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Article

Redescription of the larval stage of *Dermacentor parumapertus* Neumann (Acari: Ixodidae), with notes on hosts

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Abstract

The larva of the ixodid tick *Dermacentor parumapertus* Neumann, chiefly a parasite of hares and rabbits, is redescribed using scanning electron micrographs of seven specimens derived from two engorged females collected from two black-tailed jackrabbits, *Lepus californicus*, at the Black Gap Wildlife Management Area, Brewster County, southwestern Texas. The use of chaetotaxy for separating the genera of Ixodidae is discussed, and a morphological key is provided for separating the larvae of *D. parumapertus* from those of five other *Dermacentor* species with partly sympatric geographic ranges.

Key words: *Dermacentor parumapertus*, larva, identification, chaetotaxy, morphology, redescription, key

Introduction

The hard tick *Dermacentor parumapertus* Neumann (Acari: Ixodidae) occurs in the western United States southward at least as far as northern Mexico (Cooley 1938; Guglielmone *et al.* 2014; Guzmán-Cornejo *et al.* 2016). Hosts for all parasitic stages include hares and rabbits, particularly the black-tailed jackrabbit, *Lepus californicus* Gray. Immature stages are also commonly found on many other small mammals, and host records for larval *D. parumapertus* include >20 other species that exist sympatrically with *L. californicus* (Bishopp & Trembley 1945; Gastfriend 1955; Johnson 1966; Furman & Loomis 1984) (Table 1). Adults have been collected occasionally from hosts other than lagomorphs, including artiodactyls (Bovidae, Cervidae) and carnivores (Canidae) (Allred & Roscoe 1956; Guglielmone & Robbins 2018). Tick bite records from humans are relatively rare (Roscoe 1956; Johnson 1966; Furman & Loomis 1984). Since the adults are strictly host specific (less so for immatures) (Hoogstraal & Aeschlimann 1982), *D. parumapertus* is rarely encountered, except by hunters or scientists collecting rabbits for study. Records of *D. parumapertus* in the scientific literature are relatively scarce, and little information is available concerning this species' taxonomy, biology and ecology beyond the investigations conducted during the first half of the 20th Century (Hooker *et al.* 1912; McCampbell 1926; Cooley 1938; Fremling & Gastfriend 1955; Allred & Roscoe 1956). The original description of the immature stages of *D. parumapertus* was published in 1912 (Hooker *et al.* 1912), and the most recent redescription of the larva appeared almost 40 years ago (Furman & Loomis 1984); however, both descriptions were relatively brief. Using specimens that we obtained in 2015 and subsequently prepared for multiple scanning electron micrographs (SEM), we are now able to provide a more detailed redescription of the larval stage of *D. parumapertus*.

Methods

Source of ticks. Our collections were part of a broader tick-borne disease survey at the Black Gap Wildlife Management Area, located near Alpine, in Brewster County, southwestern Texas. Specimens were removed from black-tailed jackrabbits shot by experienced hunters and wildlife biologists, and these procedures were reviewed and approved by the Institutional Animal Care and Use Committee at the Centers for Disease Control and Prevention (Paddock *et al*. 2017). One adult male/female pair from our collections was sent to the last author (RGR) for confirmation. Larvae used in this study were obtained by rearing eggs laid by two engorged female *D. parumapertus* collected from two separate jackrabbits in July 2015. A week after eclosion, larvae were placed in 70% ethanol and kept in the lab until SEM studies could be conducted in 2022.

Scanning electron microscopy. Seven larval specimens (3 from one rabbit and 4 from the other) were removed from the storage ethanol and transferred to fresh 70% ethanol. Specimens were sonicated for 4–5 seconds to remove any debris, then larvae were further dehydrated in 90% and 100% ethanol. The specimens were subsequently placed in hexamethyldisilazide (HMDS) for 2 hours and then air dried to remove the HMDS. Tick larvae were mounted on aluminum stubs with carbon tape and coated with platinum. Specimens were then examined with a JEOL 6500F Field Emission scanning electron microscope (Tokyo, Japan) at 5 kV, and 38 images were digitally recorded.

Setal nomenclature. Terminology of setae followed that of Clifford & Anastos (1960), largely based on previous work, and was selected for its relative simplicity; an alternate system has been proposed by Klompen *et al*. (1996) but is not in wide use. Lindquist *et al*. (2016) compared and discussed these two systems.

Results and Discussion

In North America, larvae of all *Dermacentor* species possess a unique suite of morphological and setal characters that include: absence of an anal groove (Figure 1); nine festoons present (Figure 1); one pair of posthypostomal setae (Figure 2); all four palpal segments distinctly visible, dorsally and ventrally; four pairs of large wax glands (formerly sensilla sagittiformia) present, one pair dorsally between marginal dorsal setae 3 and 4 (Figure 3), and three pairs ventrally, posterior to coxae I-III (Figure 4); bases of prehalleral setae in tandem, not parallel (Figure 5) (Clifford *et al*. 1960). Additionally, across the genus *Dermacentor*, including the former genus *Anocentor* (=*Otocentor*), all nine pairs of body setae are identical in number: scutal (Sc), 3 pairs of setae; marginal dorsal (Md), 8 pairs; central dorsal (Cd), 2 pairs; supplementary (S), 0 pairs; sternal (St), 3 pairs; preanal (Pa), 2 pairs; premarginal (Pm), 4 pairs; marginal ventral (Mv), 5 pairs; anal (A), 1 pair.

Larvae of *D. parumapertus* possess each of the above characters, as do those of five generally recognized Nearctic *Dermacentor* whose ranges are partly sympatric with this species: *D. albipictus* (Packard), *D. andersoni* Stiles, *D. hunteri* Bishopp, *D. occidentalis* Marx, and *D. variabilis* (Say). There are no larval data yet available for the recently described *Dermacentor similis* (Lado *et al*. 2021). Together, larvae of these six species are difficult to separate based on morphology alone. For that reason, the following key utilizes morphological characters in combination with species-specific ecological and host information, an adaptation of the approach employed in other keys to the adult *Dermacentor* of the Western Hemisphere (Yunker *et al*. 1986).

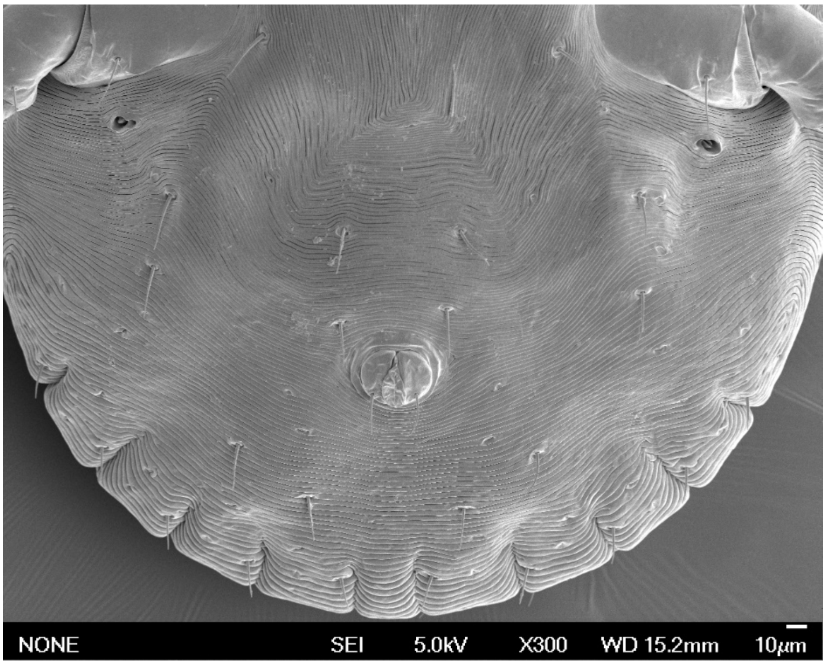

FIGURE 1. Ventral view of *Dermacentor parumapertus* larva showing nine festoons and absence of anal groove.

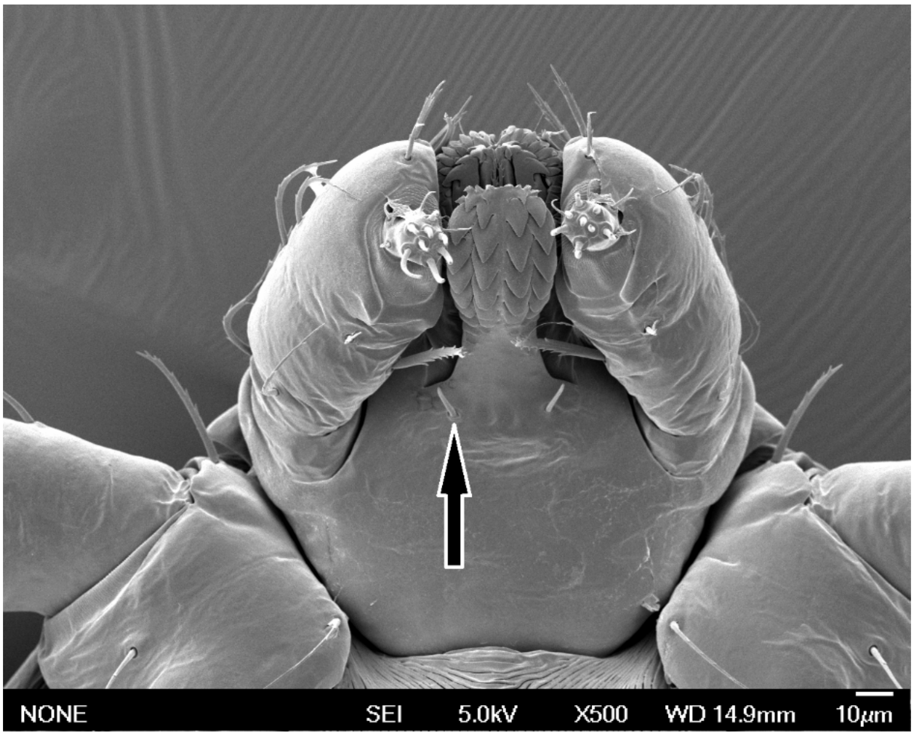

FIGURE 2. Ventral view of capitulum showing one pair of posthypostomal setae.

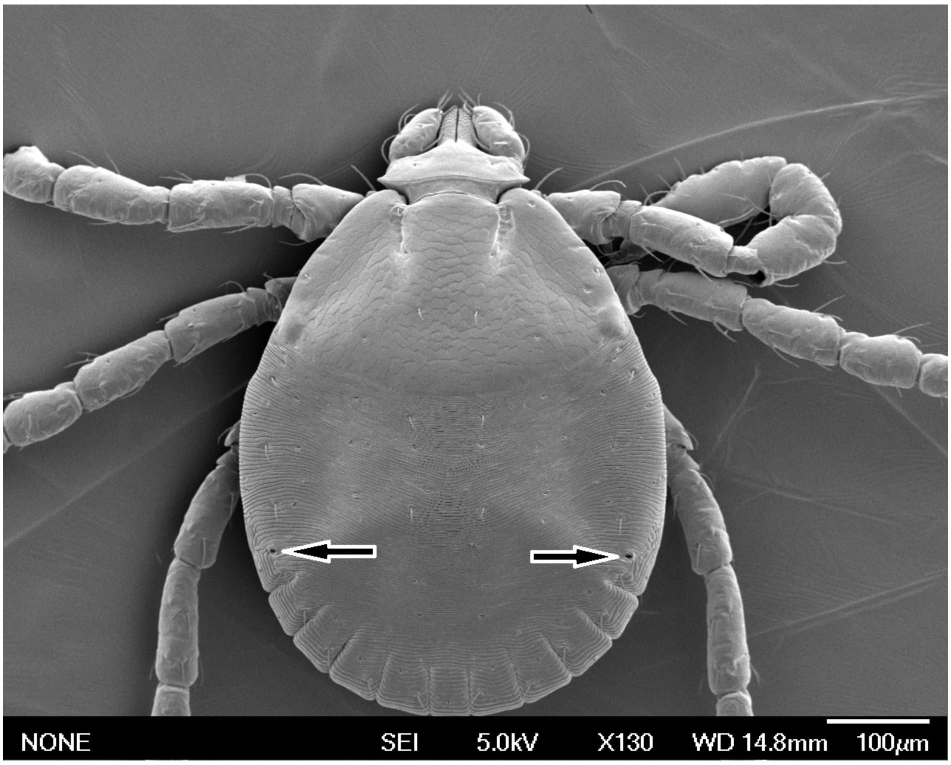

FIGURE 3. Dorsal view showing large wax glands located between marginal dorsal setae 3 and 4.

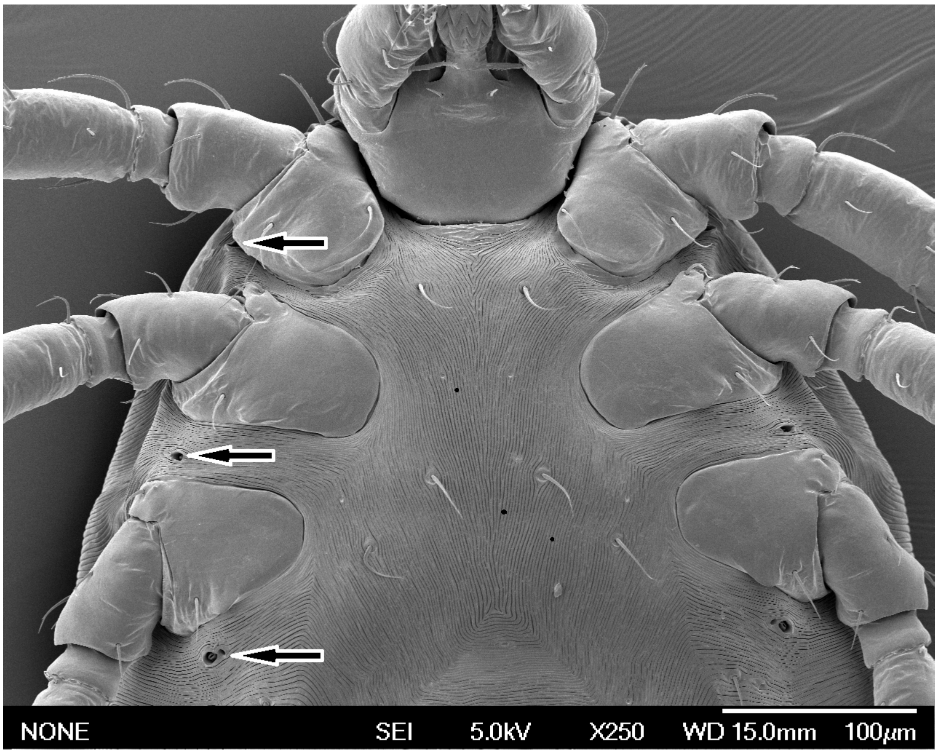

FIGURE 4. Wax glands posterior to coxae I-III.

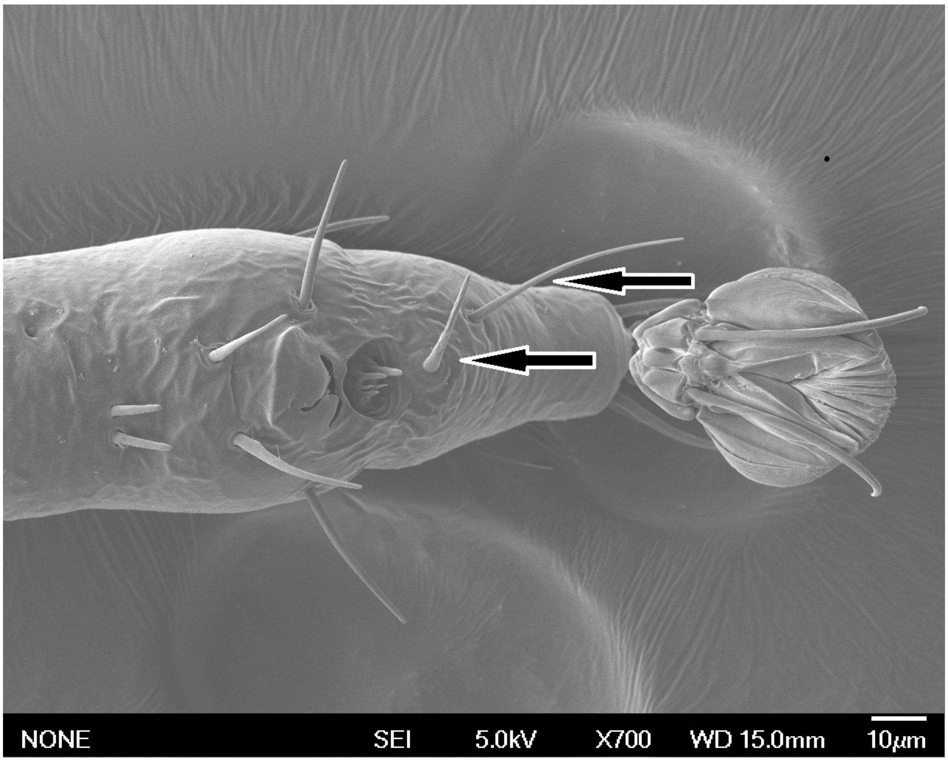

FIGURE 5. Prehalleral setae in tandem (not parallel).

Key to the larvae of *Dermacentor* species sympatric with *Dermacentor parumapertus*

1. Lateral margins of basis capituli not pointed; spurs of coxae II and III indistinct or absent; widespread in North and Central America, principally on Artiodactyla (Bovidae and Cervidae) and Perissodactyla (Equidae) . . . . *D. albipictus*
- Lateral margins of basis capituli moderately or sharply pointed; coxa II with faint or definite external spur 2
2. Internal spur of coxa I pointed and extending beyond posterior coxal margin; coxae II and III about equal in size; widespread in eastern and central North America, including eastern Mexico, principally on multiple families of Rodentia . . . . *D. variabilis*
- Internal spur of coxa I smaller and pointed or blunt; coxa II somewhat larger than coxa III 3
3. Coxa I with pointed internal spur; coxa III lacking spur; Pacific coast from Oregon to northwestern Mexico, principally on Lagomorpha (Leporidae) and multiple families of Rodentia . . . . *D. occidentalis*
- Coxa I with blunt internal spur; coxae II and III with small, broad external spurs 4
4. Lateral margins of basis capituli moderately pointed; coxae II and III with distinct, broad external spurs; scrub and xeric habitats, principally on Lagomorpha (Leporidae) and multiple families of Rodentia . . . . *D. parumapertus*
- Lateral margins of basis capituli sharply pointed; coxae II and III with small or faint external spurs 5
5. Coxa II conspicuously broader than coxa III; coxae II and III with faint external spurs; desert southwest of U.S. and northwestern Mexico, principally on Rodentia (Cricetidae) . . . . *D. hunteri*
- Coxa II slightly larger than coxa III; coxae II and III with faint external spurs, especially coxa III; xeric shrublands and temperate conifer forests, principally on Lagomorpha (Leporidae) and multiple families of Rodentia . . . . *D. andersoni*

TABLE 1. Host records for larvae of *Dermacentor parumapertus*. Scientific and common names of hosts are from the Integrative Taxonomic Information System (www.itis.gov), a consortium of U.S., Canadian, and Mexican organizations and taxonomic specialists, accessed March 2023.

Host	Common name	Reference(s)
Ammospermophilus leucurus	white-tailed antelope squirrel	Gastfriend (1955), Johnson (1966)
Chaetodipus formosus	long-tailed pocket mouse	Gastfriend (1955), Johnson (1966)
Dipodomys heermanni	Heermann's kangaroo rat	Furman & Loomis (1984)
Dipodomys merriami	Merriam's kangaroo rat	Furman & Loomis (1984)
Dipodomys microps	chisel-toothed kangaroo rat	Gastfriend (1955), Johnson (1966)
Dipodomys ordii	Ord's kangaroo rat	Bishopp & Trembley (1945)
		Gastfriend (1955), Johnson (1966)
Dipodomys panamintinu	Panamint kangaroo rat	Furman & Loomis (1984
Lepus alleni	antelope jackrabbit	Bishopp & Trembley (1945)
Lepus californicus	black-tailed jackrabbit	Bishopp & Trembly (1945)
		Johnson (1966)
		Furman & Loomis (1984)
Lepus townsendii	white-tailed jackrabbit	Bishopp & Trembley (1945)
Microdipodops megacephalus	dark kangaroo mouse	Gastfriend (1955), Johnson (1966)
Neotoma cinera	bushy-tailed woodrat	Gastfriend (1955)
Neotoma lepida	desert woodrat	Gastfriend (1955), Johnson (1966)
Onychomys leucogaster	northern grasshopper mouse	Johnson (1966)
Perognathus longimembris	little pocket mouse	Bishopp & Trembley (1945)
		Gastfriend (1955), Johnson (1966)
		Furman & Loomis (1984)
Perognathus parvus	Great Basin pocket mouse	Gastfriend (1955), Johnson (1966)
Peromyscus crinitus	canyon mouse	Johnson (1966)
Peromyscus maniculatus	deer mouse	Gastfriend (1955), Johnson (1966)
Peromyscus truei	piñon mouse	Gastfriend (1955), Johnson (1966)
Reithrodontomys megalotis	western harvest mouse	Gastfriend (1955), Johnson (1966)
Sylvilagus audubonii	desert cottontail	Johnson (1966)
Sylvilagus nuttallii	mountain cottontail	Johnson (1966)
Tamias minimus	least chipmunk	Johnson (1966)

The larva of *D. parumapertus* may therefore be further described as follows:

Body oval, tapering anteriorly, length from scutal emargination to posterior body margin 0.61–0.63 mm (mean 0.62), width 0.40–0.46 mm (mean 0.44), widest at about level of coxae III. Scutum 0.18–0.22 mm long (mean 0.20), 0.32–0.34 mm wide (mean 0.33), scutal surface reticulate, cervical grooves deep, extending about one-third length of scutum and converging posteriorly, eyes situated at posterolateral corners of scutum and slightly elevated. Capitulum dorsally 0.13–0.16 mm wide (mean 0.15), 0.11–0.12 mm long (mean 0.11) from palpal apices to posterior margin of basis. Lateral margins moderately pointed and flange-like, posterior margin broadly concave; ventrally, hypostome bluntly rounded apically, length of toothed portion 0.038–0.040 mm long (mean 0.039), dentition 2/2, with 6–7 principal denticles per file. Coxa I with blunt internal spur, coxae II–III each with distinct, broad external spur.

More comparative studies of preimaginal North American *Dermacentor* species are required, including those species that have not been redescribed for decades. For example, the larvae and nymphs of *D. halli* McIntosh and *D. hunteri* were last described by Brinton *et al*. (1965) and Furman & Loomis (1984), respectively; the latter authors were also the last to describe the nymphs of *D. occidentalis* and *D. parumapertus* (Guglielmone *et al*. 2020). It is hoped that the present work will stimulate others, particularly investigators with an interest in tick surveillance, to conduct similar studies. Future taxonomic redescriptions will require an integrative approach that incorporates molecular, geographical, ecological, and proteomic components. There are likely additional cryptic species among those current recognized, as evidenced by recent studies (Beati *et al*. 2013; Lado *et al*. 2021).

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