Hands-on Training Module on Medically Important Hard Ticks (Ixodidae)

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Foreword

Ticks have a history of about 200 million years. Ticks are ectoparasitic, blood sucking arachnids belonging to Super Order Parasitiformis which has 3 families viz., Ixodidae (Hard Ticks), Argasidae (Soft Ticks) and Nuttalliellidae with single genus Nuttalliella (reported from Southern Africa). Ticks have several animal hosts, usually ranging from rodents to higher mammals. Ticks serve as hosts to several bacteria, viruses, protozoans and spirochaetes. They, therefore, transmit several diseases to animals and zoonotic infections to humans. Some of the important diseases transmitted by the ticks are Tick Typhus, Kyasanur Forest Disease, Crimean-Congo Haemorhagic Fever, Rocky Mountain Spotted Fever, Tularemia, Babesiosis, Rickettsial pox, Q-Fever, Lyme disease, etc. In India, Kyasanur Forest Disease has spread from its stronghold in Shivamoga district in Karnataka to Wayanad in Kerala towards South to Maharashtra and Goa towards North. Hence, research on ticks assumes importance in the effective prevention, control and management of these diseases.

In this context, “Hands-on Training Module on Medically Important Hard Ticks (Ixodidae)” by Mr. A. Elango, Principal Technical Officer, VCRC, who has more than 3 decades of experience on ticks, is not only timely but also much needed document for imparting the right knowledge and training to the Entomologists and Programme Managers so that the tick borne diseases are effectively controlled. I congratulate Mr. Elango for bringing out this important manual and also thank all the VCRC colleagues, who assisted him in its production.

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1. Introduction:

Ticks are obligatory hematophagous ectoparasites widespread globally and also act as vectors or reservoirs for the transmission of pathogenic fungi, protozoa, viruses, rickettsia and other bacteria during their feeding process on the human and animal hosts. Vector-borne diseases contribute approximately 30% of the emerging infectious, including Tick-borne diseases. Tick-borne pathogens are believed to be responsible for more than 100,000 cases of illness per year in humans throughout the world. From the medical and veterinarian point of view, most of the 100 Tick-borne infections can be associated with 116 tick species (32 Argasid and 84 Ixodid species).

Sharif (1928) published a revision of Indian Ixodidae and outlined the history of tick taxonomy in India. Taxonomy of ticks in India began after the discovery of the Kyasanur Forest Disease (KFD) and incrimination of ticks as the vectors in Shimoga district, Karnataka. These tick species were mostly recorded from the adjoining areas of Kyasanur forest, foothills of the Himalayas and northeastern region of India. Information on the biodiversity of tick fauna is available for Kerala, Karnataka and Andhra Pradesh. Zoological Survey of India (ZSI) has carried out a survey of Ixodid ticks on domestic animals in different states.

Tick-borne diseases are re-emerging in the various State of India like Kyasanur Forest Disease (KFD), Crimean-Congo hemorrhagic fever (CCHF), Indian tick typhus and Lyme disease. It is essential for Public Health entomology to identify the tick vectors. Moreover, tick taxonomists in India as well as in the world are a few. The important medically important vectors belong to Genus *Haemaphysalis, Rhiphicephalus, Ixodes and Hyalomma* species. Twelve tick species for KFD, one species for CCHF and, two species for Indian tick typhus were incriminated as vectors in transmitting tick-borne diseases to humans in India.

2. Pathogens Transmitted by Ticks

Ticks are vectors or reservoirs of pathogenic fungi (Dermatophilosis), Protozoa (*Babesia*), Nairovirus [Crimean–Congo hemorrhagic fever (CCHF), Powassan encephalitis, Soldado virus, Issyk-Kul fever virus, Eyach virus, Colorado tick fever, Mono Lake virus); Flavivirus (Omsk Hemorrhagic fever, Kyasanur forest disease (KFD), and others tick-borne encephalitis (TBE)); Rickettsia spp. (Rocky Mountain spotted fever, Brazilian spotted fever, Mediterranean spotted fever, African tick bite fever, Indian Tick Typhus (ITT); *Anaplasma* bacteria (Human granulocytic

anaplasmosis), *Ehrlichia* bacteria (Human monocytic ehrlichiosis) and *Borrelia* bacteria (Lyme disease and relapsing fever), *Francisella* (Tularemia), and *Coxiella* bacteria (Q (Query) fever), etc. and transmit them during their feeding process to the Humans.

3. Major Tick Vectors in India

Haemaphysalis spinigera (Fig. 1), *H. turturis* etc., (KFD), *H. anatolicum anatolicum* (CCHF), *Rhipicephalus sanguineus* and *Rh. haemaphysaloides* (ITT), *Ixodes ricinus* (Lyme disease), and *H. intermedia* (Ganjam Virus) are the major vectors recorded in India. Ticks larvae become infected during feeding on the small mammal reservoir and the parasites are transmitted to nymph and adult transstadially (Ex. KFD and Lyme disease). On the other hand, infected females pass the infection to the offspring through transovarial transmission and transstadially to the adult ticks (Ex. *Rickettsia* sp., CCHF virus and Ganjam Virus). The nymphal stage of the tick is infective to humans in KFD and Lyme disease. However, the adult tick is the infective stage in CCHF. Human to human transmission occurs only in CCHF via percutaneous or per mucosal exposure to blood and body fluids containing the virus.

4. Human tick-borne diseases in India

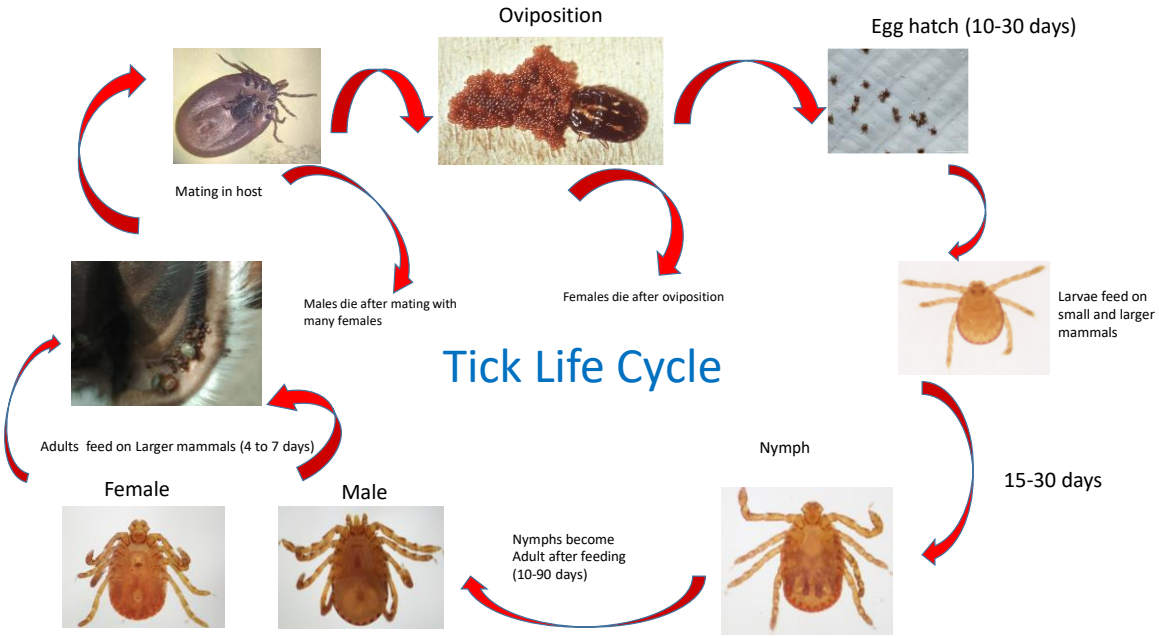
Tick-borne diseases are re-emerging in various states of India. Kyasanur Forest Disease is currently reported in Karnataka, Goa, Maharashtra, Kerala and Tamil Nadu. Every year the disease is expanding into new areas of Western Ghats. Crimean- CCHF has been reported in Gujarat, Rajasthan and Uttar Pradesh state. Indian tick typhus (ITT) cases in humans have been reported in Tamil Nadu, Pondicherry, Delhi, Uttar Pradesh and Karnataka State. Lyme disease has been reported in Kerala. A rare disease like Ganjam virus is reported in Tamil Nadu and Q fever has been reported in Puducherry.

5. Life Cycle of Ixodid Ticks

Hard tick life cycle consists of egg, the six-legged larval stage (24-253 days), eight-legged nymphal stage (75-183 days), and Adult stage (152-568 days). In their life cycle, Ixodid ticks have either one-host or two-hosts or three-hosts. In the one-host life cycle, ticks remain on the same host through the larval, nymphal and adult stages, leaving the host only prior to laying eggs (eg. *Boophilus sp*). In a two-host life cycle, larvae and nymphs feed on the same host and the adults feed on another host (eg. *Hyalomma sp*). In the three-host life cycle, all three stages feed on 3

different hosts *(Ex. Haemaphysalis sp)*. The life span of the hard tick from egg to adult is from one to three years. Male tick takes a smaller amount of blood meal before mating and dies after mating. The female takes a blood meal before mating and lays about 1000 to 20000 eggs depending on the species. Life cycle of the soft ticks consists of egg, six-legged larva, two or more eight-legged nymphal stages, and each stage takes a small blood meal on different host. Soft ticks deposit 20 to 50 eggs in a batch after each blood meal. Unlike the soft ticks, which mate in the vegetation, the ixodid ticks copulate while on their host (Fig 1).

Fig. 1: Pictorial Ixodid Tick Life cycle



6. Survey Methods

6.1 Flagging method

About three or four persons will be involved in flagging. A flag is of lint cloth (100 × 70 cm) attached to a wooden stick which is dragged on the surface of the forest floor. Each person will do random flagging every 10 meters covering 100 square meters in a selected place. Initially, five or ten times the flag shall be dragged on the floor in the same place. This will disturb the ticks present under the leaves. Now the flag should be checked for the presence of ticks. If not present on the initial dragging, then move 10 meters away and do the flagging until ticks are found.

If ticks are present, then flagging will be done in the same area until no more ticks are found. Then move another 10 meters away and repeat the flagging. Every three minutes flagging will be stopped and checking for the presence of ticks will be done.

After flagging is done at a particular village/site, the cloth should be burned. A new flag should be used on the new site.

Nymph collections should be made during December to April months. During this period the tick population (nymphal stage) is maximum on the forest floor.

Do not perform flag sampling when it is raining, when the vegetation is wet (with rain or dew), or when temperatures are less than 4^{o}C. To avoid the early morning dew, it is better to perform tick dragging in the late morning or afternoon. In cooler temperatures, the ticks are less active and wet conditions may dirty the drag cloth very quickly, making it difficult to see any possible ticks.

The ticks may attach and attempt to feed on the collector. Using personal protection by the collector can minimize the possibility of tick bites. For example, wearing white clothing (pants, shirt with long sleeves, coveralls and socks outside the bottom of the pants) will make the presence of ticks apparent (i.e. dark tick on light background).

Do a complete check of clothing (and the drag cloths) after finishing the sampling at each location (i.e., in the field). When at home, carefully re-check your clothing and boots; and thoroughly check your skin for any attached ticks. Ticks are frequently found on the head, neck, groin and underarms but may attach anywhere on the body, including the torso, arms, legs and ankles.

6.1.1 Important notes on Flagging

1. Do not use the same flag in the next area on the same day. Because some larvae and nymphs may be accidentally introduced into a new area if present on the used cloth.

2. So after flagging is completed, if not burned, the flag should be immersed in hot water and dried before next use.

3. The efficiency of the flag will be reduced because the mesh pattern (Fibers) on the lint cloth will be altered over time (many times used for flagging). Often confirm that the mesh pattern of the lint cloth is good. If not, then you can discard it and use a fresh lint cloth.

4. Better avoid flagging over plants like *Achyranthes aspera* or plants having dried seeds with spines. These seeds easily attach to the flag and you have to spend a lot of time to remove them.

5. The reason for flagging three or four times vigorously in the same place is that during first or second flagging the resting nymphs will start to move and try to hide (just like disturbing ants nest). During that time if you are doing flagging again, the moving nymph may attach to flag and cling to it with the claws.

6. Be careful during flagging on the forest floor as there may be a snake, spider, scorpion and other arthropods under the surface of leaves.

7. Do not do flagging where Red ants are present. Red ants are the predators of the ticks.

8. It is better to take a hot water bath after flagging. Check any ticks present over the body during the bath.

9. You can also do flagging over the surface of small shrubs with leaves (without spine) gently and you may get questing Adult ticks. Do not flag vigorously over the plants because the lint cloth may get struck and sometimes it will damage the cloth.

10. Be careful about the movement of the ticks on your body. It is better to check for the presence of ticks every 5-10 minutes. If any tick is present, then remove it immediately.

11. During the collection of the nymph, approximately 10 nymphs can be added per vial. Use a fresh tube for the collection of another 10 nymphs to avoid crowding. If more live nymphs are put in a vial they can escape from the top and precious collection may be lost.

12. After identification, make a pool with 20-25 nymphs in each tube of the same species.

13. Do not mix ticks of one area with another area. The collection of each area has to be pooled separately and properly labelled.

14. For adult collection, better avoid fully engorged ticks. It is difficult for the identification of species.

15. Adult ticks can be collected from under the surface or underneath of the plant leaves near the edges (questing Adults).

16. You can also collect ticks from captured Rodents/shrews (mostly larva and Nymph).

17. Do not take a rest under the shadow of trees with a lot of dried leaves. If you sit on the dried leaves for a long time there is a possibility of getting tick infestation on your body.

18. You can get a lot of information about the abundance of ticks in the forest from the villagers who are visiting the forest daily for their work.

19. More care should be taken where the monkey death has taken place in the forest. The ticks may evict the dead monkey and attach to the other vertebrate host including the human host.

20. If you see any ticks biting on your skin and the mouthparts deep inside the skin, then do not remove them by yourself. Go to the nearby hospital for removing the ticks.

21. *Haemaphysalis spp* (nymphs), *Hyalomma spp* (larva, nymphs and adults) and *Rhipicephalus spp*. (adults) are attracted more to humans than domestic and wild animals.

22. There are more chances of encountering ticks at the animal resting places under the tree or drinking water place of the animals in the forest. However, flagging in this place is dangerous where wild animals may visit for drinking water, hence should be avoided.

23. Sometimes you may find ticks on the floor of the cattle sheds in rural areas. Hence these may be included in the tick collection plan.

24. Ticks move very fast on the plain surface of the hand. Do not play with alive ticks on your hand. It will try to hide in your dress. It is difficult to feel the movement of ticks on your body.

25. Alive ticks can be killed and stored in 80%. However, sometimes the ticks will be collected alive and stored in vials. They can be identified easily if the ticks are killed in a deep freezer or stored in 80% alcohol. If the tick died without fixation or in the air, then the ticks will be dehydrated and shrink. Once the ticks are shrunk then identification of species is very difficult. Therefore, it is important not to allow the ticks to dehydrate until identified.

26. If no deep freezer is available, you can anaesthetize the ticks by keeping the vials for 10 minutes in liquid nitrogen. But be careful in handling the ticks for identification because the ticks are in brittle condition and may slip off while handling from tweezers. Do not keep the vial for a long time outside at room temperature.

27. The ticks can be fixed using 70 or 80% alcohol. Identification has to be done by immersing the ticks in 70 or 80% alcohol in a cavity block. Photographs using a cellphone can be taken by immersing a tick in 80% alcohol. Do allow the ticks to dry any time. This is very important.

6.2 Direct Collection from Domestic Animals

Fig 2. Ticks in the Ear

Tick surveillance can be done on the domestic animals in the selected villages. Ten houses with domestic animals in the selected village will be checked for the presence of Ticks. If present, ticks will be collected from domestic animals such as buffalo, cows, sheep, goats, dogs and cats. Ticks will be checked throughout the body like head, ear (Fig. 2), face, shoulder, abdomen, leg, udder etc. The embedded tick removal is accomplished by using curved, tweezer. The ticks are grasped as close as possible to the skin surface, followed by gently pulling away from the skin without twisting or jerking at 45° angle. In addition, care will be taken to avoid puncturing, crushing, or squeezing the ticks, as their body

Tick collection from domestic animals

fluids may contain infectious agents. After collection, the ticks should be transferred to 70% alcohol.

6.3 Tick collection from Plants by the handpicking method

Checking leaves of small plants from upper, lower and axis parts. The questing ticks will be collected using fine forceps.

6.4 Storage and Transportation for Molecular Assays (RT-PCR)

Ticks will be collected and anaesthetized by keeping ticks in the deep freezer overnight or minimum for 1 hr. After identification, the ticks should be stored in liquid nitrogen and transported to the laboratory for KFD virus isolation and detection by RT-PCR assays.

Ticks can also be fixed in 80% alcohol directly during the collection and transport to the lab for PCR.

6.5 Tick Indices

Infestation Rate:

$$\frac{\text{Number of infected animals}}{\text{Total number of animals examined}} \times 100$$

Tick abundance per animal:

$$\frac{\text{Number of Ticks Collected}}{\text{Number of Animals Examined (Both + ve and –ve for ticks)}}$$

Infestation intensity:

$$\frac{\text{Number of ticks collected}}{\text{Number of animals infested (only +ve animal)}}$$

Man Hour Density:

$$\frac{\text{Total number of ticks collected}}{\text{Total time spent in minutes}} \times 60$$

Example: Assuming four persons do flagging for 15 minutes in different places i.e. 10 meter distance apart from each other and collect 56 ticks altogether; then the Man Hour Density would be 56.

7. Methods of Personal Protection and Control

1. Regular removal of ticks from the domestic animal from the body and Ears.
2. **Malathion** 5% or **Malathion** 25% powder dusting around 50 feet radius of a spot of monkey death.
3. The fire can be lit along the footpath to make it clear of the ticks.
4. Vector control, particularly chemical spraying – not feasible, due to inaccessibility and difficult terrain
5. Vaccination (Formalin inactivated tissue culture Vaccine) of all individuals living in endemic areas
6. Use of personal protective measures: Repellents and Protective clothing's and Gumboots
7. Strictly prohibit the visit to affected forest area during outbreak (Dec-June), particularly the area reported with monkey deaths.
8. Partners: Health, Forest, Animal Husbandry, PWD, LAD (Municipality), Agriculture, education etc.
9. Enhanced IEC activities are required.

Source: https://tickapp.tamu.edu/control.html

Ploughing

Source: https://tickapp.tamu.edu/control.html

Removing dry leaves

Source: https://tickapp.tamu.edu/control.html

Burning the dry bushes

Source: https://tickapp.tamu.edu/control.html

Spaying Insecticide (Mechanical)

Removing ticks (manually)

Source: https://garlandmag.com/article/re-threading-the-tapestry-of-an-arid-topography/attachment/shamjis-father-removing-ticks-from-a-cows-tail-home-cumwork-shop-of-vankars/

Source: https://tickapp.tamu.edu/control.html

Spaying Insecticide (Hand spray)

8. Taxonomy of Indian Ticks

Kingdom: Animalia

Phylum: Arthropoda

Class: Arachnida

Subclass: Acaria (Acari, Acarina, Acarida)

Super Order: Anactinotrichidea (=Parasitoformes)

Order: Ixodida

Family: Ixodidae

In India, about 50 tick species have been recorded before discovery of the Kyasanur Forest Disease (KFD) and incrimination of ticks as the vectors in Shimoga district, Karnataka. Worldwide ticks fall in three families belonging to order Ixodida (Hard Ticks) and 896 species. The Nuttalliellidae family is monotypic, containing single species *Nuttalliella namaqua* and not recorded in India. The Argasidae family (soft ticks) consists of 193 species worldwide. Of these, 19 species belong to the genera *Argas* (10), *Ornithodoros* (7) and *Otobius* (2) are recorded in India. The family Ixodidae (Hard ticks) comprises 702 species in 14 genera: *Amblyomma* (130), *Anomalohimalaya* (3), *Bothriocroton* (7), *Cosmiomma* (1), *Cornupalpatum* (1), *Compluriscutula* (1), *Dermacentor* (34), *Haemaphysalis* (166), *Hyalomma* (27), *Ixodes* (243), *Margaropus* (3), *Nosomma* (2), *Rhipicentor* (2) and *Rhipicephalus* (82). Of these, 88 Ixodid ticks belong to genera *Ixodes* (11), *Amblyomma* (12), *Rhipicephalus* (8), *Dermacentor* (3), *Haemaphysalis* (44), *Nosomma* (1), and *Hyalomma* (9) are recorded in India

Important Genera of family Ixodidae

1. ***Ixodes***

This is the largest genus in the family Ixodidae containing 245 species, of which only 11 are known to occur in India. Ixodes are inornate ticks.

Palps are long with constriction near the proximal end of article II and have a few very minute and simple hairs. The ventral surfaces of the palps are much less broad than their dorsal surfaces. The capitulum of the female is considerably longer than that of the male. There are no eyes or festoons.

The anal groove is present anteriorly to the anus, whereas in all other genera the anal groove is posterior to the anus.

2. ***Haemaphysalis***

At present 155 Haemaphysalis species are known throughout the world, of which 41 have been recorded in India.

Anal grooves surround the anus posteriorly. Usually of small size. Scutum inornate and without eyes, and in the female without lateral grooves. Capitulum with base sub-rectangular, and with palps normally short and conical, broadest near the posterior end of article 2, (in some species projects laterally beyond the base). The second and third palpal segments taper anteriorly so that the capitulum anterior to the basis capitulum appears to be triangular. There are no eyes in either sex. Festoons are present. They are generally three-host ticks.

3. ***Dermacentor***

These are usually ornate, brevirostrate ticks. There are 30 species known from all over the world of which three occur in India. The base capitulum is rectangular dorsally. Coxa IV is greatly enlarged in the male, which has no ventral plates. They are generally three-host ticks.

4. ***Nosomma***

These are brevirostrate ticks with short palps. This genus comprises a single species *N. monstrosum*, which has been recorded from India and Southeast Asia. This is a three-host tick.

5. ***Hyalomma***

The genus comprises 30 known species found all over the world, out of which nine have been recorded from India.

Palps and hypostome long; Coxa I bidentate. Capitulum long with a rectangular base and without lateral angles. In females, the capitulum is sub-triangular. The male has one pair each of adanal and accessory adanal plates. *Hyalomma* species are either two- or three-host ticks.

6. ***Rhipicephalus***

This genus contains 75 known species, eight of which occur in India, including those belonging to the Boophilus group which has been merged recently with this genus.

Capitulum short, basis capituli hexagonal, with lateral projections on the dorsal aspect on each side. Palps short, broad and flat on the dorsal surface, the external border straight or convex. The first segment of palp is prolonged internally on the ventral surface and bears a number of feathery hairs. Hypostome, with six rows of teeth. Coxa I bidentate, the internal spur broad and flat, the external conical. The remaining coxae with very short external spurs. The male has adanal and accessory adanal shields or plates, the shapes of which are of diagnosable value. *Rhipicephalus* are mostly three-host ticks.

7. ***Amblyomma*** Koch, 1844

The genus is represented by 12 species in India, including those belonging to the *Aponomma* group which has been merged recently with this genus. There are 126 known species of this genus distributed all over the world.

Diagnostic characters: Anal grooves embracing the anus posteriorly. Generally ornate with dark spots and stripes on pale ground. Eyes and festoons present. Palps are usually long, with article 2 especially long. No ventral plates in the male. Species of the genus are characterized by the usually long mouthparts. The palpal article 2 is about 2 or 3 times as long as article 3. The palp 3 is bent slightly inwards. Almost all species belonging to *Ambylomma* are three-host ticks, whereas *Aponomma* species are usually one-host and feed exclusively on amphibians.

Fig. 3 Taxonomical characters of Tick [Ventral (Male) and Dorsal (Female)]

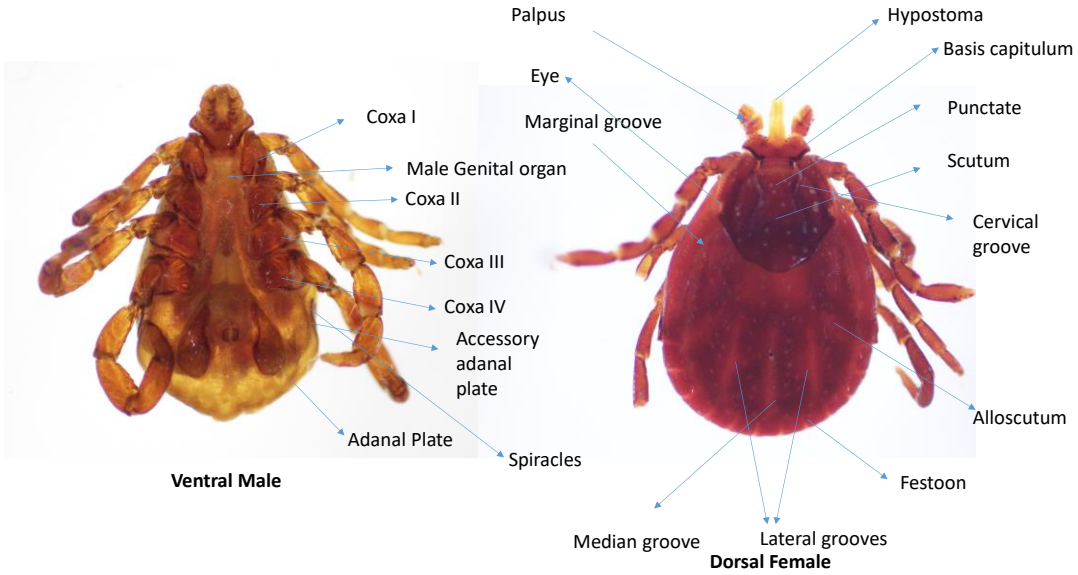
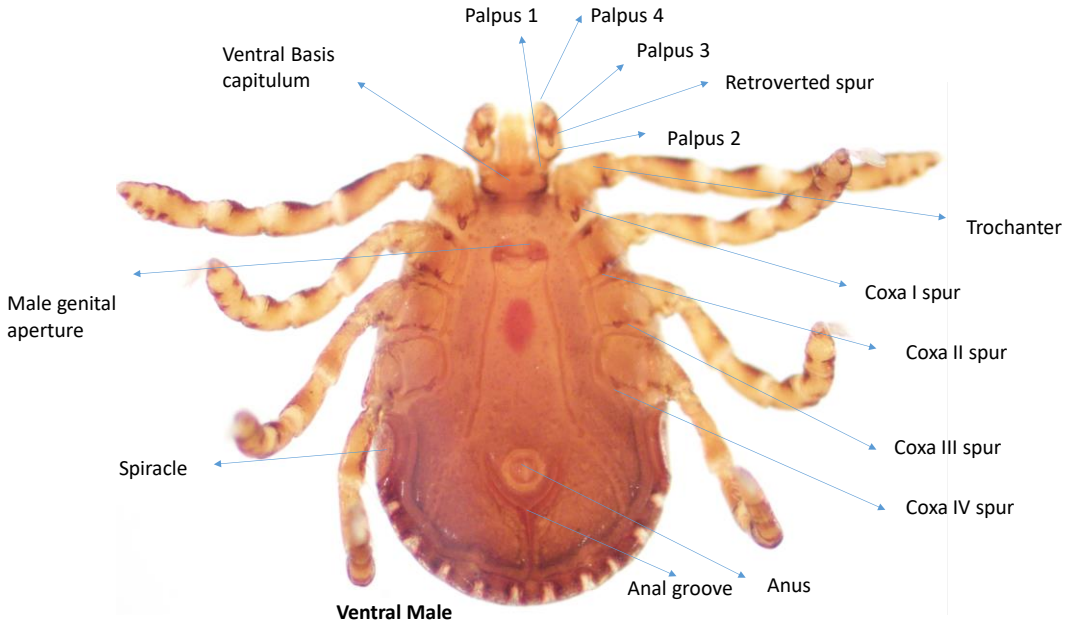


Fig. 4: Taxonomical characters of Tick (ventral view)



***1) Haemaphysalis bispinosa* (Fig. 5)**

Life cycle: Three host Ticks Larva, nymph and adult feed on different hosts.

Hosts:

Nymph: Dog, jungle cat, black-naped hare, crested porcupine, Indian roller bird, cattle, goat, sheep, jackal, leopard, bonnet monkey, spotted deer, horses, langur monkey, and buffalo.

Adults: Sheep, goat, jackal, mongoose, mule, barking deer, buffalo, cattle, cat, dog, donkey, horse, pony, rabbit, rat, spotted deer, tiger, common wood shrike, white-handed babbler, black-naped hare, wild mammals, rodents.

Diagnostic characters:

Nymph: No salience; Cox III and IV have no distinct spur; Palps narrower, an external profile without re-curvature; palpal segment 3 with ventral spur short, blunt, extending about 1/4 distance to the basal margin of palpal segment.

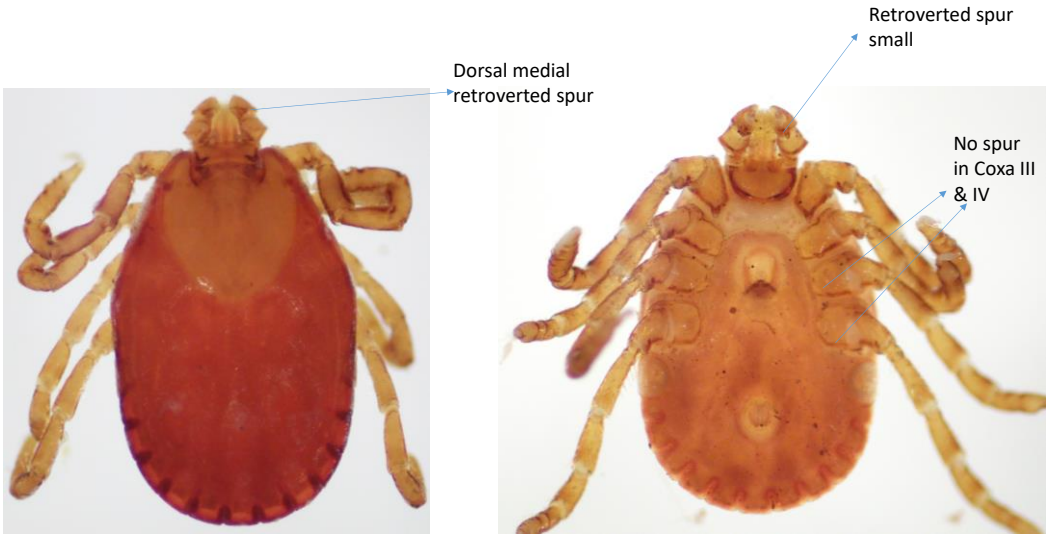
Male: No salience; Scutum elongate, punctations few and shallow; palpal segment 3 with dorsal, median, elevated spur; infrainternal setae slender, well-spaced.

Female: Similar to Male; size larger than Male; No salience; Punctations of scutum few and shallow; palpal segment 3 with dorsal median elevated spur; four or five slender, well-spaced infrainternal setae.

Distribution: Reported in all states of India like Himachal Pradesh, Jammu and Kashmir, Punjab, Assam, West Bengal, Bihar, Madhya Pradesh, Maharashtra, Tamil Nadu, Arunachal Pradesh, Andhra Pradesh, Goa, Gujarat, Karnataka, Mizoram, Orissa, Sikkim, Andaman Islands.

Disease transmission: Kyasanur Forest Disease (KFD)

Fig. 5: *Haemaphysalis bispinosa* (Female) ventral and dorsal view



***2) Haemaphysalis intermedia* (Fig. 6)**

Life cycle: Three host Ticks

Host:

Immature stages: Jungle cat, mouse deer, Asiatic jackal, black-naped hare, goat, sheep, leopard, squirrel, birds (gray partridge, painted spurfowl, Indian plaintive cuckoo, Indian pitta, bush lark, brown shrike, gray drongo, brahminy myna, common myna, common wood shrike, red vented bulbul, white-headed babbler, tailorbird, Blyth's reed warbler, magpie robin, Indian robin, coucal). The nymphs can be collected by flag dragging through the forest undergrowth.

Adults: Goat, sheep, buffalo, dog, squirrel, Asiatic jackal, bonnet monkey, hare, jungle cat, wild boar, black-naped hare, cattle, red jungle fowl, domestic chicken, and can be collected by flag dragging through forest vegetation.

Diagnostic character:

Nymph: No salience; Coxae III and IV with distinct sharp spurs; ventral trochanter spurs absent or obscure; four feathery, closely-set infrainternal setae. In ventral aspect, external profile of palps with abrupt recurvature; dorsobasal margin of palpal segment 3 extending beyond internal margin of palpal segment 2.

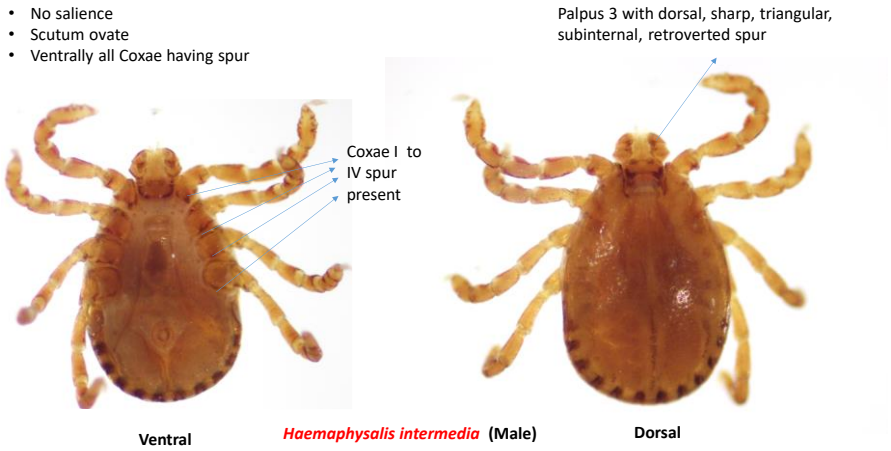
Male: No salience; Palpal segment 3 with a distinct dorsal retroverted spur; Scutum ovate, punctations numerous and deep over the entire surface; palpal segment 3 with dorsal, sharp, triangular, subinternal, retroverted spur; infrainternal setae feathery, close-set

Female: No salience; Punctations of scutum numerous and deep, distributed over the entire surface; dorsobasal margin of palpal segment 3 with sharp triangular subinternal retroverted spur; six or seven feathery, closeset infrainternal setae.

Distribution: Haryana, Himachal Pradesh, Jammu and Kashmir, Andhra Pradesh, Bihar, Assam, Delhi, Goa, Punjab, Maharashtra, Madhya Pradesh, Karnataka, Orissa, Tamil Nadu.

Disease Transmission: Kyasanur Forest disease, Ganjam Virus

Fig. 6: *Haemaphysalis intermedia* (Male) ventral and dorsal view



***3) Haemaphysalis spinigera* (Fig. 7)**

Life cycle: Three host Ticks

Host

Nymph: Indian gray mongoose, mouse deer, sambar deer, black-naped hare, crested porcupine, Asiatic jackal, toddy cat, peacock, white-throated ground thrush bird, jungle fowl, jungle myna, buffalo, shrew, jungle babbler, crow pheasant, red vented bulbul, rat, sheep, tiger, jungle cat, langur monkey, cattle, bonnet monkey, panther, wild dog, squirrel and man.

Adult: Asiatic jackal, Sambar deer, cattle, wild animals, buffalo, tiger, leopard, bear, Indian bison, jungle cat, small Indian civet, black-naped hare, mouse deer, wild dog, bullock, rat, jungle fowl, jungle myna, peacock, white-throated ground thrush bird, and from flag dragging and handpicking under stones and bushes.

Diagnostic character:

Nymph: Broad Salience; Ventral basis without cornua; ventral spur of palpal segment 3 larger, reaching about 1/4 distance to the basal margin of palpal segment 2

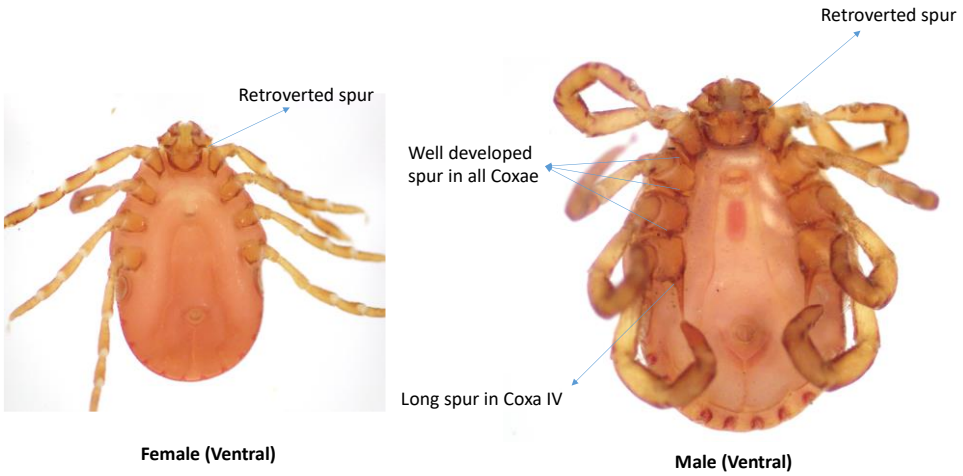
Male: Broad Salience; Coxa IV with greatly elongated sharp spur(s), much-exceeding length of other coxal spurs

Female: Broad Salience; Dorsobasal margin of palpal segment 3 with median retroverted spur; Palpal segment 2 with ventrobasal external margin forming a sharp spur.

Distribution: Karnataka, Andaman and Nicobar Islands, Andhra Pradesh, Goa, Kerala, Madhya Pradesh, Maharashtra, West Bengal, Meghalaya, Orissa, Tamil Nadu.

Disease Transmission: Kyasanure Forest Disease (KFD)

Fig. 7: *Haemaphysalis spinigera* (Female) ventral and (Male) ventral view



4) Haemaphysalis wellingtoni (Fig. 8)

Life cycle: Three host Ticks

Host

Nymph: Toddy cat, mouse deer, barking deer, buffalo, langur monkey, dog, crow pheasant, shrew, cattle and red spurfowl

Adult: Mouse deer, crested porcupine, monkey, small mammals, Gallinaceous and other bird species, crow pheasant, buffalo and dog.

Diagnostic character:

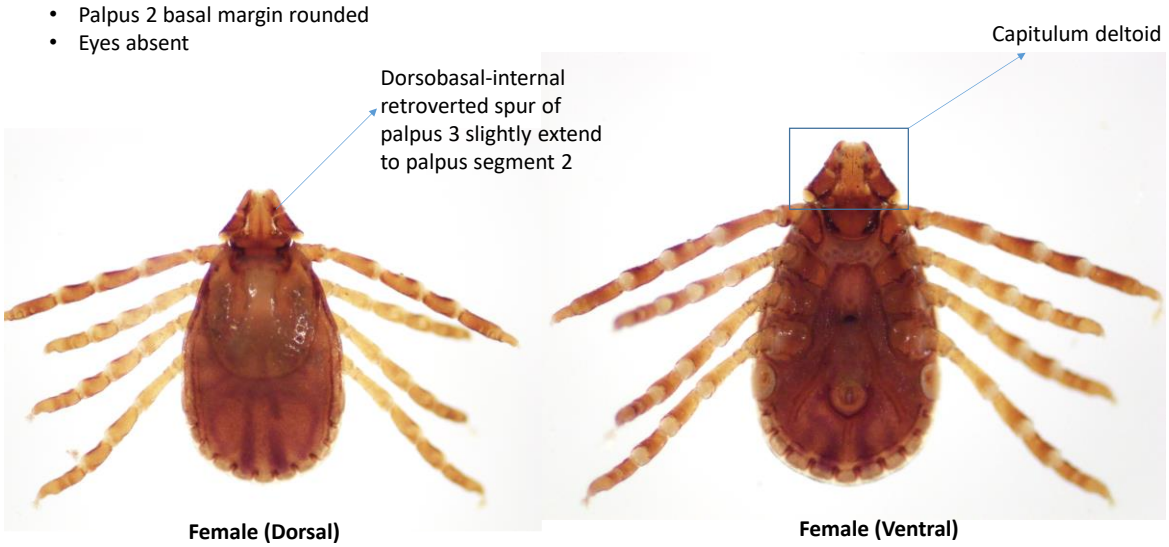
Nymph: Coxae III and IV with distinct sharp spurs; ventral trochantal spurs absent or obscure; four feathery, closely-set infrainternal setaeIn ventral aspect, external profile of palps without distinct recurvature; dorsobasal margin of palpal segment 3 reaching internal margin of palpal segment 2 only.

Male: Salience broad, rounded, breadth of palpal segment 2 greater than the length of ventral basis; Breadth of palpal segment 2 subequal to its length; palpal segment 3 with dorsointernal retroverted spur extending about 1/2 distance to the basal margin of palpal segment 2.

Female: Profile of capitulum broadly deltoid; palpal segment 2 with the juncture of ventrobasal and external margin a rounded angle; palpal segment 3 with a sharp, dorsobasal-internal retroverted spur extending about 1/2 length of palpal segment 2.

Distribution: Andaman and Nicobar Islands, Karnataka, Orissa, Assam, West Bengal.

Fig. 8: *Haemaphysalis wellingtoni* (Female) Dorsal and ventral view



***5) Haemaphysalis shimoga* (Fig. 9)**

Life history: Three host Ticks

Host

Nymph: Cattle, Goat, Sheep

Adult: Sambar deer, cattle, goat, sheep, cow, bison.

Diagnostic character:

Nymph: Salience Present; Coxa I with reduced, broad, rounded spur; coxae II to IV with broad ridge-like projections only Ventral spur of palpal segment 3 only slightly longer than its basal breadth, tapering, pointed; spur of coxa I more prominent, longer than ventral spur of palpal segment 3.

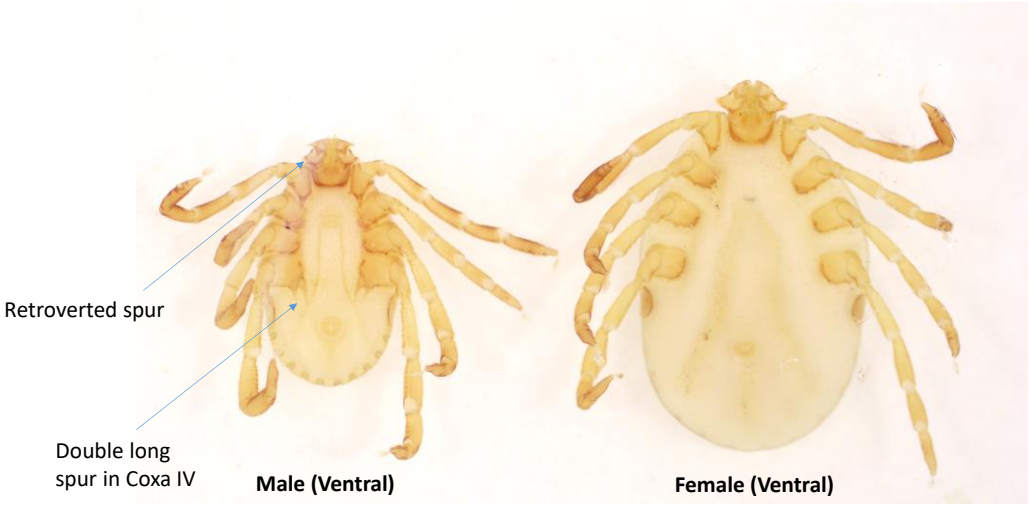
Male: Salience broad and with a ventrobasal-external margin of palpal segment 2 developed into a prominent spur or projection; Coxa IV with double long spur.

Female: Salience present; Palpal segment 3 with ventral retroverted spur prominent, length about twice its basal breadth; Dorsobasal margin of palpal segment 3 with median retroverted spur; Palpal segment 2 with the juncture of ventrobasal and external margin a blunt angle.

Distribution: Karnataka, Kerala, Meghalaya, Himachal Pradesh, Assam, West Bengal, Arunachal Pradesh, Sikkim.

Disease Transmission: Not known

Fig. 9: *Haemaphysalis shimoga* (Male) ventral and (Female) ventral view



Haemaphysalis shimoga

***6) Haemaphysalis papuana kinneari* (Fig. 10)**

Life cycle: Three host ticks

Host

Nymph: Wild boar, langur monkey

Adult: Indian wild boar

Diagnostic character:

Nymph: Salience present; Coxa I with reduced, broad, rounded spur; coxae II to IV with broad ridge-like projections only; Ventral spur of palpal segment 3 almost twice as long as its basal breadth, peg-like, blunt; spur of coxa I less prominent, length equal to or less than ventral spur of palpal segment 3.

Male

Salience broad, the ventrobasal-external margin of palpal segment 2 rounded; Palpal segment 2 with salience reduced, extending little beyond lateral; margin of basis Palpal segment 3 with ventral retroverted spur slightly longer than its basal breadth; ventrobasal margin of palpal segment 2 meeting internal margin at an acute angle; coxa I with spur subtriangular, length about equals breadth at base; dorsobasal margin of palpal segment 3 with a small median spur

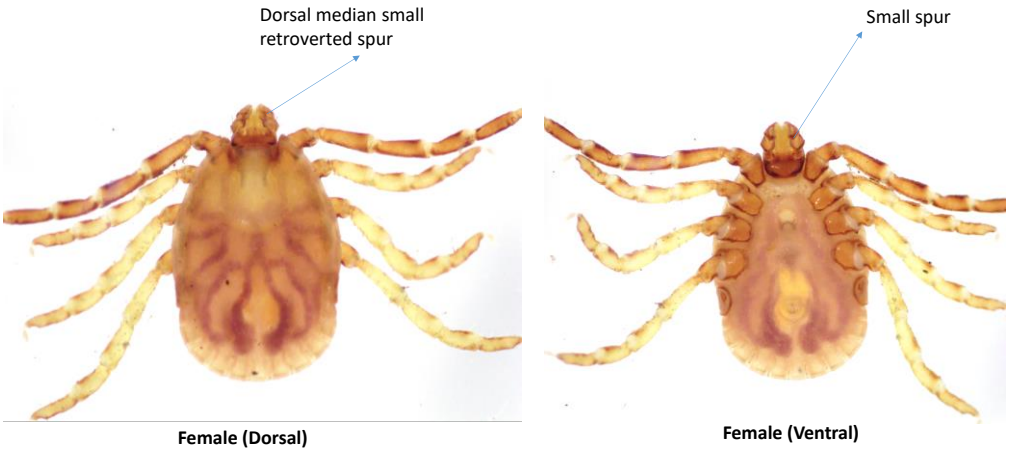
Female

Palpal segment 3 with ventral retroverted spur prominent, sharp, extending approximately 1/3 distance to the basal margin of palpal segment 2; dorsobasal margin of palpal segment 3 with small median spur; coxae II to IV with small blunt spurs

Distribution: Karnataka

Disease Transmission: Kyasanure Forest Disease

Fig. 10: *Haemaphysalis papuna kinneari* (Female) Dorsal and ventral view



Haemaphysalis papaua kinneari

7) Haemaphysalis kyasanurensis **(Fig. 11)**

Life cycle: Three host

Host:

Nymph: Mouse deer, wild dog, crested porcupine, cattle and buffalo.

Adults: Wild boar, wild dog, crested porcupine, small mammals.

Distribution: Karnataka

Diagnosis character

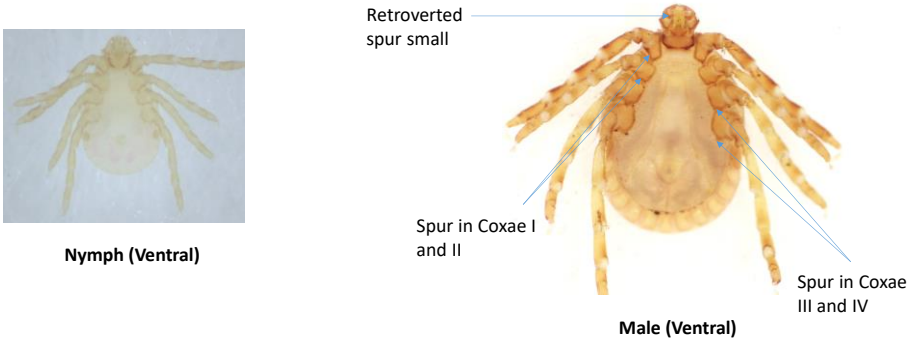
Nymph: Salience present; Juncture of ventrobasal margin of palpal segment 2 and externobasal margin an angle, blunt; Coxa I with well-developed conical spur; coxae II to IV with distinct, sharp spurs of coxa I elongate, narrow, length almost twice basal breadth; spurs of coxae II to IV reduced but retaining a relatively narrow form of coxal spur I; palpal segment 2 with a single infrainternal seta.

Male: Ventrobasal-external margin of palpal segment 2 rounded; Salience less well developed, breadth of palpal segment 2 less than the length of ventral basis; Palpal segment 3 with ventral retroverted spur rudimentary; ventrobasal margin of palpal segment 2 truncate; coxa I with spur elongate, peg-like, length about twice breadth at base; dorsobasal margin of palpal segment 3 without spur.

Female: Profile of capitulum not broadly deltoid; palpal segment 2 with a basal margin not angled; palpal segment 3 with dorsobasal-internal margin either without spur or if spur present not extending 1/2 length of segment 2; Palpal segment 3 with ventral spur short, only slightly overlapping apical margin of palpal segment 2; dorsobasal margin of palpal segment 3 without spur; coxae II to IV with distinct sharp spurs.

Disease transmission: Kyasanure Forest Disease (KFD)

Fig. 11: ***Haemaphysalis kyasanurensis*** **(Nymph) ventral and (Female) ventral view**



***8) Haemaphysalis aculeata* (Fig. 12)**

Life cycle: Three host

Host:

Immature stages: Mouse deer, crested porcupine, langur monkey, buffalo, rat, bonnet monkey, and birds like babbler, bulbul, Myna, Indian robin, and crow pheasant.

Adults: Mouse deer, man, monkey, bird species, cow, leopard, mongoose.

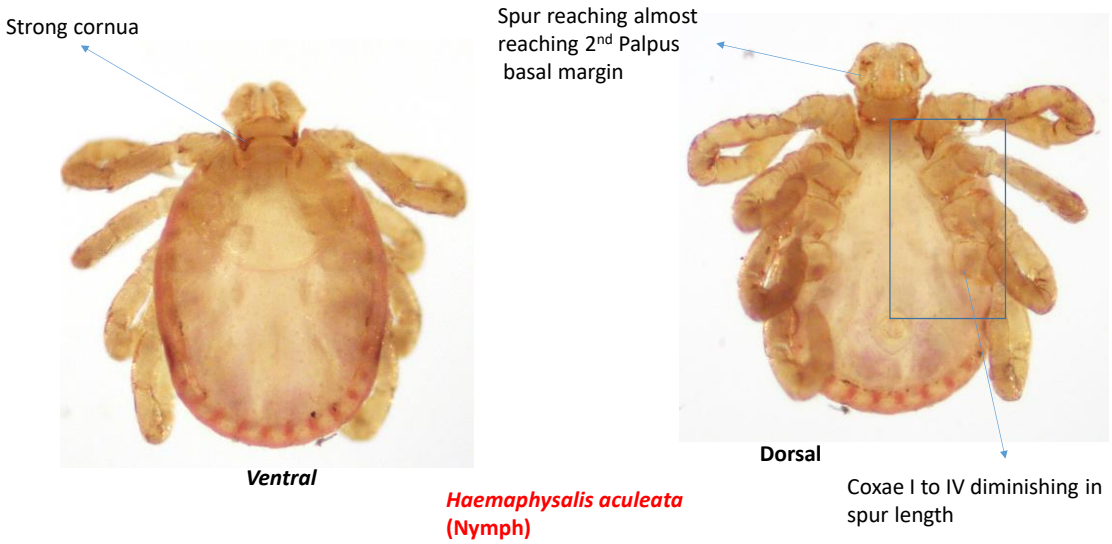
Diagnosis character:

Nymph: Salience less well developed; Ventral retroverted spur of palpal segment 8 extending more than ¾ distance to basal margin of palpal segment 2; strong dorsal cornua, 1/2 or more length of basis.

Male: Cornua very well developed, as long as dorsal basis; Spurs of coxa I and trochanter I spatulate; ventrally, palpal segment 2 one and a half times as long as segment 3

Female: Salience not broad; Ventrally, palpal segment 2 about twice length of segment 3; spurs of coxa I and trochanter I elongate, spatulate.

Fig. 12: *Haemaphysalis aculeata* (Nymph) dorsal and ventral view



9) Haemaphysalis cuspidata **(Fig. 13)**

Life cycle: Three host

Host

Nymph: Mouse deer, crested porcupine, palm civet, gray jungle fowl, magpie robin, house shrew, Malabar gray hornbill, bonnet monkey, langur monkey, crow pheasant, cattle and buffalo.

Adults: Rat, shrew, jackal, mouse deer, wild mammals, leopard, black-naped hare, bird species, palm civet, toddy cat, gray mongoose and crow pheasant.

Distribution: Karnataka, Maharashtra

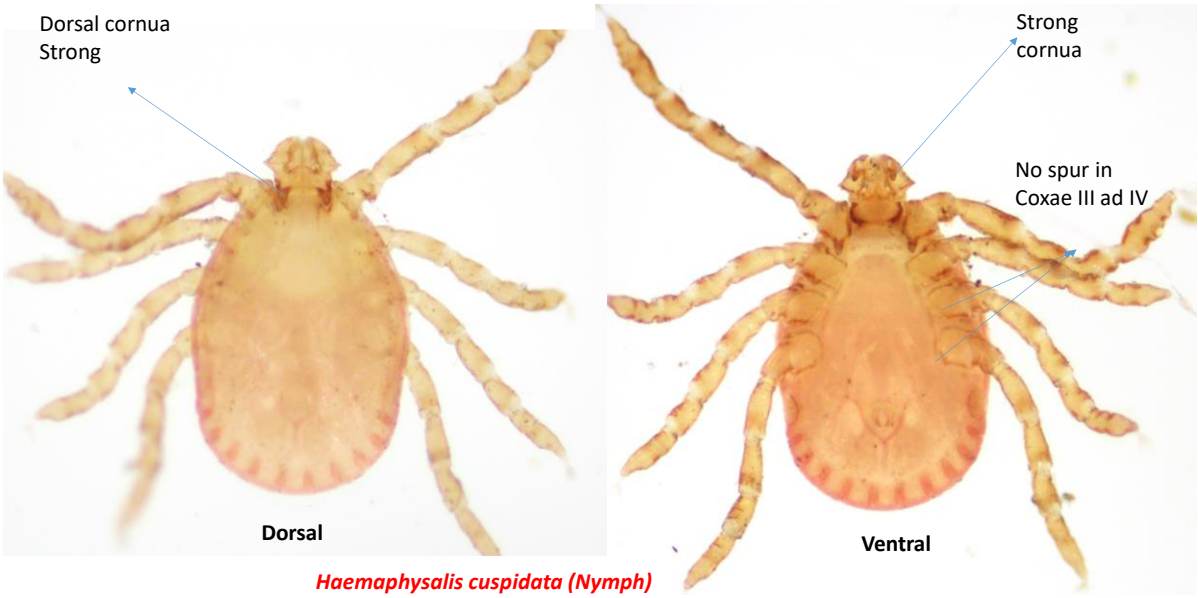
Diagnostic character

Nymph: Salience less well developed; Ventral retroverted spur of palpal segment 8 extending more than ¾ distance to the basal margin of palpal segment 2; strong dorsal cornua, 1/2 or more length of basis Coxal spur I strong, coxae II to IV with ridge-like projections; cornua greatly elongate, approximately twice as long as their basal breadth.

Male: Salience not broad, Cornua very well developed, as long as dorsal basis; Spurs of coxa I and trochanter I pointed; ventrally, palpal segment 2 subequal to length of segment.

Female: Salience not broad; Ventrally, palpal segment 2 less than twice the length of segment 3; spurs of coxa I and trochanter I not spatulate; Palpal segment 3 with dorsal and ventral retroverted spurs elongate, the ventral spur reaching to or beyond the basal margin of palpal segment 2

Fig. 13: *Haemaphysalis cuspidata* (Nymph) dorsal and ventral view



Haemaphysalis cuspidata (Nymph)

***10) Haemaphysalis turturis* (Fig. 14)**

Life cycle: Three host

Host:

Nymph: Asiatic jackal, toddy cat, wild boar, mouse deer, crested porcupine, black-naped hare, jungle cat, langur monkey, cattle, buffalo, rat, squirrel, shrew, leopard, wild dog, bonnet monkey.

Adults: Asiatic jackal, wild boar, mouse deer, sambar deer, crested porcupine, monkey, cattle, small mammals, bird species (spotted dove), wild goat, leopard, chital deer, barking deer, buffalo, jungle cat, leopard, wild hare, spotted deer, wild dog, bonnet monkey and langur monkey.

Distribution: Karnataka, Kerala, Tamil Nadu and Uttar Pradesh.

Diagnosis character:

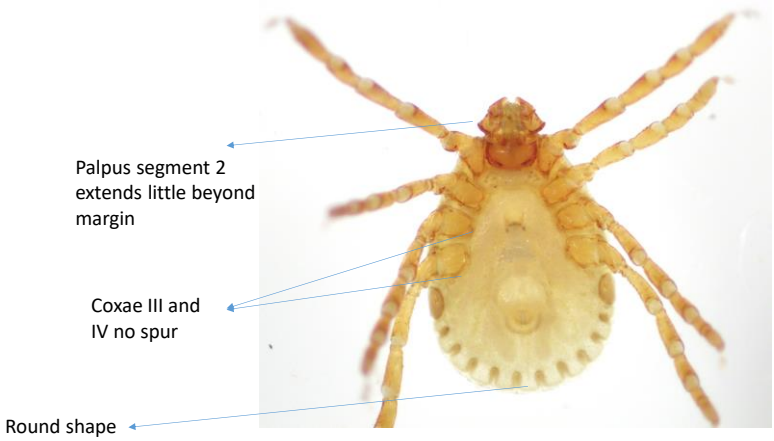
Nymph: No salience; Palps broader, external profile with pronounced, recurvature; palpal segment 3 with ventral spur strong, extending 1/2 distance to the basal margin of palpal segment 2; Cox III and IV have no spurs

Male: No salience, Palpal segment 8 with a dorsal, broad, median, ridge-like projection slightly overlapping apical margin of palpal segment 2.

Female: No salience; Profile of capitulum not broadly deltoid; palpal segment 2 with basal margin not angled; palpal segment 3 with dorsobasal-internal margin either without spur, or if spur present not extending 1/2 the length of segment 2; Palpal segment 3 with a dorsal broad projection slightly anterior to basal margin.

Disease Transmission: Kyasanure Forest Disease (KFD)

Fig. 14: *Haemaphysalis turturis* (Female) ventral view



Haemaphysalis turturis
(Female) Ventral

11) Haemaphysalis indica (leachii)

Host: Three host

Nymph: Fox, Indian gray mongoose, Indian small mongoose, Asiatic jackal, leopard, honey badger, house shrew, Indian hares, jungle cat, and large Indian civet.

Adults: Mice, mongoose, shrew, small mammals, forest wagtail bird, fox, jackal, domestic dog, honey badger, and chital deer.

Distribution: Bihar, Gujarat, Himachal Pradesh, Jammu and Kashmir, Karnataka, Maharashtra, Orissa, Rajasthan, Uttarakhand and West Bengal

Diagnosis character:

Nymph: Salience present; Ventral basis with small but distinct sharp cornua; ventral spur of palpal segment 3 minute, reaching about 1/8 distance to the basal margin of palpal segment 2

Male: Salience broad and with a ventrobasal-external margin of palpal segment 2 developed into a prominent spur or projection; Dorsal external margin of palpal segment 2 developed into a prominent spur

Female: Palpal segment 3 with ventral retroverted spur prominent, length about twice its basal breadth; Dorsobasal margin of palpal segment 3 without spur.

Disease Transmission: Kyasanure Forest Disease (KFD)

12) Haemaphysalis doenitzi

Host: Three host

Nymph: Common myna, crow pheasant.

Adults: crow pheasant birds, jungle fowl, bulbul bird, common and myna

Distribution: Karnataka, Punjab, Gujarat, Maharashtra

Diagnosis character:

Nymph: Ventrobasal external margin of palpal segment 2 without retroverted spur; Basal margin of palpal segment 2 rounded both. dorsally and ventrally; Palpal segment 3 with ventral distinct sharp spur; coxae III and IV with small sharp spurs

Male: Salience broad, rounded, breadth of. palpal segment 2 greater than the length of ventral basis; Basal margin of palpal segment 2 with blunt rounded corners; six or seven feathery, closely-set infrainternal setae

Female: Salience present; Palpal segment 3 with ventral retroverted spur reduced, length subequal to or less than its basal breadth; Dorsobasal margin of palpal segment 3 without spur; Basal margin of palpal segment 2 with blunt rounded corners; eight to ten broad, closely-set, infrainternal setae

Disease transmission: Not known

13) Haemaphysalis anomola

Host: Three host

Nymph: Rat, coucal and crow pheasant

Adult: Adults: Cow, calf, buffalo, coucal, barking deer, leopard, rats, wolf, man, cattle, goat, rodents, sambar deer and the wild ox

Distribution: Assam, Jharkhand, Himachal Pradesh, Uttar Pradesh, Uttarakhand, Jammu and Kashmir, and Meghalaya

Diagnosis character

Nymph: Basis capitulum is dorsally approximately 2 times as broad as long; cornua are triangular, approximately one-third as long as the base of basis capitulum. Palpi are broadly salient. Hypostome is slightly longer than palpi; dental formula is 2/2, with seven or eight denticles in a file

Male: All coxae have long spurs; Ventrolateral spur on palpal segment II is low or obsolete; infrainternal setae number five; ventrobasal spur on palpal segment III reaches to half of palpal segment II, presence of two long spurs on coxa IV; Deep and long lateral grooves are extending up to coxa II; punctations are irregularly scattered; both the spurs on coxa IV are posteroexternally directed, closely spaced, and approximately equal in size; trochanters ventrally have no spurs

Female: Ventrolateral spur on palpal segment II is low or obsolete; infrainternal setae number five or more; coxa I spur is moderate to long in length and decreases in size from coxa II onward; No ventrolateral spur on palpal segment II; infrainternal setae are eight in number and are long; porose areas are oval and big; punctations are irregularly scattered; coxa I spur is long but blunt, while others are broadly triangular or ridge-like; trochanters ventrally have no or obsolete spurs

***14) Amblyomma integrum* (Fig. 15)**

Host: Three host

Nymph: cattle, Buffalo and Leopard

Adult: Indian civet, cattle and Buffalo, Pig,

Diagnosis character

Nymph: Coxa I has two well-separated unequal spurs and the other coxae have each a single spur in the middle of their length; The antero-Iateral sides are convex and are almost equal in length to the postero-Iateral sides, which are straight and meet each other posteriorly in a broadly truncated angle.

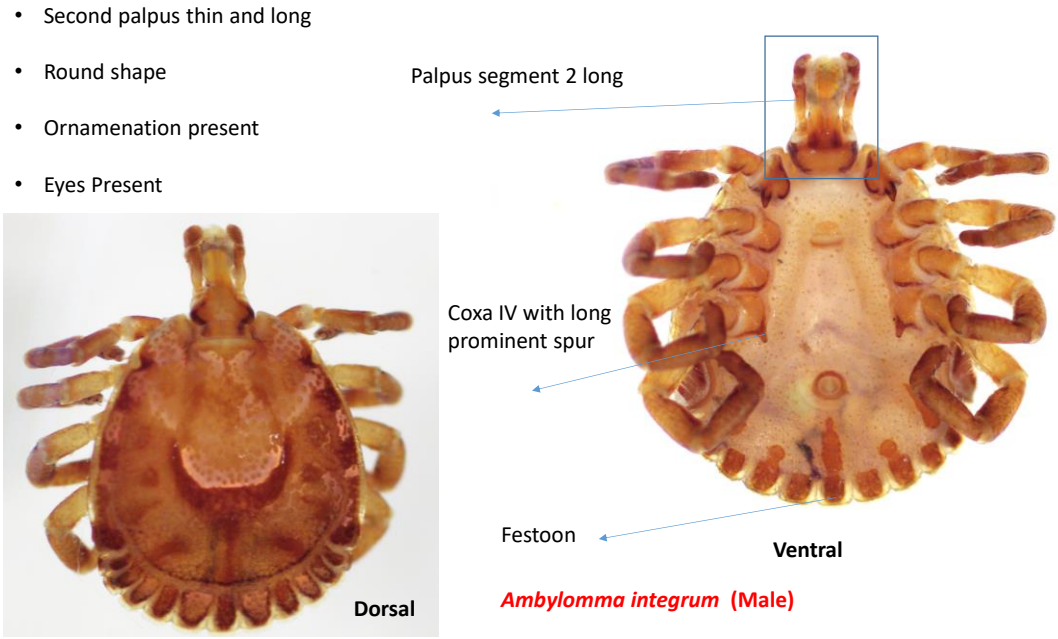
Male: Coxa I with two strongly unequal spurs; scutum pale with considerable dark brown ornamentation; falciform stripe present; punctation coarse and sub-equal; hypostome 3/3

Female: Coxa I with two short spurs and coxae II-III each with a single spur; Scutum ornate; Hypostome 3/3; coxa I with two unequal spurs.

Distribution: Jammu and Kashmir, Karnataka, Maharashtra, Orissa, Andhra Pradesh, Goa, Orissa and Tamil Nadu.

Disease Transmission: Kyasanure Forest Disease (KFD)

Fig. 15: *Amblyomma integrum* (Male) Dorsal and ventral view



***15) Rhipicephalus sanguineus* (Fig. 16)**

Life cycle: Three host

Nymph: Rodents

Adult: Dog, cattle, Goat, Horse, Donkey, wild boar, Bear, Fox,

Diagnosis character

Nymph: Basis capitulai hexagonal with cox I have bifurcated spur

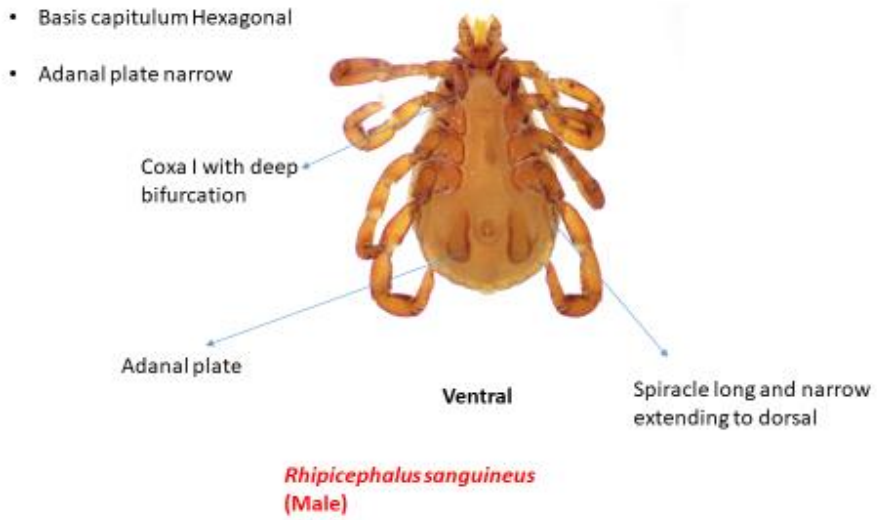
Male: Basis capitulai hexagonal; Adanal shield triangular with internal margin almost straight; punctuations comparatively numerous, unequal and irregularly arranged; basis capiltuli three times as broad as long

Female: Basis capitulai hexagonal; Punctuations numerous, close-set, irregularly arranged, unequal, larger ones not found in the posterior portion of the median field

Distribution: Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Maharashtra, Punjab, Uttar Pradesh

Disease transmission: Indian Tick typhus

Fig. 16: *Rhipicephalus sanguineus* (Male) ventral view



***16) Rhipicephalus haemaphysaloides* (Fig. 17)**

Life cycle: Three host

Host:

Nymph: Rodents,

Adults: Cattle, Buffalo, Sheep, Goat, Horse, Donkey, Camel, Deer, Wild boar, Dog, Tiger, Leopard, Bear, Wolf, Fox, Jackal, Hare

Diagnosis:

Nymph: Basis capitulai hexagonal with cox I have bifurcated spur

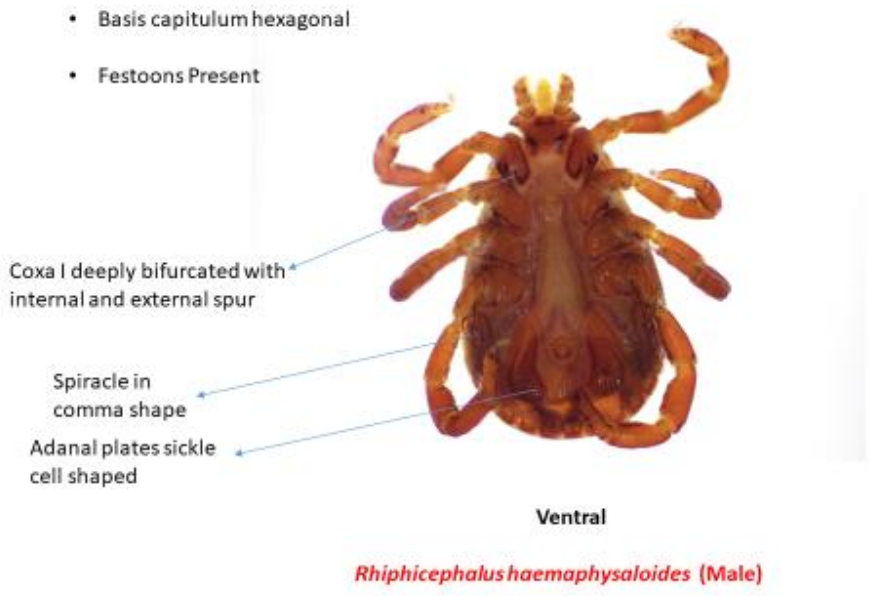
Male: Adanal shields sickle shape with external and posterior margins forming a regular curve; punctuations comparatively less numerous, strongly unequal; larger ones few in number and regularly arranged: finer ones numerous, very minute and hardly visible; basis capituli twice as broad as long

Female: Punctuations few, sparsely scattered, strongly unequal, larger ones arranged almost in longitudinal rows and found in the posterior portion of the median field, finer ones hardly visible

Distribution: Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh

Disease transmission: Indian Tick Typhus

Fig. 17: *Rhipicephalus haemaphysaloides* (Male) ventral view



17) Rhiphicephalus bursa

Life cycle: Three host ticks

Host:

Immature: Rodent, Goat

Adult: Cattle, Sheep, Goat, Dog, Horse

Nymph: Basis capiruli with. Broadly rounded lateral angles, posterior margin slightly convex, cornua absent. Palps as long as a hypostome, cylindrical. Scutum much broader than long; Ventrally coxae l each with a long narrow external spur and a shorter, broader internal spur; coxae II to IV each with an external spur only.

Male: Adanal plates triangular or sub-triangular (internal borders straight or slightly concave); Coxa IV with very short spurs, much shorter than the coxa; Marginal grooves long and deep, commencing near the eyes; Scutum with unequal punctations distributed throughout the whole surface mostly fine and non-contiguous

Female: Eyes flat; Scutum brown; Coxa IV with very short spurs, usually much shorter than the coxa Scutum short oval, or as broad as long; Scutum with large punctations close together; Scutum with regularly distributed punctations; Basis capituli together with palps as broad as long; Posterior border of scutum bending up opposite the lateral grooves

Distribution: Tamil Nadu

Disease transmission: Not known

18) Rhiphicephalus simus

Life cycle: Three host ticks

Host:

Nymph: Rodent

Adult: Cattle, Sheep, Goat, Dog, Horse

Nymph: Ventrally coxae I each with a long narrow external spur and a shorter broader internal spur; coxae II and III each with a small sharp external spur; coxae IV each with a slight salience only on its posterior border

Male: Adanal plates sub-triangular (internal borders slightly concave); Coxa IV with very short spurs, much shorter than the coxa; Marginal grooves long and deep, commencing near the eyes; Scutum with large equal punctuations, usually in longitudinal rows, intermixed with fine indistinct punctations .

Female: Scutum short oval, or as broad as long; Scutum with numerous punctuations; Scutum with no large punctuations near the posterior border; Articles of legs marked with fine punctuations; Scutum with deep lateral grooves; Scutum with the convex or slightly angular posterior border

Distribution: Tamil Nadu

Disease transmission: Not known

*19) **Rhipicephalus** (Boophilus) annulatus* **(Fig. 18)**

Life cycle: One host tick

Nymph: Cattle, Buffalo

Adult: Cattle, Buffalo, horse, sheep, goats, wildlife, dogs and cats

Diagnostic character:

Nymph: Not available

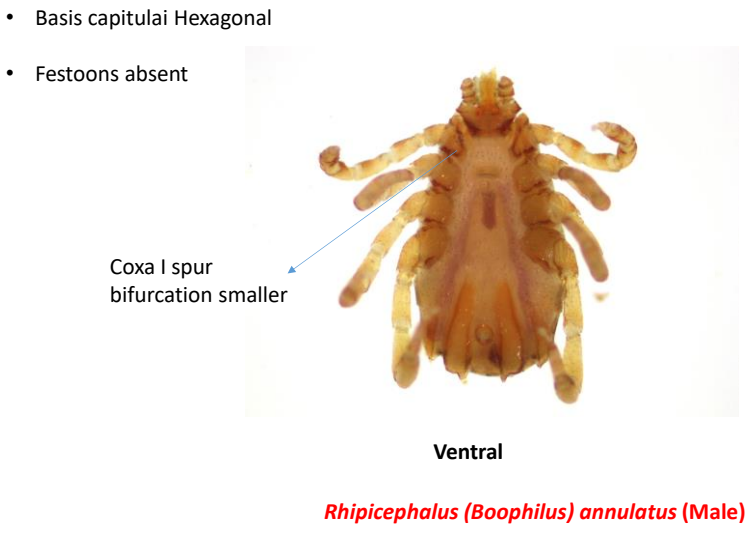
Male: Caudal appendix absent; coxae II-III without external spine; scaly (at the most one postero-external ridge); Coxa I with short external and internal spines; adanal plate to more or less acute postero-internal; 4/4 dentition in hypostome.

Female: Coxa I with very short outer and inner spines, scales wide, not separated by a narrow notch; coxae II-III without an external spur, the postero-external angle marked at most by a bordering ridge; 4/4 dentition hypostoma;

Distribution: Tamil Nadu, Uttar Pradesh, Karnataka, Kerala, Assam, Uttar Pradesh

Disease Transmission: Babesiosis

Fig. 18: *Rhipicephalus* (*Boophilus) annulatus* (Male) ventral view



*20) **Rhipicephalus (Boophilus) microplus*** **(Fig. 19)**

Life cycle: One host tick

Nymph: Cattle, Buffalo

Adult: Primary hosts are cattle, but horses, sheep, goats, swine, dogs, and free-ranging wild ungulates including native and exotic deer also serve as hosts.

Diagnostic characters:

Nymph: Not available

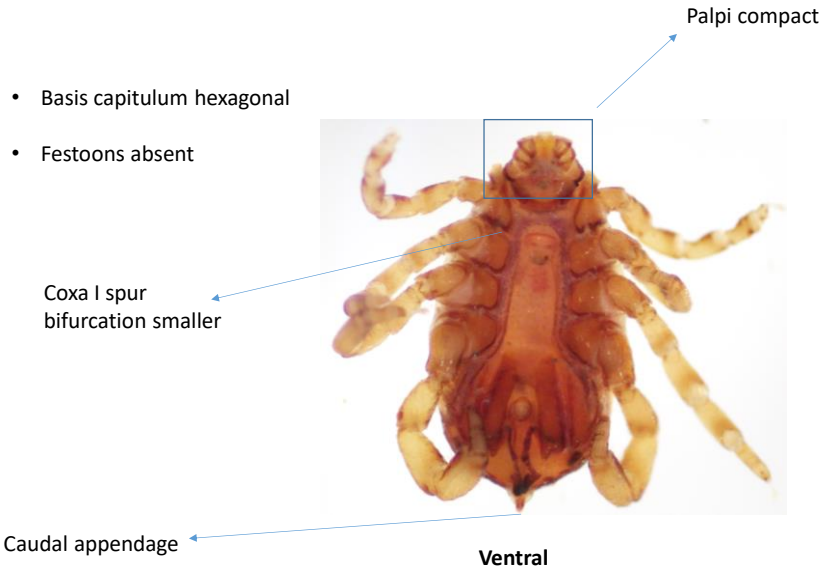
Male: Caudal appendage present; Adanal plates with more or less postero-internal angle acute; accessory plates with a sharp point; coxa II with thorn wide internal; 4/4 dentition hypostoma;

Female: Coxa I with short outer and inner spines, separated by a narrow notch; coxae II-III with scaly outer spine, Coxa II with an internal spine in scale; hypostoma dentation 4/4

Distribution: Tamil Nadu, Uttar Pradesh, Karnataka, Kerala, Assam, Uttar Pradesh

Disease Transmission: Babesiosis (caused by the protozoal parasites *Babesia bigemina* and *Babesia bovis*)

Fig. 19: *Rhipicephalus (Boophilus) microplus* **(Male) ventral view**



Rhipicephalus (Boophilus) microplus **(Male)**

21) Hyalomma hussiani

Life cycle: Two host tick

Host: Rodents

Nymph: Not known

Adult: cattle, Buffalo, Goat, Camel, Sambar deer, Dog, Tiger, Bear

Diagnostic character:

Nymph: Body elongate oval, widest at the level of coxa IV. Basis capituli dorsally triangular; ventrally posterior margin circular with triangular lateral points pointing posteriorly. Coxa I is deeply divided into 2 sub-equal spurs; coxae II and III each with a prominent triangular spur; coxa IV with a small triangular spur.

Male: The basis capituli dorsally is broader than length. It has anterior lateral projections ventrally. Adanal shields are broad and contiguous, and sub-anal shields are absent.

Female: The female operculum is widely sub-rectangular or shield-shaped.

Distribution:

Andhra Pradesh, Delhi; Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Sikkim.

Disease transmission: Not known

22) Hyalomma brevipunctata

Life cycle: Two host tick

Nymph: Rodents, Buffalo, cattle.

Adult: Cattle, Goat, Sambar deer, Dog, Tiger,

Diagnostic character:

Nymph: Body elongate, widest at the level between coxae III and IV. Basis capituli dorsally sub-triangular. Coxa I deeply divided into 2 sub-equal spurs, coxae II to IV each with a small triangular spur, progressively decreasing in size.

Male: The basis capituli is broader than long and has anterior lateral projections, adanal shields are broad and contiguous, and sub-anal shields are absent. The deep, distinct lateral grooves, which reach the level of the eyes, are dotted with heavy usually contiguous punctuations.

Female: Operculum is elongate oval in outline; in profile, it is gradually slanted posteriorly. The light brown scutum is slightly longer than wide and smooth posteriorly.

Distribution: Andhra Pradesh, Bihar, Delhi, Gujarat, Himachal Pradesh, Karnataka, Maharashtra, Madhya Pradesh, Punjab, Uttar Pradesh, Tamil Nadu, West Bengal, Manipur.

Disease Transmission: Not known

23) Hyalomma anatololicum

Life cycle: Two host

Host:

Nymph: Rodents, cattle, Buffalo

Adult: cattle, Buffalo, Sheep and Goat.

Diagnostic character:

Nymph: Body elongated, widest at the level of coxa IV. Basis capituli dorsally triangular in outline; posterior margin slightly convex; ventrally posterior margin bow-shaped. Coxa I with 2 narrow spurs almost equal in length; coxae II and III each with a small triangular spur; coxa IV with much reduced spur.

Male: Body small, somewhat elongated, yellowish-brown, with a convex, lightly punctuated scutum with short but distinct lateral grooves; a pronounced postero-median groove not reaching the parma; and small subanal shields directly posterior to the adanal shields.

Female: Bulging, small, knob-like genital operculum which is usually circular in outline. Scutum is usually longer than wide with a narrowly rounded posterior margin, with a few large punctuations in the central field and scapular areas, and a variable number of very fine, superficial punctuations over much of the surface.

Distribution: Andhra Pradesh, Delhi, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Maharashtra, Madhya Pradesh, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh.

Disease transmission: Crimean-Congo hemorrhagic fever (CCHF)

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Glossary

Accessory adanal plates: A Pair of sclerotized parts present lateral to the adanal plates Adanal plates present in some genera of Males

Alloscutum: Dorsally, the region below the scutum in females and immatures

Anal groove: Ventrally a semicircular fold present above or below the anus

Anterior process: Projection or anterior of coxa I, protrudes beyond the scapula which is visible dorsally

Anus: Present ventrally and medially, below the IV the pair of legs

Auriculae: In ventral basis, Lateral projections on the anterolateral margins

Basis capituli: Mouthparts attached to the basal portion of the capitulum

Capitulum: It contain the basis capituli, palps, hypostome and chelicerae present anterior to body.

Carinac: Anterolateral scutal margins of Ixodes species having paired raised strips especially in females

Caudal process: A projection in the posterior medial region of the body, especially in Males

Cervical fields: Paired, variously shaped areas, usually slightly sunken, on the anterior surface of conscutum or scutum, delimited by the cervical and lateral grooves

Cervical grooves: A pair of grooves on the conscutum or scutum extending posteriorly from the inner angles of the cervical pits and delineating the inner margins of the cervical fields. May be absent

Cervical pits: Paired indentations immediately to the rear of the anterior emargination

Chelicerae: Paired cutting mouthparts lying dorsal to the hypostome

Conscutum: Sclerotized plate or shield posterior to the capitulum, covering almost the entire dorsal surface of male ixodid ticks

Cornua: Paired projections on the dorsal posterior margin of the basis capituli

Coxae: Four pairs of sclerotized structures on the ventral idiosomal surface representing the first segments of the legs

Coxal spurs: Projections extending from the posterior margins of the coxae

Denticles: Small, recurved 'teeth' on the ventral surface of the hypostome

Emargination: Anterior indentation in the conscutum or scutum, between the scapulae, at the base of which the basis capituli is attached

Eyes: Pair of lens-like structures on or close to the anterolateral margins of the conscutum or scutum of some species. May be flat, convex, beady, edged with punctations or orbited

Festoons: Variable numbers of rectangular areas on the posterior margin of the body of some tick species. Distinct in males, unengorged females, nymphs and larvae, but difficult to see in engorged specimens of the latter three

Genital aperture: External opening of the genital organs; located anteriorly on the ventromedial line, posterior to the basis capituli

Genital apron: The opening to the genital aperture of females is covered with a genital apron or flap. This may be narrowly or broadly U-shaped, or V-shaped, or a number of other configurations

Haller's organ: Sensory structure located on the sub-apical dorsal surface of tarsus I

Hypostome: Medioventral mouthpart, parallel to and between the palps, ventral to the chelicerae and immovably attached to the basis capituli. It bears the denticles or 'teeth' and acts as a holdfast organ

Idiosoma: The tick's body excluding the capitulum and the legs

Inornate: Absence of colour pattern on the conscutum or scutum and other structures

Integument: Outer covering or cuticle of the tick's body

Lateral grooves: A pair of grooves on the conscutum or scutum extending posteriorly from the outer angles of the cervical pits and delineating the outer margins of the cervical fields. May be absent

Legs: Segmented appendages of which the adults and nymphs have four pairs and the larvae three pairs. The segments from proximal to distal are designated coxa, trochanter, femur, genu, tibia, metatarsus, and tarsus

Marginal grooves: A pair of grooves commencing at or posterior to eye level, along the lateral margins of the male's conscutum. They may be short and confined to the lateral margins, or slightly longer enclosing one or more festoons, or complete and delimit all the festoons

Orbited: The eyes of some species are surrounded by a groove

Ornamentation or ornate: Enamel-like colour pattern superimposed on the base colour of the conscutum or scutum as well as on other structures

Parma: An enlarged or ornate central festoon

Palps: Paired articulated appendages located anterolaterally on the basis capituli, parallel to the hypostome. Segment I is proximal, segment IV distal

Pedicel: A narrow stalk-like first palpal segment

Porose areas: A pair of pitted areas on the dorsal surface of the basis capituli of female ixodid ticks

Posterolateral grooves: Paired depressions lateral to the posteromedial groove in the conscutum of male ticks of some species. Also known as paramedial grooves

Posteromedial groove: A central depression in the conscutum of male ticks of some species terminating at or anterior to the central festoon

Pseudoscutum: Anterior portion of the conscutum of male ticks that is similar in appearance to the scutum of females, either because of its punctation pattern or smoothness. Usually absent

Scutum: Sclerotized plate or shield posterior to the capitulum, covering approximately anterior third of the dorsal surface of females, nymphs and larvae of ixodid ticks

Sub-anal plates: Pair of sclerotized structures posterior to the adanal plates of the males of Hyalomma species

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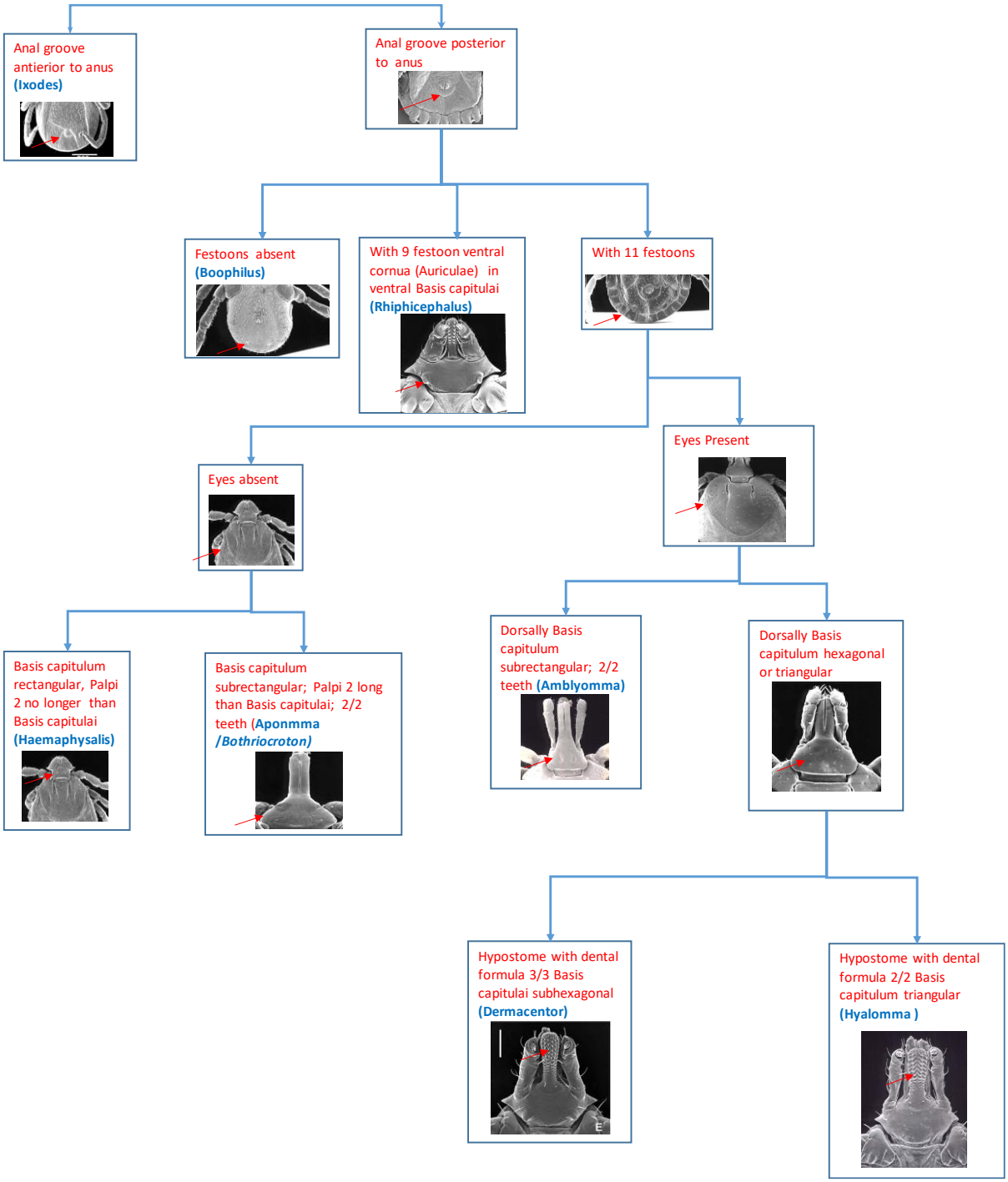
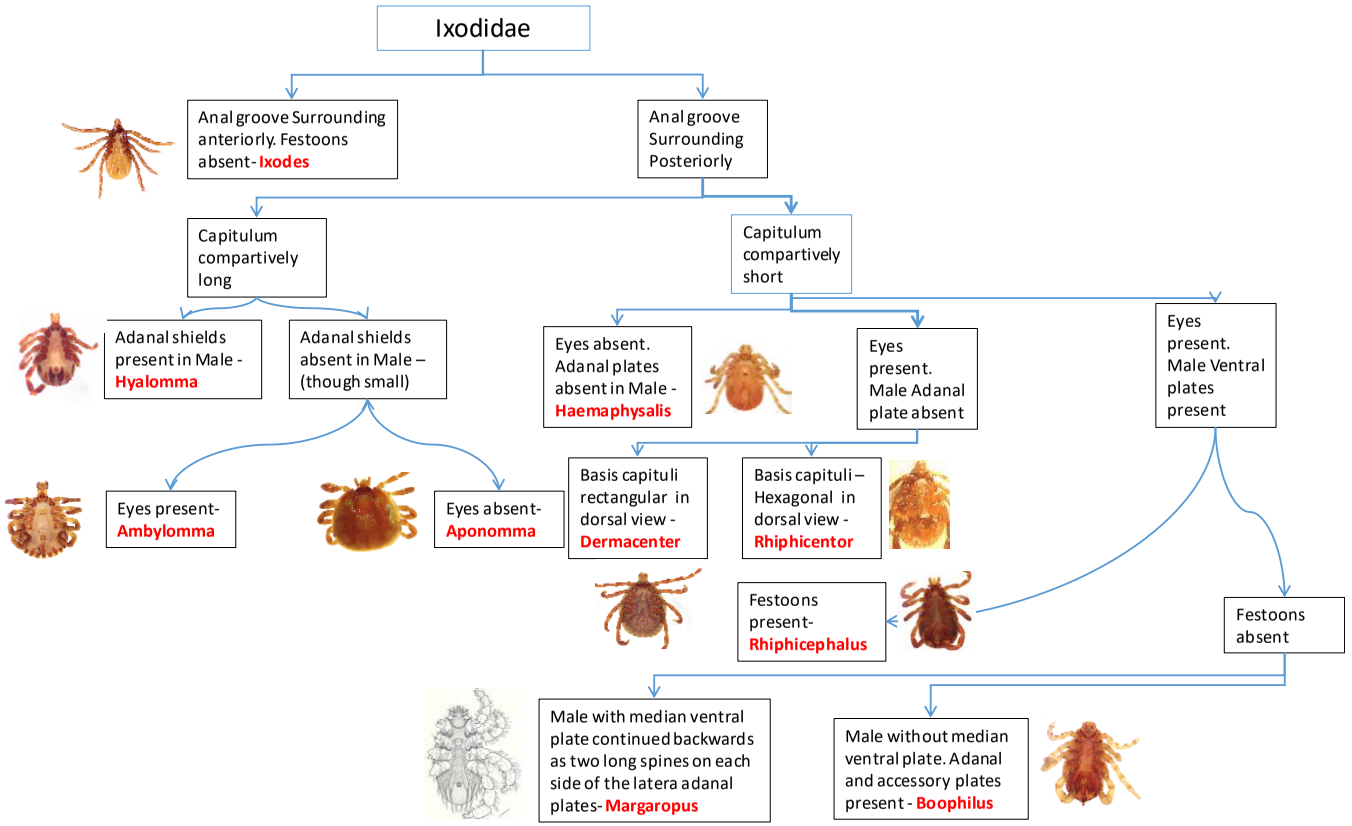
Pictorial Key for identification of Hard Ticks (Ixodidae) Nymph



Pictorial key for identification of Hard Ticks (Ixodidae) Adults



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Mr. A. Elango. M.Sc. M.Phil, Principal Technical Officer, ICMR-Vector Control Research Centre, Pondicherry, has been working in this institute since 1991. He has been pursuing, ectoparasite taxonomy especially of Ticks, Mites, Lice and Fleas of domestic animals and Rodents. He has field experience on tick collection in various States like, Tamil Nadu, Kerala and Karnataka since 2013. He has identified more than 25 tick species including nymph and adult stages. He has also worked on Scrub Typhus and carried out work on Trombiculidae mite taxonomy in the VCRC. He has recorded more than 35 Trombiculid species. He also imparted training on identification of Ticks and Mites to the District Entomologists of Kerala, West Bengal and Karnataka State. At present, he is actively involved in molecular identification of ticks using DNA barcoding technique and identification of bacteria and viruses in the ticks using PCR and RT-PCR methods.

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