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THE SCUTATE TICKS, OR IXODIDAE, OF INDONESIA¹

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¹ The material in this paper was included in a thesis, submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, at Harvard University.

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Order Edentata, or Pholidota

Family Manidae

Manis javanica Desmarest, Pangolin, or Scaly Anteater.—*Amblyomma javanense*.

Order Rodentia

Family Sciuridae

Petaurista petaurista petaurista (Pallas), Large Red Flying Squirrel, or Giant Flying Squirrel.—*Haemaphysalis koningsbergeri*.

Ratufa bicolor bicolor (Sparrmann), Black Giant Squirrel.—*Haemaphysalis koningsbergeri*.

Callosciurus notatus notatus (Boddaert), Common Malay Squirrel, or Plantain Squirrel.—*Ixodes granulatus*.

Callosciurus notatus madurae (Thomas), Common Malay Squirrel, or Plantain Squirrel.—*Ixodes granulatus*.

Callosciurus nigrovittatus nigrovittatus (Horsfield), Black-striped Squirrel.—*Ixodes granulatus*, *I. spinicoxalis*.

Lariscus insignis javanus (Thomas and Wroughton), Striped Ground Squirrel.—*Ixodes granulatus*.

Family Muridae

Rattus rattus rattus (Linnaeus), Black Rat.—*Ixodes granulatus*, *Haemaphysalis koningsbergeri*.

Rattus rattus diardi (Jentink), Malaysian House Rat.—*Ixodes granulatus*.

Rattus rattus brevicaudatus Horst and de Raadt, Ricefield Rat, or Sawah Rat.—*Ixodes granulatus*.

Rattus rattus jalorensis (Bonhote), Malaysian Field Rat.—*Ixodes granulatus*.

Rattus concolor ephippium (Jentink), Little Burmese Rat.—*Ixodes granulatus*.

Rattus maxi Sody, Giant Rat.—*Ixodes granulatus*.

Rattus lepturus (Jentink), Long-tailed Rat.—*Ixodes granulatus*, *I. spinicoxalis*.

Rattus fulvescens bukit (Bonhote), Bonhote Rat.—*Ixodes spinicoxalis*.

Rattus fulvescens treubi Robinson and Kloss, Bonhote Rat.—*Ixodes granulatus*.

Rattus fulvescens temmincki Kloss, Bonhote Rat.—*Ixodes granulatus*.

Rattus bartelsi (Jentink), Bartels Rat.—*Ixodes granulatus*.

Pithecheir melanurus melanurus Cuvier, Red Tree Rat.—*Ixodes spinicoxalis*.

Order Perissodactyla

Family Rhinocerotidae

Rhinoceros sondaicus Desmarest, Javan, or One-horned Rhinoceros.—*Amblyomma testudinarium*.

Family Tapiridae

Tapirus indicus Desmarest, Malay Tapir.—*Amblyomma testudinarium*.

Family Equidae

Equus caballus Linnaeus, Domestic Horse.—*Amblyomma babirusae*, *Boophilus microplus*, *Haemaphysalis bispinosa*, *H. hystricis*, *H. papuana*, *Rhipicephalus haemaphysaloides pilans*.

Order Artiodactyla

Family Suidae

Sus cristatus cristatus Wagner, Wild Pig.—*Amblyomma testudinarium*, *Rhipicephalus haemaphysaloides pilans*.

Sus cristatus vittatus Boie, Wild Pig.—*Amblyomma testudinarium*, *Rhipicephalus haemaphysaloides pilans*.

Sus verrucosus Müller and Schlegel, Java Pig.—*Amblyomma testudinarium*.

Sus barbatus Müller, Bearded Pig.—*Amblyomma testudinarium*.

Sus celebensis Müller and Schlegel, Celebes Pig.—*Amblyomma babirusae*, *A. cyprum*, *Haemaphysalis hystricis*.

Sus scrofa Linnaeus, Domestic Pig.—*Amblyomma testudinarium*, *Boophilus microplus*, *Dermacentor auratus*, *Haemaphysalis bispinosa*, *H. hystricis*, *H. papuana*, *Rhipicephalus haemaphysaloides haemaphysaloides*.

Babirusa babirusa (Linnaeus), Babirusa.—*Amblyomma babirusae*.

Family Tragulidae

Tragulus kanchil kanchil (Raffles), Smaller Mouse Deer, or Pelandok.—*Haemaphysalis traguli*.

Family Cervidae

Cervus unicolor equinus Cuvier, Sambar, or Rusa.—*Boophilus microplus*.

Cervus unicolor russa Müller and Schlegel, Sambar, or Rusa.—*Boophilus microplus*.

finer ones seen only with higher magnification. Legs stout.

2

2. Punctations on scutum less coarse. Hairs small and inconspicuous. Abdomen with weak hairs, sparsely distributed.

R. haemaphysaloides haemaphysaloides

Punctations on scutum coarser. Hairs larger and more conspicuous. Hairs on abdomen numerous, long thick and appressed *R. haemaphysaloides pilans*

Rhipicephalus haemaphysaloides Supino.

This species is divided into two subspecies, *Rhipicephalus haemaphysaloides haemaphysaloides* Supino and *Rhipicephalus haemaphysaloides pilans* Schulze, which form two distinct, geographical units. Zumpt in 1943 noted the presence of transitional specimens between the two subspecies on the island of Sumatra; he decided that these transitional forms belonged to *R. haemaphysaloides pilans* and named the Straits of Malacca as the boundary dividing the two subspecies. I saw numerous specimens from eleven localities in Sumatra, and I also found transitional specimens. Those from Upper Sumatra are closely allied to the typical form found in Burma, and those from Lower Sumatra are more closely allied to *pilans*. All of Zumpt's specimens probably came from Lower Sumatra. Both subspecies definitely occur in Sumatra and each is restricted to a definite portion of the island. The boundary between the two subspecies is not the Straits of Malacca, but it is somewhere between Upper and Lower Sumatra. Since no specimens were collected in Central Sumatra, the complete range of each subspecies in this region can not be determined at this time. On no other island in this area are both forms known to occur.

Rhipicephalus haemaphysaloides haemaphysaloides Supino.

Rhipicephalus haemaphysaloides niger Supino, 1897, Atti Soc. Veneto-Trent. Sci. Nat., (2) 3, pt. 1, p. 234 (♀, Yado, Burma; type in Genoa M.). Neumann, 1911, Das Tierreich, Lief. 26, Acarina, Ixodidae, p. 46 (*incertae sedis*).

Rhipicephalus haemaphysaloides ruber Supino, 1897, Atti Soc. Veneto-Trent. Sci. Nat., (2) 3, pt. 1, pp. 234-235 (♂, ♀; Mt. Moolcyit, Tenasserim; Meteleó, Thagatá, Juva, Cagó del Cadù Gianng, N.E. of Bomo, Burma; cotypes in Genoa M.); 1897, *Op. cit.*, (2) 3, pt. 2, p. 250, Pl. 12, figs. 10-11 (♂, ♀).

Rhipicephalus paulopunctatus Neumann, 1897, Mém. Soc. Zool.

France, 10, pp. 397-398, 419, 420 (1 ♂, 1 ♀, Indrapoera, Sumatra; cotypes described from Hamburg M., now lost) [in part: *nec* male = *R. sanguineus*]; 1901, *Op. cit.*, 14, p. 273 (11 ♂, 15 ♀, Canton and Fumni, China). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 418. Neumann, 1902, Arch. de Parasit., 6, pt. 1, p. 121 (♀, Ceylon, off *Bos taurus*).

Rhipicephalus haemaphysaloides Neumann, 1897, Mém. Soc. Zool. France, 10, p. 417 (Yado, Burma); 1902, Arch. de Parasit., 6, pt. 1, pp. 125-126 (description from types, 3 ♂, 1 ♀); 1904, *Op. cit.*, 8, pt. 3, p. 454 (Java and Ceylon) [Java record doubtful]. Warburton, 1907, Bull. Imper. Dept. Agric. India. No. 6, pp. 10-11, fig. 15 [*nec* fig. 14] (♂, ♀, Moradabad, United Provinces; Chin Hills, Burma, off goat, dog, sheep, cattle); 1907, Journ. Econ. Biol., 2, pt. 3, p. 93 (variability in males). Neumann, 1908, Notes Leyden Mus., 30, p. 83 (in key to males). Blanchard, 1909, L'Insecte et l'Infection, Fasc. 1, Acariens, p. 103. Warburton, 1910, Parasitology, 3, pt. 4, p. 396 (Zool. Gardens, Calcutta, other localities, off *Felis marmorata*). Neumann, 1911, Das Tierreich, Lief. 26, Acarina, Ixodidae, p. 41 (distributed as two subspecies). Patton and Cragg, 1913, Textbook Medical Ent., pp. 598, 601, Pl. 73, fig. 9, Pl. 77, fig. 6 (Madras). Warburton, 1925, Spolia Zeylanica, 13, pt. 2, p. 255 (Colombo, Ceylon, off bear, dog and leopard). Sharif, 1928, Records Indian Mus., 30, pt. 3, pp. 280-283, fig. 26, Pl. 8, figs. 3-4 (extensive distribution and host lists from Burma and India); 1930, *Op. cit.*, 32, pt. 2, pp. 111-112, Pl. 3, fig. 8 (♀, teratological specimen). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., 4, pt. 1, pp. 140, 142, map 2 [in part: Upper Sumatra record only]; 1932, Veeartsenijk. Meded., No. 79, pp. 10, 32, fig. 7, map 2 [in part: Upper Sumatra record only]. Schulze, 1932, Zeitschr. Morph. Oekol. Tiere, 25, pts. 2-3, pp. 514, 523 (morphological); 1932, Sitz-Ber. Abhand. Naturf. Gesellsch. Rostock, (3) 3, p. 117 (morphological); 1935, Wissenschaftliche Ergebnisse Exped. Karakorum, Zool., Acarina, Ixodoidea, p. 180 (in key to males); 1936, Zeitschr. f. Parasitenk., 8, pt. 5, pp. 522-523. Sharif, 1938, Indian Journ. Vet. Sci. and Anim. Husband., 8, pt. 4, pp. 356, 363, 364 (disease transmission). Schulze,

1939, Zeitschr. f. Parasitenk., 10, pt. 6, p. 728 (Burma).
 Strickland, 1939, Indian Journ. Med. Res., 27, pt. 1, pp. 251-252 (Bhawali Ramgarh, off man). Zumpt, 1943, Zeitschr. f. Parasitenk., 13, pt. 1, pp. 4, 20. Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 38-40, 84, Pls. 16-19 (♂, ♀, Indochina, off Banteng, deer, dog, *Sus cristatus*, hare). Finnegan, 1945, British Mus., Econ. Series, No. 16, pp. 46, 47, figs. 18-19.

Rhipicephalus ruber Neumann, 1897, Mém. Soc. Zool. France, 10, p. 418.

Rhipicephalus (Eurhipicephalus) haemaphysaloides Neumann, 1904, Arch. de Parasit., 8, pt. 3, p. 449.

Rhipicephalus (Eurhipicephalus) haemaphysaloides var. *paulopunctata* Neumann, 1904, Arch. de Parasit., 8, pt. 3, p. 449.

Rhipicephalus haemaphysaloides var. *expedita* Neumann, 1904, Arch. de Parasit., 8, pt. 3, pp. 454-455 (♂, ♀, China, Sumatra).

Rhipicephalus haemaphysaloides haemaphysaloides Neumann, 1911, Das Tierreich, Lief. 26, Acarina, Ixodidae, p. 41, fig. 21 (♂, ♀, China, Burma, Ceylon, Java, Borneo, Sumatra, off *Bos taurus*) [Java, Borneo records doubtful]. Schulze, 1936, Zeitschr. f. Parasitenk., 8, pt. 5, p. 522 (Burma). Zumpt, 1940, Zeitschr. f. Parasitenk., 11, p. 674; 1943, *Op. cit.*, 13, pt. 1, pp. 4, 5, 6, 20-22, figs. 20-21 (♂, ♀, India, So. China, Formosa, off *Rhinoceros sondaicus*, *Bos taurus*, *Canis familiaris* and *Rusa unicolor*).

Rhipicephalus haemaphysaloides expeditus Neumann, 1911, Das Tierreich, Lief. 26, Acarina, Ixodidae, p. 41 (♂, ♀, China, Sumatra, off "*Buffelus indicus*" = *Bos bubalis bubalis*).

Rhipicephalus haemaphysaloides paulopunctatus Schulze, 1936, Zeitschr. f. Parasitenk., 8, pt. 5, pp. 522, 523 (1 ♂, Liangang, Sumatra; 2 ♀, Lubok Paku, Sumatra, off tiger).

Male (Fig. 13A-G). Thirty Sumatra specimens range from 3.9 to 2.9 mm. long by 2.64 to 1.8 mm. wide, exclusive of capitulum; average 3.38 mm. long by 2.16 mm. wide. Body elongate-oval, about one and a half times as long as wide, tapering toward anterior end, with marked indentation in region of eyes, widest opposite spiracular plates, reddish-brown to black; larger punctations few and evenly distributed, with a small, white hair issuing

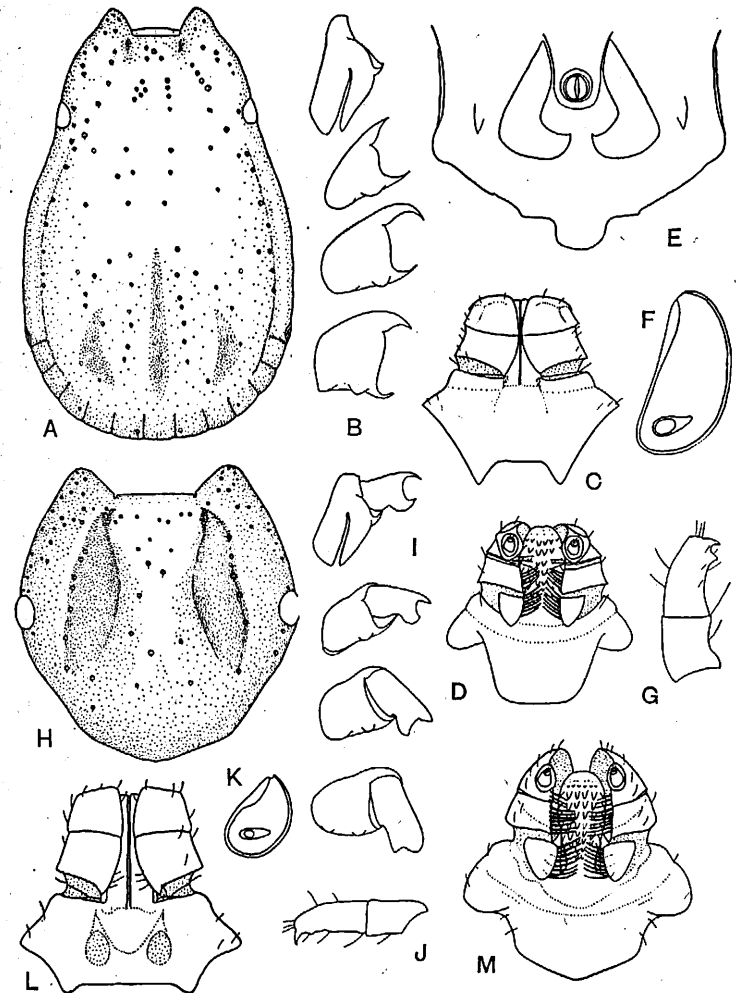


Fig. 13. *Rhipicephalus haemaphysaloides haemaphysaloides* Supino. A-G, male: A, scutum; B, coxae I-IV; C, capitulum in dorsal view; D, same in ventral view; E, ventral view of scutum, showing anal and adanal plates; F, spiracle; G, tarsus IV. H-M, female: H, scutum; I, coxae I-IV; J, tarsus IV; K, spiracle; L, capitulum in dorsal view; M, same in ventral view.

from each; finer punctations very numerous, but discernible only under higher magnification; cervical grooves short, deep and slightly convergent; lateral grooves as furrows in hind part, with large punctations linearly arranged in each; median groove long and narrow; paramedian grooves diagonal; eyes prominent, yellow, flat and elongate-oval; festoons protruding in engorged specimens; median festoon as a pronounced, caudal protrusion; body ventrally with numerous, large, white hairs; spiracular plates large and comma-shaped; genital opening opposite coxa II; anal opening opposite border of spiracular plate; anal plates sickle-shaped and heavily chitinised; adanal plates small, less chitinised and weakly developed. Legs stout and covered with long, white hairs; coxae large and conspicuous; coxa I with two large spurs, internal about twice as broad as external; coxae II and III with a short, external spur and a broad, ridge-like, scarcely visible, internal spur; coxa IV with internal and external spurs weakly developed; tarsus IV tapering gradually, ending in a terminal and subterminal spur. Basis capituli hexagonal, about twice as wide as long and salient laterally; cornua prominent and strongly projecting; palpal articles two and three together slightly longer than broad; distinct, lateral edge on palpal article three; article one with a distinct, ventral plate containing six to nine large, white hairs; article two with a similar fringe, but with less hairs; article three with a very short, ventral spur; hypostome small; 3:3 dentition, with approximately nine to ten teeth per file.

Female (Fig. 13II-M). Thirty unengorged, Sumatra specimens from 3.96 to 3.12 mm. long by 2.4 to 2.04 mm. wide, exclusive of capitulum; average 3.48 mm. long by 2.24 mm. wide; largest female 19.2 mm. long by 14.1 mm. wide. Body elongate-oval, about one and a half times as long as broad. Scutum slightly longer than wide, reddish-brown to black, posterior margin sinuous; cervical grooves deep and diagonal; well developed furrows, leading from cervical grooves, bow-shaped and divergent posteriorly; large punctations conspicuous, more or less linearly arranged, with a short, white hair projecting from each; eyes as in male. Abdomen dorsally with small, thin, white hairs; spiracular plate nearly as wide as long, with a short, curved extension; body ventrally with numerous, short, white hairs and occasional longer ones; genital opening opposite coxa II; anal opening opposite posterior border of spiracular plate. Legs similar to those of male; coxae also similar, but internal spur of coxa IV not very distinct. Capitulum

more than twice as wide as long; cornua not as strong as in male; porose areas oval and slightly divergent anteriorly; palpal articles two and three together much longer than wide; article three with blunt angle on outer edge; ventral surface of capitulum as in male; hypostome dentition 3:3, with approximately nine teeth per file.

Distribution and Hosts. Known from India, Burma, Ceylon, Indochina, southern China, Formosa. It is known in the East Indies from Upper Sumatra (Neumann, 1897, 1904, 1911; Krijgsman and Ponto, 1931, 1932; Schulze, 1936). The following records from Sumatra are based on specimens seen in the Kraneveld collection: Koetaradja, off buffalo and cow; Lhokseumawe, off buffalo, cow and dog; Medan, off buffalo, cow, goat, pig and without host stated; Padangsidimpoean, off buffalo, cow, dog and pig; Goenoengtoea, off buffalo. Numerous specimens from Burma were seen in the Rocky Mountain Laboratory taken off the following hosts: *Muntiacus muntjak vaginalis*, *Arctonyx collaris*, *Hystrix subcristatus subcristatus*, *Cervus unicolor*, *Felis tigris*, *Felis pardus*, *Gallus gallus gallus* and Orange-breasted Flycatcher. A survey of the native fauna of Upper Sumatra would probably show a similarly wide host range.

Biology. This species is indigenous to the Oriental Region and is found on a wide variety of native animals. Introduced domestic animals have proven to be suitable hosts, and the conditions of domestic life have hastened and facilitated the spread of this tick throughout the Oriental Region. It is second in importance to *Boophilus microplus* as a pest of livestock. Little is known about disease transmission by this species, but it should be regarded with suspicion as a possible vector.

Though there are hundreds of records of this species taken in various localities, the larvae and nymphs have never been observed. In the large Kraneveld collection not one immature stage was found, and in the extensive survey made by the United States Typhus Commission in Myitkyina, Burma, no young forms were collected. It must be assumed that this is either a two-host tick or a three-host tick spending part of its life cycle on other animals, probably small rodents or birds.

Rhipicephalus haemaphysaloides pilans Schulze.

Rhipicephalus pilans Schulze, 1935, Wissenschaftliche Ergebnisse Exped. Karakorum, Zool., Acarina, Ixodoidea, p. 180 (description of male in key); 1936, Zeitschr. f. Parasitenk., 8, pt. 5, p. 524, figs. 3-5 (2 ♂, Rana Mésé, Flores; 1 ♀.

Female (Fig. 18A-F). Partially engorged specimen 8.22 mm. long by 6.18 mm. wide, exclusive of capitulum. Body nearly rectangular, with sides sub-rectilinear. Scutum inornate, cordiform, broader than long, 3.0 mm. long by 3.78 mm. wide, sides rounded, with posterior angle broad; outlined by a narrow, dark brown border extending around eyes; punctations large, shallow, and only in anterior half of scutum; cervical grooves anteriorly short and deep, prolonged posteriorly as shallow depressions; eyes large and outlined by small punctations. Abdomen with numerous, large, sparsely scattered punctations and with very short, white hairs; dorsal foveae conspicuous; median groove extending from middle festoon anteriorly two-thirds distance to scutum; oblique grooves

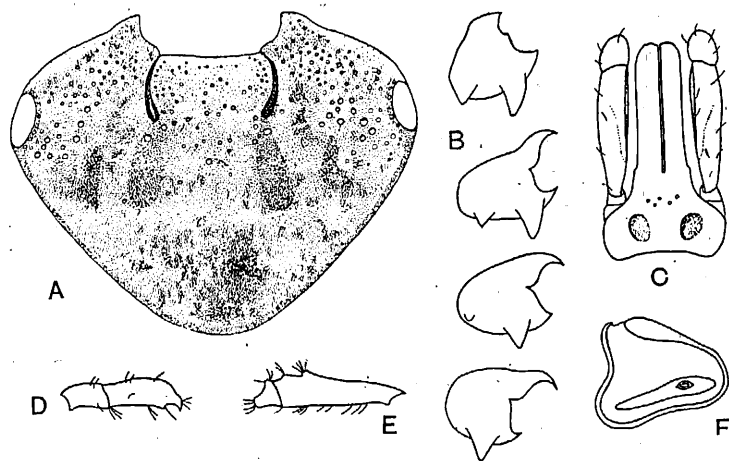


Fig. 18. *Amblyomma cordiferum* Neumann. Female: A, scutum; B, coxae I-IV; C, capitulum in dorsal view; D, tarsus IV; E, tarsus I; F, spiracle.

from second and third festoons, interrupted along their length, but continuing almost to scutum; three lateral depressions on each side; no marginal groove; festoons prominent and about as long as wide; abdomen ventrally lighter, with large punctations on lower third and with large, white hairs; genital opening opposite coxa II; anal opening opposite posterior border of spiracular plate; groove behind anal opening distinct and deep; brown, triangular, spiracular plates, with rounded angles and a dorsal prolongation. Coxae

small and finely punctate; coxa I with two unequal, conical, pointed and widely separated spurs; coxae II and III with two spurs; internal spur on coxa II distinct, but on coxa III very small, scarcely visible; coxae II-IV with external spur triangular, well developed and nearly equal; legs light and medium; femur, tibia and protarsus with pale markings on dorsal, distal portion; tarsi II-IV tapering gradually and ventrally with a distinct, terminal and sub-terminal spur; pulvillus about two-thirds length of claws. Basis rectangular and about twice as wide as long, with posterior margin slightly concave, and posterior angles slightly salient; porose areas fairly large, far apart, elliptical, and divergent anteriorly; few, small punctations anterior to porose areas; palps fairly long and slender; article two slightly over twice as long as article three; hypostome long and narrow, with 4:4 dentition.

Distribution and Hosts. Known from Banda Island (Neumann, 1899) and Krakatau Island (Krijgsman and Ponto, 1932). In the Museum of Comparative Zoölogy was seen one female collected by C. J. Aagaard at Bangkok, Siam, off *Ophiophagus hannah*.

Amblyomma crenatum Neumann.

Amblyomma crenatum Neumann, 1899, Mém. Soc. Zool. France, 12, pp. 203, 214-215, fig. 52 (1 ♀, Cape of Good Hope, off *Rhinoceros*; type in Paris M.); 1901, *Op. cit.*, 14, pp. 297-298 (2 ♂, 2 ♀, Sumatra?). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 473. Howard, 1908, Ann. Transvaal Mus., 1, pt. 2, p. 145, Pl. 12, fig. i. Blanchard, 1909, L'Insecte et l'Infection, Fasc. 1, Acariens, p. 128. Neumann, 1911, Das Tierreich, Lief. 26, Acarina, Ixodidae, pp. 54, 57, 62, 66, 77-78, fig. 34 (♂, ♀, Cape of Good Hope, Liberia, Sumatra (?), off *Rhinoceros bicornis*); 1913, Voyage de Ch. Alluaud et R. Jeannel en Afrique Orientale (1911-1912), Résultats Scientifiques, Arachnides. 2, Ixodidae, p. 29 (1 ♀, Mbuyuni, Pori de Sérenghéti, Kenya Colony). Robinson, 1926, Ticks, 2, pt. 4, *Amblyomma*, pp. 12, 21, 75-79, figs. 32-33 (1 ♂, from Imp. Bur. Ent.). Bequaert, 1933, Psyche, 40, 4, pp. 137-140 (24 ♂, 12 ♀, Sungei Lampan, Lower Perak, Federated Malay States, off *Rhinoceros sondaicus*).

Amblyomma subluteum Neumann, 1899, Mém. Soc. Zool. France, 12, pp. 201, 263 (2 ♂, one locality unknown, one

off African rhinoceros; cotypes in Paris M.); 1901, *Op. cit.*, 14, p. 309. Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), p. 472.

There is still uncertainty as to the exact range of *A. crenatum*. It has been recorded from Africa and from the Indo-Malayan region. In 1899 Neumann described the species from a single female from the Cape of Good Hope, South Africa. In the same year he also described *A. subluteum* from two males; the locality of one was unknown, and the other was from Africa. In 1901 Neumann saw in the Berlin Museum two dried males and two dried females collected in Sumatra by Mösch. On the basis of these four specimens he associated the males and females in his collection as one species, and he regarded *A. subluteum* as a synonym of *A. crenatum*. Neumann was doubtful that a species could be so widely separated, and he attempted to explain this unusual distribution by regarding the specimens from Sumatra as having been incorrectly labeled. In 1911 he added Liberia without indication of specimens. In 1913 Neumann recorded another female specimen from Mbuyuni (Pori de Sérenghéti), Kenya Colony, East Africa. This specimen was taken March 13, 1912, without indication of host. Robinson in 1926 also regarded *A. crenatum* as an African species and thought that the Sumatran material was incorrectly labeled. Bequaert in 1933 determined this species in Lower Perak, Federated Malay States. A portion of the twenty-four males and twelve females of this lot is in the Museum of Comparative Zoölogy, as well as two males collected in Java by Palmer and Bryant in 1910, with no indication of host. Bequaert, who had not seen Neumann's 1913 paper, regarded the African records as doubtful; he thought that they might have been taken off animals kept in captivity in Europe. It would be a simple matter to so disregard Neumann's two records from Africa, since they are vague as to the specific locality; however, the record of the one female from Mbuyuni is complete in this respect. The occurrence of this species in the Indo-Malayan region is now positively established, and the possibility that this species is also found in Africa can not be overlooked. Before final judgement can be made as to the complete range of this species, it is necessary that this one African specimen recorded by Neumann be re-examined. If it is not *A. crenatum* then Bequaert may be correct in assuming that the Indo-Malayan region is the only true origin of this species.

Male (Fig. 19A-F). Two Java specimens and fourteen Malayan specimens show a comparatively wide range of variation in

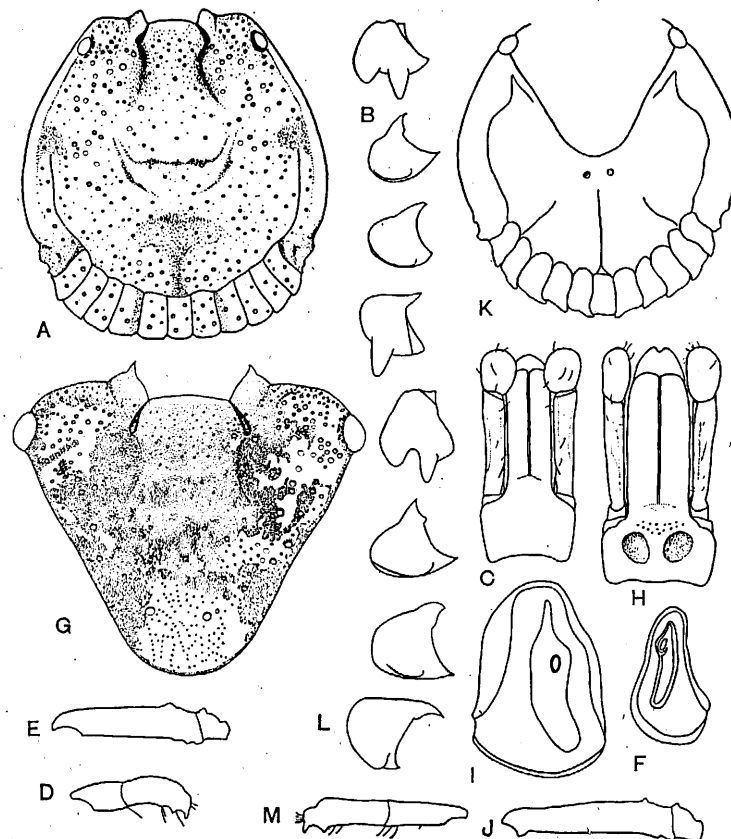


Fig. 19. *Amblyomma crenatum* Neumann. A-F, male: A, scutum; B, coxae I-IV; C, capitulum in dorsal view; D, tarsus IV; E, tarsus I; F, spiracle. G-M, female: G, scutum; H, capitulum in dorsal view; I, spiracle; J, tarsus I; K, body in dorsal view; L, coxae I-IV; M, tarsus IV.

size. from 8.1 to 5.1 mm. long by 8.1 to 5.2 mm. wide, exclusive of capitulum; average 6.98 mm. long by 7.05 mm. wide. Scutum almost orbicular, narrowed slightly behind region of spiracular plate, yellow-orange and with a few, scattered, dark-brown markings, a pale, metallic marking in region of each cervical groove and in area anterior to each eye; punctations large to small; larger ones slightly confluent in posterior portion; cervical grooves short, deep and well defined; yellow, flat eyes very far anteriorly; marginal groove extending only a short distance anteriorly from festoons; spiracular plate large and triangular; festoons very long, with graceful curves on inner margins. Legs very long, yellow-orange, with occasional dark bandings; tarsus I long, slender and with two dorsal humps; tarsus IV ventrally with a terminal and sub-terminal spur; coxa I with two spurs, external pointed and about twice as long as internal; coxae II and III with a broad and ridge-like spur; coxa IV with a single, moderately long spur, about twice as long as wide. Capitulum 3.0 mm. long; basis rectangular, slightly narrower in posterior portion; palps very long and slender; article two about three times as long as article three; hypostome dentition 3:3, with seven to eight teeth per file.

Female (Fig. 19G-M). Four unengorged Malayan specimens from 9.4 to 9.1 mm. long by 9.4 to 8.8 mm. wide, exclusive of capitulum; average 9.3 mm. long by 8.9 mm. wide; two fully engorged females respectively from 22 to 23 mm. long by 20 mm. wide by 16 to 17 mm. thick. Scutum triangular, 4.1 mm. long by 4.7 mm. wide; ornamentation variable, but with a spot in each corner; larger punctations slightly confluent and restricted to antero-lateral regions; finer punctations more numerous and more uniformly distributed; cervical grooves short and deep, continuing posteriorly as shallow furrows toward postero-lateral margin; eyes large, flat and yellow, extending beyond lateral margins of scutum. Marginal groove distinct; festoons large and longer at postero-internal angle, making posterior margin of abdomen saw-toothed; abdomen ventrally with numerous, short, white hairs and many punctations; spiracular plates large, triangular and with rounded corners. Legs very long; tarsus I long and slender, with two dorsal humps; tarsus IV ventrally with a terminal and sub-terminal spur; coxa I with two spurs, internal more blunt than that of male; coxae II and III with a broad and ridge-like spur; coxa IV with a single spur, much shorter than that of male. Capitulum 3.3 mm. long; basis nearly rectangular and broader in front; porose areas large, depressed and

divergent; palps very long and slender; notched hypostome with 3:3 dentition anteriorly, becoming 4:4 in posterior third.

Distribution and Hosts. It has been recorded from Africa (Neumann, 1899, 1911, 1913) and from the Federated Malay States (Bequaert, 1933). Six females and fourteen males were seen in the Museum of Comparative Zoölogy from Lower Perak, Federated Malay States, taken off *Rhinoceros sondaicus*. These are part of the same lot referred to by Bequaert in 1933. Two male specimens seen in the Museum of Comparative Zoölogy were collected by Palmer and Bryant in 1910 at Tamandjaija, Bantam, Java, without indication of host.

Biology. *Amblyomma crenatum* shows a remarkable adaptation to its peculiar host, the rhinoceros. The capitulum is very long, and it is capable of penetrating the thick skin easily; the large articles of the cheliceral digits are well adapted for cutting through the tough hide of this animal; and the very long legs enable the tick to move easily over the large body of its host. The two devices which aid most ticks in the process of attaching to their hosts are the claws and spurs. In this case the claws are very long and are about two and a half times as long as the pulvillus. The ventral terminal and sub-terminal spurs of the tarsus are also large. When the tick is about to attach, the claws hold the tick temporarily in place; the legs are then flexed, and this action pulls the spurs firmly into the hide anchoring the tick securely until the hypostome can be inserted. After it is inserted, the hypostome acts as the main organ of attachment. The sharpness of the spurs can be readily demonstrated when a leg is pulled across the finger, for the spur will easily penetrate the skin.

Amblyomma cyprium Neumann.

This species was divided into two subspecies by P. Schulze in 1933. The typical form has a wider distribution, whereas the subspecies, *A. cyprium aeratipes* Schulze, appears to be restricted to the Philippine Islands.

Amblyomma cyprium cyprium Neumann.

Amblyomma cyprium Neumann, 1899, Mém. Soc. Zool. France, 12, pp. 202, 204, 219-221 [in part; not one male from Philippine Islands] (3 ♂, 5 ♀, Mariana Is.; 1 ♀ without locality; cotypes at Paris M.). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), pp. 473, 474. Blanchard, 1909, L'Insecte et l'In-

Amblyomma testudinarium C. L. Koch.

Amblyomma testudinarium C. L. Koch, 1844, Arch. f. Naturgesch., 10, pt. 1, p. 226, No. 13 (♂, Java; type in Berlin M.); 1847, Uebersicht des Arachnidensystems, 4, pp. 17, 67-68, Pl. 11, fig. 40. Neumann, 1899, Mém. Soc. Zool. France, 12, pp. 202, 205, 240-242 (1 ♂, 2 ♀, Mountains of Chaudoec, Cochin China; 2 ♂, Java, off *Tapirus indicus* and *Rhinoceros sondaicus*; 1 ♂, unknown locality; 1 ♀, Borneo); 1901, *Op. cit.*, 14, pp. 303 (2 ♀, Annam, off tiger; 2 ♀, Ceylon; 4 ♂, 5 ♀, Borneo, off *Sus barbatus*; 1 ♀, Java; 1 ♂, Java, off "*Sus vittatus*" = *Sus cristatus vittatus*; 7 ♀, Java, off "*Buf-felus indicus*" = *Bos bubalis bubalis*). Salmon and Stiles, 1902, 17th Ann. Rept. Bur. Anim. Industry, U. S. Dept. Agric., (1901), pp. 473, 474. Koningsberger, 1903, Vecartsenijk. Blad. v. Nederl.-Indië, 15, pt. 2, p. 146, fig. 6. Blanchard, 1909, L'Insecte et l'Infection, Fasc. 1, Acariens, p. 134. Warburton, 1910, Parasitology, 3, pt. 4, p. 396 (Sikkim and Sibsagar, Assam). Neumann, 1911, Das Tierreich, Lief. 26, Acarina, Ixodidae, pp. 56, 58, 64, 67, 86-87 (♂, ♀, Java, Sumatra, Borneo, Cochin China, Annam, Ceylon, off *Felis tigris*, *Potamochoerus larvatus*); 1913, Supplementa Entomologica, Berlin, 2, p. 135 (1 ♂, Taihorin, off *Manis dolmani*; 11 ♂, ♀, Kosempo, off wild pig). Kishida, 1922, Zool. Mag., Tokyo, 34, No. 408, pp. 850, 851, 856. Warburton, 1925, Spolia Zeylanica, 13, pt. 2, p. 256 (Colombo, Ceylon, from bush). Larrousse, 1925, Ann. Parasit. Hum. et Comp., 3, pt. 3, p. 301 (1 ♂, Nhatrang, Annam; off cervide probably "*Cervulus muntjak*" = *Muntiacus muntjak*). Warburton, 1926, Treubia, 8, pts. 3-4, p. 280 (♀, n, Andalos (Tandjoeng) Sumatra's west coast, Pandang Island, Boö Island, off *Martes flavigula henrici*). Robinson, 1926, Ticks, 2, pt. 4, *Amblyomma*, pp. 17, 23, 253-257, figs. 125-126 (extensive host and distribution lists). Sharif, 1928, Records Indian Mus., 30, pt. 3, pp. 330-333, figs. 46-47 (♂, ♀, n, Burma, Assam, Bengal, Bombay, Coorg State, Ceylon, off bullock, *Felis tigris*, Nelore cow, Sambar deer). Krijgsman and Ponto, 1931, Zeitschr. f. Parasitenk., 4, pt. 1, pp. 141, 143, map 4; 1932, Veeartsenijk. Meded., No. 79, pp. 20-21, 35, figs. 23-24, map 4 (♂, ♀, Sumatra, Bali, Lombok, Soemba, Java, Borneo, off buffalo, cow, man, and "*Sus vittatus*" = *Sus cristatus vittatus*). Sugimoto, 1935, Taiwan-No-Chikusuan, 3, pt.

9, p. 7; 1936, *Op. cit.*, 4, pt. 2, pp. 4-7, Pl. 6, figs. 1-7, Pl. 8, figs. 1-4; 1936, Journ. Cent. Soc. Vet. Med., Tokyo, 49, pt. 7, p. 584, pl. 3, figs. 1-7; 1936, Journ. Soc. Trop. Agric., Tokyo, 8, pt. 4, p. 337 (Formosa). Ogura, 1936, Mem. Fac. Sci. Agric., Taihoku Imp. Univ., Formosa, 19, pt. 2, pp. 79-81, figs. 13-18 (♂, ♀, Formosa, off cattle, water buffalo, pig and wild boar). Sugimoto, 1937, Trans. Nat. Hist. Soc. Formosa, 27, No. 160, pp. 1-6, Pl. 1, figs. 1-6, Pl. 2, figs. 1-5 (nymph and larva from Formosa); 1937, Journ. Soc. Vet. Sci., 16, pt. 1, pp. 11-16, Pl. 5, figs. 1-6, Pl. 6, figs. 1-5; 1937, Journ. Cent. Soc. Vet. Med., Tokyo, 50, pt. 5, pp. 318-322 (synonymy, distribution; hosts, Formosa); 1937, Journ. Soc. Trop. Agric., Tokyo, 9, pt. 3, p. 287. Sharif, 1938, Indian Journ. Vet. Sci. and Anim. Husb., 8, pt. 4, p. 363 (disease transmission). Toumanoff, 1944, Les Tiques (Ixodoidea) de l'Indochine, pp. 102-104, 119, 120, Pls. 69-71, 75 (♂, ♀, Indochina, off Sambar deer, tiger cat, wild pig, dog, horse; 1 n, off wild cock).

Amblyomma infestum C. L. Koch, 1844, Arch. f. Naturgesch., 10, pt. 1, p. 226, No. 12 (♂, ♀, Bintan Island; types in Berlin M.); 1847, Uebersicht des Arachnidensystems, 4, pp. 17, 68-70, Pl. 12, figs. 41-42. Schulze, 1935, Zool. Anz., 112, pts. 9-10, p. 234; 1939, Zeitschr. f. Parasitenk., 10, pt. 6, p. 728 (Burma).

Ixodes auriscutellatus Koningsberger, 1901, Teysmannia, 11, pt. 1, pp. 61-62, figs. 7-8 (♂, ♀, Bandong and Buitenzorg, Java, off buffalo; location of types unknown).

Amblyomma compactum Neumann, 1901, Mém. Soc. Zool. France, 14, pp. 296-297, 342 (2 ♀, Sumatra; cotypes in Berlin M.).

Amblyomma infestum testudinarium Schulze, 1932, Zeitschr. f. Parasitenk., 4, pt. 3, pp. 467-469 (4 ♂, 4 ♀, Soekaranda, Sumatra); 1932, Zeitschr. Morph. Oekol. Tiere, 25, pts. 2-3, pp. 528-529 (morphological); 1941, *Op. cit.*, 37, pt. 3, p. 514 (morphological).

Amblyomma infestum infestum Schulze, 1932, Zeitschr. f. Parasitenk., 4, pt. 3, pp. 468, 469 (based on Koch's types from Bintan Island near Singapore). Bequaert, 1933, Psyche, 40, pt. 4, pp. 140-142 (1 ♂, 3 ♀, Bernam River, Selangor, Fed. Malay States, off *Rhinoceros sumatrensis*). Schulze, 1936, Zeitschr. Morph. Oekol. Tiere, 32, pt. 2, pp. 204, 206, 207, fig. 19 b (morphological).

Amblyomma fallax Schulze, 1932, Zeitschr. f. Parasitenk., 4, pt. 3, p. 468 (nomen novum for *A. testudinarium* as described and figured by Robinson, 1926, pp. 253-257). Bequaert, 1933, Psyche, 40, pt. 4, p. 141.

Amblyomma infestum taivanicum Schulze, 1935, Zool. Anz., 112, pts. 9-10, pp. 234, 236-237, fig. 2 (♂, ♀, Kosempo, Formosa, off dog; holotype ♂ in D. Ent. Inst. Berlin-Dahlem).

Amblyomma infestum borneense Schulze, 1936, Zeitschr. f. Parasitenk., 8, pt. 6, pp. 623-624, fig. 4 (3 ♂, 3 ♀, Borneo, off *Sus verrucosus*; holotype ♂ in Z. M. Berlin).

Haemalastor infestum Oudemans, 1936, Krit. Hist. Overzicht Acarologie, 3, Bd. B, pp. 497-499, fig. 202.

Haemalastor infestum var. *testudinarium* Oudemans, 1936, *Op. cit.*, pp. 544-545, fig. 225.

In 1844 C. L. Koch described *A. infestum* from Bintan Island and *A. testudinarium* from Java in the same publication as distinct species. Neumann, as first reviser, made *A. infestum* a synonym of *A. testudinarium* even though *A. infestum* had line priority. Schulze in 1932 reversed the names making *A. testudinarium* a synonym of *A. infestum*. Neumann gave no reasons for choosing the name *A. testudinarium* over *A. infestum*, but since he was the first reviser, the choice of which name to use was up to him. No case can be made for line priority in this situation, and since the name is now firmly established in the literature, no good purpose would be served by reviving the name *A. infestum*.

In 1932 Schulze stated that the male described and figured by Robinson in 1926 on page 254 as *A. testudinarium* is not that of Koch; he regarded it as a new species, and he gave it the name *Amblyomma fallax*. He said that it differed from *A. testudinarium* in that ventral muscle scutes were present and that the peltae were obliquely or diagonally placed. Schulze, however, has misinterpreted the drawing in regard to the peltae. Robinson in figure 125 has not depicted the salience of the peltae at the postero-internal angle, because it is impossible to see the peltae when the specimen is viewed from the ventral position; it is necessary to raise the posterior end of the specimen and to look down on the posterior margin in order to see the salience of the peltae. In Robinson's figure the peltae run parallel with the festoons, and this is shown by the solid lines which represent both the lateral margin of the festoons and the peltae. Robinson merely shows the dark brown, ventral scutes of which the internal, lateral border is oblique. The drawing is misleading, however, for the solid lines representing a portion of

the border of the muscle scutes could easily be mistaken for oblique peltae. Specimens were seen where the ventral muscle scutes are missing entirely and others where they are only slightly developed, but the majority of those examined show well developed ones. For these reasons I believe that the name *A. fallax* Schulze is unnecessary and that it should be regarded as a synonym of *A. testudinarium*.

Schulze attempted to separate *A. infestum* and *A. testudinarium* as distinct races in 1932, but I can not agree with this division. The characters used by Schulze to separate these races are color, pattern of the ornamentation and size. All of these characters are known to vary widely and have little, if any, taxonomic value. Numerous specimens were seen from Burma, Assam, Formosa, the Philippine Islands, India, China, Siam, the Federated Malay States and the East Indies, and I am convinced that they are all the same species. I compared specimens from Formosa with the description and figures given by Schulze for *A. infestum taivanicum*, and I am convinced that this is the same as *A. testudinarium*. I saw no material from Borneo, but the description and figures given by Schulze for *A. infestum borneense* show that it is also *A. testudinarium*. Both these subspecies should be considered as synonyms of *A. testudinarium*.

Male (Fig. 25A-G). Numerous, unengorged specimens from Sumatra, Java, Celebes, Flores from 6.42 to 5.4 mm. long by 6.0 to 5.1 mm. wide, exclusive of capitulum. Body broad-oval, and narrowed anteriorly. Scutum yellow-orange and light-brown, some more ornate than others; punctations numerous, large and irregularly distributed, with a slight confluency in region immediately anterior to festoons; elevations present generally free of punctations; cervical grooves short, deep and comma-shaped; eyes large, yellow and flat. Festoons distinct and longer than wide, with interval between them wide. Ventral body surface yellow, finely wrinkled and with numerous, small punctations; genital opening opposite coxa II; anal opening opposite posterior margin of spiracular plate; spiracular plate comma-shaped and obliquely placed; muscle scutes in region of festoons dark brown; peltae parallel to festoons and postero-internal angle slightly salient. Legs long and stout; with a faint, circular marking at distal end of each joint; coxa I with two long, subequal spurs, external spur slightly longer; coxae II and III each with a broad, single, rounded spur; coxa IV with a single spur about twice as long as wide; tarsi short, ending in a distinct terminal and sub-terminal spur; pulvillus about one-

half as long as claws. Capitulum long; basis rectangular, with sides slightly convex and posterior margin slightly concave; palps long, with article two a little more than twice as long as article three;

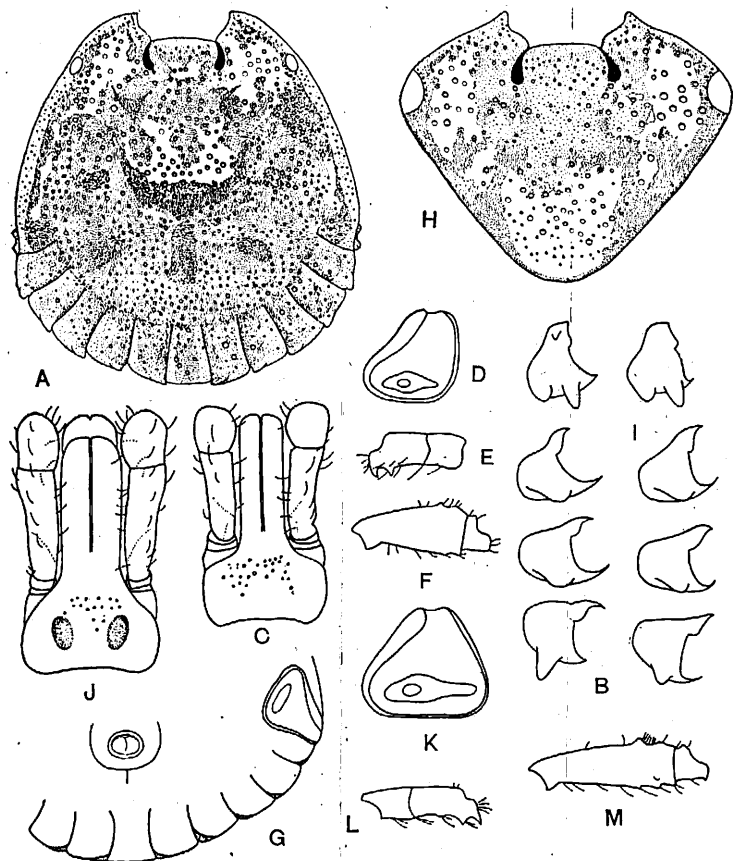


Fig. 25. *Amblyomma testudinarium* C. L. Koch. A-G, male: A, scutum; B, coxae I-IV; C, capitulum in dorsal view; D, spiracle; E, tarsus IV; F, tarsus I; G, ventral muscle scutes, or muscle attachments. H-M, female: H, scutum; I, coxae I-IV; J, capitulum in dorsal view; K, spiracle; L, tarsus IV; M, tarsus I.

hypostome long and slender; dentition 4:4, but internal row on each side beginning about one-fourth distance from anterior tip; eight to nine teeth per file.

Female (Fig. 25II-M). Fully engorged specimen 25 mm. long by 18 mm. wide by 15 mm. thick. Body of unengorged female nearly circular. Scutum triangular, wider than long, posterior angle narrow, 3.15 mm. long by 3.9 mm. wide, amount and pattern of ornamentation variable; punctations unequal, irregularly distributed, with larger ones in lateral margins near eyes; cervical grooves small and comma-shaped; eyes yellow, large and conspicuous. Abdomen dorsally with numerous, large punctations and short, white hairs; dorsal foveae small, dark and conspicuous. Abdomen ventrally with numerous, fine wrinkles and many, small punctations; genital opening opposite coxa II; anal opening opposite posterior border of spiracular plate; spiracular plate large and triangular, with rounded corners. Coxae I-III with spurs similar to those of male; coxa IV with spur much shorter than that of male; tarsi longer than those of male. Capitulum long; basis rectangular, with sides slightly convex; in some specimens posterior margins slightly concave, in others straight; porose areas large, oval and parallel; hypostome long and slender; dentition 4:4; inner row with smaller teeth than other rows.

Distribution and Hosts. This species is common and is widely distributed throughout the Oriental Region; it is known from Burma, Indochina, Annam, Ceylon, Borneo, India, Federated Malay States, Formosa, Japan (?), Cochin China and the East Indies. In the East Indies it has been recorded from Java (Koch, 1844; Neumann, 1899, 1901, 1911; Koningsberger, 1900; Robinson, 1926; Krijgsman and Ponto, 1931, 1932), Sumatra (Neumann, 1901; Robinson, 1926; Krijgsman and Ponto, 1931, 1932; Schulze, 1932), Bintañ Island (Koch, 1844; Schulze, 1932), Andalos, Pandang and Boö Island (Warburton, 1926), Bali (Robinson, 1926; Krijgsman and Ponto, 1931, 1932), Lombok and Soemba (Krijgsman and Ponto, 1931, 1932).

Numerous specimens were seen from the following localities: Sumatra (Lhokseumawe, off buffalo and goat; Medan, off buffalo; Padangsidimpean, off buffalo and goat; Lahat, off buffalo and cow; all in Kraneveld collection), Java (Blitar, off buffalo; Djember, nymph, off pig, in Kraneveld collection; two females, off *Sus verrucosus*, in Museum of Comparative Zoölogy; West Java, two males, four females, off *Bos sondaicus sondaicus* collected by F. C. Kraneveld, in Museum of Comparative Zoölogy), Celebes (two females, without host; four males, off *Sus barbatus*, in Museum of Comparative Zoölogy), Flores (Roeteng, one male and one nymph, off cow, in Kraneveld collection).