



## Introduction

*Neoseiulus* Hughes (Acari: Phytoseiidae) is one of the largest genera in the subfamily Amblyseiinae, with about 350 valid species (Beard, 2001; Chant & McMurtry, 2003; Zannou et al, 2006; Papadoulis et al, 2009; Demite et al, 2014; 2019). Previously, 17 species of *Neoseiulus*, from various ecosystems and habitats, including agricultural areas, have been reported for the Turkish fauna (Duzgunes & Kilic, 1983; Ozman & Cobanoglu, 2001; Cobanoglu, 2002; 2004; Cakmak & Cobanoglu, 2006; Kasap & Cobanoglu, 2009; Faraji et al, 2011; Doker et al, 2014; 2015; 2016a).

Among them, *N. californicus* (McGregor, 1954) *sensu* Athias-Henriot (1977) [= *N. chilensis* (Dosse, 1958)] (see Beaulieu & Beard, 2018), *N. cucumeris* (Oudemans, 1930) and *N. barkeri* Hughes, 1948, are widely used in biological control programs for spider mite and thrips control around the world (Doker et al, 2016b; Li et al, 2017; Knapp et al, 2018). Some *Neoseiulus* species, such as *N. californicus*, *N. longispinosus* (Evans, 1952) and *N. fallacis* (Garman, 1948) are considered to be selective predators of *Tetranychus* spp. (Acari: Tetranychidae) characterized by Type II feeding habits (McMurtry & Croft, 1997). However, some species can feed and reproduce on different food sources that include small soft bodied insects, as well as pollen (McMurtry et al, 2013). Therefore, each *Neoseiulus* species may be a promising candidate for biological control programs.

In this study, *N. cinctatus* (Livshitz & Kuznetsov, 1972) is reported for the first time for the Turkish fauna, based on adult females collected from *Verbascum* sp. in Denizli Province.

## Materials and Methods

Mites were directly collected using a camel hair brush (000) and preserved in 75% alcohol in Eppendorf® tubes. The phytoseiid mites were examined using a stereo-microscope and then transferred to a lacto phenol solution in watch glasses. The clearing units were kept at 25 °C for 24 hours. The mites were mounted in Hoyer's medium on microscope slides. An Olympus® CX41 microscope and an Olympus® U-DA drawing attachment were used to prepare the illustrations. The most widely used taxonomic system, proposed by Chant & McMurtry (2007), was followed. The setal nomenclature used followed Lindquist & Evans (1965), as adapted by Rowell et al (1978) for the family Phytoseiidae. All measurements are given in micrometers (µm). Voucher slides have been deposited in the mite collection of the Acarology Laboratory, Department of Plant Protection, Cukurova University, Adana, Turkey.

## Results

### *Neoseiulus cinctutus* (Livshitz & Kuznetsov) (Figures 1–5)

*Amblyseius cinctutus* Livshitz & Kuznetsov, 1972: 24; Swirski & Ragusa, 1977: 80; Beglyarov 1981: 38; Papadoulis & Emmanuel, 1991: 51; Papadoulis, 1993: 193.

*Neoseiulus cinctutus* (Livshitz & Kuznetsov), Moraes et al. 1986: 75; 2004: 113; Chant & McMurtry, 2003: 37; 2007: 25; Stathakis, 2011: 70.

*Amblyseius* (*Neoseiulus*) *cinctutus* (Livshitz & Kuznetsov), Karg, 1993: 190.

#### **Female** (n=2).

*Dorsum* (Figure 1). Dorsal setal pattern 10A:9B (*r3* and *R1* off shield). Dorsal shield oval with slight waist, sclerotized, smooth with a few lateral striations, bearing seven pairs of solenostomes (*gd1*, *gd2*, *gd4*, *gd5*, *gd6*, *gd8* and *gd9*); muscle-marks (sigilla) visible mostly on podosoma, length of dorsal shield (*j1*–*J5*) 320–325, width (distance between bases of setae *s4*) 155–158, (distance between bases of setae *S2*) 173–176. All dorsal setae smooth. Measurements of dorsal setae follows: *j1* 15, *j3* 20–23, *j4* 13–15, *j5* 13–15, *j6* 15–18, *J2* 15–18, *J5* 10, *z2* 18–20, *z4* 18–20, *z5* 14–16, *Z1* 20–23, *Z4* 45, *Z5* 53, *s4* 26–30, *S2* 30–34, *S4* 28–30, *S5* 15–18, *r3* 20 and *R1* 15–18.

*Peritreme*. Extending to level between setae *j1* and *j3*.

*Venter* (Figure 2). Ventral setal pattern 14:JV–3:ZV. Sternal shield smooth, lightly sclerotized, with three pairs of setae (*ST1*, *ST2* and *ST3*), and two pairs of pores (*pst1* and *pst2*); distance *ST1*–*ST3* 63–65, distance *ST2*–*ST2* 65–68; metasternal setae *ST4* and a pair of pores (*pst3*) on metasternal shields. Genital shield smooth; width at level of genital setae (*ST5*) 60. Ventrianal shield pentagonal, reticulated, bearing three pairs of pre-anal setae (*JV1*, *JV2* and *ZV2*), a pair of para-anal (*Pa*) and a post-anal setae (*Pst*). With a pair of rounded solenostomes (*gv3*). Length of ventrianal shield 110–113, width at level of setae *ZV2* 105–108. Setae *JV4*, *JV5*, *ZV1*, *ZV3*, and six pairs of pores on integument surrounding ventrianal shield. Setae *JV5* much longer than other ventral setae, 43–45 in length. All ventral setae smooth.

*Chelicera* (Figure 3). Fixed digit 28 long with three apical teeth and *pilus dentilis*; movable digit 28 long without tooth.

*Spermatheca* (Figure 4). Calyx V-shaped, 30 in length (plus neck) flaring distally; atrium enlarged, deeply forked at juncture with major duct joined to calyx by an elongated stalk; neck 15 in length; minor duct visible.

*Legs* (Figure 5). Length of legs (base of coxae to base of claws) as follows: leg I 345–350, leg II 243–245, leg III 230–233, leg IV 345–355. Genua II, III, and IV each with seven setae. Leg IV with one macroseta smooth and pointed, *StIV* 65–68.

**Male.** Not collected in this study.

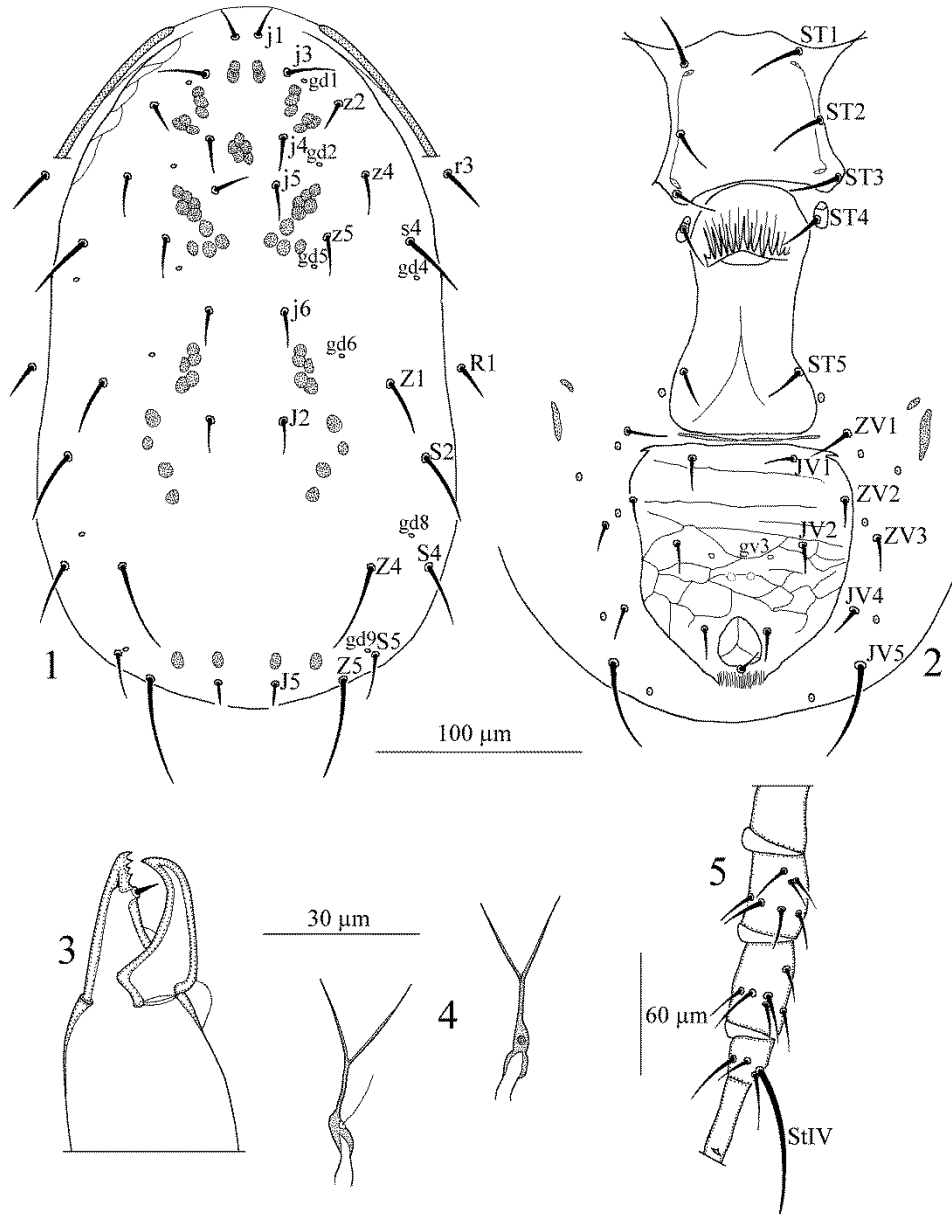


Figure 1-5. *Neoseiulus cinctus* (Livshitz & Kuznetsov, 1972) Female: 1. Dorsal shield; 2. Ventral idiosoma; 3. Chelicera; 4. Spermatheca; 5. Leg IV. Scale bar = 100 µm for 1 and 2; 30 µm for 3 and 4; 60 µm for 5.

**Material examined.** Two females collected from Buldan Municipality, Denizli Province, May 10, 2014, on *Verbascum* sp. (Scrophulariaceae).

**World Distribution.** Georgia (Wainstein, 1977), Greece (Papadoulis & Emmanouel, 1991), Ukraine (Livshitz & Kuznetsov, 1972) and Turkey (this study).

**Remarks.** *N. cinctutus* is a new record for the Turkish fauna. Morphological characters and measurements of Turkish specimens are very close to those of original description and re-descriptions. Some *Neoseiulus* species are widely used in biological control programs around the world (Zhang, 2003; McMurtry et al, 2013). Therefore, further studies to determine the prey preference and feeding habits of *N. cinctutus* and its potential as a biological control agent are of considerable importance.

**Key to Turkish species of *Neoseiulus* Hughes based on adult females**

1. Ventrianal shield without preanal solenostomes; genu II with nine setae.....*N. karandinosi* Papadoulis, Emmanouel & Kapaxidi  
 – Ventrianal shield with preanal solenostomes; genu II with less than nine setae.....2
2. Seta Z4 longer than seta Z5.....*N. ornatus* (Athias-Henriot)  
 – Seta Z4 shorter than seta Z5.....3
3. Spermatheca with atrium forked at juncture with major duct, or atrium appearing thick-walled, vacuolated.....4  
 – Spermatheca with atrium neither forked at juncture with major duct nor appearing thick-walled, vacuolated.....11
4. Genu II with 8 setae.....5  
 – Genu II with 7 setae.....6
5. Atrium connected to calyx with a long neck.....*N. neomarginatus* Stathakis, Kapaxidi & Papadoulis  
 – Atrium connected to calyx with a very short neck.....*N. sekeroglui* Döker & Stathakis
6. Seta Z5 shorter than 40 µm.....*N. agrestis* (Karg)  
 – Seta Z5 longer than 40 µm.....7
7. Atrium directly connected to calyx without a neck.....8  
 – Atrium connected to calyx with a neck.....9
8. Dorsolateral setae much shorter than the distances between their bases; dorsal shield smooth; movable digit of chelicera with one tooth.....*N. barkeri* Hughes  
 – Dorsolateral setae as long as or longer than the distances between their bases; dorsal shield reticulated posteriorly; movable digit of chelicera with two teeth.....*N. alustoni* Livshitz & Kuznetsov
9. Dorsal shield reticulated; calyx longer, about 2/3 length of calyx plus neck plus atrium.....*N. alpinus* (Schweizer)  
 – Dorsal shield smooth with anterolateral striae; calyx shorter, about 1/2 length of calyx plus neck plus atrium.....10
10. Movable digit of chelicera smooth.....*N. cinctutus* (Livshitz & Kuznetsov)

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– Movable digit of chelicera with one tooth.....*N. marginatus* (Wainstein)

11. Movable digit of chelicera smooth.....*N. zwoelferi* (Dosse)

– Movable digit of chelicera with teeth.....12

12. Movable digit of chelicera with more than one tooth.....13

– Movable digit of chelicera with only one tooth.....15

13. Movable digit of chelicera with two teeth.....*N. umbraticus* (Chant)

– Movable digit of chelicera with three teeth.....14

14. Both setae *r1* and *R3* longer than 40 µm.....

.....*N. sharonensis* (Rivnay & Swirski)

– Both setae *r1* and *R3* shorter than 40 µm.....

.....*N. californicus* (McGregor) *sensu* (Athias-Henriot)

15. Spermatheca with a short neck between calyx and atrium.....

.....*N. bicaudus* (Wainstein)

– Spermatheca without a neck between calyx and atrium.....16

16. Macroseta of basitarsus IV longer than the distance between its base and the dorsal slit organ.....*N. cucumeris* (Oudemans)

– Macroseta of basitarsus IV shorter than the distance between its base and the dorsal slit organ.....17

17. Seta *S2* subequal to *Z4*; seta *S2* reaches to the insertion of *S4*; calyx of spermatheca short, L:W 1:1.....*N. insularis* (Athias-Henriot)

– Seta *S2* shorter than *Z4*; seta *S2* not reaching the insertion of *S4*; calyx of spermatheca longer, L:W > 3:1.....*N. astutus* (Beglyarov)

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