

66 Supplement

ARTHROPODA

Acari (Order): Keys to the Ticks

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Phylum Arthropoda

Order Acari

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Chapter 66 Supplement

Acari (Order):

Keys to the Ticks

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Morphological Keys for Extant Tick Families and Genera

Comprehensive identification guides for argasid and ixodid ticks are available for some regions (for example, the Neotropical region, Southern Code of South America, Europe, North Africa, and Southern Africa) (Barros-Battesti et al., 2006; Nava et al., 2017; Estrada-Peña and De La Fuente, 2018; Horak et al., 2018).

Keys for ixodids are usually for males and females. Immature stages of many species of ixodids need to be redescribed and identification keys are available only for few genera and for single countries (for example, Martins et al., 2010; 2014) or group of countries (for example, Nava et al., 2017). For argasids, keys are usually for larvae, considering that nymphs and adults of various species are morphologically indistinguishable.

The key of families and genera of adult ticks is adapted from Keirans (2009) and Sonenshine and Roe (2013). The keys to genera of Argasidae larvae and nymphs are based on Barros-Battesti and colleagues (2013). The keys for Ixodidae larvae and nymphs are based on Cooley and Kohls (1945), Cooley (1946), Clifford and Anastos (1960), Clifford and colleagues (1961; 1973), Robbins and Keirans (1992), Durden and Keirans (1996), and Nava and colleagues (2017; 2018). Some illustrations are also included, some of which were re-drawn from schematic drawings available in the literature and others were originally produced for the chapter on ticks in Concepts in Animal Parasitology (Barros-Battesti et al., 2024).

Key to the families and genera of Ixodida

- 1a. Capitulum terminal or subterminal. Scutum or leathery pseudoscutum present. Spiracular plates situated posterior to coxa IV.....2
- 1b. Capitulum terminal in larvae and ventral in nymphs and adults. Dorsal plate present or absence in larvae. Pseudoscutum rarely present in nymphs and adults. Spiracular plates situated between coxa III and IV.....family Argasidae...3
- 2a. Capitulum subterminal. Scutum podonotal present in larvae and leathery papillated pseudoscutum present in nymphs and adults.....family Nuttalliellidae, genus*Nuttalliella*
- 2b. Capitulum terminal. Podonotal scutum podonotal present in larvae, nymphs and females, and holonotal scutum in males.....family Ixodidae...7
- 3a. Sutural line separating the dorsal and ventral surfaces of idiosomal.....genus *Argas* (Figure 1A)
- 3b. Sutural line absent.....4
- 4a. Pseudoscutum present.....genus *Nothoaspis*
- 4b. Pseudoscutum absent.....5
- 5a. Nymphs with spiny dorsal integument and well-developed hypostome. Adults with granular integument and vestigial hypostome.....genus *Otobius*
- 5b. Dorsal integument mamillated or tuberculated. Hypostome of various forms.....6
- 6a. Dorsal integument tuberculated, sometimes with areas of smooth cuticle. Hypostome denticulate in larvae and nymphs (last nymphal instars present only minute denticles), but vestigial and scoop-like in adults.....genus *Antricola* (Figure 1B,C)
- 6b. Dorsal integument mamillated (except *O. marinkellei*, in which it is smooth in nymphs and adults). Hypostome usually denticulate and of various forms, but usually not scoop-like (except *O. rondoniensis*).....genus *Ornithodoros* (Figure 1D)
- 7a. Eyes absent.....8

7b. Eyes present.....	12
8a. Festoons absent. Anal groove curving anteriorly to anus.....	genus <i>Ixodes</i> (Figure 2A)
8b. Festoons present. Anal groove curving posteriorly to anus or absent.....	9
9a. Scutum usually ornate (rarely inornate). Palps elongate and subcylindrical.....	10
9b. Scutum inornate. Palps long or short and conical (not subcylindrical).....	11
10a. Trochanters with subterminal spurs.....	genus <i>Bothriocroton</i> (Figure 2B)
10b. Trochanters lacking subterminal spurs.....	genus <i>Amblyomma</i>subgenus <i>Aponomma</i> * (Figure 2C)
11a. Basis capituli rectangular. Palps short, with article II as broad as long, and extended laterally in most species.....	genus <i>Haemaphysalis</i> (Figure 2D,E)
11b. Basis capituli quadrangular with diverging anterolateral margins in males and hexagonal in females. Palps long, with article II at least twice as long as broad, not extended laterally.....	genus <i>Anomalohimalaya</i> (Figure 2F)
12a. Spiracular plates with irregular ridges, partially ornamented with ivory colour. Festoons present (9 in number).....	genus <i>Cosmiomma</i>
12b. Spiracular plates lacking irregular ridges or ornamentation. Festoons present or absent (if present, never 9 in number).....	13
13a. Palps much longer than basis capituli (except <i>Nosomma</i> , in which it is subequal), with article II much longer than broad.....	14
13b. Palps as long as basis capituli, with article II about as long as broad.....	16
14a. Scutum and palps ornamented. Palps with article III with dorsal and ventral flange. Males with adanal, accessory and subanal (trilobed) plates.....	genus <i>Nosomma</i> (Figure 3A)
14b. Scutum ornate or inornate. Palps with article III lacking dorsal and ventral flange. Males with or without ventral plates.....	15
15a. Scutum inornate. Males with adanal, accessory and subanal plates. Festoons irregular (7–11 in number), partially fused.....	genus <i>Hyalomma</i> (Figure 3B)

- 15b. Scutum usually ornate. Males lacking adanal, accessory and subanal plates (males of some species present sclerotized ventral plates). Festoons regular (11 in number), not fused
genus *Amblyomma* (Figure 3C)
- 16a. Palps extremely short (shorter than hypostome), ridged dorsally and laterally. Anal groove indistinct. Festoons absent.....genus *Rhipicephalus* (*Boophilus*) (Figure 3D)
- 16b. Palps not extremely short (at least as long as hypostome), not ridged dorsally and laterally. Festoons present or absent.....17
- 17a. Festoons absent. Males with leg IV greatly enlarged.....genus *Margaropus*
- 17b. Festoons present. Males with leg IV not greatly enlarged.....18
- 18a. Festoons 7 in number. Spiracular plates round with few large goblet cells. Scutum inornate.....genus *Dermacentor* (*Anocentor*) (Figure 3E)
- 18b. Festoons 11 in number. Spiracular plates round or with dorsal prolongation and with numerous goblet cells. Scutum ornate or inornate.....19
- 19a. Basis capituli rectangular. Scutum usually ornate.....genus *Dermacentor*
- 19b. Basis capituli hexagonal. Scutum usually inornate.....20
- 20a. Scutum usually inornate (only four ornate species). Males with adanal and accessory plates. Males with coxa IV not much larger than the others and lacking two long spurs.....
genus *Rhipicephalus* (*Rhipicephalus*) (Figure 3F)
- 20b. Scutum inornate. Males lacking adanal and accessory plates. Males with coxa IV much larger than the others and with two long spurs.....genus *Rhipicentor* (Figure 3G)

*This includes 2 species (*A. elaphense* and *A. sphenodonti*) that were recently transferred to 2 new genera *Robertsicus* and *Archaeocroton* (Barker and Burger, 2018). These new genera were proposed to resolve the polyphyly of the genus *Amblyomma*, not necessarily because of relevant morphological traits that would allow their classification into separate genera.

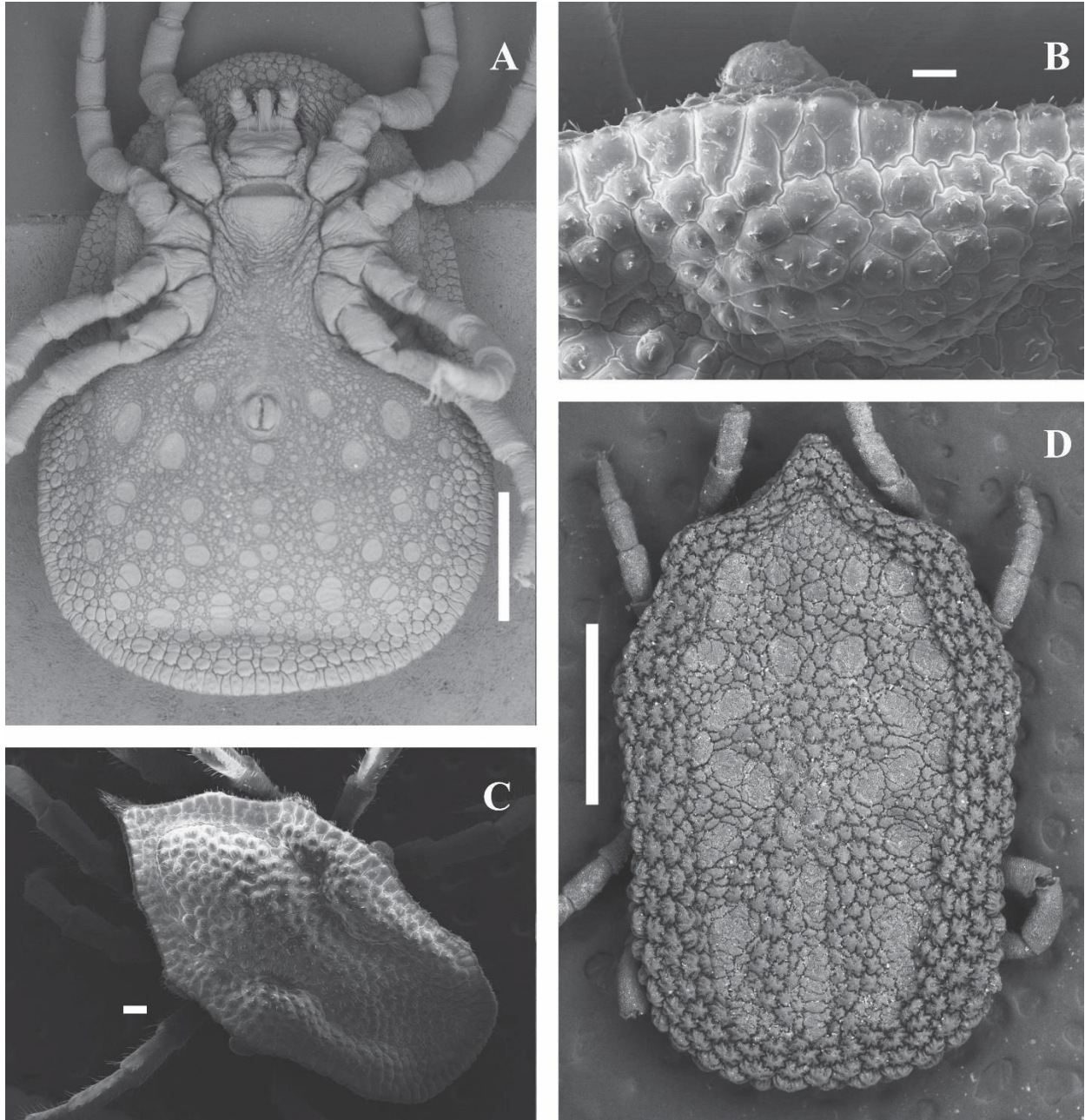


Figure 1. Adults of Argasidae genera. A) *Argas miniatus* female, ventral view; B, C) *Antricola guglielmonei*, spiracular plate and dorsal view; D) *Ornithodoros* sp., dorsal view. Scale bars: A, D = 1,000 μm ; B = 100 μm ; C = 200 μm . Source: D. Moraes Barros-Battesti, V. Castilho Onofrio, and F. Dantas-Torres. License: CC BY-NC-SA 4.0.

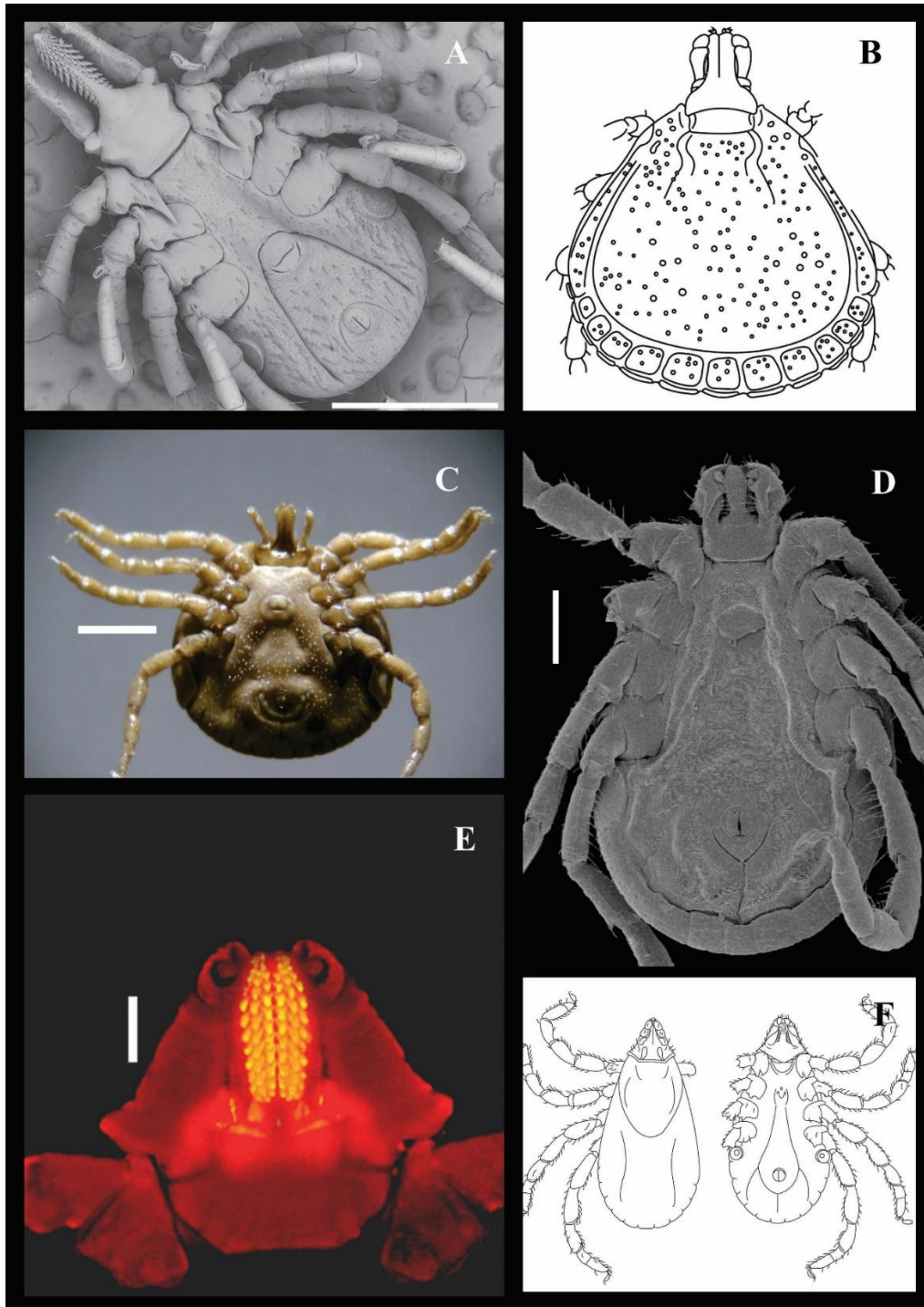


Figure 2. Adults of Ixodidae genera. A) *Ixodes aragai* female, ventral view; B) *Bothriocroton* male, dorsal view; C) *Amblyomma (Aponomma) quadricavum* female, ventral view; D) *Haemaphysalis juxtakochi* male, ventral view; E) *H. leporipalustris*, gnatosoma ventral view; F) *Anomalohimalaya* female, dorsal and ventral view.

Scale bars: A = 500 μm ; C = 1,000 μm ; D = 300 μm ; E = 100 μm . Sources: A, C–E) D. Moraes Barros-Battesti, V. Castilho Onofrio, and F. Dantas-Torres; B) Adapted from Barker and Walker (2014); F) Adapted from Hoogstraal et al. (1970). License: CC BY-NC-SA 4.0.

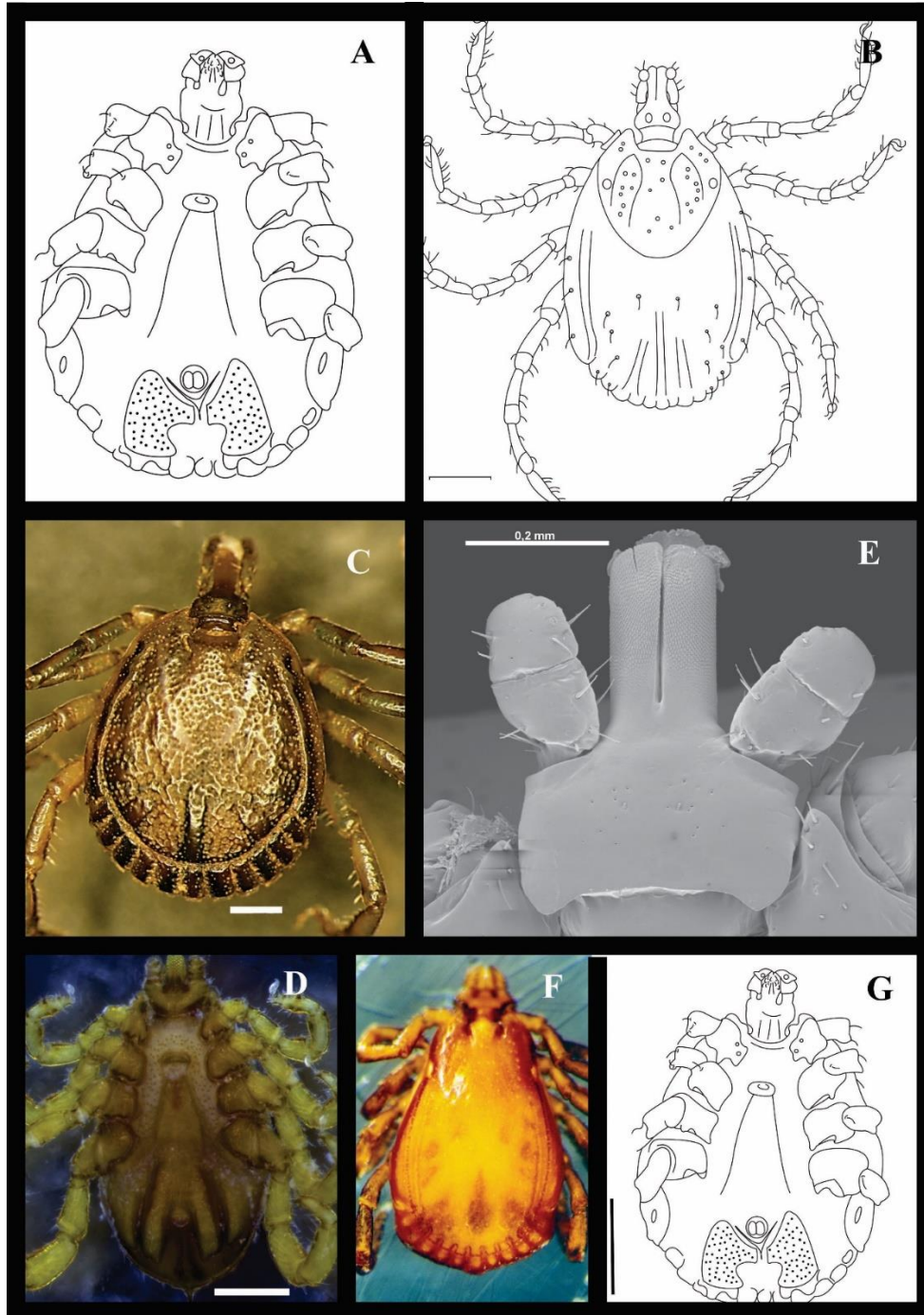


Figure 3. Adults of Ixodidae genera. A) *Nosomma* male, ventral view; B) *Hyalomma* female, dorsal view; C) *Amblyomma sculptum* male, dorsal view; D) *Rhipicephalus (Boophilus) microplus* male, ventral view; E) *Dermacentor* male, gnathosoma dorsal view; F) *Rhipicephalus sanguineus* s. l. male, dorsal view; G) *Rhipicentor* male, ventral view.

Scale bars: C = 250 μ m; D = 500 μ m; E = 250 μ m. Sources: A) Adapted from Prakasan and Ramani (2007); B) Adapted from Walker et al. (2003); C–F) D. M. Barros-Battesti, V. Castilho Onofrio, and F. Dantas-Torres; G) Adapted from Nuttall and Warburton (1908). License for all: CC BY-NC-SA 4.0.

Keys to genera of Argasidae larvae of the Neotropical region

1. Eyes present; Haller’s organ with capsule aperture large and rounded, with posterior projections like branches, posthalleral setae very long; dorsal idiosoma striated with 7–10 pairs of setae, dorsal plate large, elongate tapering slightly posteriorly; ventral surface with 5 pairs of setae + 1 pair on valvae; hypostome long without corona, dental formula 2/2
*Otobius* (Figure 4A)
 - Eyes absent.....2
2. Palpal segment 4 as long as, or longer than the other palpal segments. Dorsal idiosoma with 25–30 pairs of setae, dorsal plate oval elongate; ventrally with less than 7 pairs; hypostome rounded on apex, dentition 2/2 from basis to posterior third, then 3/3 to apex; trumpet-shaped sensillum on tarsus I present or absent; if present, extending posteriorly from the capsule of Haller’s organ, claws present.....*Argas* (Figure 4B)
 - Dorsal idiosoma with 13–21 pairs of setae (with few exceptions), hypostome pointed or rounded at apex, claws present or absent on tarsi.....3
3. Pulvilli extended, claws absent (except in *A. marginatus*); with 14–15 pairs of dorsal setae, dorsal plate large with lateral border parallel, narrowing anteriorly; hypostome pointed at apex, dentition 3/3 extending from posterior third to apex and 2/2 at base, 3 pairs of postcoxal setae*Antricola*
 - Pulvilli reduced; claws present.....4
4. Dorsal plate with isosceles triangle shape occupying entire length of the dorsum (in unfed specimens); dorsal surface with 12–13 pairs of setae; hypostome with apex pointed, dental formula 2/2, corona absent.....*Nothoaspis*
 - Dorsal plate elongated and subrectangular, with anterior extremity narrowed, piriform or triangular; hypostome with apex rounded or pointed, hypostomal dentition 2/2 to 4/4; tarsi surface glabrous or rugous; dorsal surface with 13–21 pairs of setae (with few exceptions)*Ornithodoros* (Figure 4C,D)

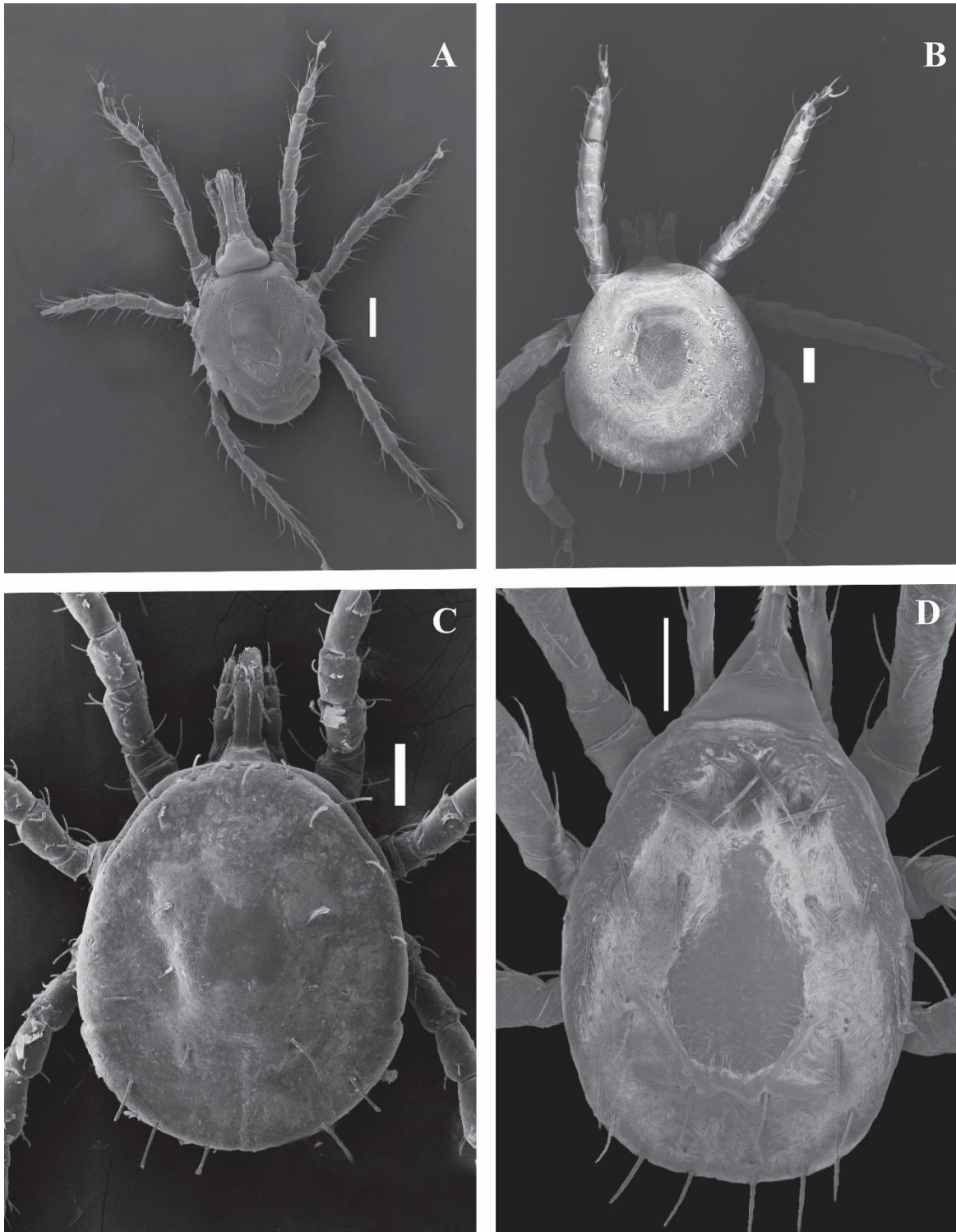


Figure 4. Larvae of Argasidae genera. A) *Otobius megnini*, dorsal view; B) *Argas miniatus*, dorsal view; C) *Ornithodoros brasiliensis*, dorsal view; D) *Ornithodoros fonsecai*, dorsal view.

Scale bars: A–C = 100 μ m; D = 120 μ m. Source: D. Moraes Barros-Battesti, V. Castilho Onofrio, and F. Dantas-Torres. License: CC BY-NC-SA 4.0.

Keys for genera of Argasidae nymphs of the Neotropical region

1. Periphery of the body flat and structurally different from dorsum, with suture distinguishing dorsal surface of the ventral.....*Argas* (Figure 5A,B)
 - Periphery of the body not differentiated, without a line sutural defined distinguishing the surface dorsal to the ventral.....2
2. Nymphs with integument spinose, hypostome long and denticulate, dentition 4/4; body panduriform, spiracular plates conical*Otobius* (Figure 5C)
 - Integument not spinose, mammillated or tuberculated, spiracular plates not conical.....3
3. False plate occupying the antero-central area of dorsum; ventrally palpi I elongate; large flaps shielding the hypostome, which is pointed; dental formula 4/4 to 5/5 at basis; spiracular plate subcircular and lateral to coxa.....*Nothoaspis*
 - False plate absent; flaps on internal side of palpal article I; if present, they are small and never shielding the hypostome.....4
4. Hypostome with a few small denticles, not clearly in a definite row; idiosoma tuberculated; most tubercles on dorsum bearing short setae, some single, others in group; spiracular plate oval; humps on tarsi absent, Haller’s organ with capsule small, rounded opening.....
.....*Antricola* (Figure 5D)
 - Hypostome with distinct denticles in rows; idiosoma mammillated, discs present; Haller’s organ with capsule aperture transversely slit-like and large, with many small setae; camerostome present; surface of tarsi mammillated without dorsal humps in bat-associated species, or surface of tarsi flat dorsally, without mammillae and with dorsal humps present.....*Ornithodoros* (Figure 5E)

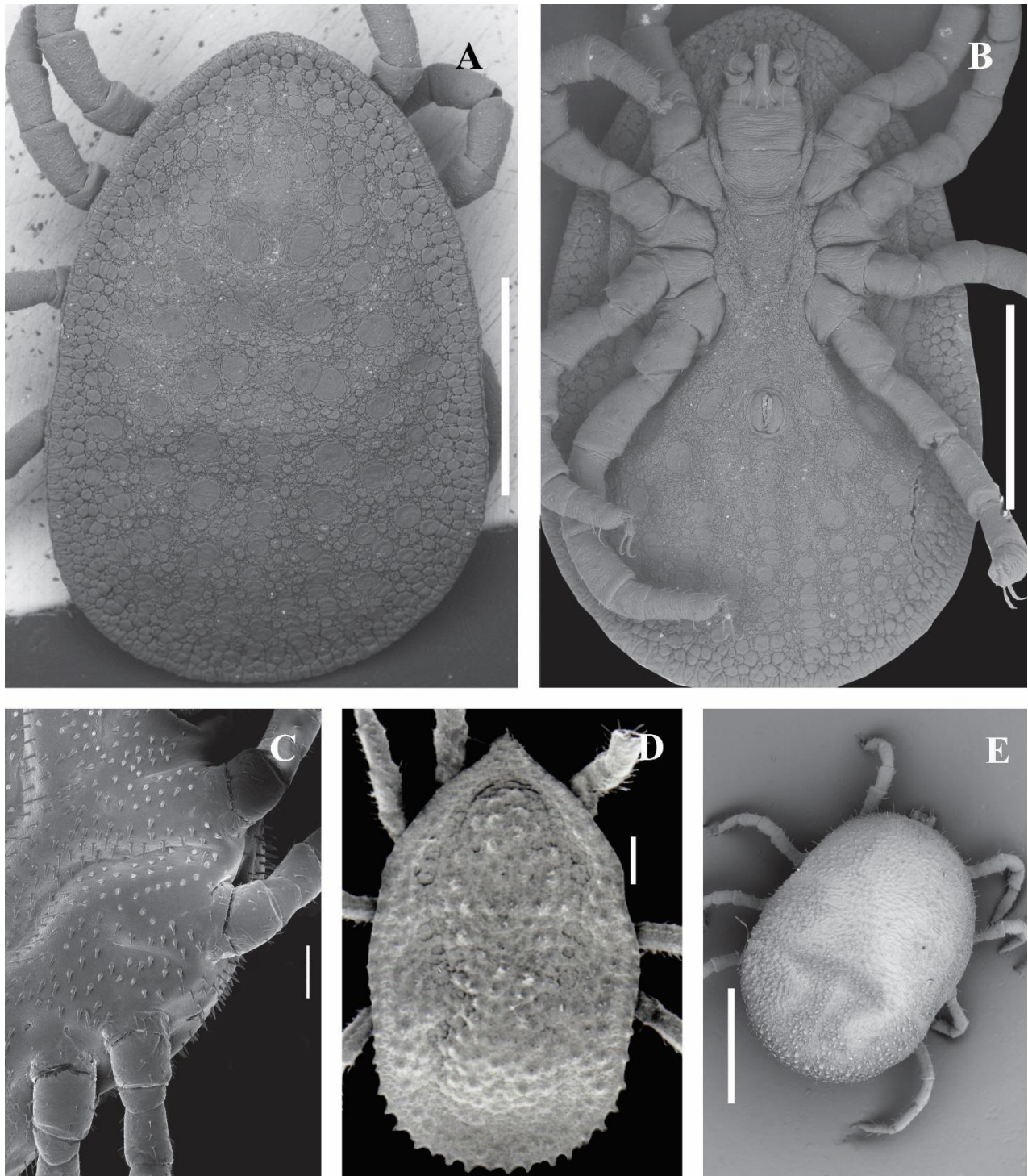


Figure 5. Nymphs of Argasidae genera. A, B) *Argas miniatus*, dorsal and ventral view, C) *Otobius megnini*, ventral view; D) *Antricola guglielmonei*, dorsal view; E) *Ornithodoros brasiliensis*, dorsal view.

Scale bars: A, B, E = 1,000 μm ; C = 300 μm ; D = 200 μm . Source: D. Moraes Barros-Battesti, V. Castilho Onofrio, and F. Dantas-Torres. License: CC BY-NC-SA 4.0.

Keys for genera of Ixodidae larvae proposed by Clifford and Anastos (1960)

1. Sensilla sagittiformia absent. With 2 pairs of posthypostomal setae. Anal groove present.....
*Ixodes* (Figure 6A)
- Sensilla sagittiformia present. With 1 pair of posthypostomal setae. Anal groove absent2
2. Palp long with 4 articles (article 1 present).....3
- Palpi short with 3 articles (article 1 absent).....5
3. With 2 marginal dorsal setae anterior to the sensilla sagittiformia. Idiosoma with 11 festoons
*Amblyomma* (Figure 6B)
- With 3 or 4 marginal dorsal setae anterior to the sensilla sagittiformia. Idiosoma with 7 or 9
 festoons.....4
4. With eyes raised and protruding. With 4 marginal dorsal setae anterior to the sensilla
 sagittiformia (occasionally 5). Idiosoma with 7 festoons.....*Hyalomma*
- With eyes flat and not protruding. With 3 marginal dorsal setae anterior to the sensilla
 sagittiformia. Idiosoma with 9 festoons.....*Dermacentor* (Figure 6C)
5. With 2 or 3 marginal dorsal setae anterior to the sensilla sagittiformia.....6
- With 4 or 5 marginal dorsal setae anterior to the sensilla sagittiformia.....7
6. Eyes absent. With 2 marginal dorsal setae anterior to the sensilla sagittiformia. Palpi with
 second article usually extended laterally. Idiosoma with 11 festoons.....
*Haemaphysalis* (Figure 6D)
- Eyes present. With 3 marginal dorsal setae anterior to the sensilla sagittiformia. Palpi with
 second article not extended laterally. Idiosoma with 9 festoons.....*Rhipicentor*
7. With 5 marginal dorsal setae anterior to the sensilla sagittiformia. Idiosoma without festoons.
 Tip of palpi blunt. Lateral sides of basis capituli rounded.....
*Margaropus* and *Rhipicephalus (Boophilus)* (Figure 6E)
- With 4 pairs of marginal dorsal setae anterior to the sensilla sagittiformia. Idiosoma with 9 festoons;
 lateral sides of basis capituli rounded or acute.....*Rhipicephalus (Rhipicephalus)* (Figure 6F)

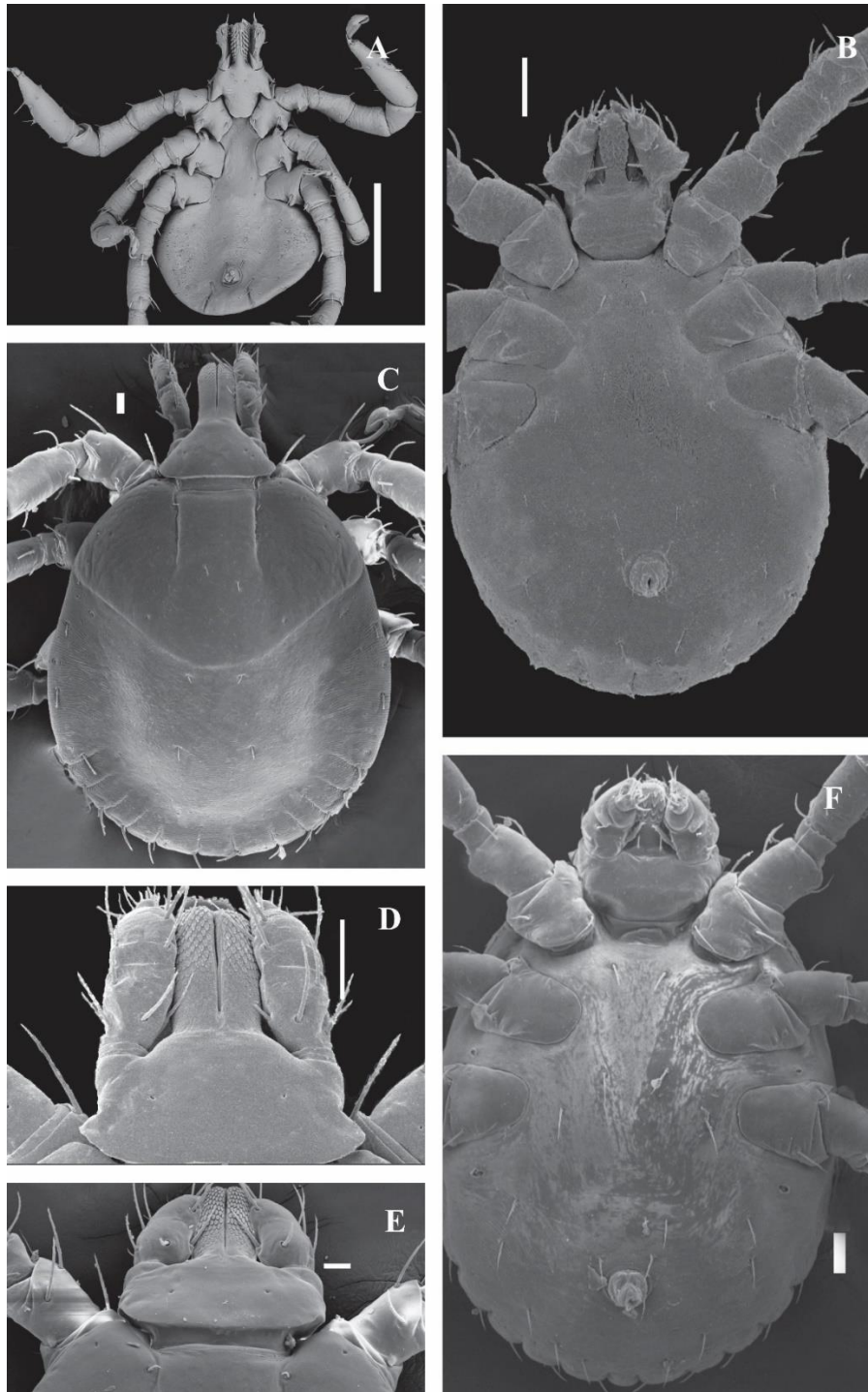


Figure 6. Larvae of Ixodidae genera. A) *Ixodes auritulus* group, ventral view; B) *Amblyomma romitii*, dorsal view; C) *Dermacentor nitens*, gnathosoma dorsal view; D) *Haemaphysalis juxtakochi*, ventral view; E) *Rhipicephalus microplus*, gnathosoma dorsal view; F) *Rhipicephalus sanguineus*, ventral view.

Scale bars: A = 250 μm ; B = 30 μm ; C = 40 μm ; D = 60 μm ; E = 20 μm ; F = 30 μm . Source: D. Moraes Barros-Battesti, V. Castilho Onofrio, and F. Dantas-Torres. License: CC BY-NC-SA 4.0.

Keys for genera of Ixodidae nymphs of the Neotropical region

1. Anal groove anterior to anus.....*Ixodes* (Figure 7A)
 - Anal groove posterior to anus or indistinct.....2
2. Eyes absent; palpi extended laterally; article III of palpi with a retrograde ventral spur.....
.....*Haemaphysalis* (Figure 7B)
 - Eyes present; palpi not extended laterally.....3
3. Capitulum longer than wide; palpi longer than basis capituli; basis capituli subtriangular or subpentagonal; anal groove posterior to the anus.....*Amblyomma* (Figure 7C)
 - Capitulum short (as long as wide).....4
4. Basis capituli rectangular, spiracular plate rounded in shape, with few goblets cells; anal groove posterior to the anus.....*Dermacentor* (*Anocentor*) (Figure 7D, 7D1)
 - Basis capituli hexagonal; anal groove distinct or indistinct.....5
5. Dental formula 2/2; small auriculae present; anal groove posterior to the anus present.....
.....*Rhipicephalus* (*Rhipicephalus*) (Figure 7E)
 - Dental formula 3/3; auriculae absent; anal groove indistinct.....
.....*Rhipicephalus* (*Boophilus*) (Figure 7F,G)

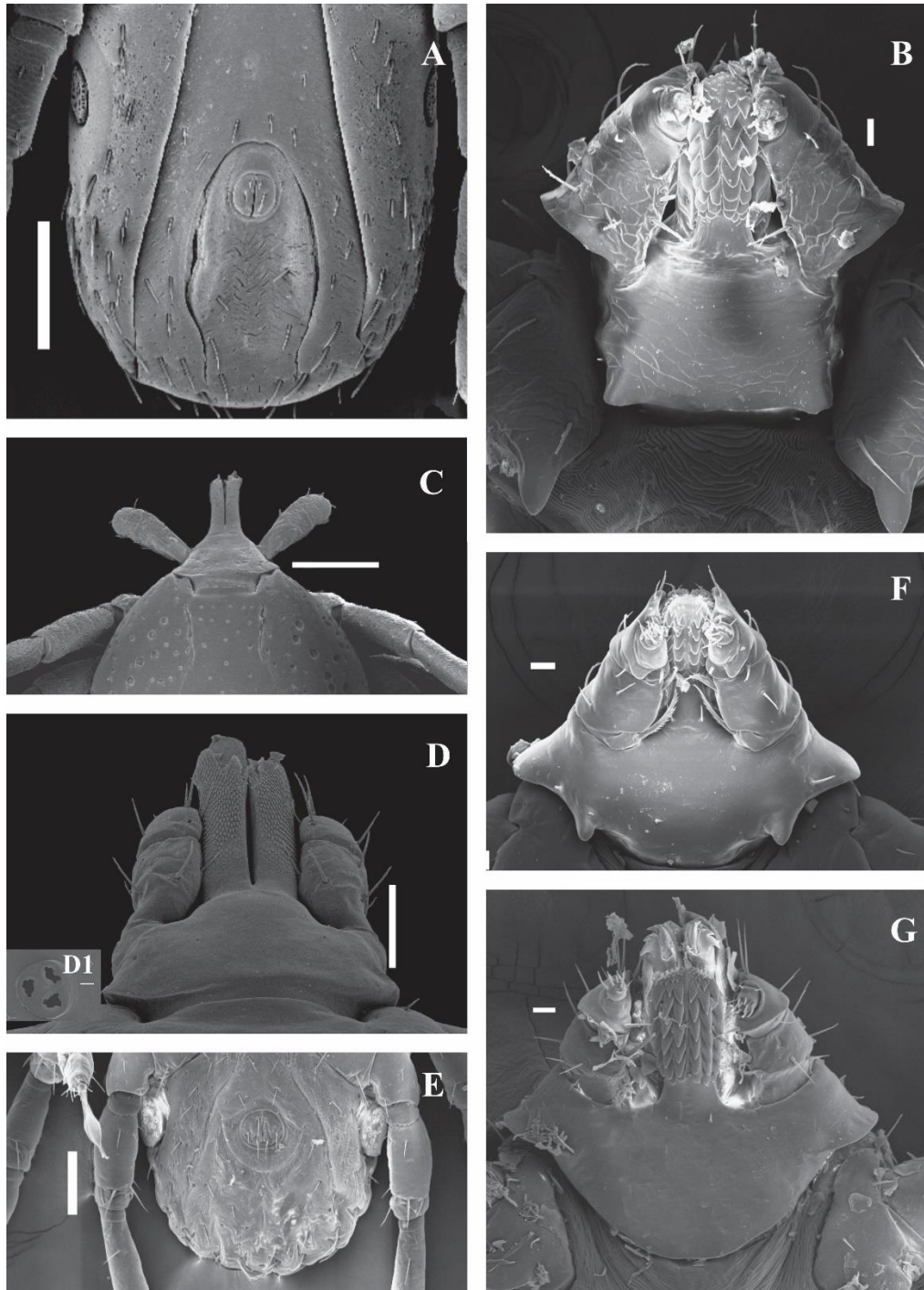


Figure 7. Nymphs of Ixodidae genera. A) *Ixodes luciae* anal groove, ventral view; B) *Haemaphysalis juxtakochi* gnathosoma, dorsal view; C) *Amblyomma longirostre*, dorsal view; D) *Dermacentor nitens* gnathosoma, dorsal view; d1) *D. nitens* spiracular plate; E) *Rhipicephalus sanguineus* s. l. anal groove, ventral view; F) *Rhipicephalus sanguineus* s. l. gnathosoma, ventral view; G) *Rhipicephalus microplus* gnathosoma ventral view.

Scale bars: A, E = 100 μ m; B = 20 μ m; C = 300 μ m; D = 80 μ m; d1 = 40 μ m; G = 20 μ m. Source: D. Moraes Barros-Battesti, V. Castilho Onofrio, and F. Dantas-Torres. License: CC BY-NC-SA 4.0.

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Supplemental Reading

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