Ticks: A-Z

Amblyomma to Zumpt*

Written by : Dr. James E. Joy
In collaboration with: Mohammed I. Ranavaya II

*Dr. F. Zumpt produced a number of important monographs and articles on arthropods whilst associated with the South African Institute for Medical Research.

Table of Contents

The Ticks – Order Parasitiformes: Suborder Ixodida

The Ticks – Order Parasitiformes; Suborder Ixodida

Most terrestrial animals are vulnerable to attack by ticks, particularly mammals. Both sexes of ticks are hematophagous (blood-feeders) that affect hosts by their feeding activities and/or transmission of various pathogenic agents (although males of some species do not take blood meals). Indeed, ticks are thought to transmit a greater variety of viral, bacterial, protozoan, and fungal pathogens than any other arthropod group, and thus are of considerable importance to those interested in medical and/or veterinary acarology. In addition, the bites of ticks sometimes produce toxic reactions or paralysis (tick paralysis is known in both birds and mammals), and wounds created by tick bites offer potential sites for the invasion by organisms that may cause secondary infections. Furthermore, ticks are not "loved" animals. Most of us have a ready aversion to these animals, and we react quickly when finding a "tick" crawling on us (or worse, attached to us), or associated with our pets. Finding a tick, attached and swollen with blood on one's pet, can be particularly disconcerting.

The principle aim of this e-Book is to assist the beginning reader in gaining a better understanding of basic tick morphology rather than offering discussions on pathogens or epidemiology of tick-borne diseases that can be found in various reference works. Additionally, while there are many genera and species with wide geographic distributions, it is not my intent to discuss taxonomic issues that are best left to the experienced acarologist. Any student wishing to consult a reference work on this subject could begin with Mullen & Durden, which I have been using for a number of years in my classes, because of the thorough treatments given to these arthropods, and the pathogens they vector.

Mullen, G. R. and L. A. Durden, eds. Medical and Veterinary Entomology,
2nd Edition, Academic Press, 637 pp. (2009).

Tick "Groups"

There are three "groups", or families, of ticks: the Ixodidae, the Argasidae, and the Nuttalliellidae. The Nutalliellidae contains but a single species, *Nuttalliella namaqua*, a species relegated to southern Africa that feeds on lizards, mammals, and perhaps birds. Thought to be the prototypical tick, it possesses characteristics of both the other two families. We do not cover the Nuttalliellidae in this e-Book.

(Note; using the term "family" before the names of these tick groups is redundant because in zoological nomenclature an "-idae" ending denotes a family name).

The Ixodidae and Argasidae are differentiated on the basis of: (1) life cycles; and (2) body morphology.

1. Life cycles

It is difficult to provide a generalized account of tick life histories because of the variability among the many species. Still, all species pass through four life cycle stages; the egg, larva, nymph and adult in periods ranging from six weeks to as long as three years. Fully engorged females lay from 100 eggs (in lair or den associated host species) to as many as 18,000 eggs (for free-ranging host species). Eggs are deposited off the host. The larval stage of ticks possesses six legs (i.e., hexapod larva), but nymphs and adults have eight legs. Members of the Ixodidae have but one nymph stage, whereas species of the Argasidae may have as many as five nymph stages (each nymph stage visiting a host to obtain a blood meal) before molting to the adult.

1-a. Life cycle of the Ixodidae

"Ixodids" have a pretty straightforward life, or developmental, cycle involving the parasitization of mammalian hosts. Briefly, males inseminate females which then must take a blood meal to provide for egg development. Fully engorged females then leave the host to deposit eggs (which may be produced in the thousands). A hexapod (6-legged) larva emerges from the egg, takes a blood meal (usually on a small host) and leaves that host to molt into an 8-legged nymph. Typically nymphs are smaller than adults, and they are sexually immature; i.e., they lack a genital atrium. The nymph feeds, often for prolonged intervals, on another host (often a different species), and after taking a blood meal leaves that host to molt and develop into an adult male or female which, in turn, may feed on yet another host species for another blood meal. Thus ixodid tick species are often referred to as "3-host ticks", or "2-host ticks", implying the taking of blood meals from individuals representing different species of mammalian hosts. Some ticks, however, are host specific (e.g., *Boophilus annulatus*), with all developmental stages often occurring on the same host individual.

Ornithodoros sp., pre-adult stages (two larvae at far left, three nymphal instars).

Ixodes sp.; hexapod larva.

1-b. Life cycle of the Argasidae

"Argasid" ticks, which may attack both mammals or fowl, depending on the species involved, are sometimes referred to as "many host ticks." These ticks have the same developmental stages as seen in "ixodid" ticks (i.e., larva, nymph, adult), but there may be multiple nymph stages in the developmental cycle of some argasid species – as opposed to only one nymph stage in ixodids – with each nymph stage feeding for brief intervals on a different host individual (but often of the same host species) on multiple occasions. As an aside, adults of one argasid genus, *Otobius*, do not feed.

As a result of these "multiple host" feeding strategies, both ixodid and argasid ticks have several opportunities to feed on a host infected with some type of pathogen throughout the course of their developmental cycle, and it is this feeding strategy that makes ticks potentially efficient vectors of disease agents.

Ticks also make "good" vectors (from the standpoint of a pathogen) because they are hardy creatures that: (1) lack natural enemies/predators; (2) have a high reproductive potential; (3) can go for long periods without feeding; (4) are able to withstand harsh environmental conditions; (5) can be widely dispersed geographically through movements of their hosts; and (6) are, in general, not host specific (i.e., most species take blood meals from a wide variety of animal hosts).

2. Morphology (Body, Mouthparts)

Ticks are dorso-ventrally flattened arthropods, with leathery sac-like bodies . Larvae possess six legs (i.e., hexapod larvae) whereas nymphs and adults possess eight legs.

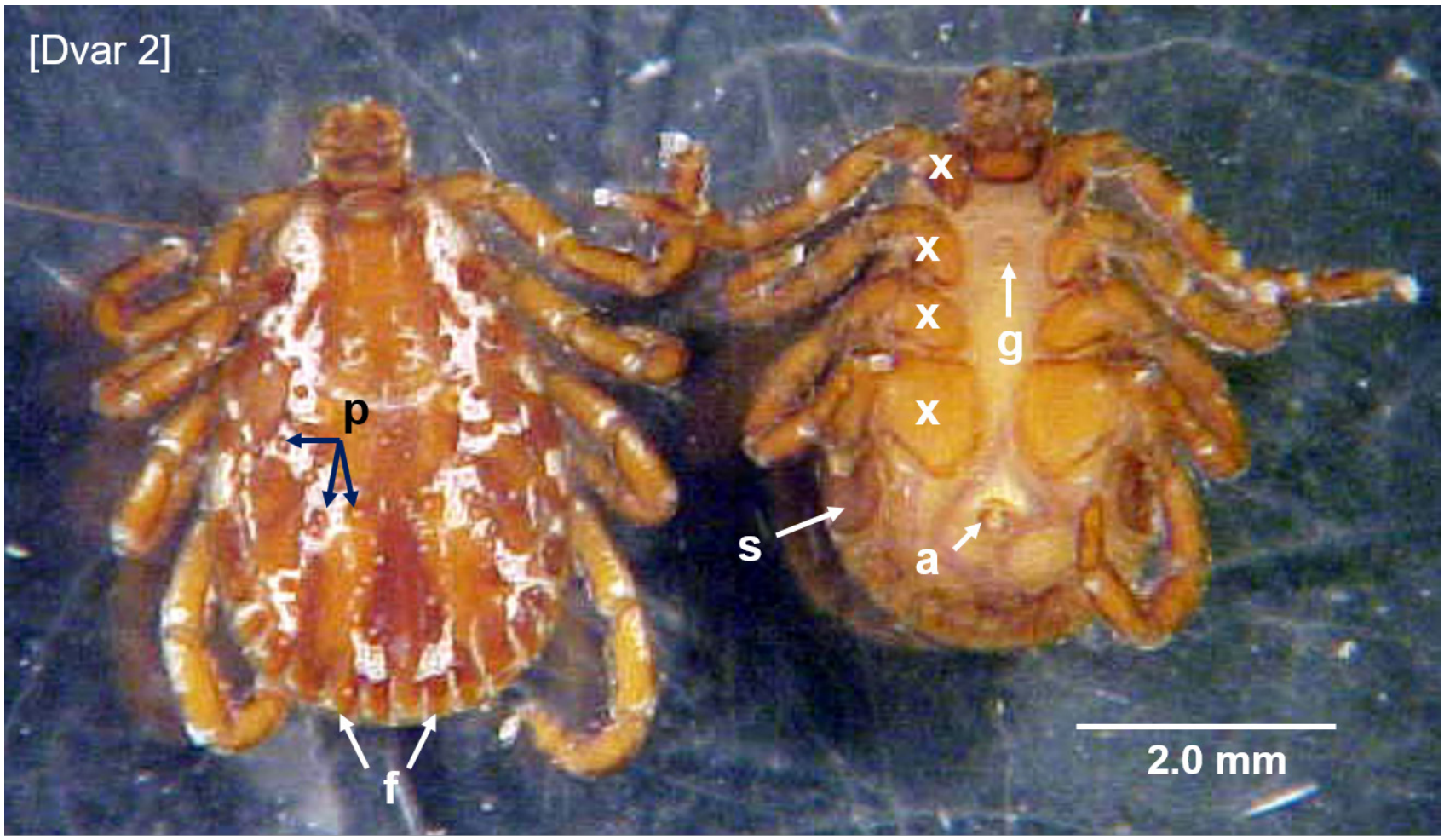
Dermacentor variabilis, females (partially engorged).

Ornithodoros sp., adults: dorsal (left) ventral (right). Specimens taken from alcohol preservative, dried, and photographed.

There are two basic groups of ticks, the Ixodidae and the Argasidae. Members of each group can be quickly differentiated on the basis of adult body morphology and position of mouthparts.

2-a. Morphological features of the Ixodidae

Members of the Ixodidae ("ixodids") are sometimes referred to as "hard ticks", or "scutate ticks", because they possess a hard dorsal plate called the scutum. The scutum is clearly a sexually dimorphic structure, covering the entire dorsal surface of males, but only a portion (perhaps the anterior third, or fourth) of the dorsum of unfed females. Since the scutum covers the entire dorsal surface in males, this hard plate prevents males from taking large blood meals. Conversely, in feeding, or fully engorged females, the soft leathery abdomen becomes greatly expanded making the scutum appear as a small plate near the anterior end of the body.

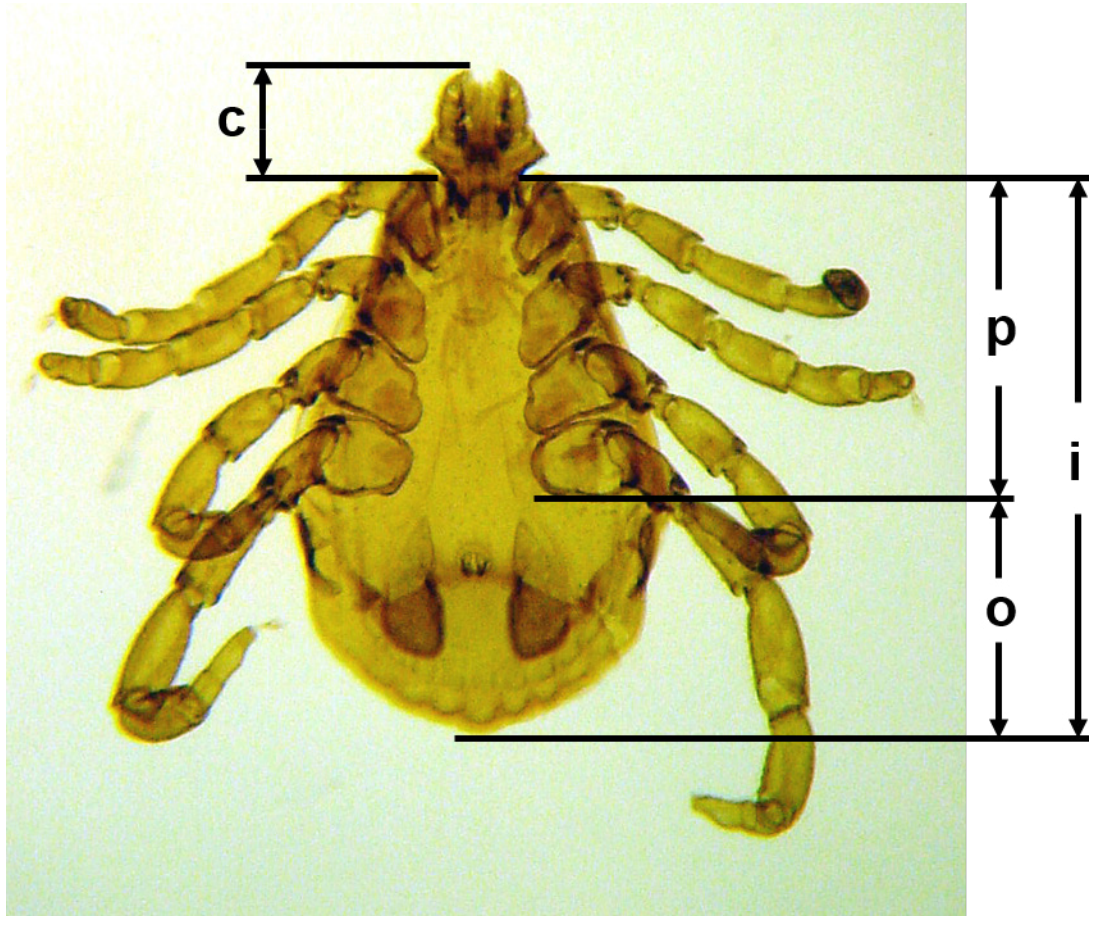


D. variabilis, males; dorsal (left) ventral (right). Note that dorsal scutum covers entire portion of body (a sexually dimorphic character of hard ticks indicating a male). Note too that coxae of male (ventral) increase in size, anterior to posterior. This species is referred to as an "ornate" (i.e., fancy) tick. The scutum is colorful and possesses punctations and grooves.

Legend**:** a, anus; f, festoons; g, genital pore; p, punctations; s, spiracle; x, coxae.

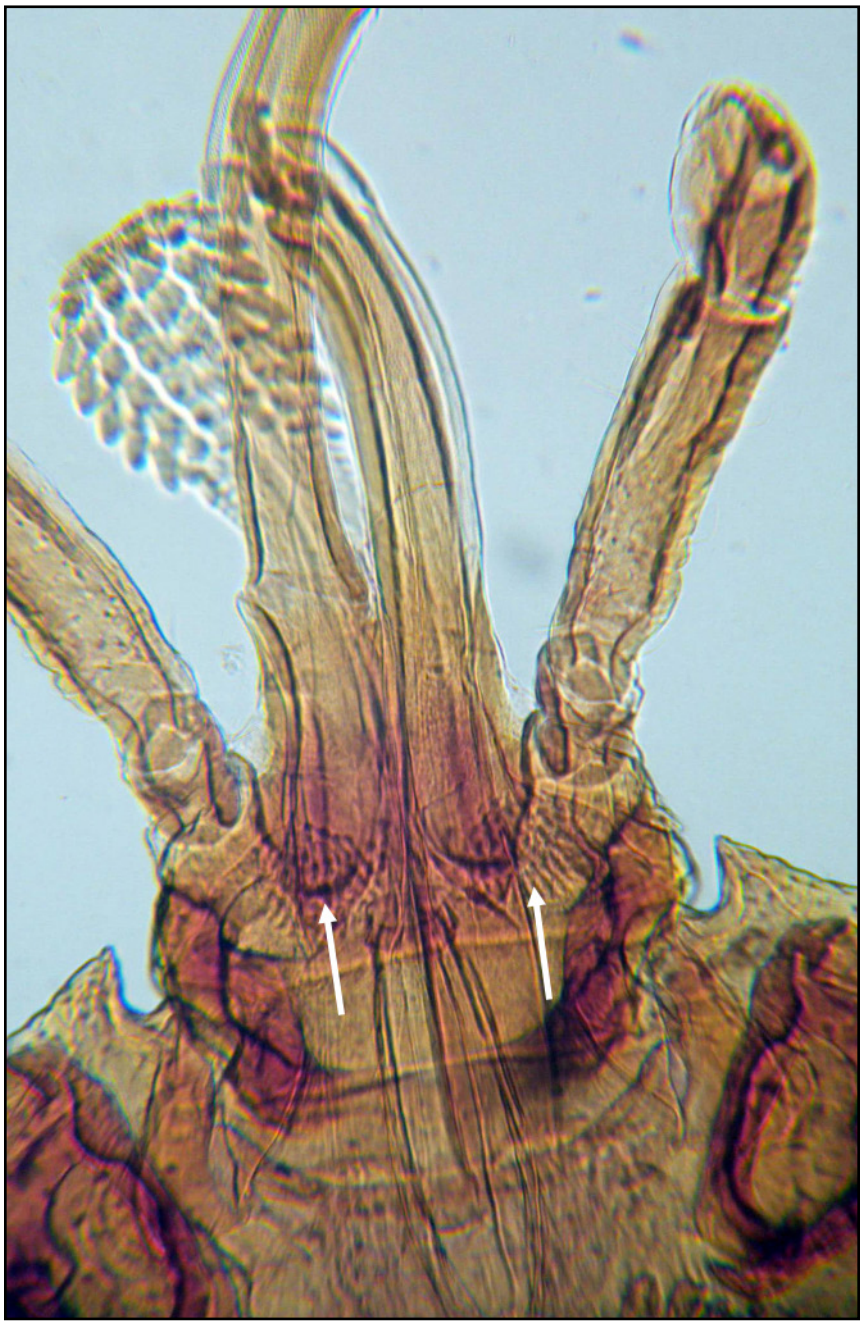
Dermacentor sp.; adult male with dorsal surface covered by hard "ornate" scutum. Example of "ornate", or "scutate", tick. Scutum of female covers only approximately anterior third of dorsal surface. Note also, festoons along posterior body margin. [Dvar 1]

The body of ixodid ticks is comprised of two distinct regions; an anterior gnathosoma (or capitulum), and the larger, broader, idiosoma (the cephalothorax and abdomen, respectively, in some older literature). The idiosoma of ixodids is relatively smooth, lacking wrinkles, or mammilations, often seen on the bodies of argasids. The idiosoma is sometimes further subdivided into an anterior podosoma, bearing four pairs of legs and the genital pore (in adults), and the opisthosoma, posterior to the 4th pair of legs.

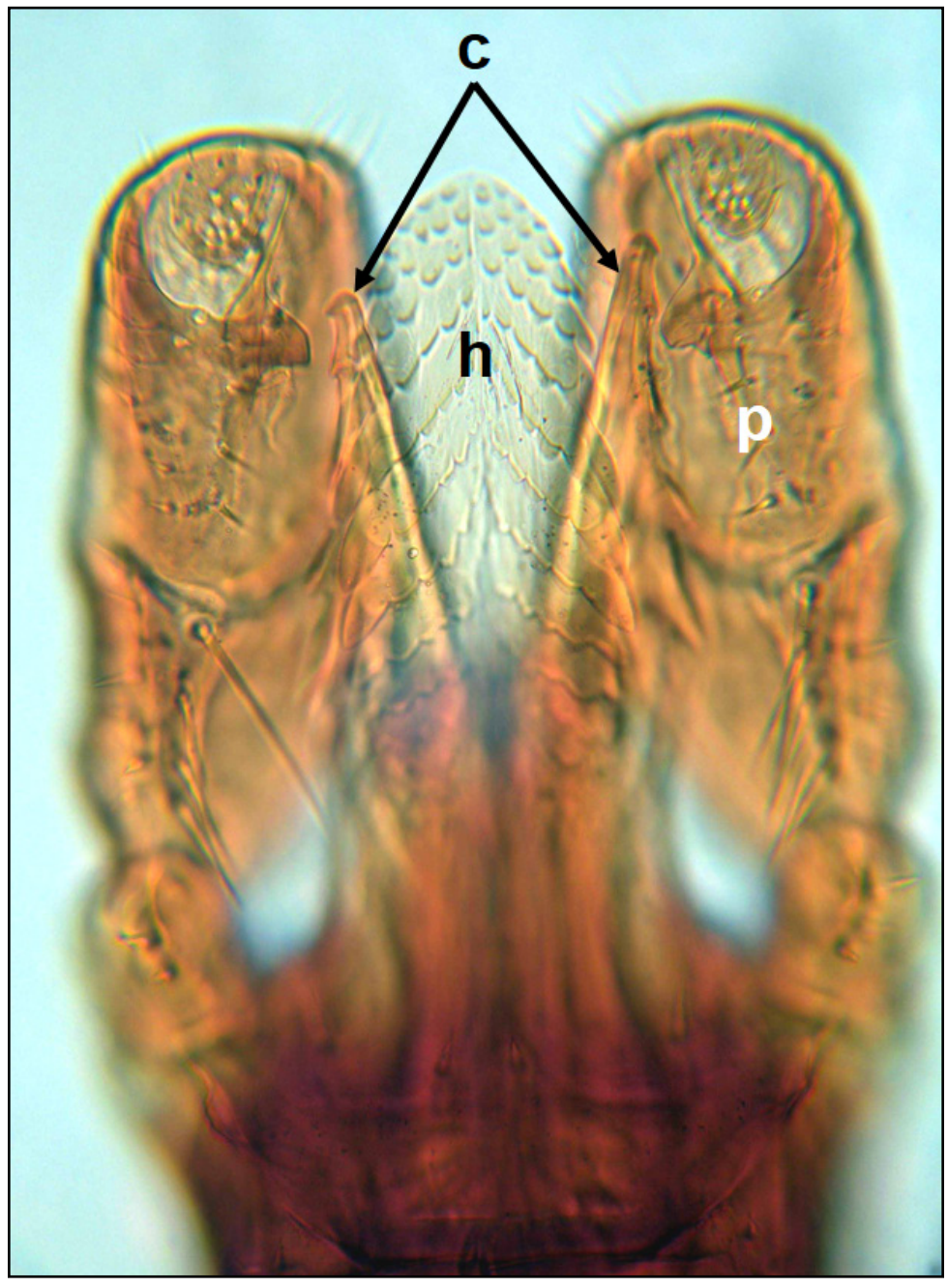


Rhipicephalus sanguineus
Legend: c, capitulum; i, idiosoma; o, opisthosoma; p, podosoma.

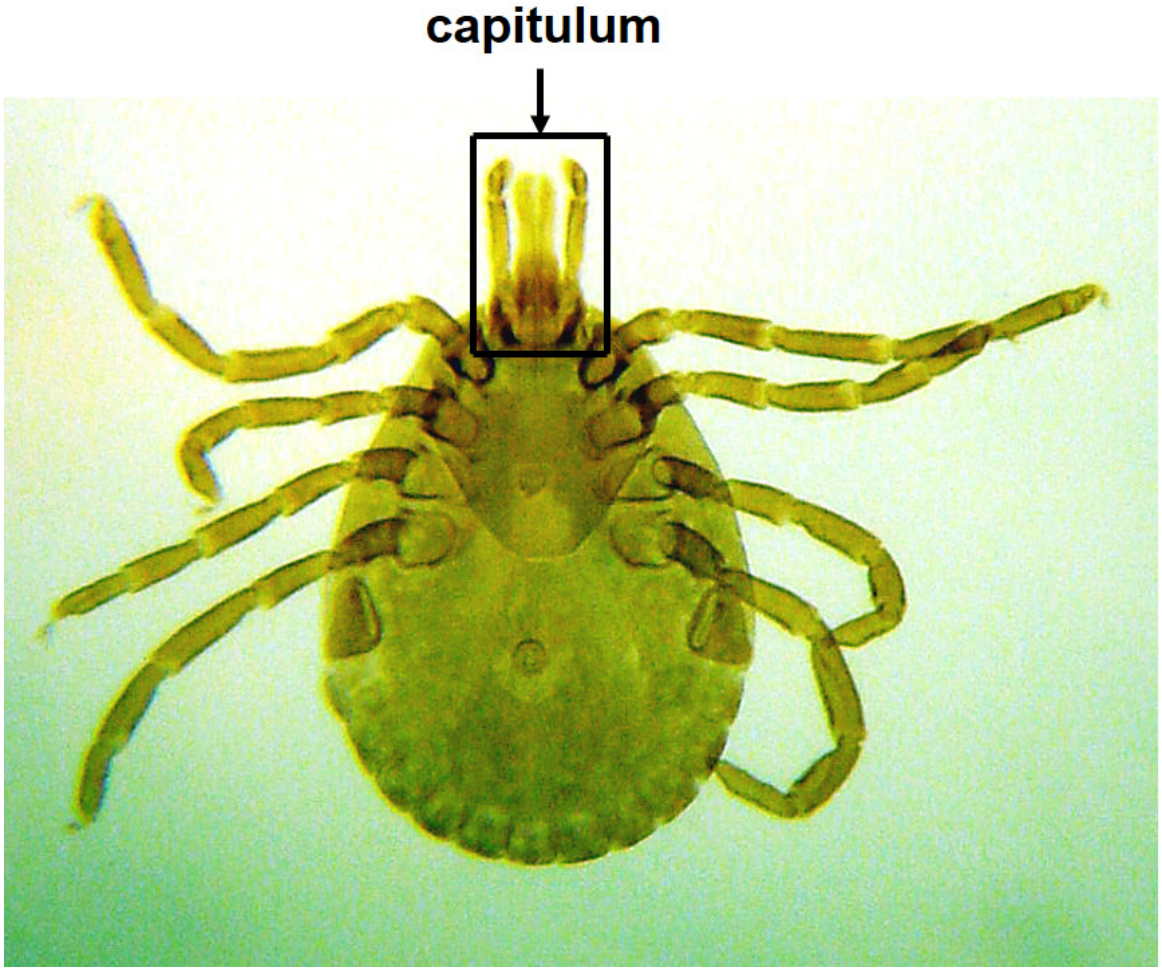
The capitulum, projects from the anterior terminus of the ixodid tick so that it can easily be seen when viewing the tick in the dorsal (or ventral) aspect. The capitulum is made up of a basis capitulum that articulates with the idiosoma, and the mouthparts. Female hard ticks possess porose areas on the base of the basis capitulum. Attached to the basis capitulum are the anteriorly projecting mouthparts, consisting of a single, median, hypostome, a pair of chelicerae positioned lateral to the hypostome (often overlying the hypostome), and a pair of palps positioned lateral to the chelicerae. The hypostome, with its broad, backward projecting "teeth", serves to anchor the tick to its host. The hypostome also possesses the feeding tube.



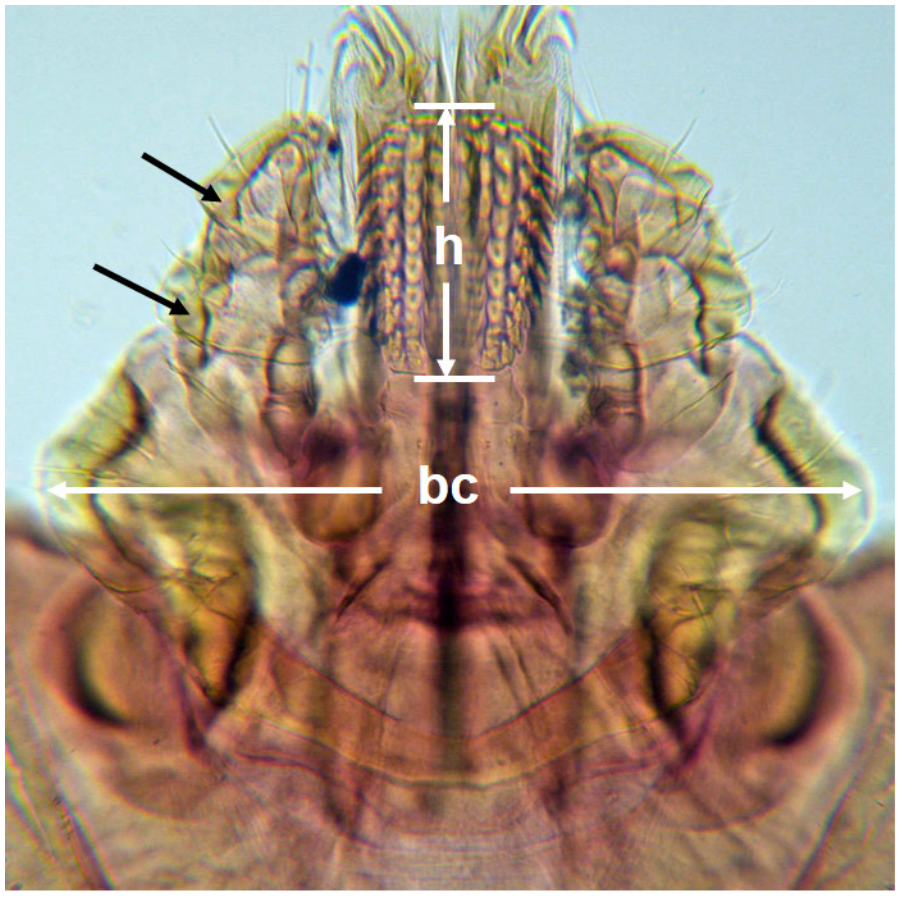
A. americana, female. Note porose areas (arrows) near base of capitulum, a character of female hard ticks.



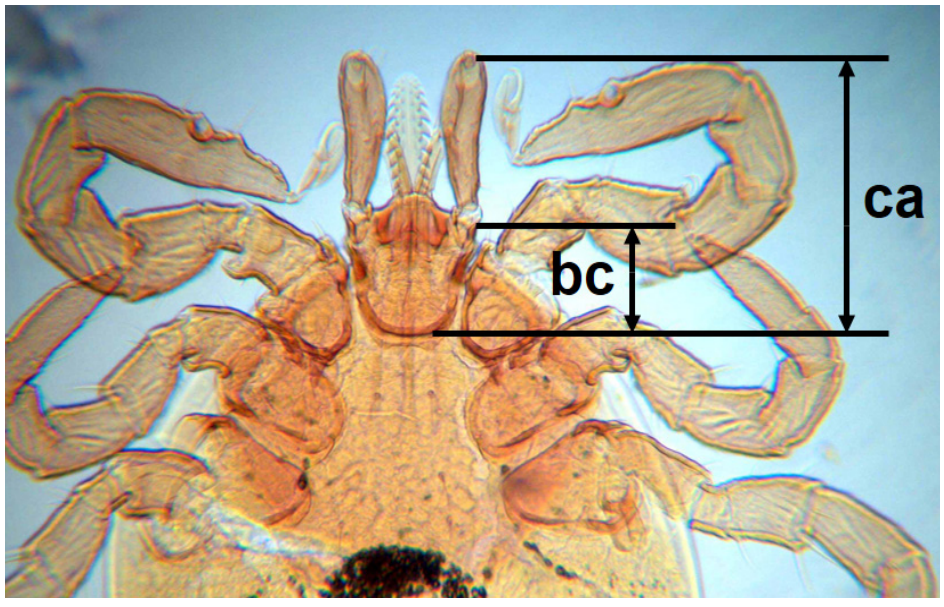
Ixodes sp.: adult mouth parts (two depth of field views). Legend: c, chelicerae (distal tips); h, hypostome, p, palp.



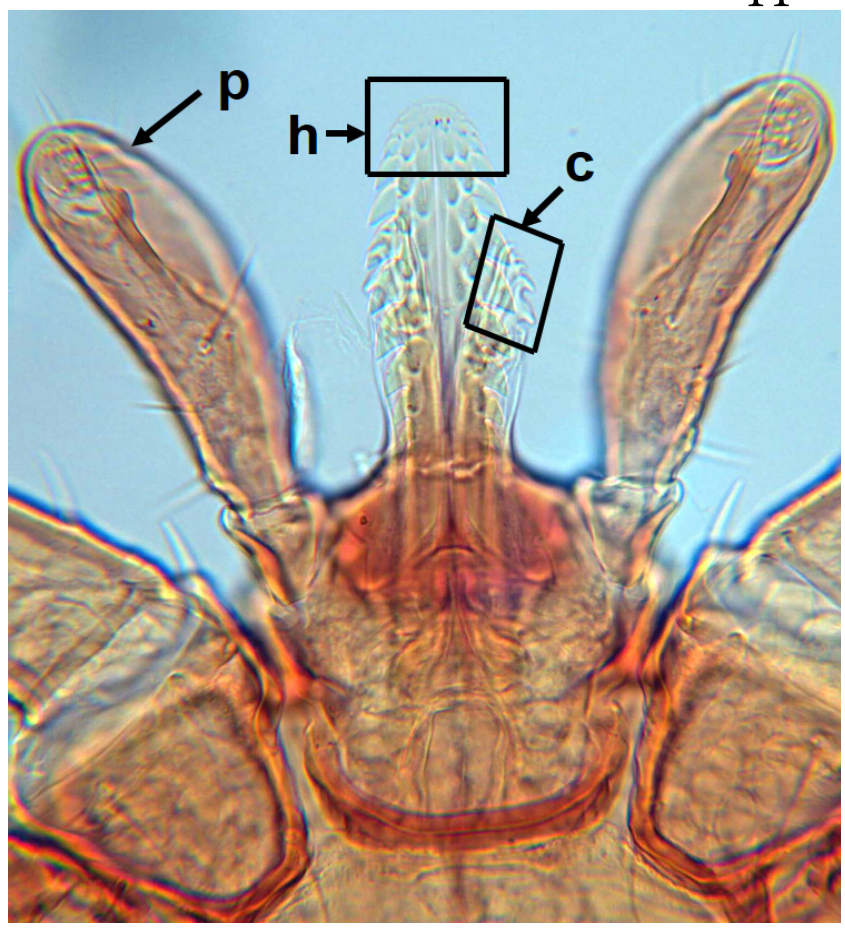
A. americanum: adult female (left); nymph (right).Note size difference.



B. annulatus. Legend**:** bc, basis capitulum; c, chelicerae; h, hypostome. Note; annuli on palpus (arrows). Chelicerae and hypostome enlarged right.



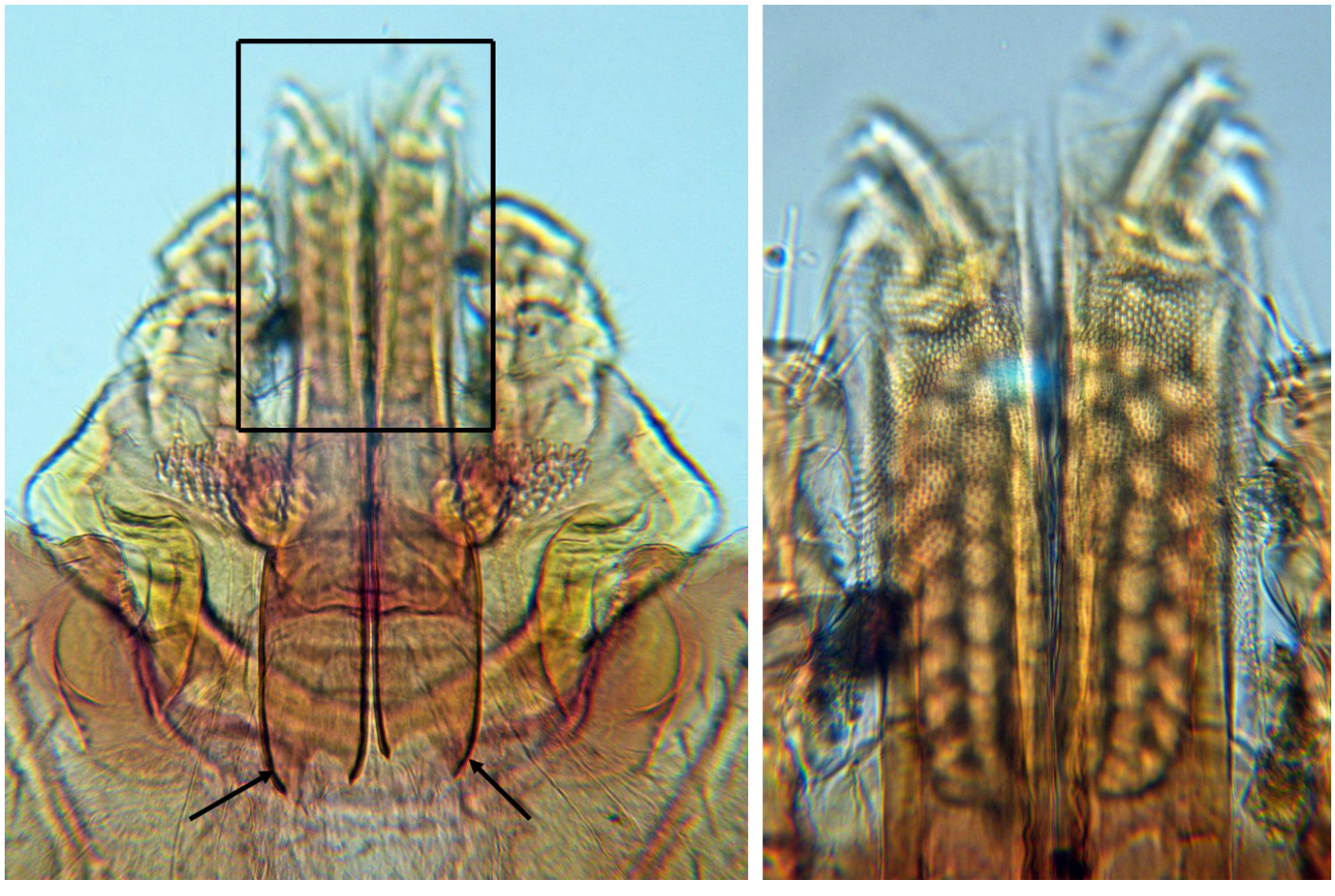
Anterior



Mouthparts (enlarged)

Ixodes sp., hexapod larva. Legend: bc, basis capitulum; ca, capitulum; c, tip of chelicera; h, tip of hypostome; p, palp.

Chelicerae, housed in cheliceral sheaths covered by minute spines, are employed to cut the host's skin for insertion of the hypostome. The segmented palps are sensory in function.



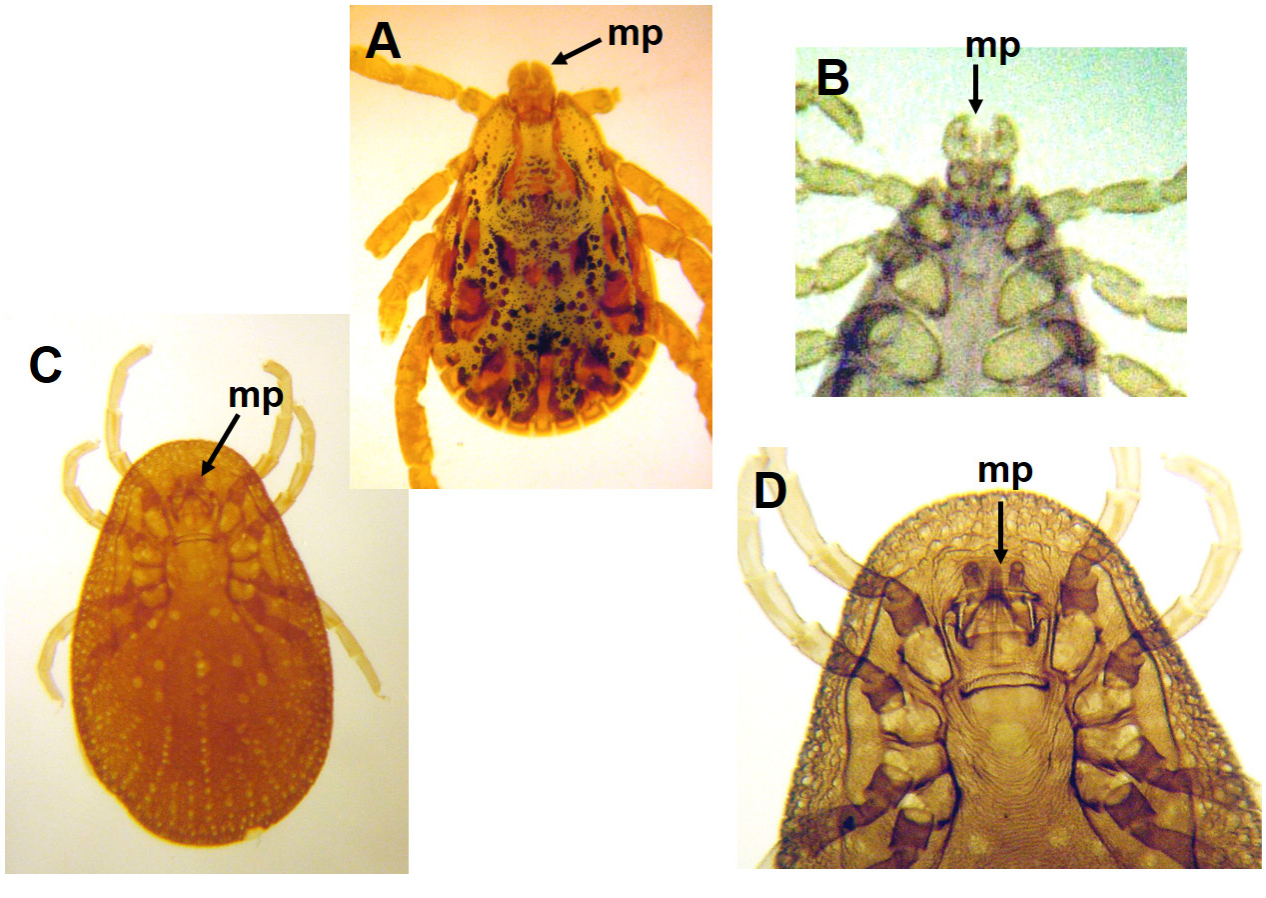
B. annulatus, chelicera sheaths (bases of, arrows). Box enlarged right to show minute spines on the sheaths.

2-b. Morphological features of the Argasidae

Members of the Argasidae ("argasids") are referred to as "soft ticks", or "non-scutate ticks", because they lack a scutum. In the absence of a scutum adult "argasids" exhibit little sexual dimorphism. Soft ticks often possess "wrinkled" bodies, or they may have bodies that are mammillated (i.e., possess "nipple-like" protuberances).

The capitulum of argasid ticks, unlike ixodids, is often placed ventrally (i.e., does not project anteriorly) so that the capitulum cannot be seen when viewing the tick from the dorsal aspect. Larval and nymphal soft-ticks, however, often display a terminal capitulum. The capitulum of soft ticks has the same features (i.e., possessing the basis capitulum, hypostome, chelicerae, and palps) as seen in hard ticks, except there are no porose areas in females of soft ticks.

Hard, or "scutate", ticks (Ixodidae) vs. soft, or "non-scutate", ticks (Argasidae).	
Ixodidae	Argasidae
• Scutum (hard dorsal shield) present; mouthparts, anterior, terminal.	• Scutum absent, body often wrinkled; mouthparts not at extreme anterior end of body, but rather sub-terminal (ventral).
• Note: scutum is a sexual dimorphic structure covering entire dorsal surface of male, but only anterior third (approximately) of unengorged female.	• Note: sexual dimorphism not pronounced because of absence of scutum.



A & C, dorsal views; B & D, ventral views.

"Hard" tick (*Dermacentor*) vs. "Soft" tick (*Argas*). Note hard scutum (A) and terminal mouthparts (B) of "hard" tick, versus lack of hard scutum (C) and sub-terminal (ventral) mouthparts (D) of "soft" tick.

Legend: mp, mouthparts

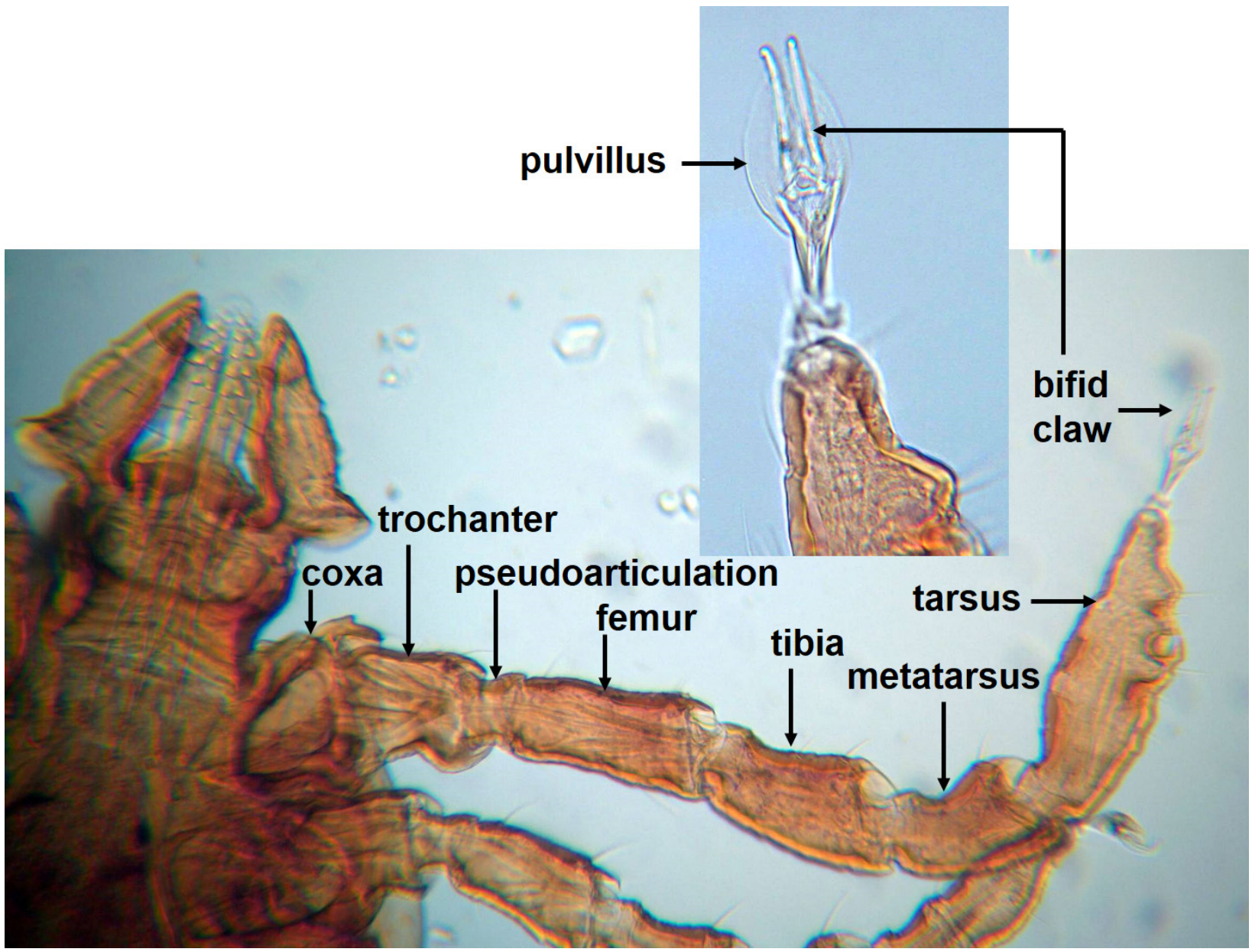
3. Other morphological features of ticks

3-a. Legs

Larval ticks are sometimes called hexapod larvae because they possess only six legs. The nymph and adult stages possess 8 legs. Remember, nymphs look like adults except these pre-adult stages are smaller and not sexually mature.

We will also use the "hard" tick, *Hemaphysalis* sp., as an example for identifying tick leg segments in the adult body form. The coxa is that leg segment attached to the body. Proceeding distally from the coxa you should be able to identify, in sequence, the trochanter, pseudoarticulation joint, femur, tibia, metatarsus, tarsus, and terminal bifid claw with a pad-like pulvillus. Some authors may describe leg segments differently, as; coxa, trochanter, femur, patella (genu), tibia and tarsus.

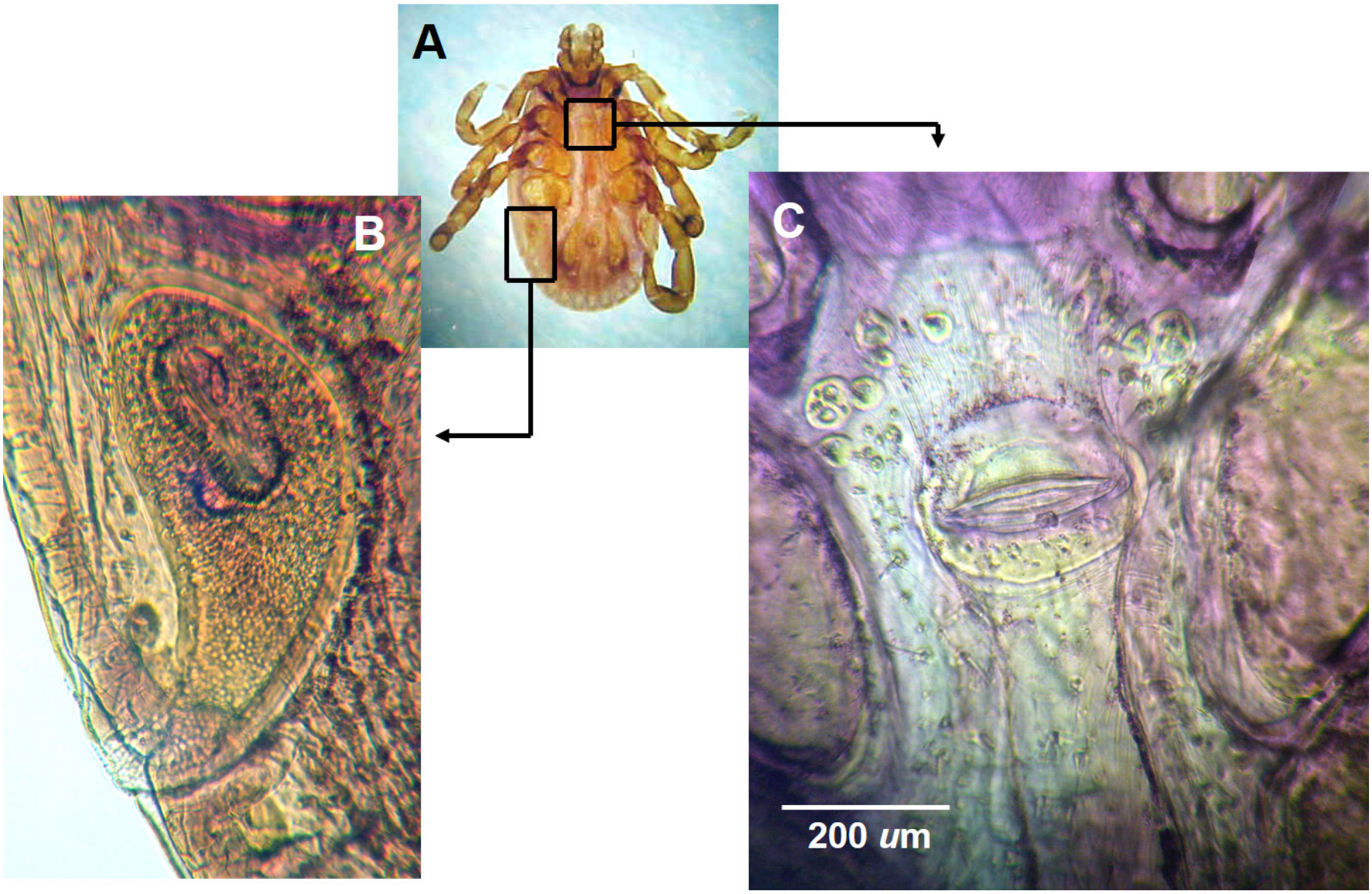
Leg segments of "soft" ticks are the same as seen in "hard" ticks (see *Ornithodoros* sp.). The pulvillus is absent, or rudimentary, on "soft" ticks.



Tick leg segments (*Haemaphysalis* sp.)

3-b. Spiracles

Spiracles, or stigmata, are openings into the tracheal (or breathing) system positioned on the lateral aspect of the body posterior to the 4th coxae in "hard" ticks, and anterior to the 4th coxae in "soft" ticks. In Ixodid ticks the spiracles are surrounded by a spiracular plate. The spiracles, and accompanying plates, are prominent in hard ticks (from a ventro-lateral perspective), but difficult to locate in soft ticks because they are relatively small, and appear on a wrinkled or mammillated body.



Rhipicephalus sp., male. A, entire; B, spiracle; C, gonopore.

3-c. Plates

Plates are hard, or sclerotized, areas of the integument separated from one another by softer regions referred to as "grooves." Typically, plates are features of "hard" ticks, soft ticks lack these structures on their softer, wrinkled bodies.

We have already mentioned the scutum, a hard dorsal plate characteristic of ixodid ("scutate") ticks, and the spiracular plate surrounding the spiracles. Another series of plates, referred to as festoons, can be seen from both the dorsal and ventral aspects along the posterior body margin of most hard ticks. Only members of the hard tick genus, *Ixodes*, lack festoons. Other dominant plates are the: genital plate, surrounding the genital opening; genito-ventral plate, situated along the ventral

mid-line of the body; the anal plate, surrounding the anus; and the adanal plates on either side of the anal plate.

3-d. Foveal pores (hard ticks)

Foveal pores, thought to emit pheromones (i.e., sex hormones), occur as a pair of small openings immediately posterior to the scutum in femal hard ticks. Female members of genus, *Ixodes*, lack these openings.

3-e. Eyes

The eyes of ticks are simple, light perceiving, organs (called ocelli) situated on the lateral aspect of the scutum of ixodid ticks. Being small, they are difficult to see, especially in microscope slide mounted specimens. Eyes (ocelli) of argasid ticks, when present, are lateral in position in folds above the legs.

4. Supplemental materials (PowerPoint slides)

Although this narrative outline, and accompanying PowerPoint presentations, focuses on just a few species of ticks of medical and/or veterinary importance, what you learn here can be applied in identifying a much broader range of tick species.

The Ixodidae

The following six PowerPoints (ppt's) have been designed for your study of "ixodid", "scutate", or "hard" ticks. Each tick species is given a 4 letter code followed with a photo slide number on a ppt to aid the student in studying the pertinent ppt for viewing structures in greater detail.

Amblyomma americanum	[slides Amer 1 – Amer 11; 21 photos]
**Boophilus annulatus*	[slides Boan 1 – Boan 5; 8 photos]
Dermacentor variabilis	[slides Dvar 1 – Dvar 9; 17 photos]
Haemaphysalis sp.	[slides Haem 1 – Haem 2; 3 photos]
Ixodes sp.	[slides Ixod 1 – Ixod 10; 17 photos]
Rhipicephalus spp.	[slides Rhip 1 – Rhip 10; 18 photos]

*The genus *Boophilus* is now considered to be in the genus *Rhipicephalus*.

PowerPoint (ppt) slides supplementing this narrative have a total of 84 photographs with labels identifying various key features/structures of hard ticks. The structures you will be required to identify in lab quizzes are underlined in the narrative.

The quizzes will also be in ppt format, and they are designed as if you were viewing the specimen under a dissecting or compound microscope in a lab test setting. You will be required to match the structures indicated on the quiz photo with its/their appropriate term(s). In some cases you may be required to provide a genus name for a photo of a whole mount tick. To prepare for hard tick quizzes in this section you should study all of the hard tick ppt's, learning the names and locations of all structures emphasized in the narrative. Remember, pertinent structures, or features, are underlined throughout this narrative.

Amblyomma americanum (The Lone Star Tick)

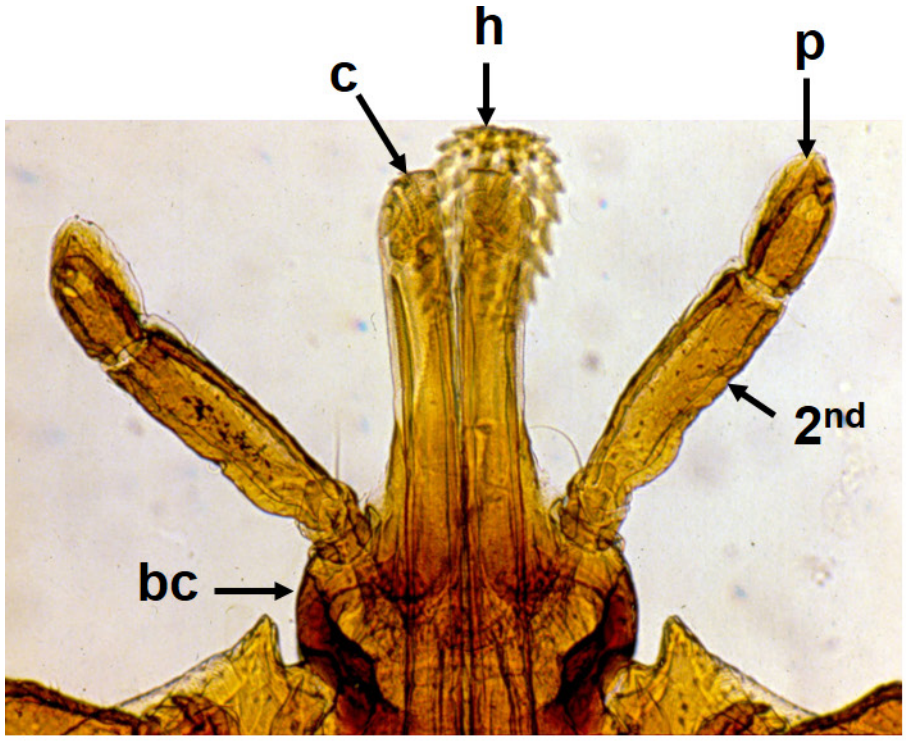
There is a "splotch" of cream-colored pigment on the scutum of these ticks giving them the "lone star" name. This "splotch" is difficult to see in microscope slide mounted specimens because the fat soluable coloration is dissolved in clearing agents (i.e., xylene, methyl salicylate, etc.) used in preparing study slides.

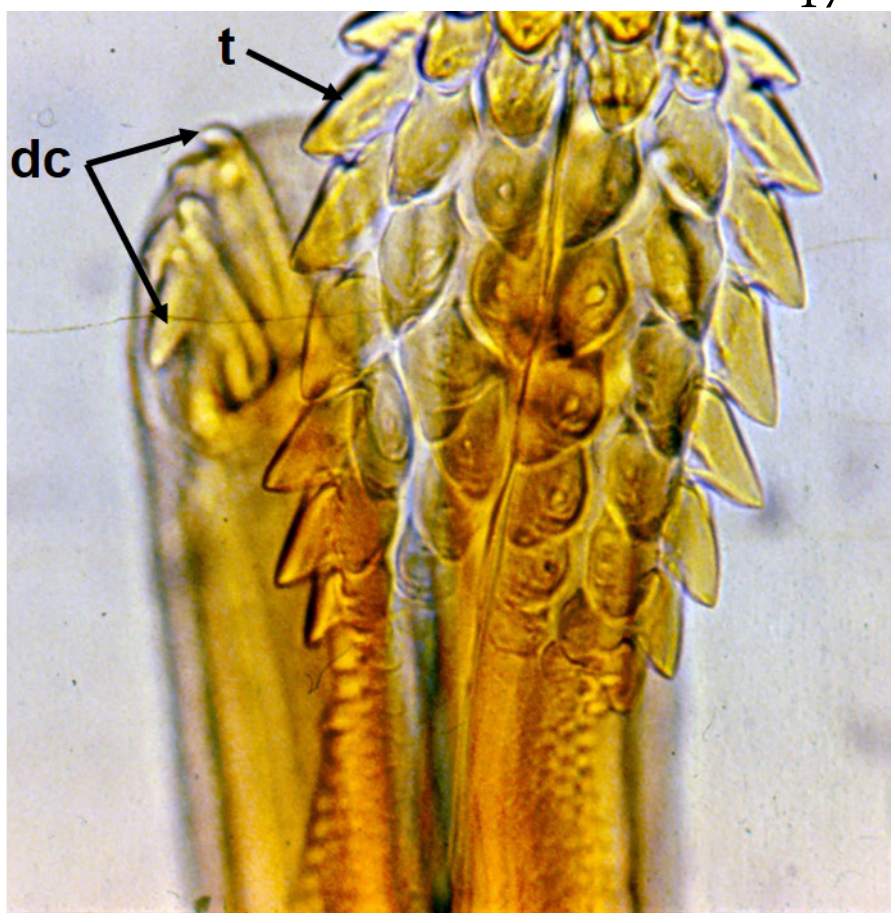
Cleared slide mounted specimen.

Ethanol mount specimen

A. americanum: adult female. Note that scutum coloration of slide mounted specimen is muted (arrow) because clearing process dissolves fat based pigment. Coloration is retained in specimen photographed in ethanol mount.

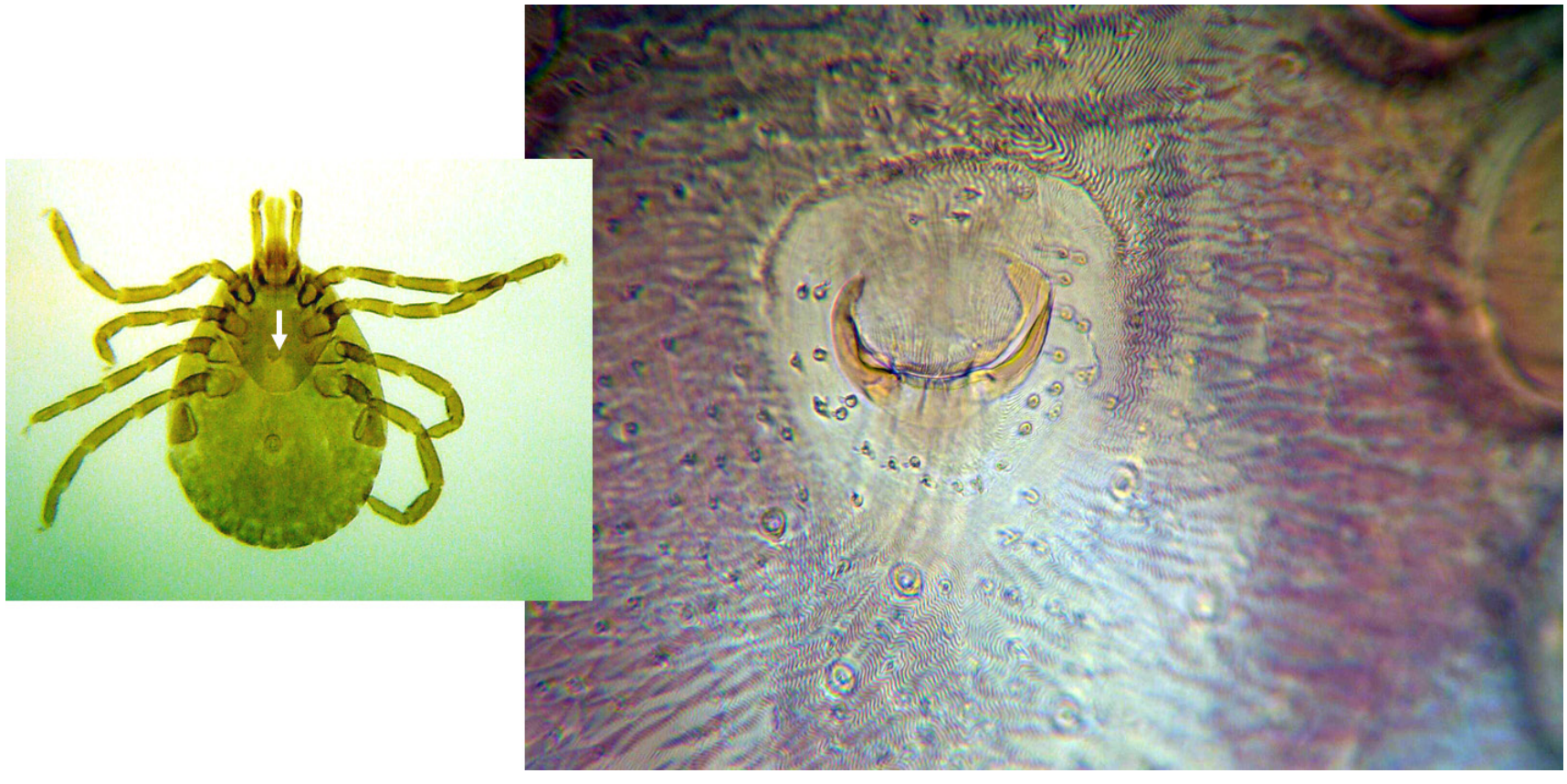
The capitulum (mouthparts – hypostome, chelicerae and palps) is long relative to width in this species; the 2nd palpal segment decidedly elongate; eyes present on lateral margin of scutum (but difficult to see in cleared, slide mounted specimens). Observe the backward pointing triangular-shaped teeth on the hypostome, and serrated tips of chelicerae used for cutting the skin of the host.



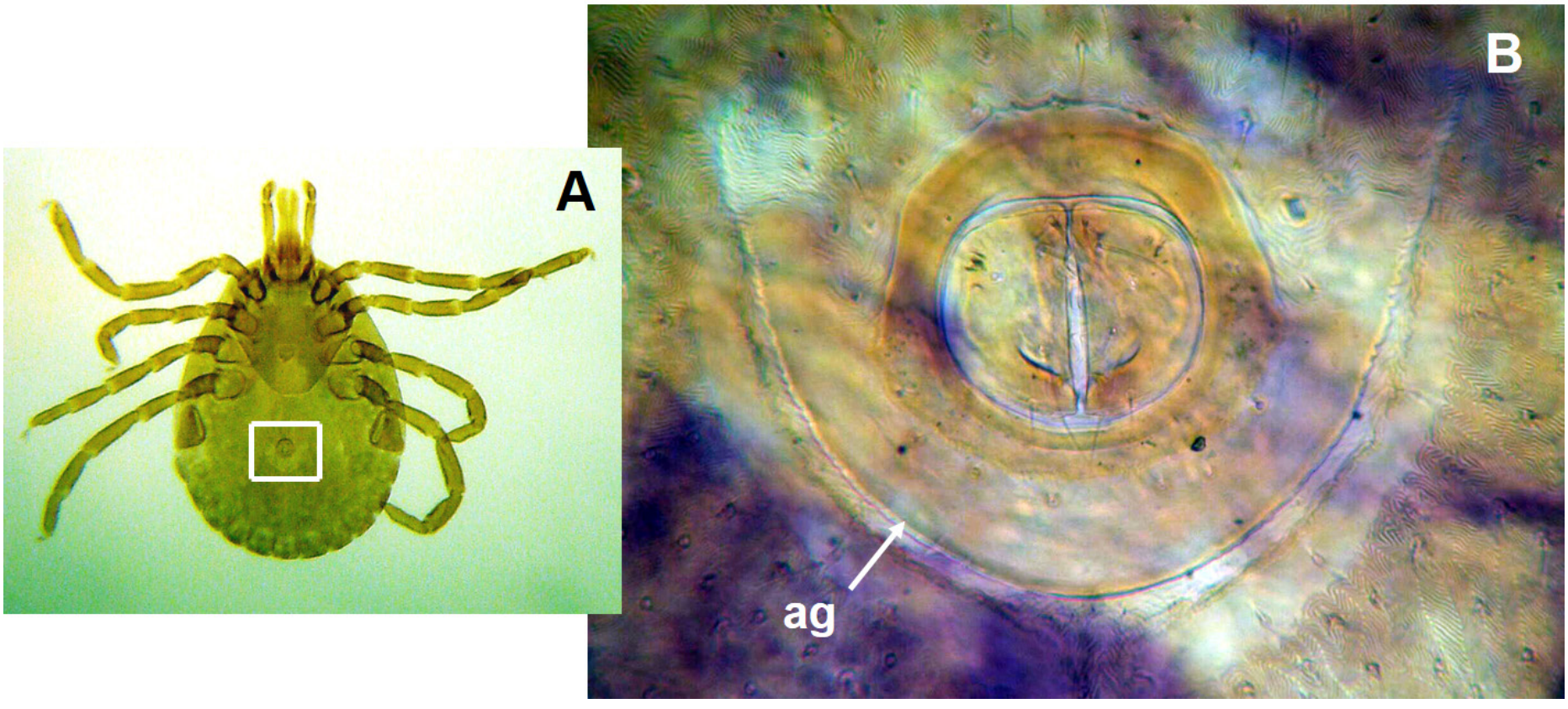


A. americanum (mouthparts). Note elongated 2nd palpal segment characteristic for this genus. Legend**:** bc, basis capitulum; c, chelicera; dc, distal tips of chelicera; h, hypostome; p, palp; 2nd, second palpal segment; t, tooth of hypostome.

The gonopore (= genital aperature) lies on the mid line of the body between the 3rd coxae . Spiracles (= stigmata), openings into the breathing system (tracheal system), can be seen immediately posterior to the 4th coxae. The anus lies ventrally on the mid line of the body at the level of the spiracles. There is a distinct anal groove posterior to the anus. Finally, note the plate-like festoons (dotted arrows, photo below) on the posterior margin of the body giving this body region a scalloped appearance.



A. americanum: gonopore (arrow); enlarged below.



A. amblyomma: example of anal groove (ag) posterior to anus. Box in A, enlarged in B.

These ticks are serious pests of livestock and humans, and they serve as vectors of ehrlichiosis in humans, dogs and ruminants.

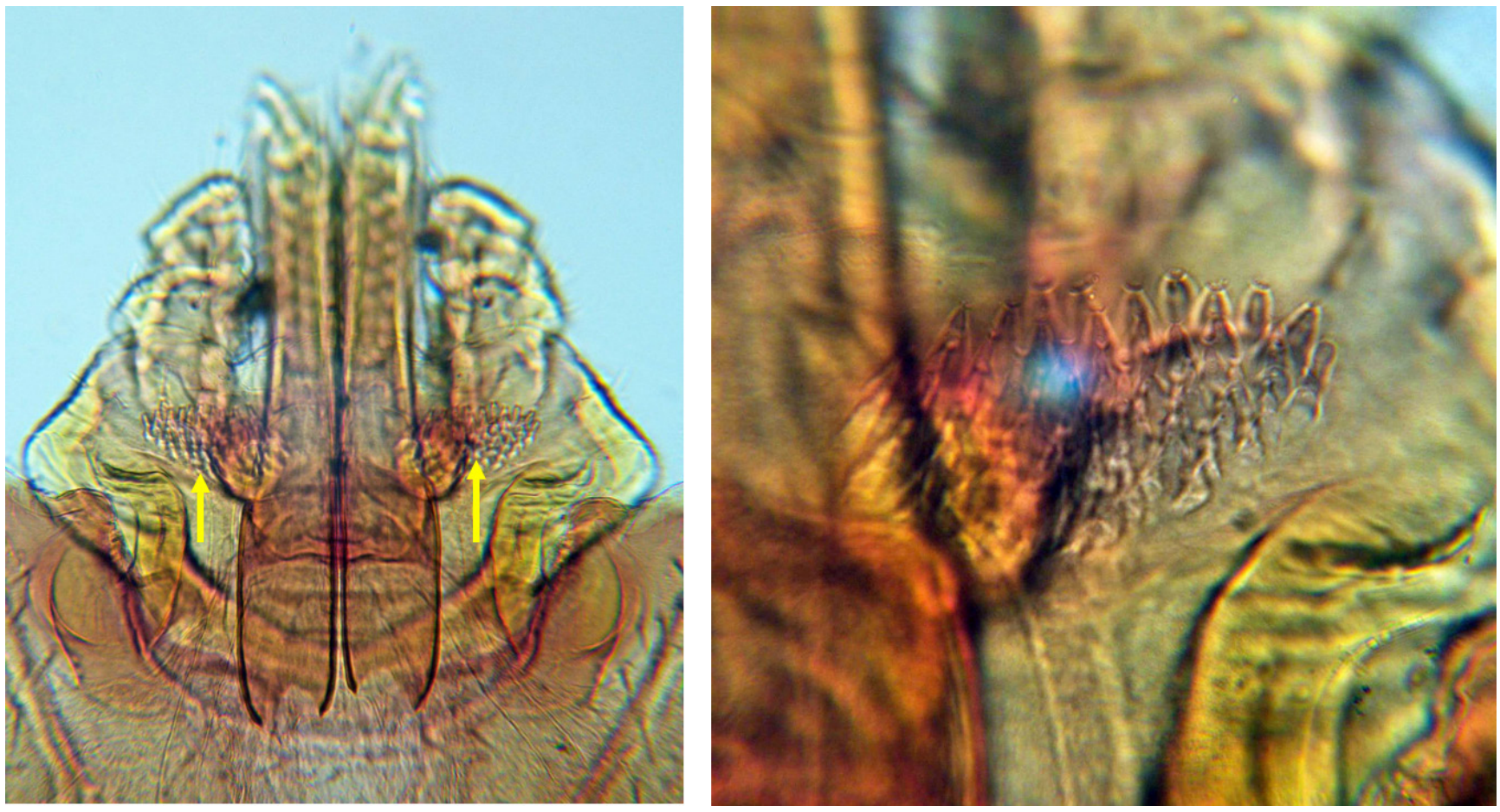
Boophilus annulatus **(The "one host" Cattle Tick)**

Capitulum compressed (i.e., short relative to width) and the palps, which are shorter than the chelicerae, have transverse ridges. The chelicerae, which function as cutting structures, are enclosed within chelicerae sheaths which can easily be identified by their covering of small dentate spines.

Boophilus annulatus, female.

Other than the capitulum, the overall body structure is typical for hard ticks, except that festoons are lacking. In females, foveal pores can be seen in higher magnifications. These dorsal pores which lie immediately posterior to the scutum are responsible for emitting a sex pheromone.

An extensively branched tracheal (breathing) system branching from the external spiracle can often be viewed in slide mounted specimens.

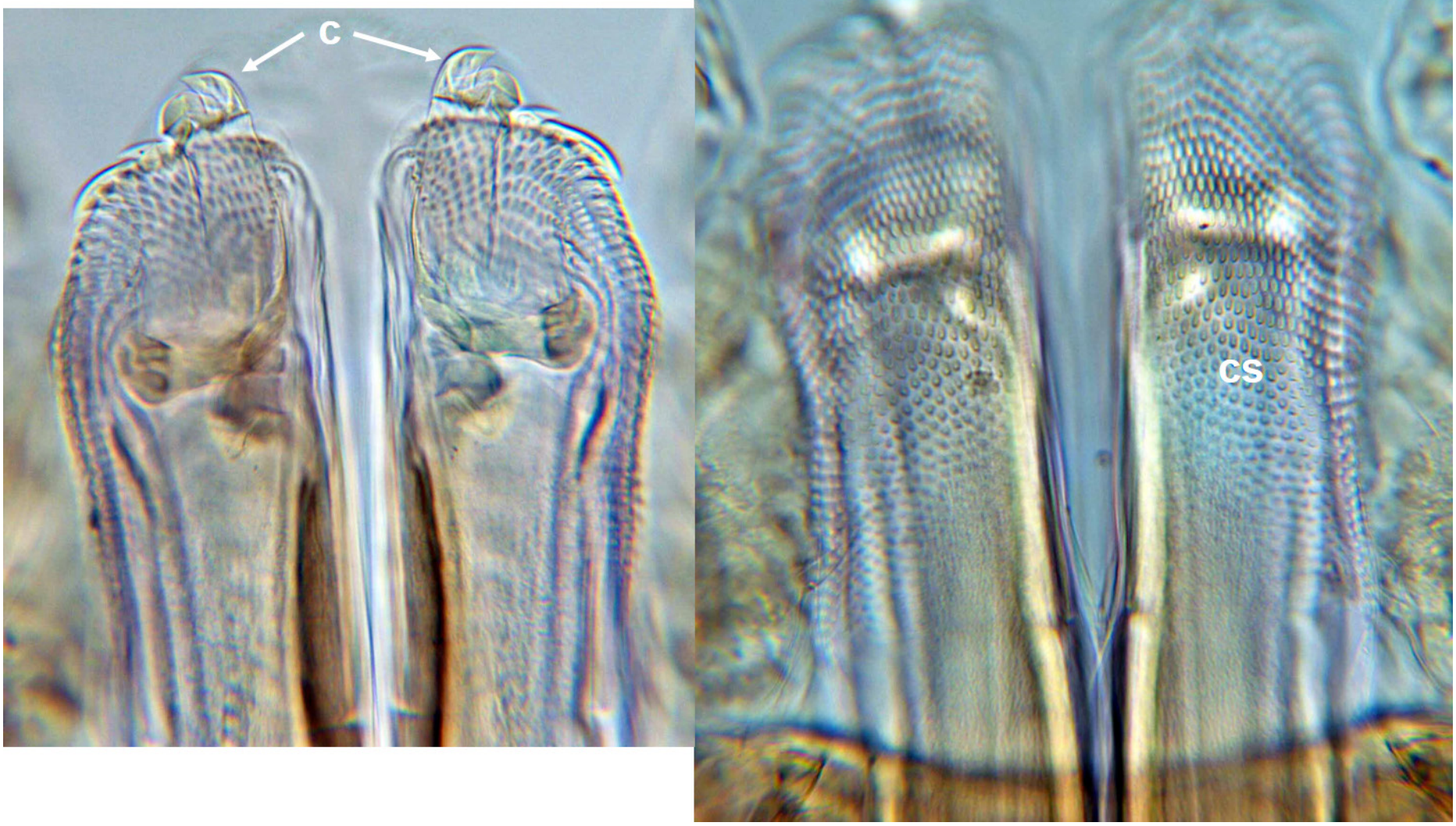


B. annulatus, female, porose areas (arrows); enlarged right.

These ticks are unusual in that all life cycle stages usually remain on the same host. They serve as vectors for bovine piroplasmosis (i.e., babesiosis, Texas cattle fever).

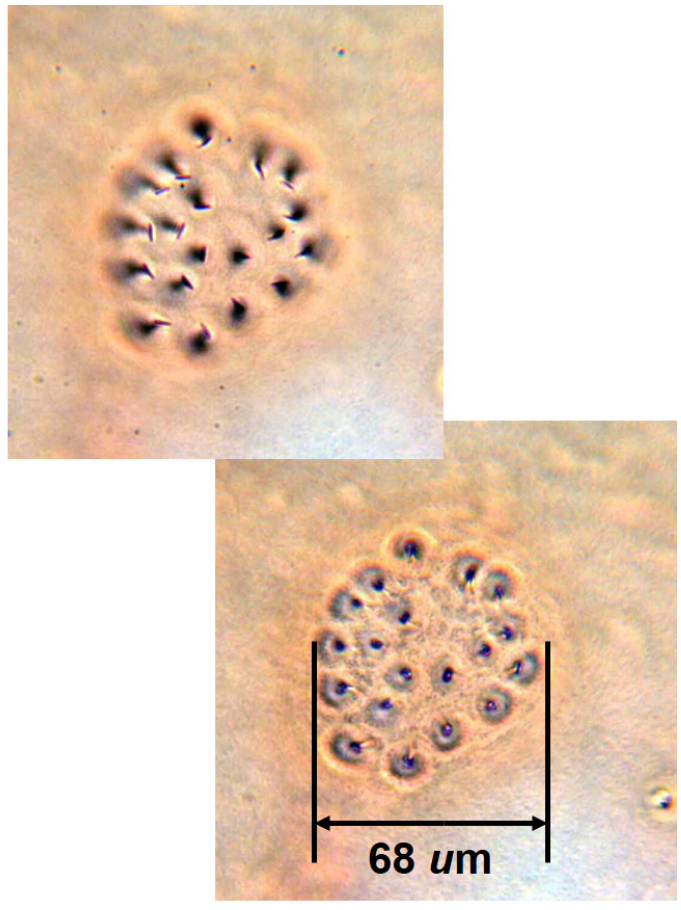
Dermacentor variabilis (The "3 host" Tick)

This is one of the most common tick species in the eastern United States. It is often called the "dog tick" because it is so frequently seen by dog owners in the summertime. In reality, this tick species exhibits almost no host specificity, the different life cycle stages take blood meals from a wide variety of mammals. These ticks are often describe as being "ornate"; that is the scutum is distinctly colored and possesses grooves and "punctations" (small holes), in addition to prominent festoons giving the posterior body a scalloped appearance . Another prominent feature of this species is that (viewed ventrally) the coxae of males are progressively larger (proceeding from coxa I to coxa IV) so that the 4th coxae (i.e., IV) appears very large. Dentate cheliceral sheaths (i.e., cs) are also clearly evident.



Dermacentor sp.: distal chelicerae (c), and dentate chelicerae sheaths (cs). Note; hypostome not in field of focus.

Two <u>foveal pores</u>, from which a sex pheromone is emitted, can be seen on the female dorsum immediately posterior to the scutum margin.

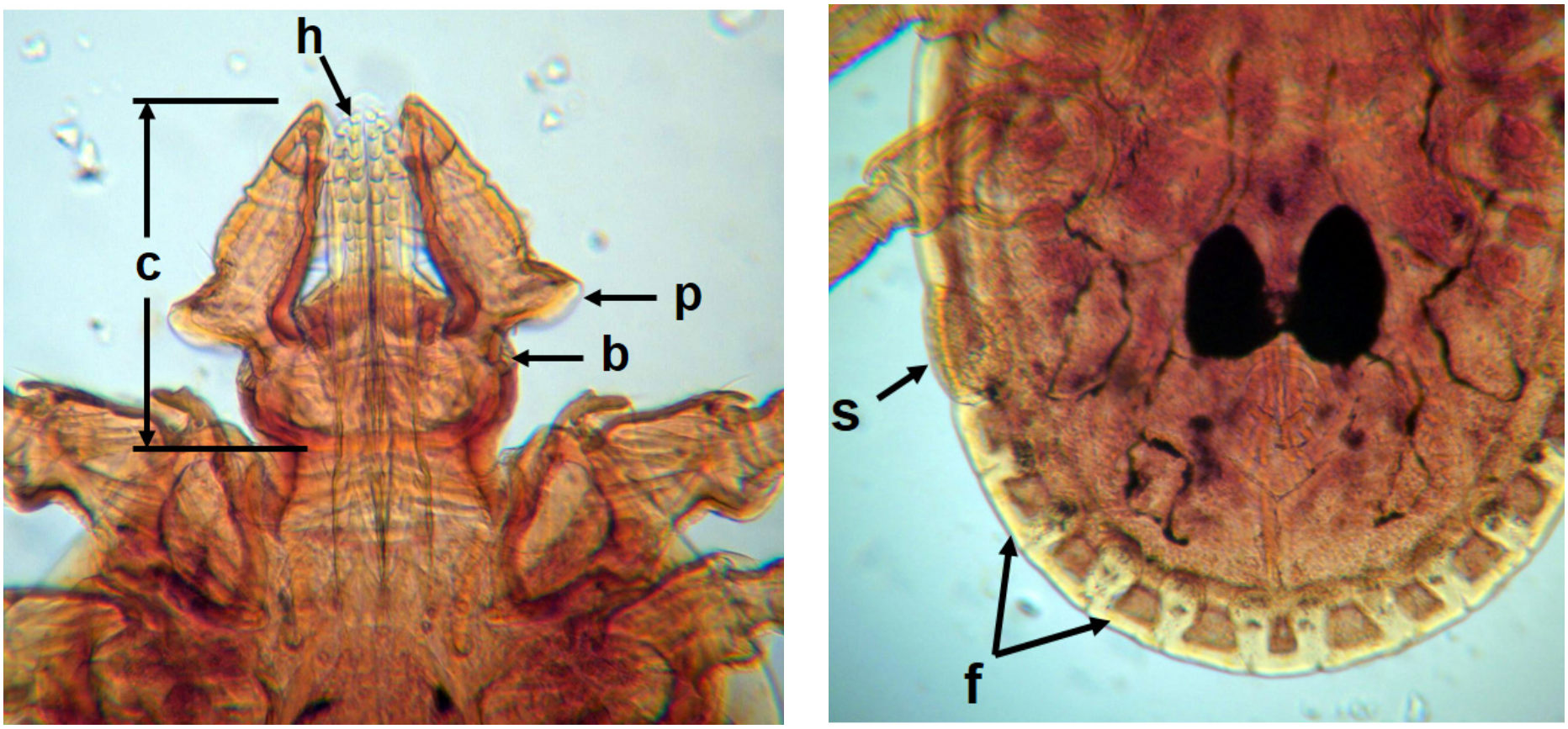


Dorsal foveal pores on this adult female *Dermacentor* (approximate location shown by asterisks in A). Note too, festoons along posterior body margin.

Interestingly, these ticks have pharmacologically active compounds in their saliva that suppress the host tissue response (e.g., edema and inflammation). In addition to being a pest species associated with pets and humans, these ticks have been incriminated as vectors of Rocky Mountain spotted fever, feline cytauxzoonosis, anaplasmosis, and tularemia.

Haemaphysalis sp. *(H. leporispalustris,* the Rabbit Tick)

There are only two species of this genus in North America; *H. leporispalustris*, considered host specific on rabbits, and *H. chordeilis*, found on turkeys and other birds. The key identifying feature of this tick is a pronounced lateral projection extending from the base of the palps.



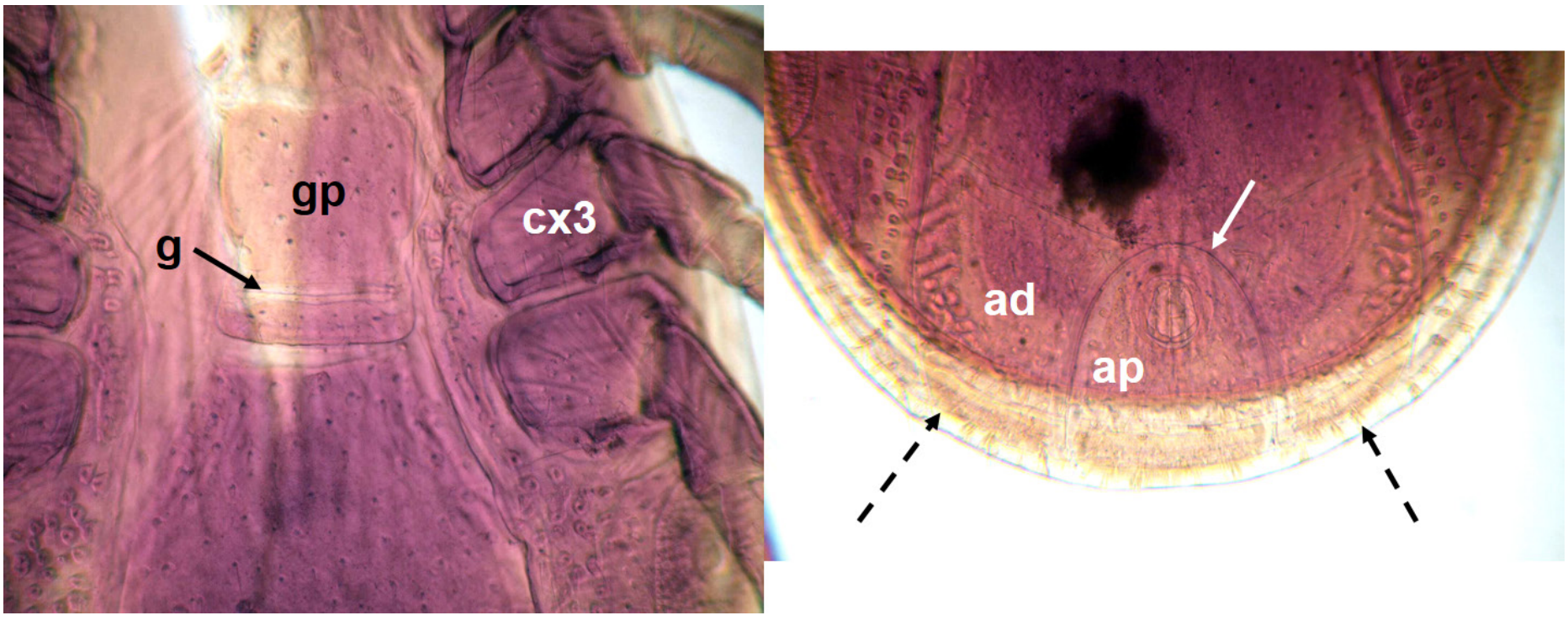
Haemaphysalis sp. Note lateral extension of basal palpal segment characteristic for this genus. Legend: b, basis capitulum; c, capitulum; f, festoons; h, hypostome; p, palpal segment; s, spiracle.

Ixodes sp. *(Ixodes scapularis,* the Black-Legged Tick)

There are several species of *Ixodes* endemic to the eastern United States, the most common being the Lyme disease vector, *I. scapularis (= I. dammini)*. Living specimens of this tick are characterized by reddish-brown bodies and very dark (nearly black) mouthparts (i.e., capitulum), and legs. (Coloration is not as evident on cleared, slide mounted specimens). The capitulum of these ticks is decidedly elongated, and the coxae of males, unlike *Dermacentor*, do not increase greatly in size from Coxa I to Coxa IV.

In addition, members of this genus lack festoons (giving the posterior body margin a smooth appearance), and the anal groove (arrow), unlike all other genera of hard ticks, is anterior to the anus. In addition, this is one hard tick species where females do not possess foveal pores.

Ixodes sp. entire. Note festoons absent (i.e., posterior body margin smooth).

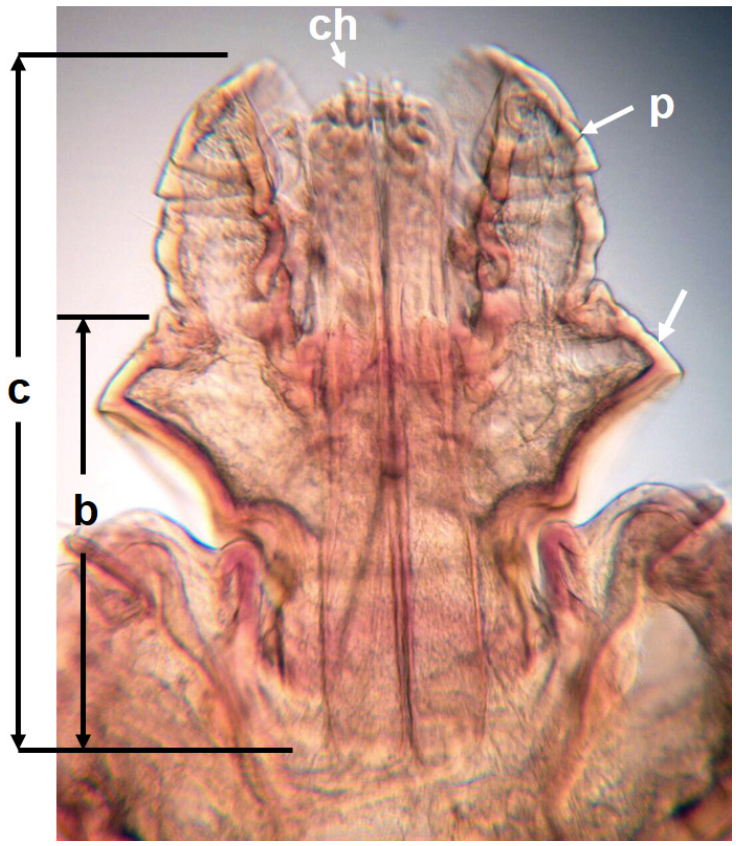


Ixodes sp.: gonopore and genital plate (left); anal groove (right). Note: absence of festoons (dashed arrows), and anal groove anterior to anus (solid arrow) characteristic of this genus. Legend: ad, adanal plate; ap, anal plate; cx3, 3rd coxa; g, gonopore; gp, genital plate.

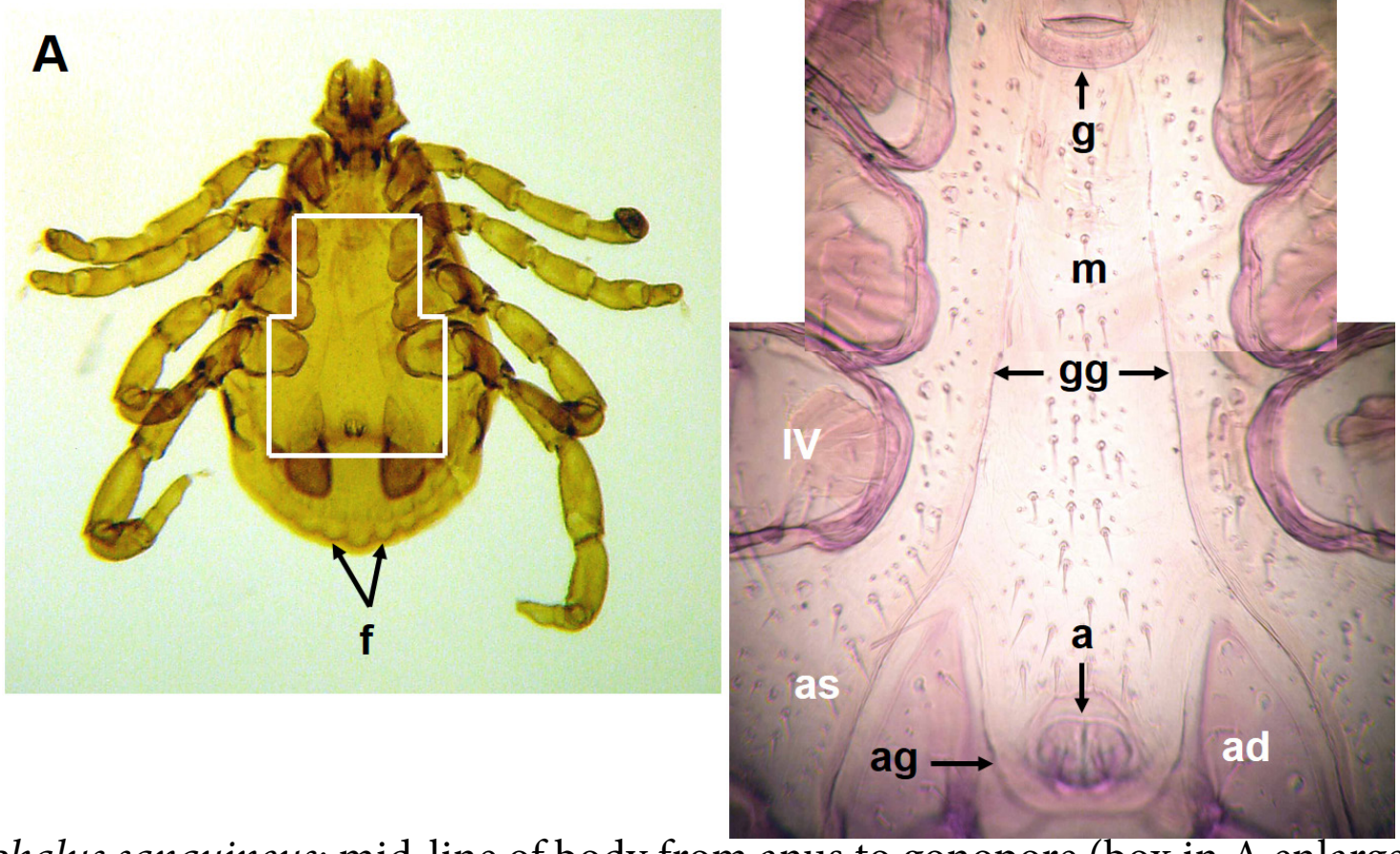
Species of *Ixodes,* like *Dermacentor*, feed on a wide variety of mammals. In addition to Lyme disease these ticks are responsible for vectoring Tick-borne fever (a type of anaplasmosis) to dogs, humans, horses, and domestic and wild ruminants.

Rhipicephalus sanguineus (The Dog Tick), and *Rhipicephalus* sp.

Many species of this genus are endemic to Africa, but only *R. sanguineus* is cosmopolitan. In the United States this species is most frequently associated with dogs, although it feeds on a variety of mammals, humans infrequently. The key identifying feature is a lateral extension of the basis capitulum. Members of this genus also possess prominent festoons. The genital aperature lies between the 2nd coxae just anterior to the median plate, and there is a distinct genital groove medial to coxa II through coxa IV. Large adanal plates (or shields) can be seen lateral to the anus, and accessory adanal plates may be evident, as well.



Rhipicephalus sanquineus: entire (left) Legend: b, basis capitulum; c, capitulum; ch, chelicera; p, palp. Note lateral extension of basis capitulum, characteristic of this genus.



Rhipicephalus sanquineus; mid-line of body from anus to gonopore (box in A enlarged in B). Legend: a, anus; ad, adanal shield; ag, anal groove; as, accessory adanal shield; IV, coxa IV; f, festoons; g, gonopore; gg, genital groove; m, median plate.

These ticks have been incriminated as vectors for a rickettsial pathogen causing Boutonneuse fever in small mammals, dogs and humans. Another species, *R. appendiculatus*, is the principle vector of East Coast cattle fever (theileriosis) in African cattle and water buffalo.

The Argasidae

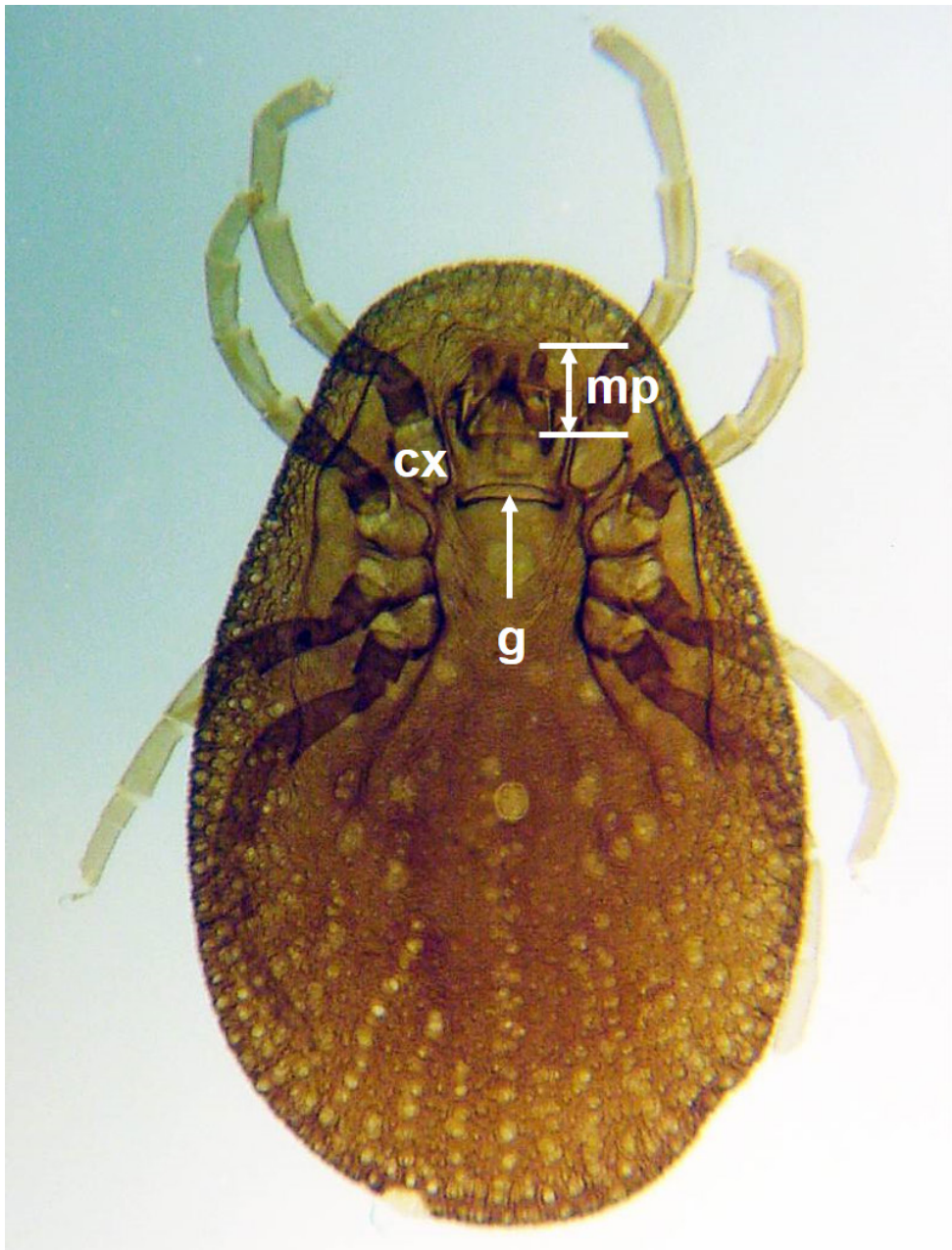
The following three PowerPoints (ppt's) have been designed for your study of "argasid", or soft ticks.

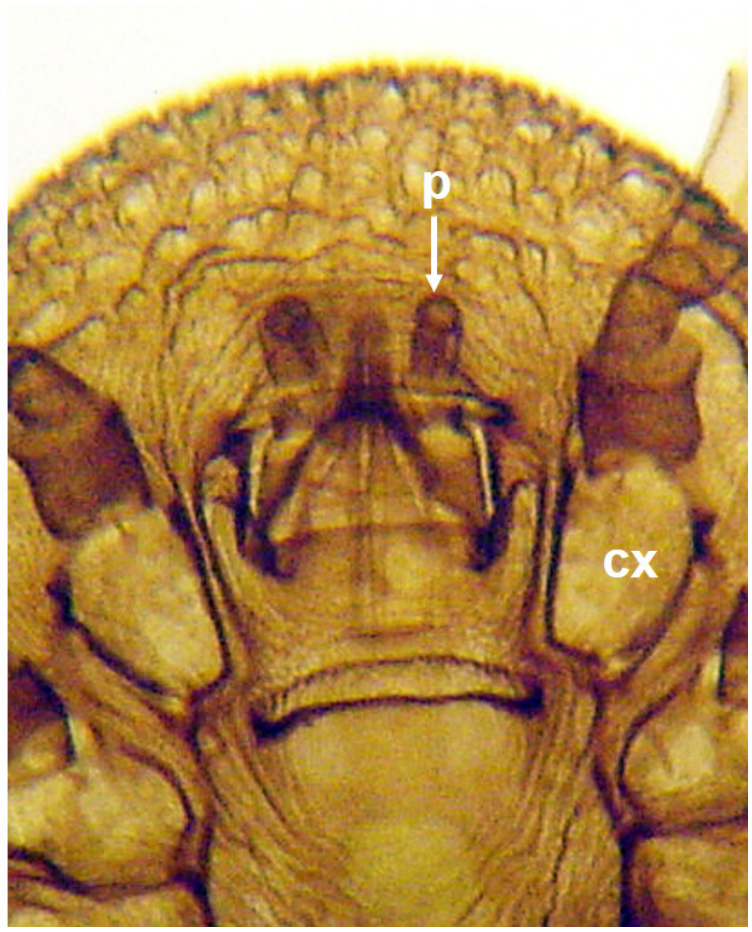
Argas persicus	[slides Aper 1 – Aper 8; 15 photos]
Ornithodoros sp.	[slides Orni 1 – Orni 5; 7 photos]
Otobius megnini	[slides Otmg 1 – Otmg 2; 4 photos]

These ppt's have a total of 26 photographs with labels identifying various key features/structures of soft ticks. The structures you will be required to identify in quizzes are underlined in the narrative. The quizzes will also be in ppt format, and they are designed as if you were viewing the specimen under a dissecting or compound microscope in a lab test setting. You will be required to match the structure(s) indicated on the quiz photo with its/their appropriate term(s). To prepare for soft tick quizzes in this section you should study all of the ppt's, learning the names and locations of all structures underlined in the narrative and appearing in ppt slides.

Members of the family Argasidae possess the hypostome, chelicerae and palps (collectively the capitulum) as do hard ticks, but these structures in adult soft ticks are generally situated ventrally and thus cannot be seen from above; i.e., in the dorsal aspect (in adults).There is no scutum, so sexual dimorphism is not evident. The integument of soft ticks is often mammillated, and festoons (and other body plates) are absent. The spiracles are often indistinct.

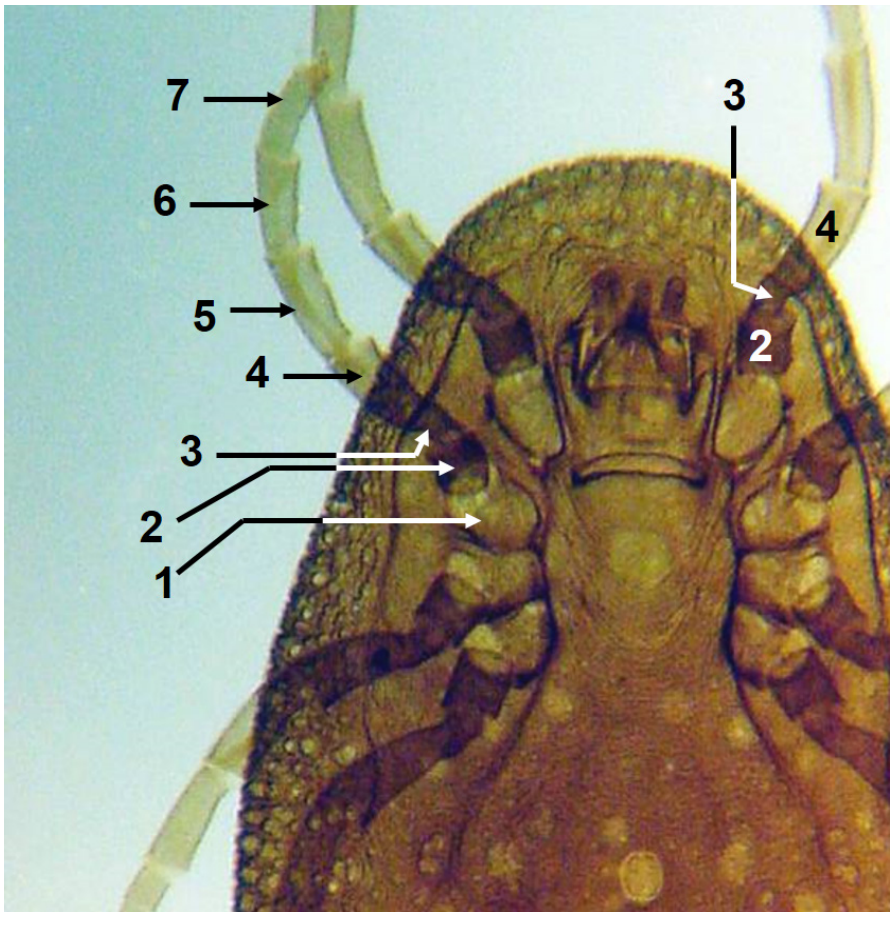
Ornithodoros sp., adults: dorsal (left) ventral (right). Specimens taken from alcohol preservative, dried, and photographed





Argas persicus, adult, entire. Legend: cx, 1st coxa; g, gonopore; mp, ventral mouthparts; p, palp. Note "bumpy" integument.

When the tick is viewed ventrally, you can easily identify the leg segments. The coxa articulates with the body. Proceeding distally from the coxa the leg segments are the trochanter, pseudoarticulation joint, femur, tibia, metatarsus, and tarsus.

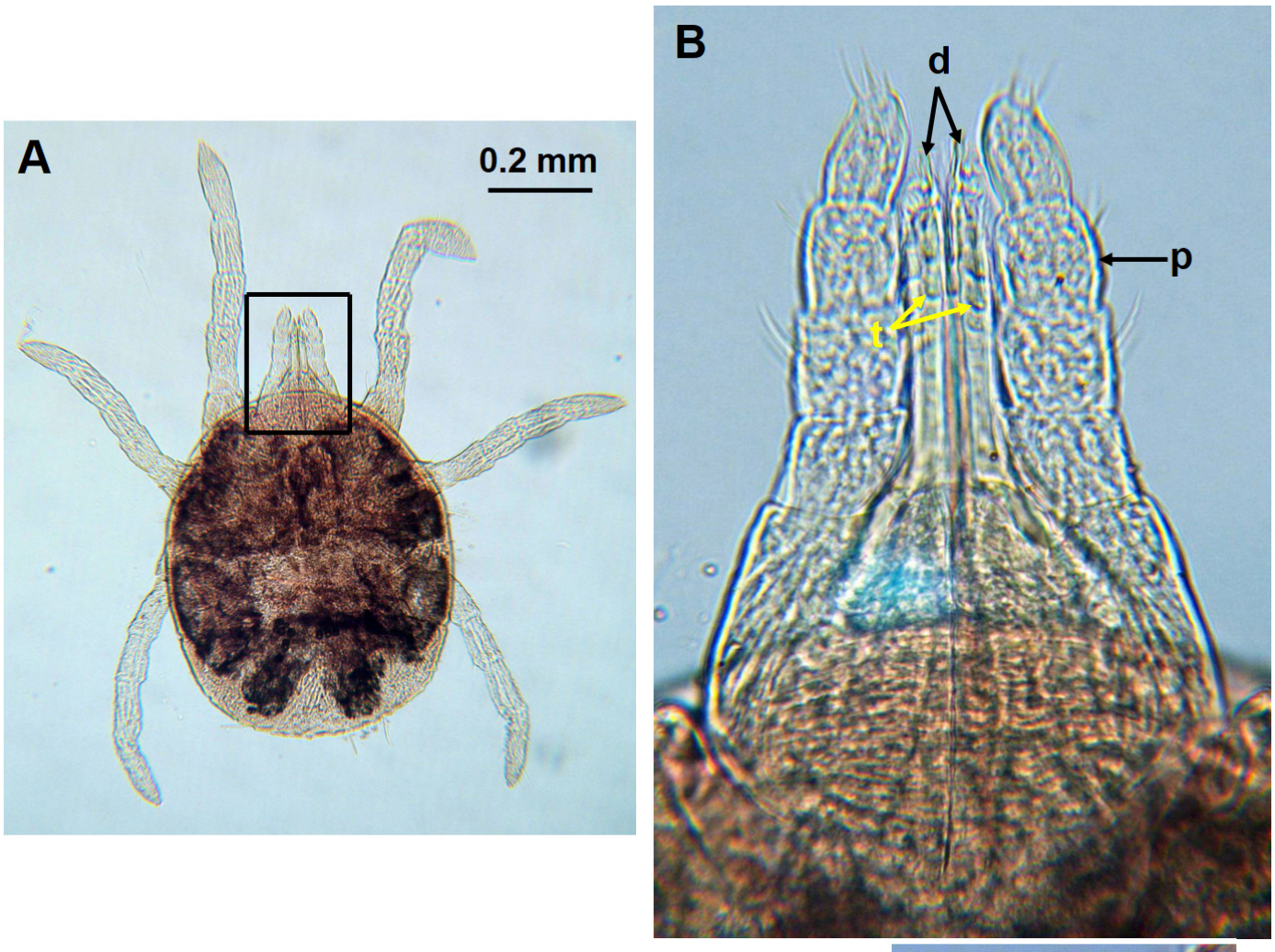


A. persicus leg segments: 1, coxa; 2, trochanter; 3, pseudoarticulation joint; 4, femur; 5, tibia; 6, metatarsus; 7, tarsus.

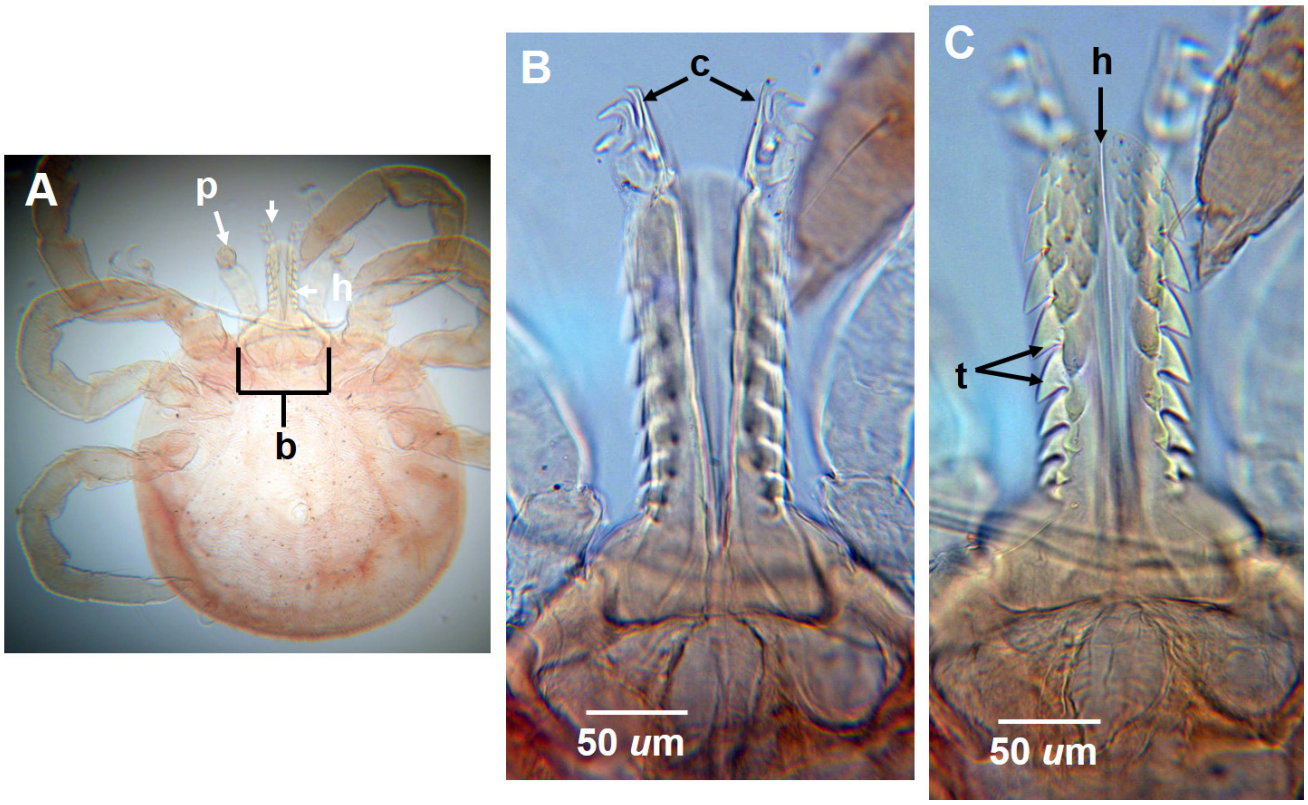
The transverse slit-like gonopore (= genital aperature of some authors) lies between the first and second pair of coxae.

Larval Argasid Identification – Body Morphology

The larval form of soft ticks, like hard ticks, possesses six legs (i.e., a hexapod larva). Furthermore, mouthparts of soft tick larvae are at the terminal end of the body rather than located ventrally. You can easily identify the chelicerae (with their serrated distal tips), the hypostome (with its heavily dentate backward-pointing teeth), and palps, all projecting forward from the basis capitulum of larval *Argas persicus* and *Ornithodoros sp.*



Ornithodoros sp., hexapod larva. Box in A enlarged in B. Legend: d, distal tips of chelicerae; p, palp; t, teeth of hypostome.

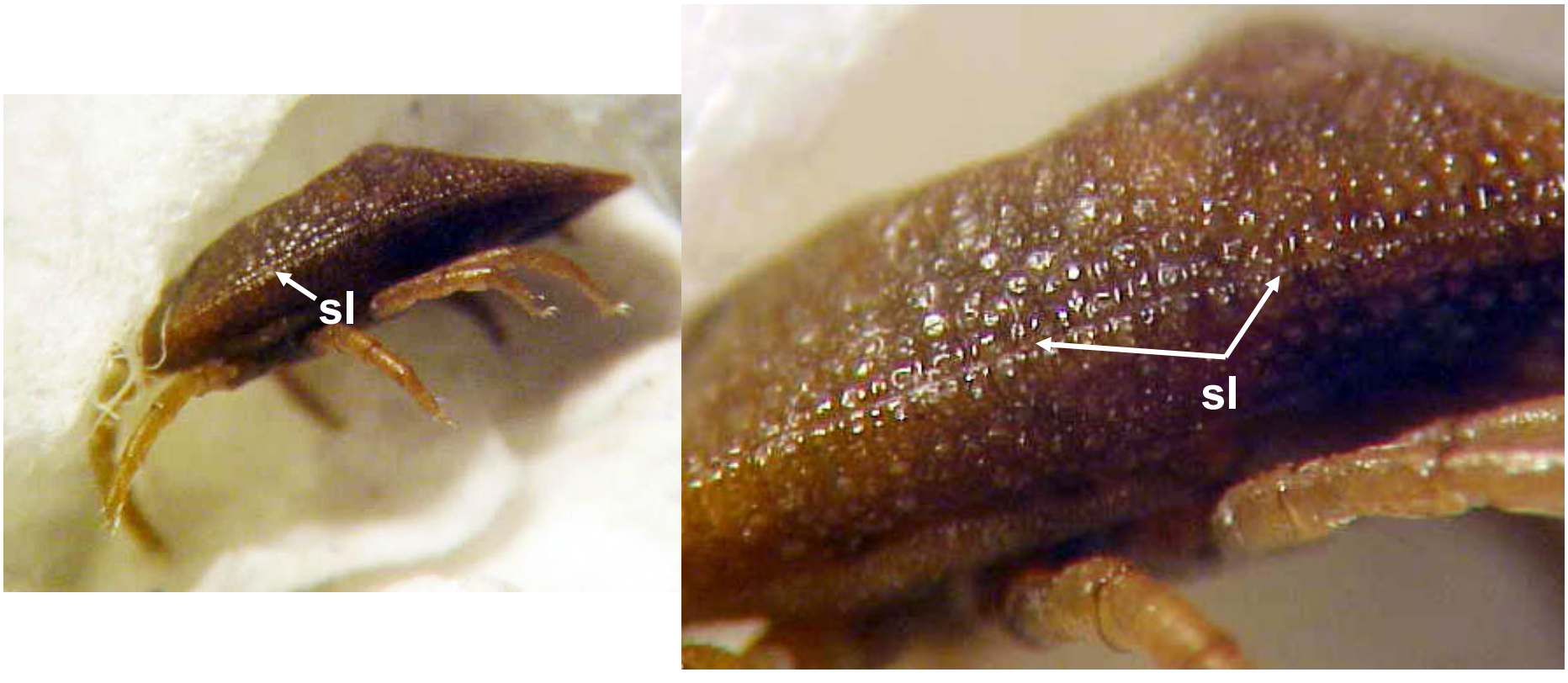


Argas persicus, hexapod larva: A, entire; B, chelicerae; C, hypostome. Legend: b, basis capitulum; c, chelicera; h, hypostome; p, palp; t, teeth of hypostome.

Argas persicus (The Fowl Tick)

Ticks of this species are important poultry ectoparasites, although they may attack bats, limbed reptiles and small insectivores, as well. In the New World what is called the fowl tick may be A. *persicus, A. radiatus, A. sanchezi,* or *A. miniatus*, some of which may infest wild bird species. In *Argas* there is a lateral sutural line essentially dividing the body into dorsal and ventral regions. This character separates *Argas* from other genera of soft ticks.

Life cycles of these soft ticks generally have two or more (as many as six or seven) nymph stages in their life cycle, unlike the hard ticks. Each nymph stage usually requires a blood meal. These nymphs feed on a host for a short period, leave the host and return to protected areas (cracks and crevices or accumulated debris of chicken houses, for example) to molt to the next nymph stage. Because of this multiple host feeding strategy, and their ability to survive for long periods without feeding, argasid ticks often live for several years. Once these ticks reach the adult stage they may continue this multiple feeding strategy. For example, females feed repeatedly on birds, laying small batches of eggs (usually less than 500 eggs) in protected areas after a blood meal.



A. persicus, lateral view. Note suture line (sl) characteristic for this genus. Suture line enlarged right.

Ornithodoros spp.

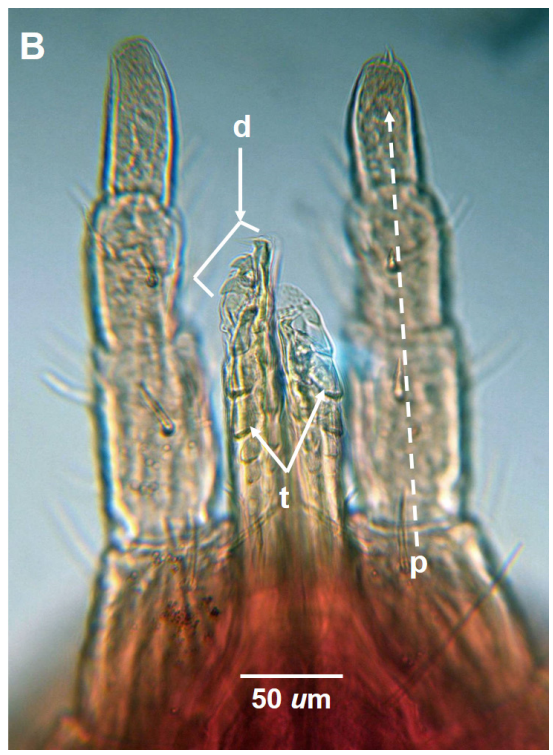
Members of this genus have a subterminal capitulum with a well developed hypostome, chelicerae, and palps typical of soft ticks. The body is flattened dorsoventrally in unfed individuals; strongly convex dorsally after engorgement. The integument of ticks in this genus is mammillated, but there is no sutural line as in *Argas*.

There are about 100 species in the genus, utilizing bird and mammalian hosts.

Ornithodoros sp., adults: dorsal (left) ventral (right). Specimens taken from alcohol preservative, dried, and photographed.

Perhaps the best know species is *O. moubata*, a mammalian ectoparasite found widespread throughout sub-sahara Africa. *Ornithodoros moubata* is a "species complex" (i.e., actually made up of several species). This is the only known vector of relapsing fever spirochaetes (*Borrelia duttoni*) in Africa. In North America, *O. hermsi* has been incriminated with vectoring relapsing fever spirochaetes (*B. hermsi*) in rodents, sometimes in humans.

Ticks of this genus exhibit a typical soft tick life cycle. Females oviposit in sheltered areas with a hexapod larva hatching from the egg. After engorging, the larva molts to a nymph. (Curiously, larvae of *O. moubata* do not feed but rather hatch to the nymph within the eggshell to the first nymphal stage). There are multiple nymph stages, each taking a blood meal before molting. Larvae, nymphs and adults may survive for long periods in the absence of suitable hosts.



Ornithodoros sp., nymphs (A). Mouthparts (mp) enlarged (B). Legend: d, distal tips of chelicera; p, palp; t, teeth of hypostome.

Otobius megnini (The Spinose Ear Tick)

This tick is primarily a parasite in the ears of cattle, although it has been recorded from a range of hosts (e.g., donkeys, sheep, goats, dogs, cats, deer and rabbits) in North America. Another species, *O. lagophilus* is associated with cottontail and jack rabbits in western North America.

Female ticks often reside in cracks and crevices of sheltered areas (i.e., barns or stables). Adult spinose ear ticks have a poorly developed hypostome and consequently do not feed. Females are autogenous (i.e., oviposit without feeding), laying up to 1,500 reddish eggs in small batches over a period of several weeks (sometimes months) in protected areas. Under optimal summertime conditions eggs may hatch in 11 days, but may take three to eight weeks to hatch in cooler conditions. A hexapod larva emerges from the egg and enters the ear of a host where it engorges. After a quiescent period the fed larva molts to an octopod nymph. There are two nymph stages, characterized by terminal mouthparts and a spiny, rather than mammillated, integument. Nymphs attach to the host's skin lining the ear and suck blood. Most nymphs leave the ear canal within 5 weeks, but some may remain in the host for several months. Upon leaving the host, nymphs move to cracks and crevices in walls of shelters, or seek refuge under stones or the bark of trees. The second nymph molts to an adult in one to four weeks.

Otobius megnini, nymph. Dorsal view (left); ventral view (right).

O. megnini: A, entire; B, terminal mouthparts and spiny integument.

Spinose ear ticks do not vector pathogens but may do considerable damage to the ears, ear drums, and auricular nerves by their feeding. In heavy infections these ticks may predispose the host to secondary bacterial infections.