43 (38–48); *z1* 19 (14–25); *z2* 65 (57–70); *z5* 42 (39–45); *z6* 51 (45–55); *s2* 53 (47–60); *s3* 64 (58–67); *s4* 71 (62–75); *s5* 66 (60–75); *s6* 65 (55–72); *r2* 62 (57–67); *r3* 63 (57–67); *r4* 58 (51–65); *r5* 30 (20–35); *r6* 27 (25–30); *J2* 45 (40–50); *J5* 29 (21–33); *Z1* 67 (60–75); *Z3* 61 (50–65); *Z4* 60 (50–65); *Z5* 59 (51–67); *S1* 53 (50–57); *S2* 61 (52–70); *S4* 68 (57–75); *S5* 67 (59–76); *R1* 29 (25–35); *R2* 33 (28–40); *R3* 38 (33–43); *R4* 38 (33–43); *R5* 43 (38–45); *R6* 48 (43–55); *Rx* 53 (48–55). All setae distinctly pilose distally (Figure 6), *r6* aciculate and smooth; *j1* stouter than other setae and with remote insertions.





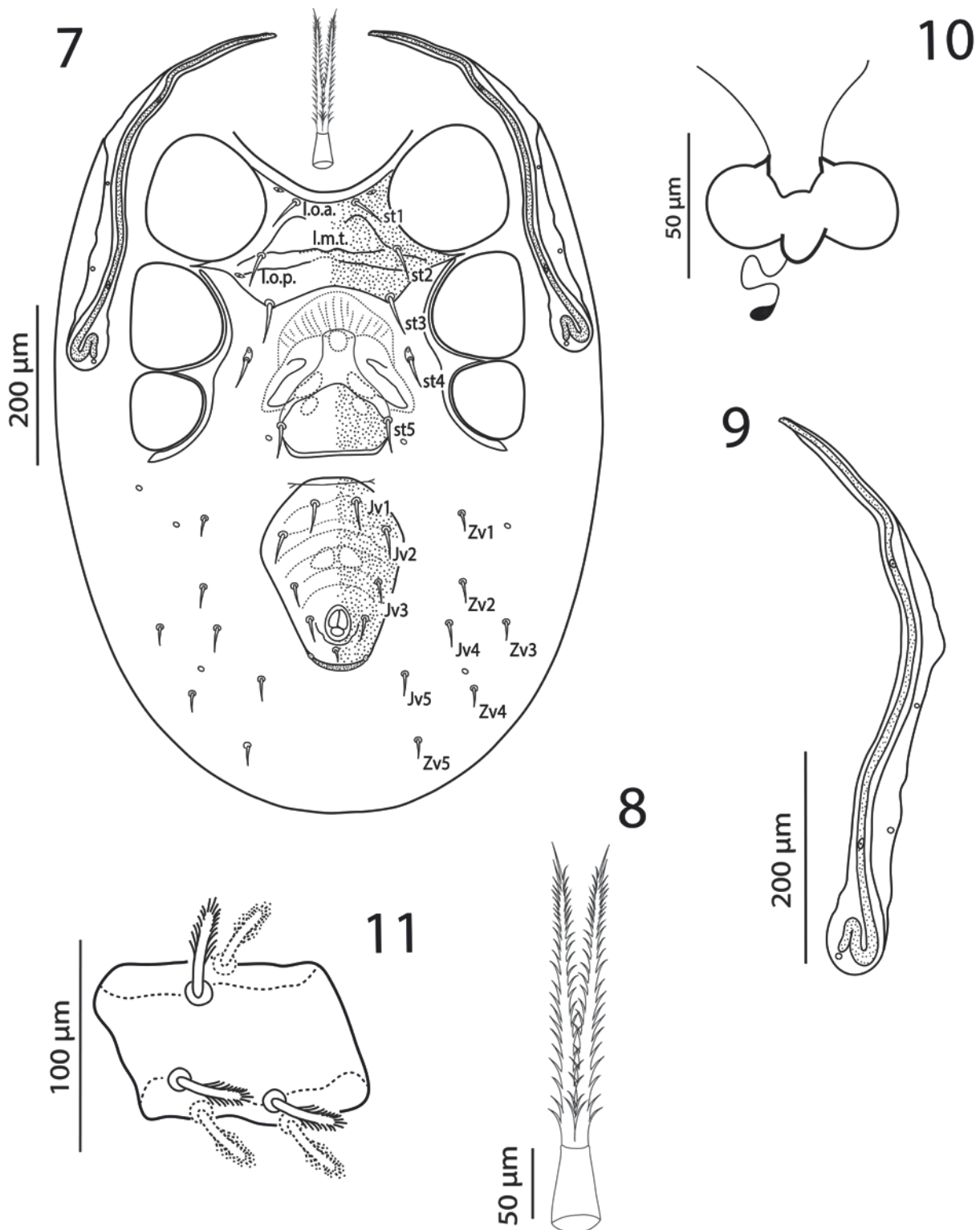
**Figure 2.** *Macrocheles* n. sp. Female. 2. Lateral (antiaxial) view of chelicera; 3. Epistome; 4. Hypostome; 5. Dorsal idiosoma; 6. Seta *j*5.

**Ventral idiosoma** (Figure 7). Base of tritosternum 54 (43–65) long and 24 (23–25) wide proximally; laciniae 117 (95–133) long, pilose (Figure 8). Sternal shield with micropunctations and lines *l.m.t.*, *l.o.a.* and *l.o.p.*; *a.p.p.* absent; 123 (120–125) long and 170

(162–183) wide at level of coxae II; with three pairs of setae and two pairs of lyrifissures. Seta *st4* and associate lyrifissure on metasternal platelet. Epigynial shield with micropunctations; 149 (138–155) long and 147 (133–158) wide at widest level, posterior margin straight; with a pair of accessory sclerites and with a pair of epigynial setae (*st5*). Ventrianal shield with micropunctations and semiconcentric lines; 245 (220–262) long and 187 (165–203) wide at widest level; with three pairs of preanal setae (*Jv1*, *Jv2* and *Jv3*) in addition to circum-anal setae; without distinguishable pores. Opisthogastric unsclerotised cuticle with seven pairs of setae (*Jv4*, *Jv5* and *Zv1*–*Zv5*). Peritreme extending anteriorly almost to level of *z1*; with two pairs of lyrifissures (at level of posterior margin of coxa III and at level of coxa I) (Figure 9). Peritrematic shield restricted to the length of peritreme, fused to dorsal shield at level of *z4*; with one pair of pores next to posterior tip of peritreme and one pair of pores at level of median region of coxa II; one pair of lyrifissures at level of posterior margin of coxa III. The cribral glands tuberculate and easily discernible at the cribral margins. Measurements of setae: *st1* 56 (50–60); *st2* 56 (50–58); *st3* 53 (47–58); *st4* 45 (43–50); *st5* 44 (43–48); *Jv1* 39 (33–42); *Jv2* 38 (30–42); *Jv3* 33 (30–38); *Jv4* 33 (30–35); *Jv5* 32 (30–35); *Zv1* 30 (23–38); *Zv2* 33 (28–35); *Zv3* 33 (28–35); *Zv4* 34 (28–38); *Zv5* 46 (40–55); para-anal 37 (35–40); post-anal 11 (10–13). All ventral idiosomal setae aciculate and smooth.

**Spermathecal apparatus** (Figure 10). Similar to that of *Macrocheles robustulus* Berlese, illustrated by Costa (1966). Solenostome apparently opening at posteromedian margin of base of coxa III; infundibulum discreet. *Sacculus foeminus* consisting of two globular structures connected by a broad passage; *tubulus annulatus* meeting each globular structure via cone-shaped *ramus sacculus*; *cornu sacculus* thick-walled at region near *sacculus foeminus*, continuing as a narrow duct that flares distally into a rugose structure.

**Legs.** Length of legs (except ambulacrum): I, 620 (600–650); II, 654 (560–750); III, 676 (630–720); and IV, 1000 (920–1060). Chaetotaxy (coxa–tibia), I: 0-0/2,0/0-0, 1-0/1,1/1-1, 1-3/2,2/3-2, 3-2/2,1/1-2, 3-2/2,1/2-2; II: 0-0/1,0/1-0, 1-0/1,0/2-1, 2-3/1,2/2-1, 2-3/1,2/1-2, 2-2/1,2/1-2; III: 0-0/1,0/1-0, 1-1/2,0/0-1, 1-3/1,0/0-1, 1-2/1,2/0-1, 1-2/1,1/1-1; IV: 0-0/1,0/0-0, 1-1/2,0/1-0, 1-2/1,1/0-1, 1-2/1,1/0-1 (Figure 11), 1-2/1,1/1-1. Tarsi II–IV with 18 setae each. Tarsus I without ambulacrum and claw; tarsi II – IV with well developed ambulacra and claws.



**Figure 3.** *Macrocheles* n. sp. Female. 7. Ventral Idiosoma; 8. Tritosternum; 9. Peritreme; 10. Spermathecal apparatus; 11. Genu of leg IV.

**Material examined.** Holotype female and four paratype females from manure at “Fazenda Paraíso” (22°27’20’’S; 49°20’15’’W), Cabrália Paulista, São Paulo state, Brazil, 24 March 2014. All types collected by L.H. Azevedo and deposited at Departamento de Entomologia e

Acarologia, Escola Superior de Agricultura “Luiz de Queiroz” (ESALQ), Universidade de São Paulo (USP), Piracicaba, State of São Paulo, Brazil.

### Remarks

*Macrocheles* n. sp. is similar to species of *dimidiatus* complex of the *dimidiatus* species group (Krantz, 2007), mainly by having dorsal shield attenuated posteriorly and with procurved line, *j*1 pectinate and stouter than *j*2. *Macrocheles* n. sp. is more similar to *Macrocheles dimidiatus* Berlese but females of the latter species have setae *z*5, *j*6, *J*2 and *r*5 aciculate and smooth, unsclerotised cuticle laterad of dorsal shield with 11 pairs of setae (*r*5–*r*6, *R*1–6 and three *R*x), sternal shield with *l.ang.* and *a.p.p.* present.

The species of this group are a strongly cohesive assemblage not only morphologically, but also geographically and behaviorally. Members of the group are confined to the New World, with the vast majority of species being found in the neotropics (Krantz, 2007).

### *Macrocheles insignitus* Berlese, 1918

*Macrocheles (Cophrolaspis) insignitus* Berlese, 1918: 158.

*Macrocheles insignitus*.— Evans & Browning, 1956: 21; Filipponi & Pegazzano, 1963: 78; Bregetova, 1977: 355; Hyatt & Emberson, 1988: 113; Krantz & Whitaker, 1988: 236; Masán, 2003: 116; Faraji *et al.*, 2008: 234; Ács & Kontschán, 2014: 114.

*Macrocheles (Macrocheles) insignitus*.— Karg, 1971: 134; Karg, 1993: 110.

*Macrocheles whartoni* Delfinado & Baker, 1975: 55 [Synonymy by Krantz & Whitaker, 1988: 236].

**Material examined.** Four females from Pirapozinho, 25 March 2014; one female from Araçoiaba da Serra, 25 February 2014.

**Diagnosis of female.** Dorsal shield relatively small [less than 525 µm in length; 570 (480–590) long and 332 (280–370) wide at level of coxa III (n= 5) in specimens collected in this study] and broadly oval. Dorsal setae smooth, except *J*5, pilose; *j*1 spine-shaped. Sternal shield with *l.o.a.* connected by four punctuate transversal lines; *l.m.t.* arched forwards.

**Previous records.** Bulgaria, Canada, China, England, France, Georgia, Hungary, Iran, Italy, Macedonia, Mexico, Poland, Romania, Russia, Serbia, Slovakia, Wales.

**Note.** First record in Brazil.

### *Macrocheles mammifer* Berlese, 1918

*Macrocheles (Nothrolaspis) mammifer* Berlese, 1918: 171.

*Macrocheles mammifer*.— Krantz, 1967a: 150; Bregetova, 1977: 363; Wallace, 1986: 11; Krantz & Whitaker, 1988: 236; Masán, 2003: 94; Takaku *et al.*, 2012: 108.

*Macrocheles (Macrocheles) mammifer*.— Karg, 1993: 113; Ahadiyat *et al.*, 2014: 236.

*Macrocheles tridentatus*.— Delfinado & Baker, 1975: 53 [Misidentification, according to Krantz & Whitaker, 1988: 236].

*Holostaspella polyornata* Turk, 1948: 105 [Synonymy by Krantz, 1967b: 143].

*Macrocheles pavlovskii* Bregetova & Koroleva, 1960: 83 [Synonymy by Krantz, 1967a: 150].

*Macrocheles (Macrocheles) pavlovskii*.— Karg, 1971: 138.

*Macrocheles (Macrocheles) postneri* Krauss, 1970: 28 [Synonymy by Krantz & Whitaker, 1988: 236].

*Glypholaspis orientalis* Iavorschi, 1980: 149 [Synonymy by Krantz & Whitaker, 1988: 236].

**Material examined.** Three females from Piracicaba (22°42'25.7"S, 47°38'30.4"W), 15 females from Cajuru (21°12'28.5"S, 47°19'35.2"W) and eight females from Cajuru (21°17'30"S, 47°17'05"W), 18 February 2014; 25 females from Paraibuna, 10 March 2014; 19 females from Pirapozinho, 25 March 2014; two females from Araçoiaba da Serra (23°31'20,46"S, 47°38'24,05"W), 25 February 2014; three females from Nipoã (20°54'48" S, 49°46'40"W), 31 March 2014.

**Diagnosis of female.** Dorsal shield moderately large [882 (840–900) long and 626 (600–660) wide at level of coxa III (n=5)], reticulate and punctate; *j*<sub>2</sub>, *j*<sub>5</sub>, *j*<sub>6</sub>, *z*<sub>1</sub>, *z*<sub>5</sub>, *z*<sub>6</sub>, *s*<sub>2</sub>, *s*<sub>6</sub>, *r*<sub>4</sub>, *J*<sub>2</sub>, *J*<sub>5</sub> and *S*<sub>1</sub> aciculate, other dorsal setae plumose distally. Sternal shield punctate; *l*.ang. convergent medially. Ventrianal shield expanded laterally, reticulate-punctate.

**Previous records.** Argentina, Australia, Brazil, Cuba, Germany, Indonesia, Iran, Israel, Japan, Malaysia, Mariana Island, Micronesia, Philippines, Poland, Russia, Singapore, Slovakia, Spain, Trinidad and Tobago, USA.

### ***Macrocheles merdarius* (Berlese, 1889)**

*Gamasus tardus* (protonymph).— Berlese, 1882a: 103 [Misidentification; see subsequent note].

*Holostaspis marginatus* (“prima forma giovanile”).— Canestrini & Canestrini, 1882: 25 [Misidentification; see subsequente note].

*Holostaspis merdarius* Berlese, 1889: 1.

*Holostaspis merdarius*.— Berlese, 1892: 70.

*Macrocheles (Coprholaspis) merdarius*.— Berlese, 1918: 146.

*Macrocheles merdarius*.— Sellnick, 1940: 86; Evans & Browning, 1956: 21; Bregetova & Koroleva, 1960: 145; Filipponi & Pegazzano, 1963: 83; Axtell, 1963: 628; Krantz & Filipponi, 1964: 36; Krauss, 1970: 17; Emberson, 1973a: 120; Bregetova, 1977: 355; Wallace, 1986: 9; Hyatt & Emberson, 1988: 113; Krantz & Whitaker, 1988: 243; Jesus & Rueda, 1990: 712; Masán, 2003: 117; Faraji *et al.*, 2008: 234; Takaku *et al.*, 2012: 108.

*Macrocheles medarius* [sic].— Axtell, 1961: 748.

*Macrocheles (Macrocheles) merdarius*.— Karg, 1971: 134; Karg, 1993: 110.

*Holostaspis adulescens* Berlese, 1910: 252 [Synonymy by Filipponi & Pegazzano, 1963: 83].

*Macrocheles (Coprholaspis) adulescens*.— Berlese, 1918: 146.

**Note.** Specimens reported by Berlese (1882a: 103) as protonymph of *Gamasus tardus* Koch and by Canestrini & Canestrini (1882: 26) as “prima forma giovanile” of *Holostaspis marginatus* (Hermann) were described as *Holostaspis merdarius* Berlese by Berlese, 1889: 1.

**Material examined.** Eight females from Piracicaba (22°42'25.7"S, 47°38'30.4"W), 13 March 2014; 147 females from Cajuru (21°12'28.5"S, 47°19'35.2"W) and 223 females from Cajuru (21°17'30"S, 47°17'05"W), 18 February 2014; 13 females from Pariquera-Açu and 54 females from Registro, 24 February 2014; five females from São Luis do Paraitinga and 223 females from Paraibuna, 10 March 2014; 109 females from Piratininga and one female from Cabrália Paulista, 24 March 2014; 55 females from Pirapozinho and two females from Narandiba, 25 March 2014; 15 females from Araçoiaba da Serra (23°31'20,46"S, 47°38'24,05"W) and 80 females from Araçoiaba da Serra (23°31'18,07"S, 47°36'26,34"W), 25 February 2014; 12 females from Nipoã (20°54'48" S, 49°46'40"W) and 57 females from Nipoã (20°40'20"S, 49°10'22"W), 31 March 2014.

**Diagnosis of female.** Dorsal shield relatively small [488 (470–510) long and 302 (290–310) wide at level of coxa III (n=5)], broadly oval and reticulate; dorsal setae smooth, except *J5*, denticulate and shorter than in *M. insignitus*; *j1* spine-shaped. Ventral shields broadly reticulate. Sternal shield poorly marked with punctate transverse lines; without punctate areas behind *l.m.t.*.

**Previous records.** Australia, Austria, Brazil, Bulgaria, Canada, China, Czech Republic, Ecuador, England, Finland, France, Galapagos Islands, Georgia, Germany, Greece, Iceland, India, Indonesia, Iran, Israel, Italy, Japan, Kenya, Malaysia, Mexico, Morocco, New Zealand, Norway, Papua New Guinea, Philippines, Poland, Russia, Slovakia, South Africa, South Korea, Tajikistan, Ukraine, USA.

***Macrocheles muscaedomesticae* (Scopoli, 1772)**

*Acarus muscae domesticae* Scopoli, 1772: 125.

*Macrocheles muscaedomesticae*.— Pereira & Castro, 1945: 161; Evans & Browning, 1956: 12; Axtell, 1963: 628; Krantz & Filipponi, 1964: 36; Bregetova & Koroleva, 1960: 131; Méndez Olivo, 1968: 142; Krauss, 1970: 14; Krantz, 1972: 273; Bregetova, 1977: 378; Hyatt & Emberson, 1988: 105; Halliday, 1990: 417; Jesus & Rueda, 1990: 711; Masán, 2003: 114; Faraji *et al.*, 2008: 234; Takaku *et al.*, 2012: 113.

*Macrocheles muscae domesticae*.— Sellnick, 1940: 78.

*Macrocheles (Macrocheles) muscaedomesticae*.— Karg, 1971: 138; Karg, 1993: 114.

*Macrocheles vagabundus* var. *australis*.— Womersley, 1942: 166 [Misidentification, according to Halliday, 2000: 302].

*Acarus marginatus* Hermann, 1804: 76 [Synonymy by Evans & Browning, 1956: 12].

*Macrocheles marginatus*.— Latreille, 1829: 282; Hull, 1925: 215.

*Gamasus marginatus*.— Berlese, 1906: 282.

*Gamasus (Holostaspis) marginatus*.— Berlese, 1882b: 636.

*Holostaspis marginatus*.— Canestrini & Canestrini, 1882: 26; Canestrini, 1885: 61; Berlese, 1892: 70; Berlese, 1913b: 98.

*Holostaspis favosa* Müller, 1860: 180 [Synonymy of *Holostaspis marginatus* (Hermann) by Berlese, 1892: 71].

*Holostaspis submarginatus* Foà, 1900: 135 [Synonymy by Krantz & Filipponi, 1964: 36].

*Holostaspis posteroarmatus* Berlese, 1904a: 263 [Synonymy by Filipponi & Pegazzano 1962: 204].

*Holostaspis sita* Trojan, 1908: 1 [Synonymy by Berlese, 1918: 189].

*Macrocheles canadensis* Banks, 1912: 98 [Synonymy by Hennessey & Farrier, 1988: 20].

**Material examined.** Two females from Piracicaba (22°42'25.7"S, 47°38'30.4"W) and one female from Cajuru (21°12'28.5"S, 47°19'35.2"W), 18 March 2014; three females from São Luis do Paraitinga and 22 females from Paraibuna, 10 March 2014; two females from Piratininga, 24 March 2014; three females from Pirapozinho, 25 March 2014; 99 females from Araçoiaba da Serra (23°31'18,07"S, 47°36'26,34"W), 25 February 2014; two females from Nipoã (20°54'48" S, 49°46'40"W), 31 March 2014.

**Diagnosis of female.** Dorsal shield widest in its anterior part, relatively large [974 (940–1,000) long and 658 (640–670) wide at level of coxa III (n=5)], reticulate and smoothly punctuated; *j*1 brush-shaped and plumose; some dorsocentral and mediolateral dorsal setae,

including *j5*, smooth and needle-shaped; *J5* pilose. Sternal shield with distinct *l.o.a.*, without punctuated areas; *l.m.t.* approximately straight; section of sternal shield behind *l.m.t.* with 1-2 transverse lines and irregularly arranged punctures. Ventrianal shield subpentagonal and reticulate.

**Previous records.** Argentina, Australia, Austria, Brazil, Canada, China, Czech Republic, Ecuador, Egypt, England, Finland, France, Galapagos Islands, Germany, Greece, Hawaii, Hungary, Iceland, India, Indonesia, Iran, Iraq, Israel, Italy, Japan, Libya, Malaysia, Mexico, New Zealand, Philippines, Poland, Russia, Slovakia, South Korea, Switzerland, Tajikistan, Tasmania, Turkey, USA, Uzbekistan.

***Macrocheles robustulus* (Berlese, 1904)**

*Holostaspis subbadius* var. *rubustulus* [sic] Berlese, 1904a: 264.

*Macrocheles robustulus*.— Axtell, 1961: 748; Filipponi & Pegazzano, 1962: 230; Axtell, 1963: 628; Costa, 1963: 32; Krantz & Filipponi, 1964: 40; Costa, 1966: 533; Krauss, 1970: 136; Krantz, 1972: 271; Bregetova, 1977: 376; Emberson, 1980: 136; Cicolani, 1985: 172; Wallace, 1986: 11; Hyatt & Emberson, 1988: 106; Faraji *et al.*, 2008: 235.

*Macrocheles (Macrocheles) robustulus*.— Karg, 1971: 132; Karg, 1993: 109.

*Holostapis humeratus* Berlese, 1908: 13 [Synonymy by Filipponi & Pegazzano, 1962: 234].

*Nothrolaspis punctillatus* Willmann, 1939: 176 [Synonymy by Filipponi, 1959: 210].

*Macrocheles punctillatus*.— Bregetova & Koroleva, 1960: 126.

*Macrocheles coprophila* Womersley, 1942: 167 [Synonymy by Filipponi & Pegazzano 1962: 234].

*Macrocheles rothamstedensis* Evans & Browning, 1956: 15 [Synonymy of Filipponi, 1959: 210].

**Note.** *rubustulus* - incorrect original spelling of *robustulus* (Berlese), ICZN Opinion 1638.

**Material examined.** Ten females from Cajuru (21°12'28.5"S, 47°19'35.2"W) and three females from Cajuru (21°17'30"S, 47°17'05"W), 18 February 2014; one female from Registro, 24 February 2014; two females from Araçoiaba da Serra (23°31'20,46"S, 47°38'24,05"W), 25 February 2014.

**Diagnosis of female.** Dorsal shield relatively medium sized [616 (640–740) long and 350 (380–450) wide at level of coxa III (n=5)]; seta *j1* elongate, over twice as long as *j2* and noticeably longer than *j3*, minutely pilose distally; *J5* aciculate, about half as long as *Z5*. Sternal shield without distinct lines but with a more or less symmetrical pattern of punctures, some of which may be linearly arranged.



**Previous records.** Argentina, Australia, Austria, Brazil, Bulgaria, Czech Republic, England, France, Georgia, Germany, Greece, Hungary, Iran, Israel, Italy, Morocco, New Zealand, Poland, Russia, Slovakia, Switzerland, USA.

***Macrocheles roquensis* Mendes & Lizaso, 1992**

*Macrocheles roquensis* Mendes & Lizaso, 1992: 359.

**Material examined.** Nine females from Cajuru (21°17'30"S, 47°17'05"W), 18 February 2014; 16 females from Pirapozinho, 25 March 2014.

**Diagnosis of female.** Dorsal shield large [1088 (980–1250) long and 708 (640–850) wide at level of coxa III (n=5)], reticulate; lateral margins undulated; procurved line present and clear; seta *j*<sub>1</sub> long and pilose in two distal thirds; *z*<sub>1</sub> short and smooth; *J*<sub>5</sub> long and serrate; other dorsal shield setae long and smooth. Sternal shield with *l.m.t.* flanked by pores in the antero-central part; *l.o.p.* continuous and flanked by pores; *a.p.p.* with large pores.

**Previous record.** Brazil.

***Macrocheles subbadius* (Berlese, 1904)**

*Gamasus tardus*.— Berlese, 1882a: 105 [Misidentification; see subsequent note].

*Holostaspis marginatus*.— Berlese, 1889: 6 [Misidentification; see subsequent note].

*Macrocheles subbadius*.— Filipponi & Seganti, 1957: 27; Bregetova & Koroleva, 1960: 132; Axtell, 1961: 748; Filipponi & Pegazzano, 1963: 73; Axtell, 1963: 628; Emberson, 1973: 294; Bregetova, 1977: 354; Wallace, 1986: 12; Hyatt & Emberson, 1988: 111; Masán, 2003: 115; Faraji *et al.*, 2008: 234.

*Macrocheles* (*Macrocheles*) *subbadius*.— Karg, 1993: 109.

*Macrocheles situs* Karg, 1978: 364 [Synonymy by Krantz & Whitaker, 1988: 257].

**Note.** Specimens reported by Berlese (1882a: 105) as *Gamasus tardus* Koch and by Berlese (1889: 6) as *Holostaspis marginatus* (Hermann) were described as *Holostaspis subbadius* Berlese by Berlese, 1904a: 264.

**Material examined.** 13 females from Cajuru (21°12'28.5"S, 47°19'35.2"W), 18 February 2014; 21 females from Registro, 24 February 2014; five females from Paraibuna, 10 March 2014; one female from Araçoiaba da Serra (23°31'20,46"S, 47°38'24,05"W), 25 February 2014; one female from Nipoã (20°40'20"S, 49°10'22"W), 31 March 2014.

**Diagnosis of female.** Dorsal shield medium sized [640 (570–680) long and 394 (380–450) wide at level of coxa III (n=5)]; dorsal shield setae aciculate; seta *j*<sub>1</sub> short. Sternal shield with *l.o.a.* joined by four or five transverse lines, the most posterior of which is the *l.m.t.*

**Previous records.** Australia, Austria, China, England, Germany, Greece, Indonesia, Iran, Ireland, Italy, New Zealand, Poland, Russia, Saudi Arabia, Slovakia, Switzerland, USA.

**Note.** First record in Brazil.

### 3.3.2. Distribution of the species collected in the study area

In addition to being by far more numerous, *M. merdarius* was also the species most widely distributed, being found in all of the eight regions where the study was conducted (Table 1). Likewise, Ribeirão Preto was the region where the largest number of specimens and of species was found.

Table 1. Numbers of specimens of each macrochelid species collected in the survey conducted in São Paulo state in February and March 2014 at each of the following region: A. Piracicaba; B. Ribeirão Preto; C. South Coast; D. Vale do Paraíba; E. Bauru; F. Presidente Prudente; G. Sorocaba; H. São José do Rio Preto.

Region Species	A	B	C	D	E	F	G	H	Total
<i>Glyptolaspis confusa</i>	3	4	1	14	-	24	-	3	49
<i>Holostaspella bifoliata</i>	-	2	-	-	-	5	-	-	7
<i>Macrocheles insignitus</i>	-	-	-	-	-	4	1	-	5
<i>Macrocheles mammifer</i>	3	23	-	25	-	19	2	3	75
<i>Macrocheles merdarius</i>	8	370	67	228	110	57	95	69	1,004
<i>Macrocheles muscaedomesticae</i>	2	1	-	25	2	3	99	2	134
<i>Macrocheles</i> n. sp.	-	1	-	-	5	-	-	-	3
<i>Macrocheles robustulus</i>	-	13	1	-	-	-	2	-	16
<i>Macrocheles roquensis</i>	-	9	-	-	-	16	-	-	25
<i>Macrocheles subbadius</i>	-	13	21	5	-	-	1	1	41
Total	16	436	90	297	114	128	200	78	1,359

### 3.4. Discussion

The macrochelid species found in this study seems a good representation of the fauna of São Paulo state in commercial cow raising farms. Most of the samples taken from those places represent the most natural microhabitats where the stable fly develops (Dominghetti et

al., 2015), intending to determine species that could be naturally related to this parasite, and that could be considered in subsequent works concerning its biological control.

An unpublished laboratory study showed the quick development and reproduction of *Macrocheles* n. sp. when offered the stable fly as prey, suggesting that this could be a good control agent of that parasite. In order for that study to be published, this macrochelid species needs to be officially named.

However, the methodology used in the study does not allow inferences about the potential effect of each species on the stable fly, given that other fly species are commonly associated with cow droppings, so that the macrochelids found could be feeding on other fly species. Yet, the results facilitate the selection of sites envisioning the collection of each species for specific biological studies.

In addition to that, despite the widely variable abundances of the different species, mite numbers are not necessarily good indicators of the importance of natural enemies. Many other factors could also be important, one of which is biomass. In the present work, the number of specimens of *M. muscaedomesticae* represented only 10% of the number of specimens of *M. merdarius*. However, the mean biomasses of those species are quite different (respectively 0.32 and 0.04 mg, determined using an analytical balance). Thus, the biomasses of specimens of those species in this study were quite similar, despite the large difference in numbers, and size could be related to consumption capacity of those predators. Also of importance for subsequent studies is the determination of the age of the droppings and their position on the farm.

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## 4. POTENTIAL OF MACROCHELID MITES (ACARI: MESOSTIGMATA: MACROCHELIDAE) AS CONTROL AGENTS OF HARMFUL MUSCID FLIES (DIPTERA: MUSCIDAE)

### ABSTRACT

The stable fly (*Stomoxys calcitrans*), housefly (*Musca domestica*) and horn fly (*Haematobia irritans*) are parasites which attacks mainly cattle and horses, and can be disease vectors. In addition, other edaphic organisms can cause severe damage to cultivated plants. Predatory mites of the family Macrochelidae often occur in habitats with a high content of organic matter in decomposition and have been considered promising biological control agents of eggs and larvae of flies and others harmful organisms. The aim of this study was to evaluate the effect of 3 species of Macrochelidae, *Macrocheles* n. sp., *Macrocheles muscaedomesticae* and *Macrocheles robustulus*, on six prey species: *Stomoxys calcitrans*, *Musca domestica*, *H. irritans*, *Bradysia matogrossensis*, *Protorhabditis* sp. and *Rhizoglyphus* sp. Experiments were conducted in a chamber at  $30 \pm 2$  °C,  $70 \pm 10\%$  RH in the dark. The three macrochelids consumed all evaluated prey types, but *Macrocheles* n. sp. presented higher predation and oviposition rates in larvae of *S. calcitrans* (23.8 larvae consumed and laid about 4 eggs per day, respectively). Feeding on *Rhizoglyphus* sp. resulted in extremely low oviposition rates of the three predators. Survivorship was high ( $\geq 73$ ) for all predators on all prey items. These results suggest that all the natural enemies evaluated are promising for use as control agents of flies tested.

Keywords: *Macrocheles*; Predatory mites; Biological Control; Harmful organisms

### 4.1. Introduction

The Macrochelidae constitute an abundant and diverse group of soil predatory mites mostly associated with decomposing organic matter where fly larvae are commonly found, sometimes also found in the litter where flies are not common (Gerson *et al.*, 2003; Lindquist *et al.*, 2009). A revision about the biology and ecology of mites of this group was recently published (Azevedo *et al.* 2015). This large group, comprising about 520 species (Chapter two of this thesis), some of which have been evaluated for some time for their predaceous behavior on fly larvae and immatures of other invertebrates. Macrochelids have being mentioned as potentially useful as biological control agents of arthropods, especially of fly species (Krantz, 1983; Azevedo *et al.*, 2015). One of these species, *Macrocheles robustulus* (Berlese), has been commercialized in Europe for the control of fungus gnats (Sciaridae),

thrips and a species of *Lyprausta* fly (Keroplastidae). Several papers have been published about the macrochelid species found in Brazil (Chapter two of this thesis). However, the potential of macrochelid populations naturally found in this country has not been evaluated.

Several fly species are known as harmful organisms in Brazil. One of these is the stable fly, *Stomoxys calcitrans* L.. Adults of this species are considered serious parasites of different animals, especially cattle, as well as of humans in different parts of the world (Australia, United States of America, Costa Rica, Colombia, Tanzania and Congo) (Fosbrooke, 1963; Herrero *et al.*, 1989; Mora *et al.*, 1997; Cook *et al.*, 1999; Broce *et al.*, 2005; Elkan *et al.*, 2009). In Brazil, its importance has increased tremendously in recent years, especially in the central and southeastern states, in association with the increased field applications of vinasse, a byproduct of the sugar and alcohol industry. A mixture of vinasse with sugarcane leaves left in the field during harvesting constitutes an excellent substrate for the development of immature stable flies (Cançado *et al.*, 2013; Dominghetti *et al.*, 2015).

The housefly, *Musca domestica* L., is worldwide the most common nuisance insect, that in the immature phase develops in substrates found in different habitats, as in aviaries and stables, and then, as adults, can vector microorganisms harmful to humans and other animals (Legner, 1995; Mariconi *et al.*, 1999; Skovgård & Nachman, 2004; Malik *et al.*, 2007). The horn fly, *Haematobia irritans* L., is also considered an important harmful organism in several countries in Europe, Americas, Asia and non-tropical Africa. Immatures of this fly develop in cattle droppings, and adults live as cattle parasites (Barros, 2001; Pruett *et al.*, 2003; Almeida, 2010).

Several other soil organisms are potential prey for macrochelid mites. Some of those can cause severe damage to cultivated plants. An example are the fungus gnats, flies of the family Sciaridae and the bulb mite, *Rhizoglyphus* species of the family Acaridae, that damage plant parts underground on at soil level. Still another group of organisms extensively found in the soil are nematodes, some of which are free living and others are plant parasites (Weischer & Brown, 2001; Zhang, 2003; Moraes & Flechtmann, 2008; Navarro & Gea, 2014).

Control of all those harmful organisms is often difficult and has commonly been done with the use of chemicals. Thus, evaluation of the potential of macrochelid mites for the control of those organisms is warranted.

In the development of a biological control strategy, after the determination of the fauna in the area where the pest or parasite is intended to be controlled, the second step usually consists of the evaluation of the potential of the native natural enemies to be used as biological control agents. Thus, the aim of this study was to evaluate the potential of three

species of *Macrocheles* [*Macrocheles* n. sp., *Macrocheles muscaedomesticae* (Scopoli) and *Macrocheles robustulus*] as predatory mites of the above harmful organisms.

## 4.2. Material and Methods

The study was conducted at ESALQ-USP and EMBRAPA Gado de Leite, between October 2014 and November 2015. It was conducted in incubators, at  $30 \pm 1$  °C,  $95\% \pm 3\%$  RH and in the dark. The voucher specimens of the species studied were deposited in the mite reference collection of ESALQ/USP.

### 4.2.1. Mite sampling and rearing

Specimens of *Macrocheles* n. sp., *M. muscaedomesticae* and *M. robustulus* were collected from cattle manure at Cabrália Paulista, Piracicaba and Araçoiaba da Serra, respectively, in São Paulo state, Brazil, in February and March 2014. The colonies were maintained in the laboratory in plastic units (8 cm diameter and 7 cm high) whose bottom was covered with a layer of 0.5 cm of a mixture of nine parts of gypsum and one part of activated charcoal; this layer was maintained humid by daily additions of distilled water. Each unit was filled to 70% of their capacity with vermiculite, and the predatory mites were fed with a mixture of all stages of a free-living nematode [*Protorhabditis* sp. (Nematoda: Rhabditidae)], and with eggs and larvae of housefly.

The following species were reared in the laboratory to be evaluated as prey: *S. calcitrans* (larvae in a protein mixture and adults on cattle blood, according to the method described by P.H.D. Cançado, personal communication); *M. domestica* (larvae in wheat bran and adults in a mixture of milk and sugar); *B. matogrossensis* (adults and larvae on dog food inoculated with the fungus *Rhizopus* sp.); *R. echinopus* (all stages on dog food); and the nematode *Protorhabditis* sp. (all stages in thin layers of pods of *Canavalia ensiformis* L.). The tests using eggs of *H. irritans* were not conducted with all species of predatory mites due to the absence of an established colony of this fly and because of the difficulty in getting these eggs in the field. *Protorhabditis* sp. was used as a control.

#### 4.2.2. Predation tests

The method adopted was based on similar previous studies of Phytoseiidae, Rhodacaridae and Laelapidae predatory mites (Furtado *et al.* 2007; Castilho *et al.* 2009; Moreira *et al.*, 2015). The experimental unit consisted of a Petri dish (2.7 cm in diameter x 1.2 cm in height). The bottom of each unit was covered with a layer of 0.5 cm of a mixture of nine parts of gypsum and one part of activated charcoal, maintained humid by daily additions of distilled water. The open end of each unit was sealed with a piece of transparent plastic film (Magipac®), to prevent organisms from escaping.

Initially, the following prey species were separately transferred to each experimental unit: 50 eggs of *S. calcitrans*, 50 larvae of first instar (L1) of *S. calcitrans*, 20 eggs of *M. domestica*, 20 larvae of first instar (L1) of *M. domestica*, 20 eggs of *H. irritans*, 20 larvae of first instar (L1) of *B. matogrossensis*, 30 nymphs of *Rhizoglyphus* sp., or a surplus amount of *Protorhabditis* sp. (determined in preliminary tests). In the latter case, the nematodes were transferred and remained in each unit on a slice of jack bean pod. Soon after, a 0 to 2-day old gravid adult female of each predatory mite taken from the stock colonies were transferred to each unit. Each unit constituted a replicate and 30 replicates were considered for each species of predatory mite.

The units were examined at 12 h intervals for 10 consecutive days to determine the number of prey killed, the number of eggs laid by the predator and their survivorship. The number of nematodes killed was not determined, because of the difficulty in doing so with the adopted methodology. At each examination, preys killed were replaced and eggs laid were discarded.

Predation rates and oviposition of the different predators were compared for each prey species, in a completely randomized design. Data of the comparative tests were analyzed by ANOVA, in a completely randomized design, comparing the means by Tukey's test (5%), after  $(\sqrt{x+0.5})$  transformation. Average predation rates by each predator on different prey were not compared statistically because of the different biomasses of the prey.

#### 4.3. Results

The three macrochelids consumed all evaluated prey types (Table 1). However, a comparison between predators showed predation to be generally highest for *Macrocheles* n. sp., except that it was statistically the same as that of *M. muscaedomesticae* on eggs of *M.*

*domestica* and *H. irritans* and as that of *M. robustulus* on *B. matogrossensis*, and lower than that of the latter predator on *Rhizoglyphus* sp.

Table 1. Number of eggs and first instar larvae (L1) of *S. calcitrans* and *M. domestica*, first instar larvae of *Bradysia matogrossensis* and nymphs of *Rhizoglyphus* sp. preyed upon daily by *Macrocheles* sp. n., *Macrocheles muscaedomesticae* and *Macrocheles robustulus*, at  $30 \pm 2^\circ\text{C}$ ,  $70\% \pm 10\%$  RH and in the dark

Prey	Predators		
	<i>Macrocheles</i> n. sp.	<i>Macrocheles</i> <i>muscaedomesticae</i>	<i>Macrocheles</i> <i>robustus</i>
<i>S. calcitrans</i> (eggs)	12.5 ± 0.6a	8.7 ± 0.9b	3.5 ± 0.5c
<i>S. calcitrans</i> (L1)	23.8 ± 1.0a	7.2 ± 1.0c	15.1 ± 1.0b
<i>M. domestica</i> (eggs)	12.4 ± 0.7a	11.0 ± 1.2a	4.4 ± 0.6b
<i>M. domestica</i> (L1)	8.9 ± 1.7a	2.5 ± 0.1b	3.5 ± 0.5b
<i>H. irritans</i> (eggs)	5.5 ± 0.4a	4.3 ± 0.4a	Not evaluated
<i>B. matogrossensis</i>	6.4 ± 0.2a	0.4 ± 0.2b	4.1 ± 0.5a
<i>Rhizoglyphus</i> sp.	0.9 ± 0.2b	<0.1b	2.6 ± 0.4a

Means followed by the same letters in each line are not significantly different (Tukey's test,  $p > 0.05$ ).

Concurrently, the three macrochelid species oviposited when fed all prey types (Table 2). However, feeding on *Protorhabditis* sp. resulted in some of the highest oviposition rates of the three evaluated predator (*Macrocheles* n. sp.:  $F = 36.92$ ;  $df = 4$ ;  $p < 0.0001$ ; *M. muscaedomesticae*:  $F = 53.51$ ;  $df = 4$ ;  $p < 0.0001$ ; *M. robustulus*:  $F = 61.57$ ;  $df = 4$ ;  $p < 0.0001$ ). Feeding on *Rhizoglyphus* sp. resulted in extremely low oviposition rates of the three predators, while oviposition on *B. matogrossensis* was also extremely low for *M. muscaedomesticae* but one of the two highest for *M. robustulus*. Survivorship was high ( $\geq 73$ ) for all predators on all prey items.



Table 2. Daily oviposition (mean±SE) and % survival rates (in parentheses) of three macrochelid predators on different prey at 30 ± 2°C, 70% ± 10% RH and in the dark.

Prey	Predators		
	<i>Macrocheles</i> n. sp.	<i>Macrocheles</i> <i>muscaedomesticae</i>	<i>Macrocheles</i> <i>robustus</i>
<i>S. calcitrans</i> (eggs)	4.3 ± 0.4* Ba (100)	0.8 ± 0.2 Bb (98.0)	0.6 ± 0.1 Cb (90.0)
<i>S. calcitrans</i> (L1)	4.2 ± 0.5 Ba (99.0)	0.5 ± 0.1 Cc (85.0)	2.3 ± 0.3 Ab (98.0)
<i>M. domestica</i> (eggs)	3.1 ± 0.4 Ca (93.0)	1.5 ± 0.2 Ab (87.0)	1.9 ± 0.2 Bb (87.0)
<i>M. domestica</i> (L1)	3.6 ± 1.1 Ca (95.0)	1.1 ± 0.1 ABb (90.0)	1.9 ± 0.9 Bb (85.0)
<i>H. irritans</i> (eggs)	1.5 ± 0.3 Da (98.0)	0.4 ± 0.1 Cb (98.0)	-
<i>B. matogrossensis</i>	2.7 ± 0.5 Ca (91.0)	<0.1 Db (80.0)	2.3 ± 0.6 Aa (73.0)
<i>Rhizoglyphus</i> sp.	0.2 ± 0.04 Ea (83.0)	<0.1 Db (90.0)	0.1 ± 0.04 Da (83.0)
<i>Protorhabditis</i> sp.	5.4 ± 1.5 Aa (85.0)	1.7 ± 0.6 Ab (84.0)	2.0 ± 1.0 Bb (78.0)

\*Means followed by the same uppercase letters in each column and low case letters in each line are not significantly different (Tukey's test,  $p > 0.05$ ).

A comparison between predators showed oviposition to be highest for *Macrocheles* n. sp. on all prey item, except that it was statistically the same as that of *M. robustulus* on *B. matogrossensis* and *Rhizoglyphus* sp.

#### 4.4. Discussion

The present study indicates that eggs and larvae of *S. calcitrans* are suitable to *Macrocheles* n. sp.; eggs and larvae of *M. domestica* to *M. muscaedomesticae*; and larvae of *S. calcitrans* and *B. matogrossensis* to *M. robustulus*.

The results of this study are very promising, especially in relation to *Macrocheles* n.sp. on almost all prey items. This particular species not only had best performance in comparison with the other species evaluated in this same work, but also in comparison with what has been reported in the literature for other predator species of the same or other families on the same or related prey.

In what seems to be the only other study about potential of predatory mites to control *S. calcitrans*, Kinn (1966) reported that *M. muscaedomesticae* would be ineffective as control agent of *S. calcitrans*, because of the low predation rate, which the author suggested that to be possibly due to the thicker chorion in comparison with that of *M. domestica*. The rate in that study (maximum 4.3 eggs/ female/ day) was much lower than observed for the Brazilian population of the same predator, and still much lower than observed for *Macrocheles* n.sp.. Oviposition rates of *M. muscaedomesticae* were however low in this study on both eggs and larvae of *S. calcitrans*, but, again, oviposition of *Macrocheles* n. sp. was relatively high on

both stages of *S. calcitrans*. Given the great importance of *S. calcitrans* in Brazil and elsewhere, further study about the possible use of *Macrocheles* n.sp. for its control is highly recommended.

Literature about the potential of macrochelids as control agents of *M. domestica* is very extensive (Azevedo et al., 2015). Oviposition and prey consumption rates of the Brazilian *Macrocheles* n. sp., *M. muscaedomesticae* and *M. robustulus* on eggs and larvae of *M. domestica* were higher than those determined for *M. muscaedomesticae* and *M. robustulus* of other countries by Wade and Rodriguez (1961), Singh et al. (1966), Afifi (1989), Ho (1989) and Guanilo and Cordero (2003). The predation rates of eggs of *H. irritans* by *Macrocheles* n. sp. and *M. muscaedomesticae* were higher (at least 30%) than reported by Halliday and Holm (1987) and Perotti (2001) for *M. robustulus* and by Doube et al. (1986) for *Macrocheles peregrinus* Krantz.

Not much effort has been dedicated to the evaluation of mites as predators of *H. irritans* (Azevedo et al., 2015). In relation to the behavior, Perotti (2001) mentioned that the biggest mites were able to attack eggs with a heavy chorion while the smaller mites caused mortality mainly among eggs with a light chorion.

The determined rate of oviposition and consumption for *Macrocheles* n. sp. and *M. robustulus* on *B. matogrossensis* as prey were higher (at least 45%) than reported by Castilho et al. (2009) for *Protogamasellopsis posnaniensis* (Rhodacaridae) on *B. matogrossensis*, and by Wright and Chambers (1994) for *Hypoaspis miles* (Laelapidae) on *Bradysia paupera* Tuomikoski.

The rates of predation and oviposition of *M. muscaedomesticae* were very low in relation to the other two species evaluated in this work. These low rates could be due to the unsuitability of that species as prey, but could also be due to the aggressive behavior of the prey. Castilho et al. (2009) demonstrated the ability of larvae of *B. matogrossensis* to prey on eggs of the predatory mite *Protogamasellopsis zaheri* (reported as *Protogamasellopsis posnaniensis* Wisniewski & Hirschmann) (Rhodacaridae). Aggressive behavior by larvae of *M. domestica* has been observed even towards adult predatory mites our laboratory (Azevedo, our observation). In that unpublished work, up to three larvae of the dipteran were observed to direct themselves towards a predator that attacked a nearby member of their population, in a successful attempt to drive it away. The aggressive behavior of dipteran species towards other macrochelid species should deserve further consideration.

The oviposition and predation rates for the three macrochelids when fed on *Rhizoglyphus* sp. were very low when compared to mites of other families (Ragusa and

Zedan, 1988; Castilho et al., 2015; Moraes et al., 2015; Moreira and Moraes, 2015; Massaro et al., 2016). Soliman et al. (1978) observed that *Macrocheles matrius* Hull did not feed on *Rhizoglyphus echinopus* (Fumouze & Robin).

The high rate of oviposition by *Macrocheles* n. sp. on *Protorhabditis* sp. as prey is compatible with the easiness with which the colony of this predatory mite is maintained in the laboratory using that nematode species together with *M. domestica* as prey. Ito (1973) also observed that the reproduction rate of *M. muscaedomesticae* was remarkably enhanced by the feeding of nematodes.

The promising results of this study warrants further investigation on the possibility to use macrochelid species for practical control of parasites and pests found in places usually inhabited by those predators. At the moment, this seems particularly true in relation to the possible use of *Macrocheles* n. sp. for the control of *S. calcitrans*. The scientific logical next step in this regard should be the conduction of a detailed study about the biology of that predator when offered *S. calcitrans* as prey. As revised by Azevedo et al. (2015), several works have shown the preference of adults of macrochelids for fly larvae as prey, and the preference of immatures for nematodes. This should be taken into consideration in subsequent studies.

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## 5. LIFE CYCLE OF *Macrocheles* n. sp. (ACARI: MESOSTIGMATA: MACROCHELIDAE) ON EGGS OF *Stomoxys calcitrans* AND *Musca domestica* (DIPTERA: MUSCIDAE) AND ON A MIXTURE OF ALL STAGES OF *Protorhabditis* sp.

### ABSTRACT

The aim of this study was to evaluate the life cycle of *Macrocheles* n. sp. on eggs of *S. calcitrans* L., a serious parasites of cattle and horses, *M. domestica* L., vector microorganisms harmful to humans and other animals, as well as on *Protorhabditis* sp., that could be used as factitious food in its mass rearing. Experiments were conducted in a chamber at  $30 \pm 1$  °C,  $95 \pm 10\%$  RH and in the dark. Total immature development (egg-adult) was completed in  $1.3 \pm 0.01$ ,  $1.3 \pm 0.01$  and  $1.5 \pm 0.03$  days on eggs of *S. calcitrans* and *M. domestica* and on *Protorhabditis* sp., respectively. Fecundity was higher on *Protorhabditis* sp. ( $77.2 \pm 5.1$  eggs/female) than on *S. calcitrans* ( $58.0 \pm 5.9$ ) and *M. domestica* ( $55.0 \pm 5.3$ ). *Macrocheles* n. sp. produced about 0.34 female/female/day ( $r_m$ : 0.34) on *S. calcitrans*, 0.31 on *M. domestica* ( $r_m$ : 0.31) and 0.28 on *Protorhabditis* sp. ( $r_m$ : 0.28). Results of this study suggest that *Macrocheles* n. sp. is a promising biological control agent of *S. calcitrans* and *M. domestica*, and that it could be mass reared with the use of *Protorhabditis* sp. or eggs of *M. domestica*.

Keywords: Biology, Predatory mites; Stable fly; Housefly

### 5.1. Introduction

The stable fly, *Stomoxys calcitrans* L. (Diptera: Muscidae), is considered a serious parasite of different animals, especially cattle and horses, as well as of humans (Dominghetti et al., 2015). The immature stable fly develops usually in substrates containing decaying vegetable matter, sometimes mixed with animal excrements (Koller et al., 2009). In Brazil, especially in the central and southeastern states, the mixture of vinasse (a byproduct of the distillation of sugarcane fermented broth) with sugarcane leaves left in the field during harvesting is an excellent substrate for the development of immature stable fly (Cançado et al., 2013; Dominghetti et al., 2015).

The housefly, *Musca domestica* L. (Diptera: Muscidae), is worldwide one of the most common nuisance insect. The immature phase develops in substrates found in different habitats, as in aviaries and stables, and then, as adults, can vector microorganisms harmful to



humans and other animals (Legner, 1995; Mariconi et al., 1999; Skovgård and Nachman, 2004; Malik et al., 2007).

The Macrochelidae constitute an abundant and diverse group of predaceous soil mites, frequently associated with substrates in which larvae of *S. calcitrans* and *M. domestica* are found (Azevedo et al., 2015). Most studies on the life cycle and prey consumption of macrochelid species of the genus *Macrocheles* Latreille have shown that they use flies and nematodes as prey (Azevedo et al., 2015), but many studies refer to predation without providing details about the process (Pereira and Castro, 1945; Filipponi, 1959; Ito, 1973; Filipponi et al., 1971; Manning and Halliday, 1994).

In the development of a biological control strategy, the two first steps are usually the determination of the fauna in the area where the pest or parasite is intended to be controlled and the determination of native natural enemies potentially useful as its biological control agents. The third step usually consists of the evaluation of the life cycle of the potential native natural enemies. The present work corresponds to the third step in an attempt to control *S. calcitrans* biologically with the use of predatory mites. *Macrocheles* n. sp. was described from specimens collected in São Paulo state, southeastern Brazil (chapter 3). A laboratory study has recently indicated the potential of this predator as a biological control agent of eggs and larvae of *S. calcitrans* and *M. domestica* (chapter 4).

The successful use of a biological control agent requires the availability of an efficient process for its mass production. Discovery of alternative factitious food sources for mass rearing can reduce the production cost of predatory mites, improving the chances for their adoption as biological control agents (Moreira et al., 2015). Ho et al. (1990) developed a mass production method for *Macrocheles muscaedomesticae* (Scopoli), involving the use of spent housefly media, frozen housefly eggs, and the nematode *Protorhabditis* sp. (Rhabditina: Rhabditidae). In Chapter 4 of this thesis, the free-living nematode *Protorhabditis* sp. was observed to promote the highest oviposition level of *Macrocheles* n. sp. in comparison with other food sources.

The aim of this study was to evaluate the life cycle of *Macrocheles* n. sp. on eggs of *S. calcitrans* and *M. domestica*, as well as on *Protorhabditis* sp., that could be used as factitious food in its mass rearing.

## 5.2. Material and Methods

The study was conducted at ESALQ – USP, between October 2014 and November 2015. It was conducted in incubators, at  $30 \pm 1$  °C,  $95\% \pm 3\%$  RH and in the dark. The voucher specimens of the species studied were deposited in the mite reference collection of ESALQ/USP.

### 5.2.1. Mite sampling and rearing

Specimens of *Macrocheles* n. sp. were collected from cattle manure at Cabrália Paulista, São Paulo state, Brazil, in March 2014. The colonies were maintained in the laboratory in plastic units (8 cm diameter and 7 cm high) whose bottom was covered with a layer of 0.5 cm of a mixture of nine parts of gypsum and one part of activated charcoal; this layer was maintained humid by daily additions of distilled water. Each unit was filled to 70% of their capacity with vermiculite, and the predatory mites were fed with a mixture of all stages of the free-living nematode *Protorhabditis* sp., and with eggs and larvae of housefly.

The origin of the organisms used as prey were as follows: larvae of *M. domestica* were fed with wheat bran and adults with a mixture of milk and sugar, while all stages of the nematode *Protorhabditis* sp. (used as a control) were produced in thin layers of pods of *Canavalia ensiformis* L.; eggs of *S. calcitrans* were obtained from a colony established in the Laboratory of Entomologia Veterinária of Embrapa Gado de Corte, Campo Grande, Mato Grosso do Sul, Brazil. These eggs were kept in a freezer for use during the study.

### 5.2.2. Life table

The experimental unit consisted of a Petri dish (2.7 cm in diameter x 1.2 cm in height). The bottom of each unit was covered with a layer of 0.5 cm of a mixture of nine parts of gypsum and one part of activated charcoal, maintained humid by daily additions of distilled water. The open end of each unit was sealed with a piece of transparent plastic film (Magipac®), to prevent organisms from escaping.

This study was initiated with eggs of *Macrocheles* n. sp. of known average age. To obtain them, 100 adult females were transferred from the stock colony to each of 100 experimental units, each containing a surplus amount of all developmental stages of

*Protorhabditis* sp. as food. Three hours later, each of the eggs laid was isolated in an experimental unit. The study was initiated with 50 eggs for each prey.

After eclosion, the predator was fed *ad libitum* on the eggs of *S. calcitrans*, eggs of *M. domestica* or all developmental stages of *Protorhabditis* sp.. The units were examined every 3 h to determine the duration of each immature stage. After reaching adulthood, females were paired with males (Figure 1f) of the colony for only 24 h to avoid cannibalism. The units were examined twice a day (7 AM and 7 PM) to determine the duration of each adult phase as well as oviposition. Eggs laid were discarded soon after detection for the first time.

### 5.2.3. Survival of adult *Macrocheles* n. sp. in the absence of food

Twenty-five deutonymphs were transferred from the stock colony to each of 25 experimental units similar to those previously described. The experimental units were maintained without food but moistened by daily addition of distilled water. After the mites reached adulthood, the units were examined every 24 h to determine longevity.

### 5.2.4. Statistical analysis

The mean duration of each stage, as well as of the total immature phase (egg-adult), and duration of the periods of pre-oviposition, oviposition, post-oviposition, longevity and fecundity on different prey were submitted to analyses of variance, using non parametric Kruskal–Wallis test for comparisons of treatments. Net reproductive rate ( $R_0$ ), intrinsic rate of population increase ( $r_m$ ), finite rate of population increase ( $k$ ), mean generation time ( $T$ ) and the standard errors were calculated using “jackknife” procedure and compared by Student’s *t* test using “LifeTable.SAS” in the software “SAS System” (Maia et al. 2000; Maia and Luiz 2006).

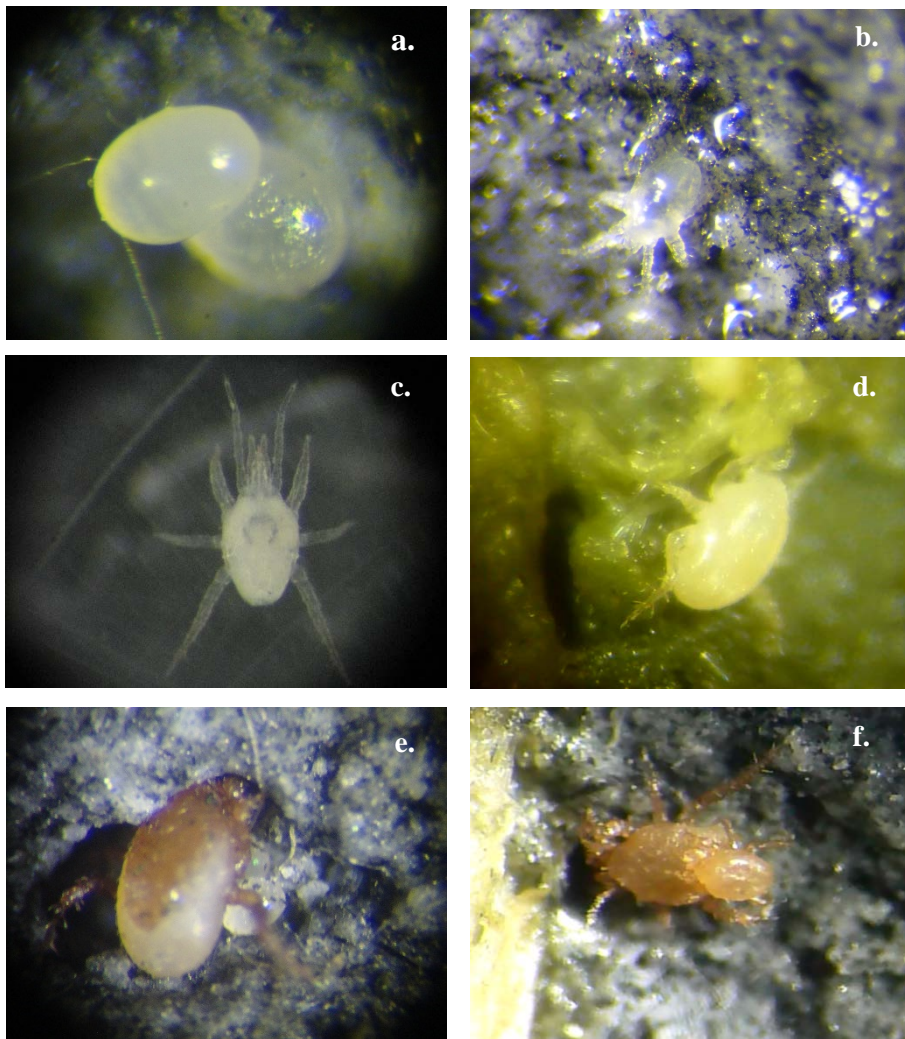
## 5.3. Results

No significant differences between treatments were observed for the durations of the egg, larval and protonymphal stages (Table 1) (Figure 1a, 1b, 1c). Durations of the deutonymphal stages (Figure 1d) as well as of the entire immature phase (egg-adult) were significantly longer on *Protorhabditis* sp., while difference was not significant between

treatments in which prey were *S. calcitrans* and *M. domestica* ( $\chi^2 > 76.874$ ; df 2;  $p < 0.0001$ ). Survivorship of each stage was high on all prey species (77 – 97 %); thus, taking into account the three prey species, survivorship for the entire immature phase (egg-adult) ranged between 61.5 and 63.9 %.

Eggs were usually laid in protected places in the rearing unit (depressions or next to particles of mixture of gypsum and activated charcoal); in some cases, females were observed trying to hide the eggs by pushing particles onto them. In several occasions, larval development (especially the presence of distinct appendages) was observed in eggs inside slide mounted gravid females, but larval emergence from the eggs always required a few hours to occur.

Immatures were rarely observed moving onto the rearing unit, remaining most often in secluded places. Differently from the later stages, larvae were never observed feeding. Cannibalism of immature by adults was occasionally observed.



**Figure 1.** *Macrocheles* n. sp. **a.** eggs; **b.** larvae, **c.** protonymphal stage, **d.** deutonymphal stage, **e.** adult female hiding the eggs, and **f.** copulation

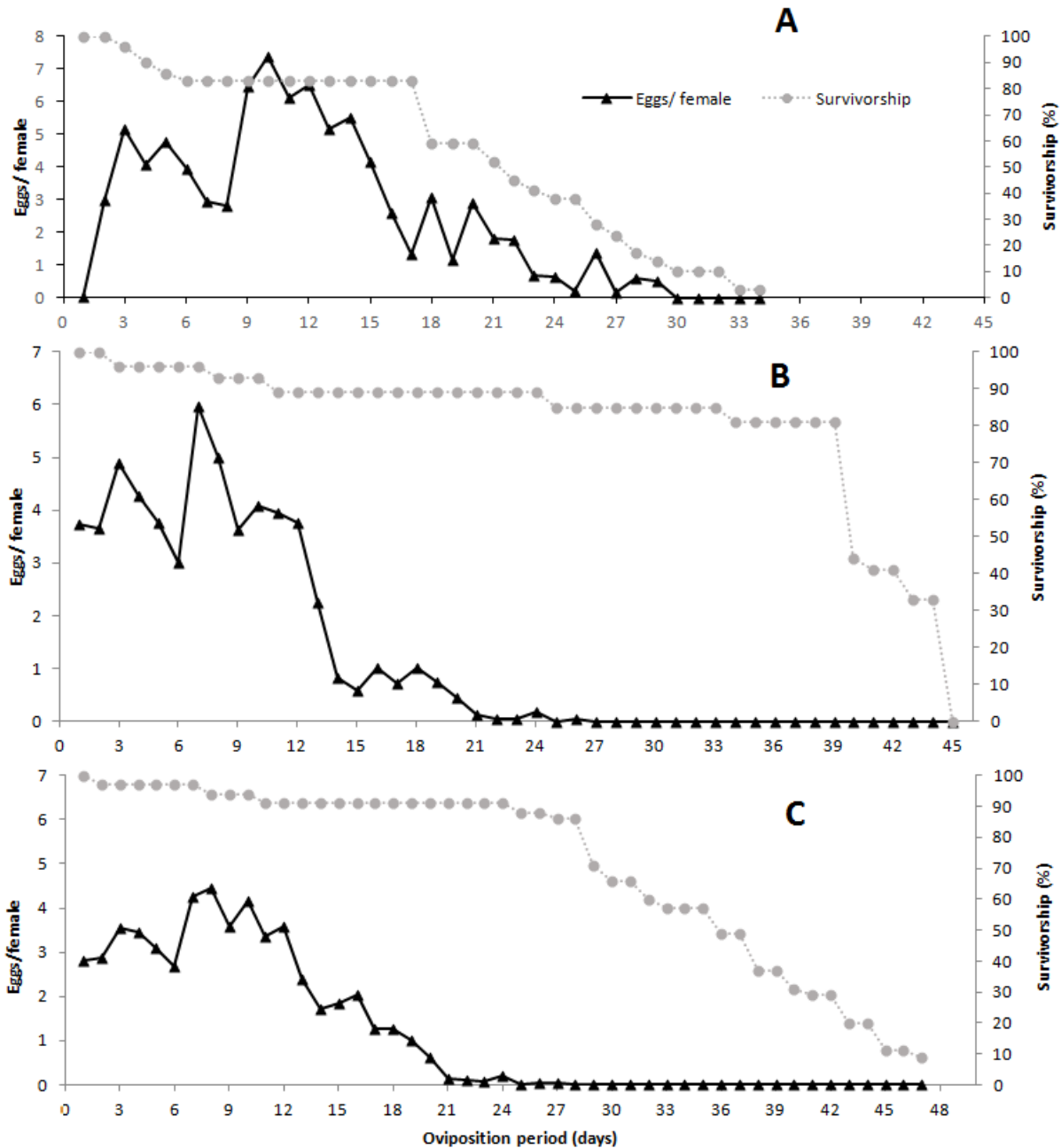
The oviposition period was longer ( $\chi^2 > 95.738$ , df 2,  $p < 0.0001$ ) whereas pre-oviposition and post-oviposition and female longevity were shorter (respectively  $\chi^2 > 61.492$ , df 2,  $p < 0.0001$ ;  $\chi^2 > 69.483$ , df 2,  $p < 0.0001$  and  $\chi^2 > 90.027$ , df 2,  $p < 0.0001$ ) on *Protorhabditis* sp. than on other prey species (Table 1). For each of those parameters, no significant differences were observed for predators fed *S. calcitrans* and *M. domestica*. After adult emergence, the proportions of females and males were 25 and 7, 27 and 17, and 35 and 12 on *Protorhabditis* sp., *S. calcitrans* and *M. domestica*, respectively. Male longevity was shorter on *S. calcitrans* than *M. domestica* and *Protorhabditis* sp., but no significant differences were observed between the latter two treatments.

Table 1. Duration of different developmental stages (days  $\pm$  SE); survivorship (% , in parentheses) and mean duration (days  $\pm$  SE) of pre-oviposition, oviposition and post-oviposition periods of *Macrocheles* n. sp. fed all stages of *Protorhabditis* sp. and eggs of *Stomoxys calcitrans* and *Musca domestica* at  $30\pm 2^\circ\text{C}$ ,  $95\pm 10\%$  RH and in the dark.

Stages	Prey		
	<i>Protorhabditis</i> sp.	<i>S. calcitrans</i>	<i>M. domestica</i>
Egg	0.3 $\pm$ 0.04a (86.0)	0.3 $\pm$ 0.02a (96.0)	0.3 $\pm$ 0.02a (96.0)
Larva	0.2 $\pm$ 0.02a (91.0)	0.2 $\pm$ 0.01a (94.2)	0.2 $\pm$ 0.01a (98.0)
Protonymph	0.3 $\pm$ 0.03a (95.0)	0.4 $\pm$ 0.03a (92.0)	0.4 $\pm$ 0.03a (100)
Deutonymph	0.7 $\pm$ 0.06b (97.3)	0.4 $\pm$ 0.03a (93.3)	0.4 $\pm$ 0.02 (100)
Egg-adult	1.5 $\pm$ 0.03 (72.0)	1.3 $\pm$ 0.01a (78.0)	1.3 $\pm$ 0.01a (94.0)
Pre-oviposition	1.3 $\pm$ 0.08a	2.9 $\pm$ 1.1b	2.9 $\pm$ 0.18b
Oviposition	19.5 $\pm$ 1.1b	14.1 $\pm$ 1.1a	16.2 $\pm$ 0.59a
Post-oviposition	2.9 $\pm$ 0.6a	17.6 $\pm$ 1.8b	14.9 $\pm$ 1.60b
Female longevity	23.5 $\pm$ 1.4a	30.1 $\pm$ 2.1b	29.3 $\pm$ 2.10b
Male longevity	13.6 $\pm$ 1.3b	8.8 $\pm$ 0.9a	17.4 $\pm$ 0.71b

Treatments followed by the same letters in the same line do not differ statistically (Kruskal-Wallis Nemenyi;  $p > 0.05$ ).

Male guarding of quiescent deutonymphs was often observed, with mating (of very short duration) occurring while females were still molting to the adult stage. For all prey species, oviposition reached the highest rates at the beginning of the oviposition period, reducing slowly afterward, reaching very low levels at the end of 25 – 30 days (Figure 1). Also for all prey species, the highest oviposition levels occurred roughly in the first 12 – 15 days of the oviposition period, with maximum rates varying between 4.5 on *M. domestica* to 7.4 on *Protorhabditis* sp. Yet, fecundity was significantly higher on *Protorhabditis* sp. ( $77.2 \pm 5.1$ ), that on *S. calcitrans* ( $58.0 \pm 5.9$ ) and on *M. domestica* ( $55.0 \pm 5.3$ ) ( $\chi^2 > 37.574$ , df 2,  $p < 0.0001$ ). About 80% of all eggs were laid in the first 14, 13 and 15 days of oviposition on *Protorhabditis* sp., *S. calcitrans* and *M. domestica*, respectively. Female survivorship reached 50% respectively after 21, 40 and 36 days of the emergence on *Protorhabditis* sp., *S. calcitrans* and *M. domestica*, all females dying after respectively 35, 45 and 48 days.



**Figure 2.** Mean daily oviposition (eggs/female/day) of *Macrocheles* n. sp. fed all stages of *Protorhabditis* sp. (A), and eggs of *Stomoxys calcitrans* (B) and *Musca domestica* (C) at  $30 \pm 2^\circ\text{C}$ ,  $95 \pm 10\%$  RH and in the dark.

On *S. calcitrans* and *M. domestica*, the population of *Macrocheles* n. sp. increased approximately 30 times at each generation ( $R_0 = 30.80$  and  $30.59$ , respectively), rate significantly lower than on *Protorhabditis* sp. (about 34 times) (Table 2). *Macrocheles* n. sp. produced about 0.34 female/female/day ( $r_m: 0.34$ ) on *S. calcitrans*, value significantly higher than on *M. domestica* ( $r_m: 0.31$ ) and *Protorhabditis* sp. ( $r_m: 0.28$ ). Concurrently, daily increase in population size was about 41% ( $\lambda: 1.41$ ) on *S. calcitrans*, also significantly higher than on

*M. domestica* ( $\lambda$ : 1.37) and *Protorhabditis* sp. ( $\lambda$ : 1.32). However, the mean duration of a generation of the predator was significantly lower on *S. calcitrans* (T= 9.9 days) and *M. domestica* (T= 10.9 days) than on *Protorhabditis* sp. (T= 12.5 days).

Table 2. Life table parameters of *Macrocheles* n. sp. fed all stages of *Protorhabditis* sp. and eggs of *Stomoxys calcitrans* and *Musca domestica* at  $30 \pm 2^\circ\text{C}$ ,  $70 \pm 10\%$  RH and in the dark.  $R_o$ : net reproductive rate,  $r_m$ : intrinsic rate of increase,  $\lambda$ : finite rate of increase, T: mean generation time in days.

Prey	n	$R_o$	$r_m$	$\lambda$	T
<i>Protorhabditis</i> sp.	25	34.12	0.28	1.32	12.5
<i>S. calcitrans</i>	27	30.80	0.34	1.41	9.9
<i>M. domestica</i>	35	30.59	0.31	1.37	10.9

### 5.3.1. Survival of adults of *Macrocheles* sp. in the absence of food

All deutonymphs survived and developed to adult stage. Adults survived for a relatively long period without food ( $20.5 \pm 6.1$  days). Regardless the starvation, 16 out of the 25 evaluated females (64%) oviposited, producing on the average  $0.6 \pm 0.14$  eggs/ female; one of those laid two eggs while others laid a single egg, always on the first day after emergence, except for one female, which oviposited a single egg on the third day. Oviposition was assumed from the presence of larvae in each unit where only the adult female was present the day before.

## 5.4. Discussion

The results of this study indicated *Macrocheles* n. sp. to be able to complete its life cycle on all stages of *Protorhabditis* sp. and eggs of *S. calcitrans* and *M. domestica*. The similar duration of the egg as well as of the larval stages in the presence of different prey was expected, because eggs (and apparently larvae) do not feed. Costa (1966; 1967) also observed that larvae of respectively *Macrocheles robustulus* (Berlese) and *Macrocheles parapsentii* Costa did not feed. Thus, non-feeding larvae could be common in *Macrocheles* species.

The quick immature development of *Macrocheles* n. sp. on all prey is similar to that reported by Filipponi & Mosna (1968) and Cicolani et al. (1977) respectively for *M. robustulus* and *Macrocheles subbadius* (Berlese), on *M. domestica*. Duration of the immature



phase is much shorter than reported for other common groups of predatory mesostigmatids in the literature (see for example McMurtry et al., 2015 for phytoseiids and Moreira and Moraes, 2015 for laelapids), but comparisons are hampered by the different temperatures at which studies have been conducted. Despite the quick immature development of *Macrocheles* n. sp., ovoviviparity (emergence of larvae from the eggs soon after oviposition) was not observed. Marquardt et al. (2015) reported ovoviviparity to be facultative in several *Macrocheles* species and related to the occurrence of unfavorable environmental conditions.

Quick development, secluded behavior and eventual cannibalism seem appropriate characteristics of organisms living in temporarily favorable habitats, as macrochelid species do. While cannibalism could reflect unsuitability of available prey in a rearing process, making predators more prone to prey on more vulnerable stages of their own, it can also represent an important strategy of survival for species that predominate in temporarily suitable habitats (Tayeh et al., 2014), as macrochelids do. Marquardt et al. (2015) added to those two other characteristics, ovoviviparity and phoresis, the latter not evaluated in this study. Ability to survive long periods of starvation and to oviposit even if a few eggs before feeding and to copulate quickly after female reaches adulthood should also be added as important for those species.

The results of the present study showed adequate biological performance of *Macrocheles* n. sp. on *S. calcitrans*. The values of intrinsic rate of population increase were comparable with what has been reported for *Phytoseiulus persimilis* Athias-Henriot and *Phytoseiulus macropilis* (Banks), mites of the family Phytoseiidae widely used commercially for the control of pest mites of the family Tetranychidae (Sabelis, 1985), as well as for *Phytoseiulus longipes* Evans (Furtado et al., 2007). Values of intrinsic rate of population increase reported for *Phytoseiulus* species are considered high within the Phytoseiidae. Rates also were higher than reported by Enkegaard et al. (1997) for *Stratiolaelaps miles* (Berlese) (Laelapidae) (cited as *Hypoaspis miles*) on Sciaridae species (Diptera) ( $r_m = 0.074$ ); this laelapid species also have been used commercially for the control of various harmful soil organisms.

The result of this study seems highly relevant, given the major difficulty presently faced in controlling *S. calcitrans* in Brazil with the use of any strategy. The problem caused by this fly in parts of central and southeastern Brazil nowadays is considered of major concern to both cattle raisers and sugarcane producers (Koller et al., 2009). The discovery of promising species for the control of this parasite is highly desirable.

Results obtained with *M. domestica* were similar to that obtained on *S. calcitrans*. Although Cicolani (1979) reported a much higher intrinsic rate of population increase (0.90) for *M. muscaedomesticae* on that prey, the oviposition period of *Macrocheles* n. sp. was about 1.25 longer, fertility was about twice higher, and intrinsic rate of increase was about 1.3 higher than determined by Almeida (1994) for *M. muscaedomesticae* on the same prey. Thus, the results of this and previous works suggest that *M. domestica* is a suitable prey for the mass production of *Macrocheles* n. sp. for the control of that or other fly species. In a mass production program, the use of *M. domestica* as prey may be more convenient than the use of other food sources, given the easiness with which this prey can be produced.

The biological performance of *Macrocheles* n. sp. on *Protorhabditis* sp. indicate that free-living nematodes could be important as factitious food, for maintaining these predators under natural conditions or, potentially, to maintain field released *Macrocheles* n. sp. in a biological control program. Rodriguez et al. (1962) also reported *M. muscaedomesticae* to reproduce relatively fast when fed with the nematode *Rhabditella leptura*. *Protorhabditis* sp. seem promising for use as for the mass rearing of *Macrocheles* n. sp.. The ability of predators to survive in the absence of prey is also a desirable attribute to consider in the selection of prospective candidates for practical use.

In conclusion, the results of this study suggest that *Macrocheles* n. sp. is a promising biological control agent of *S. calcitrans* and *M. domestica*, and that it could be mass reared with the use of *Protorhabditis* sp. or eggs of *M. domestica*. Future studies of this predator should involve an evaluation of its development and reproduction when nematodes and fly immatures are offered together as prey, given that several studies have demonstrated the preference of macrochelid immatures for nematodes and of macrochelid adults for fly immatures (Filipponi and Delupis, 1963). Also important is to study the dispersal process of *Macrocheles* n. sp. under natural conditions, given the importance of phoresy for this mite group. Knowledge about this aspect is essential for the potential use of this predator in the control of *S. calcitrans* and possibly other pests or parasites.

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