

Some *Tydeus* mites (Acariformes: Prostigmata: Tydeidae) of Kermanshah province, western Iran, with remarks on *Tydeus caudatus*

Maryam DARBEMAMIEH¹, Hamidreza HAJIQANBAR^{1*}, Mohammad KHANJANI², Dariusz J. GWIAZDOWICZ³ and Andrzej KAŻMIERSKI⁴

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¹ Department of Entomology, Faculty of Agriculture, Tarbiat Modares University, 14115-336, Tehran, Iran. darbemamieh@gmail.com; hajiqanbar@modares.ac.ir (*Corresponding author)

² Department of Plant Protection, College of Agriculture, Bu Ali-Sina University, Hamedan, Iran. mkhanjani@gmail.com

³ Department of Forest Protection, Poznań University of Life Sciences, ul. Wojska Polskiego 71c, 60-625 Poznań, Poland. dagwiazd@up.poznan.pl

⁴ Department of Animal Morphology, Faculty of Biology, Adam Mickiewicz University, Umultowska 89, 61-614 Poznań, Poland. akazmierski@flen.pl

ABSTRACT — During a survey in Kermanshah province, western Iran, seven species of mites of the genus *Tydeus* (Acari: Prostigmata: Tydeidae) were collected from 2006 to 2013. *Tydeus helenipanoue* Kaźmierski, 1998 is recorded for the first time in Iran. *Tydeus californicus* (Banks, 1904), *T. electus* Kuznetzov 1973, *T. inclutus* Livshitz, 1973, *T. kochi* Oudemans, 1928 and *T. mississippiensis* Baker 1970 are new for the fauna of this province. Previously invalidated *T. caudatus* is herein revalidated. Several new hosts for these species have been recorded, diagnoses for *T. caudatus* and *T. helenipanoue* proposed, and an identification key is provided for all these species. A list of previously recorded mites of genus *Tydeus* from Iran until 2015 is also added.

KEYWORDS — Tydeinae; new records; taxonomy; fauna; checklist; key

INTRODUCTION

The family Tydeidae (Trombidiformes: Prostigmata) is a large and taxonomically complex family with a worldwide distribution (Krantz 1978). These species are fast moving small soft-bodied mites with color ranged from white, yellow, green and orange to black, about 0.25 - 0.5 mm in length. They live in moss, lichen, soil, litter, rotten wood, humus, mushrooms and grass, on straw and hay, on trees, under the bark and on the bark of trees, on plants leaves, in bird nests and in stored products (Khanjani and Ueckermann 2003). Tydeids are reported as plants and fungi feeders, scavengers and

predators. *Tydeus californicus* has been reported by Fleschner and Arakawa (1953) and Hernandez *et al.* (2006) feeding on plants. As fungivorous mites, they might play an important role in decreasing the impact of plant pathogens and as scavengers they are effective in cleaning the leaf surface. As an example, the mite *Orthotydeus lambi* (Baker) reported to decrease the population of the fungus *Uncinula necator* (Schwein) in grapes by feeding on its hyphae (English-Loeb *et al.* 1999). Several species are found associated with insects (Treat 1970) or harmful to human and domestic animals (Kaźmierski 1998).

Linnaeus (1758) introduced first a tydeid mite in

the "Fauna suecia" as *Acarus croceus* and then he described the same species in "Systema naturae" as *Acarus salicinae rosae* (Sepasgosarian 1997). Koch (1835), 77 years later, established the genus *Tydeus* for two species *T. velox* and *T. croceus*. In the following three years, Koch (1838) described 11 additional species. Berlese (1883) described one species, and Cannestrini (1886) described four species (Sepasgosarian 1997). Meanwhile, Ashmead (1879) has described one mite species as *Acarus gloveri* in the USA, known as *T. gloveri* today. Moniez (1894) described *T. molestus* in Belgium and Kramer (1877) created the family Tydeidae.

During the first half of the 20th century, Berlese (1908, 1910) described six genera, Thor (1933) four and Oudemans (1937) one, including several related species. Grandjean (1938) and other scientists described several species too. One of the most known mite specialists, Edward W. Baker, proposed six genera and described many new species from 1943 to 1974. Kuznetsov also described many new species with Livshitz and other authors (André 1980).

André (1979) started a series of publications called "Generic revision of family Tydeidae". He introduced some new genera and ignored some well-known genera such as: *Lorryia* Oudemans, 1925 and *Paralorryia* Baker, 1965. Kaźmierski started series of publications from 1978 on tydeid mites. He rehabilitated the genera *Lorryia* and *Paralorryia*, and recognized as synonyms the genera *Homeotydaeus* André, 1981, *Orthotydeus* André 1980, *Homoiorthydeus* Schiess, 1981 and some other valid genera from the system of André (Kaźmierski, 1989). Kaźmierski (1998) reviewed the Tydeinae of the world based on the genera and gave a key to all species.

The aim of this study was to determine the diversity and habitats of mites of the genus *Tydeus* in the Kermanshah agricultural ecosystems, located in western Iran and to review their taxonomic status. As some Tydeidae species might be beneficial organisms, it is important to have accurate species descriptions for their correct identification (Darbemamieh *et al.* 2010).

MATERIAL AND METHODS

Sampling was carried out from 2006 to 2013 on farms and in orchards of Kermanshah province, Iran. Mites were collected on leaves by two methods:

(i) placing plant, bark and branch samples into plastic zip-clip bags for stereomicroscopic examination later, or

(ii) beating branches over a white plastic board (with a screen above to prevent unwanted materials and insects), and then transferring mites with a 00 paintbrush into vials containing 75 % ethanol.

The soil mites were extracted with a Tullgren funnel and collected under a stereomicroscope. After clarifying in lactic acid, permanent mountings were made using Hoyer's solution (Walter and Krantz 2009). Specimens were identified under a phase contrast microscope (Olympus BX 51). The nomenclatural-terms and setal notations of the idiosoma and appendages follow that of Kaźmierski (1998). All specimens have been collected by the senior author and are deposited at the Acarological Collection of Agricultural Faculty, Tarbiat Modares University, Tehran, Iran.

RESULTS

Family Tydeidae Kramer, 1877

Subfamily Tydeinae André, 1979 sensu Kaźmierski, 1996b

Genus *Tydeus* Koch, 1835 sensu Kaźmierski (1989)

Collected material from Kermanshah Province:

Tydeus californicus (Banks, 1904)

Locality and habitat where specimens have been presently found: Songhor, Cherry leaf, 12 Oct. 2013, 34°45'58"N, 47°34'45"E, Altitude: 1663 m, 1♀ & 3 TN (Tritonymph).

Tydeus caudatus (Dugès, 1834) sensu Baker, 1970

Locality and habitat where specimens have been presently found:

1) Kermanshah, Sour cherry leaf, 05 Sep. 2007, 34°21'41"N, 47°56'16"E, Altitude: 1298 m, 1♀,

- 2) Rijab, Walnut leaf, 10 Aug. 2011, 34°24'57"N, 46°54'29"E, Altitude: 1531.5 m, 1 TN,
- 3) Sahne, Apple leaf, 19 Oct. 2010, 34°29'09"N, 47°41'29"E, Altitude: 1376.5 m, 1 TN,
- 4) Kermanshah, Soil, 30 Apr. 2011, 34°19'28"N, 47°05'56"E, Altitude: 1326 m, 1 DN,
- 5) Kermanshah, plum leaf, 05 Sep. 2007, 34°20'11"N, 47°05'38"E, Altitude: 1323 m, 1 TN,
- 6) Songhor, Cherry leaf, 12 Oct. 2013, 34°45'58"N, 47°34'45"E, Altitude: 1663 m, 2 TN.



FIGURE 1: *Tydeus caudatus* collected from Kermanshah orchards.

Diagnosis — This species (figure 1) has a short, slender ωI which is not 1/2 as long as tarsus width; the dorsal leg setae are slightly lanceolate and serrate; the dorsal setae of genua III and tibiae III-IV are blunt distally; the coxae may have faint reticulate patterns; there are no empodial claws. Palpi are typically elongate. Dorsal body striae are typical; the ventral hysterosomal striae are longitudinal. The propodosomal trichobotriae are stout, slightly serrate and not much longer than the other dor-

sal body setae; the dorsal body setae are slightly lanceolate and serrate except *h1*, *h2* and *ps1* which are spatulate distally. Gravid female contain many eggs (figure 2). This species is widespread on many plants in the most temperate areas of the world (Baker 1970).



FIGURE 2: *Tydeus caudatus* female with eggs and prelarva inside. Spatulate setae are visible.

Tydeus electus Kuznetsov, 1973

Locality and habitat where specimens have been presently found:

- 1) Ravansar, Apple leaf, 25 Aug. 2012, 34°42'09"N, 46°39'13"E, Altitude: 1345 m, 1 ♀ with 4 eggs.,
- 2) Songhor, Soil, 05 Sep. 2012, 34°44'23"N, 47°36'24"E, Altitude: 1695 m, 1 ♂,
- 3) Kermanshah, Soil, 02 Oct. 2011, 34°21'43"N, 47°06'19"E, H: 1299 m, 1 ♂,
- 4) Kermanshah, Soil, 26 Jul. 2011, 34°19'35"N, 47°06'43"E, Altitude: 1315 m, 1 TN,
- 5) Rijab, Apple leaf, 08 Sep. 2011, 34°24'56"N, 46°54'38"E, Altitude: 1540 m, 1 ♀,

6) Kermanshah, Apple leaf, 02 Sep. 2012, 34°23'21"N, 47°07'33"E, Altitude: 1356 m, 1♀, 7) Kermanshah, Maple leaf, 07 Aug. 2013, 34°19'33"N, 47°05'55"E, Altitude: 1324 m, 1♀.

***Tydeus helenipanoue* Kaźmierski, 1998**

Locality and habitat where specimens have been presently found: Kermanshah, Koozaran, soil, 21 Oct. 2011, 34°24'34"N, 46°51'52"E, Altitude: 1325 m, 1 TN.

Diagnosis — Dorsal idiosomal setae are equal in shape, narrowly lanceolate and serrate, but unequal in length (caudal ones are slightly longer). Setae *f1* longer than half distance *f1-h1*. Setae *ps1* situated dorsally. Ventral striation between *mt* longitudinally. Adults of this species has four pairs of genital setae.

This species is related to *T. munsteri* Meyer and Ryke (1959) and *T. quadrisetosus* (Schiess 1981) but can be distinguished from the former by narrower and longer dorsal idiosomal setae and from the latter by having serrated setae (Kaźmierski 1998).

Remark — There is a very small $\omega 1$ on tarsus I that is much smaller than in the description. This difference is because collected mite was in tritonymph stage where as the description is based on females. This is first record of this mite from Iran.

***Tydeus inclutus* Livshitz, 1973**

Locality and habitat where specimens have been presently found: Songhor, soil under *Cupressus* sp., 4 Sep. 2013, 34°46'22" N, 47°36'48" E, Altitude: 1713 m, 1♀.

***Tydeus kochi* Oudemans, 1928**

Locality and habitat where specimens have been presently found: 1) Kandooleh, Grape leaf, 03 oct. 2011, 34°38'59" N, 47°14'20" E, Altitude: 1590 m., 2♀, 2) Kangavar, soil, 29 Apr. 2012, 34°35'22" N, 47°56'46" E, Altitude: 1505 m, 1♀ with two eggs inside.

***Tydeus mississippiensis* Baker, 1970**

Locality and habitat where specimens have been presently found: Sarab Ghanbar, plum leaf, 5 Sep. 2007, 34°15'52" N, 47°02'44" E, Altitude: 1526 m, 1♀.

Key to *Tydeus* species from Kermanshah province (Females)

1. Dorsal idiosomal setae similar in shape 2
— Dorsal idiosomal setae different in shape 6
2. Cheliceral stiletto as long as palp tarsus; setae *f1* nearly as long as *f1-h1* distance or even longer; solenidion $\omega 1$ shorter than half distance *ft-tc*
..... *T. electus* Kuznetsov, 1973
— Cheliceral stiletto shorter than palp tarsus 3
3. Dorsal setae long and serrate, especially *f* or *f* and *h* (about 40 μ m or more); body elongate; *f1* more or less reaches to base of *h1*
..... *T. mississippiensis* Baker, 1970
— Dorsal setae not so long, *f1* obviously not reaching to base of *h1* 4
4. Body small, about 220 μ m in length; female with four pairs of genital setae
..... *T. helenipanoue* Kaźmierski, 1998
— Body longer, at least 280 μ m in length; female with six pairs of genital setae 5
5. Gnathosoma almost hidden under aspidiosoma and only its distal part is visible from above; ventral striae between *mt* β is in "U" shape pattern; bothridial setae (50) rough and longer than other dorsal setae *T. inclutus* livshitz, 1973
— Gnathosoma visible from above and ventral striae between metasternals are "V" shape; bothridial setae long, simple and significantly longer than other setae *T. kochi* Oudemans, 1928
6. Dorsal idiosomal setae slender, spindle like or narrowly lanceolate with exception of *h1*, *h2* and *ps1* which are broadened for 2/3 their end distally; fertile female with many eggs inside.....

..... *T. caudatus* (Dugès, 1834) sensu Baker, 1970
 — Five pairs of caudal dorsal setae spindle and spoon-like and rounded distally, *f1* not reaches to base of *h1*, *ω1* one third of tarsus width; bothridial setae longer than other dorsal setae; striae between *d1* setae are obtuse "U" shape
 *T. californicus* (Banks, 1904) sensu Baker, 1970

List of reported *Tydeus* species from Iran until the end of 2015

Tydeus Koch, 1835

1) *Tydeus calabrui* (Castagnoli, 1984)

Habitat or host: Citrus trees

Distribution in Iran: Mazandaran (Faraji and Kamali 1993, Sadeghi *et al.* 2012).

2) *Tydeus californicus* (Bank, 1904) sensu Baker, 1970

Habitats or hosts: Apple, pear, apricot, peach, almond, walnut, grape, plum, coco weed, citrus, sainfoin, pomegranate, soil.

Distribution in Iran: Caspian sea areas, Hamedan, East Azerbaijan, Saveh, Mazandaran, Khorasan razavi, Shabestar (Abaii 1984, Behdad 1988, Daneshvar 1978a,b, 1990, Faraji and Kamali 1993, Khanjani and Kamali 1993, Modarres Awal 1994, 1997, Soroush 1994, Khanjani 1996, Sadeghi *et al.* 2012, Akbari *et al.* 2014).

3) *Tydeus caryae* Khanjani and Ueckermann, 2003

Habitats or hosts: *Juglans regia* L., pomegranate, palm, citrus, soil

Habitat or hosts: Galls of *Eriophyes tristriatus* (Nalepa), the walnut leaf gall mite, orchards

Distribution in Iran: Hamadam, Tuiserkan, Kermanshah, Kerman, Shabestar (Khanjani and Ueckermann 2003, Babakfard *et al.* 2008, Izadi *et al.* 2010, Akbari *et al.* 2014).

4) *Tydeus caudatus* (Dugès, 1834)

Habitats or hosts: sour cherry, grape, plum, walnut, greengage, soil

Distribution in Iran: Kermanshah, Shabestar (East Azerbaijan) (Darbemamieh *et al.* 2010, Akbari *et al.* 2014)

5) *Tydeus darekiwani* Sadeghi, Łaniecka and

Kaźmierski, 2012

Habitat or hosts: Apple, pear

Distribution in Iran: Khorasan Razavi (Sadeghi *et al.* 2012)

6) *Tydeus electus* Kuznetsov, 1973

Habitat or hosts: Apple, pear, pomegranate

Distribution in Iran: Khorasan, Tehran (Modarres Awal 1997, Sadeghi Nameghi 1995, Soroush 1994)

7) *Tydeus gloveri* (Ashmead, 1879)

Habitat or host: Unknown

Distribution in Iran: Northern provinces (Khalilmanesh 1979, Modarres Awal 1994, 1997)

8) *Tydeus inclutus* Livshitz, 1973

Habitats or hosts: Tea, Austrian pine, oriental arbor vitae, soil

Distribution in Iran: Mazandaran, Shabestar (Barimani-Varandi 1996, Barimani-Varandi and Kamali 1998, Taghavi 1996, Taghavi *et al.* 1998, Akbari *et al.* 2014).

9) *Tydeus kabutarahangensis* Khanjani and Ueckermann, 2003

Habitats or hosts: Soil covered with wheat

Distribution in Iran: Hamadan (Khanjani and Ueckermann 2003)

10) *Tydeus kochi* Oudemans, 1928

Habitats or hosts: Cereals, apple, apricot, sugar beet, soil

Distribution in Iran: Chahar Mahal and Bakhtiari, West Azerbaijan, Shabestar (Noorbakhsh 1993, Noorbakhsh and Kamali 1995, Modarres Awal 1997, Haddad Irani Nejad *et al.* 2005, Akbari *et al.* 2014).

11) *Tydeus longisetosus* (El Bagoury and Momen, 1988)

Habitat or hosts: Apple, bean

Distribution in Iran: Maragheh (Khodayari *et al.* 2010)

12) *Tydeus meshkinensis* André, Ueckermann and Rahmani, 2010

Habitat or hosts: apple, soil

Distribution in Iran: Meshkinshahr (Zanjan), Shabestar (East Azerbaijan) (André *et al.* 2010, Akbari *et al.* 2014)

13) *Tydeus mississippiensis* Baker, 1970

Habitat or hosts: pear, peach, pistachio, plum, walnut, apricot and sour cherry

Distribution in Iran: East Azarbaijan (Daneshvar 1978, Kamali *et al.* 2001).

14) *Tydeus shabestariensis* Akbari, Haddad and Kaźmierski, 2015

Habitat or hosts: soil of apple orchards

Distribution in Iran: East Azarbaijan (Akbari *et al.* 2015).

DISCUSSION

The species *T. electus* and *T. caudatus* were the most abundant *Tydeus* species collected in the Kermanshah province. *Tydeus caudatus* is the most common tydeid species in Italian vineyards (Castagnoli 1984); it is reported as predator of *Colomerus vitis* in the laboratory (Camporese and Duso 1995). Studies showed that *T. caudatus* populations can persist and increase in vineyards without eriophyids and other potential preys, as a result of non-prey foods in its diet (Duso *et al.* 2005). Darbemamieh *et al.* (2010) first recorded *T. caudatus* for Iranian fauna from Kermanshah orchards and discussed some aspects of its biology and foraging behavior. Akbari *et al.* (2014) reported this species from Shabestar, East Azerbaijan province of Iran again. In this study we collected this mite from most parts of Kermanshah province on many hosts; that show its host diversity and abundance in western part of Iran.

Dugès' *caudatus* is a mite listed in both Tenuipalpidae and Tydeidae, based on different publications (André 2011, Castro *et al.* 2016). André (2011) collected mites on laurustinus shrubs (*Viburnum tinus*) around Montpellier (France) to retrieve the species described by the French scientist. He suggested that Dugès' *caudatus* is probably a Tenuipalpidae not a Tydeidae. Then he re-described *Tenuipalpus caudatus* (Dugès, 1834) from specimens collected in Montpellier and a neotype that is deposited at Paris. Recently, Castro *et al.* (2016) provided another new description for this tenuipalpid. The most frequent tydeid observed by André on *Viburnum tinus* in Montpellier was *Tydeus goetzi* Schruft, 1972, and therefore he provided a re-description for it (André 2011). Based on this information, he introduced *Tydeus caudatus* as an invalid name according to his findings and mentioned that

T. goetzi can be the appropriate name that represents *T. caudatus* characters.

The mysterious question is that if Dugès described two species with one description? Or he saw *T. goetzi* and did not understand that was something different with tenuipalpid one in case that they have completely different appearance? The other hypothesis is that, there were two descriptions and one was lost. If we accept the presence of both species in Dugès slides, why he wrote only one note for both? If we consider that he described tenuipalpid mite and did not talk about tydeid one, so why should we consider *T. goetzi* (another species) presenting name for *caudatus* in case that we have older descriptions of it?

Baker (1970) re-described *Tydeus caudatus* and provided figures and measurements for it that followed and supported by Jeppson *et al.* (1975). This description is older than schruft's *T. goetzi* and even followed by lots of scientists. Also, we have some older descriptions from Oudemans (1928) and Thor (1933) with measurements and information about *T. caudatus* that prove the presence of this species. On the other hand, there are some differences between these two near species based on their descriptions. In *T. goetzi*, spatulate setae (20 – 25 µm) abruptly broadened in distal 1/3 and rounded distally, nearly spoon like otherwise in *T. caudatus* relatively long (30 – 36 µm) spatulate setae tapered distal and maximally broadened in at most 2/3 of their length (Figures 1 and 2). Even if the Dugès *caudatus* is tenuipalpid mite, because of these old descriptions on *T. caudatus* and its differences with *T. goetzi*, we can't omit the species name easily.

Lots of ecological changes may cause moving one species from its habitat and sampling is a random process that cannot be representative of all inhabitants of one place in all seasons and all times. We cannot expect to find a species after 180 years in the same place because of ecological and climatic changes as well as usage of pesticides or other treatments. Since *T. caudatus* is older name than *T. goetzi*, reported in many papers, belongs to real characters that observed in lots of places on different plants and reported as an abundant species in different places of the world, it does not seem that lack of

collecting this species after many years in one place can invalid this old and frequent name. *T. caudatus* and *T. goetzi* are two near species, but if with considering descriptions of Schruft (1972), Baker (1970) and André (2005, 2011) they were synonyms, *T. caudatus* is older and valid name based on Baker's re-description even with omitting Dugès description. Meanwhile, no one has information about the holotype of Dugès species and no one has checked it before crystallization.

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