Brigham Young University
Science Bulletin

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BIOLOGICAL SERIES — VOLUME XV, NUMBER 1

AUGUST 1971

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by

Noboru Yamaguti,[1] Vernon J. Tipton,[2] Hugh L. Keegan,[3]
and Seiichi Toshioka[4]

ABSTRACT

This publication is a revision of *Ixodid Ticks of Japan, Korea, and the Ryukyu Islands* by Keegan and Toshioka (1957). The tick fauna of these areas is represented by 36 species in the genera *Argas, Ornithodoros, Amblyomma, Boophilus, Dermacentor, Haemaphysalis, Ixodes,* and *Rhipicephalus.* Three species of the family Argasidae and 10 species of Ixodidae were not treated in the original edition. The additional information contained in this revision was derived from field collections and a thorough review of the literature. Keys are provided for the identification of genera and species. For each species we have given synonymy, a brief diagnosis, geographical distribution, hosts, and, if known, the biology and relationship to disease. Collection data for material actually examined or recorded in the literature are given in chart form at the end of the paper. Illustrations of 65 adults and 53 immatures are provided.

INTRODUCTION

The importance of ticks as vectors of viral and rickettsial diseases of man has been reviewed by Hoogstraal (1966, 1967a, 1967b). Ticks are also important vectors of pathogens affecting domestic and game animals. The manual, *Ixodid Ticks of Japan, Korea, and the Ryukyu Islands* by Keegan and Toshioka (1957), represented a significant contribution to our knowledge of tick vectors of disease. Inasmuch as there have been several biological and taxonomic studies of the tick fauna of Japan published since 1957, and to a lesser extent Korea and the Ryukyu Islands, Colonel Keegan suggested that Tipton and Yamaguti revise the original paper. We have supplemented information from the literature with our own collecting and life cycle studies at the 406th Medical Laboratory. Some additions and changes have been made in the format, such as the inclusion of the argasid ticks, a diagnosis for each species, an illustrated key to the genera, and a map for each species showing distribution based on all collection records available. We have also chosen to present the collection data in chart form rather than as a part of the text. The format used by Elbl and Anastos (1966) has been used as a guide in the preparation of the collection data chart.

Much of the information contained in this paper has been copied verbatim from the original 1957 manual. The order in which the authors are listed does not infer that Keegan and Toshioka have made any less contribution than the other two authors, and as a matter of fact this paper would hardly have been possible without the original manual as a starting point. Furthermore, we received constant encouragement and assistance from Colonel Keegan and Dr. Toshioka.

As in the 1957 manual, the generic classification given by Anastos (1950) and Hoogstraal (1956) has been followed. We have also relied heavily on the assistance of Mr. Glen M. Kohls (Rocky Mountain Laboratory, Hamilton, Montana), Dr. Harry Hoogstraal (Naval Medical

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Research Unit No. 3, Cairo, Egypt), and Dr. Shigeo Kitaoka (National Institute of Animal Health, Tokyo).

Taxonomically important structures are labeled in Fig. 2 to 4. A detailed discussion of tick morphology is not given in this paper. Such information may be obtained from texts of medical entomology or the excellent monographs of Nuttall and Warburton (1908, 1911, 1915).

Synonymy listed under the specific name involves only those papers in which specimens from Japan, Korea, or the Ryukyu Islands were examined or discussed by those authors. Though there have been several papers dealing with specimens from Taiwan (Formosa, previously controlled by Japan before World War II), they were purposely excluded as sources of synonyms and literature, except in those cases where data contained were pertinent to the populations in the areas discussed. Hence, the synonymy presented here is less extensive than that of other monographic papers. Literature containing biological information germane to this paper is included.

With practicality in mind a brief diagnosis of each species is given rather than a detailed description. Keys to the immature forms are not included, but many illustrations of larvae and nymphs, as well as adults, which were not provided in the publication of Keegan and Toshioka (1957) have been added. We believe this will be beneficial to field workers concerned with tick biology.

At the time of the writing of this paper (1970), the political boundary between Japanese and American administration of the Ryukyu Islands lies between Amami Gunto and Okinawa Gunto, the former having already reverted to Japan. In 1972, the remaining islands in Okinawa and Sakishima Gunto (including Miyako and Yaeyama Retto) will return to Japanese administration, probably as Okinawa Prefecture. Even though Amami Oshima is politically Japanese, for the purpose of geographical clarity, it is shown in Appendix 2 as being part of the Ryukyu Islands. It is administered by Kagoshima Prefecture in Kyushu.

MATERIALS AND METHODS

Most of the material examined as a part of this study was collected during extensive field trips on the four main islands of Japan and on islands of the Ryukyu Archipelago. A few specimens were provided by one of us (Tipton) in connection with field excursions made to Korea.

Engorged females were kept in vials until oviposition, and larvae were fed on ears of rabbits so that laboratory life cycle studies could be initiated. Unengorged females (freshly collected from the field) were likewise reared in the laboratory. These procedures enabled us to properly associate adults with immature forms. Tentative identifications were recorded on cards with collection data. One card per host was prepared. Specimens from each lot were sent to Mr. Glen M. Kohls, Rocky Mountain Laboratory, for confirmation of identifications.

Unmounted specimens collected in Japan, Korea, and the Ryukyu Islands and preserved in 70% alcohol were used as a basis for most of the illustrations. Often it was necessary to remove legs and spiracular plates in order to get a clear view of contour and chaetotaxy. In some instances the capitulum of the adult and whole body of the nymph or larva were mounted temporarily in Hoyer's solution on a cavity slide for detailed examination of the chaetotaxy and dentition of the hypostome.

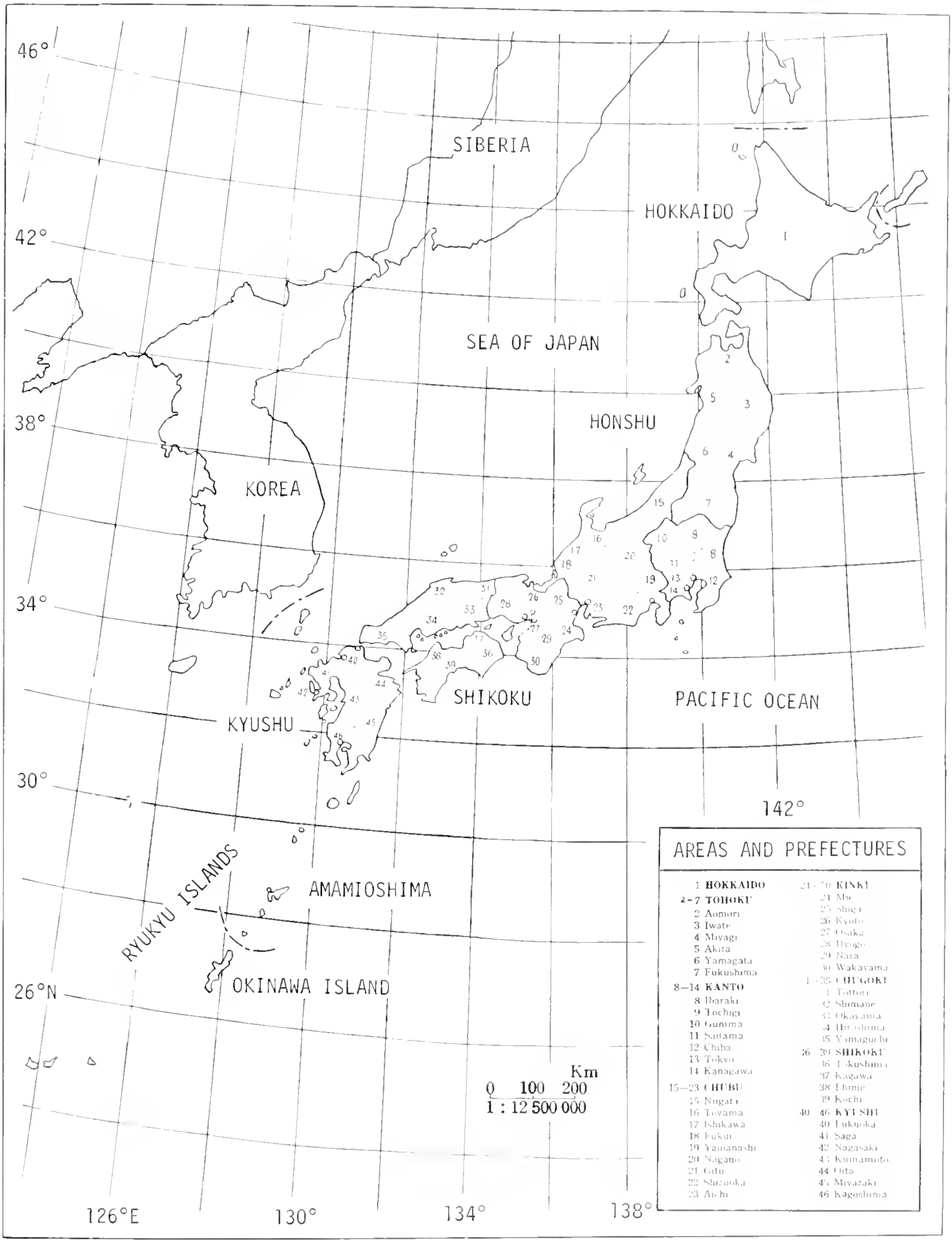
Illustrations were prepared by the artists named in the acknowledgments.

Family Argasidae Canestrini, 1890

Nonscutate "soft ticks." Sexual dimorphism very slight. Integument of adults and nymphs mammilated, wrinkled, leathery, granulated, or with tubercles. Capitulum of adults and nymphs in camerostome on ventral side; apart from anterior margin of body. Palpal articles subequal, leglike, free, never fused in all stages. Porous areas absent. Eyes present or absent; when present, on the supracoxal folds. Spiracles of adults and nymphs usually anterior to coxae IV. Pulvilli usually absent or rudimentary in adults and nymphs, whereas functional in larvae. Number of nymphal stages variable. Type genus: *Argas* Latreille, 1796.

Key to the Species of the Family Argasidae

1. Suture between dorsal and ventral surface of body absent; dorsal surface mammilated; on seabirds (Fig. 9, 10) .... *Ornithodoros capensis*
   Suture between dorsal and ventral surface of body definitely present; dorsal surface finely wrinkled .... Genus *Argas* 2
2. Body nearly round; on bats (Fig. 7, 8) .... *Argas vespertilionis*
   Body longer than wide; on swallows (Fig. 5, 6) .... *A. japonicus*



MAP 1. Map of Japan, Korea and the Ryukyu Islands.

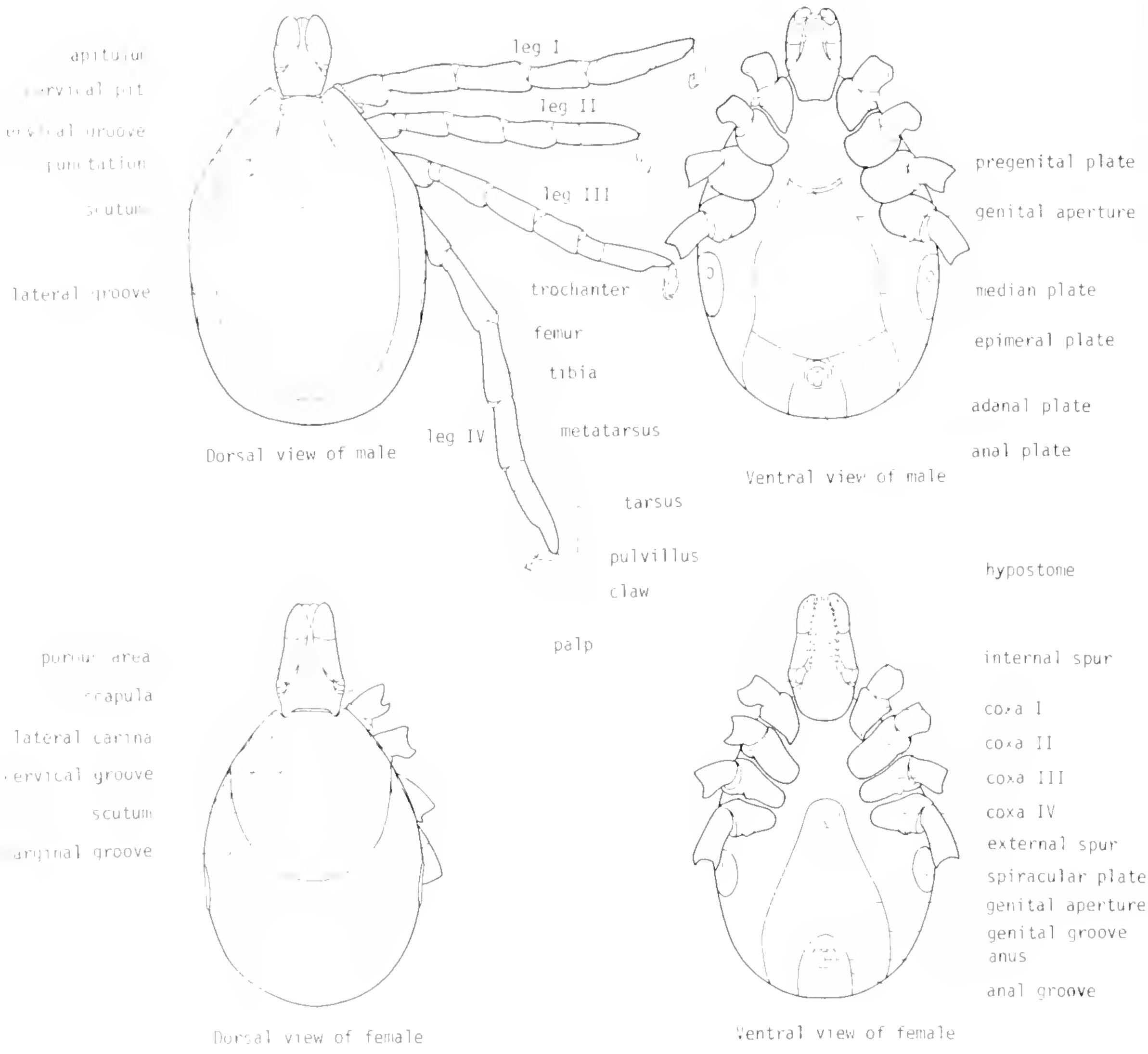


FIG. 1. Key characteristics of ticks - 1 (genus *Ixodes*)

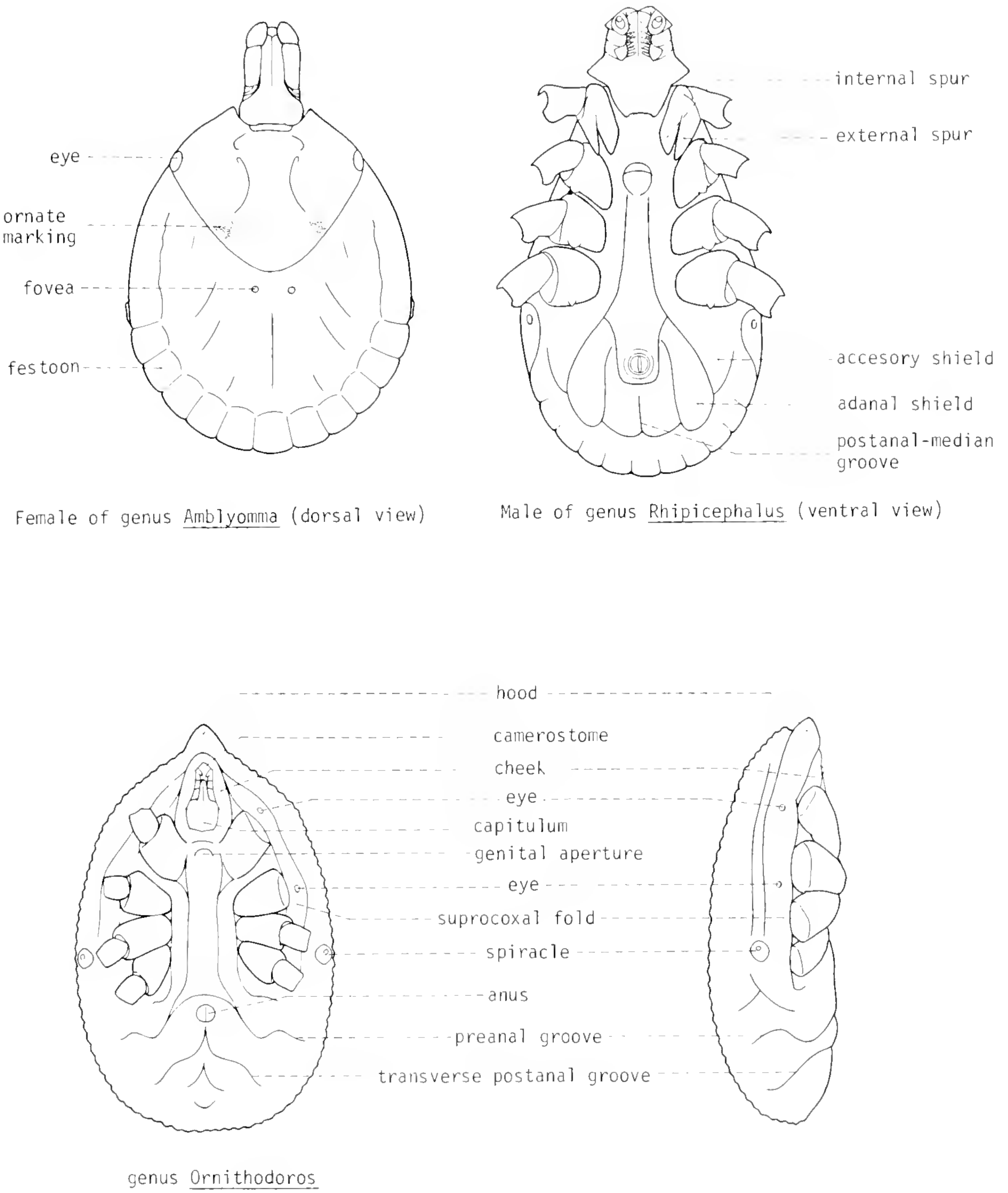


Fig. 2. Key characteristics of ticks - 2.

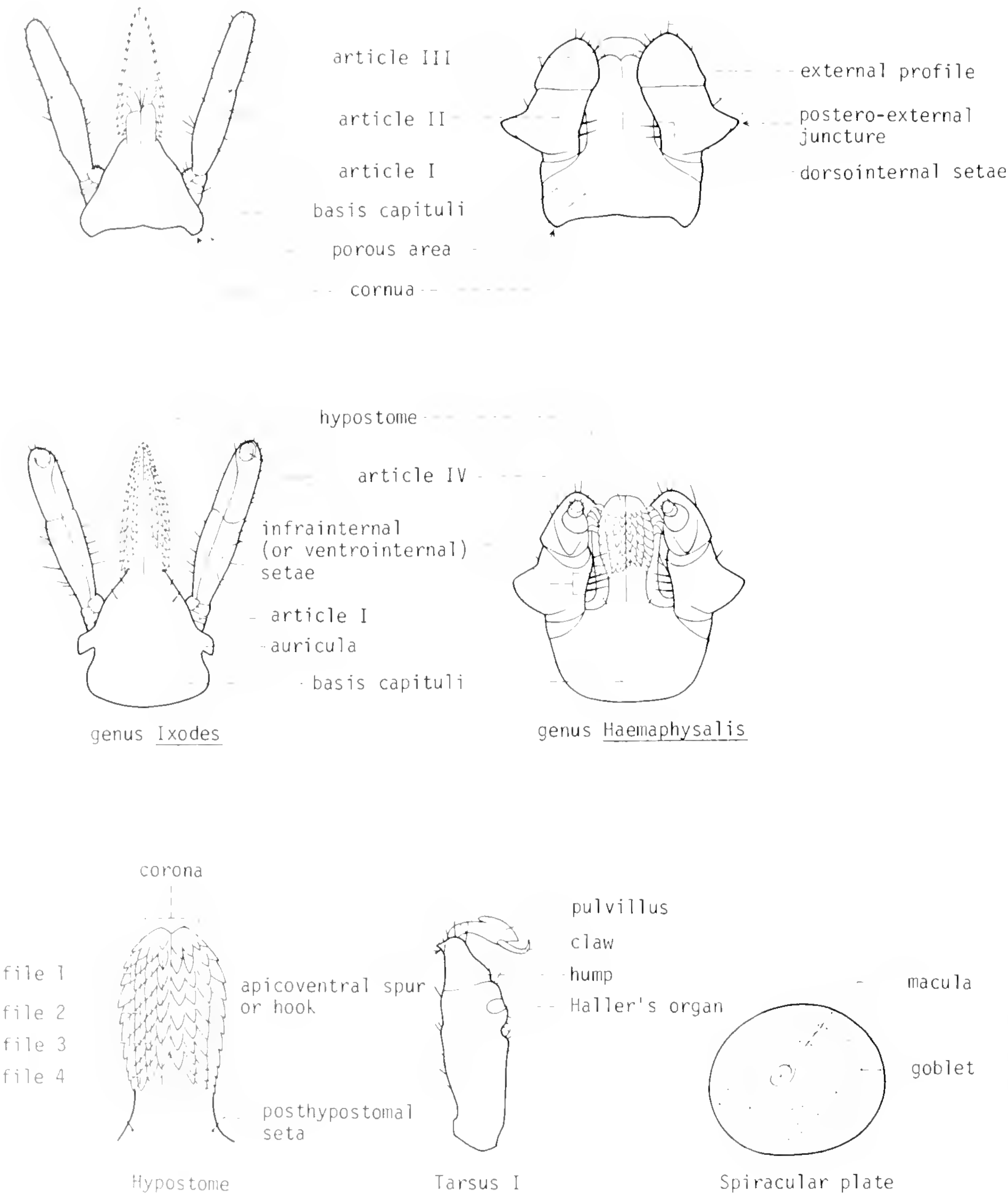


FIG. 3. Key characteristics of ticks - 3.

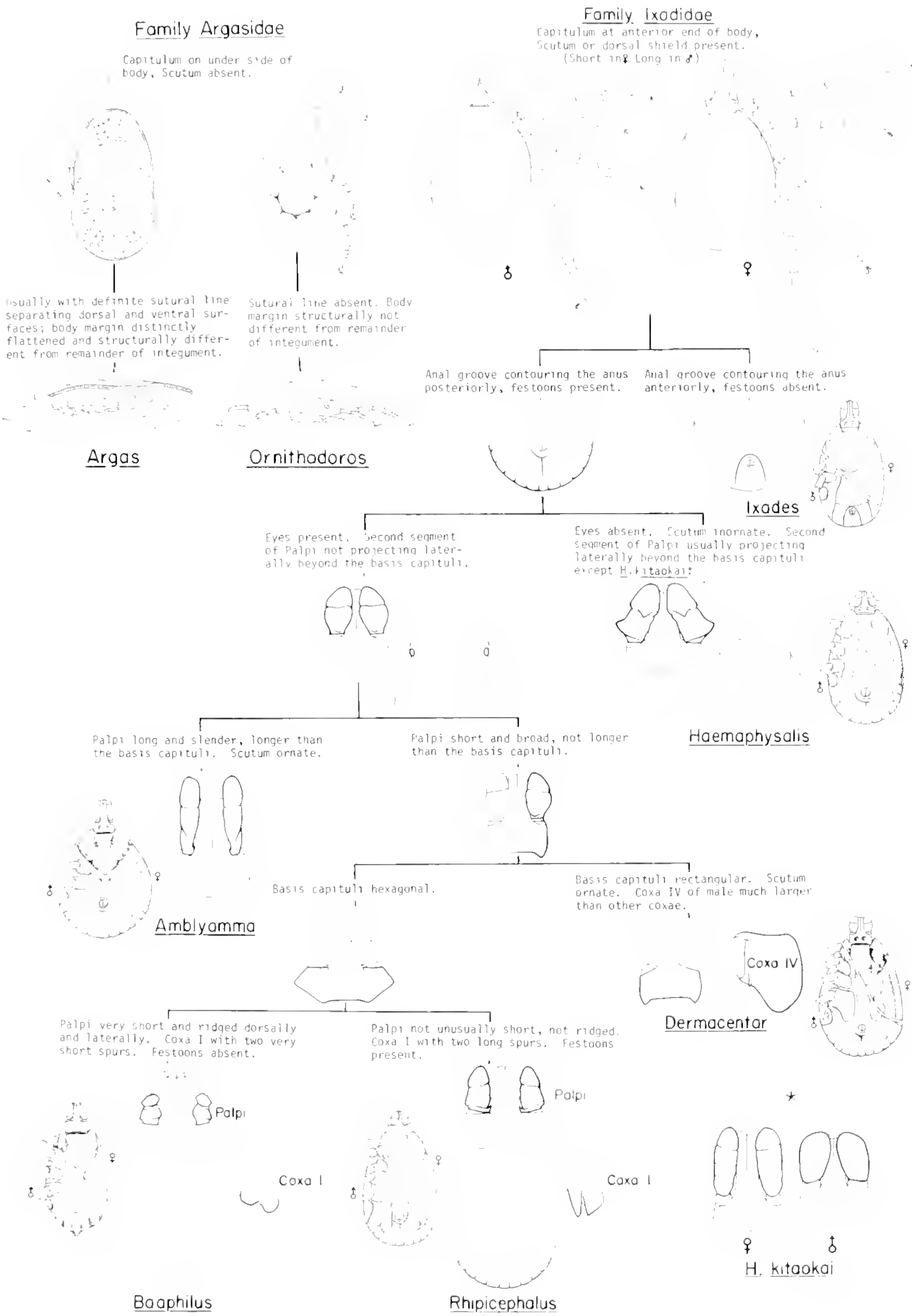


FIG. 4. Illustrated key to the genera of ticks of Japan, Korea, and the Ryukyu Islands.

Genus *Argas* Latreille, 1796

Body distinctly flattened dorsoventrally; dorsal and ventral surfaces subequal in area. Body margin flattened even when depleted, consisting of radial striations or quadrangular plates. Sutural line separating dorsal and ventral surface present. Integument leathery or finely wrinkled, intermingled with small "buttons"; discs arranged more or less radially. Eyes absent. Adults and nymphs similar. Parasitic principally on birds or bats. Type species: *Argas reflexus* (Fabricius, 1794).

Argas japonicus Yamaguti, Clifford, and Tipton (Fig. 5 and 6)

Argas japonicus Yamaguti, Clifford, and Tipton, 1968:453-459, Fig. 1-17; Uchikawa and Sato, 1968:157-161, Fig. 1, 1969:95-97; Saito, Iijima, and Minai, 1969:39-41.

Argas sp.: Inatomi and Yamaguti, 1960:17-18; Uchikawa, Sato, and Kugimoto, 1967:141-151, Fig. 1-20.

Argas reflexus var. *japonicus* Yamaguti and Inatomi, 1961:142.

Argas persicus (not Oken, 1818): Hara, 1963: 123-125, Fig. 1.

DISCUSSION:

The occurrence of this soft tick was first reported by Inatomi and Yamaguti (1960) from nests of the Japanese striated swallow, *Hirundo daurica japonica*, which were built under eaves of the post office at Niimi City, Okayama Prefecture, Honshu. They gave a brief account of adult morphology. The following year, Yamaguti and Inatomi (1961) examined immature forms from this locality and considered this population to be a new variety of *Argas reflexus*, which they designated *japonicus*.

Hara (1963) reported the occurrence of *Argas persicus* from nests of the house martin at Agematsu, Nagano Prefecture. Uchikawa, Sato, and Kugimoto (1967) found a large number of specimens of *Argas* sp. in swallow nests built under eaves of the University Hospital of Shinshu University, Matsumoto City, Nagano Prefecture. Yamaguti, Clifford, and Tipton (1968) examined this material, including Hara's *persicus*, and indicated that all specimens were identical to the new species, *A. japonicus*, described by them.

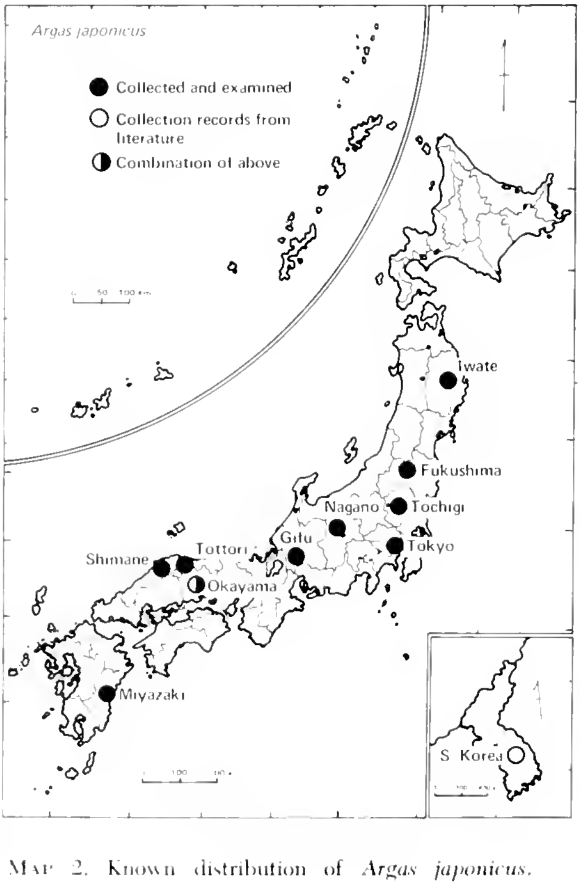
DIAGNOSIS:

This species is similar to *A. cooleyi* Kohls and Hoogstraal, 1960, of western North America, *A. lagenoplastis* Froggatt, 1906, of Australia, and *A. vulgaris* Filippova, 1961, of eastern Russia, but adults may be differentiated from these species on the basis of number and distribution of setae on the tarsi, basis capituli, and anal valves. Larvae may be differentiated on the basis of length, number, distribution, and structure of body setae (*A. lagenoplastis*); dentition of the hypostome and number and distribution of body setae on the posterior quadrant (*A. cooleyi*; and dentition of the hypostome and size of the dorsal plate (*A. vulgaris*).

This swallow argasid is easily distinguished from other soft ticks of the Japanese fauna in that the body is ovate, the ventral "paired organs" are lacking, the mouth parts are not so close to the anterior margin of the body as in *vespertilionis*, and the tarsi have distinct subapical dorsal protuberances.

DISTRIBUTION AND HOSTS:

To date this species is known only in Japan and Korea. Reported hosts are the Japanese striated swallow, *Hirundo daurica japonica*, and the Japanese house martin, *Delichon urbica dasypus*. Under experimental conditions *A. japonicus* will feed on chickens.



MAP 2. Known distribution of *Argas japonicus*.

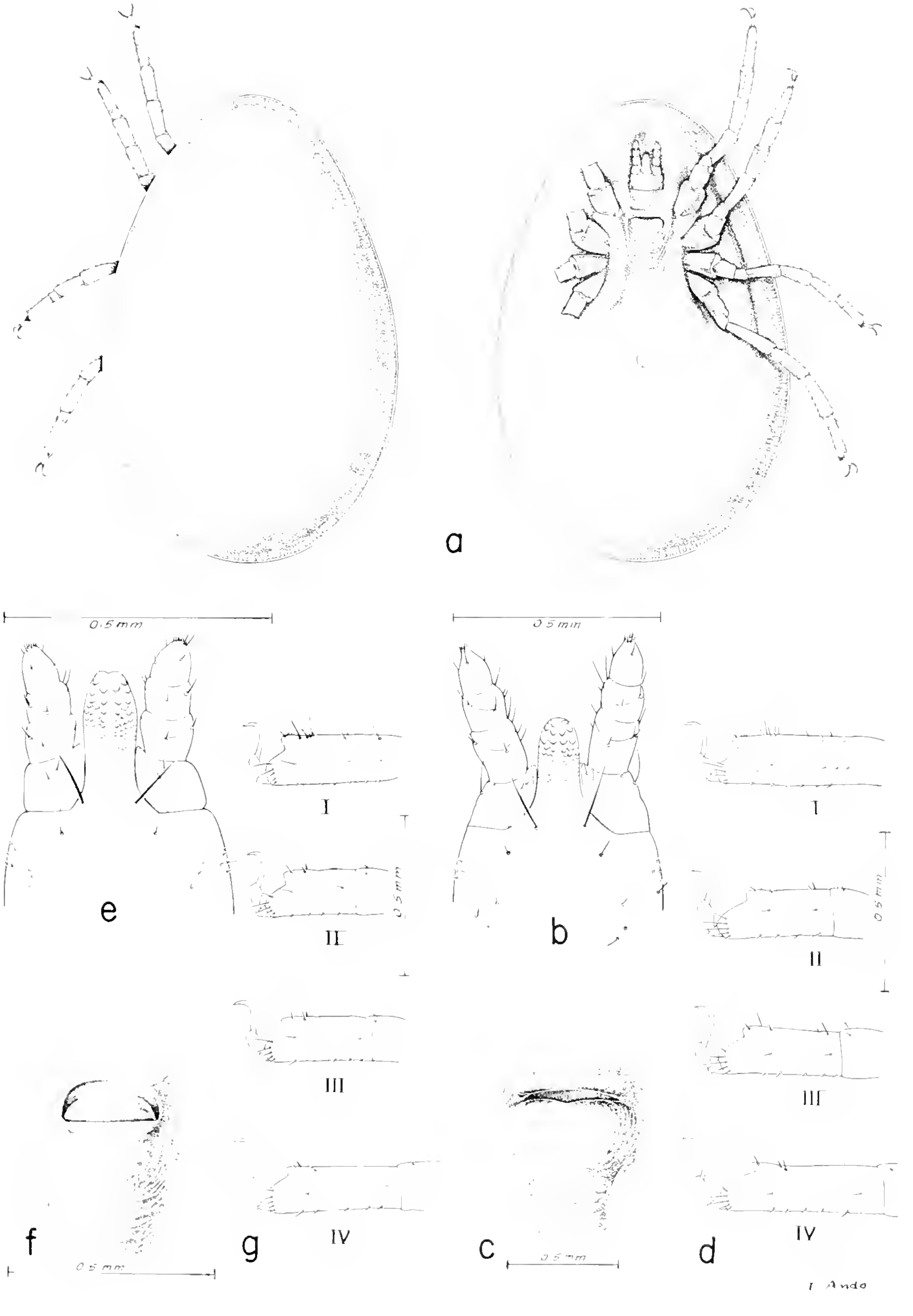


Fig. 5. *Argas japonicus*, female and male.

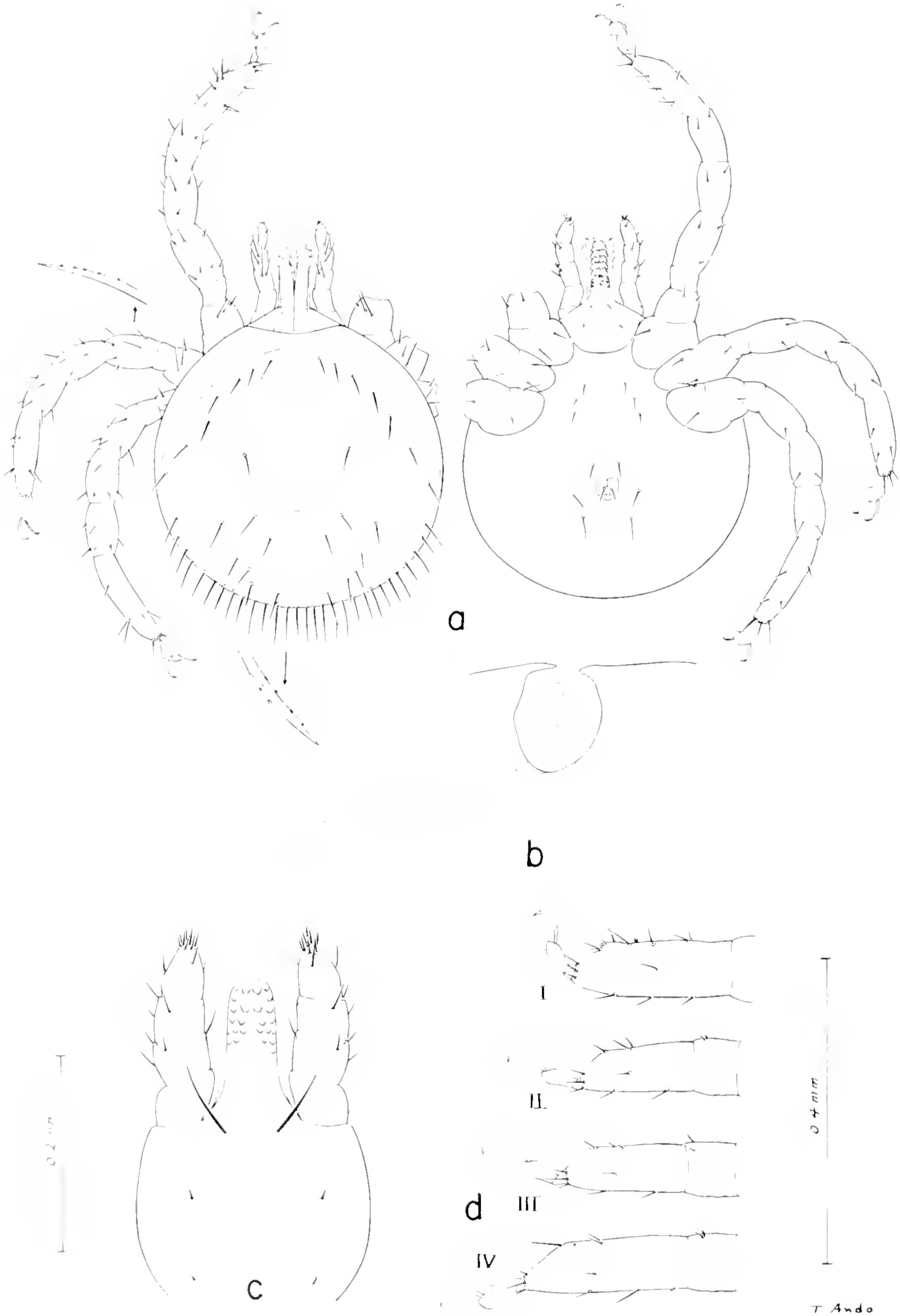


Fig. 6. *Argas japonicus*, larva and nymph.

Biology:

Uchikawa et al. (1967) and Uchikawa and Sato (1968, 1969) examined a natural population in Nagano Prefecture and studied a laboratory colony fed on chickens. They found the ticks to be very active, and some of them intruded into the wards of the hospital (Shinshu University Hospital) during the period from late March to September when the host birds were nesting. All developing stages, as well as eggs, were found in the holes and crevices of mud used in construction of nests. After the host birds leave and migrate to southern regions, the ticks stay in the same niches and overwinter there. Uchikawa et al. (1967) state that the winter colony consists of unfed specimens plus those which have fully digested a previous blood meal. Unfed larvae die within three weeks when kept at 30 C, but they survive until the following spring without a blood meal under natural conditions. There are at least two instars in the nymphal stage, and both are often found in natural populations. In laboratory colonies 4th instar nymphs are seen only occasionally. Morphological differences among nymphs of different stages are generally very slight. Uchikawa and Sato (1968) studied the morphological differences of these nymphs and found that the apicoventral setae on the tarsi change with molting, and this serves to discriminate the nymphal instars. In the laboratory Uchikawa et al. (1967) found that larvae, nymphs, and adults began to feed on chickens after a short preparasitic period of about 3 days. Larvae fed for 3-6 days, and nymphs and adults for 9 minutes to an hour. At 30 C the postparasitic period for larvae was 5-12 days, for 1st instar nymphs it was 8-18 days, and 2nd and 3rd instar nymphs which molted into adults it was 12-20 days. The period was prolonged at lower temperatures. Each female laid 36-200 eggs during a 5-12 day period, and the larvae hatched in 12-16 days.

At the 406th Medical Laboratory rearing experiments on chickens were undertaken under conditions somewhat different than those described by Uchikawa et al. (1967). Newly hatched larvae were reared individually, and some of them emerged to adults after passing through the 4th nymphal instar. Most of the larvae developed to adults, but they remained in a postparasitic quiescent phase without ovipositing for more than one year. After feeding, the body outline of the larvae changed and closely approached the nymphal shape. The details of rearing experiments will be summarized and reported elsewhere in the near future.

Disease Relationship:

There are some reports of invasion of dwellings by this tick, and inhabitants have often complained of tick bites (Inatomi and Yamaguti, 1960; Hara, 1963; Uchikawa et al., 1967; and Uchikawa and Sato, 1969). However, there is no definite evidence of biting by *A. japonicus*, and it may be that bites were caused by the fleas, *Frontopsylla setiger* Smith or *Ceratophyllus farreni chaoi* Smit and Allan, which were often associated with *A. japonicus* in swallow nests.

The relationship of this tick to human disease is not known, but because it lives in close proximity to man the potential for transmission of disease to humans is real.

In 1960 Yamaguti found a nestling bird heavily infested with larvae and nymphs of *A. japonicus*. The bird appeared to be weakened to the point of death.

Argas vespertilionis (Latreille)
(Fig. 7 and 8)

Caris vespertilionis Latreille, 1802/1803:67-68; Kishida, 1936:142.

Argas vespertilionis: Kishida, 1927:986, Fig. 1899, 1947:975, Fig. 2775; Saito, 1955:7-12, Fig. 7-14; Kamo, 1962:173; Kishida and Asanuma, 1965:395, Fig. 214; Asanuma, 1965a: 124; Yamaguti, Clifford, and Tipton, 1968: 453.

Argas sp. Ito and Saito, 1954:563-564; Saito, 1955:7-12, Pl. II.

Discussion:

The first record of *A. vespertilionis* in Japan is probably Kishida's account in the 1927 edition of the *Illustrated Encyclopedia of the Fauna of Japan*. He stated that this species occurs in Honshu, Shikoku, Kyushu, Korea, and the Ryukyu Islands and listed seven species of bats as host animal in the above areas. Kishida (1936) also reported his collection of *Caris vespertilionis* in Korea. Saito (1955) collected *Argas* sp. from bats in Niigata City and reared the species on the host, *Pipistrellus abramus*. He did not definitely identify the tick, but he mentioned that his material was very close to *A. vespertilionis*. Although specimens were not available for study, morphological characters shown in photographs of the tick are similar to those of *vespertilionis*. Additional material has been collected from *Pipistrellus* spp. at Fukuota, Kyushu, and Sapporo, Hokkaido, and from *Vespertilio superans* at Shojo, Fukushima Prefecture, Honshu. The lot from *Vespertilio superans* was sent to Kohls and it was his opinion that the specimens differ

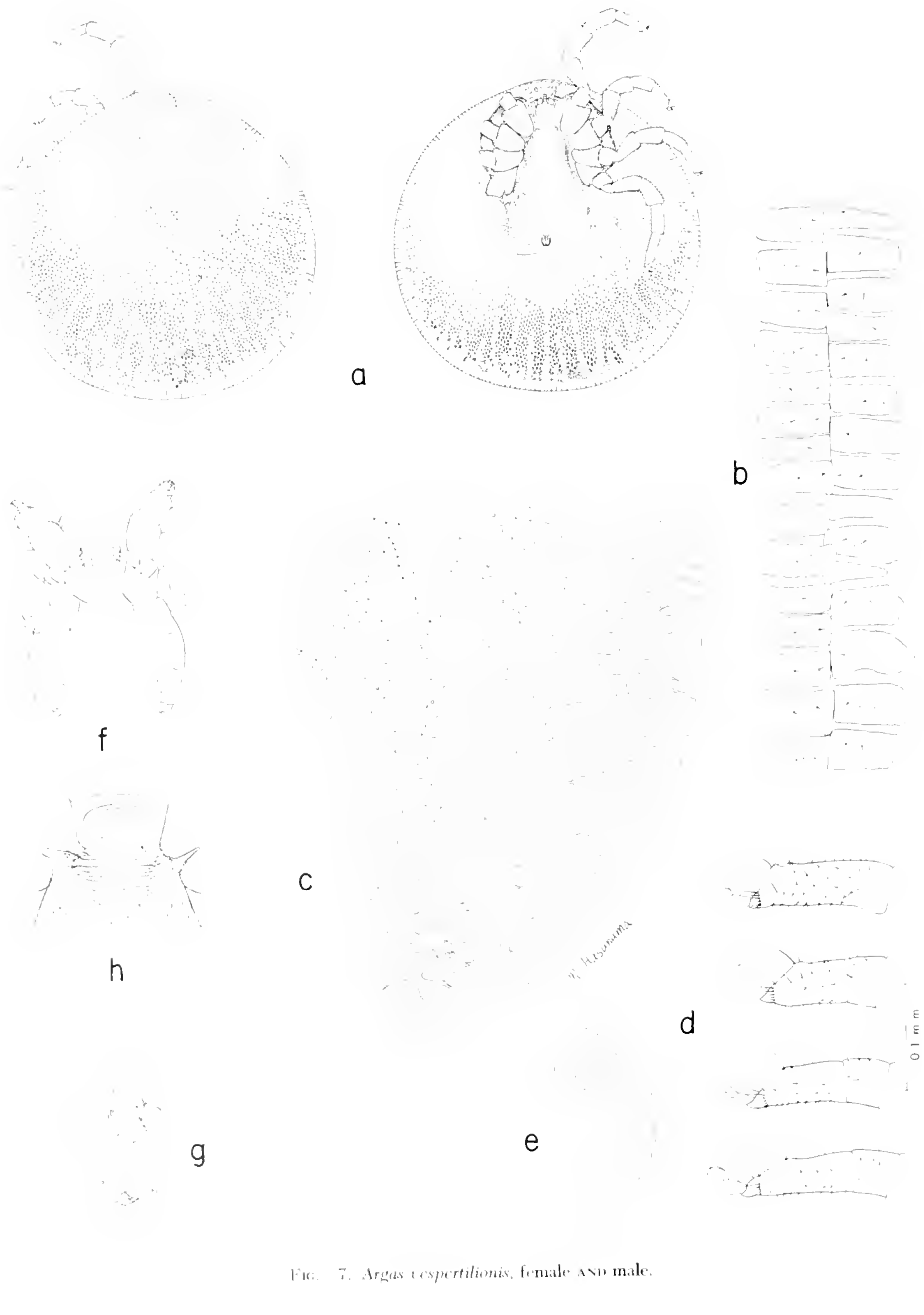


Fig. 7. *Argas vespertilionis*, female and male.

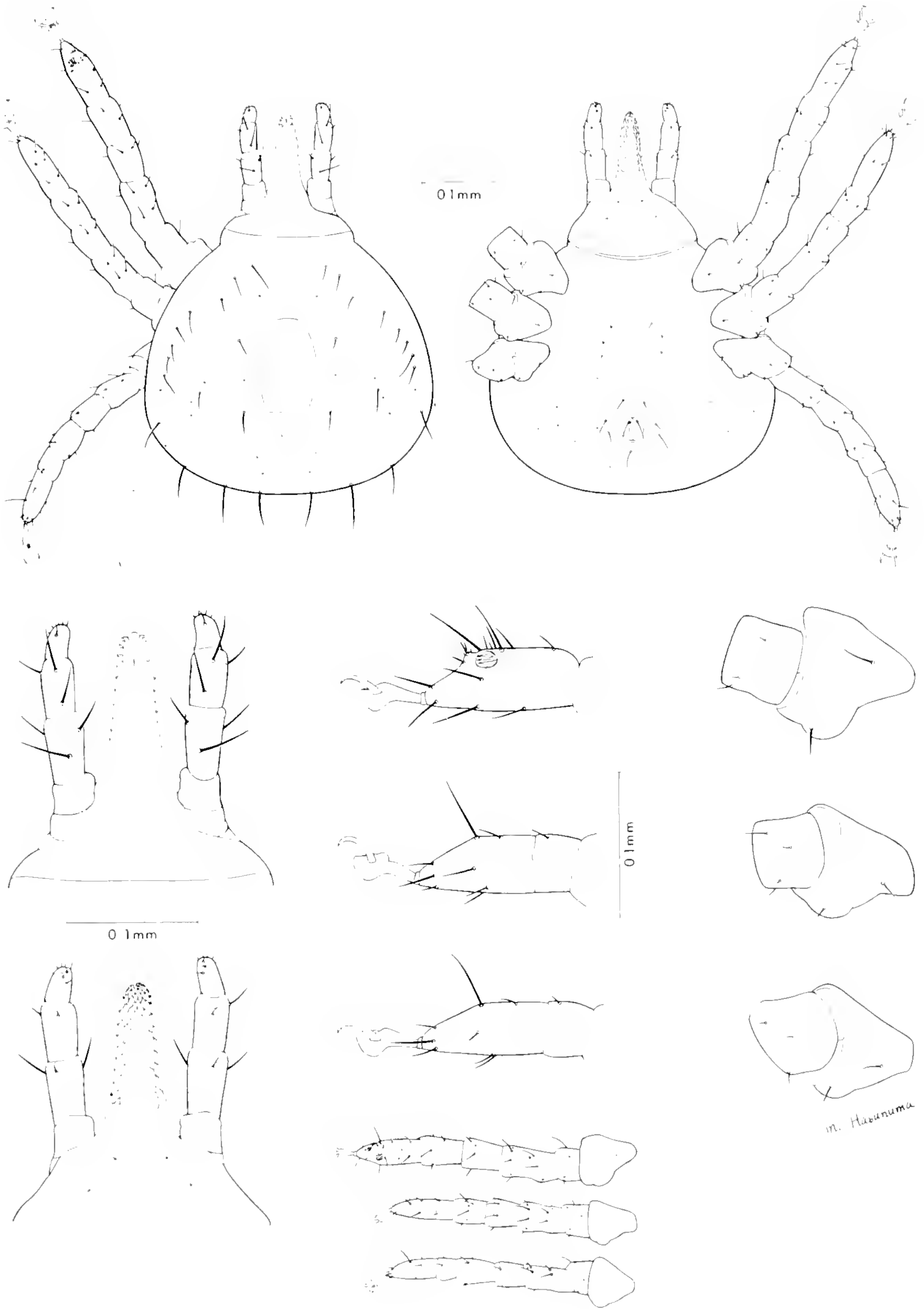


Fig. 8. *Argas vespertilionis*, larva.

only slightly in integumental characters from Egyptian *vespertilionis* and may well be the same species.

Hoogstraal (1956) considers the *A. vespertilionis* group to include European and African *vespertilionis*, *A. pussilus* Kohls, 1950 on Palwan Island in the Philippines, and closely related populations of uncertain species status, and that this group ranges throughout the continent and island groups of the world except in the Americas.

DIAGNOSIS:

This round bat-tick is the sole argasid species parasitizing bats in Japan and Korea and is readily distinguished from other argasids in this fauna. The body is circular, the anterior margin has a very slight anterior projection, in the peripheral area there are rectangular "cells" and a definite sutural line dividing the dorsal and ventral surfaces, there are distinct ventral "paired organs" posterior to the anus, and the mouth parts are close to the anterior margin of the body.

DISTRIBUTION AND HOSTS:

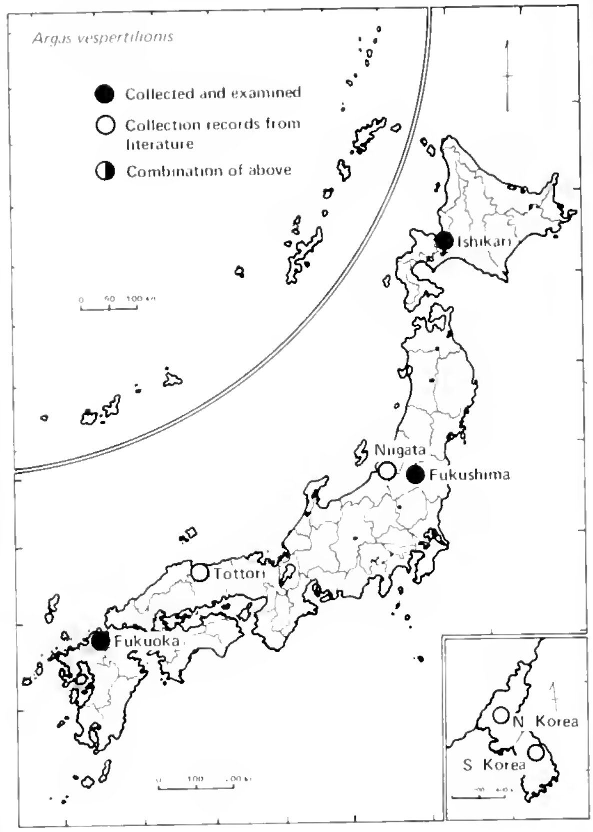
Hoogstraal (1956) gave the distribution and hosts of the *vespertilionis* group as England, the Netherlands, Sweden, Spain, Germany, Africa, Korea, China, the Philippines, and Ceylon. The group is also known to occur in southern India, Cambodia, Australia, France, Italy, Russia, and Japan. Sugimoto (1936b) cited Sauter's collection of *A. vespertilionis* on Taiwan. Almost all species of bats within the distributional range of *A. vespertilionis* may be parasitized by this tick, and all stages of the tick may infest these bats. Both nymphs and adults occasionally attack man.

BIOLOGY:

Saito (1955) reared this species on the host bat in the laboratory but did not mention details of the life cycle, except that the nymphs fed at night, adults appeared about three months after passing through three nymphal instars at 25-30 C, and that below 10 C the ticks of each stage went into hibernation.

Hoogstraal (1956) reported that *A. vespertilionis* was successfully reared in his laboratory at 80-90 F and 40-50% relative humidity.

> Eggs hatched 16-20 days after oviposition and larvae fed as soon as 4 days afterwards. Larvae fed for 14-31 days, usually 17-19 days, and molted 5-10 days later. Nymphs fed 3-4 days after molting and they usually fed twice, followed by a molt 8 or 9 days after the first meal and 12-14 days after the second meal. Nymphs become replete in 20-50 minutes, usually 30-40 minutes. Adult males may develop from the first nymphal molt, but usually nymphs molt twice before becoming adults. Males and females may feed within 7 days after molting, and they feed for 30-40 minutes. No females oviposited within 6 months after the nymphal-adult molt, even though with males continuously and given two to six blood meals. The first oviposition follows a blood meal by about a week and appears to trigger a physiological release mechanism, because in several instances females have deposited fertile eggs three months afterwards with or without a meal.



MAP 3. Known distribution of *Argus vespertilionis*.

DISEASE RELATIONSHIP:

Nymphs and adults may attack man (several authors), and in Japan, Kamo (1962) reported one instance of a human being bitten by this tick. Reports indicate that mild itching may persist for several weeks. This tick may be a vector of a spirochete of bats, but conclusive supporting evidence is not available. The relationship of this tick to human disease has not been studied.

Genus *Ornithodoros* C. L. Koch, 1844

Body more or less flattened. Dorsal surface usually convex when fully fed. Body margin structurally not different from adjacent areas. Sutural line absent. Capitulum subterminal or apart from anterior margin of the body. Hood, cheeks, and camerostome present. Dorsal humps and protuberances prominent on tarsi. Eyes absent or present.

TYPE SPECIES: *Ornithodoros savignyi* (Audouin, 1826).

Ornithodoros capensis Neumann (Fig. 9 and 10)

Ornithodoros talaje var. *capensis* Neumann, 1901:258.

Ornithodoros capensis Neumann, 1901; Kohls, 1957a:89-90, Fig. 1; Keegan and Toshioka, 1957:23; Asanuma, 1960:94, 1965a:124, Fig. 7.16.

DISCUSSION:

The original description of this species was based on material taken from nests of penguins on islands off the coast of Cape Colony, South Africa. Kohls (1957a) considers *capensis* to be distinct enough to warrant full specific status and to be readily distinguishable from *talaje* on the basis of morphological differences as well as host relationship and distribution. In Japan, *O. capensis* was first found by Asanuma associated with *Ixodes signatus* in July 1955 at Kabujima, Aomori Prefecture, Honshu. He did not, however, refer to this soft tick in his two papers on *Ixodes signatus* published in 1955 and 1957. In his paper of 1960 Asanuma assembled the known information on *O. capensis* in Japan up to that time and indicated he had collected this species in 1955. Later the tick was collected by 406th Medical Laboratory personnel at the same locality, as well as from several other localities.

DIAGNOSIS:

This soft tick is the only species of the genus *Ornithodoros* parasitizing sea birds in this area and is easily recognized by the generic characters used in the key. As reported by Kohls (1957a), this species resembles *O. amblus*, but differs from that species in having a more pointed anterior margin of the body and cheeks with partially overlapping mouth parts.

DISTRIBUTION AND HOSTS:

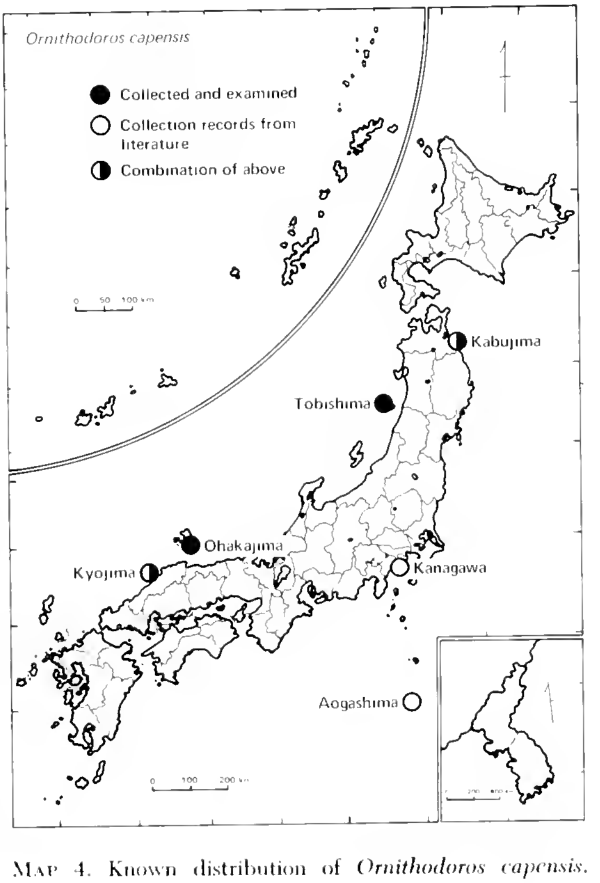
O. capensis is known to be widely distributed throughout the world. Kohls (1957a) reviewed the distributional records of this species and listed the names of islands where the species is known to occur. These include islands off the coasts of South Africa, southern Australia and Japan, and additional islands in the Atlantic, Pacific, and Indian oceans.

Amerson (1968) states: "It is presently known from 32 islands and at sea in the Central Pacific and immediate surrounding areas from 22 sea and shore bird species, as well as from man, the European rabbit, sea turtles (*Celonia mydas*), and ground litter . . . Since 1901 *O. capensis* has been recorded around the world in the tropical and temperate regions and has been associated with 29 species of sea and shore birds throughout the world (from published and unpublished records)." Amerson also gives a world distribution map of this species.

In Japan *O. capensis* has been found on the black-tailed gull, *Larus crassirostris*, the streaked shearwater, *Calonectris leucomelas*, and the ancient auk, *Synthliboramphus antiquus*. According to Asanuma (1960), *O. capensis* will attack domestic fowls.

BIOLOGY:

O. capensis has been reared on chickens at the 460th Medical Laboratory. Larvae fed for 5-6 days and molted to 1st instar nymphs 1-4



MAP 4. Known distribution of *Ornithodoros capensis*.

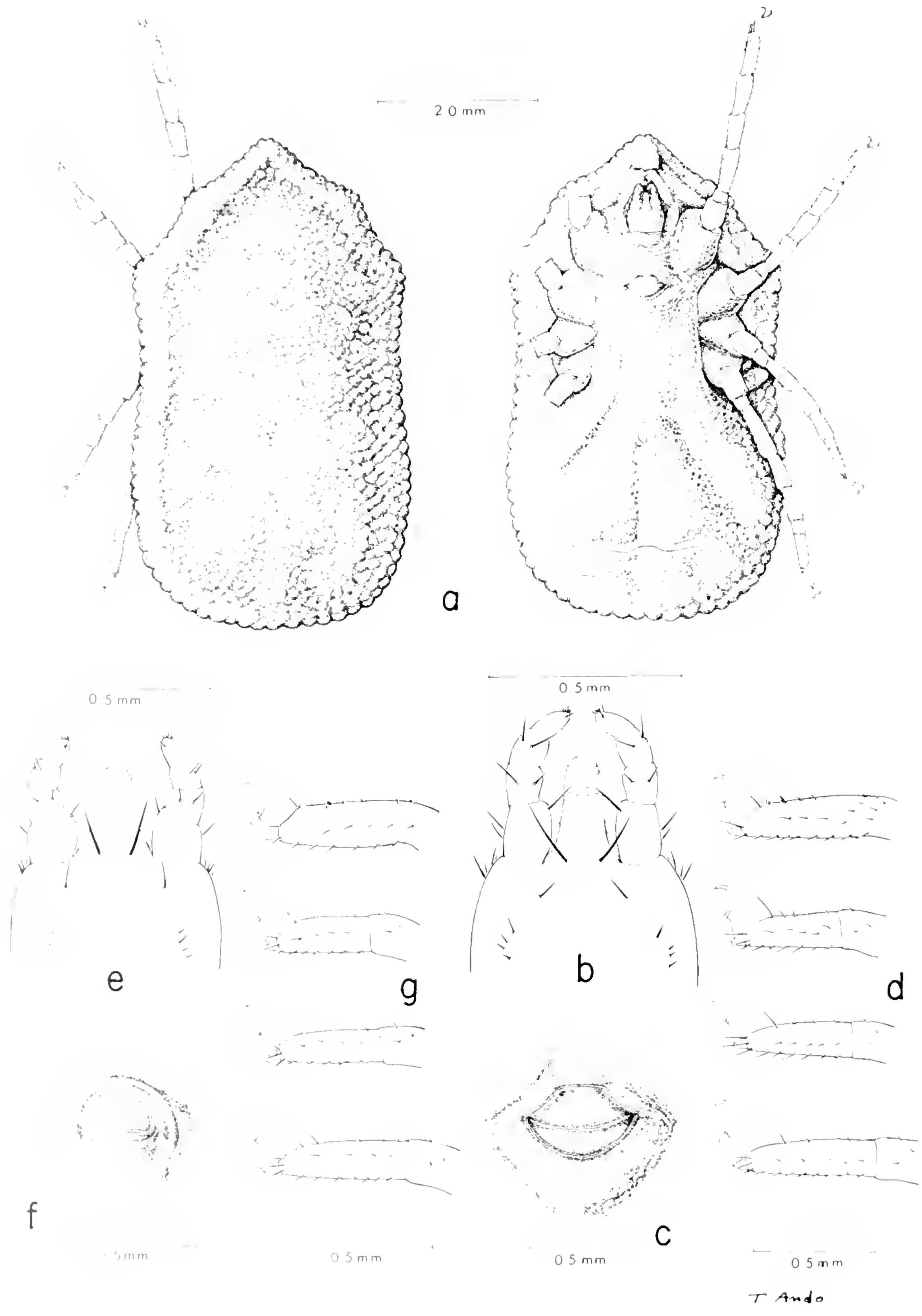


Fig. 9. *Ornithodoros capensis*, female and male.

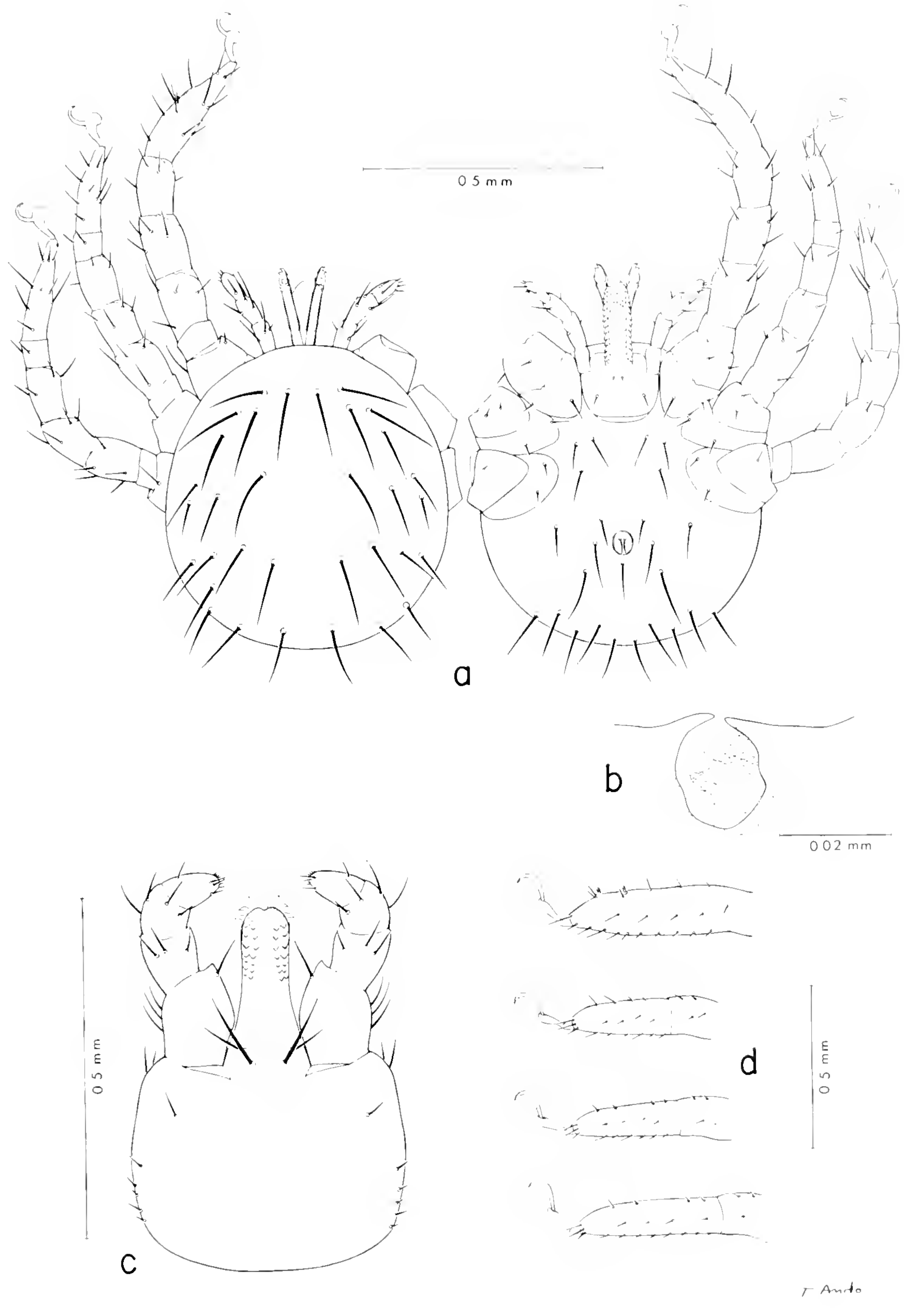


FIG. 10. *Ornithodoros capensis*, larva AND nymph.

days afterwards. 1st instar nymphs molted to 2nd instar nymphs in 13-17 days without a blood meal. These 2nd instar nymphs, when given a blood meal within 9 days after molting, molted again to 3rd instar nymphs 14-18 days after the blood meal. There were at least three instars in the nymphal stage under laboratory conditions at approximately 25 C, but some 3rd instar nymphs developed into 4th instar nymphs. Details of the life cycle shall be reported elsewhere at the conclusion of current rearing and life-cycle studies.

Disease Relationship:

Unknown.

Family Ixodidae Murray, 1877

Scutate "hard ticks." Sexual dimorphism marked; well-sclerotized scutum covering the dorsal surface almost entirely in males, partially (behind capitulum) in females, nymphs, and larvae. Capitulum at anterior margin of body. Porous areas present in female on dorsal side of basis capituli. Eyes present or absent; when present, laterally on the scutum. Palpal articles not free; 4th article much reduced, inserted ventrally on 3rd article. Spiracular plate present, posterior to coxae IV.

Type Genus: *Ixodes* Latreille, 1795.

Genus *Amblyomma* C. L. Koch, 1844

Generally ornate. Palpi long; article II at least twice as long as wide. Eyes and festoons present. Basis capituli variable in form; usually roughly triangular or rectangular dorsally. Adanal shield absent in male. Spiracular plate roughly triangular or comma-shaped.

Type Species: *Amblyomma cajennense* (Fabricius, 1787).

Key to the Males of the Genus *Amblyomma*

1. Hypostome with denticles of inner file almost equal with others; coxae II, III, IV with subequal external spurs; on tortoises (Fig. 12) .... *geoemydae*
   Hypostome with denticles of inner file much smaller than others; coxa IV with external spur much longer than those of coxae II and III; on larger wild and domestic mammals (Fig. 17) .... *testudinarium*

Key to the Females of the Genus *Amblyomma*

1. Hypostome with denticles of inner file much smaller than others; coxa IV with external spur slightly longer than those of coxae II and III; on larger wild and domestic mammals (Fig. 16) .... *testudinarium*
   Hypostome with denticles of inner file almost equal with others; coxae II, III, IV with subequal external spurs 2
2. Coxa I with two spurs; body with thick setae; dorsal foveae unusually large; on tortoises (Fig. 11) .... *geoemydae*
   Coxa I with single small spur; body without thick setae; dorsal foveae inconspicuous; on sea snakes (Fig. 15) .... *nitidum*

Amblyomma geoemydae (Cantor)
(Fig. 11-14)

Ixodes geoemydae Cantor, 1847:608.

Amblyomma malayanum Neumann, 1908:14-16, 26, Fig. 9-10; Keegan and Toshioka, 1957:8, Pl. 4, 5; Kawashima, 1963:103; Asanuma, 1965a:107.

Discussion:

This tick, originally described by Cantor in 1847, was collected from the neck of *Geoemyda spinosa* in Sumatra. Keegan and Toshioka (1957) collected males, females, and nymphs from tortoises on Kyushu and in the Ryukyu Islands. Anastos (1950) reviewed the synonymy and distribution of *malayanum* and *geoemydae* and noted morphological characters, but he did not mention the relationship between the two, probably because specimens of *geoemydae* were not available for study. Later Kohls (1957b) discussed both species and showed *malayanum* to be a synonym of *geoemydae*.

Specimens reported here were all taken from tortoises on Kyushu and in the Ryukyu Islands. One specimen, a nymph found on a human, was probably a stray from a tortoise examined the same day.

Diagnosis:

This tortoise tick is easily distinguished from *nitidum* and *testudinarium* by the combination of characters used in the key. The female of this species is especially distinctive in that the

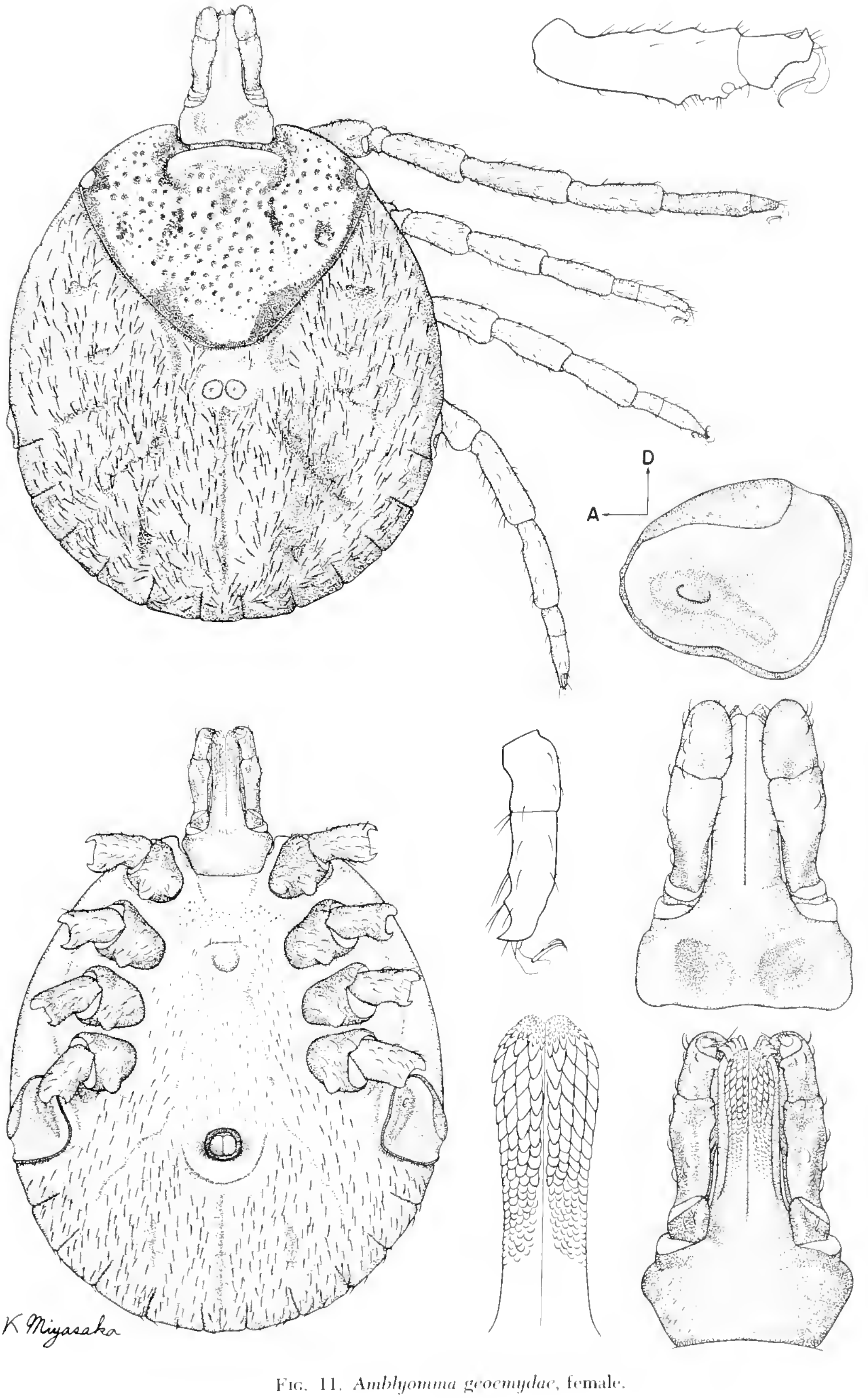


FIG. 11. *Amblyomma geoemydae*, female.

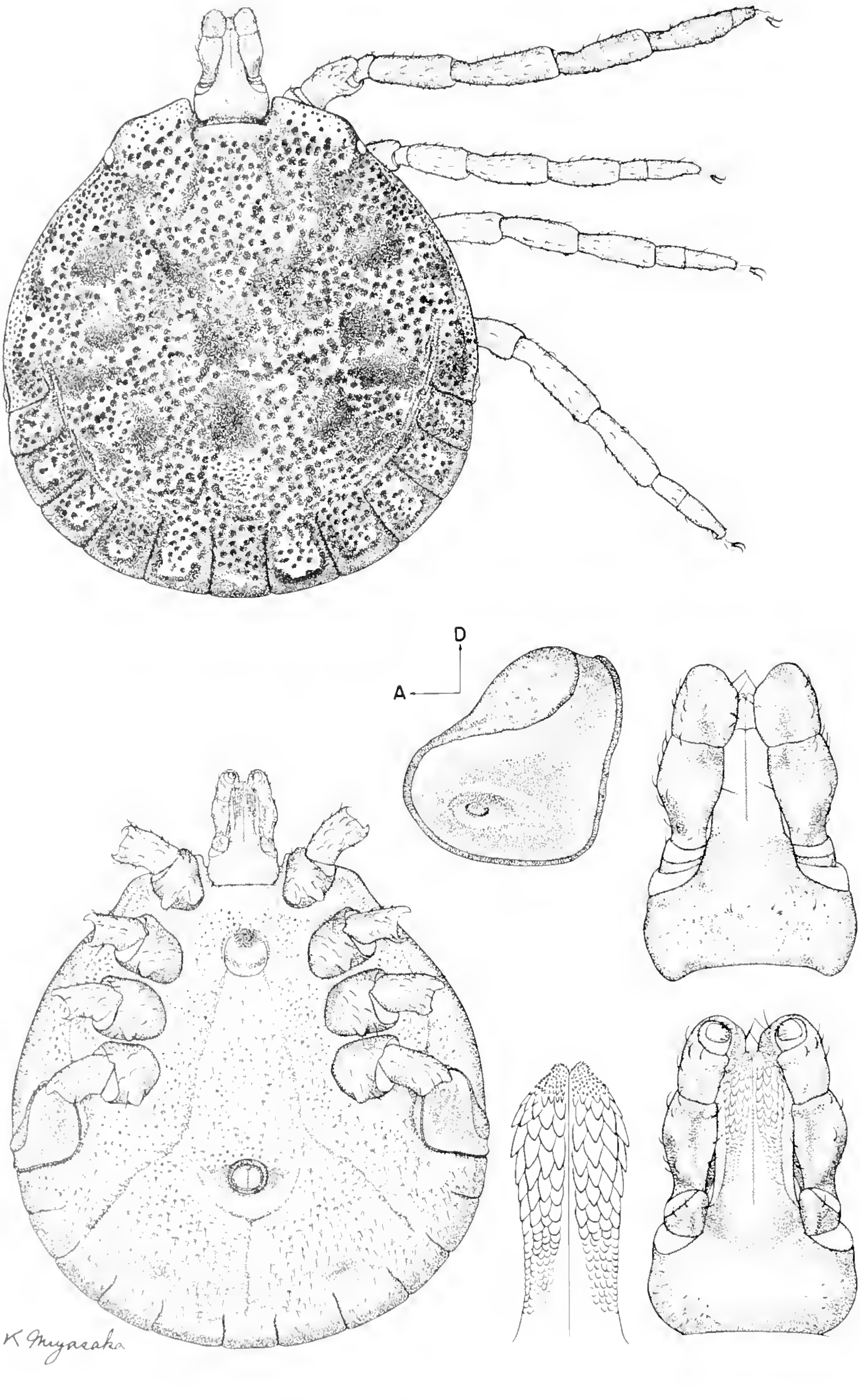


FIG. 12. *Amblyomma geoemydae*, male.

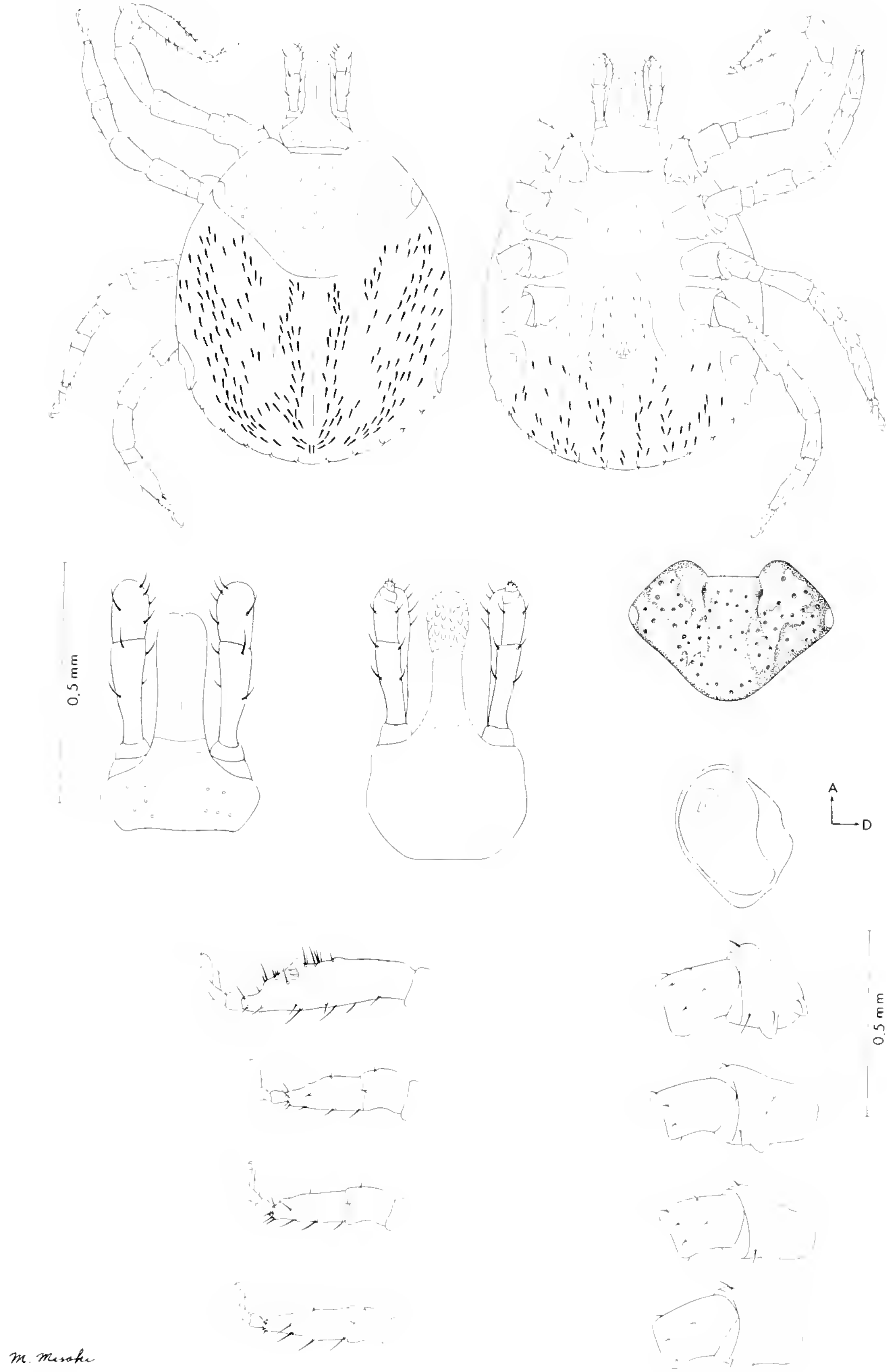


Fig. 13. *Amblyomma geoemydae*, nymph.

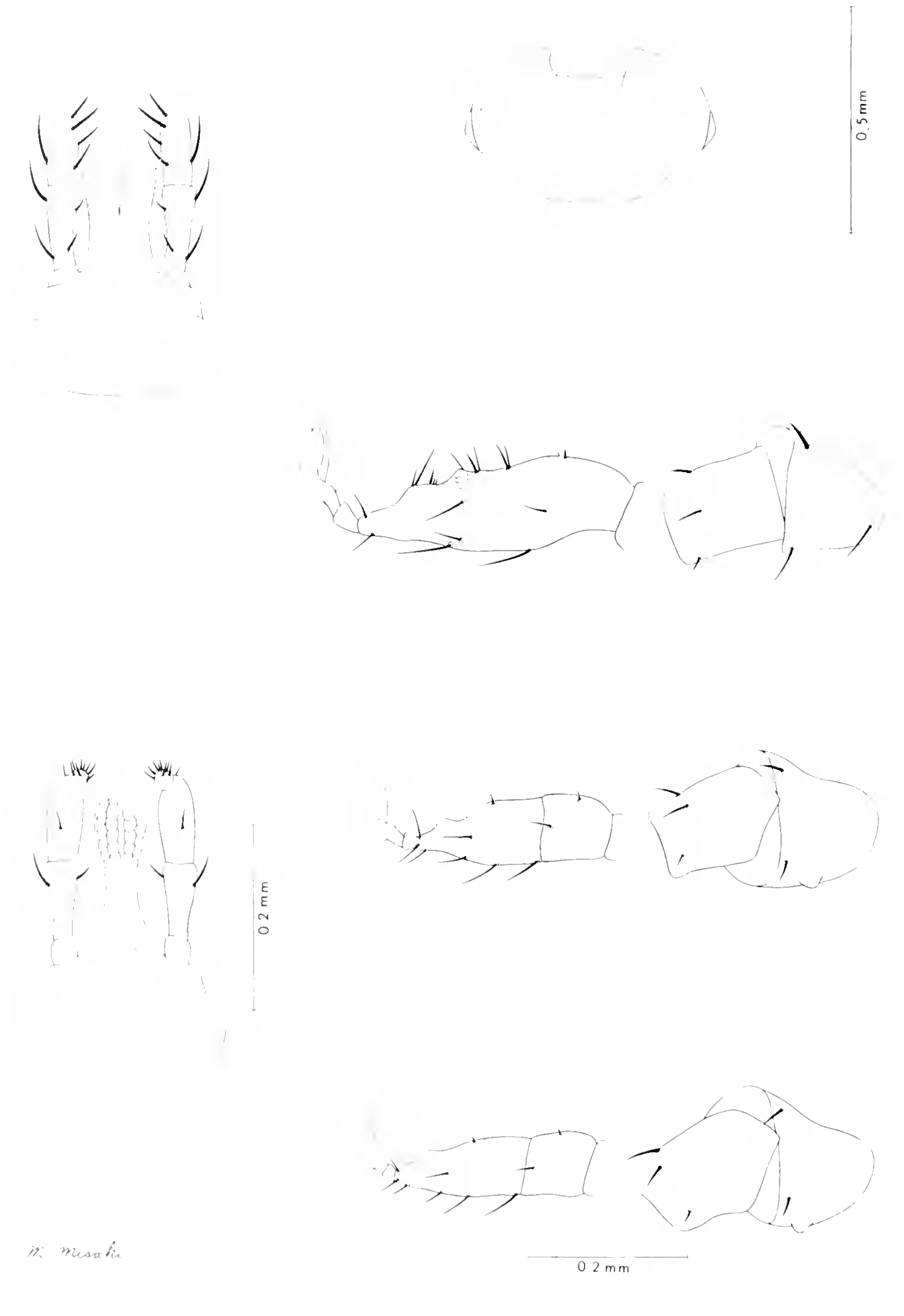
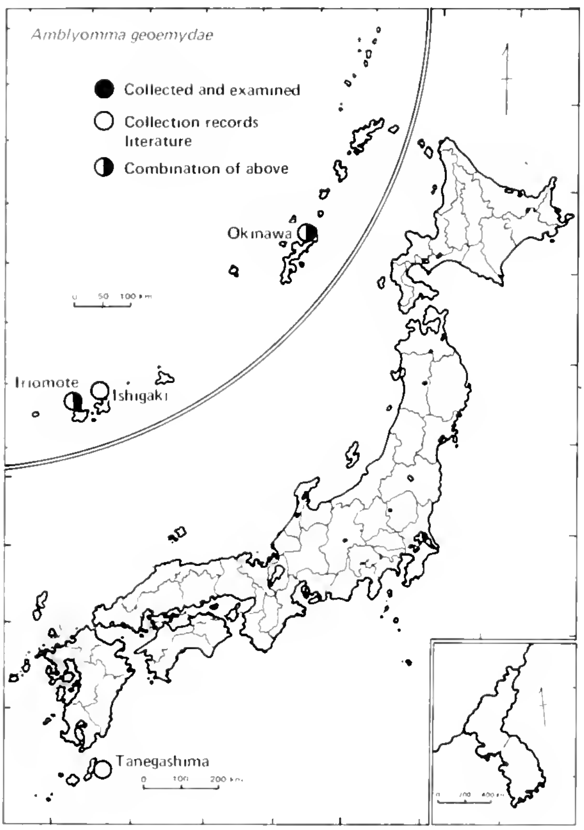


Fig. 14. *Amblyomma geoemydae*, larva.

dorsum has a pair of large, adjacent foveae on the postscutal area; the dorsal surface has thick, short setae; and the basis capituli has large porous areas.

Distribution and Hosts:

Anastos (1950) stated that the species was known only from tortoises collected in Singapore, Malaya, Sumatra, and the Philippines. Kohls (1957b) also reported this species from Sarawak ex *Varanus salvator*, *Cylemys dentata* (as *C. dhor*), *Heosemys spinosa* (as *Geoemyda spinosa*), *Testudo emys*, and "stomach of fish," *Pontius sealei*.



Map 5. Known distribution of *Amblyomma geoemydae*.

Biology:

One of us (Toshioka) reared to adults, nymphs collected from *Clemmys japonica* in Tanegashima, Kagoshima Prefecture, 19 July 1955. In the laboratory the nymphs attached to the wet skin of the tortoise, *Geoclemys reevesii*, and molted on 13 September 1955.

Nadchatram (1960) used *Testudo emys*, *Cuora amboinensis* (a box tortoise), and a guinea pig as hosts for his life-cycle studies. *Testudo emys* was the most suitable host for larvae, nymphs, and adults; the box tortoise was a little less suitable host, and the guinea pig was an unsatisfactory host.

Laboratory life cycle of *Amblyomma geoemydae* (reared on *Testudo emys*) (from Nadchatram, 1960)

Stage or Activity	Days
Female oviposited after	5
Female continued oviposition for	21
Larvae hatched out after	20-32
Larvae were fed after	24
Larvae fed for	8-20
Engorged larvae quiescent for	3-5
Nymphs emerged after	10-14
Nymphs were fed after	20
Nymphs fed for	12-28
Engorged nymphs quiescent for	5-10
Adults emerged after	25-30
Adults were fed after	14
Adults fed for	18-48
Number of days required to complete life cycle	185-271

Disease Relationship:

Unknown.

Amblyomma nitidum Hirst and Hirst (Fig. 15)

Amblyomma nitidum Hirst and Hirst, 1910: 304-305.

Discussion:

The original description of this tick was based on specimens collected from a sea snake in the Solomon Islands. Sharif (1928) stated that there were specimens of all stages in the Indian Museum from Port Blair, Andaman Islands. Warburton (1932) described *Amblyomma laticaudae* as a new species taken from a sea snake *Laticauda colubrina* in Singapore. Kohls (1957b) reported on *Amblyomma* sp. from *L. colubrina* from Singapore, and Audy, Nadchatram, and Lim (1960) also reported *A. nitidum* from the same host and locality. Audy et al. (1960) stated that Kohls later compared these specimens and listed *laticaudae* as a synonym of *nitidum*.

Two females collected from *Laticauda semifasciatus* on Ishigaki (Is.) were the first reported specimens of *A. nitidum* in the Ryukyu Islands.

Diagnosis:

The female of this sea snake tick is distinct from the other two *Amblyomma* spp. included in this publication in that the coxae have very small external spurs; the lateral margin of the basis capituli is convex at the middle when viewed from the ventral side; the dorsum does

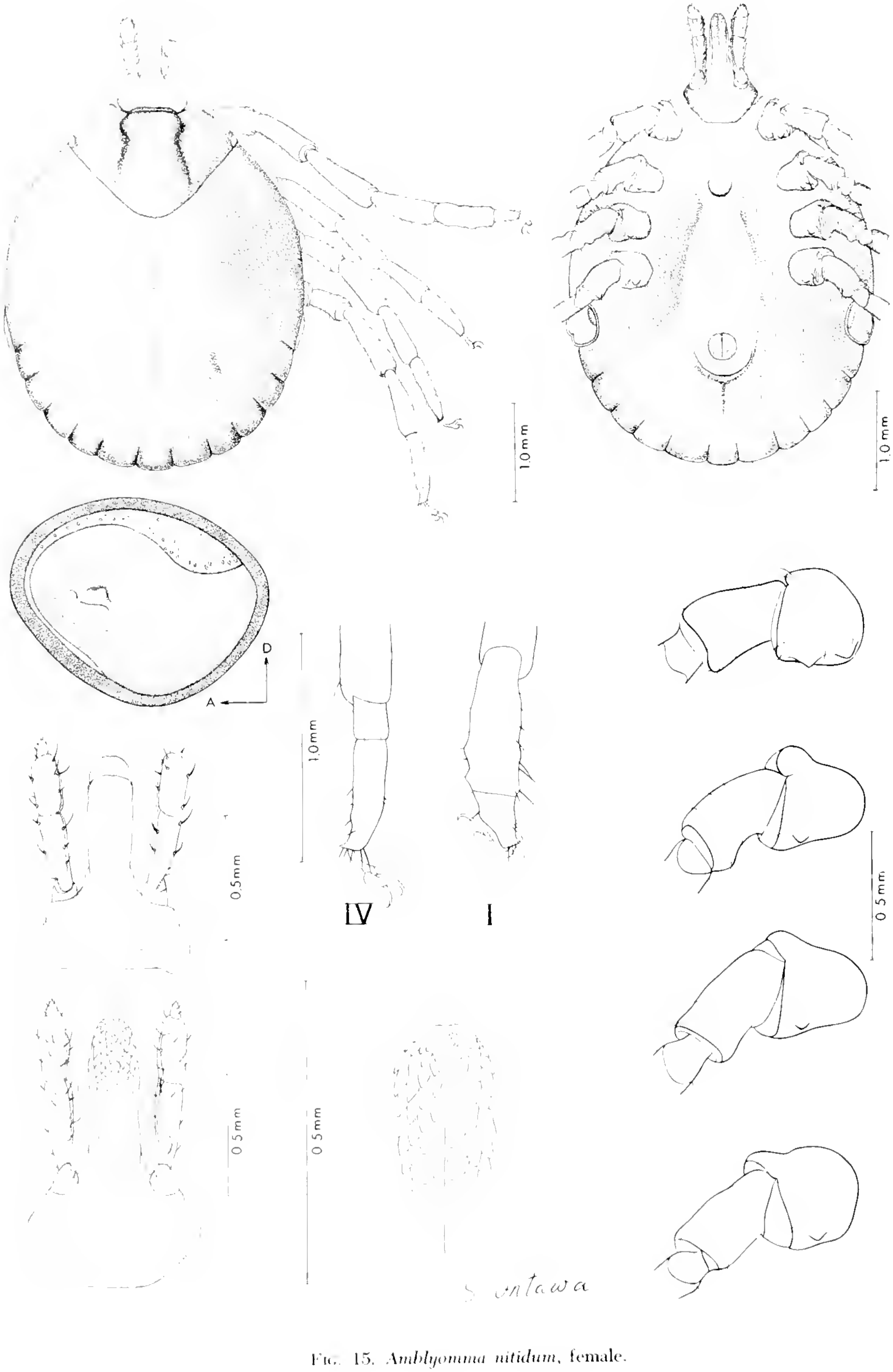
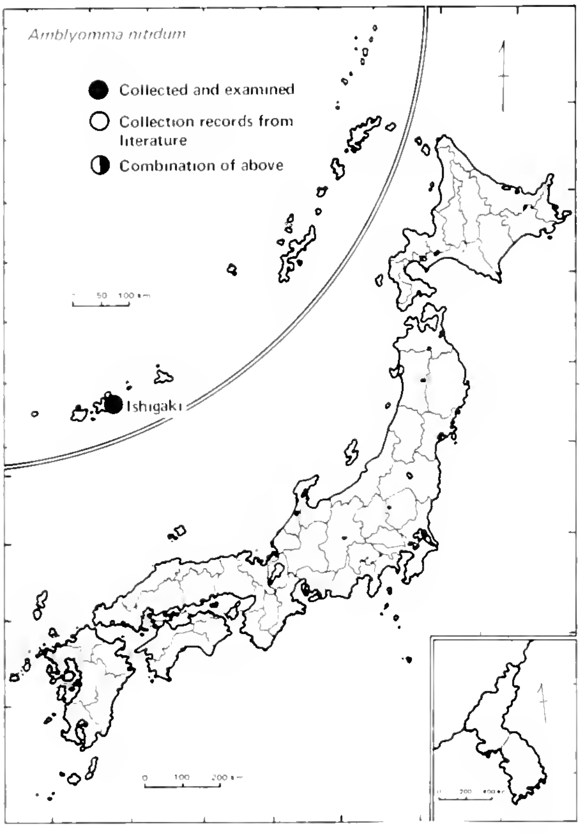


Fig. 15. *Amblyomma nitidum*, female.

not have marginal grooves; and the dorsal foveae are inconspicuous.

DISTRIBUTION AND HOSTS:

The known distribution includes: Solomon Islands, ex sea snake (Hirst and Hirst, 1910); Andaman Islands, host unmentioned (Sharif, 1928); Singapore ex *Laticauda colubrina* (Warburton, 1932, as *A. laticaudae*: Audy et al., 1960); and the first record from the Ryukyu Islands reported herein.



MAP 6. Known distribution of *Amblyomma nitidum*.

BIOLOGY:

It is of interest that this nocturnal sea snake spends the daytime resting, often in tightly-packed groups, in mangrove tree-holes or in rock crevices out of the water. Furthermore, the genus *Laticauda* appears to have evolved from an elapid stem much later than the other sea snakes. This would explain not only the infestation by *Amblyomma*, but also the infestation of the air-sacs by larvae of a peculiar trombiculid mite, *Vatacarus ipoides* Southcott . . . It will be interesting to discover how *A. nitidum* is adapted to parasitizing this sea snake (Audy et al., 1960).

DISEASE RELATIONSHIP:

Unknown.

Amblyomma testudinarium C. L. Koch
(Fig. 16-19)

Amblyomma testudinarium C. L. Koch, 1844: 226; Kishida, 1922a:850-851, 856; Robinson, 1926:257; Sugimoto, 1937a:317-323, 1937b: 612-613, Pl. 4; Nakamura and Yajima, 1937: 174-175, Fig. 1-9 in Pl. XIV; Itagaki, Noda, and Yamaguchi, 1944:1-97, Pl. 17, 22, 1959: 1-118, Pl. 17, 22; Keegan and Toshioka, 1957: 9, Pl. 6, 7; Kawashima, Kamo, and Miyazaki, 1960:77-80; Tanaka et al., 1960:69-70, Fig. 1-3; Nagahana and Matsuo, 1962:119-120; Asanuma, 1965a:106-107, Fig. 7.3, 1965b:400, Fig. 226.

Amblyomma yajimai Kishida, 1935:137-138, Fig. 1-4; Nakamura and Yajima, 1937:176, Fig. 7, 8 in Pl. I, Fig. 5-10 in Pl. XV; Itagaki, Noda, and Yamaguchi, 1944:1-97, Pl. 18, 22, 1959:1-118, Pl. 18, 22.

DISCUSSION:

Anastos (1950) and Kohls (1950) have reviewed the extensive synonymy of this widely distributed species. The first report of this tick from Japan (Kishida, 1922a) was based on a specimen collected from a pig in Tokyo. Sugimoto (1937a, 1937b) reported two collections of larvae from the frog, *Microhyla fissipes*, and from a green frog (sp?) on Ishigaki, an island in the Ryukyu archipelago. These two lots were not collected by Sugimoto but submitted to him by the collector. Considering the host-parasite relationship of this tick, it is very questionable that *A. testudinarium* was parasitic on a frog.

In his description of *Amblyomma yajimai* Kishida (1935) included illustrations of venter, scutum, spiracular plate, and the 1st tarsus of the holotype female. He gave only diagnostic characters to separate it from *A. testudinarium*, and a precise description of the holotype was given later by Nakamura and Yajima (1937). The holotype specimen labeled as "1291 1.VII. 1935. Taito-cho, Hinan-ku (Formosa), Pasicau, from mammae of water buffalo, Yajima *Amblyomma yajimai* Kishida" was examined by Kohls, and it was his opinion that *A. yajimai* is is conspecifie with *A. testudinarium* Koch. *A. yajimai* was also reported by Itagaki et al. (1944, 1959), and all of these collections are from water buffalo, *Bubalus bubalis*, on Formosa.

DIAGNOSIS:

This large tick is easily distinguished from *nitidum* and *geoemydae* in that the denticles of

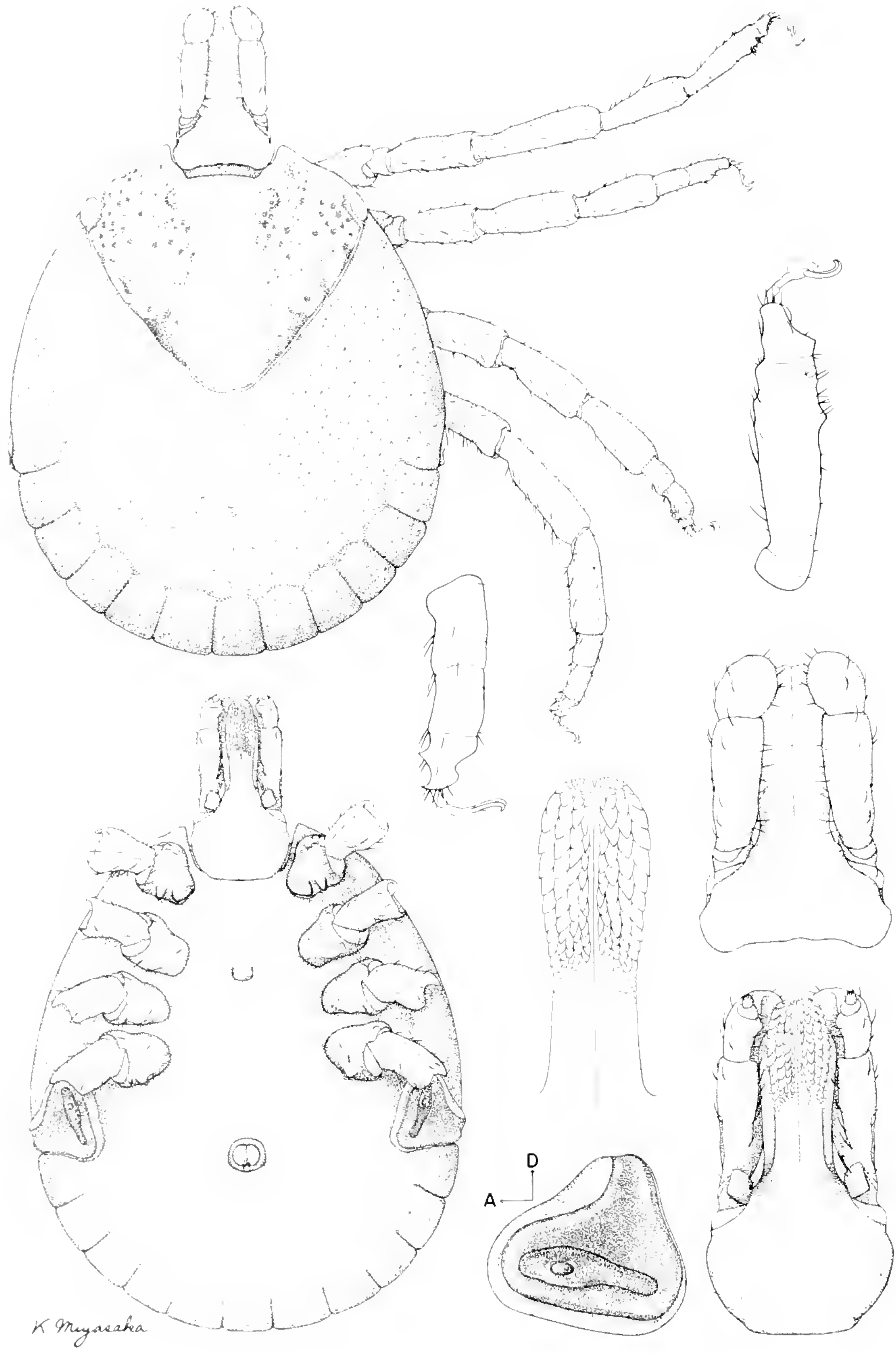


Fig. 16. *Amblyomma testudinarium*, female.

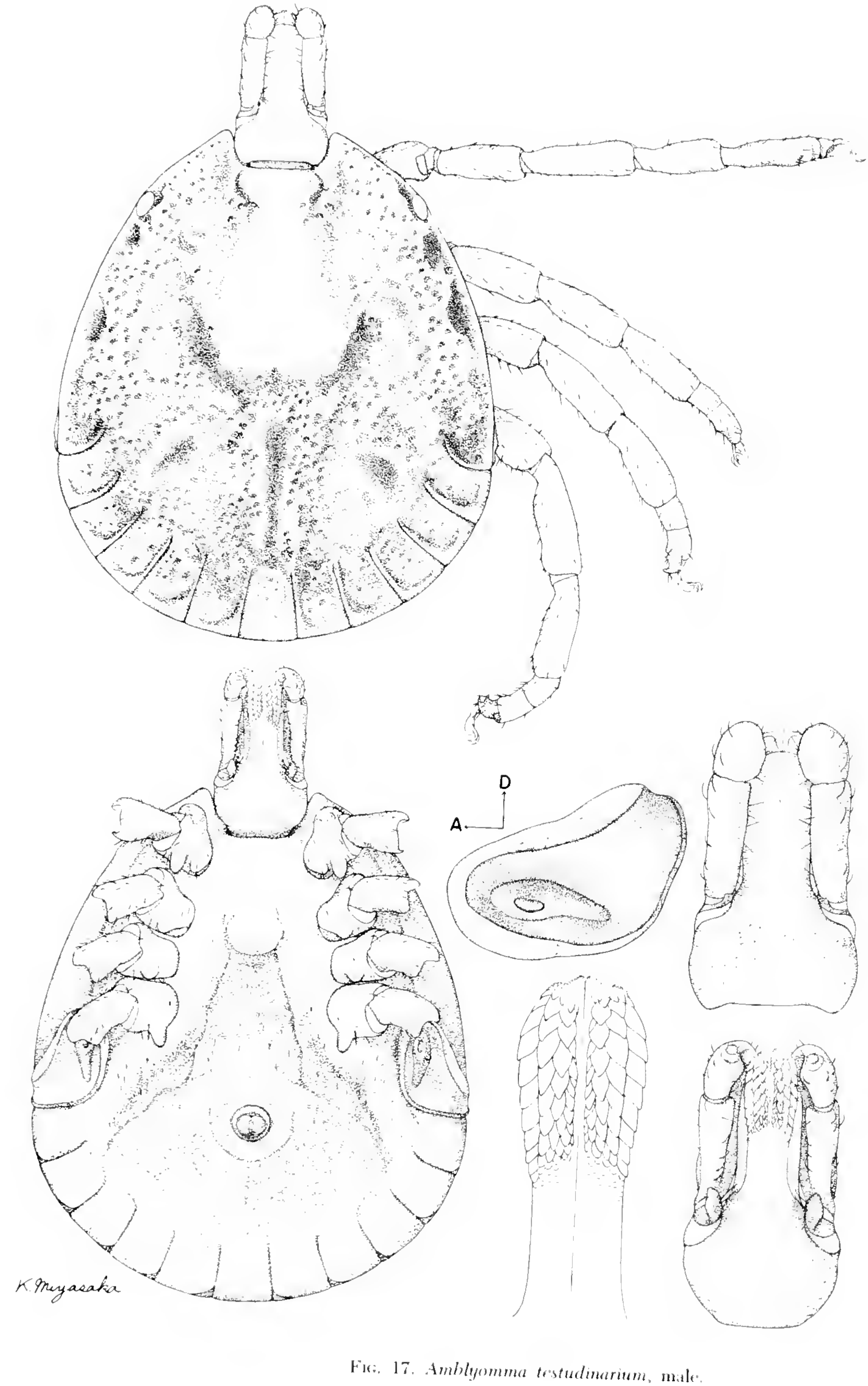


FIG. 17. *Amblyomma testudinarium*, male.

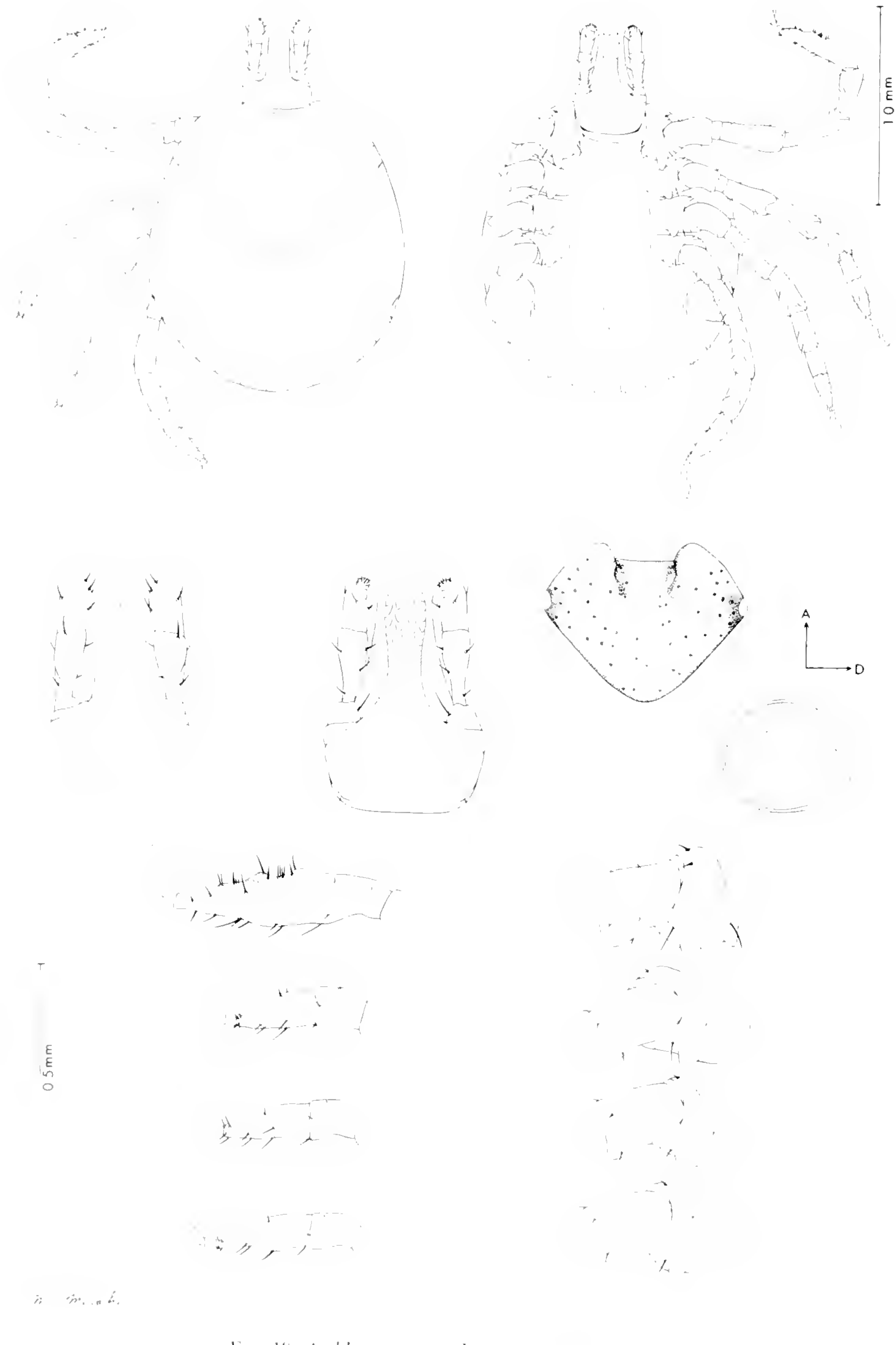


FIG. 18. *Amblyomma testudinarium*, nymph.

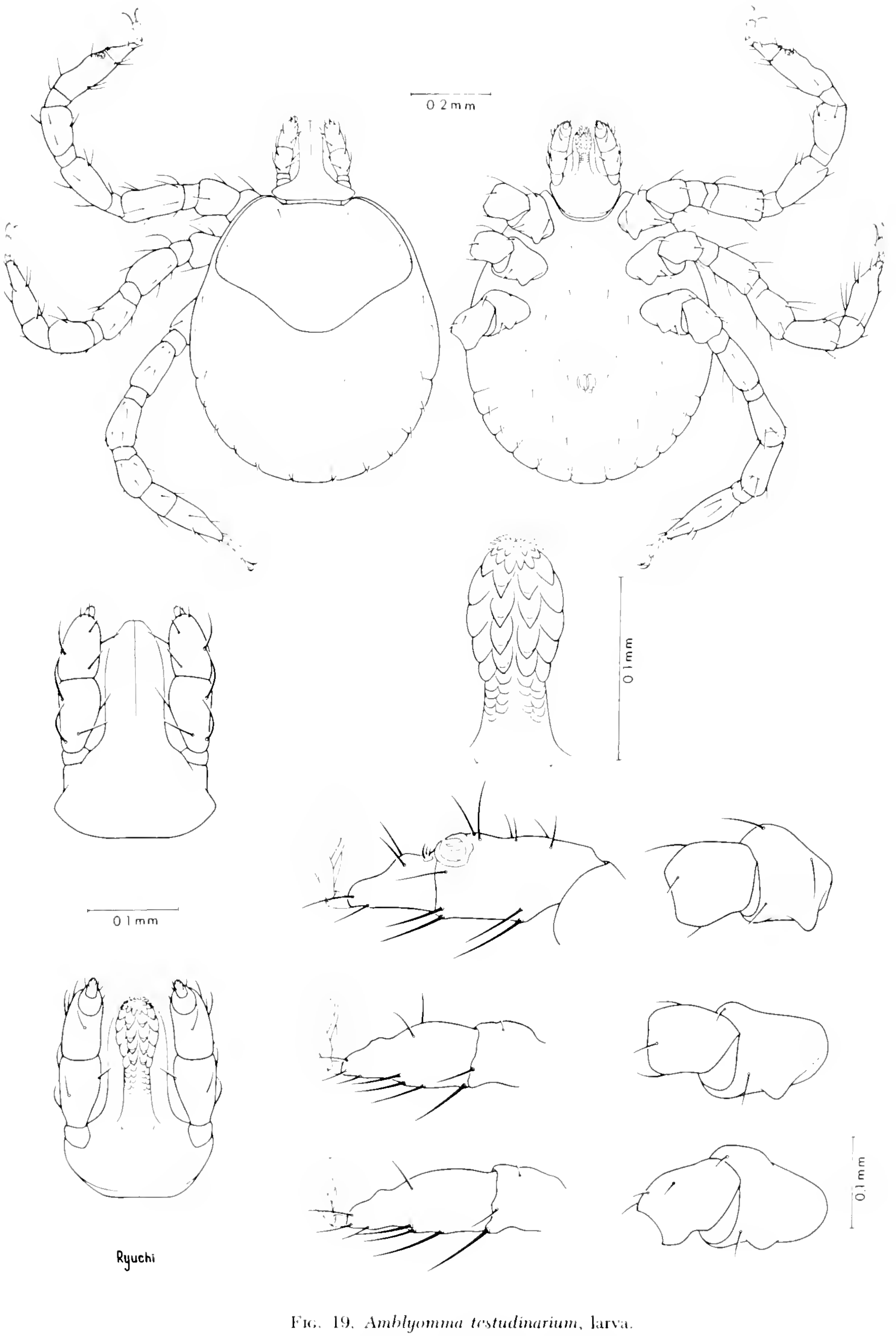
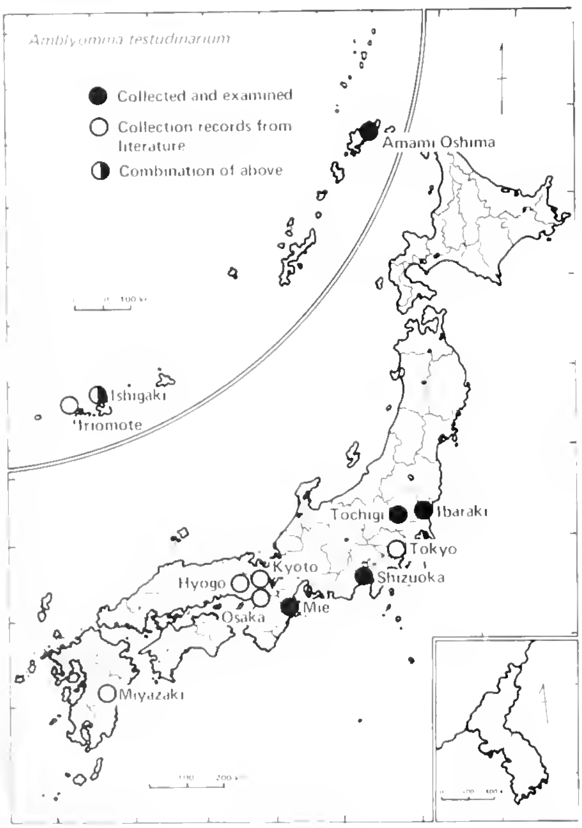


FIG. 19. *Amblyomma testudinarium*, larva.

the inner file are much smaller than those of the other files; the external spur of coxa I is longer than the internal spur; the spur of coxa IV is longer than those of coxa II and III which are short and blunt in the male, broad and ridgelike in the female; tarsi III and IV have two distinct subapical ventral spurs; the dorsum has a pair of small foveae which are well separated in the female.

Distribution and Hosts:

Kohls (1957b) has listed the distribution and hosts of this species. It is widely distributed in the Far East and is known to occur in the following areas: India, Burma, Ceylon, Indonesia, Borneo, Malaya, Indochina, Formosa, the Philippines, and Japan. Hosts recorded by Sugimoto (1937a), Nakamura and Yajima (1937), and also by Kohls (1957b) are usually larger animals such as water buffalo, horse, cow, wild boar, wild pig, goat, dog, tiger, rhinoceros, deer, tapir, and human.



Map 7. Known distribution of *Amblyomma testudinarium*.

Biology:

According to Anastos (1950) all stages in the life cycle are known, and this tick occurs on a wide variety of wild as well as domestic animals. One of the unengorged females collected by 406th laboratory personnel from Amami Oshima was placed on a rabbit's ear in the laboratory on 6 November 1967, fed for a week, and increased in size to 23 mm in length and 21 mm in width. After engorgement this tick died on 26 November 1967 without laying eggs.

Disease Relationship:

"Krijgsman and Ponto (1932) stated that this species transmits piroplasmosis and anaplasmosis, and Sharif (1938) considered this species as a possible disease vector" (Anastos, 1950). In Japan, however, its disease transmission capability is not known. Japanese workers have reported that it attacks humans.

Genus *Boophilus* Curtice, 1891

Inornate. Palpi short, compressed, ridged dorsally and laterally. Basis capituli hexagonal dorsally. Eyes present. Festoons absent. The males with adanal and accessory shields. Anal groove obsolete in the female, faintly indicated in the male. Caudal process present or absent in the male. Spiracular plate round or oval in both sexes. Coxa I bifid.

Type Species: *Boophilus annulatus* (Say, 1821).

Boophilus microplus (Canestrini) (Fig. 20-23)

Haemaphysalis micropla Canestrini, 1887:104-105, 110, Pl. 9, Fig. 3, 3a-d, 5, 5a-b.

Rhipicephalus annulatus caudatus Neumann, 1897:413, Fig. 42.

Uroboophilus australis Fuller, 1899:389-392; Kishida, 1939a:541-544.

Boophilus annulatus caudatus: Tokishige, 1911; Ogura, 1936:75, Fig. 1-6 in Pl. IV.

Boophilus sp.: Nuttall and Warburton, 1915: 433.

Boophilus caudatus: Minning, 1934:25-27; Kishida, 1927:985; Itagaki, Noda, and Yamaguchi, 1944:1-97, Pl. 15, 19, 1959:1-118, Pl. 15, 19; Kitaoka and Yajima, 1958a:135-147, 1958b:148-162, 1958c:179-188.

Uroboophilus sinensis Minning, 1934:25-27; Schulze, 1935:234; Kishida, 1939a: 541-544; Nakamura and Yajima, 1937:168-175, Pl. XIII.

Uroboophilus sharifi Minning, 1934:1-48; Kishida, 1939a:541-544.

Palpoboophilus minningi Kishida, 1936:140-142, Fig. 1-9; Nakamura and Yajima, 1937:168-175, Pl. XI.

Margaropus annulatus australis: Sugimoto, 1936c:582-583, 1937b:599-601.
Margaropus annulatus caudatus: Sugimoto, 1937b:601-603.
Palpoboophilus brachyuris Kishida, 1939a:538-552, Pl. I, II; Shigemori, Aso, and Yajima, 1953:290-293.
Uroboophilus caudatus: Kishida, 1939a:541-544; Nakamura and Yajima, 1937:168-175, Pl. XII, 1942b:34-39, Fig. 1-3 in Pl. II; Shigemori, Aso, and Yajima, 1953:290-293.
Boophilus microplus: Keegan and Toshioka, 1957:9-10, Pl. 8, 9; Kitaoka, 1961a:85-95, 1961b:96-104, 1961c:105-112, 1967:18-21; Kitaoka and Yajima, 1961a:41-52; Kitaoka and Morii, 1963:32-35, 1967b:126-129.

DISCUSSION:

This tick occurs in Japan, Korea, and the Ryukyu Islands and is apparently the only species of the genus *Boophilus* found in these areas. It is known under a great variety of names in the Japanese literature. This is partially due to the fact that most Japanese workers have followed the classification of Minning (1934, 1935, 1936). In this paper we have accepted the opinions of Anastos (1950) and Hoogstraal (1956) in the classification of species of *Boophilus*. These workers reject the subdivisions of the genus and additional species designations proposed by Minning and are of the opinion that only a careful study of the vast *Boophilus* materials available will resolve current inconsistencies. They list three species: *B. decoloratus* (C. L. Koch, 1844), *B. annulatus* (Say, 1821), and *B. microplus* (Canestrini, 1887) to which must be added *B. kohlsi* Hoogstraal and Kaiser, 1960. Of these only *microplus* has been shown to occur in Eastern Asia. Sugimoto (1936c, 1937b) reported *Margaropus annulatus australis* and *M. a. caudatus* ex cattle, horse, and dog from Kumamoto, Oita, and Kagoshima prefectures, and also from four islands of the Ryukyus, but in the light of our collection these may have been misidentified. Specimens also have been erroneously identified as *Boophilus annulatus caudatus* by Tokishige (1911) and Ogura (1936), both of which were cited by Sugimoto (1937b). Kishida (1929) also reported *B. annulatus caudatus* from Okinawa and Tanegashima (Is.). The holotype of *B. (Palpoboophilus) minningi* Kishida, 1937, as well as other specimens under these various names, were examined by Keegan and Toshioka, and none of them differed significantly from *microplus*.

DIAGNOSIS:

Anastos (1950) and Arthur (1960) stated there are only three valid species of *Boophilus* in the world, but *B. kohlsi* Hoogstraal and Kaiser, 1960 should be included as the fourth species. Although these species are similar in general appearance, *B. microplus* may be distinguished by the following combination of characteristics: the male has a distinct caudal appendage (this serves to discriminate *microplus*, *decoloratus*, and *kohlsi* from *annulatus*), and the dentition of the hypostome is 4/4 in both sexes (*micoplus* and *kohlsi*), while 3/3 or rarely 3.5/3.5 in *decoloratus*; in the female, the inner margin of the palpal basal segment is concave, while this segment has an inner bristle-bearing protuberance in *decoloratus* and *kohlsi*.

Hoogstraal (1956) states that *microplus* males have adanal shields in which the inner margin does not reach the body margin, but in Japanese specimens this spurlike projection often goes beyond the posterior body margin, and the tips may be seen from the dorsal side.

DISTRIBUTION AND HOSTS:

Anastos (1950) and Hoogstraal (1956) give detailed information concerning distribution and hosts of *B. microplus*. It is known to occur in Central America, South America, Australia, the Orient, southern Florida, and Africa. In the Orient it is known from Formosa, Indonesia, the Philippines, New Guinea, Borneo, Burma, India, Assam, and small islands of Southeast Asia. Occasionally it has been found on domestic chickens and in Africa has been collected from a lion. Other hosts recorded are cattle, horses, buffalo, sheep, deer, and dogs. Kishida (1927) adds the pheasant as a host of this species.

BIOLOGY:

Boophilus microplus is a one-host tick; the larvae attach to the host and remain thereon until maturity. Molting and mating occur on the host. "Engorged females leave the host from 35 to 149 days after having attached as larvae and there may be from two to three generations a year in South Africa" (Lounsbury, 1905, cited by Hoogstraal, 1956). "Wilson (1946) observed no seasonal periodicity of adults in Nyasaland. He found larvae with nymphs and adults on cattle only once. Nymphs and adults were usually found together. . ." (Hoogstraal, 1956).

Kitaoka and Yajima (1958c) calculated the duration of each stage on bulls which were experimentally infested with batches of larvae throughout the year. "Fifty percent of the larvae and nymphs molted 6.0 and 14.0-15.6 days after infestation, respectively. Fifty percent of engorged female ticks dropped in 22.1-24.2 days after infestation. Adult males migrated to search

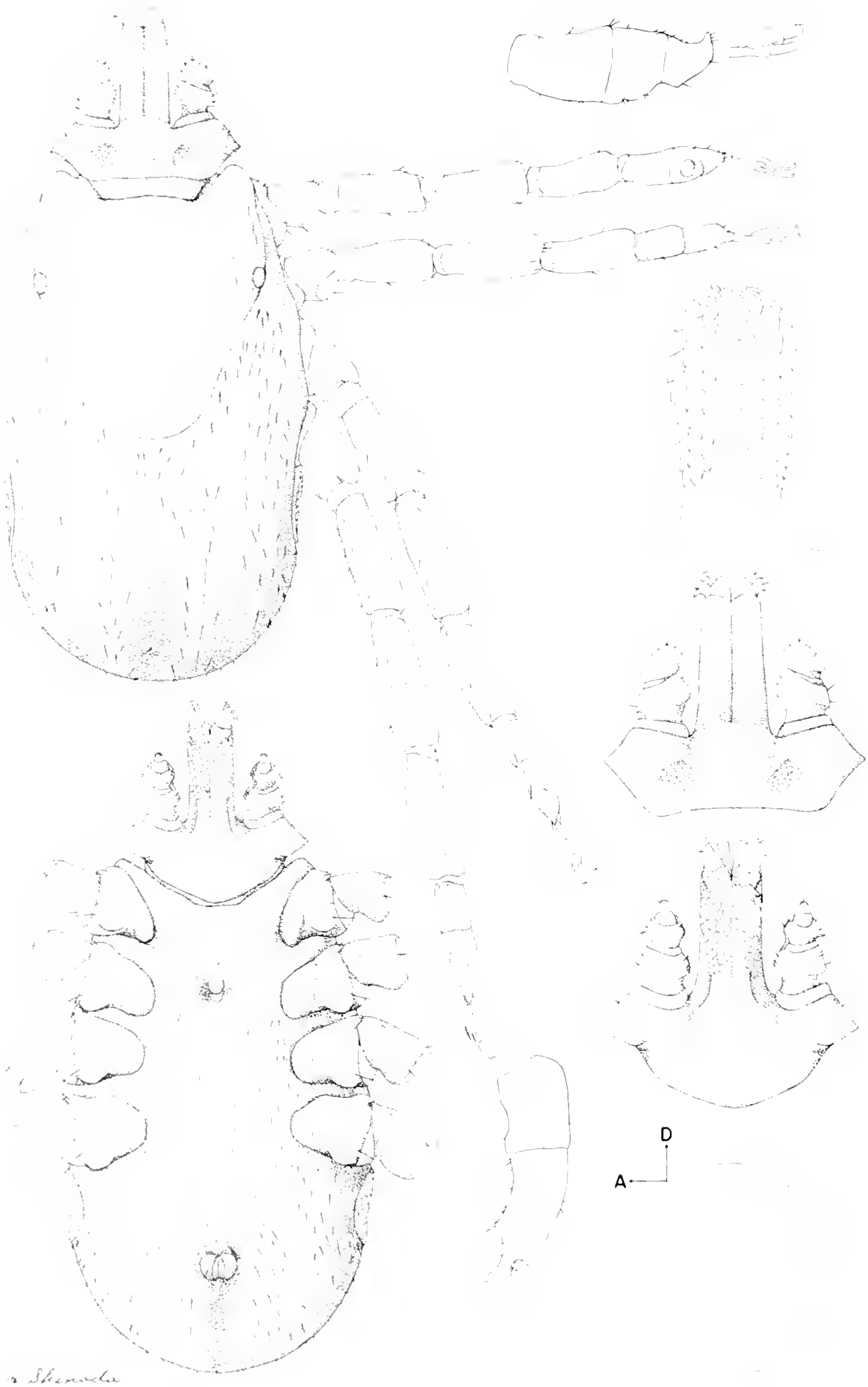


FIG. 20. *Boophilus microplus*, female.

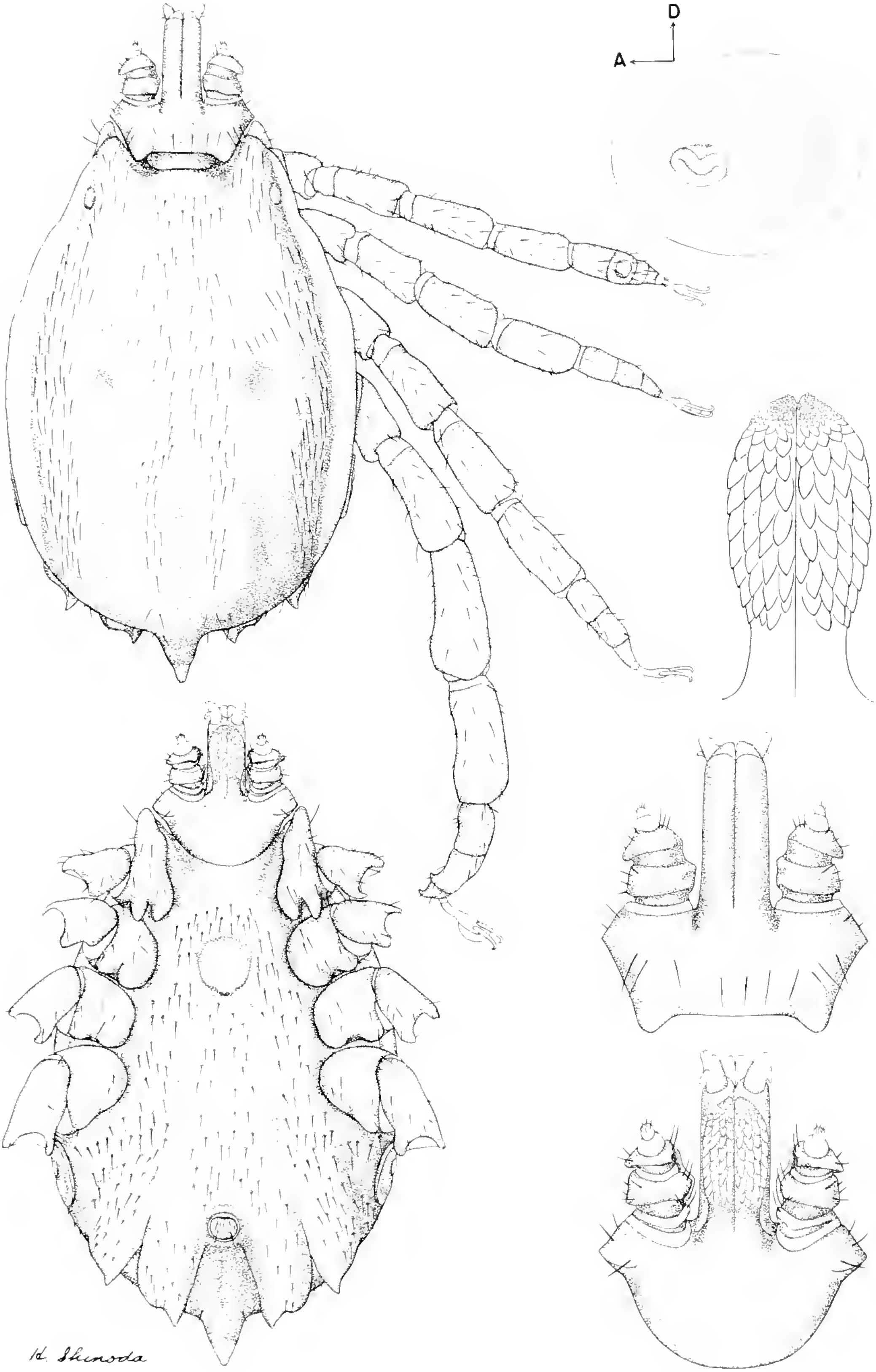


Fig. 21. *Boophilus microplus*, male.

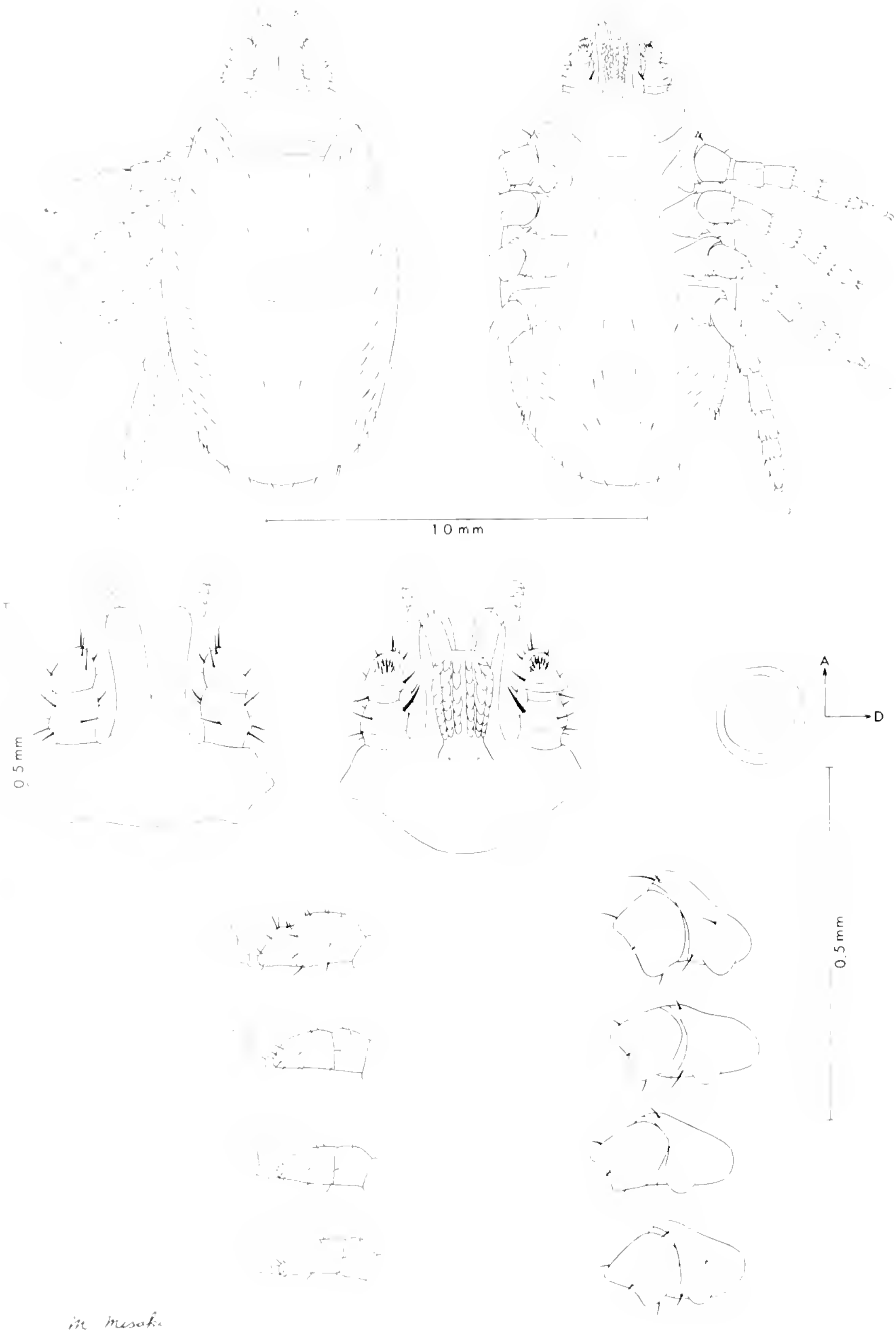


Fig. 22. *Boophilus microplus*, nymph.

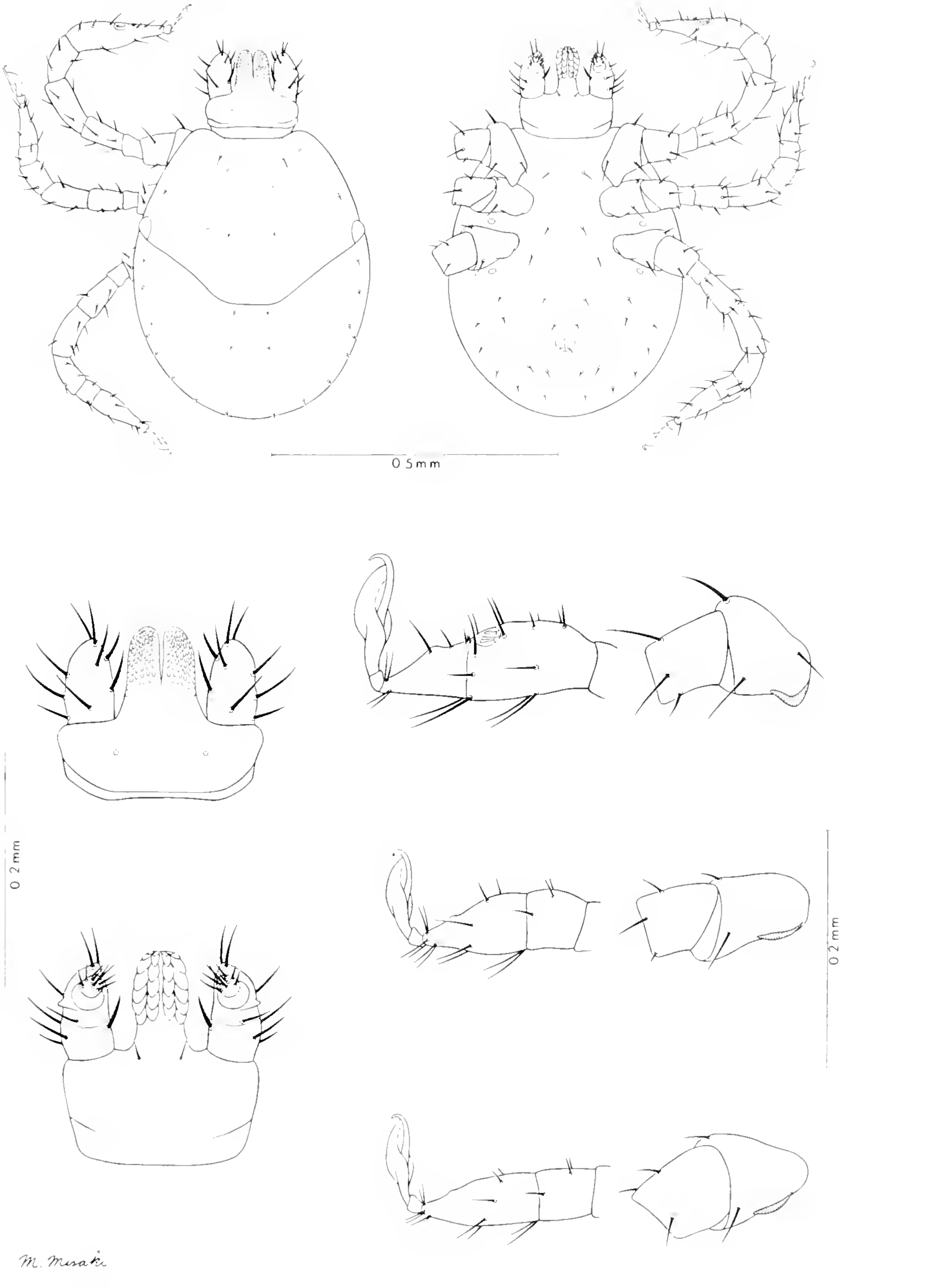


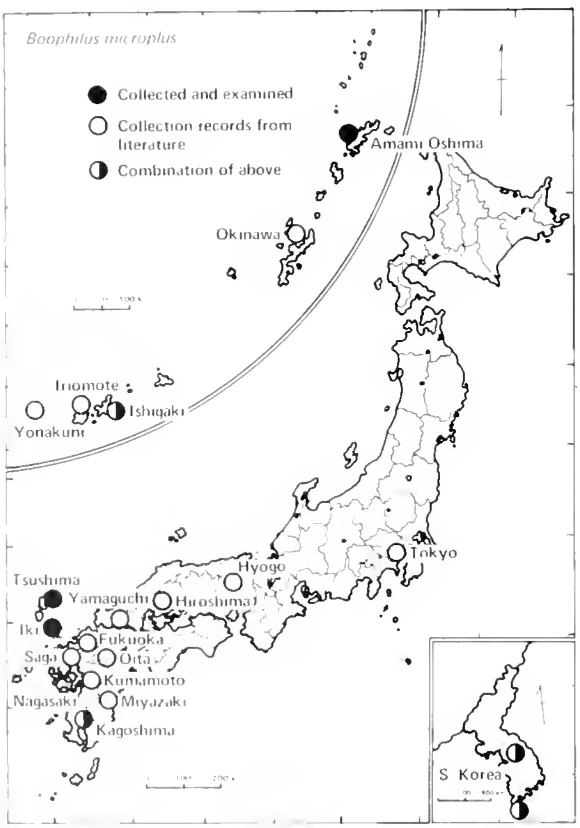
FIG. 23. *Boophilus microplus*, larva.

for females after ecdysis and feeding for 2-3 days. The duration of the whole parasitic stage was influenced by seasonal temperature to a much less degree, and the longest duration varied from 27-32 days in all seasons in Tokyo." A series of excellent physiological studies on this species (as *B. caudatus* and *microplus*) has been worked out by Kitaoka and Yajima (1958a, 1958b, 1958c) and Kitaoka (1961a, 1961b, 1961c).

Rabbits were used as host animals for a rearing experiment at the 406th Medical Laboratory. An engorged female (collected from a black calf from Ishigaki [Is.], 8 February 1967, Tipton, 67-R-0011) laid 2,318 eggs from 14 February to 3 March 1967.

Laboratory life cycle of *Boophilis microplus* (reared on ears of rabbits)

Phase	Date	Remarks
Female oviposited on	14 Feb.-3 Mar.	
Larvae hatched on	17 Mar.-31 Mar.	Rate of hatch 98.4%
Larvae placed on host	4 Apr.	
Earliest nymph emerged on	13 Apr.	
Earliest adult emerged on	21 Apr.	
Engorged adults dropped on	1 May-5 May	93 females, 78 males through 5 days



Map 8. Known distribution of *Boophilus microplus*.

Disease Relationship:

This species is one of the most important pests of cattle, and a vector of organisms pathogenic to domestic animals in the Americas, Asia, and Australia. These pathogens are *Anaplasma marginale*, *Babesia bigemina*, *B. berbera*, *B. ovis*, *Borrelia* spp., *Coxiella burnetii*, *Haematoxenus veliferus*, and *Nuttalia equi*. *Babesia bigemina* is the causal agent of the disease known under the various names of Texas cattle fever, red water fever, splenic fever, bloody murrain, Mexican fever, and tick fever.

Genus *Dermacentor* C. L. Koch, 1844 (Fig. 24-28)

Usually ornate. Palpi short, broad, or moderate. Basis capituli rectangular dorsally. Eyes and festoons present. Males with coxa IV much larger than others. Ventral plates or shields absent in males. Coxa I bifid in both sexes. Spiracular plate ovate or comma-shaped.

Type Species: *Dermacentor reticulatus* (Fabricius, 1794).

We did not attempt to determine the species of the genus *Dermacentor* for the same reason that was given by Keegan and Toshioka (1957). Whereas adequate information on other genera has been published by Japanese workers since 1957, very little is available for the genus *Dermacentor*. Kohls (1967) stated that specific determinations within the genus will continue to be difficult until more extensive studies on intraspecific variation in the Far East have been made. We followed his suggestion and included only the collection records derived from the literature in chart form in Appendix 2.

At least four species have been reported as occurring from Korea and Japan by Kishida (1922a, 1936), Nakamura and Yajima (1937), Yajima (1942), and Itagaki, Noda, and Yamaguchi (1944, 1959). They include *D. auratus*, *D. coreus*, *D. recticulatus*, and *D. variegatus*. Arthur

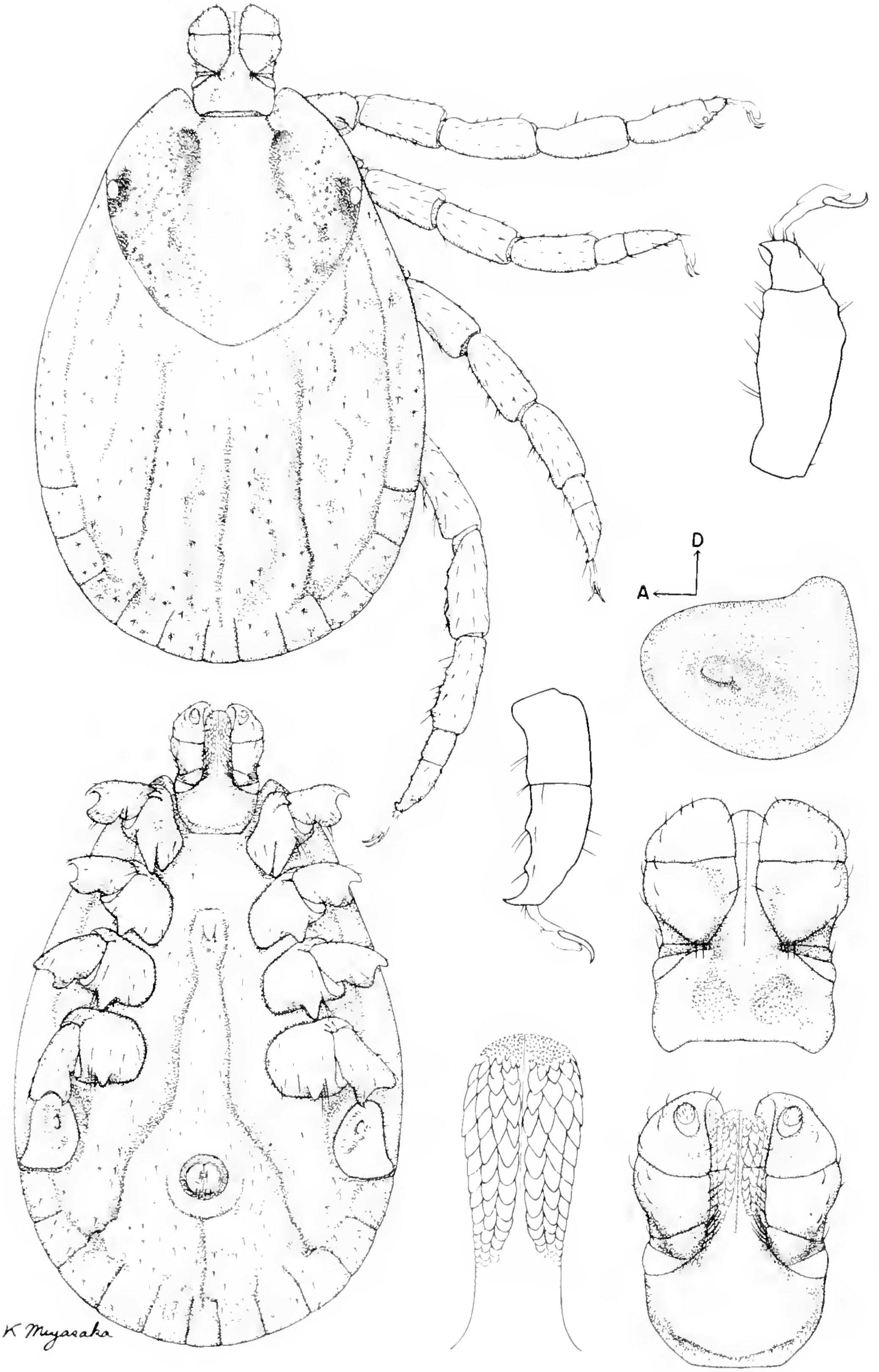


Fig. 24. *Dermacentor* sp., female.

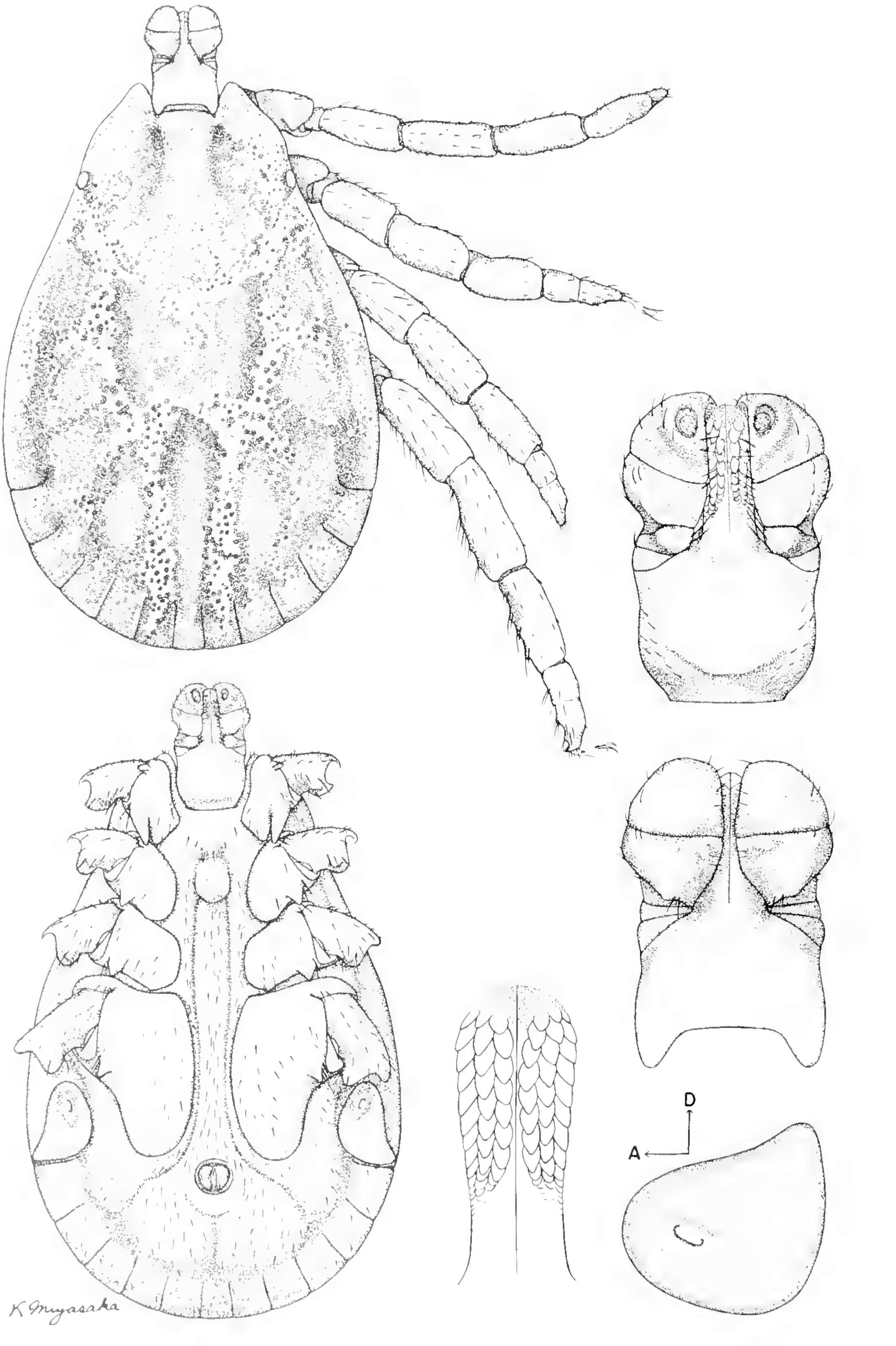


FIG. 25. *Dermacentor* sp., male.

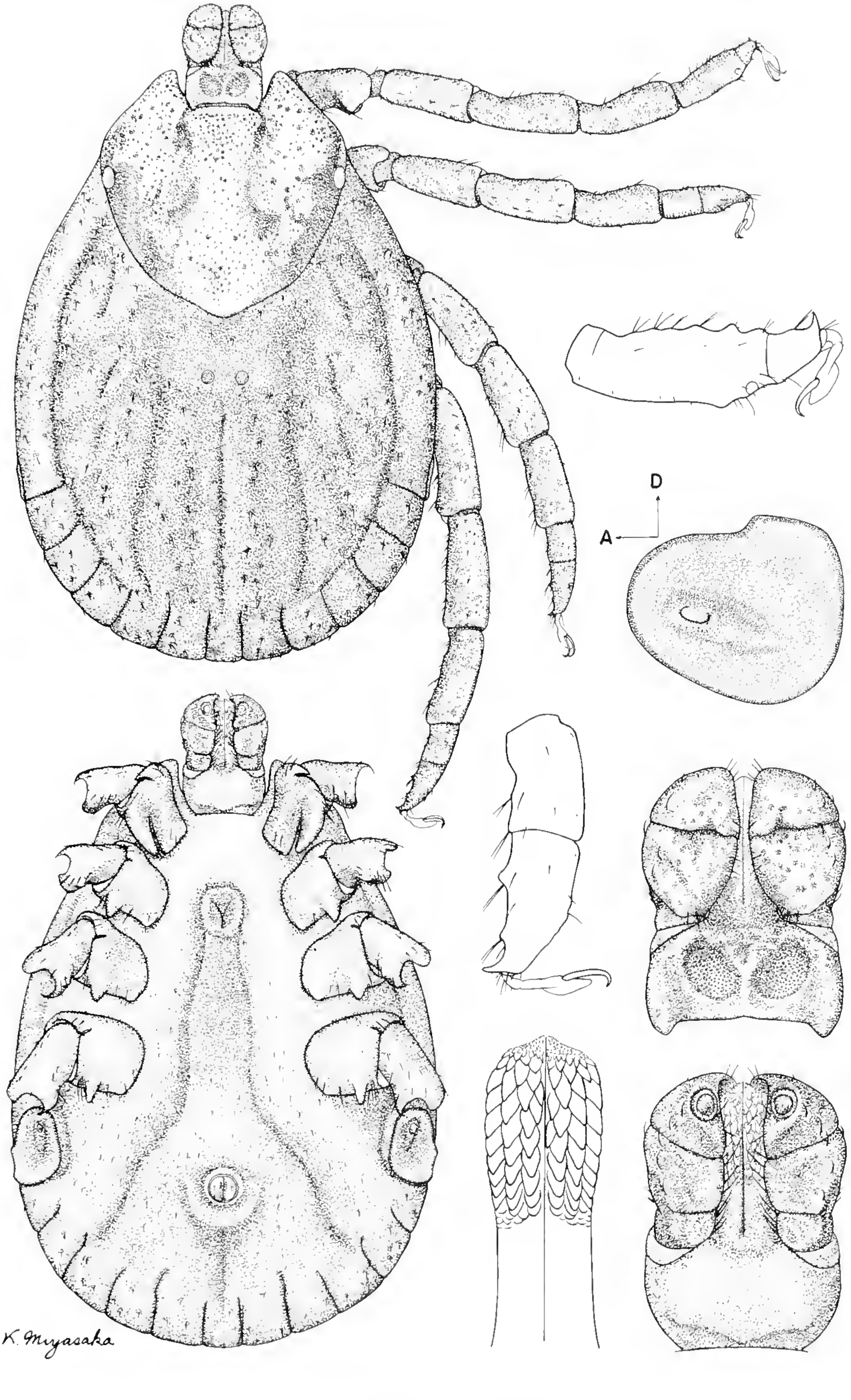


Fig. 26. *Dermacentor* sp., female.

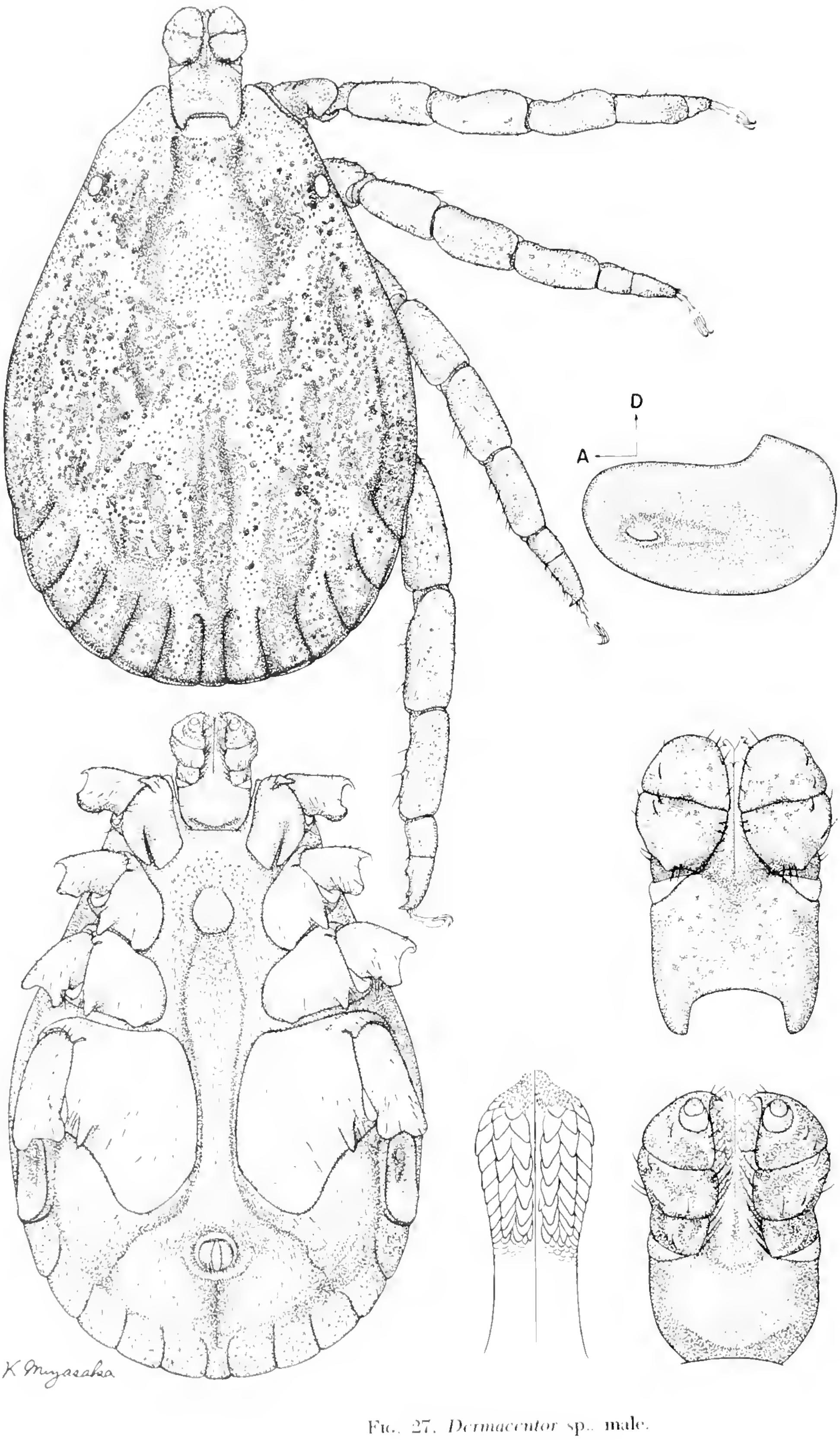


FIG. 27. *Dermacentor* sp., male.

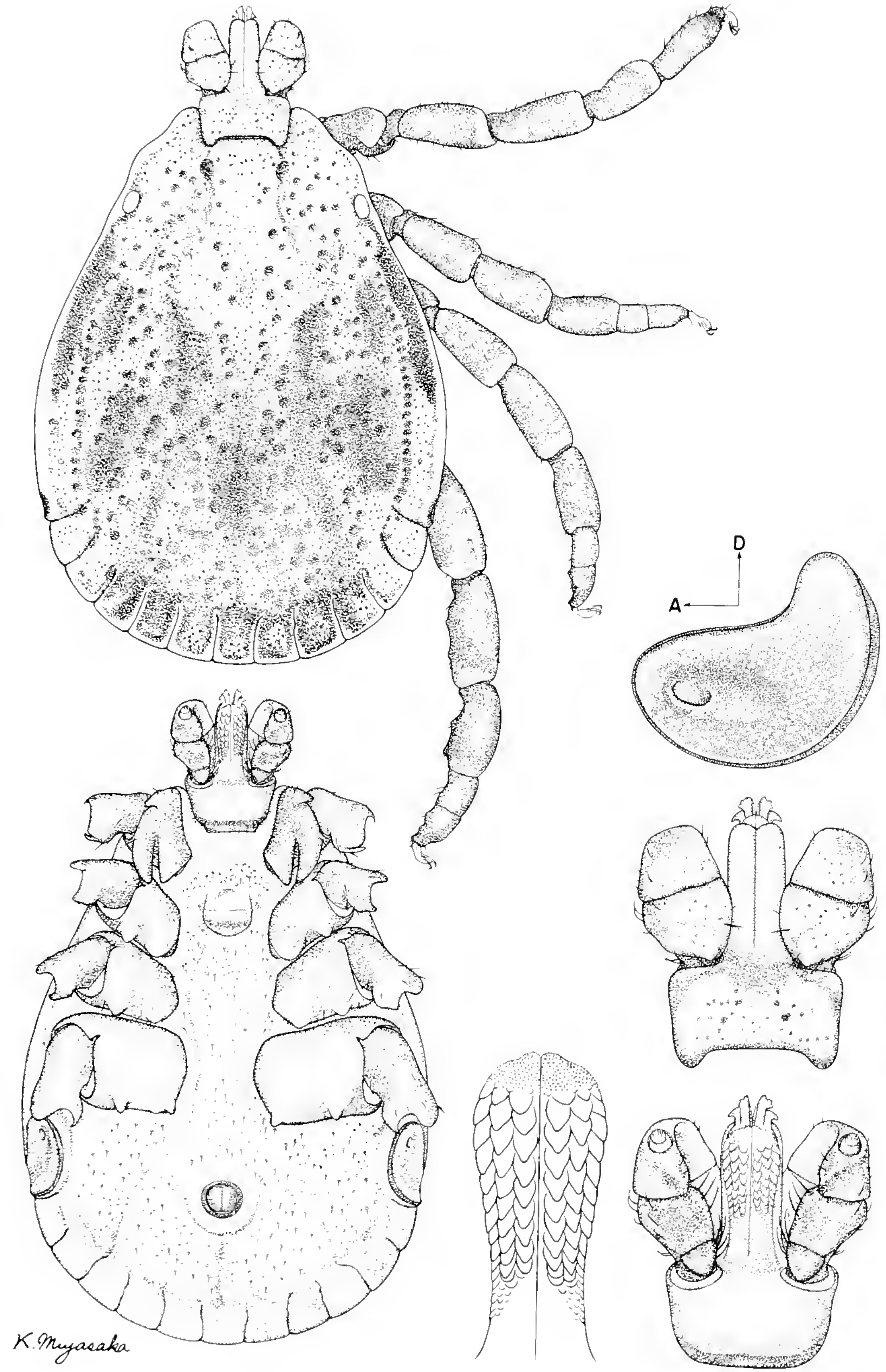


FIG. 28. *Dermacentor* sp., male.

(1960) synonymized *D. variegatus* under *D. albipictus*.

The illustrations used in Keegan and Toshioka (1957) are reproduced without change. They were made from specimens identified and loaned by Dr. Asanuma (*D. auratus* and *D. coreus*) and Dr. Yajima (*D. reticulatus*).

Genus *Haemaphysalis* C. L. Koch, 1844

Inornate. Eyes absent. Festoons present. Sexual dimorphism slight. Palpi usually conical with 2nd article salient laterally beyond width of basis capituli (except *H. kitaokai*). Basis capituli rectangular. Ventral plates absent in the male. Platelike dorsal spur present on trochanter I. Spiracular plates usually comma-shaped in males, round or oval in females. Posterior margin of coxa I never bifid.

TYPE SPECIES: *Haemaphysalis concinna* C. L. Koch, 1844.

Key to the Males of the Genus *Haemaphysalis*

1. Palpal segment III with dorsal retrograde spur 2
   Palpal segment III without dorsal retrograde spur 5
2. Palpal segment III with dorsal spur at middle (Fig. 55 and 66) 3
   Palpal segment III with dorsal spur not at middle (Fig. 38 and 77) 4
3. Palpal segment II with lobelike, anterointernal projection dorsally; ventroposterior margin forming an angle at middle; lateral groove absent (Fig. 55) .... *hystricis*
   Palpal segment II without such projection as above; ventroposterior margin slightly convex; lateral groove present (Fig. 66) .... *longicornis*
4. Coxa IV with two long spurs; palpal segment III with a dorsal spur externolaterally (Fig. 38) .... *cornigera* group
   Coxa IV with a short spur; palpal segment III with a dorsal spur on internal margin (Fig. 77) .... *wellingtoni*
5. Palpal segment II long, clavate, not salient laterally; suture between II and III not clear; spiracular plate about twice as long as wide (Fig. 62) .... *kitaokai*
   Palpal segment II slightly salient laterally with round contour posterolaterally, scarcely beyond basis capituli; suture between II and III well defined (Fig. 47) .... *formosensis*
   Palpal segment II distinctly salient laterally beyond basis capituli; suture between II and III well defined 6
6. Palpal segment III clawlike, strongly curved inward at tip, overlapping when closed (Fig. 34) .... **concinna*
   Palpal segment III otherwise 7
7. Coxa IV with long internal spur 8
   Coxa IV with short internal spur 9
8. Color light yellow; length 2.02-2.97 (avg. 2.49 mm), breadth 1.37-1.63 (avg. 1.51 mm); spur on coxa IV long, sharply pointed, usually straight, approximately ⅔ the length of coxa (Fig. 43) .... *flava*
   Color yellowish-brown; length 2.89-3.70 (avg. 3.30 mm), breadth 1.43-2.14 (avg. 1.80 mm); spur on coxa IV stout, wide at base, usually curved, less than half the length of coxa (Fig. 70) .... *megaspinosa*
9. Coxa I without spur; on Ryukyu black rabbit (Fig. 74) .... *pentalagi*
   Coxa I with internal spur 10
10. Posterior half of palpal segment II prominently flared, forming bell-shape; junction of segments II and III definitely notched, tarsi with strongly dorsal hump; on dog (Fig. 30) .... *campanulata*
    Posterior half of palpal segment II otherwise; junction of segments II and III without definite notch; tarsi tapering (Fig. 59) .... *japonica*

*H. *lunsana* is not included in the above key.)

Key to the Females of the Genus *Haemaphysalis*

1. Palpal segment III with dorsal retrograde spur 2
   Palpal segment III without dorsal retrograde spur 4
2. Palpal segment II strongly salient externolaterally; palpal segment III with long ventral

spur; hypostome 4/4 (Fig. 37) .... *cornigera* group
Palpal segment II moderately salient externolaterally; palpal segment III with moderate ventral spur; hypostome 5/5 (Fig. 54, 65) 3

3. Palpal segment II with an anterointernal lobelike projection dorsally (Fig. 54) .... *hystricis*
Palpal segment II without such a projection (Fig. 65) .... *longicornis*

4. Palpal segment II long, parallel-sided, not salient laterally; cornua absent; lateral grooves absent; hypostome 3/3 (Fig. 61) .... *kitaokai*
Palpal segment not parallel-sided, at least slightly salient laterally; cornua present; lateral grooves present, hypostome 4/4 or more 5

5. Palpal segment II slightly salient laterally with round contour posteroexternally, scarcely beyond basis capituli; cornua present; lateral grooves present; hypostome 4/4 in anterior half, 5/5 in posterior half (Fig. 46) .... *formosensis*
Palpal segment II salient laterally, distinctly beyond basis capituli; cornua present; lateral grooves present; hypostome more than 4/4 6

6. Posterior half of palpal segment II strongly salient or flared externolaterally forming boot-shape (Fig. 41) or bell-shaped (Fig. 29) 7
Palpal segment II salient laterally but not forming such shape as above 8

7. Palpal segment II protruding externolaterally at base at right angle to the axis, boot-shaped; cornua very slight; tarsi tapering (Fig. 41) .... *doenitzi*
Posterior half of palpal segment II prominently flared, bell-shaped; external profile with a definite notch at junction of palpal segments II and III; cornua short but well defined; tarsi humped (Fig. 29) .... *campanulata*

8. Coxa I without spur; external profile of palpal segment II with a short salience, pointed, slightly directed externolaterally at the posteroexternal juncture; on Ryukyu black rabbit (Fig. 73) .... *pentalagi*
Coxa I with a short spur; external profile of palpal segment II nearly straight or slightly bulged externally at the posteroexternal juncture 9

9. Coxae I-III with short, blunt, subequal spurs; coxa IV with a spur longer than others 10
Coxa I with a spur distinctly longer than others 11

10. Color light yellow; coxa IV with a spur slightly longer than others; length 1.89-1.92 (avg. 1.90 mm), breadth 1.19-1.28 (avg. 1.23 mm) (Fig. 42) .... *flava*
Color brownish; coxa IV with a strong, triangular spur distinctly longer than others; length 2.99-3.48 (avg. 3.31 mm), breadth 1.88-2.21 (avg. 2.03 mm) (Fig. 69) .... *megaspinosa*

11. External profile of palpal segment III longer than that of II; spurs on coxae II, III, IV short but distinctly extend beyond posterior coxal margins (Fig. 58) .... *japonica*
External profile of palpal segment III subequal to that of II; spurs on coxae II, III blunt, scarcely extend beyond posterior coxal margins (Fig. 33) .... *concinna*

Haemaphysalis campanulata Warburton (Fig. 29-32)

Haemaphysalis campanulata Warburton, 1908: 508-514, Fig. 5, 6; Nuttall and Warburton, 1915:491-492, Fig. 431-432; Kishida, 1922a: 852; Nakamura and Yajima, 1937:155, Pl. VI, 1942b:37, Fig. 8 in Pl. II, Fig. 1-5 in Pl. III; Asanuma, 1942:17-26, 1947b:972, Fig. 2768, 1956a:111-112, 1956b:400, Fig. 225; Itagaki, Noda, and Yamaguchi, 1944:1-97, Pl. 4, 1959: 1-118, Pl. 4; Shigemori, Aso, and Yajima, 1953:290-293; Keegan and Toshioka, 1957:12, Pl. 17, 18.

Discussion:

Warburton's original description (1908) was based on numerous specimens taken from Chinese dogs in Mongolia by M. L. Hearn. He also stated that the type specimens agreed in details with the specimens in the British Museum named *H. flava* by Neumann. Warburton (1908) did not mention the collection data of the latter, but the lot presumably is tube No. 137 (see Nuttall and Warburton, 1915, p. 408), which he determined to have contained *flava*, *campanulata*, and *japonica*. Subsequently, Nuttall and Warburton (1915) stated that Warburton's types of *japonica* (from a tube labeled "No. 173 *H. flava*")[6] were found on *Nemorhaedus crispus*, now known as the Japanese serow, *Capricornis crispus*, at Hondo, Japan, by the Duke of Bedford's collectors (see discussion

[6] In Nuttall and Warburton, 1915, p. 408, *H. flava*, this number is 137

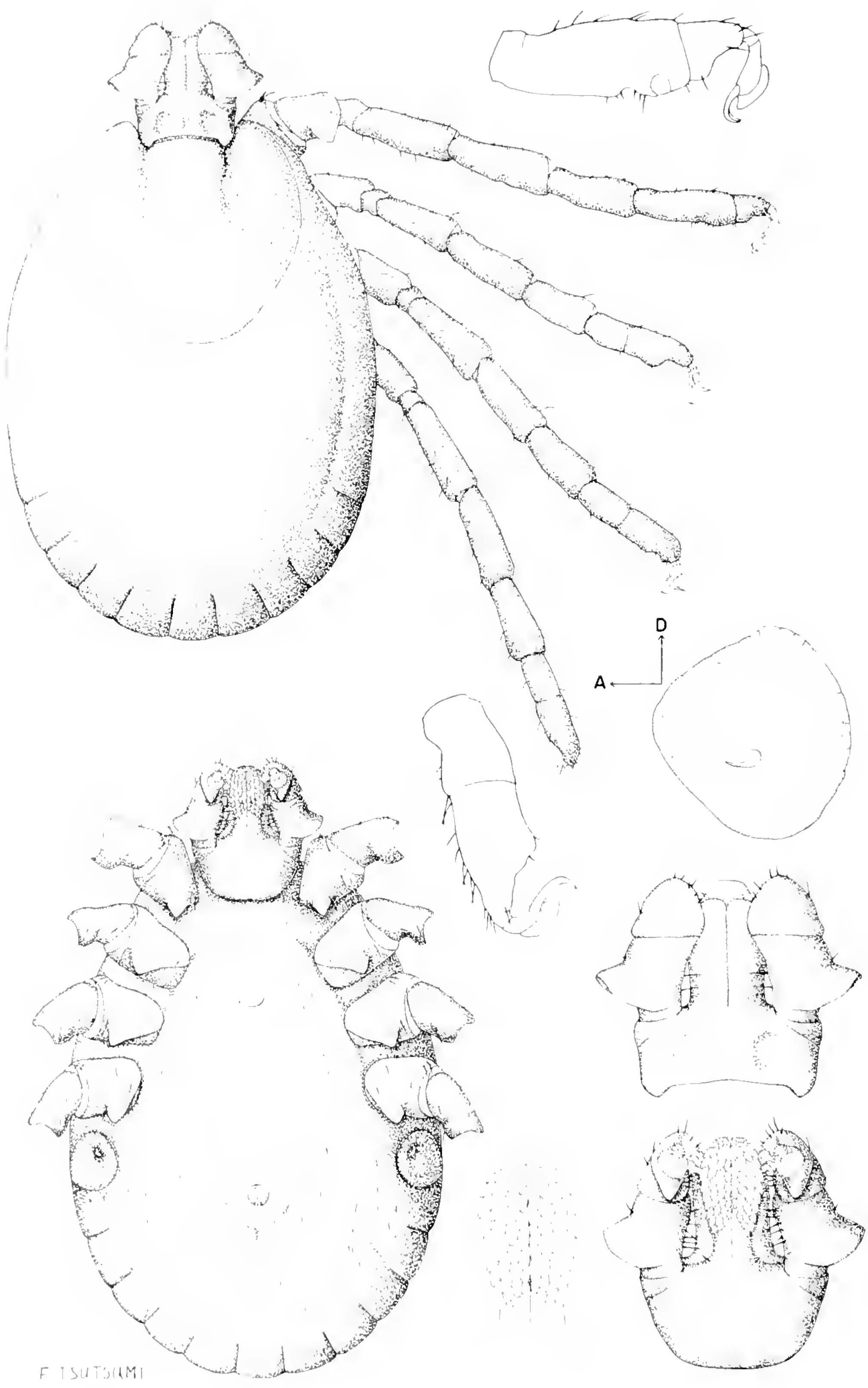


Fig. 29. *Haemaphysalis campanulata*, female.

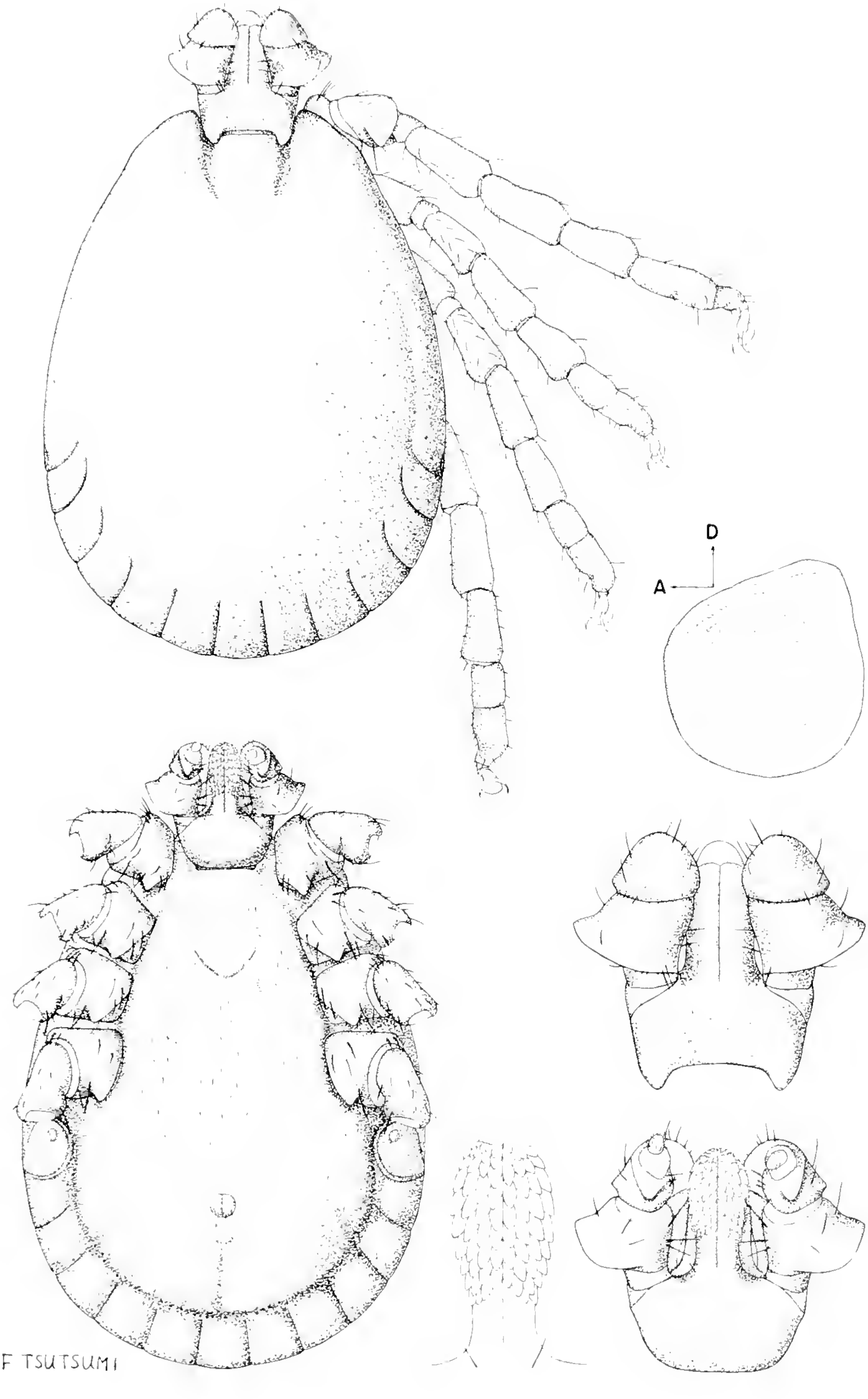


FIG. 30. *Haemaphysalis campanulata*, male.

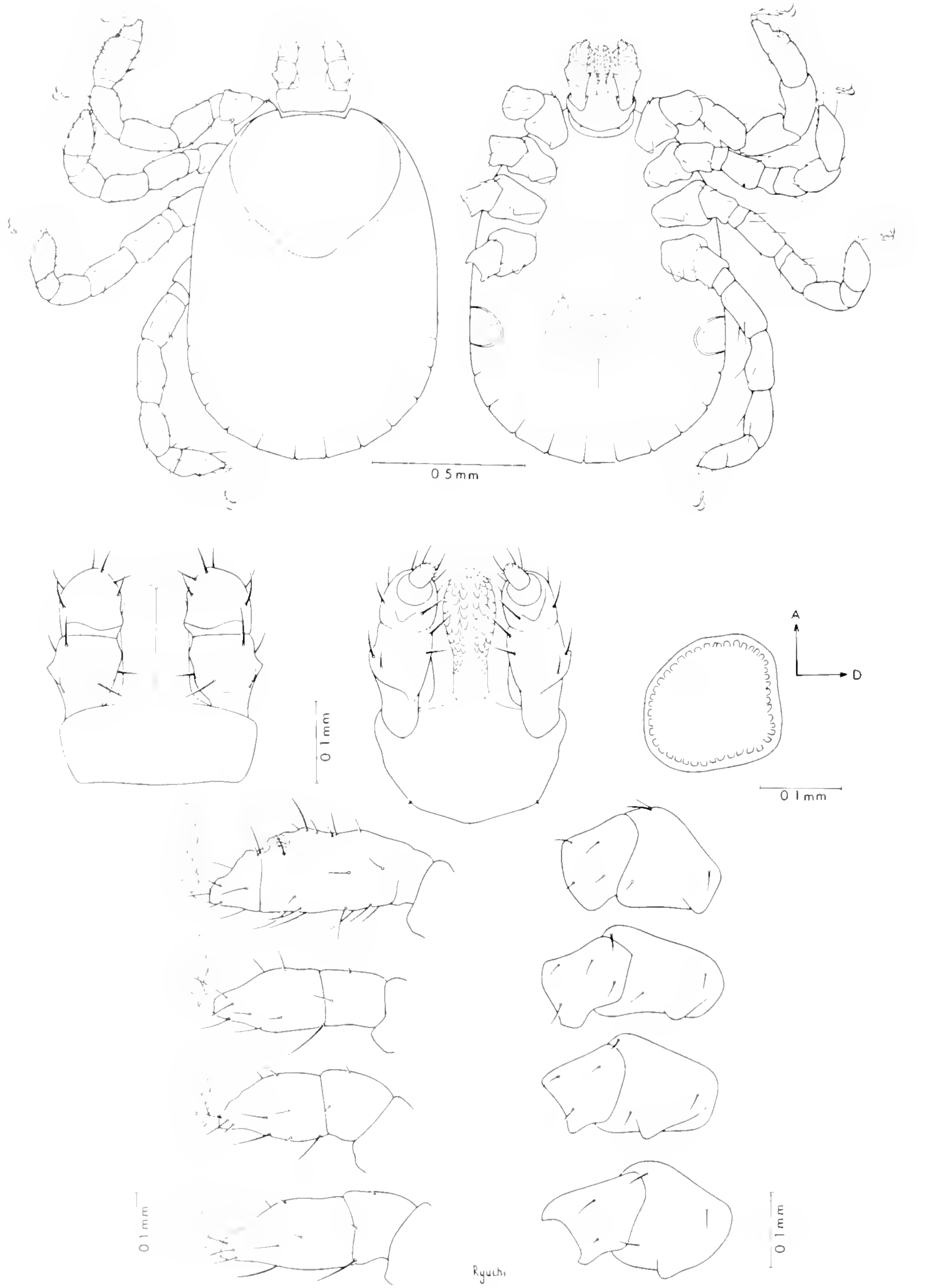


FIG. 31. *Haemaphysalis campanulata*, nymph.

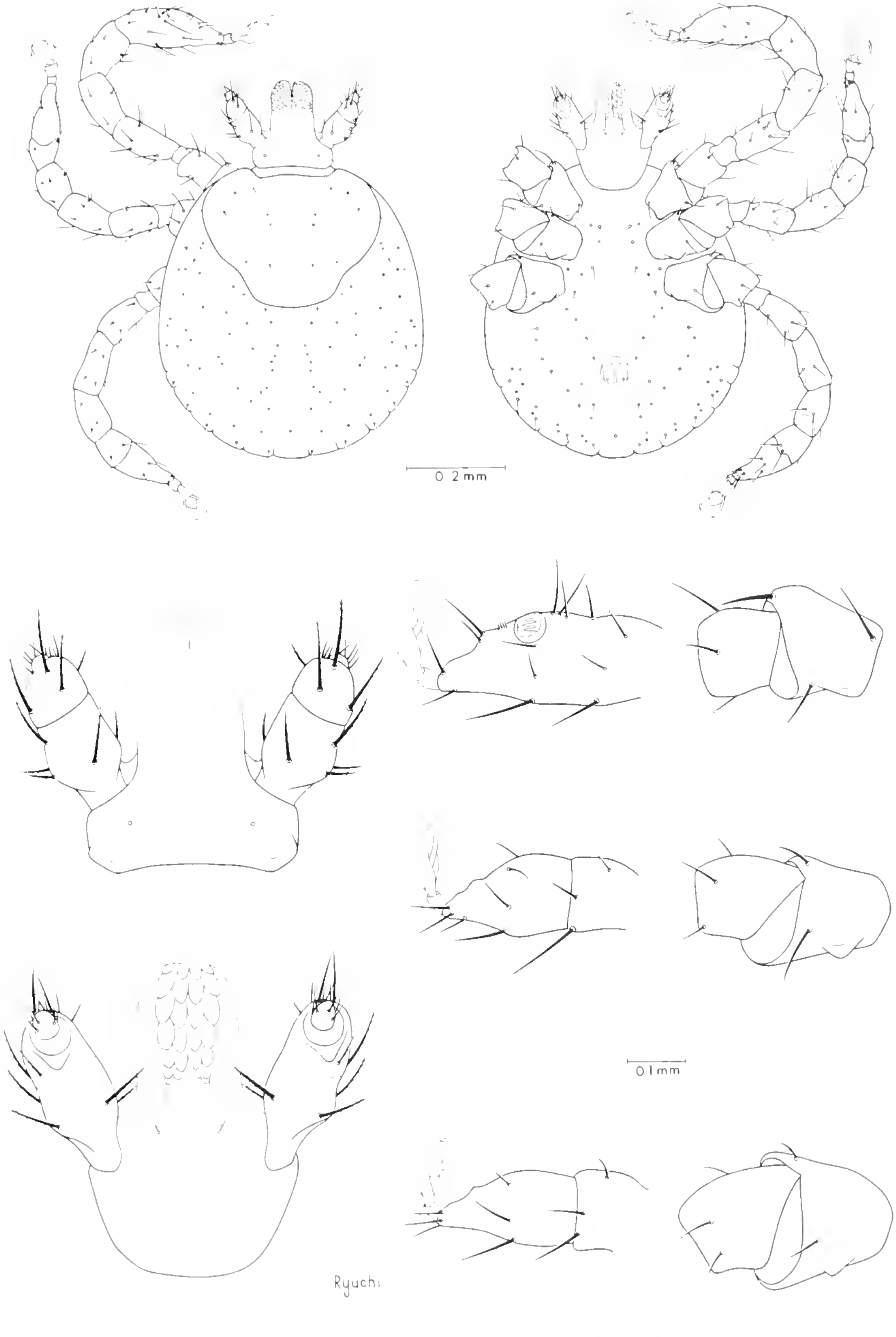


Fig. 32. *Haemaphysalis campanulata*, larva.

of *H. japonica*). If it is true that all of the specimens in tube N. 173 (No. 137?) were collected from the same host and locality, this collection data of *japonica* might apply to that of *campanulata*. Therefore, Warburton's reference to the specimens of *campanulata*, which had been mixed with *flava* in the tube, might well be the first record of this species from Japan.

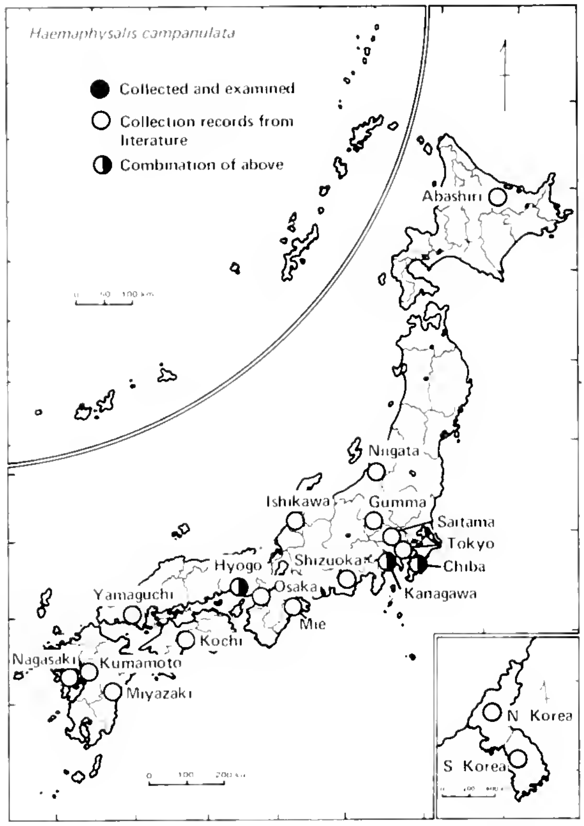
Nuttall and Warburton (1915) examined Warburton's Mongolian specimens and reported additional samples from Japan. They were collected from dogs in Tokyo and Yokohama and from a house rat in Tokyo.

DIAGNOSIS:

This common dog tick is distinct from other haemaphysalids in that palpal article II is strongly salient laterally; the posterior margin is flared upward to become "bell-shaped," hence the name "*campanulata*;" the junction of article II and III is deeply notched; the tarsi are humped.

DISTRIBUTION AND HOSTS:

This species is known from China, Mongolia, Manchuria, Japan, and Korea. Hosts include cows, horses, dogs, rats, and man. One lot submitted to us (collection, 41-J-002; see Appendix 2) contained 33 females, 11 males, and 4 nymphs, but it seems doubtful that so great a number of ticks were taken from a human host. There are no records of this species from the Ryukyu Islands.



MAP 9. Known distribution of *Haemaphysalis campanulata*.

BIOLOGY:

Both immature and adult ticks are very common on Japanese dogs, even in urban areas. All stages in the life cycle may be found on the ground around dog kennels. Asanuma (1942b) has provided an excellent account of the life

Laboratory life cycle of *Haemaphysalis campanulata*
(reared on rabbits)

Generation and Stage	Phase	Period in Days	Remarks
F_1 Adult	Feeding	9-14	Females were placed on host with males on 29 Nov. 1967.
F_1 Adult	Postparasitic (Preoviposition)	4-7	
F_1 Adult	Oviposition	12-24	Egg number: 826-1,749
F_2 Egg	Incubation	25-29	10,126 F_2 larvae hatched from 10,693 eggs.
F_2 Larva	Feeding	2-10	Larvae were placed on host 29 Jan. 1968.
F_2 Larva	Postpartsitic (Premolting)	10-13	
F_2 Nymph	Feeding	3-7	
F_2 Nymph	Postparasitic (Premolting)	11-27	

Ticks were reared in facilities at the 406th Medical Laboratory in which temperature was maintained at approximately 25 C and relative humidity fluctuated from 10-70%.

cycle of this species.

Rearing was attempted at the 406th Medical Laboratory. A single female was obtained from a dog in Chiba Prefecture, 12 June 1967, and 12 females of the F_1 progeny were fed on rabbit ears.

DISEASE RELATIONSHIP:

Unknown.

Haemaphysalis concinna C. L. Koch (Fig. 33-36)

Haemaphysalis concinna C. L. Koch, 1844:237-238; Nuttall and Warburton, 1915: 452-458, Fig. 387-393; Kishida, 1922a:852, 1936:142; Ogura and Takada, 1927:202-204, Pl. XII; Yajima, 1942:499-510, Fig. 4; Itagaki, Noda, and Yamaguchi, 1944:1-97, Pl. 7, 1959:1-118, Pl. 7; Keegan and Toshioka, 1957:13; Asanuma, 1965a:111-112.

Haemaphysalis hirudo L. Koch, 1877:786; Neumann, 1897:341; Keegan and Toshioka, 1957: 30.

Haemaphysalis concinna var. *kochi* Neumann, 1905:239.

Haemaphysalis concinna kochi: Newmann, 1911: 111.

DISCUSSION:

Neumann (1897) at first referred his specimens from Japan to *H. hirudo* Koch, then subsequently (1905) renamed them *H. concinna* var. *kochi*, realizing that the type had been lost. The specimens were three females collected by Hilgendorf (Berlin Museum) and two females from a dog at Saga collected by Yamaguchi. Neumann (1911) raised this variety to subspecies, but later Nuttall and Warburton (1915), having examined Neumann's specimens in the Berlin Museum, synonymized the subspecies under *concinna*. Koch's original description was not available, but judging from the French quotation by Neumann (1911),[7] it is very adequate for determining the species. As cited by Keegan and Toshioka (1957), Nuttall and Warburton (1915) condemned the name *hirudo*. Consequently, Neumann's *hirudo* (1897) might be the first reliable record of *concinna* from Japan, provided we follow Nuttall and Warburton (1915).

Ogura and Takada (1927) reported *H. concinna* on cattle and horses at Tokachi, Kushiro, Nemuro, and Kitami, all on Hokkaido. Kishida (1936) reported collection of this species by M. Akasawa in 1928 from North Korea. Itagaki et al. (1944, 1959) also recorded a collection from a horse in Hamgyong-pukto, Korea. Yajima (1942) reported it from horses in Aomori Prefecture. During the preparation of this paper, one female and three males loaned by Dr. Kitaoka were available for study.

Pomerantzev (1950), who gave a detailed discussion of the morphology, biology, and distribution of the species, states that "it possibly covers all of eastern and southeastern Asia (Japan, Kokhinkina)."

DIAGNOSIS:

The male of this species is very distinct in that the tips of palpal articles III are curved inward to form "pincers" which overlap when closed. Tarsus IV is tapered and without a dorsal protuberance. In the female the palpal profile is very similar to *flava* and *japonica*, but may be distinguished from *flava* in that the spur on coxa I is longer than the others, and from *japonica* in that the external profile of palpal article III is subequal to II, palpal article II has 3-4 infrainternal setae, and spurs on coxae II, III, and IV are wide, blunt and extend scarcely beyond the posterior margin of the coxae.

DISTRIBUTION AND HOSTS:

The distribution of this species includes Western Europe, the Balkan peninsula, and the USSR. According to Pomerantzev, adults of this species parasitize large domestic and wild animals, while nymphs and larvae are found on a wide variety of small and large mammals and birds, and occasionally on reptiles. Olsufjev and Petrov (1960) state that larvae and nymphs are parasitic on rodents and small mammals. Both adults and nymphs have been known to attack man.

BIOLOGY:

The biology of this three-host tick has been studied by Russian workers, and Pomerantzev (1950) has briefly summarized the life cycle under laboratory conditions. The engorged female begins oviposition in 4-16 days and lays more than 1,000 eggs over a 30-32 day period. Larvae begin to appear in 16-30 days and feed for 3-6 days. Larvae molt to nymphs in 16-25 days, and nymphs feed 8-16 days or more. The cycle can be completed in the laboratory within 120-160 days. Larvae and nymphs can be starved for more than 13 months. Pomerantzev suggests that the life cycle in nature may take 1.5-2 years. Mel'nikova (1958) observed the life cycle in nature and concluded that it would take 3-4 years for completion. He also found

[7] Ecusson dorsal presque discoide, palpes courts, a peine plus longe que large — L. 9 mm, la 7 mm — male inconnu

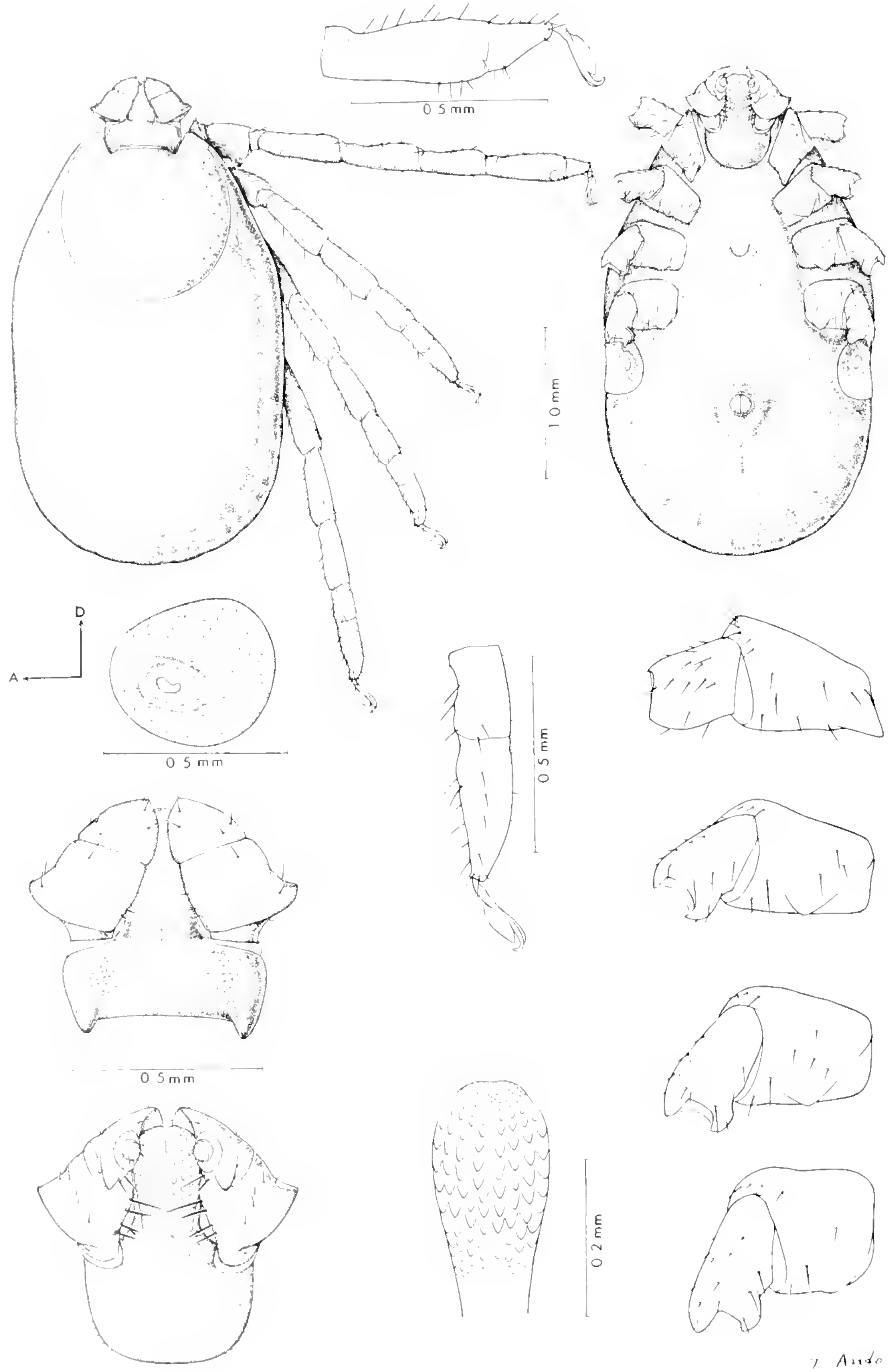


Fig. 33. *Haemaphysalis concinna*, female.

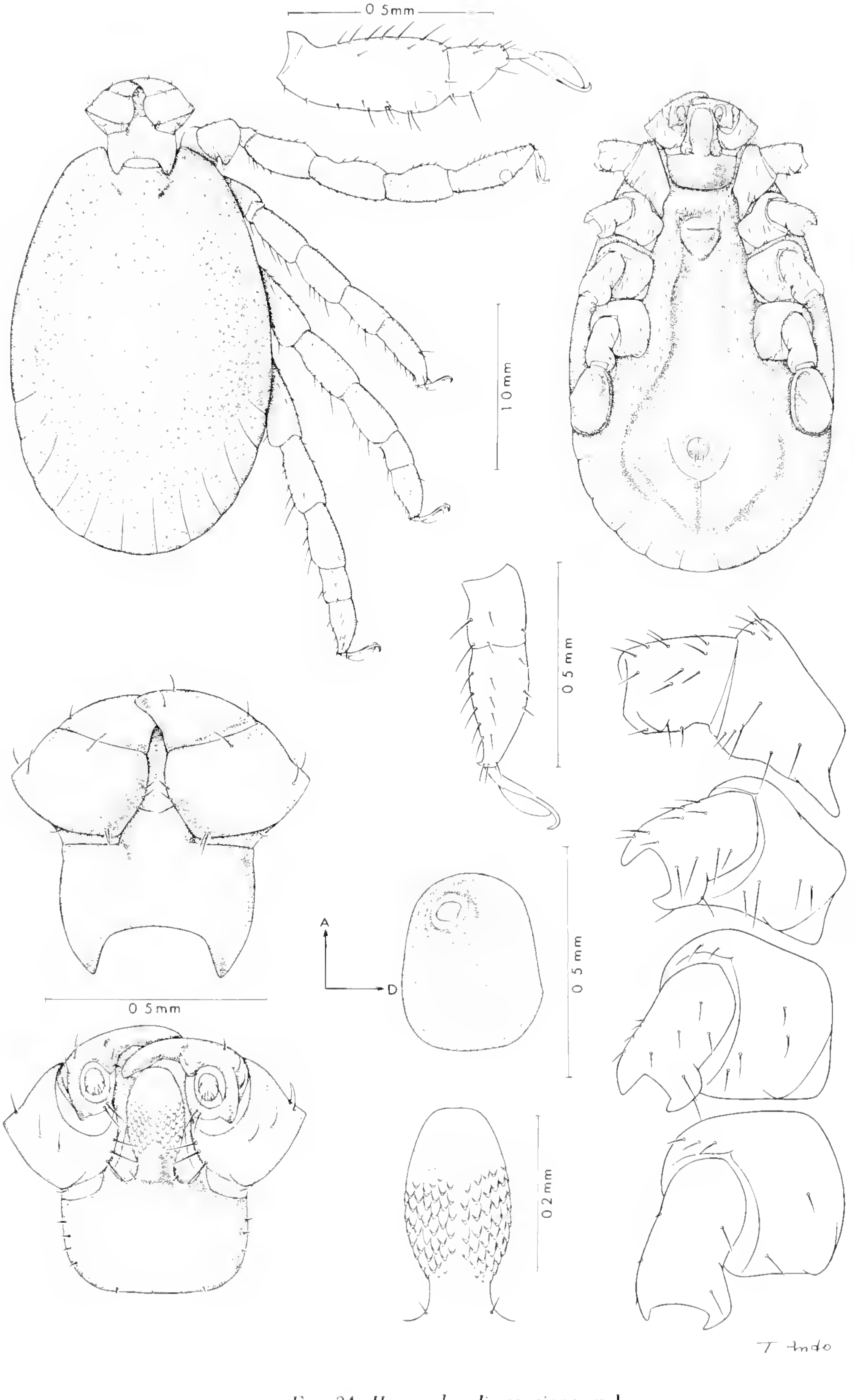


FIG. 34. *Haemaphysalis concinna*, male.

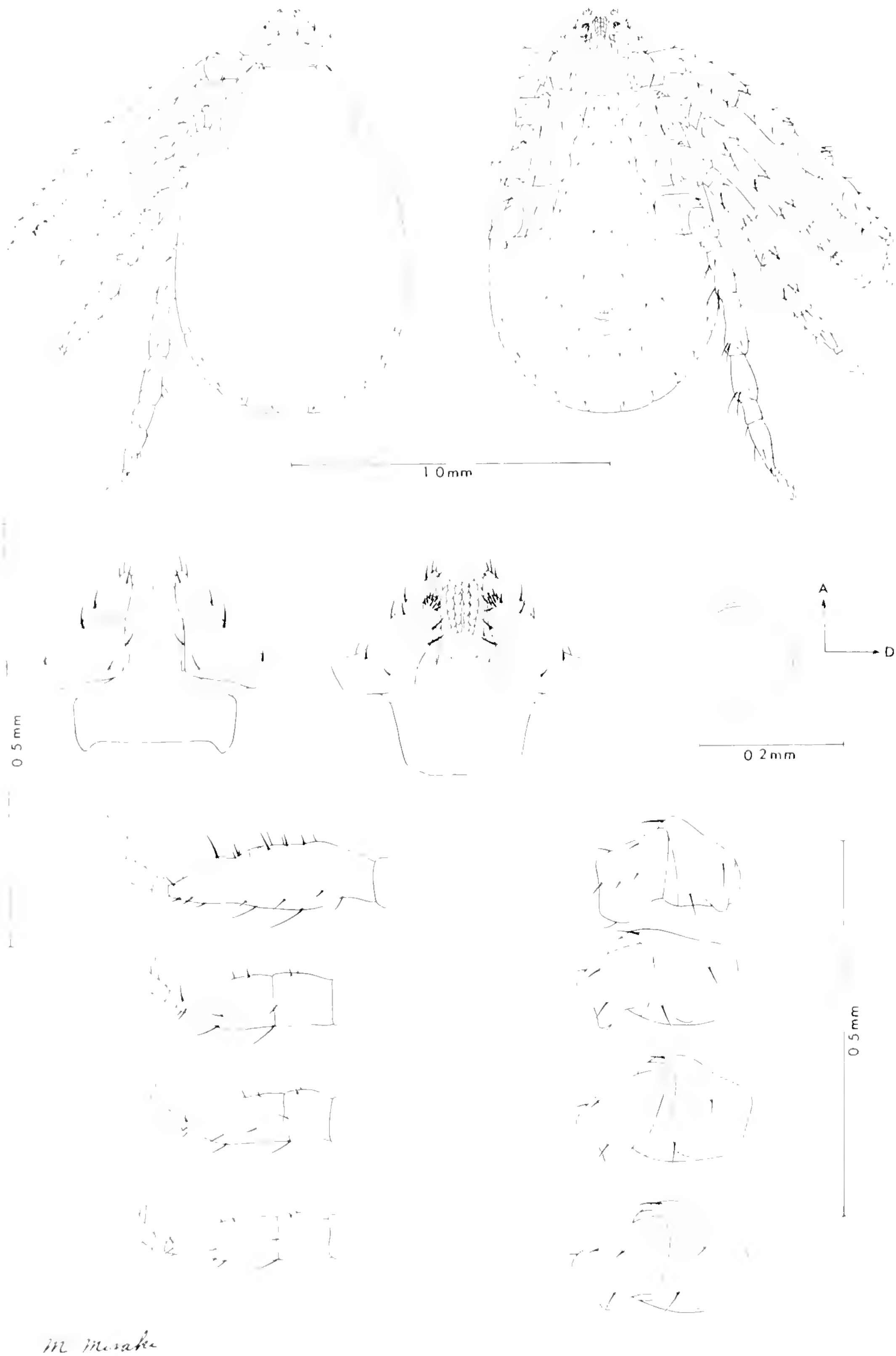


Fig. 35. *Haemaphysalis concinna*, nymph.

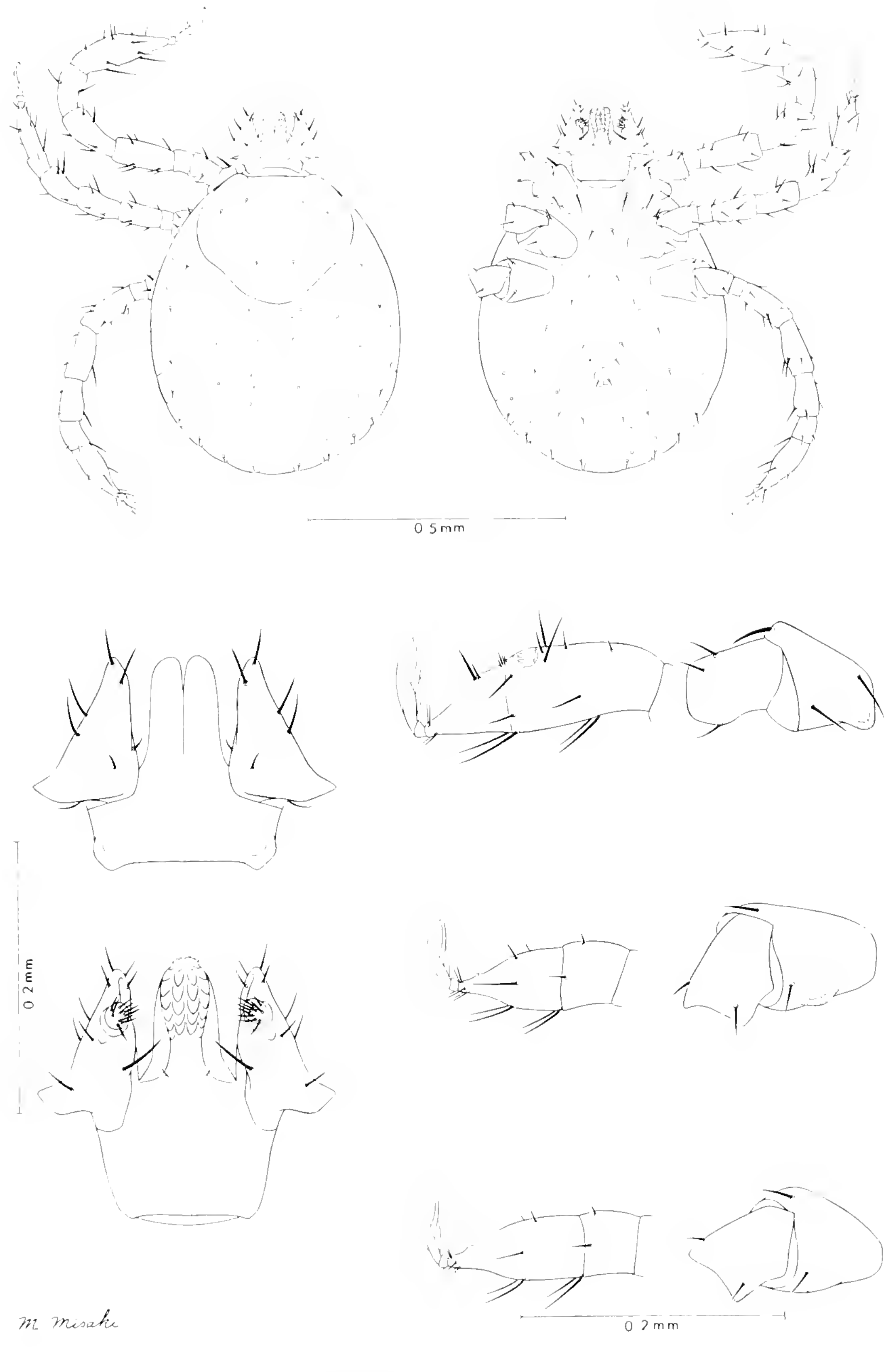
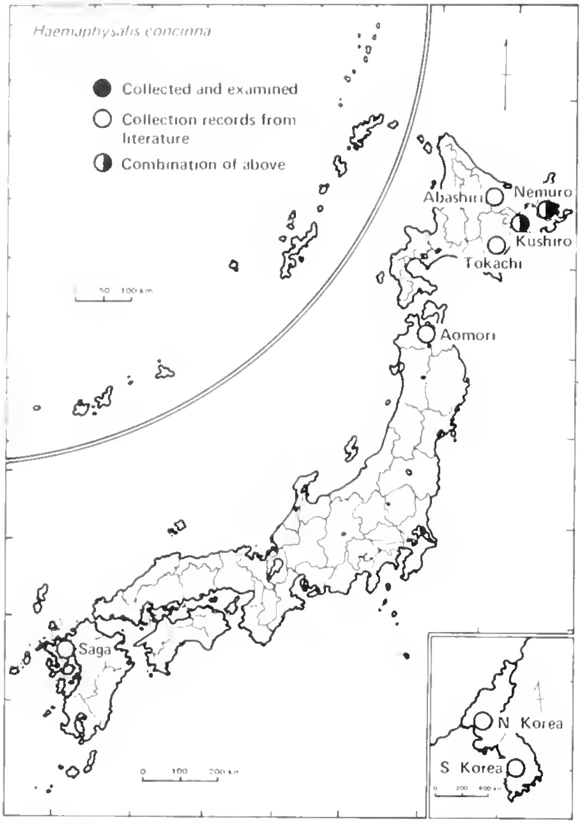


FIG. 36. *Haemaphysalis concinna*, larva.



MAP 10. Known distribution of *Haemaphysalis concinna*.

that optimum conditions for development occur in the middle mountain zone of oak forest and inter-alpine valleys (400-800 meters above sea level) covered with broadleaf forests where humidity is high. According to Cerny and Kratochvilova-Kralova (1963), *H. concinna* in Czekoslovakia occurs in southern Moravia and southern Slovakia, chiefly on goats. Active adults are found mainly in May and June. He also observed that the entire life cycle took three years.

DISEASE RELATIONSHIP:

This species is reported to be a proven vector of the causal agent (rickettsia) of tick typhus in the USSR and experimentally transmits the virus of spring-summer encephalitis. Pavlovsky and Soloviyev (1963) demonstrated the capability of transmission of the virus by bites of the adults as well as transovarian transmission to its progeny. Ticks collected with a flannel-flag harbored the agent of tularemia according to Olsufjev and Petrov (1960).

REMARKS:

Nuttall and Warburton (1915) and Pomerantzev (1950) described the dentition of the female hypostome as 5/5 or 6/6, but in the specimen examined by us the dentition was 4/4.

Haemaphysalis sp. (*H. cornigera* group) (Fig. 37-40)

Haemaphysalis cornigera Neumann, 1897:350-352, Fig. 16-17; Keegan and Toshioka, 1957: 13, Pl. 19, 20; Asanuma, 1965a:111-112, 1965b:399, Fig. 223.

Haemaphysalis cornigera var. *taiwana* Sugimoto, 1936a:1-11, Pl. I-IV; Sugimoto, 1936d:336-346, Pl. I.

Haemaphysalis ias Kishida, 1936:(? unpublished); Nakamura and Yajima, 1937:160, Fig. 10, 11 in Pl. VIII, Fig. 1 in Pl. IX; Nakatsuji, 1942:295; Yajima, 1950:197-200, Fig. 1-4.

DISCUSSION:

This species is known in the Japanese literature as *H. ias* Kishida, 1936. Actually, it seems that Kishida not only did not publish a description of *ias* but did not even publish a reference to this name in 1936. Apparently he had made a verbal reference to the five male specimens taken from a cow on Miyake (Is.) as a new species. In the following year Nakamura and Yajima (1937) published a description of the male of this tick and referred to it as *H. ias* Kishida, 1936. Yajima (1950) later described the female and immature stages of the species. This material was also taken from a cow on Miyake (Is.). Yajima also mentioned adult ticks collected from cattle on Hachijo (Is.). Nakatsuji (1942) reported occurrence of *ias* on a dog on Miyake (Is.), but he did not give details. Keegan and Toshioka (1957) examined the holotype male and other material loaned by Dr. Kishida, Dr. Asanuma, and Dr. Yajima. They stated that all of the specimens were taken from cows on Hachijo (Is.) and Miyake (Is.) and that they were unquestionably *cornigera*. Since there is still some doubt about the status of *H. ias* Kishida, 1936, the Japanese population in this paper is treated tentatively as a part of the *cornigera* group until there is opportunity to further study the problem.

DIAGNOSIS:

This is the only haemaphysalid species in the Japanese fauna in which the male has an exceptionally large coxa IV with two long spurs. Palpal article II is prominently salient laterally in both sexes. In the male the ventroposterior margin of palpal article II undulates irregularly, giving it the appearance of having two spurs. The dorsal retrograde spur on palpal article III

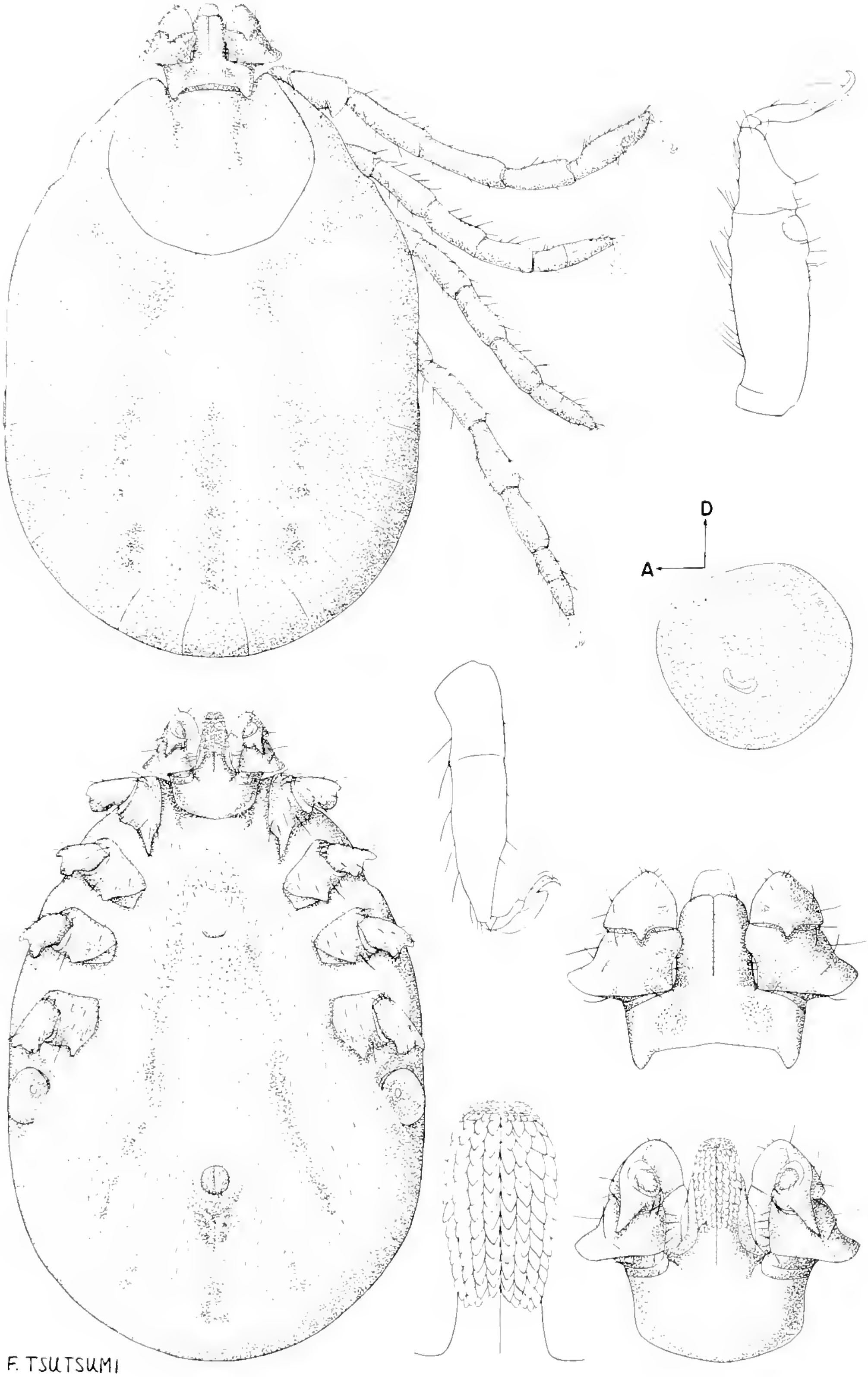


FIG. 37. *Haemaphysalis* sp. (*H. cornigera* group), female.

Fig. 38. *Haemaphysalis* sp. (*H. cornigera* group), male.

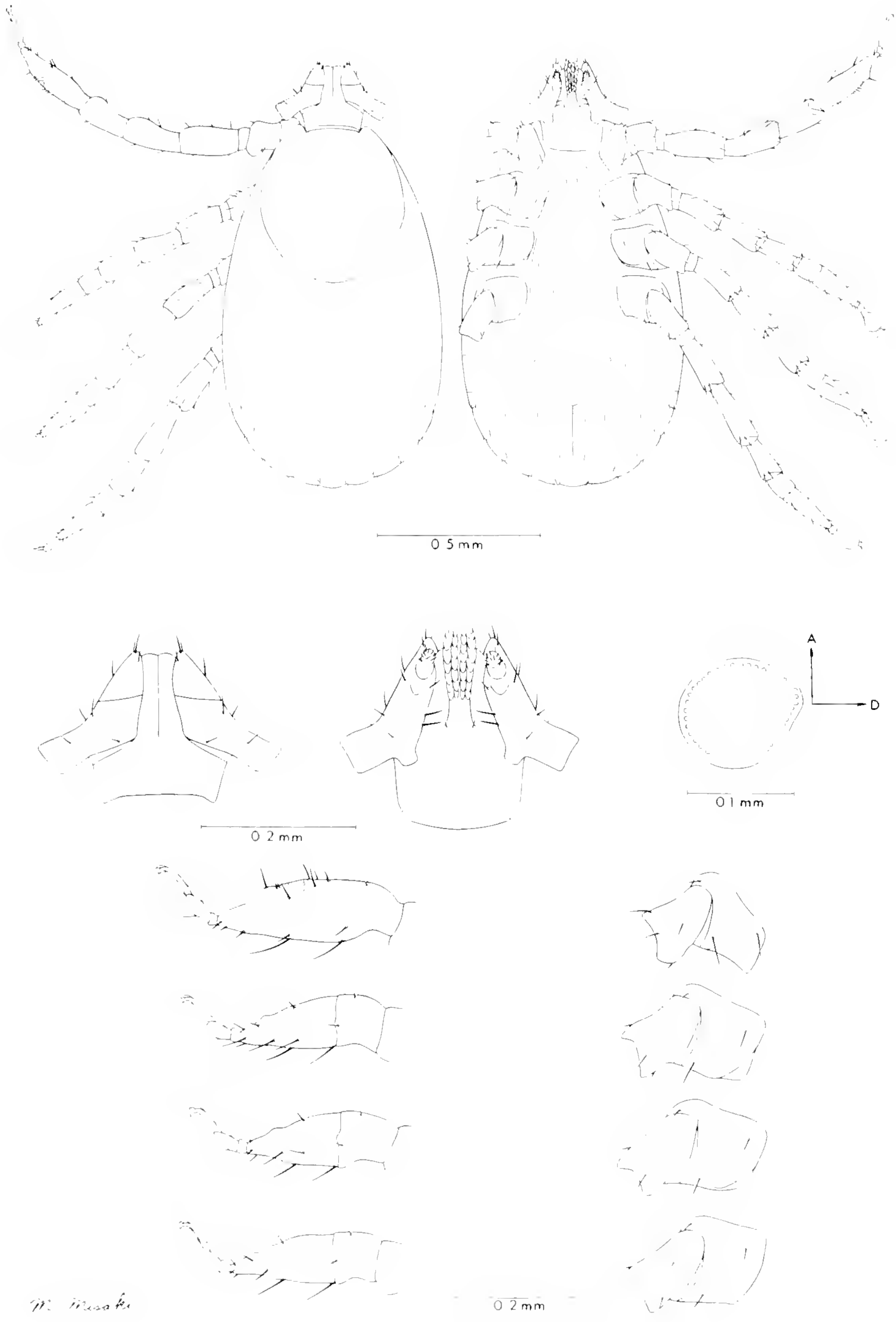


Fig. 39. *Haemaphysalis* sp. (*H. cornigera* group), nymph.

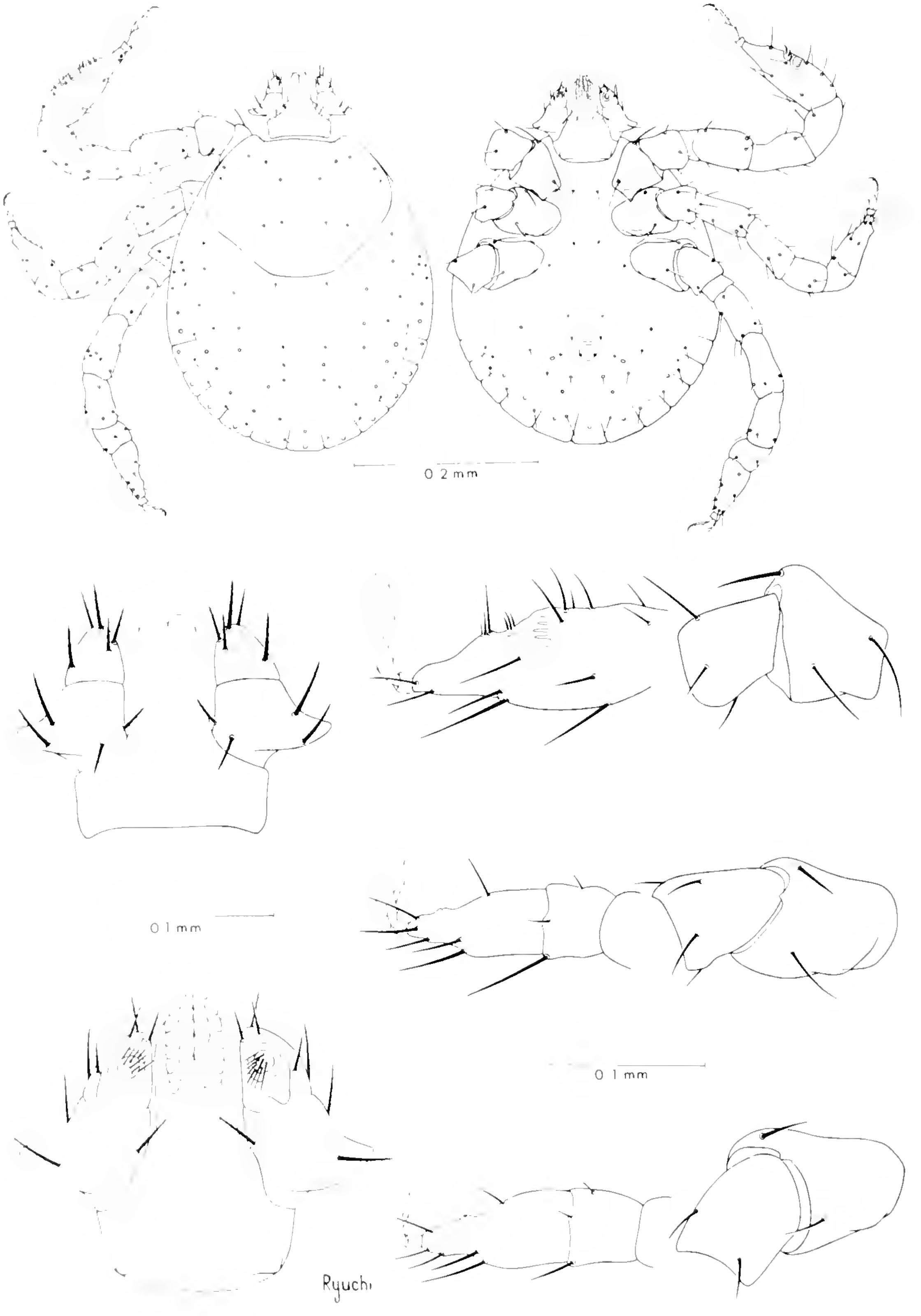
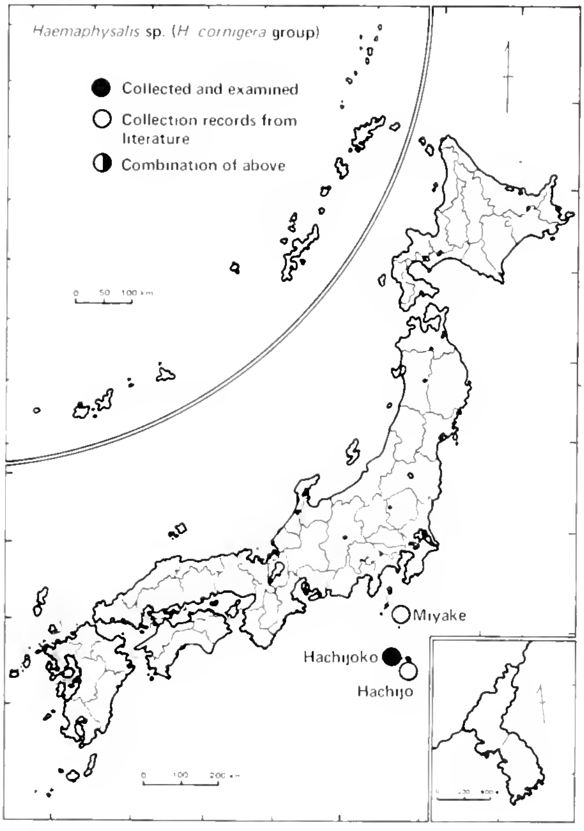


Fig. 40. *Haemaphysalis* sp. (*H. cornigera* group), larva.

is slightly lateral rather than medial. Tarsi III and IV have small midventral spurs and apicoventral spurs.

DISTRIBUTION AND HOSTS:

Anastos (1950) discussed the distribution and hosts of *H. cornigera*. It is widely distributed in Southeast Asia from Burma through the East Indies and Taiwan. It has not yet been reported from the Ryukyu Islands, and the only records from Japan are those from the Izu Islands off the coast of Honshu now included in Tokyo-to. Recorded hosts for *cornigera* are cattle, deer, water buffalo, pigs, man, and a wide variety of smaller mammals and birds. Specimens reported from Japan have been taken from cattle, and on one occasion from a dog.



MAP 11. Known distribution of *Haemaphysalis* sp. (*H. cornigera* group).

BIOLOGY:

Unknown.

DISEASE RELATIONSHIP:

Unknown.

Haemaphysalis doenitzi Warburton and Nuttall
(Fig. 41)

Haemaphysalis doenitzi Warburton and Nuttall, 1909:64-65; Keegan and Toshioka, 1957:18, Pl. 28; Saito, 1959b:193-209.

DISCUSSION:

This species was originally described from material collected from a water-hen in Singapore in 1909. A female tick taken from a pheasant at Akune, Kagoshima Prefecture, 10 January 1956, by Toshioka was the specimen illustrated in Keegan and Toshioka (1957, Pl. 28). This specimen was listed as species *incertae sedis* in that manual because Kohls had expressed the opinion that it was very similar to *H. doenitzi* except for the 5/5 dentition of the hypostome (original description of *doenitzi*, 4/4). Hoogstraal (1969a) has expressed the opinion that laboratory rearing will be necessary in order to resolve the problem involving forms in the Oriental tropics with 4/4 dentition versus temperate forms with 5/5 dentition.

DIAGNOSIS:

H. doenitzi is a very small species. In the female, the boot-shaped palpal article II is sharply salient laterally and at right angles to the axis of the basis capituli; palpal article III is subtriangular from a dorsal view, without dorsal spur; the cornua is poorly developed; the hypostome has 5/5 dentition (4/4 according to Nuttall and Warburton, 1915); and coxae I-IV have very short, blunt spurs.

DISTRIBUTION AND HOSTS:

In addition to the original record of *H. doenitzi* from a water-hen in Singapore, this species was recorded from Indochina (Toumanoff, 1944) without the specific locality or host being mentioned. In Japan, Saito (1959b) collected immature forms and adults from pheasants and a male from vegetation. In his laboratory he fed *H. doenitzi* on a domestic fowl, *Gallus gallus domesticus*.

BIOLOGY:

Unknown.

DISEASE RELATIONSHIP:

Unknown.

Haemaphysalis flava Neumann
(Fig. 42-45)

Haemaphysalis flava Neumann, 1897:333-336, Fig. 3 (in part), 1901:260 (in part); Dönitz, 1905:129-130; Warburton, 1908:510-512, Fig. 1, 2; Blanchard, 1909:151; Nuttall and Warburton, 1915:408-410, Fig. 342, 343; Kishida, 1922a:846-854, 1927:985, Fig. 1897, 1936: 142,

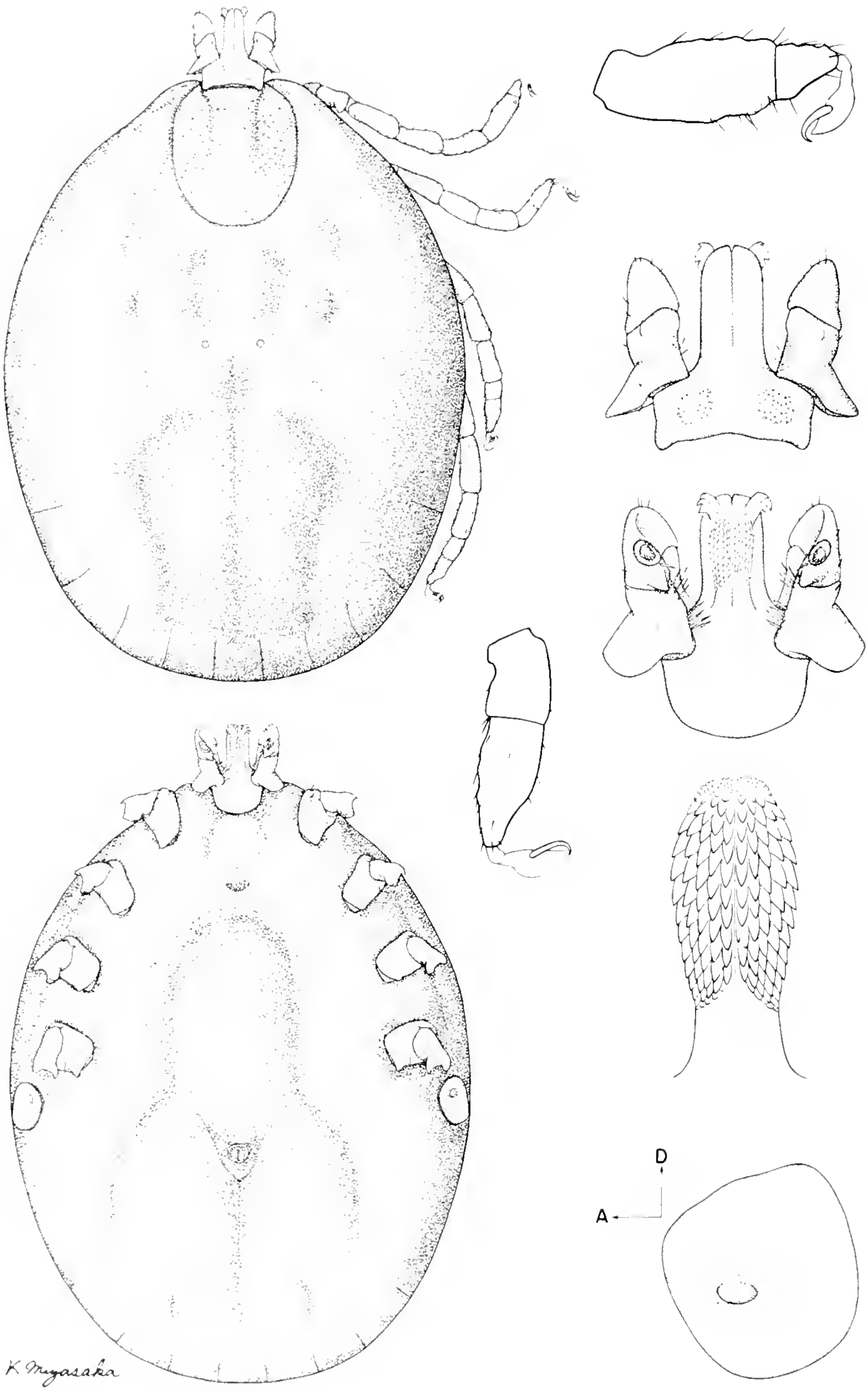
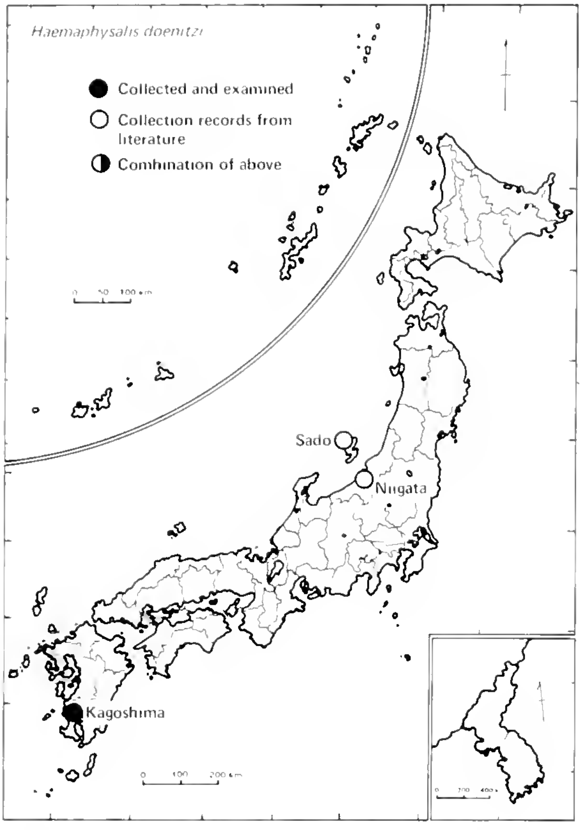


FIG. 41. *Haemaphysalis doenitzi*, female.



MAP 12. Known distribution of *Haemaphysalis doenitzi*.

1947:972, Fig. 2767; Sugimoto, 1935:23-24, Fig. 5 in Pl. I, Fig. 2 in Pl. II, Fig. 4 in Pl. III, 1936c:580, 1937a:308; Nakamura and Yajima, 1937:157; Yajima, 1942:503-509, Fig. 3; Nakatsuji, 1942:294; Itagaki, Noda, and Yamaguchi, 1944:1-97, Pl. 5, 1959:1-118, Pl. 5; Shigemori, Aso, and Yajima, 1953: 290-293; Asanuma et al., 1955:127-128; Asanuma, 1956a:91-96, 1965a:111-112, Fig. 7.7, 1965b: 400, Fig. 224; Asanuma and Sakurai, 1958: 28-39, Keegan and Toshioka, 1957:14-15, Pl. 21, 22; Ohara et al., 1959:8-17, Fig. 1-6, Pl. I-XIV; Saito, 1959b:193-209, 1960a:303-321, 1960b:189-239, Fig. 1-37, 1962a:127-146, 1962b:147-159; Honma and Ohara, 1961:1-7; Saito, Ohara, and Unagami, 1960: 323-329; Saito and Ohara, 1961:1-32; Saito et al., 1965: 143-159.

Haemaphysalis flava var. *armata* Neumann, 1905:237-238.

Haemaphysalis flava armata: Neumann, 1911: 112; Kishida, 1922a:852.

Haemaphysalis i Kishida, 1922a:852-853, Pl. 26; Nakamura and Yajima, 1937:148.

Haemaphysalis orientalis Kishida, 1934. (*nomen nudum*); Keegan and Toshioka, 1957:14.

Haemaphysalis watanabei Yajima, 1942:500-502, Fig. 1; Keegan and Toshioka, 1957:30.

DISCUSSION:

Neumann's original description (1897) was based on material collected from dog, horse, cow, hare, and vegetation in Japan. However, as pointed out by Warburton (1908), this material (type series) contained at least two distinctly different species. They were *H. flava* and *H. campanulata*. Moreover, Warburton (1908) found *japonica* mixed with *flava* and *campanulata* in a tube labeled as No. 137 "*H. flava*," identified by Neumann himself, which had been deposited in the British Museum. More confusingly, Dönitz (1905) pointed out that *H. neumanni* Dönitz, 1905 (now considered to be a synonym of *H. longicornis* Neumann, 1901), was found with *flava* in the lot which Neumann sent him.

Neumann (1897) originally described the male of *flava* as having a long spur on coxa IV, and in 1901 he mentioned the presence of a short-spurred form of *flava* (Warburton, 1908: 513). Subsequently (1905), he considered his original long-spurred form to be a variety (*flava* var. *armata*) and in 1911 made the short-spurred form the type of *H. flava flava*. This was criticized by Warburton (1908). To make the situation clear, Warburton (1908) redescribed the true *flava* (=Neumann's long-spurred form) based on one female and one male given him by Dönitz, which were taken from a dog at Ise and from cattle or a horse at Hiroshima.

In the same paper Warburton established *japonica* (=Neumann's short-spurred form) and *campanulata* (see discussion of *H. campanulata* and *H. japonica*). Nuttall and Warburton (1915) repeated Warburton's original description and added measurements and collection records of Indian specimens. However, the specimens from India are now considered to be a separate species, *H. indoflava*.

Kishida (1922a) described *H. i*, the holotype of which was a male collected from a wild boar on Mt. Kiyosumi, Honshu, by Aoki, 30 October 1909. Although the holotype specimen was not available for study, both the description and the illustrations agree with the morphological characters of *H. flava*. Asanuma (1969) concurs with this opinion.

Keegan and Toshioka (1957) examined the holotype of *H. orientalis* Kishida, 1934, taken from a dog at Tokyo, and listed it as a synonym of *flava*. Since the original description was not published, *orientalis* is apparently a *nomen nudum*.

Yajima (1942) described *H. watanabei* based on two females taken from a horse at Okunakayama, Iwate Prefecture, Honshu, 16 October 1939, by Y. Watanabe. One of the holotype series, No. 2535 (the date on the label was 16 VIII 1939), mounted on a slide, was loaned to us for study through the courtesy of Dr. Kitaoka, and it is our opinion that *H. watanabei* is conspecific with *H. flava*.

DIAGNOSIS:

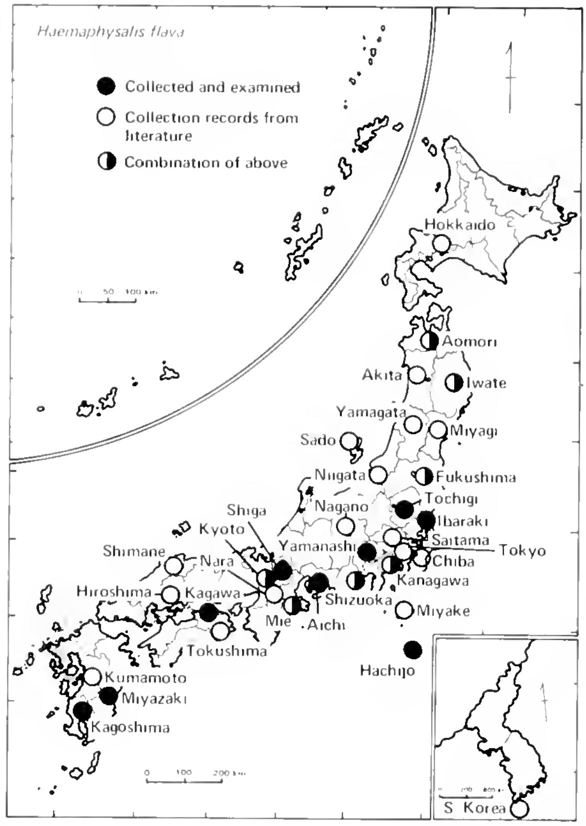
This species resembles *H. japonica* but may be distinguished from that species in that in both sexes the spur on coxa IV is longer than the others; in the male the spur is straight, sharply pointed, and approximately as long as the coxa; in the female it is slightly longer than the other short, blunt, subequal spurs on coxae I-III. This species is commonly found on dogs, whereas there are no collection records of *japonica* from dogs.

DISTRIBUTION AND HOSTS:

According to the available literature, this species is known only from Japan and Korea. In Japan it has been collected on all four principal islands. Nuttall and Warburton (1915) referred to records from dogs, wild boar (*Sus cristatus*), and sheep in India; however, Dhanda and Bhat (1968) consider the materials from India to be *H. indoflava*. They state that there is no evidence that *H.* (*H.*) *flava* Neumann occurs in India. Adult *H. flava* have been taken most frequently from hares and dogs, but they have also been found in considerable numbers on cows, horses, wild boar, deer, and bear (*Ursus thibetanus japonicus*). Asanuma et al. (1955) listed hosts for each stage and indicated that bird hosts were parasitized only by immature forms. Immature forms are also found on the same hosts as adults and on small rodents. Saito (1959b) and Saito et al. (1965) also studied occurrence of this tick in Niigata Prefecture including Sado Island, and they found *flava* from animals other than those on Asanuma's list. We have identified specimens as *flava* from the following prefectures: Honshu - Aomori, Iwate, Fukushima, Niigata, Ibaraki, Tochigi, Tokyo, Kanagawa, Chiba, Shizuoka, Nagano, Aichi, Shiga, Kyoto, Nara, Mie, Hiroshima, and Shimane; Kyushu - Miyazaki, Kagoshima, and Kumamoto; and Shikoku - Ehime and Kagawa.

BIOLOGY:

The biology of *H. flava* has been studied by Asanuma (1956a), Asanuma and Sakurai (1958) in Chiba Prefecture, and by Saito (1959b) in Niigata Prefecture. Asanuma found that on



MAP 13. Known distribution of *Haemaphysalis flava*.

hares, adults were most abundant in late autumn and winter. Saito observed a similar trend in Niigata Prefecture, except for the fact that there was a peak in March instead of winter, and adults disappeared in summer. Nymphs were found active on hares throughout the year, but generally adults were most abundant from autumn to winter. Larvae were found most frequently in November in Niigata Prefecture and in summer in Chiba Prefecture. Asanuma (1956a) studied the laboratory life cycle of *H. flava*. Eggs of *H. flava* hatched in 24-25 days when maintained at a constant tempeature of 30 C and at 80-90% relative humidity. Eggs deposited early in May hatched in 28 days at room temperature, while eggs deposited in late May hatched in 32 days. Duration of larval attachment to the host varied from 2-13 days. Most larvae dropped from the host on the third, fourth, or fifth day after attachment. After detachment from the host, larvae entered a postparasitic period which varied in length according to temperature. At a constant temperature of 30 C and at 100% relative humidity, duration of the postparasitic period was from 9-15 days (average 11 days). At 25 C, it was from 14-21 days. When kept at room temperature, after

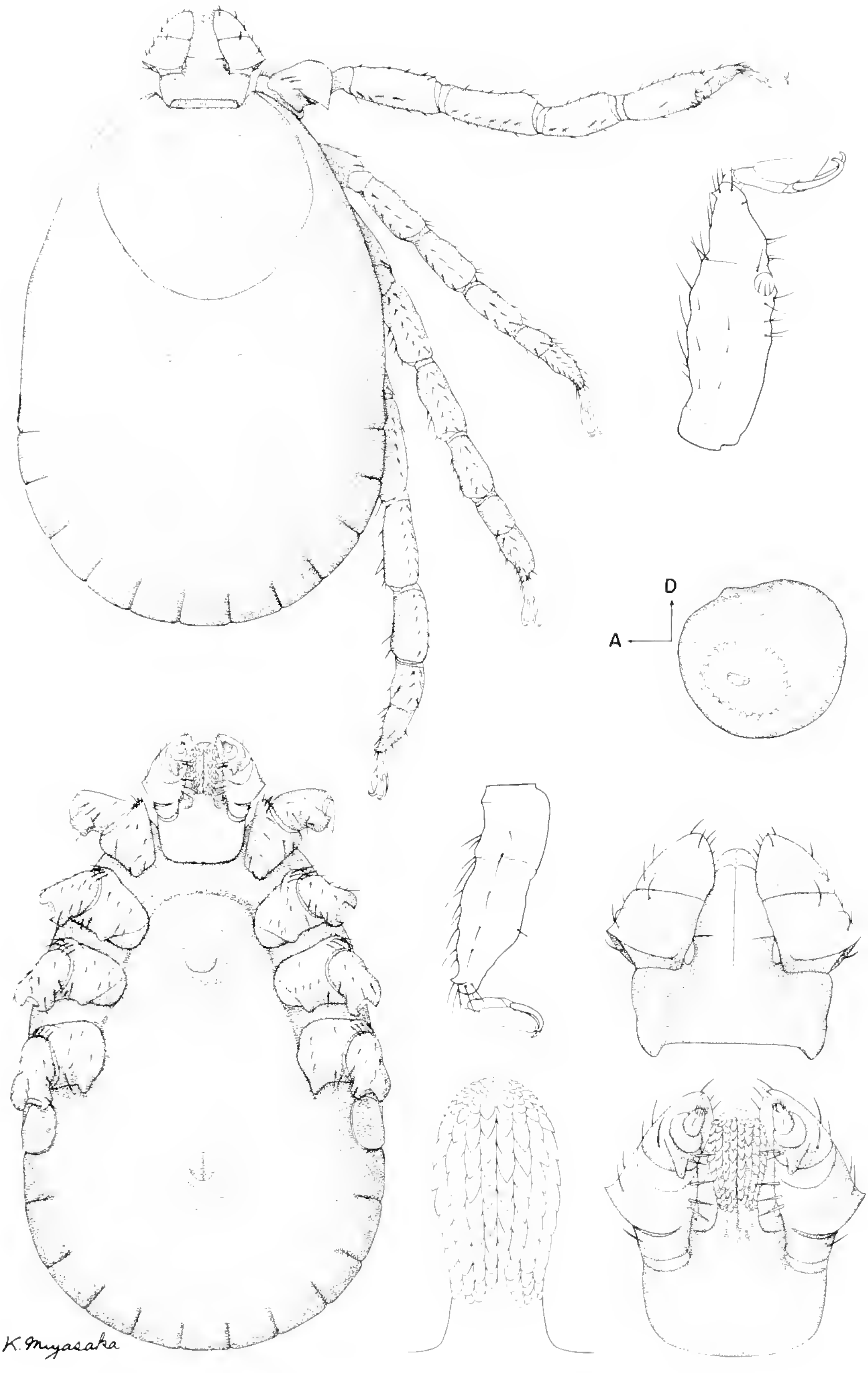


FIG. 42. *Haemaphysalis flava*, female.

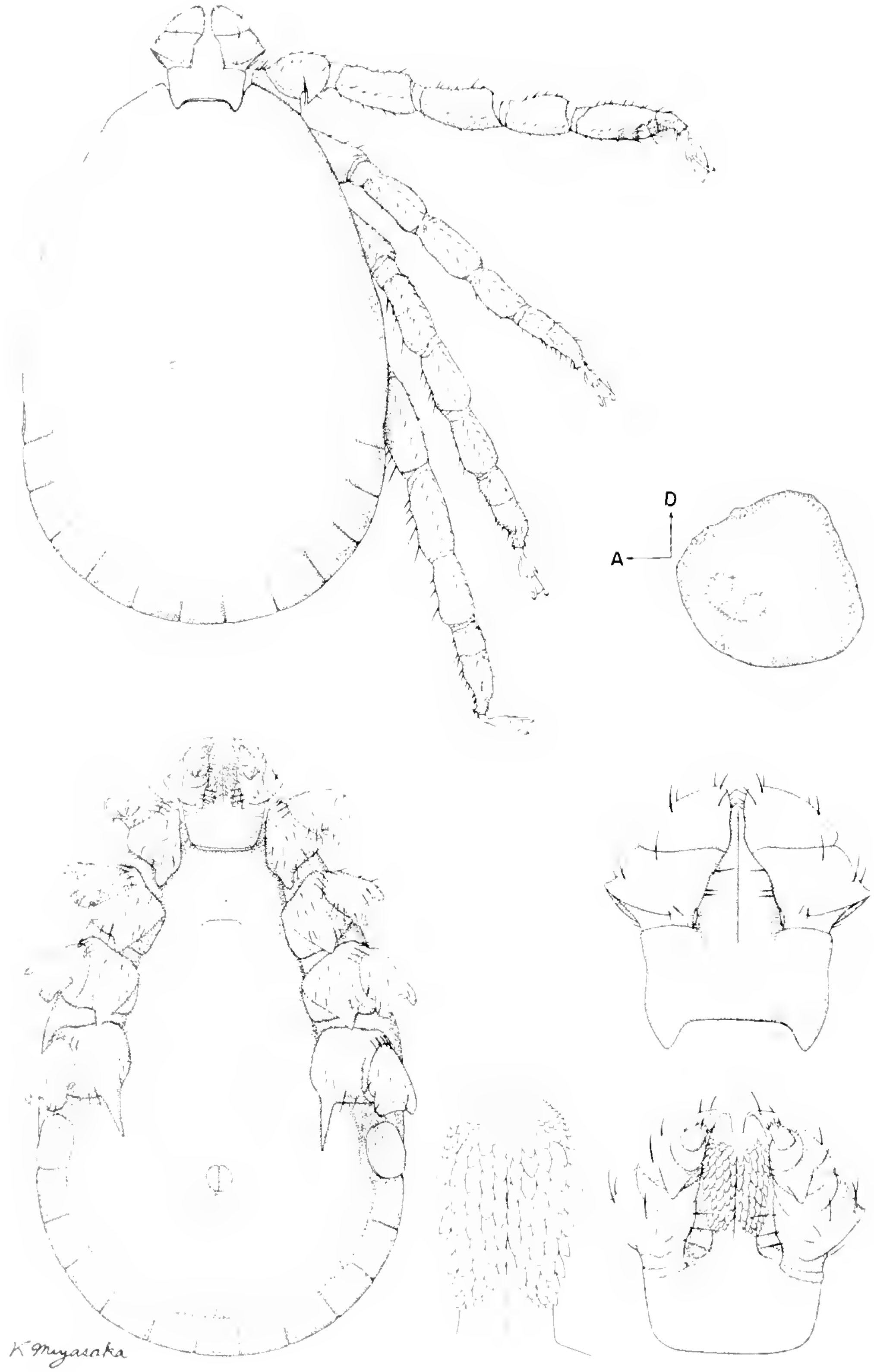


Fig. 43. *Haemaphysalis flava*, male.

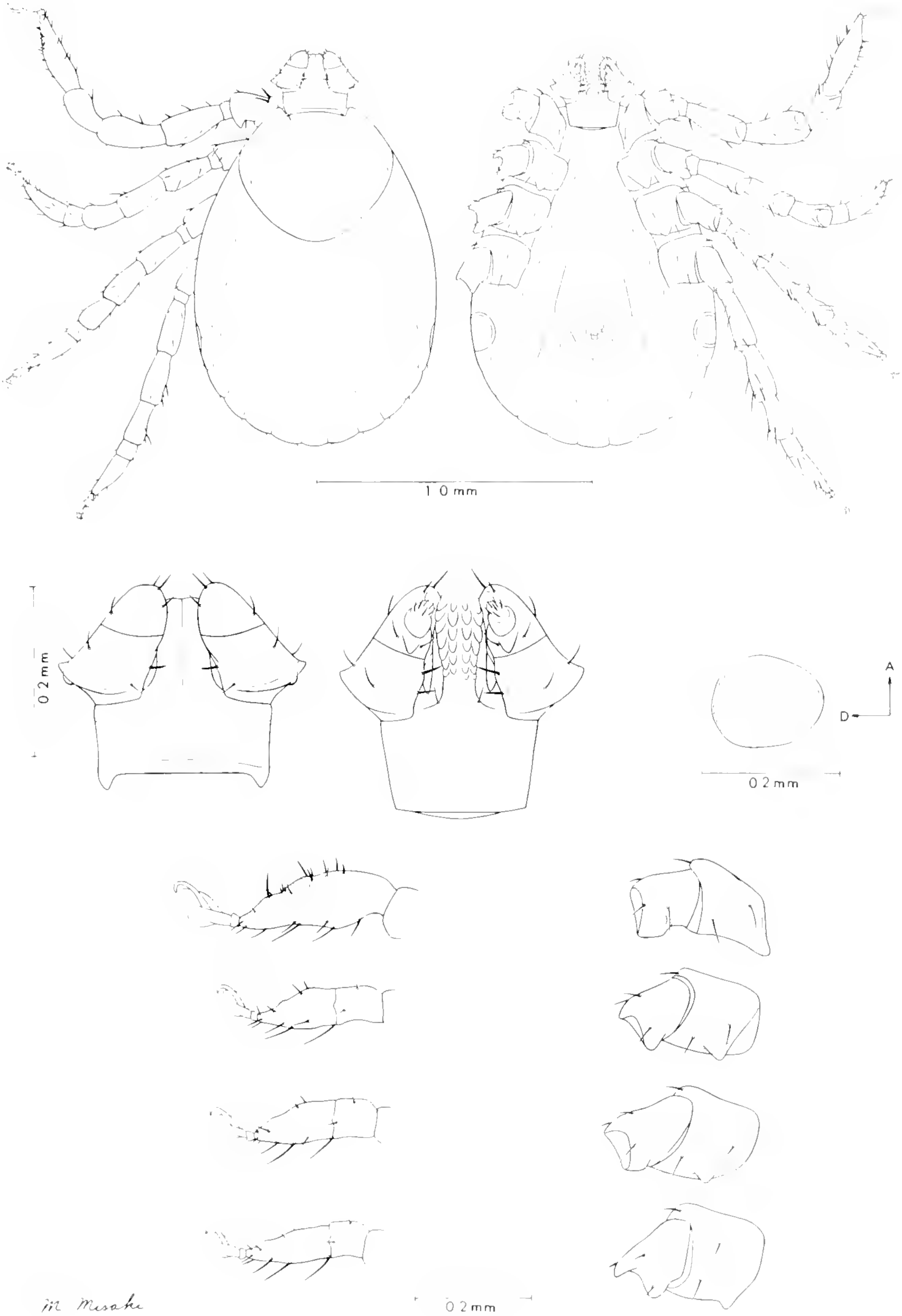


Fig. 44. *Haemaphysalis flava*, nymph.

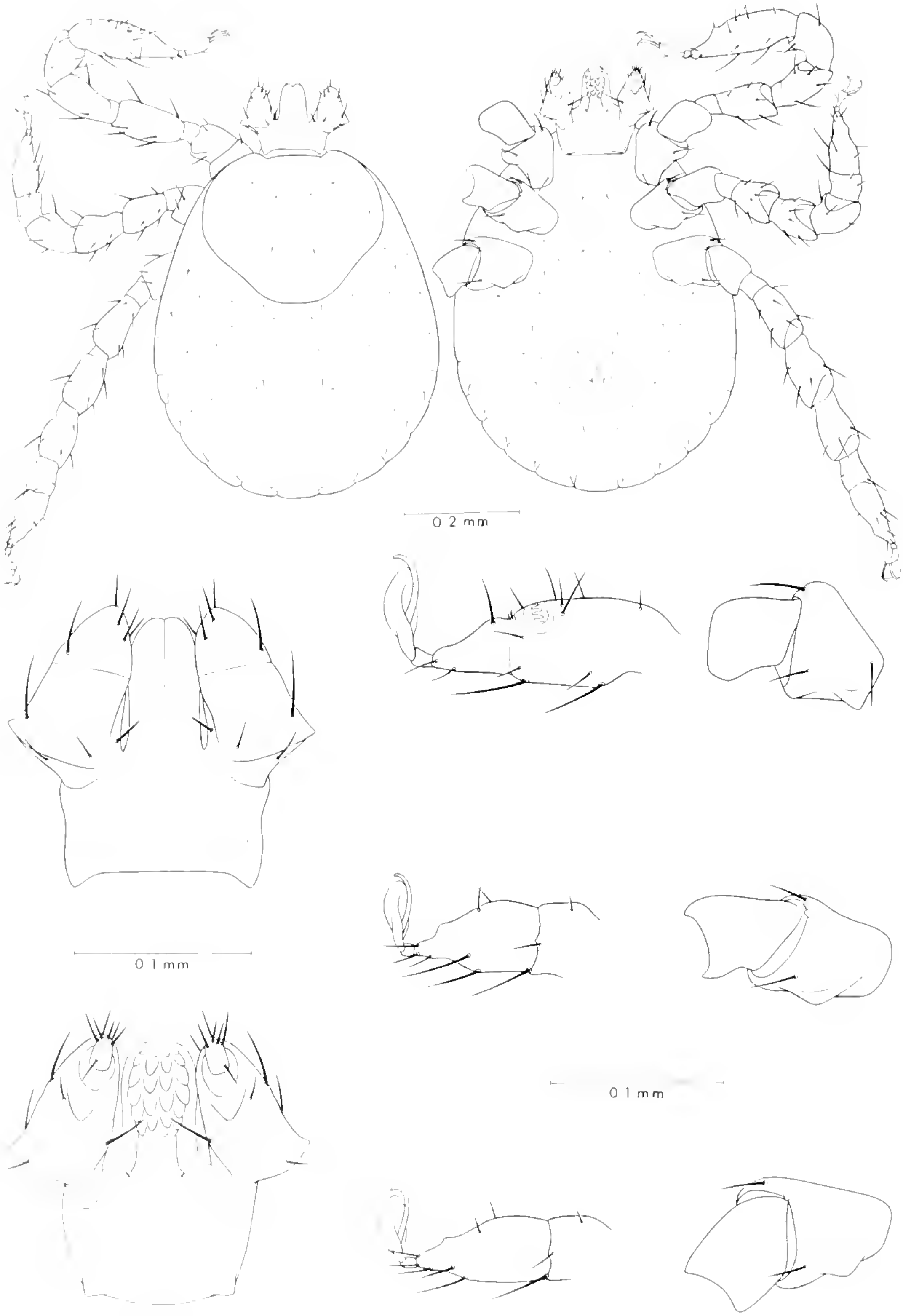


FIG. 45. *Haemaphysalis flava*, larva.

dropping off the host, it was three months for those detaching in February; for those detaching in June, it was 17 days; for those detaching in September, it was 17 days; for those detaching in October, it was about 32 days; for those detaching in late November it was 5 months, and the larvae molted the following May. Nymphs remained attached to the host for 2-13 days. A large number fell from the host on the fifth or sixth day. Again the postparasitic period varied in length at different temperatures. It was 16 days under laboratory conditions, at a constant temperature of 30 C and 100% relative humidity. At room temperature this period was considerably longer. For nymphs which engorged in February, it was about three months; in July it was 16 days; and in September it was 21 days. The length of time necessary for the female to engorge varied from 9 to 28 days in several experiments. Engorged females varied considerably in weight. Duration of the preoviposition period was 5-90 days and was correlated with changes in temperature. Females which fell from the host in December did not oviposit until the following spring, but as the weather became warmer this period decreased in length. In March it was about one month, in May it was about 10 days, and in July it was about 6 days. In general, heavier female ticks deposited more eggs than lighter females. Partially fed females were also observed to lay eggs. At a constant temperature of 30 C the ovipositing period lasted 12-22 days. The number of eggs produced daily reached a maximum several days after the beginning of the period. From 80-90% of the eggs were deposited in the first half of the oviposition period.

Asanuma also stated that some ticks which were removed from hosts by scratching or forced to leave because of the death of the host before they were fully engorged could oviposit or feed again on a new host. This observation is of epidemiological importance in that such ticks are capable of mechanical transmission of tularemia to new hosts.

In the 406th laboratory, ticks were fed on rabbits' ears and the following results were obtained:

Laboratory life cycle of *Haemaphysalis flava*
(reared on rabbits)

Generation and Stage	Phase	Period in Days	Remarks
P Adult	Feeding	7-11	3 unengorged females (67-J-0294) were placed on host on 23 Dec. 1967.
P Adult	Postparasitic (Preoviposition)	11-24	
P Adult	Oviposition	8-27	Egg number: 1,219-2,564 (average 1,937)
F_1 Egg	Incubation	23-34	5,550 larvae hatched from 5,811 eggs.
F_1 Larva	Feeding	3-5	Larvae were placed on host on 1 March 1968.
F_1 Larva	Postparasitic (Premolting)	13-19	
F_1 Nymph	Feeding	3-5	
F_1 Nymph	Postparasitic (Premolting)	17-20	

The rearing experiment extended from 23 December 1967 to the middle of April 1968. Laboratory conditions were similar to those for *Haemaphysalis campanulata*.

Disease Relationship:

From a medical viewpoint, *H. flava* may be the most important tick in Japan because of its probable role in the epidemiology of tularemia on Honshu. The distribution of this tick in Japan has been discussed by many Japanese acarologists (see Appendix 2). Asanuma (1956a) conducted a U.S. Government sponsored study on the biology of *H. flava* and on its efficiency as a vector of tularemia under experimental conditions.

Japanese literature contains only two records in which tularemia was definitely transmitted to man by tick bite (Ohara and Ichikawa, 1962).

Asanuma et al. (1955) carried out a series of experiments to determine the effectiveness of *H. flava* as a vector of tularemia. Adult and immature *H. flava* were fed on rabbits infected with tularemia. Ticks which had fed were pooled according to stage of development and sex, and material from each pool was inoculated into mice and guinea pigs. All experimental animals became infected with tularemia, and the etiological agent was recovered from the heart blood of each of these animals. Positive results were also obtained with adults which were infected as nymphs and with nymphs which had been infected as larvae. Studies on transovarial transmission were not attempted.

Saito (1959a, 1962b) removed ticks from wild hares which had died of tularemia and found them to be infected with *Pasteurella tularensis*. He also observed that infected ticks were able to transmit *P. tularensis* from host to host, but he could not isolate the causal agent of tularemia from ticks collected in the field by the flagging method.

Haemaphysalis formosensis Neumann (Fig. 46-49)

Haemaphysalis formosensis Neumann, 1913:135-137; Kishida, 1922a: 852.

Discussion:

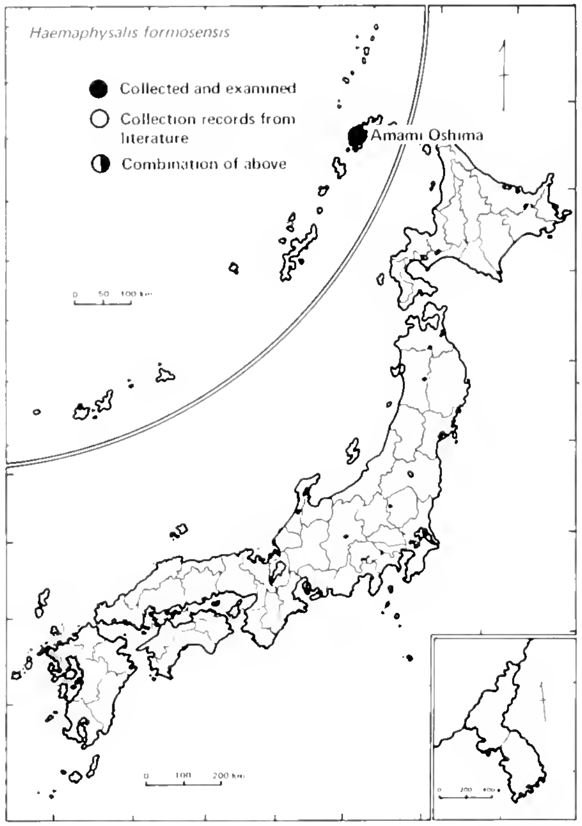
This species has not been previously reported from Japan, Korea, or the Ryukyu Islands, but Neumann (1913) and Ogura (1936) reported it from dogs in Taiwan, and Sugimoto (1936e) cited these records. Other papers by Sugimoto published in 1935-1937 include records from Taiwan but not from Japan or the Ryukyu Islands. Kishida (1922a) included *H. formosensis* in his key, but he did not give data on hosts and locality. Thus, the occurrence of this tick in Japan was in doubt until it was collected by 406th personnel from wild boar and the Ryukyu black rabbit on Amami Oshima.

Diagnosis:

This species is easily distinguished from other haemaphysalid ticks by the following combination of characters: the palps are blunt; palpal article II is very slightly salient laterally but extends scarcely beyond the basis capituli, and the lateral margins are almost parallel, with a round posteroexternal margin; palpal article III has a blunt tip (dorsal view) and a ventral spur but no dorsal spur; the hypostome dentition is 6/6 in the male and 4/4 in the female.

Distribution and Hosts:

Nuttall and Warburton (1915) collected a female, probably from either *Hystrix bengalensis* or *Ursus torquatus*, in Burma. Neumann's (1913) record was from dogs in Taiwan. Toumanoff (1944) reported *H. formosensis* collected from deer in Haut-Chlong, Indochina.



Map 14. Known distribution of *Haemaphysalis formosensis*.

Biology:

Unknown.

Disease Relationship:

Unknown.

Haemaphysalis fujisana Kitaoka (Fig. 50-53)

Haemaphysalis fujisana Kitaoka, 1970:73-81, Fig. 1-25.

Discussion:

The relationship between *H. fujisana* and other *Haemaphysalis* species which parasitize cattle in Japan requires additional study.

H. fujisana is related to *H. concinna* Koch, 1844, but the male of *H. concinna* is easily separated from *H. fujisana* in that palpal segment III is chelate. The female closely resembles *H. concinna* in general appearance, but "the palpi of the

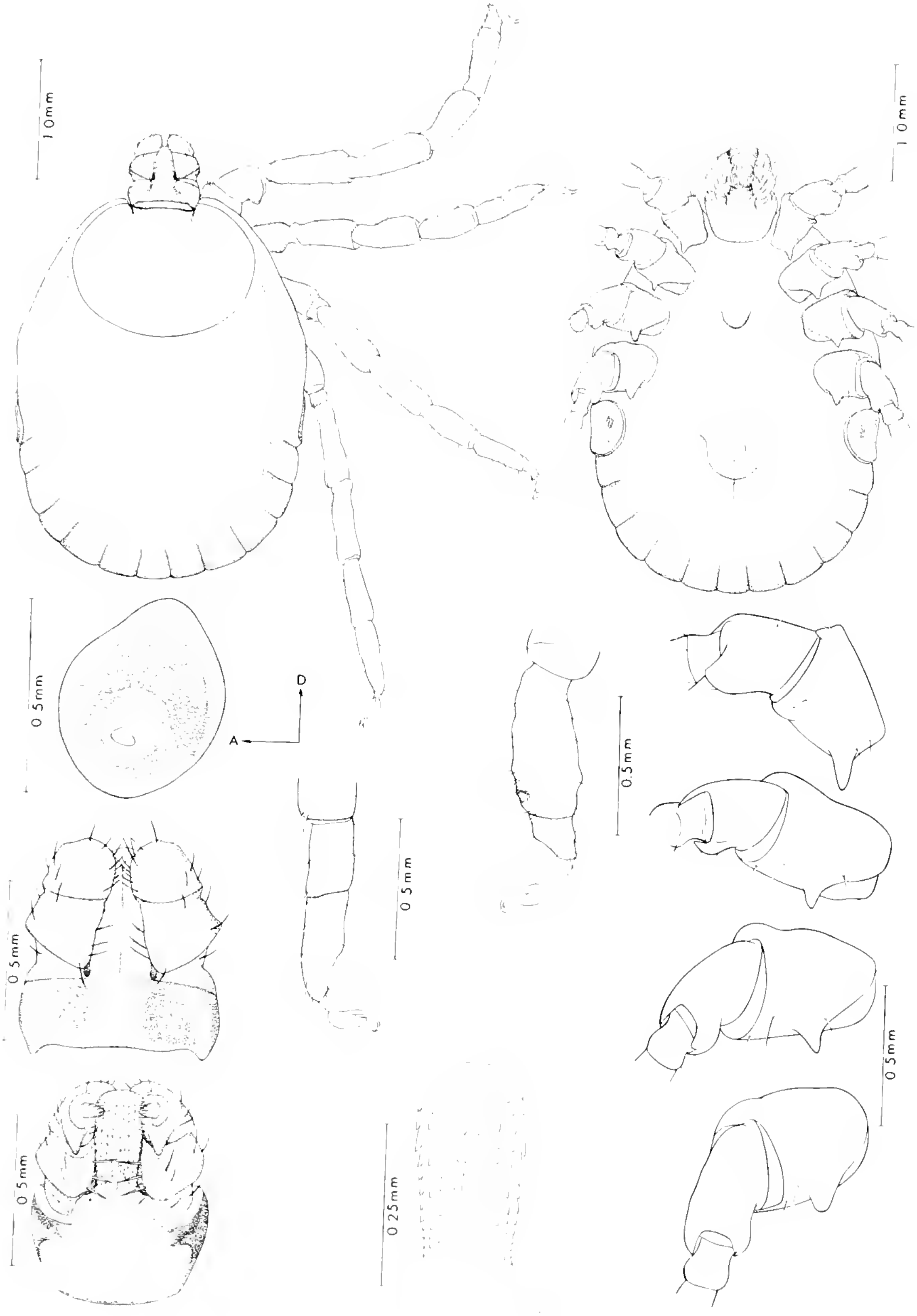


FIG. 46. *Haemaphysalis formosensis*, female.

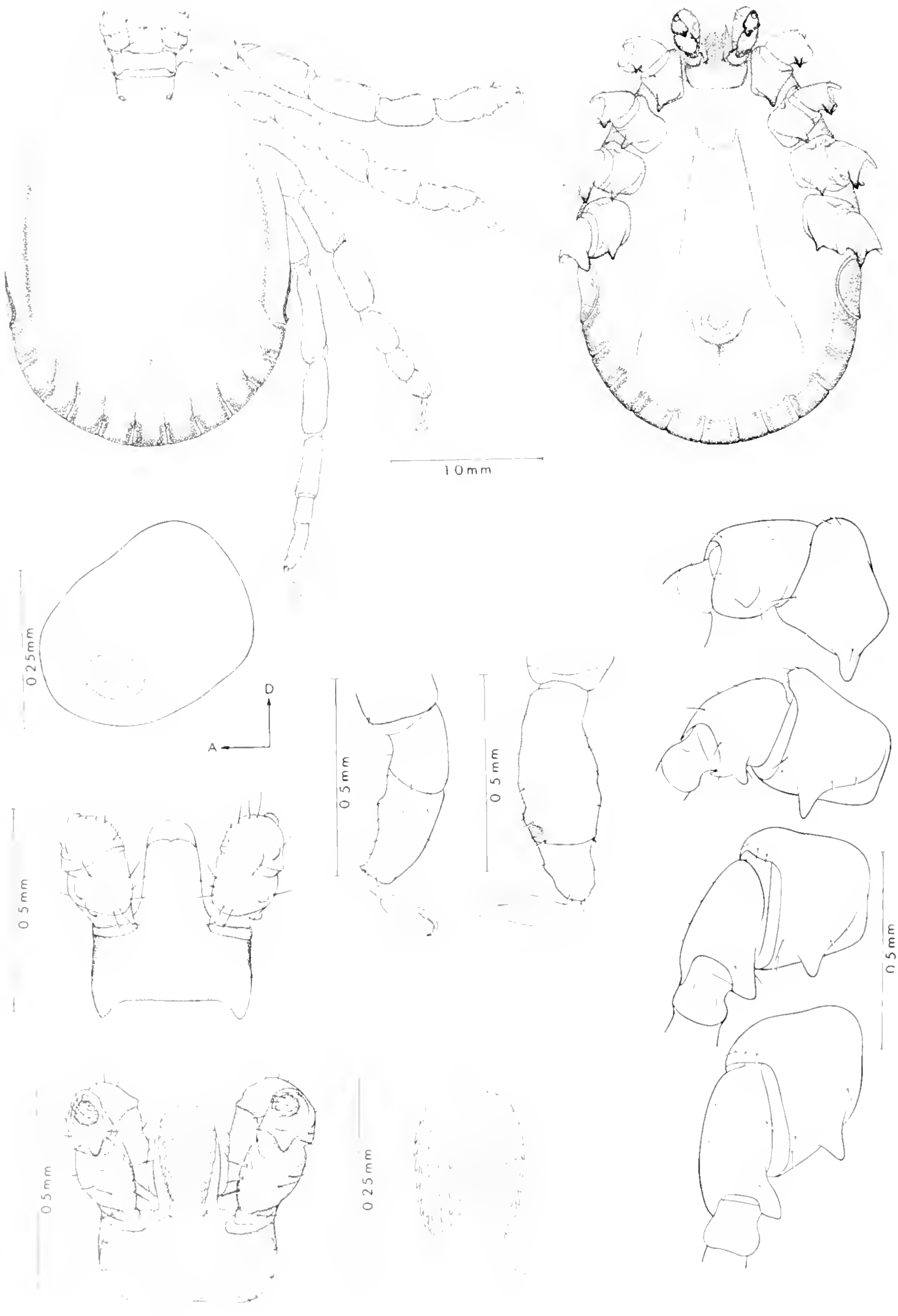


Fig. 47. *Haemaphysalis formosensis*, male.

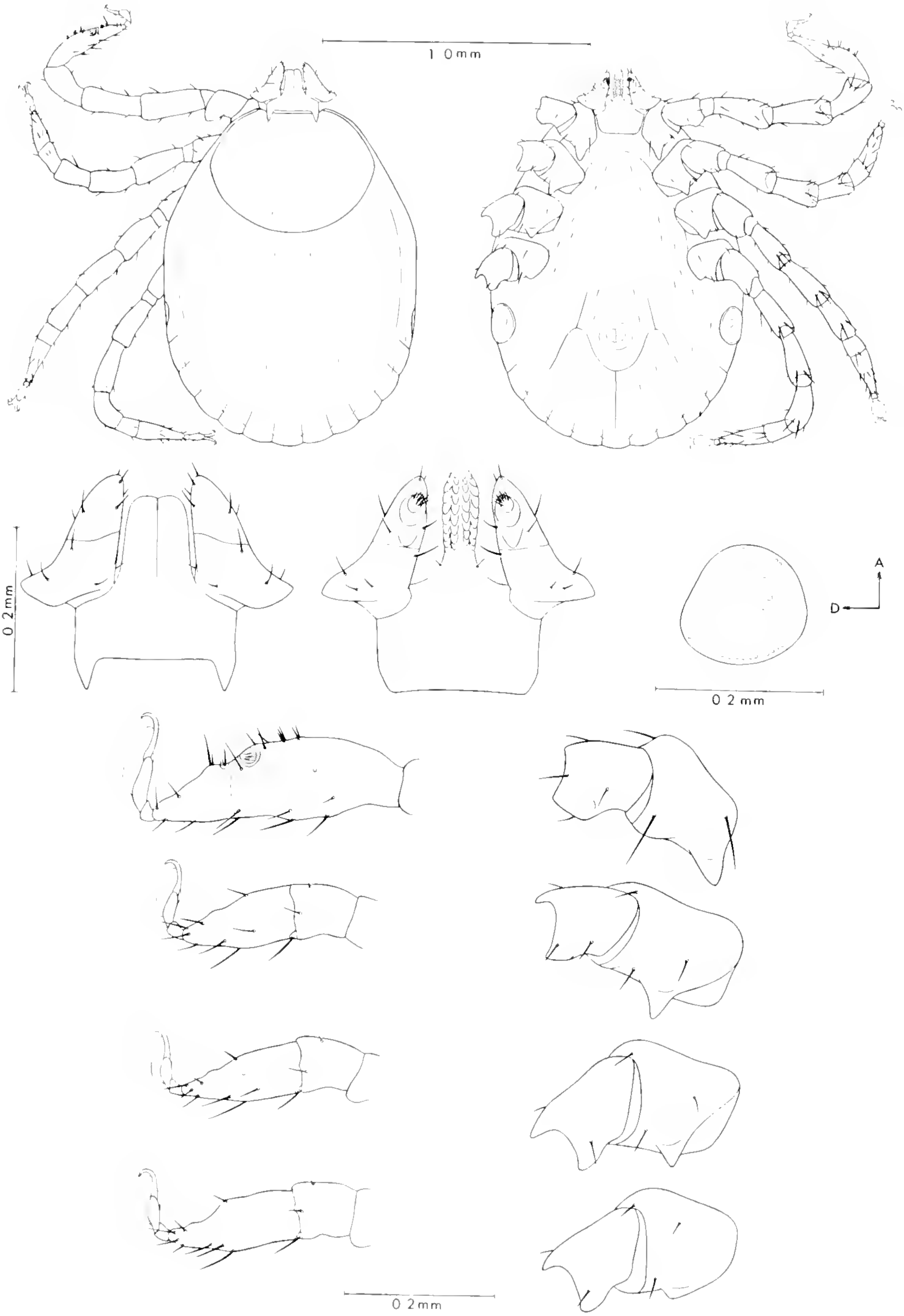


Fig. 48. *Haemaphysalis formosensis*, nymph.

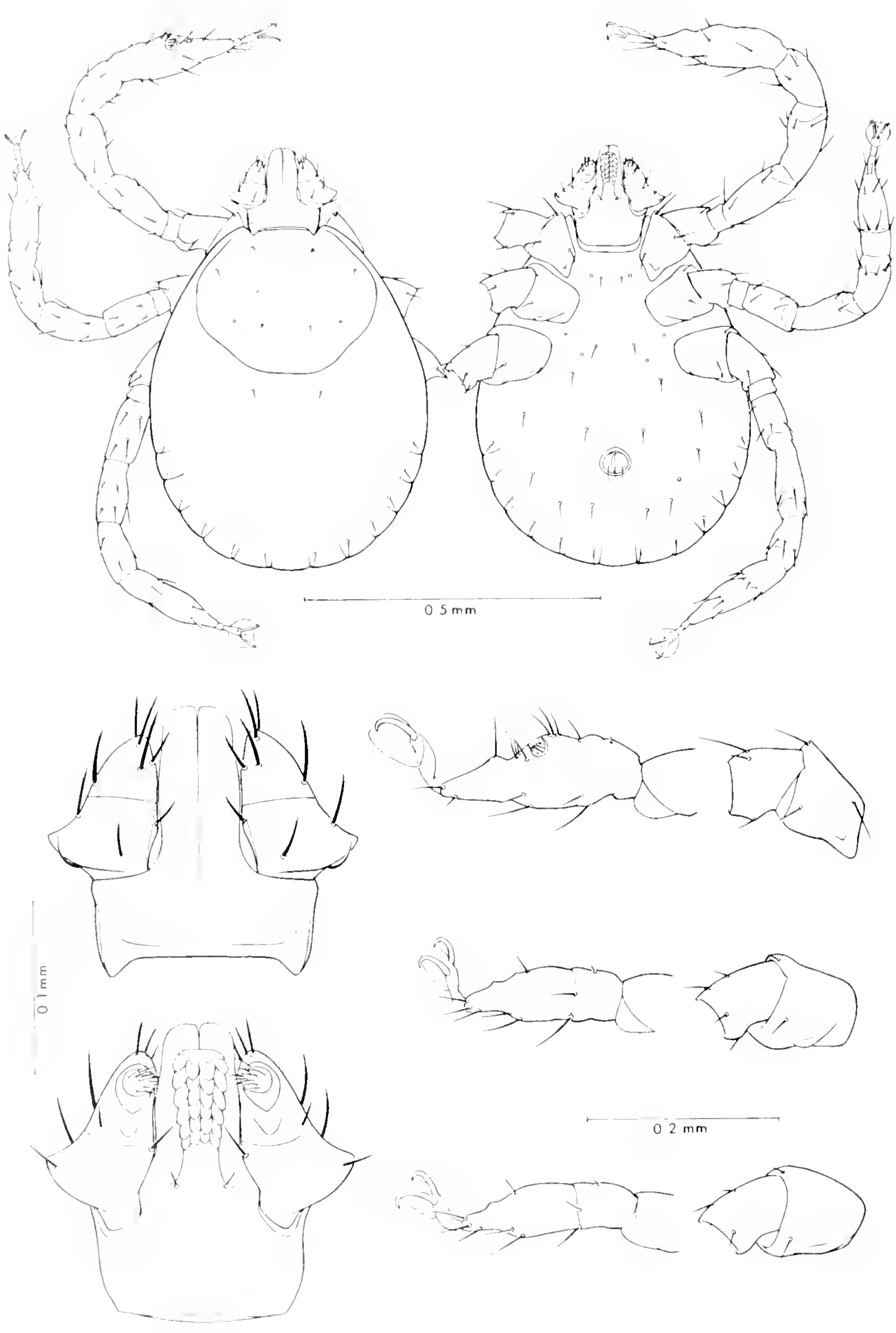


FIG. 49. *Haemaphysalis formosensis*, larva.

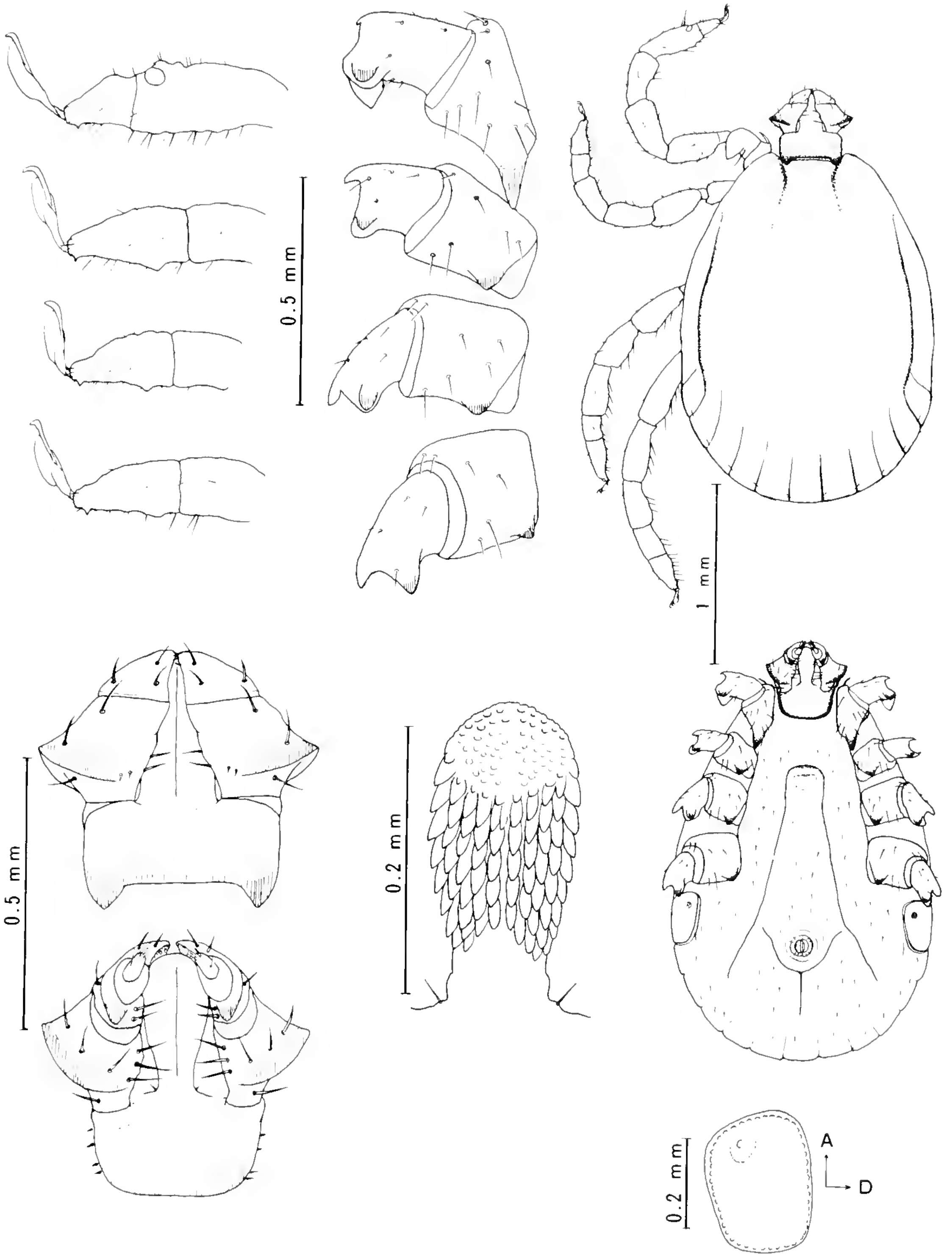


FIG. 50. *Haemaphysalis fujisana*, male. (After Kitaoka, 1970)

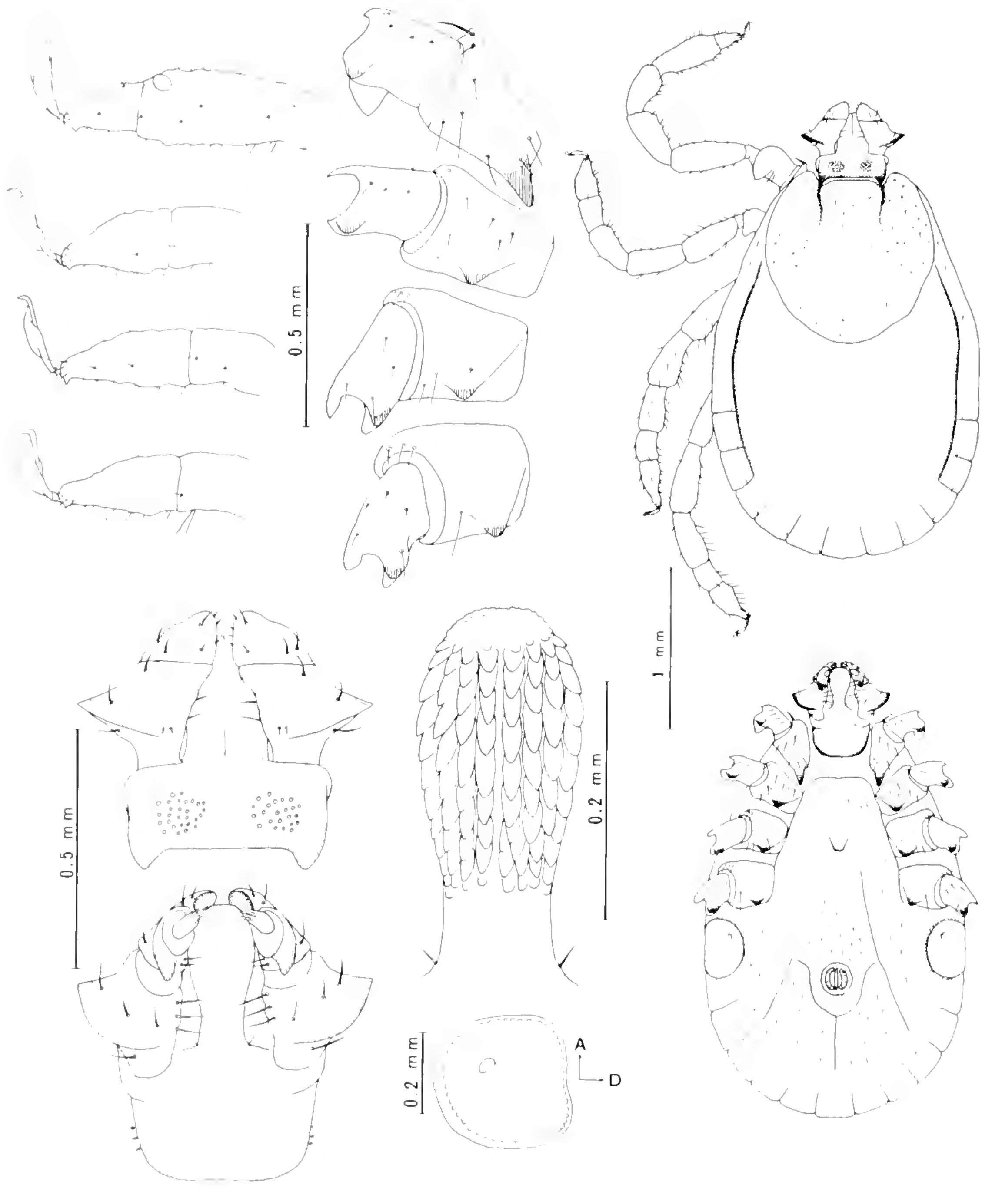


Fig. 51. *Haemaphysalis fujisana*, female. (After Kitaoka, 1970)

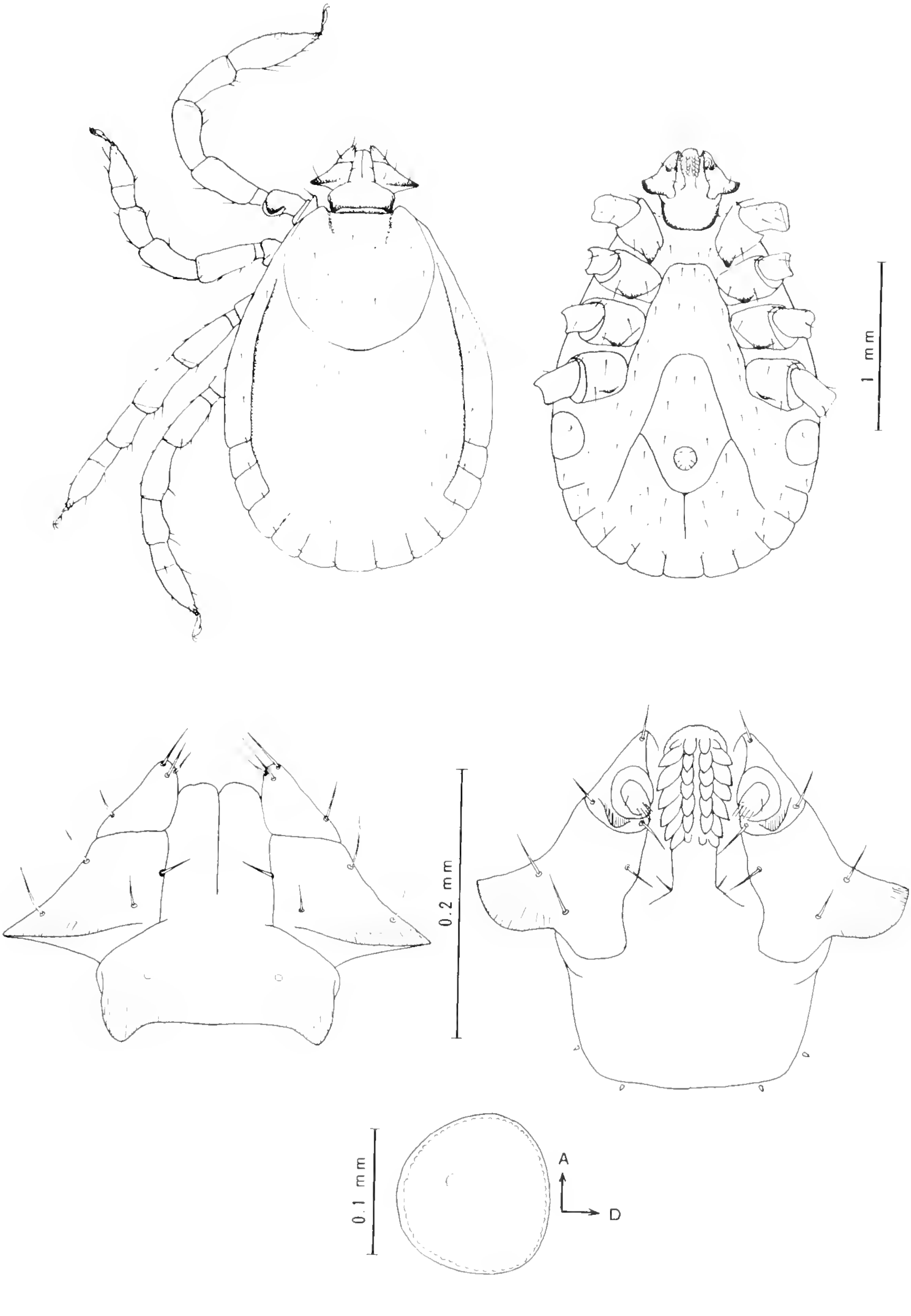


FIG. 52. *Haemaphysalis fujisana*, nymph. (After Kitaoka, 1970)

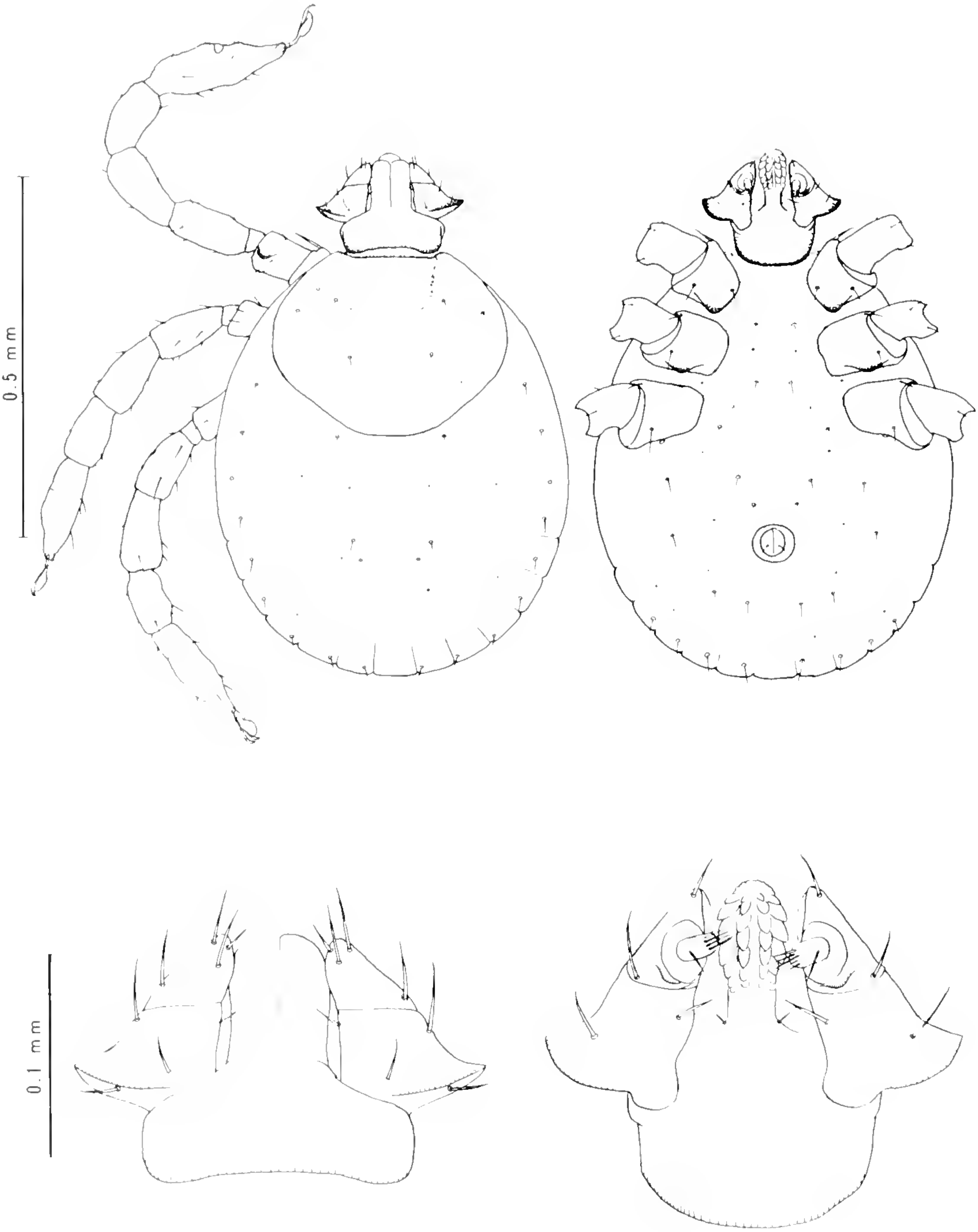


Fig. 53. *Haemaphysalis fujisana*, larva. (After Kitaoka, 1970)

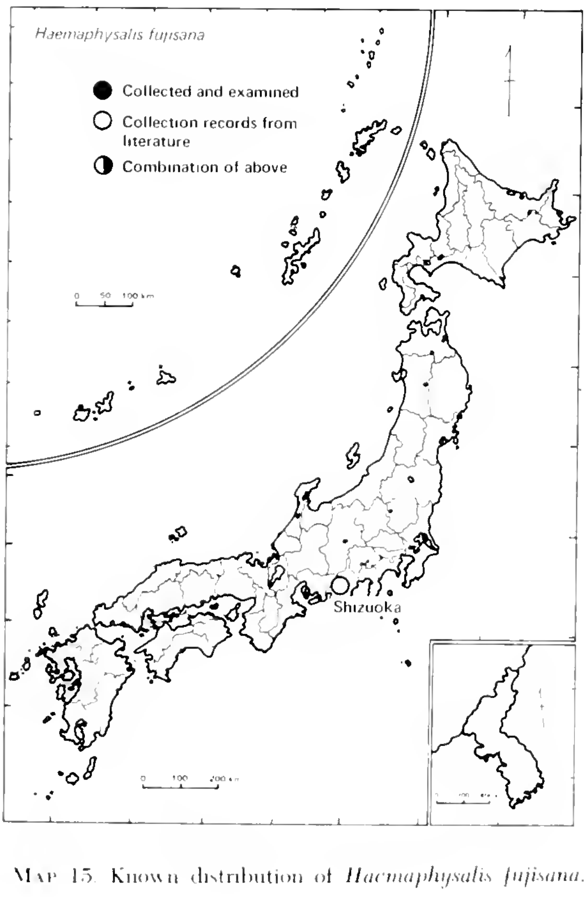
adult of the new species have a small, abrupt basolateral salience that is lacking in *H. concinna.* The immature form has more salient palpi than the adult" (Kitaoka, 1970).

This species is also similar to *H. japonica* in that the spur on coxa I is longer than those of coxae II-IV. But in both sexes the dorsal view of palpal segment II differs from *H. japonica.* In *H. fujisana,* palpal segment II has an external profile which is longer (male), and subequal to or slightly longer (female) than that of segment III, and the basolateral (posteroexternal) juncture is more sharply ridged; ventrally palpal segment II bears 3 infrainternal setae. The spiracular plate of the male is longer than wide and without a dorsal process.

In *H. japonica,* on the contrary, palpal segment II has an external profile distinctly shorter than that of segment III, and the basolateral juncture is somewhat blunt with a dull angle; ventrally it bears more (5-6) infrainternal setae. The spiracular plate of the male is wider than long and with a dorsal process.

DISTRIBUTION AND HOSTS:

This species has been collected only from Holstein calves near the foot of Mt. Fuji, near Fujinomiya, Shiznoka, Japan.



MAP 15. Known distribution of *Haemaphysalis fujisana.*

BIOLOGY:

Kitaoka (1970) reared the progeny of one engorged female. About 250 eggs were deposited during a period of nine days. Eggs began to hatch in 17 days. Larvae fed for 3 to 4 days and molted 11 to 18 days later at 25 C and in 8 to 10 days at 30 C. Nymphs fed for 3 to 4 days in August and 4 to 5 days in September. Nymphs molted in about 15.9 days (males) and 17.5 days (females) at 25 C.

DISEASE RELATIONSHIP:

Unknown.

Haemaphysalis hystricis Supino
(Fig. 54-57)

Haemaphysalis hystricis Supino, 1897:251-253; Kishida, 1922a:852; Sugimoto, 1937a:311-313, 1937b:609; Asanuma, 1947b:973, Fig. 2771, 1965a:111; Keegan and Toshioka, 1957:15, Pl. 23, 24; Kawashima, 1963:103; Hoogstraal, Trapido, and Kohls, 1965:467-480, Fig. 1-38.

Haemaphysalis bispinosa: Neumann, 1901:261-262: (Not Neumann, 1897).

Haemaphysalis nishiyamai: Sugimoto, 1935:29-33, Pl. I-III, 1936c:581-582, Pl. II, 1937a:317, 1937d:287-290, Pl. III; Nakamura and Yajima, 1937:148.

Haemaphysalis iwasakii Sugimoto, 1937:610, Pl. III.

DISCUSSION:

Sugimoto (1937a, 1937b) reported the occurrence of *H. hystricis* in Yonakuni, one of the Ryukyu Islands, but made no mention of the host. Kishida (1922a) included this species in his key but gave no collection details. Asanuma (1947b) gave a brief account of this species in the *Illustrated Encyclopedia of the Fauna of Japan.* A collection by 406th personnel includes four lots from wild boar on Ishigaki (Is.) and Iriomote (Is.) in the Ryukyus, but in more recent surveys this species was collected from dogs, pigs, and the Ryukyu black rabbit on Amami Oshima, Kagoshima Prefecture.

H. nishiyamai was originally described by Sugimoto, who examined 13 males taken from a wild boar, a dog, and a man on Taiwan. Subsequently (1937a), he listed an additional male from a dog, and in 1937 he redescribed the male and described the female. He stated (1937d) that the male of *nishiyamai* was very close to *hystricis* but distinct from it in that palpal segment II has "a fairly strong ventral

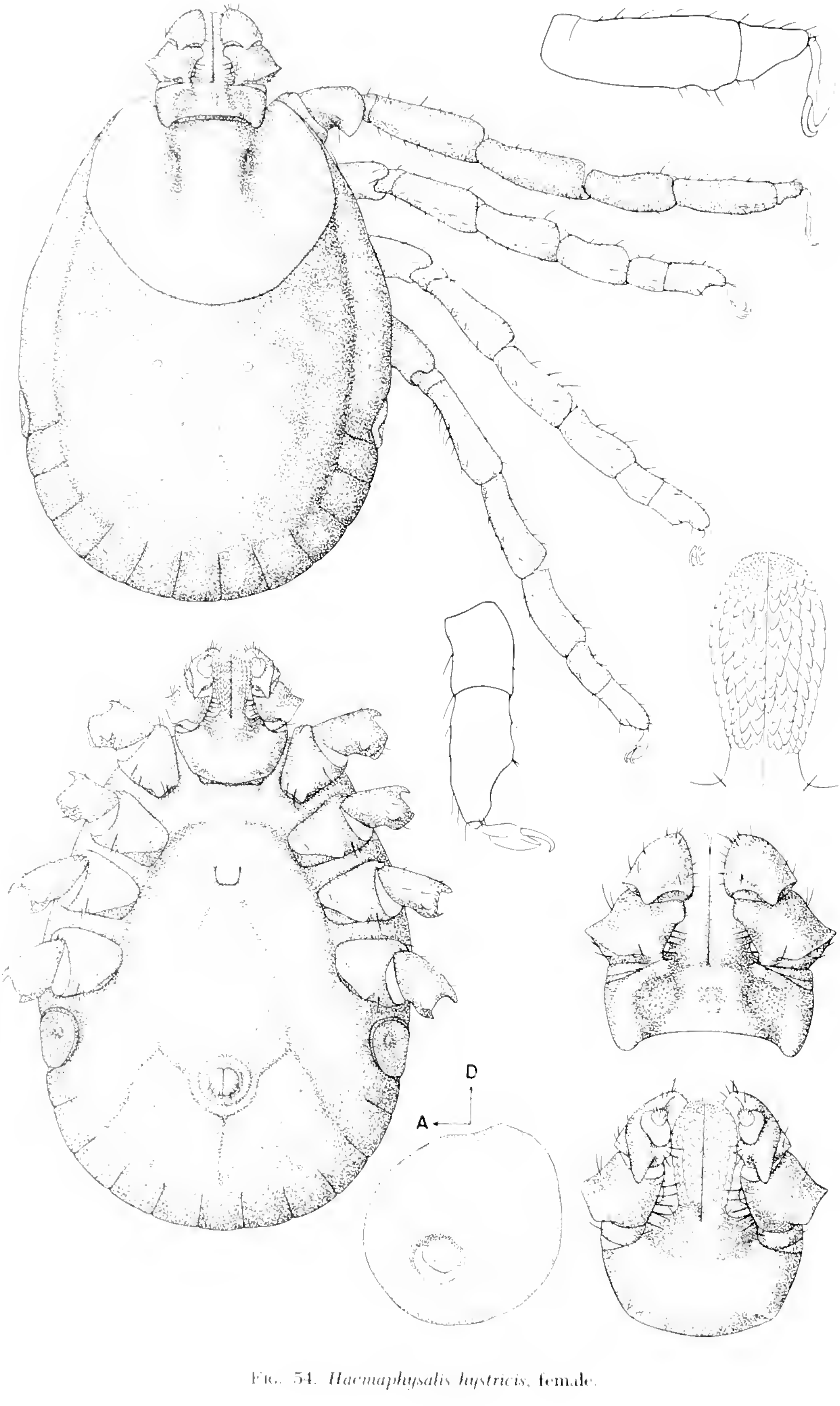


Fig. 54. *Haemaphysalis hystricis*, female.

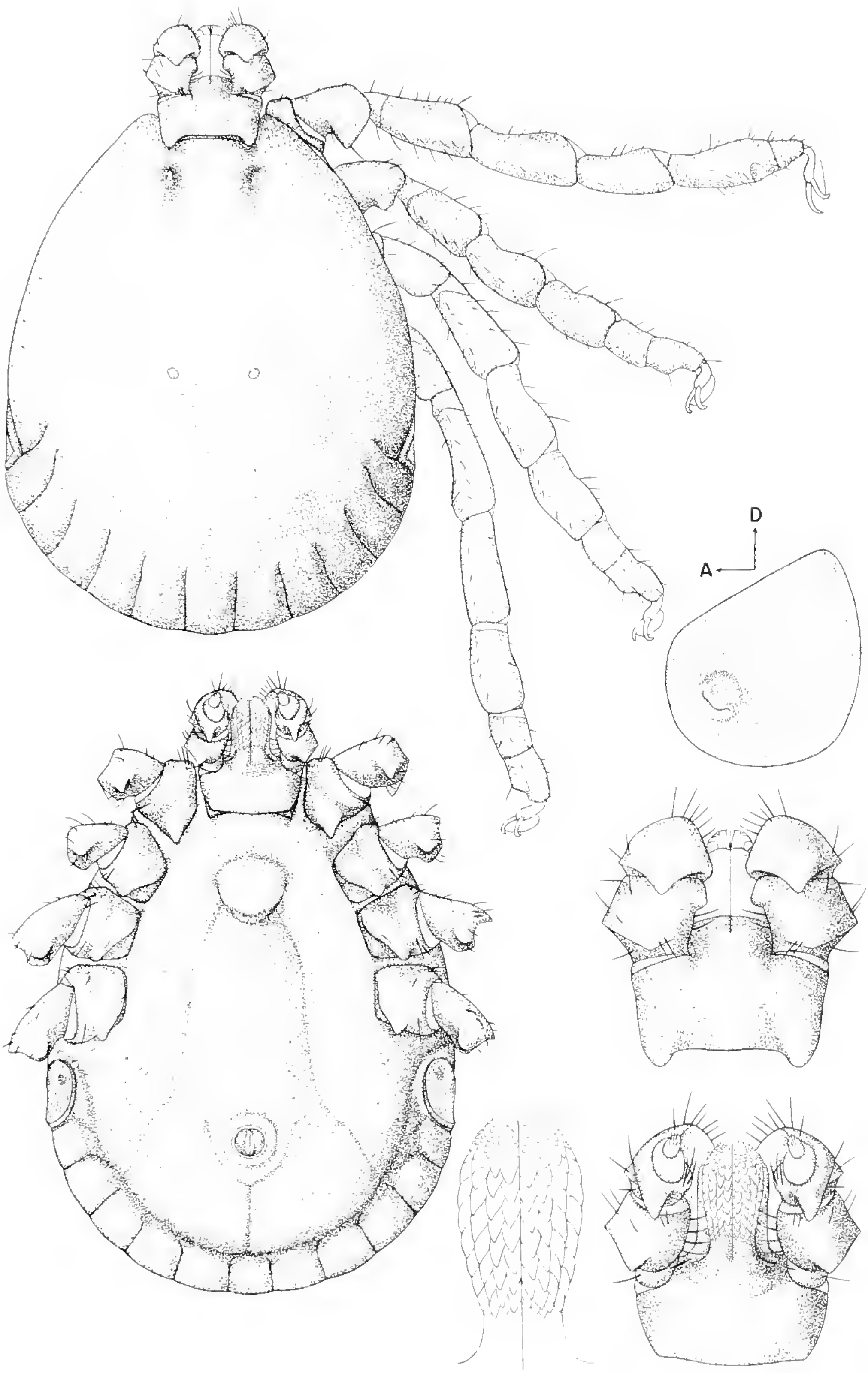


FIG. 55. *Haemaphysalis hystricis*, male.

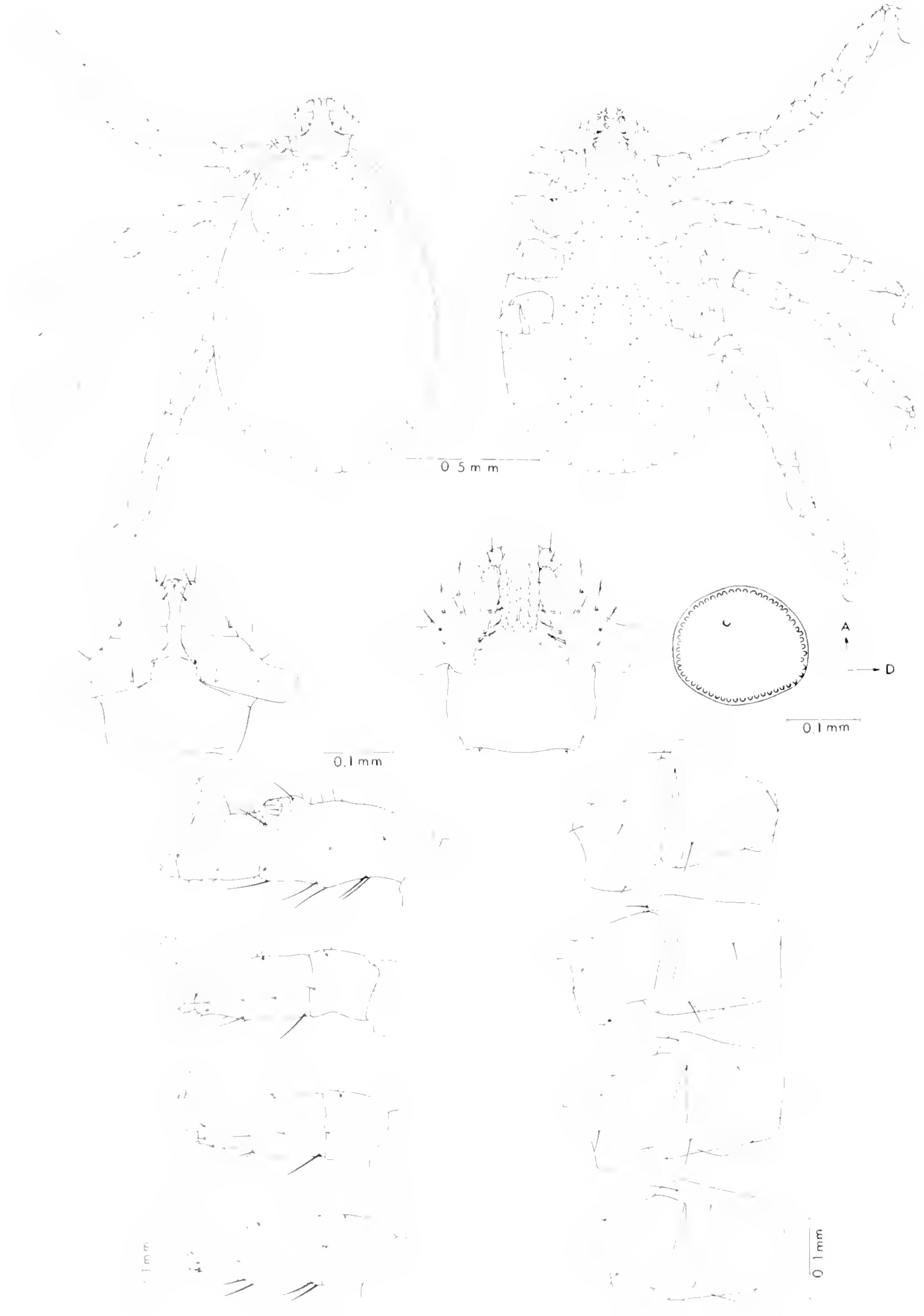


FIG. 56. *Haemaphysalis hystricis*, nymph.

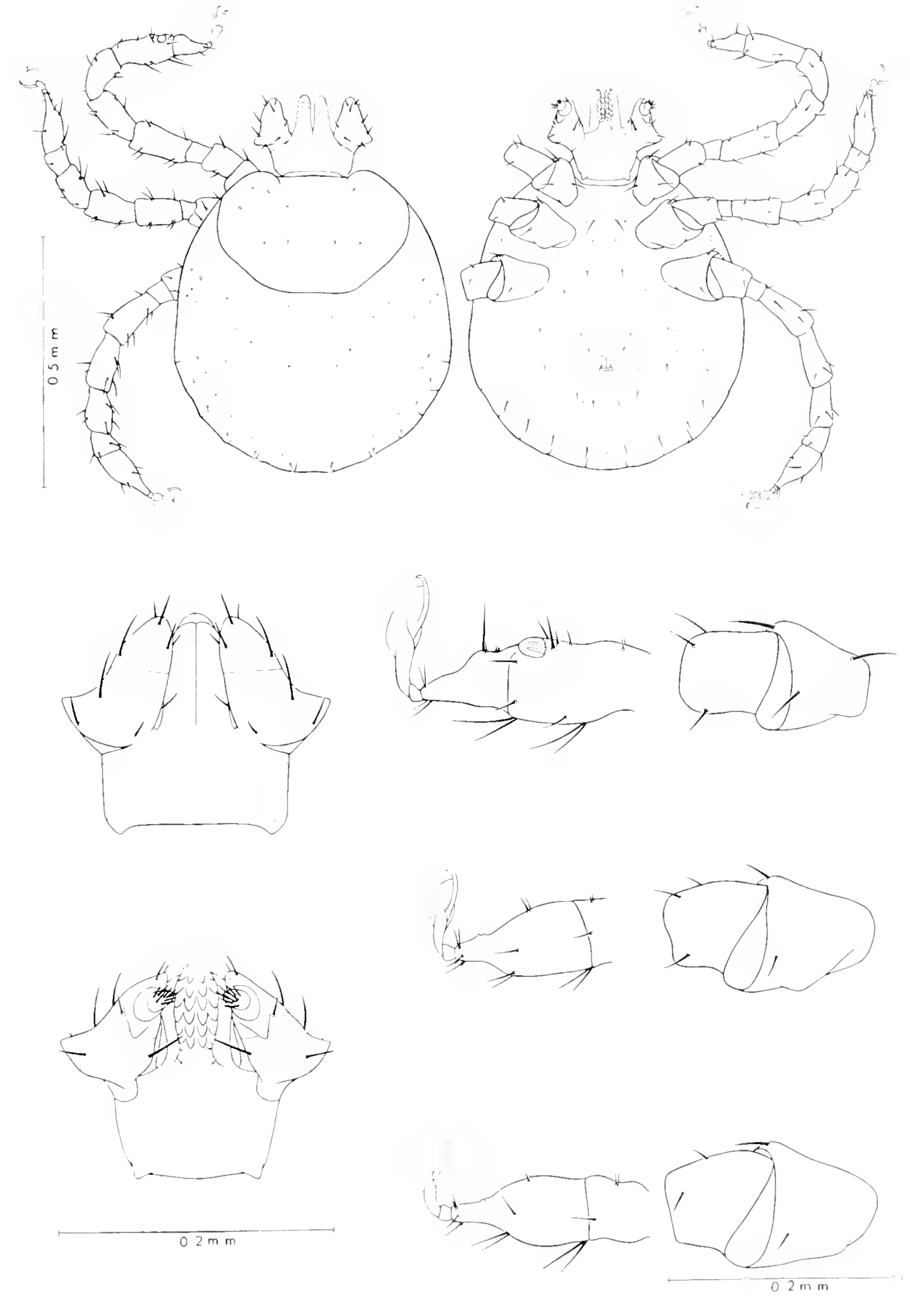


Fig. 57. *Haemaphysalis hystricis*, larva.

retrograde spine" and "lateral grooves medium, faint, including one festoon" and the first leg is of dark color. However, these morphological characters are not enough to separate this species from *hystricis*, and his description and illustrations fit *hystricis* well. Hoogstraal et al. (1965) examined two males and two females of *nishiyamai* from the Sugimoto collection in Taiwan and considered them conspecific with *hystricis*.

Sugimoto (1937b) described *H. iwasakii* based on a male specimen taken from the bedding site of a wild pig on Ishigaki (Is.). Although the specimen was not available for study, the illustration and description indicate that *iwasakii* is probably a synonym of *hystricis*. Recently, Hoogstraal et al. (1965) studied the identity of *hystricis*, and they considered *H. iwasakii* Sugimoto, 1937 to be a synonym of *hystricis*.

Neumann (1901) erroneously described a species under the name of *bispinosa* using specimens of a different species. These specimens were not those from India, the type locality of *bispinosa*, but others collected from China and Japan. The Japanese lot contained two female specimens (Hilgendorf Coll. Berlin Museum). According to Nuttall and Warburton (1915), Neumann misidentified them, and what he (1901) described as *bispinosa* was possibly *hystricis*. The following year Neumann (1902) examined Supino's type of *hystricis*, wrongly synonymized *bispinosa* under *hystricis*, regarding them to be identical. This was criticized by Warburton (1908) and Nuttall and Warburton (1915), but if the specimens were actually *hystricis*, Neumann's report (1901) might be the first collection record of *hystricis* from Japan.

Diagnosis:

H. hystricis is similar to *longicornis* in having dorsal and ventral spurs on palpal article III, and palpal article II is salient laterally. However, it may be distinguished from *longicornis* by the presence of a dorsal knoblike, anterointernal projection on palpal article II, and a median projection on the ventroposterior margin of palpal article II. In the male there are no lateral grooves, and in the female the cornua is short, the basis capituli is at least twice as wide as long with a depression in the middle of the porous area, and coxa I has a short spur.

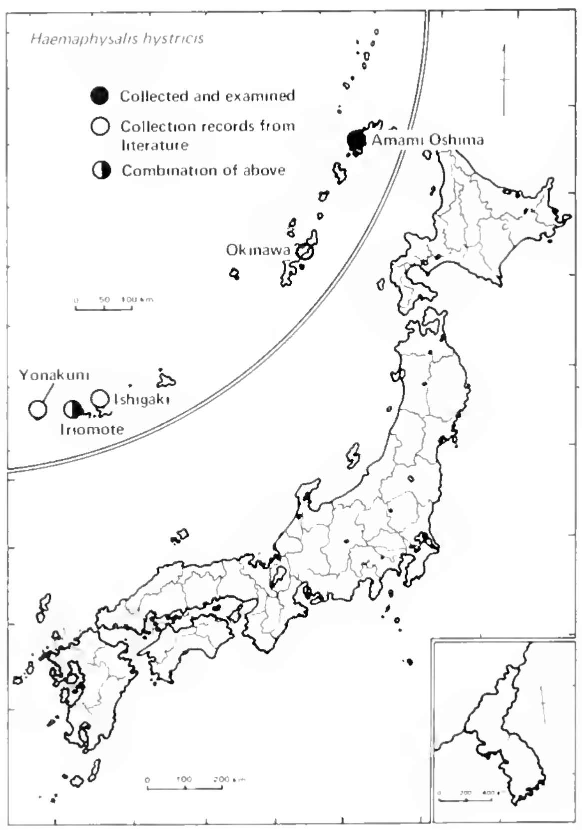
Distribution and Hosts:

This species has previously been considered to be widely distributed in temperate and tropical eastern Asia and on numerous nearby islands. According to Hoogstraal et al. (1965), the distribution is restricted to a subtropical and temperate belt extending from the eastern Himalayas of India to the coasts of Vietnam and Fukien Province of China, and to Taiwan, Ishigaki, and Okinawa. Amami Oshima may be now included in this belt as a result of recent collections. All previously published records from China, Ceylon, Macao, Celebes, Java, Borneo, and the Malay Peninsula are either definitely in error or highly suspect. Authentic localities for *hystricis* lie between about 87° and 130° east longitude and 29° and 16° north latitude.

Adults of *hystricis* have a fairly wide host range.

Hoogstraal et al. (1965) listed hosts as humans, domestic dogs, buffalo, wild boars (*Sus scrofa*), tigers, hog-badgers (*Arctonyx collaris*), Teledu badger (*Mydanus multiceps*), sambar deer (*Cervus unicolor*), and the Formosan barking deer or muntijac (*Muntiacus reevesi micrurus*).

The often-quoted record of a single female from the spiny hill tortoise, *Geoemyda spinosa*, (Nuttall and Warburton, 1915:425) in "India" is considered questionable since *G. spinosa* does not occur in India.



Map 16. Known distribution of *Haemaphysalis hystricis*.

Biology:

Ecologically this tick appears to be a forest-inhabiting species which occurs at low to intermediate elevations. Newly molted females often have been observed crawling on birds by Hoogstraal et al. (1965), and it is supposed that they seek a host unusually early, perhaps several days before they reach a developmental condition that allows attachment and feeding; or else nymphs molt to adults on the host rather than on the ground. At the 406th Medical Laboratory nymphs fed on rabbits' ears dropped off the host after they had fully engorged. Seventy larvae collected on vegetation on Amami Oshima were reared to adults on rabbits' ears. These adults were used for subsequent life cycle studies.

Laboratory life cycle of *Haemaphysalis hystricis*
(reared on rabbits)

Generation and Stage	Phase	Period in Days	Remarks
P Adult	Feeding	8-9	4 unengorged females (67-J-0308) were placed on host on 29 Nov. 1967.
P Adult	Postparasitic (Preoviposition)	7-8	
P Adult	Oviposition	15-18	Egg number: 3,245-4,528 (average 3,953)
F_1 Egg	Incubation	32-34	15,698 larvae from 15,814 eggs.
F_1 Larva	Feeding	3-5	Larvae were placed on host on 25 Jan. 1968.
F_1 Larva	Postparasitic (Premolting)	10+	
F_1 Nymph	Feeding	2-5	
F_1 Nymph	Postparasitic (Premolting)	17-22	

The rearing experiment extended from 29 November 1967 to the middle of March 1968, in the 406th Medical Laboratory under conditions similar to those for *Haemaphysalis campanulata*.

Disease Relationship:

Unknown.

Haemaphysalis japonica Warburton
(Fig. 58-60)

Haemaphysalis japonica Warburton, 1908:512-513, Fig. 3, 4; Nuttall and Warburton, 1915:402-403, Fig. 336-337; Kishida, 1922a: 852; Itagaki, Noda, and Yamaguchi, 1944:1-97, Pl. 6, 1959:1-118, Pl. 6; Keegan and Toshioka, 1957:16-17, Pl. 27; Asanuma, 1958:279, 1965a:112.

Haemaphysalis flava flava Neumann, 1911:112; Nuttall and Warburton, 1915:402, 514.

Haemaphysalis jezoensis Ogura and Takada, 1927:205-206, Pl. XV; Nakamura and Yajima, 1937:148.

Discussion:

As already mentioned under *H. campanulata* and *H. flava*, the type specimens of *japonica* were found together with *flava* and *campanulata* in tube No. 173 (No. 137 ?) at the British Museum. Warburton (1908) stated that *japonica* was undoubtedly conspecific with the short-spurred form of *flava* mentioned by Neumann (1901). He did not give the collection data of the type. Subquently, Nuttall and Warburton (1915) based their discussion of *japonica* on Warburton's type specimens, collected from the Japanese serow, *Nemorhaedus crispus* (= *Capricornis crispus*), at Hondo, Japan, and 24 males taken from a roe-buck at Kansu, China. Hondo, the type locality, is a town on one of the Amakusa Islands, Kumamoto Prefecture, Kyushu.

It is apparent that Warburton misspelled the name as *japonnica* for *japonica*. There is evidence that this species has been mistakenly reported as *H. concinna* Koch, 1844. It has also been reported as *H. jezoensis* Ogura and Takada, 1927, now considered to be a synonym of *H. japonica*. Keegan and Toshioka (1957) examined specimens labeled *concinna* and *jezoensis* loaned by Japanese workers, and found them to be *japonica*.

Nuttall and Warburton (1915) described *H. japonica* var. *douglasi* based on four males collected from roe-deer at Ten-an-fu, Shensi, north-

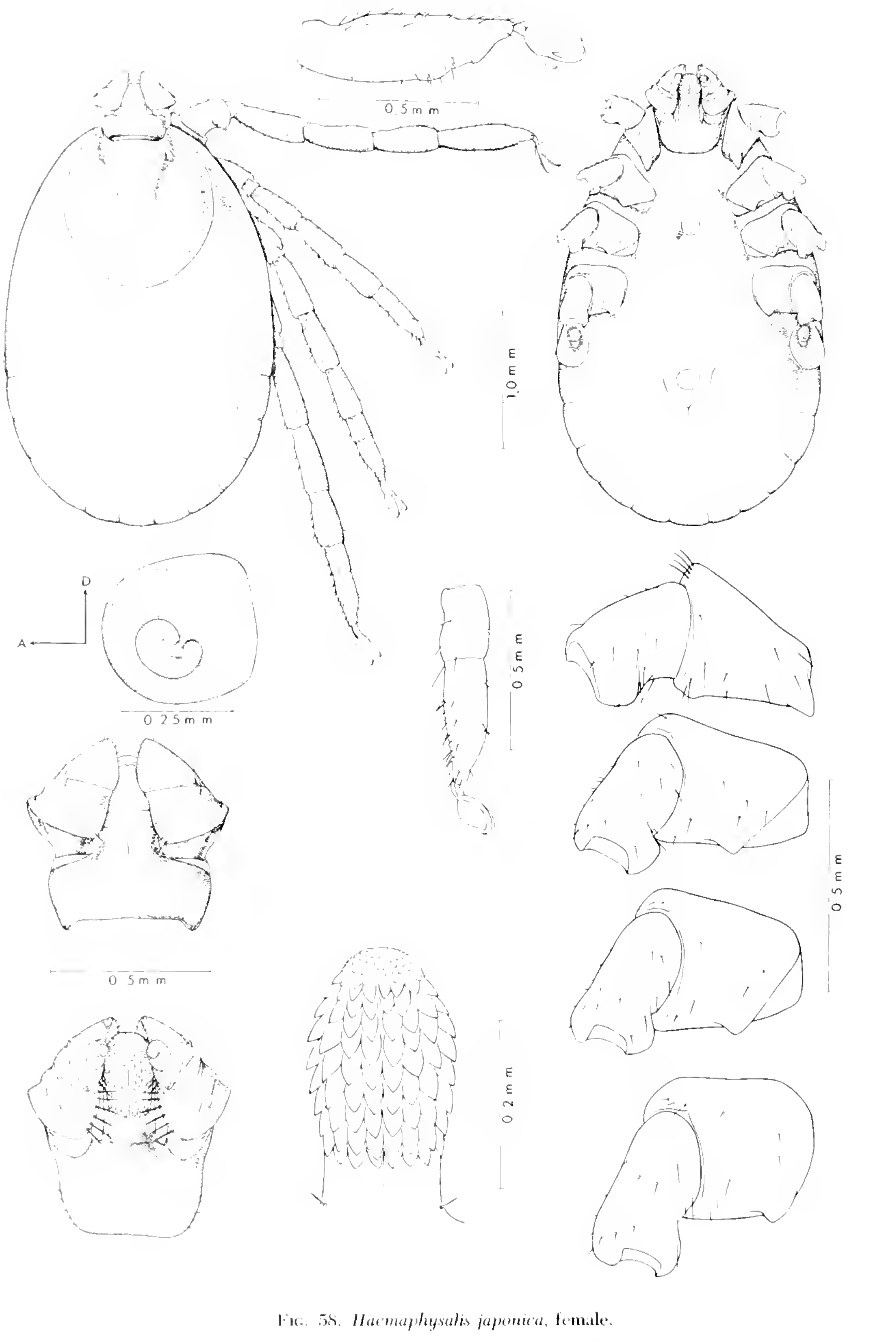


Fig. 58. *Haemaphysalis japonica*, female.

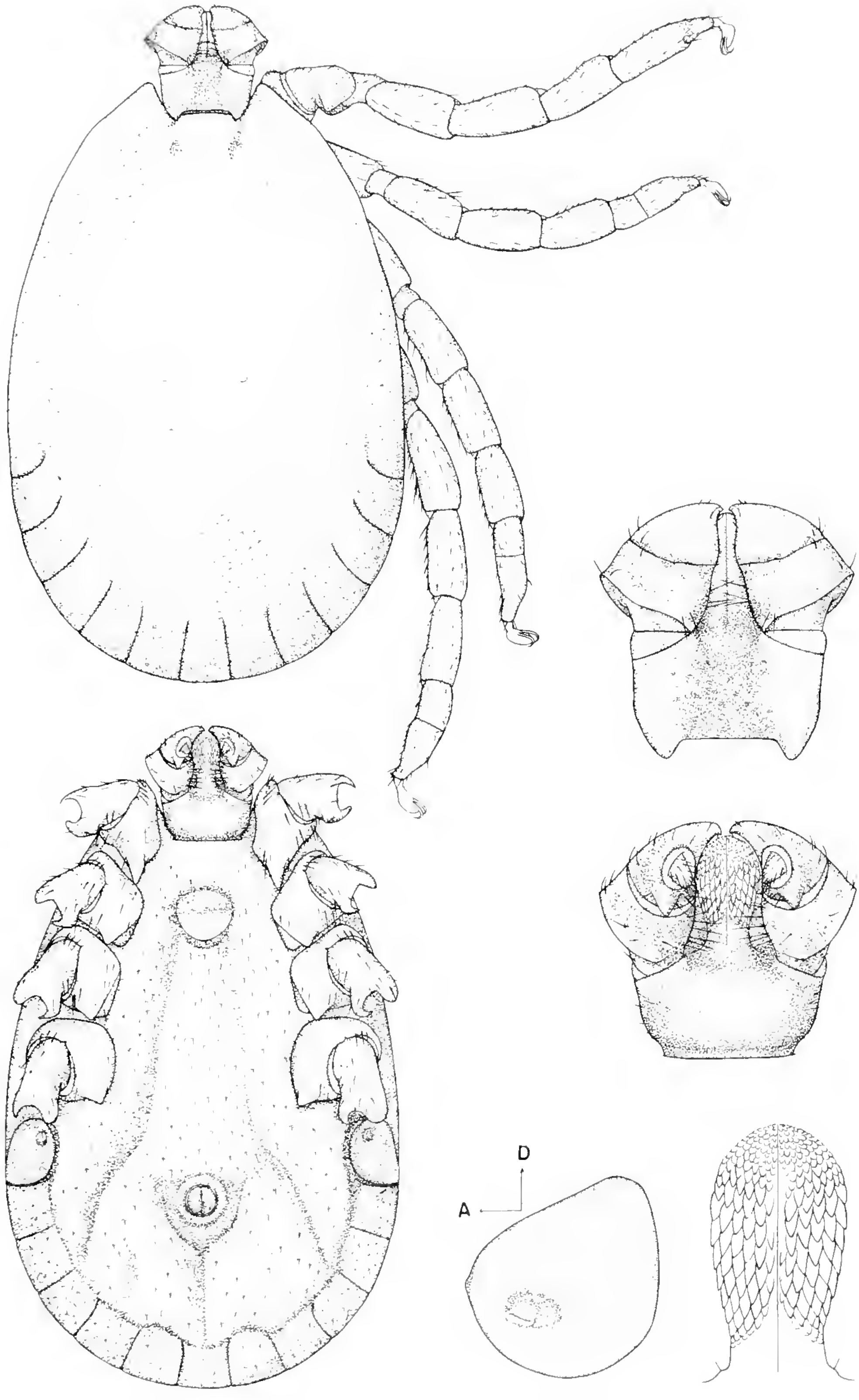


FIG. 59. *Haemaphysalis japonica*, male.

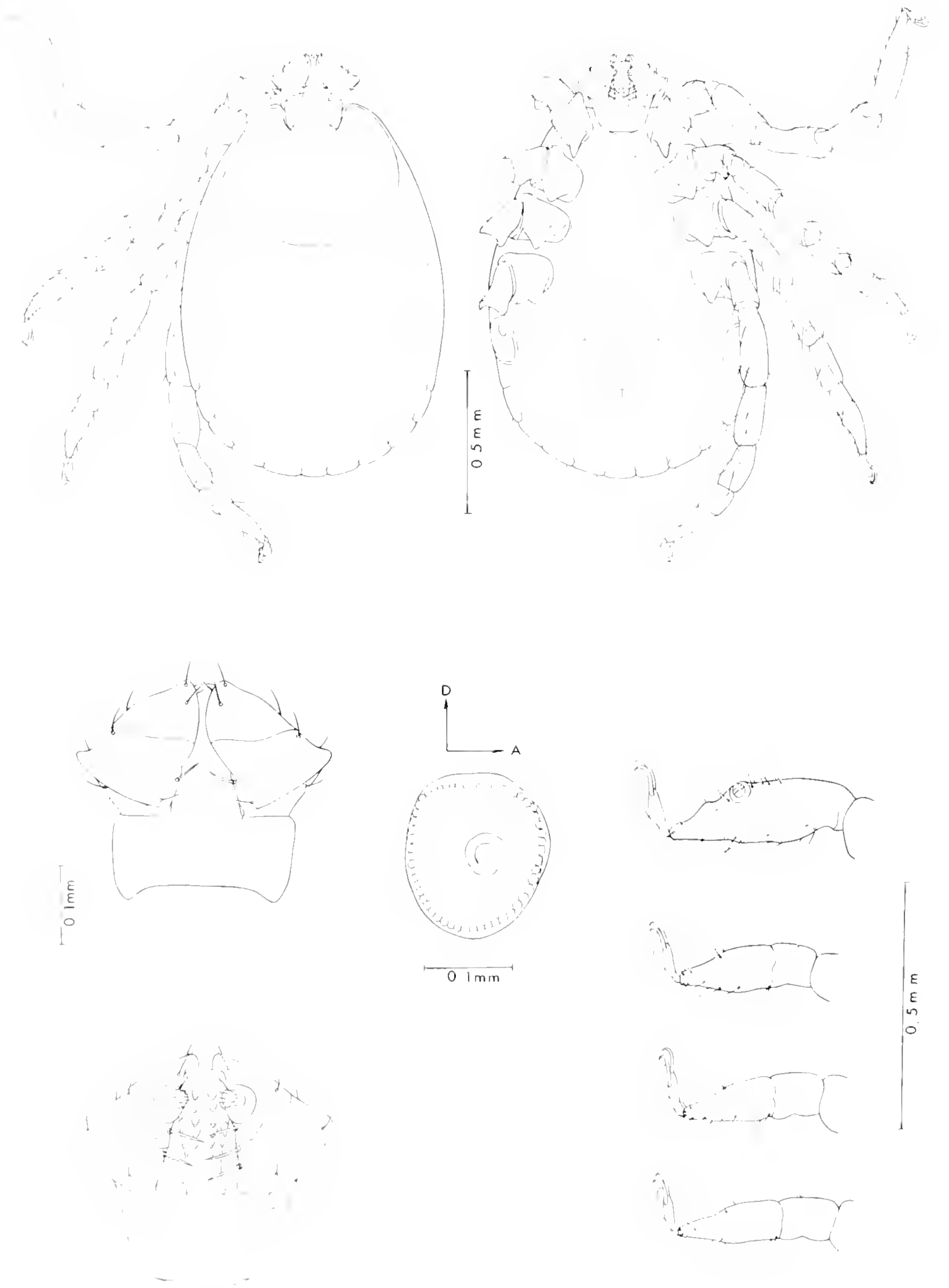


Fig. 60. *Haemaphysalis japonica*, nymph.

ern China, and they stated that it is distinctly smaller, narrower in front with straighter sides and lateral grooves, and with a longer and sharper ventral spur on palpal article III. Pomerantzev (1950) referred to *douglasi* as a subspecies and indicated that it inhabits the USSR. The relationship of *japonica* to *japonica douglasi* is not clear at the moment, and further study will be necessary to elucidate this problem. Hoogstraal (1968) considers *japonica* and *japonica douglasi* to be identical.

DIAGNOSIS:

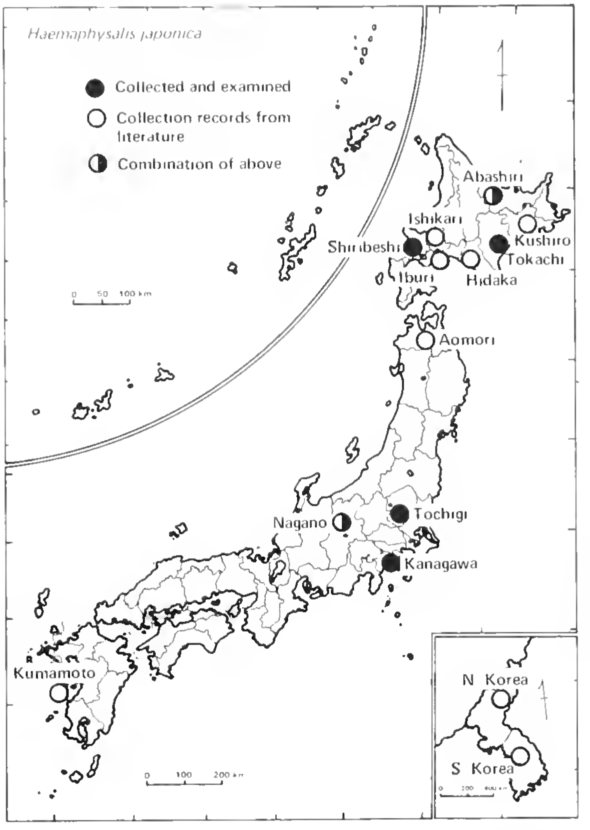
This species is close to *H. flava* and has been mistakenly reported as *H. concinna* because of the similarity of the palpal profile. However, unlike *flava*, the spur on coxa I is longer than the other coxal spurs in both sexes, and especially in the male, coxa IV does not have such a long, sharp spur as in *flava*. It is also distinguishable from *concinna* in that the tips of palpal article III are not so strongly recurved inward to become "pincerlike" in the male; the external profile of palpal article III is longer than that of II, while they are subequal in *concinna*; palpal artical II has 5-6 infrainternal setae; and the spurs on coxae II and III are short but apparently extend beyond the posterior margin of the coxae. See diagnosis of *H. concinna* for comparison with that species.

DISTRIBUTION AND HOSTS:

Recorded distribution in Japan is Hokkaido, Aomori, and Nagano prefectures. It is also known to occur in Korea and China. Pomerantzev (1950) gave the distribution of *japonica* as Southern Primor, USSR, in addition to the above, and the distribution of *japonica douglasi* as the USSR and northern China. Hosts recorded in Japan and Korea are horses, cattle, Japanese serow, deer, dogs, and on one occasion, one nymph from a wild hare. Pomerantzev (1950) gave the hosts for *japonica douglasi* as deer, bear, lynx, badger, hedgehog, cattle, dogs, and humans. Immature stages were found on small rodents, badgers, squirrels, deer, dogs, *Mustela sibirica*, and birds.

BIOLOGY:

Unstudied in Japan. Pomerantzev (1950) briefly cited the seasonal occurrence of *japonica douglasi* in the USSR. "From October to March, males are exclusively found on animals, often in large numbers; from March through April, they are joined by females which parasitize mainly during the 1st half of the summer, are found until October and cease to be found entirely in the winter. Young stages feed from June to August



MAP 17. Known distribution of *Haemaphysalis japonica*.

and often are found along with semi-mature ones." Somov and Shestakov (1963) describe the habitat of *H. japonica douglasi* as follows: ". . . inhabits foothills and valleys with rich grass growths and shrub thickets. On exposed slopes this tick species rarely occurs." (Translation through the courtesy of the U.S. Naval Medical Research Unit No. 3, Cairo, UAR.)

DISEASE RELATIONSHIP:

Not known in Japan. In the USSR, *japonica douglasi* is suspected of being a vector of the virus of Russian spring-summer encephalitis (Pomerantzev, 1950). *Rickettsia sibericus* (Siberian Tick Typhus) has been isolated from *H. japonica douglasi* by Russian workers (Somov and Shestakov, 1963).

Haemaphysalis kitaokai Hoogstraal
(Fig. 61-64)

Haemaphysalis kitaokai Hoogstraal, 1969b:211-221, Fig. 1-35.

Haemaphysalis ambigua Neumann, 1906:217 (not Neumann, 1901), 1911:109; Kitaoka and Morii, 1967a:145-152, Fig. 1-9.

Haemaphysalis inermis: Nuttall and Warburton,

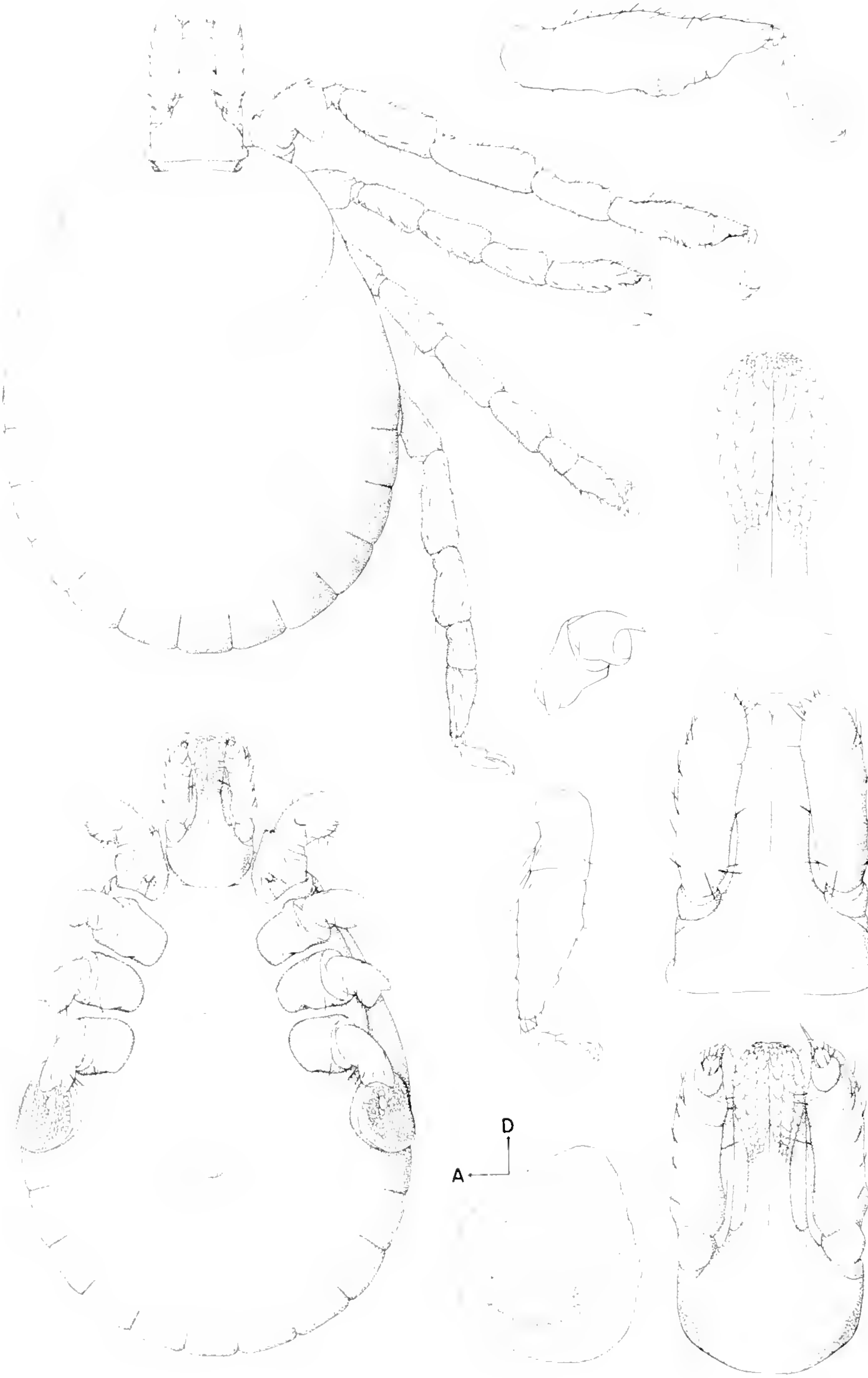


FIG. 61 *Haemaphysalis kitaokai*, female.

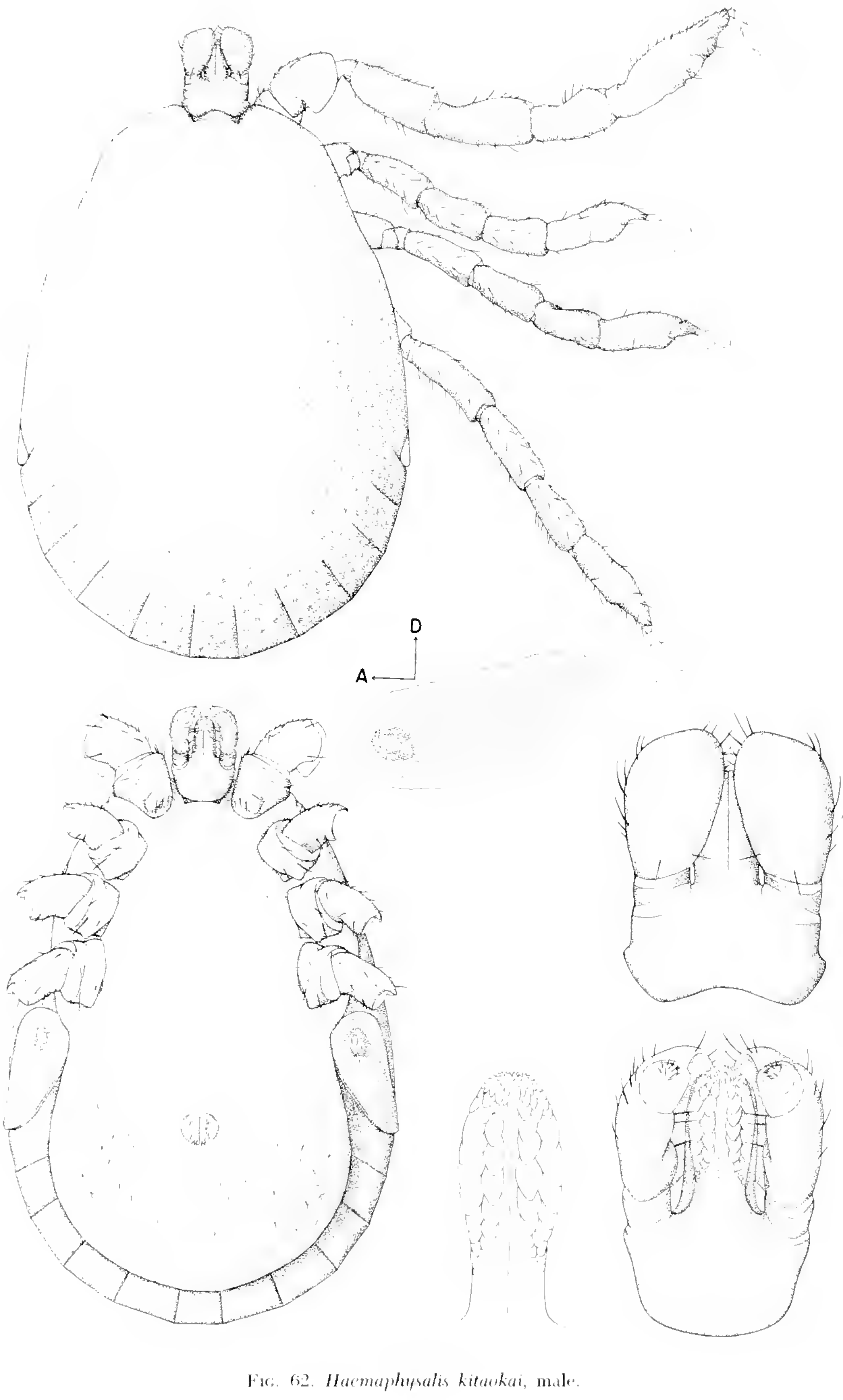


Fig. 62. *Haemaphysalis kitaokai*, male.

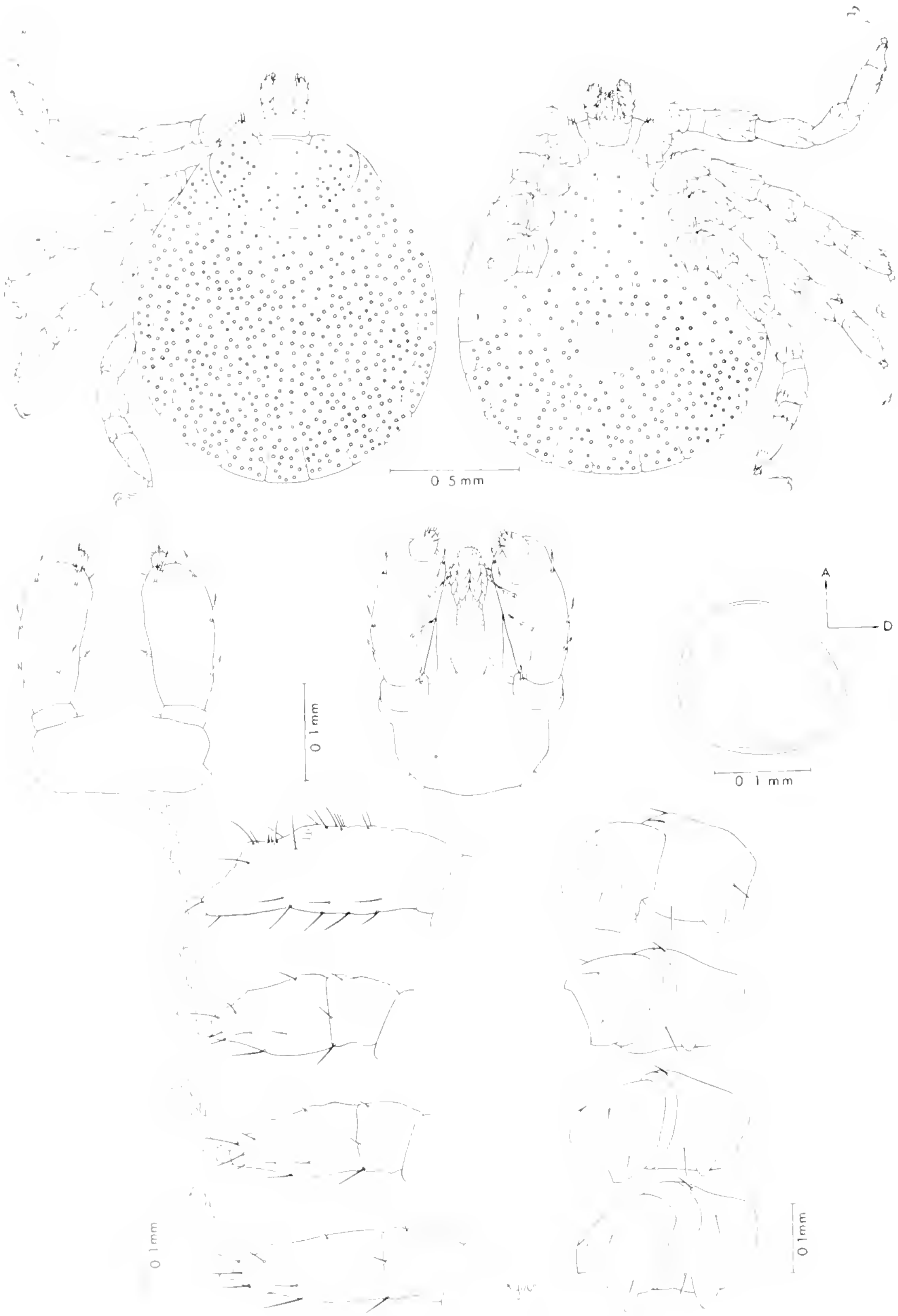


Fig. 63. *Haemaphysalis kitaokai*, nymph.

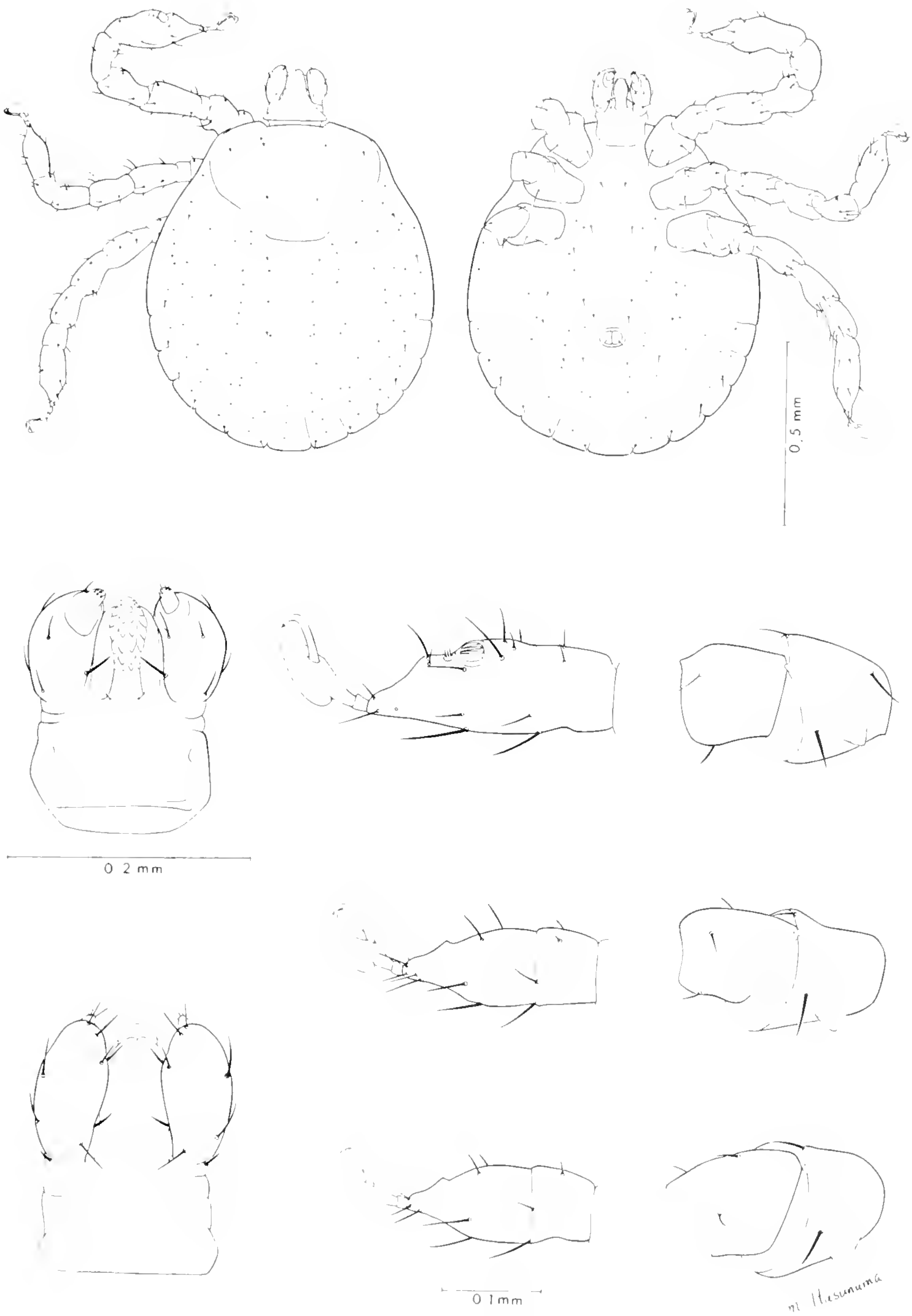


Fig. 64. *Haemaphysalis kitaokai*, larva.

1915:367; Kishida, 1922a:852; Sugimoto, 1937a:313-317, Pl. II, Fig. 7, 8 in Pl. VIII; Keegan and Toshioka, 1957:16, Pl. 25, 26; Iwasaki et al., 1964:1-10; Tsuchie, Iwasaki, and Okui, 1966:1-15; Asanuma, 1965a:111-112.

Haemaphysalis inermis var. *aponomoides* Warburton, 1913:128-130, Fig. 8; Nuttall and Warburton, 1915:367-369.

Discussion:

This unique Japanese species has been called *H. ambigua* or *H. inermis* including *H. inermis* var. *aponomoides*. Neumann (1906) reported one female *ambigua* which was found together with *H. flava* and an undetermined *Ixodes* sp. in a lot at the British Museum. The lot was taken from *Naemorhaedus crispus* (= *Capricornis crispus*), the Japanese serow. Nuttall and Warburton (1915) considered *ambigua* to be a synonym of *inermis*. They did not see the female specimen referred to as *ambigua* by Neumann (1906); therefore, they carefully cited Neumann's record in brackets under synonyms of *inermis*. This record was repeated by Kishida (1922a) and Sugimoto (1937a) without provoking any attention until Kitaoka and Morii (1967a) expressed doubt about the occurrence of *H. inermis* in Japan (see below).

Warburton (1913) described a variety, *inermis* var. *aponomoides*, based on 23 females taken from the Himalayan Zebu of India, and Nuttall and Warburton (1915) stated that they found one female of the variety from a horse at "Fukoka" (apparently misspelled for "Fukuoka"), Japan (Berlin Museum No. 173).

Sugimoto (1937a) described a Formosan species as *inermis* based on eight females taken from *Cervus unicolor swinhoii* on Formosa, giving the distribution of the species as occurring also in Japan (see above).

Keegan and Toshioka (1957) identified the Japanese population as *H. inermis*, and no further attempt was made to clarify the status of the Japanese specimen of *inermis* var. *aponomoides* reported by Nuttall and Warburton (1915).

Hoogstraal (1962), having examined the type of *inermis* var. *aponomoides* and also the two Formosan specimens (RML lot 16603, off "wild deer," Su-ao, Formosa, sent by Dr. Sugimoto), raised the variety to the species *H. aponomoides* for the population at high altitudes in the Himalayas and on Formosa. He (1962), however, did not see the female specimen (Berlin Museum No. 173) of *inermis* var. *aponomoides*.

On the other hand, Kitaoka and Morii (1967a) indicated that there are structural differences between specimens from the Japanese population and *H. inermis* of Eurasia, and they suggested that the Japanese material should be a species separate from valid Eurasian *inermis*. They tentatively adopted the name *ambigua* for Japanese material.

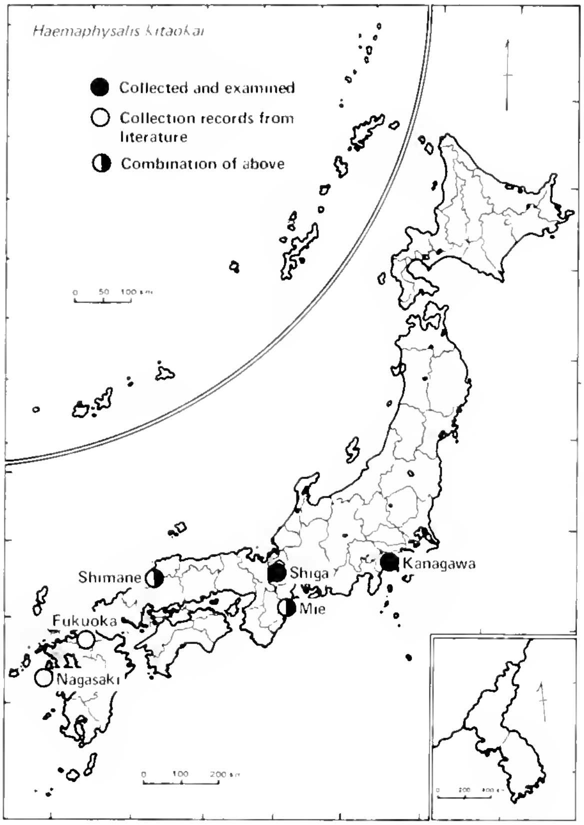
Hoogstraal (1969) subsequently examined the one female specimen (Berlin Museum No. 173) and the two female *ambigua* identified by Neumann (1906), and after comparing the newly collected Japanese specimens with numerous collections of the related Eurasian species, he concluded that the Japanese population represents a distinct species and described it as *H. kitaokai*. He considers the female specimen of *inermis* var. *aponomoides* (Berlin Museum No. 173) to be *H. kitaokai* and *H. ambigua* a synonym of *H. inermis*. He reexamined Sugimoto's Formosan *inermis* (RML lot 16603), which he once identified as *aponomoides* (1962) and tentatively assigned them to *H. kitaokai*. The specimens were in poor condition.

Diagnosis:

This species is morphologically distinct from all other haemaphysalids in Japan. The unique characters are as follows: in both sexes the palpi are elongate as in *Ixodes* spp., palpal article I is short but visible from a dorsal view; palpal article II is not salient laterally; palpal article III does not have either a dorsal or a ventral retrograde spur; the basis capituli has no cornua; lateral grooves are absent; coxa I has an extremely short internal spur. It is close to *H. inermis* Birula of southern Europe, southwestern USSR, and northern Iran, but can be distinguished from that species in that there are three dorsointernal setae and a single ventrointernal seta on palpal segment II of the male, and these setae number two and one respectively in the female; the male hypostome is 2.2 times longer than broad compared with three times longer than broad in *inermis*; in the nymphs and larvae the tarsi are moderately stout in *kitaokai* but narrowly elongate in *inermis*, and the coxal spurs are rudimentary in *inermis* but discrete in *kitaokai* (Hoogstraal, 1969b).

Distribution and Hosts:

This species has been collected only in Japan on deer and the Japanese serow in Mie, Shiga, and Kanagawa prefectures, but more commonly on cattle in the Sanbe Pasture, Shimane Prefecture. Yajima's single female specimen was from a cow in Nagasaki Prefecture. There are some records of *inermis* or *inermis* var. *aponomoides*, but occurrence of these species in Japan is considered to be erroneous (as mentioned above).



Map 18. Known distribution of *Haemaphysalis kitaokai*.

Biology:

Iwasaki et al. (1964) observed the seasonal occurrence of this tick in a pasture at the foot of Mt. Sanbe, Shimane Prefecture. There are two peaks of adult prevalence, one is a small peak appearing early in spring to June and another more prominent peak from October to November. No larval and nymphal forms were found in the pasture or on cattle. Kitaoka and Morii (1967a) suggest this is possibly due to the fact that the immature forms are exceptionally rapid feeders and are attached to the host for a short period of several hours. Tsuchie et al. (1966) reported observations on overwintering of this tick. On 19 November 1964, they placed jars containing 60 engorged ticks and dried, fallen leaves out-of-doors, and found quiescent ticks 1 cm deep under the leaves on 18 February the following year. The 53 females which had successfully wintered oviposited in early May. Ten specimens were observed and they laid 109-1,020 (average 617) eggs during the period from 5 May until 6 June, when the average outdoor temperature began to rise to 15 C at the Sanbe Pasture.

Kitaoka and Morii (1967a) studied the biology of this species at Kodaira, Tokyo, using material originally collected at Sanbe Pasture in November 1962. They suggested that the life cycle was probably completed in one year in nature. The following table is a summary of data from Kitaoka and Morii (1967a). Nymphs and adults were fed on calves' ears.

Laboratory life cycle of *Haemaphysalis kitaokai*

Generation and Stage	Phase	Period in Days 25 C	Outdoor	Remarks
P Adult	Feeding	-	8-15	In Nov. and Dec. 1962. Engorged on calves on 1 Dec.
P Adult	Postparasitic (Preoviposition)	5-7	94-102	
P Adult	Oviposition (No. of eggs)	23-36 (369-899)	57-81 (117-959)	Laid by 14 females at 25 C and 19 females outdoors.
F_1 Egg	Incubation	28-33	40-51	
F_1 Larva	Feeding	1:50-20:00 hrs		In May, fed on mice, rabbits, or calves.
F_1 Nymph	Feeding	3:30-6:00 hrs		In June and July, fed on calves.
F_1 Nymph	Postparasitic (Premolting)	24, 27	=	A female emerged after 24 days; a male, after 27 days.

Thirty females and eleven males were collected in the field and brought into the 406th laboratory, but only four semiengorged females were fed on rabbits' ears. One female placed on the rabbit on 8 November dropped off on 15 November and laid 823 eggs from 10 to 30 December from which 588 larvae hatched out beginning on 7 January. The F_1 progeny were fed on a rabbit's ear on 22 January, dropped off on 23 January, but all died before they molted. Another lot of F_1 larvae were put on a rabbit's ear at 1400 of 1 February and were observed to have already dropped off by 0800 the next morning. The rapid feeding of larvae was also observed, but only a single larva survived until it molted to a nymph on 3 March. The room temperature in the laboratory was approximately 25 C.

DISEASE RELATIONSHIP:

Unknown.

Haemaphysalis longicornis Neumann (Fig. 65-68)

Haemaphysalis longicornis Neumann, 1901:261, Fig. 2; Hoogstraal, Roberts, Kohls, and Tipton, 1968:1197-1213, Fig. 1-36.

Haemaphysalis neumanni Dönitz, 1905:127-129, Fig. 4-6; Warburton, 1908:508-519; Neumann, 1911:109; Kishida, 1936:139, 1939b: 17-19, Pl. 4; Trapido, 1965:160; Hoogstraal and Trapido, 1966:1192, Fig. 10-26.

Haemaphysalis bispinosa (not Neumann, 1897); Nuttall and Warburton, 1915:426-433, Fig. 358-362 (in part); Kishida, 1922b:852; Ogura and Takada, 1927:204-205, Pl. 14; Sugimoto, 1936c:580, Pl. 1, 1937b:605-609, Pl. II; Nakamura and Yajima, 1937:151, Pl. IV, 1942a:21-33, 1942b:34-39, Pl. II, III; Nakatsuji, 1942: 294-295; Yajima, 1942:502-509, Fig. 2, 1963: 103; Itagaki, Noda, and Yamaguchi, 1944:1-97, Pl. 3, 1959:1-118, Pl. 3; Asanuma, 1947a: 7-14, 1947b:973, Fig. 2770, 1958:279, 1965a: 111-112, Fig. 7.6, 1965b:399, Fig. 222; Shigemori, Aso, and Yajima, 1953:290-293; Namba, 1953:130-135, 1954:49-55, 1958:1-99, Pl. I, 1963a:21-28, 1963b: 103-114; Chikaki, Otake, and Miura, 1956: 53-62; Keegan and Toshioka, 1957:11-12, Pl. 15-16; Kitaoka and Yajima, 1958a:135-147, 1958b:149-162, 1958c: 179-188; Kitaoka, 1961a:85-95, 1961b:96-104, 1961c:105-112, 1961d:142-144, 1962:106-111; Nagahana and Matsuo, 1962:119-121; Saito and Ohara, 1961:1-32, Fig. 19, 20, 26; Saito, 1962a:127-146, Fig. 1-30; Saito et al., 1965: 143-159, Fig. 1-24.

DISCUSSION:

For many years this tick has been referred to as *H. bispinosa* Neumann, 1897 in the Japanese literature. Hoogstraal and Trapido (1966) selected and studied a female neotype of *bispinosa* in the Nuttall Collection (N167) in the British Museum and a paralectotype of *neumanni* (N1425) in the Neumann Collection in the National Veterinary School, Toulouse. The former specimen was taken from southern Madras, India, and the latter was from Japan. Since then it has been thought doubtful that *bispinosa* actually occurs in Japan. All materials in the 406th collection have been examined by Kohls and Hoogstraal and identified as *H. neumanni*. It is likely that the specimens in the Japanese literature are also *neumanni*, since our specimens were collected from the same host species and in essentially the same geographical localities. More recently Hoogstraal et al. (1968) compared numerous specimens from Australia, New Zealand, tropical Asia, northern China, Japan, and Korea. They confirmed that specimens of "*bispinosa*" and "*neumanni*" from temperate northern China, Japan, Korea, and northeastern USSR are structurally identical to those from Australia and New Zealand referred to as *H. longicornis* Neumann, 1901, which appears to be a prior name applicable to these northern populations. We accept their opinion and use the name *H. longicornis* in this paper. Published reports indicate there are two strains (bisexual and parthenogenetic) within the Japanese population. *H. bispinosa* Neumann, 1897, a tropical Asian species, typically a bisexual species, is known from India, Ceylon, Pakistan, Nepal to Burma, Thailand, and the Malay Peninsula.

DIAGNOSIS:

H. longicornis is very close to *H. bispinosa* Neumann, 1897 but may be distinguished from that species on the basis of its larger size: male 2.47 mm (2.30-2.57); female 2.60 mm (2.0-2.8); while in *bispinosa*, male, 2.0 mm; female, 2.2 mm in length; hypostome with dentition of 5/5 (rarely 4/4 in female), *bispinosa* always with 4/4 dental formula; nymphs with 3/3 dental formula, whereas *bispinosa* with 2/2; nymphs without dorsal spur on palpal article III, but *bispinosa* has a bulging posterodorsal margin of palpal article III. *H. longicornis* may also be distinguished from *H. hystricis* on the basis of the following characters: well-developed cornua; no dorsal knoblike projection on anterointernal margin of palpal article II; lateral grooves present in the male and shape of spiracular plate as illustrated.

DISTRIBUTION AND HOSTS:

Neumann's original description (1897) was based on females from a cow, Kempsey, New South Wales, Australia. According to Hoog-

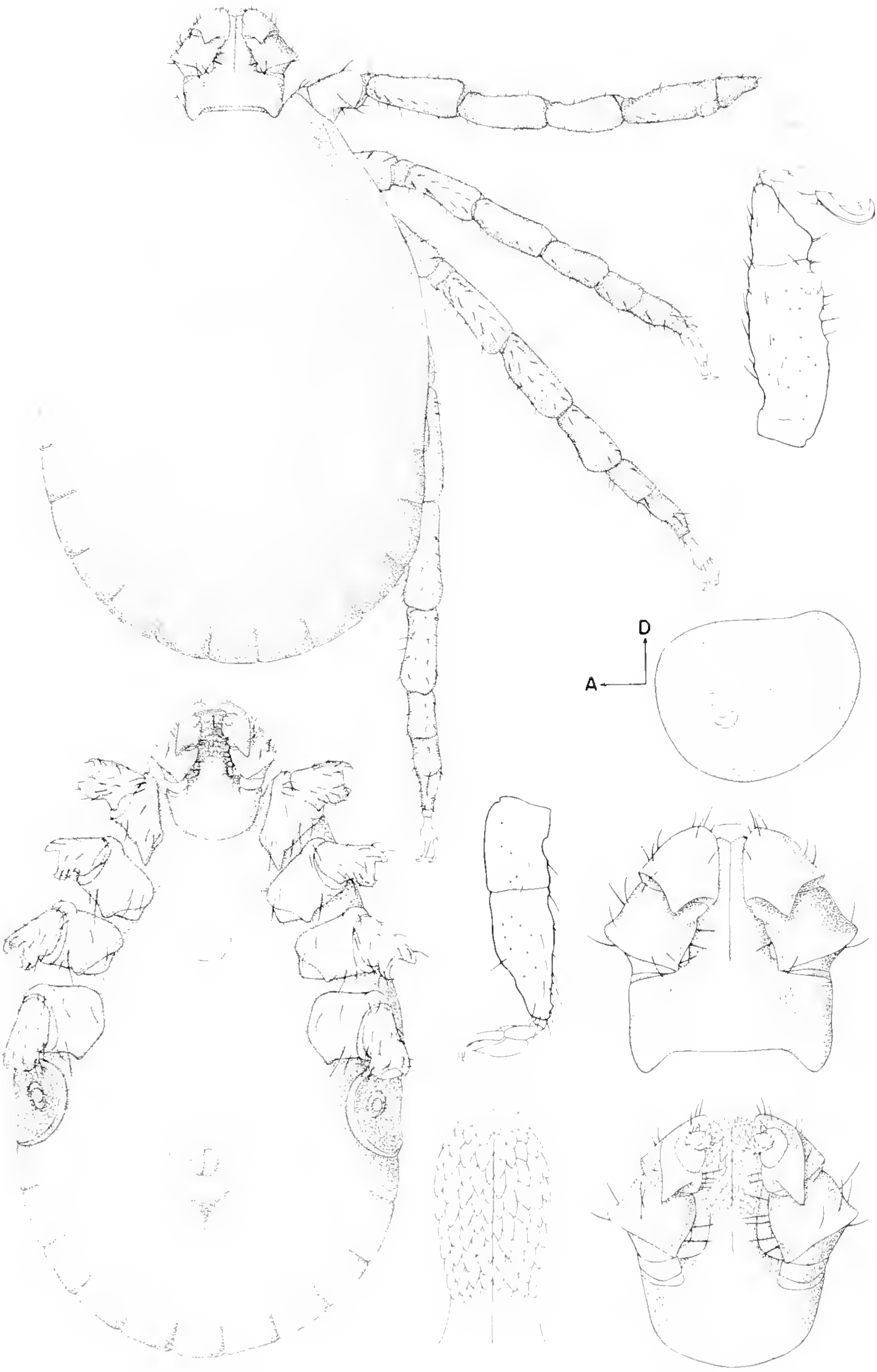


Fig. 65. *Haemaphysalis longicornis*, female.

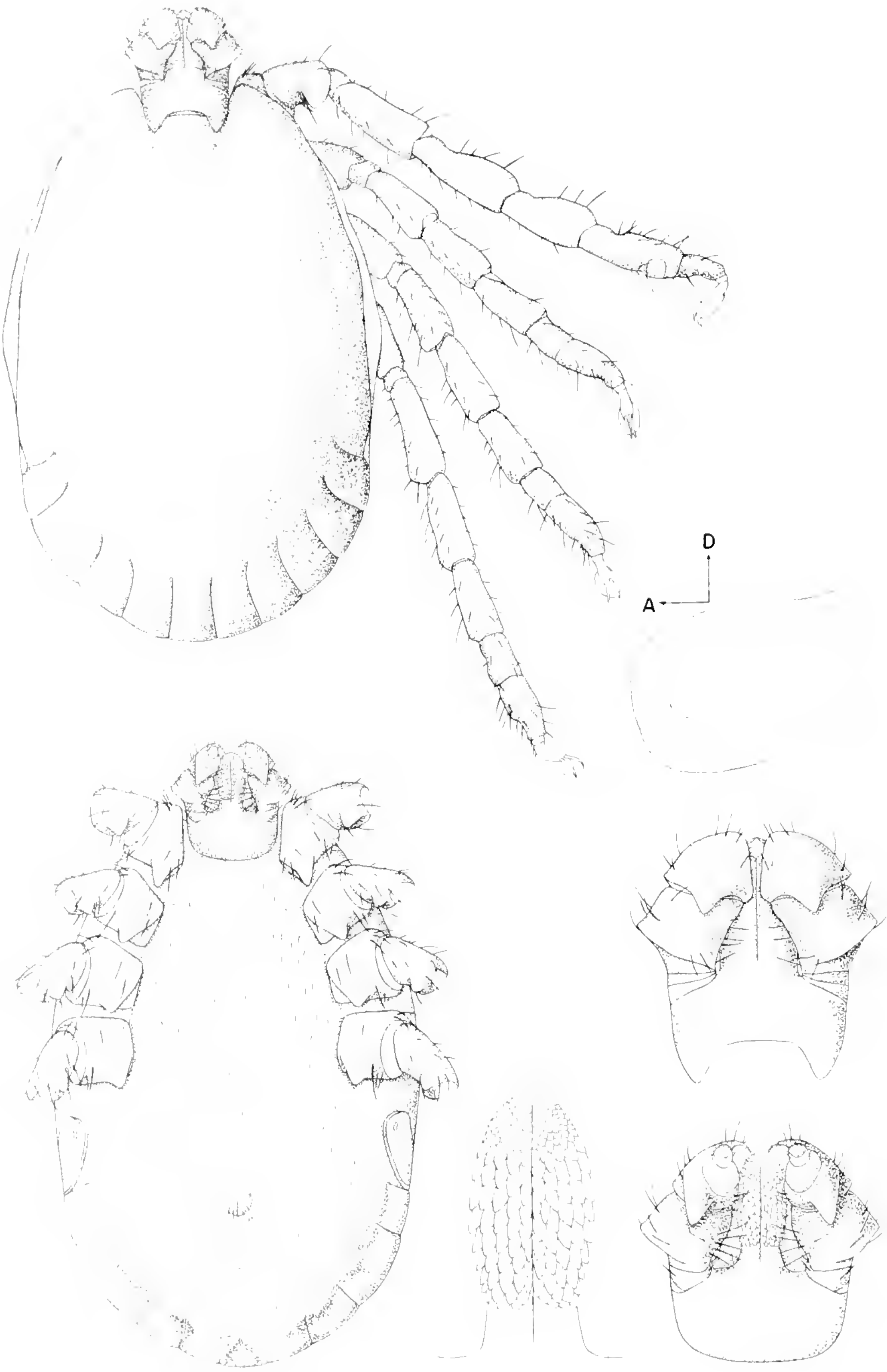


Fig. 66. *Haemaphysalis longicornis*, male.

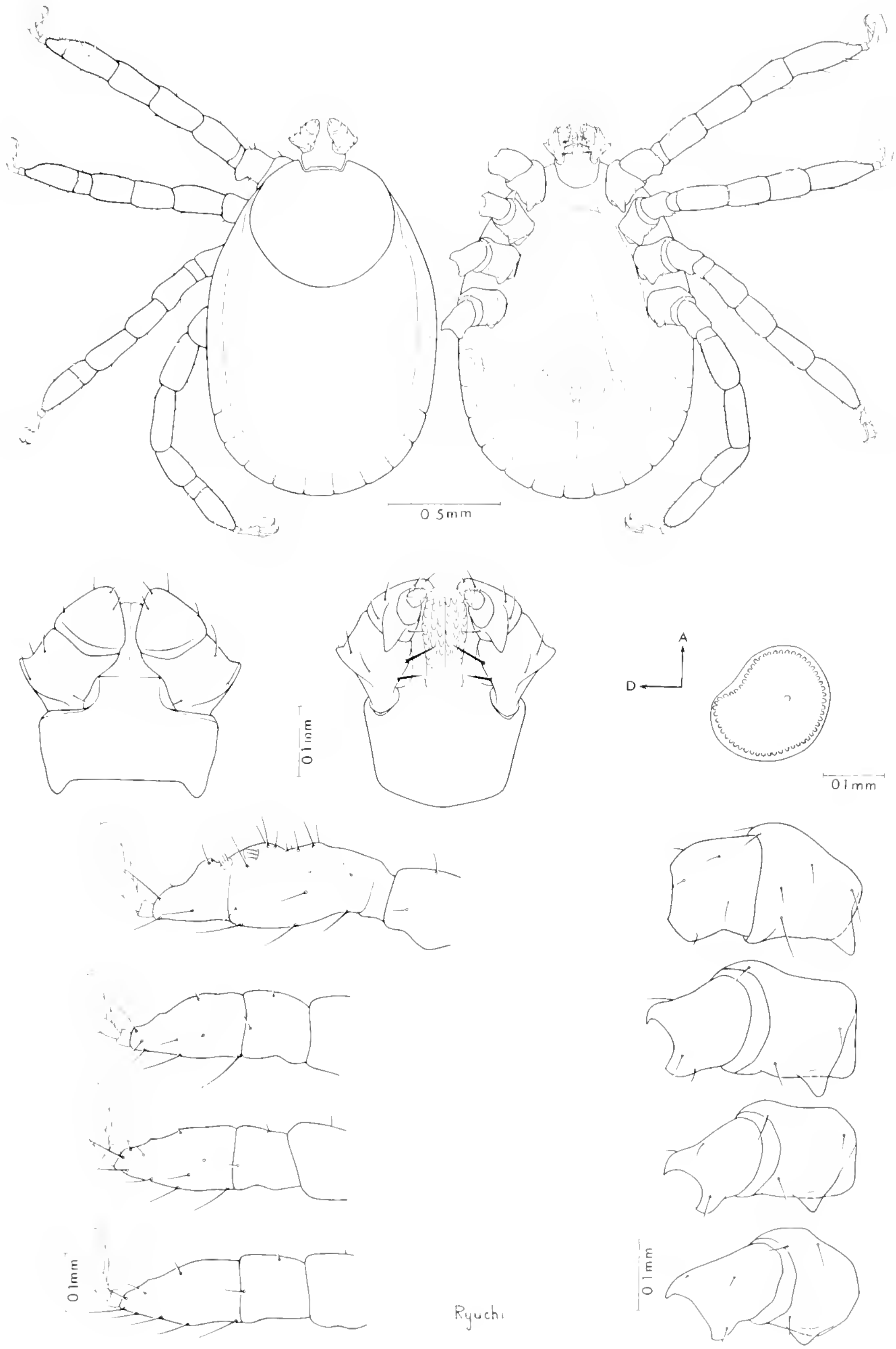


Fig. 67. *Haemaphysalis longicornis*, nymph.

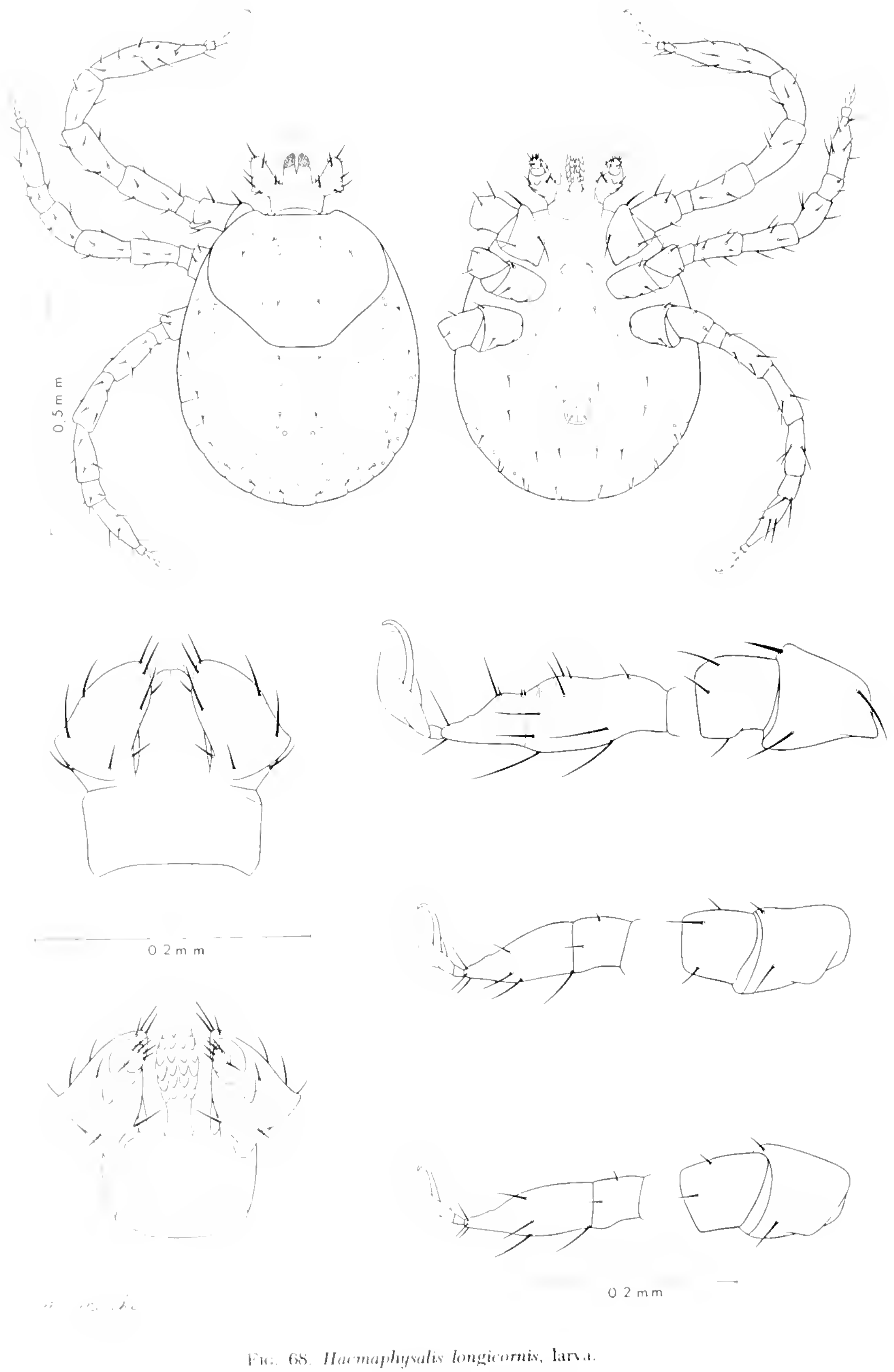


FIG. 68. *Haemaphysalis longicornis*, larva.

straal et al. (1968), this species occurs in Australia, New Zealand, New Caledonia, Fiji Islands, Tonga, Friendly Islands, Efate Island, New Hebrides, northern China (Peking), Japan, Korea, and northeastern USSR. They suggest that the bisexual population is presumably predominant on the Korean peninsula. It may be noteworthy that reliable records of this species on the Ryukyu Islands cannot be found. The distribution and sex ratio of this species in Japan have been reviewed by Kitaoka (1961d).

H. longicornis parasitizes many animals from small to large mammals, and birds. Hosts recorded are cattle, horses, sheep, goats, deer, bears, pigs, foxes, raccoons, badgers, cats, dogs, rabbits, house sparrows, skylarks, thrushes, turkeys, ducks, chickens, pheasants, and humans.

Biology:

This tick is known to be parthenogenetic. In Japan the ratio of males to females varies with geographical locality, and our collection confirms Kitaoka's finding (1961d) of predominantly parthenogenetic populations in the north of Japan and bisexual populations in the southern islands. However, we have both parthenogenetic and bisexual populations from Oki Island. In the laboratory the bisexual strain readily converts to parthenogenetic type of reproduction when the females are isolated from the males. Bremner (1959) found a ratio of approximately 1 male to 400 females in the Australian population and no spermatozoa in all males dissected, irrespective of whether they were fed or unfed. Excellent physiological and ecological studies of this species (as *bispinosa*) were done by Kitaoka (1961d), Namba (1953, 1954, 1958, 1963a, 1963b), and Asanuma (1947a). Nakamura and Yajima (1942a) studied the laboratory life cycle. In the 406th Medical Laboratory both parthenogenetic and bisexual strains were reared on rabbits' ears, and their life cycle data is summarized in the following table.

Laboratory life cycle of *Haemaphysalis longicornis*
(parthenogenetic and bisexual populations)
(reared on rabbits)

Period	Number of Days					
	Least		Most		Average	
	P	B	P	B	P	B
Oviposition to hatching	24	38	31	39	27.5	38.6
Resting (larvae)	3	3	5	4	4.0	3.5
Feeding (larvae)	4	5	5	7	4.5	6.0
Drop-off to molt (larvae)	14	20	17	22	15.5	21.0
Resting (nymphs)	2	3	3	3	2.5	3.0
Feeding (nymphs)	5	4	7	5	6.0	4.5
Drop-off to molt (nymphs)	12	14	16	16	14.0	15.0
Resting (adults)	4	2	6	4	5.0	3.0
Feeding (adults)	11	11	19	13	15.0	12.0
Drop-off to oviposition (females)	3	3	7	6	5.0	4.5
Oviposition (females)	11	17	27	18	19.0	17.5
Number of eggs					2,024	2,740
Egg hatch (%)					94	96

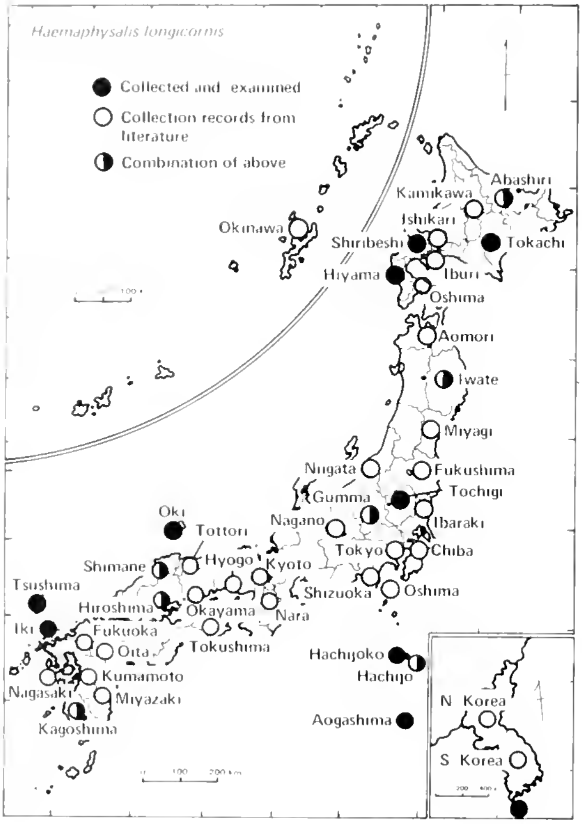
P = Parthenogenetic population
B = Bisexual population

Disease Relationship:

This species is a proven vector of *Coxiella burnetii* (Q fever) among Australian cattle and is also capable of transmitting the causal virus of Russian spring-summer encephalitis in northern USSR. In Japan it is suspected of transmitting bovine piroplasmosis. Experimental infection of calves with *Theileria mutans* by the bite of this species (listed as *bispinosa*) was reported by Ishihara and Ishii (1956). Namba (1963b) also referred to this species as an important vector of *T. mutans* in Japan.

Remarks:

The only known example of triploidy in ticks occurs in *H. longicornis.* Oliver and Bremner (1968) found the chromosome number to be 32 or 33 in the obligate parthenogenetic female and 31 in the reproductively nonfunctional male in the Australian population. According to information supplied by Oliver and Tanaka (1968), the chromosome number of the Japanese parthenogenetic population is 32 or 33 in females and 31 or 32 in males (two males found among approximately 3,000 samples of females which



Map 19. Known distribution of *Haemaphysalis longicornis*.

were produced from ten batches of eggs), and in the Japanese bisexual population it is 22 in females and 21 in males. In parthenogenetic females from Cheju Do, Korea, 22 to 24 chromosomes have been observed.

Haemaphysalis megaspinosa Saito (Fig. 69-72)

Haemaphysalis megaspinosa Saito, 1969:87-96, Fig. 1-16.

Discussion:

Saito, using the flagging method, collected adults of this species in a cedar forest of a mountainous area in Kanagawa Prefecture. Personnel of the 406th Medical Laboratory collected this species from a wild boar, deer, and Japanese serow. Three lots, J-0177, J-0179, and J-0184, collected from a wild boar and two deer in Mie and Shiga prefectures, contained this species along with *H. flava*. The female of *H. megaspinosa* resembles *H. flava*; therefore, the records of *flava* from these hosts which have been previously reported by Japanese acarologists might possibly include *H. megaspinosa*. Other specimens were loaned for study through the courtesy of Dr. Kitaoka, and two females were found in Dr. Yajima's collection at the National Institute of Animal Health, Kodaira, Tokyo.

Diagnosis:

This species is close to *H. flava* in general appearance but may be distinguished in that the body color is brownish and darker, and the body size is remarkably larger in both sexes. In the male, the cornua is longer; the dentition of the hypostome is 5/5 to 6/6; the posteroexternal juncture of palpal segment II is somewhat blunt, whereas in *flava* the angle is sharper, the juncture itself being a small tip; legs more robust; trochanteral spur I is much reduced; coxae I and IV have relatively shorter spurs, especially on coxa IV the spur is stronger, more or less curved, wider at base; tarsi II-IV have a triangular, spur-like ventral projection at approximately the middle. The female of this species is quite similar to that of *flava*. However, palpal segment II differs ventrobasally as in the male (see illustrations), and coxa IV has a longer spur.

Distribution and Hosts:

Saito collected *H. megaspinosa* from vegetation, but adults of this species were collected from a wild boar, deer, and Japanese serow (*Capricornis crispus*). This species is known at present from Mie, Shiga, Miyazaki, and Kanagawa prefectures. Immature forms have not yet been collected from the field.

Biology:

This species fed on rabbits in the 406th Medical Laboratory, and the life cycle was studied. Compared with *H. flava*, it showed slower development in each stage. Five engorged females (68-J-0301) began oviposition on 29 to 31 March 1968 and laid batches of 368-2,077 eggs during the ovipositing period of 23 to 26 days. After the incubation period of 33 to 37 days, larvae hatched out on 3 to 6 May. The hatch rates of the two batches were 98.1% and 96.9%. A considerable number of larvae from the two colonies were fed on a rabbit for life-cycle studies. In the first series of rearing experiments, larvae were put on the host 9 days after hatching and nymphs were put on the host 4 days after molting. In the second series, larvae were put on the host 28 days after hatching and the nymphs were put on the host 26 days after molting. The feeding periods of larvae and nymphs did not differ essentially between the two experimental series, and the results are summarized as follows:

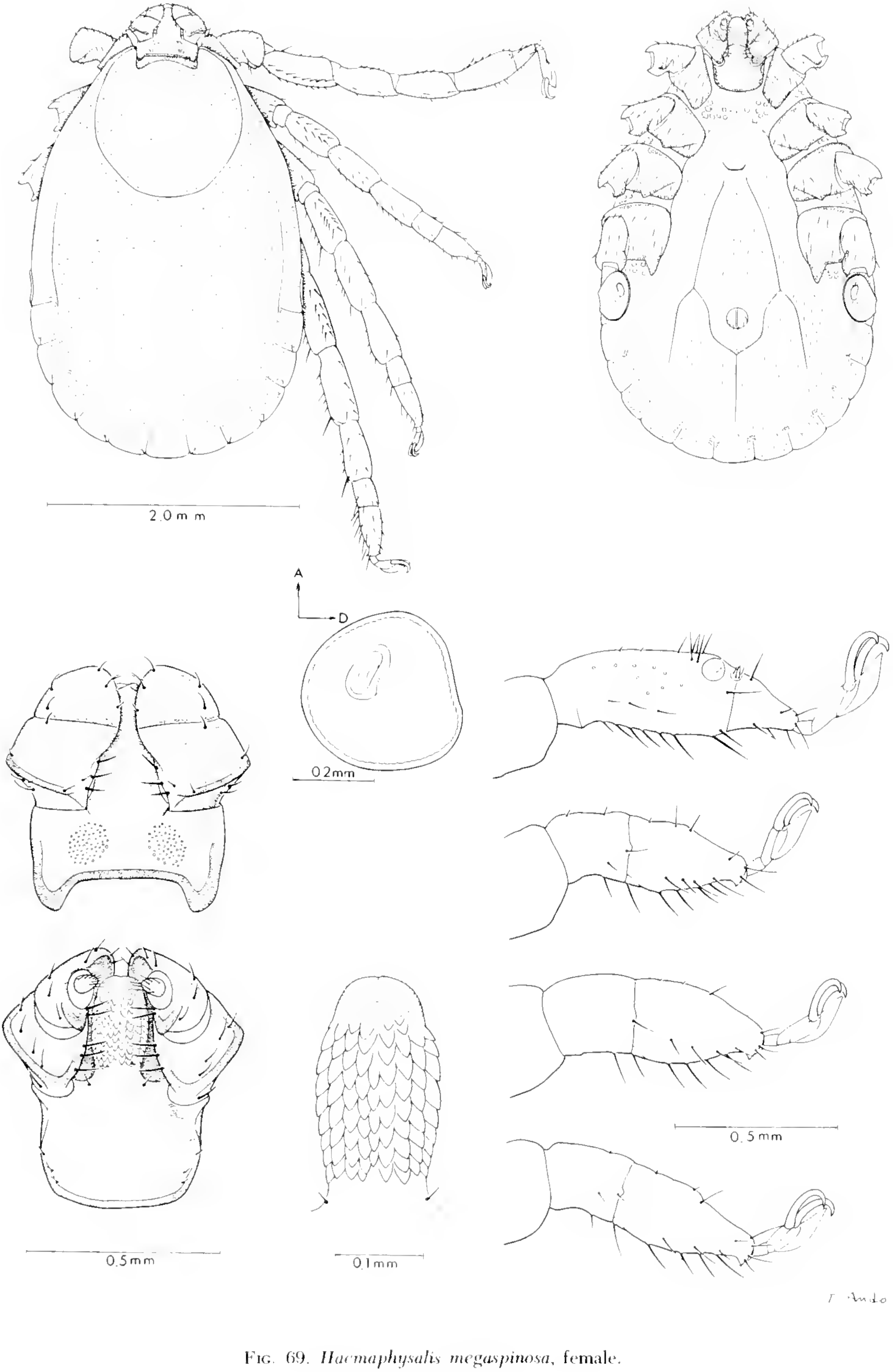


FIG. 69. *Haemaphysalis megaspinosa*, female.

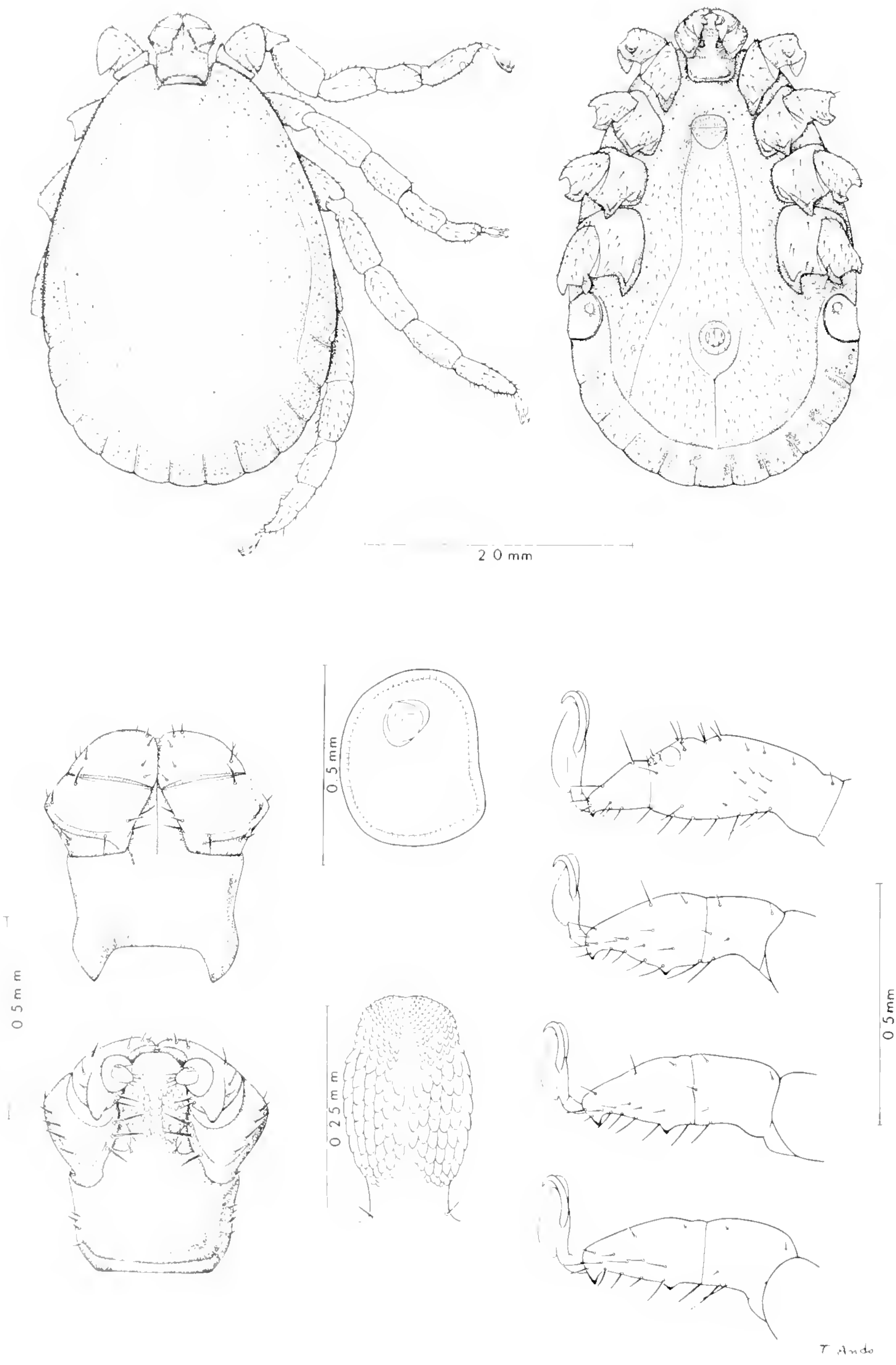


Fig. 70 *Haemaphysalis megaspinosa*, male.

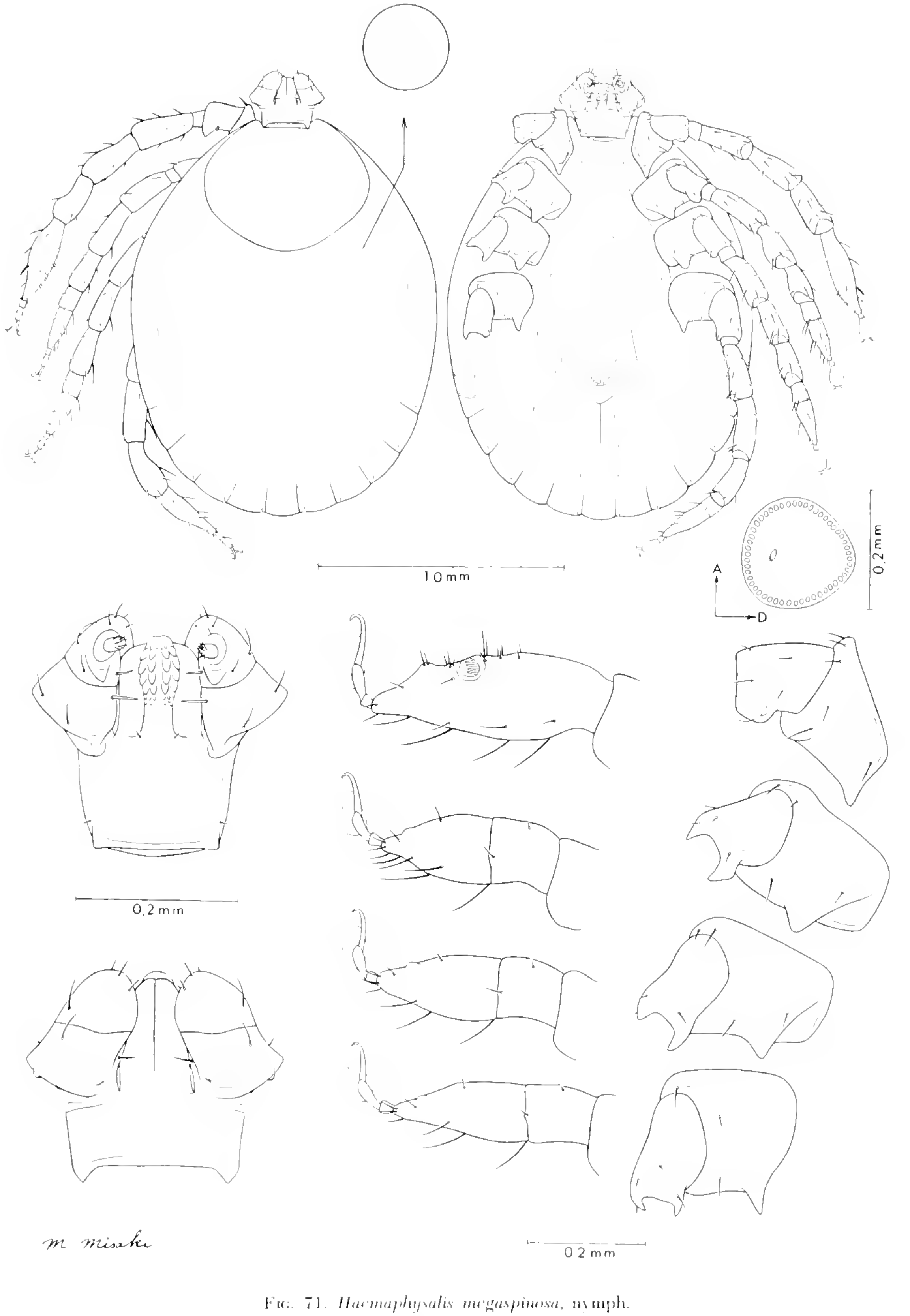


FIG. 71. *Haemaphysalis megaspinosa*, nymph.

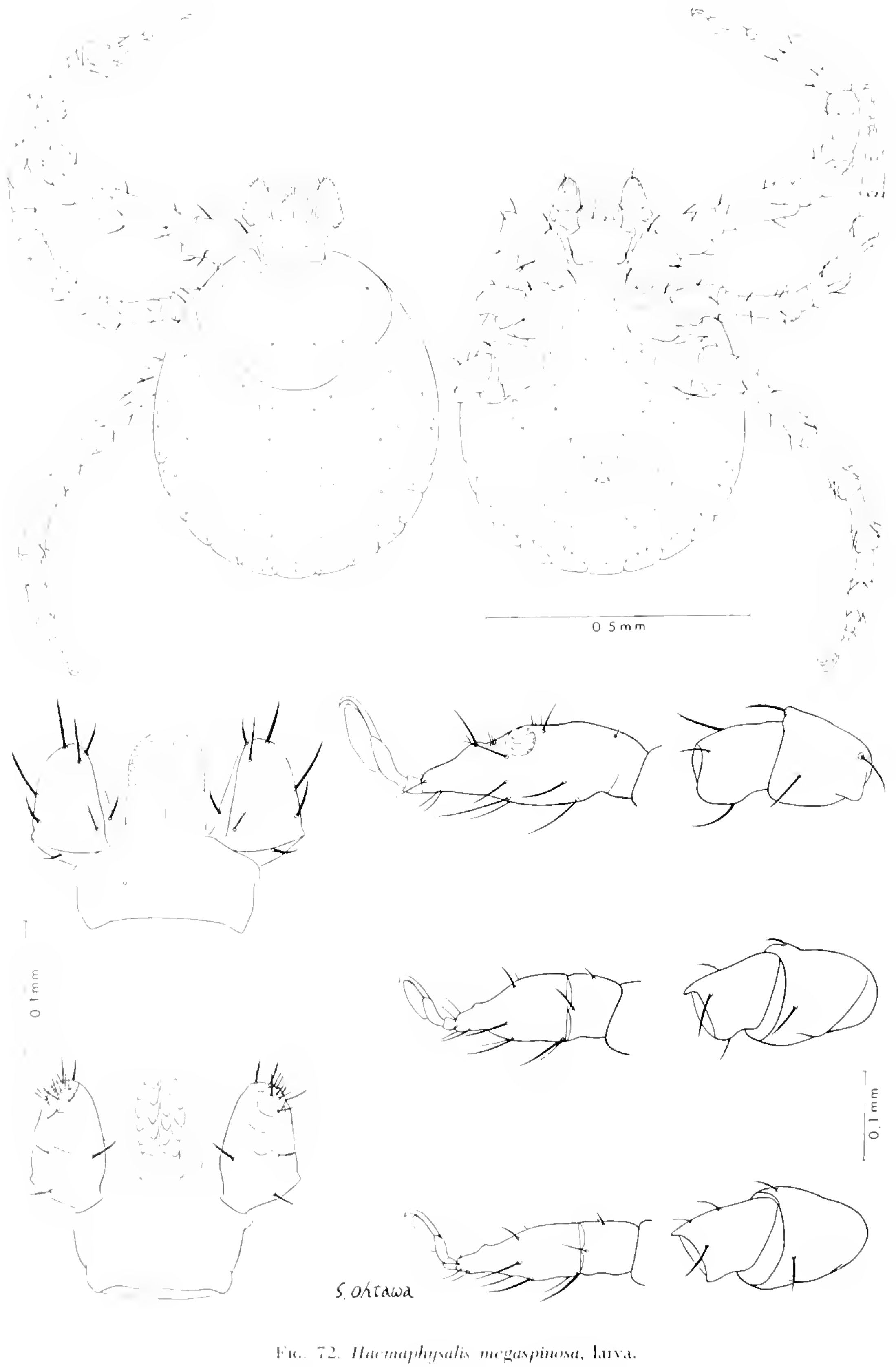
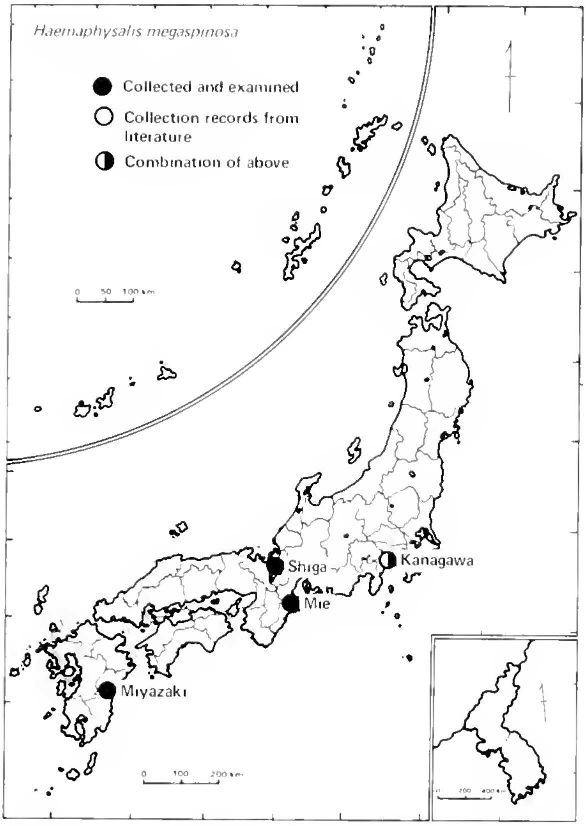


Fig. 72. *Haemaphysalis megaspinosa*, larva.



Map 20. Known distribution of *Haemaphysalis megaspinosa.*

Laboratory life cycle of *Haemaphysalis megaspinosa* and *Haemaphysalis flava*

		Period in Days	
Stage	Phase	*megaspinosa*	*flava*
Adult	Oviposition	23-26	8-27
Egg	Incubation	33-37	23-34
Larva	Feeding	4-9	3-5
Larva	Postparasitic (Premolting)	17-18	13-19
Nymph	Feeding	4-7	3-6
Nymph	Postparasitic (Premolting)	20-	17-20

Eggs: *megaspinosa* 368-2,077 (by 5 females) *flava* 1,219-2,564 (by 3 females)

At approximately 25 C, reared on laboratory white rabbits.

Disease Relationship:

Unknown.

Haemaphysalis pentalagi Pospelova-Shtrom (Fig. 73-76)

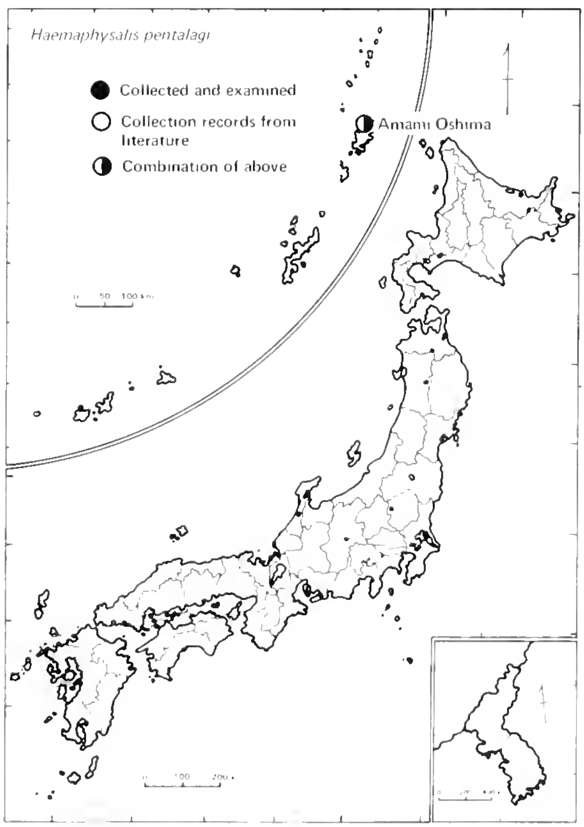
Haemaphysalis pentalagi Pospelova-Shtrom. 1935:205-217, Fig. 9-12; Keegan and Toshioka, 1957:28; Hoogstraal and Yamaguti, 1970:367-374.

Discussion:

The description of this species was based on a single male specimen taken from a young Ryukyu black rabbit from Liu-Kiu, Japan, in 1927. Pospelova-Shtrom (1935) did not mention the specific locality, but Liu-Kiu is presumably Amami Oshima because the Ryukyu rabbit, *Pentalagus furnessi*, is found only on Amami Oshima and Toku no Shima, and the latter may not have been easily accessible in 1927. Since 1927 no specimens resembling *pentalagi* have been collected by Japanese workers. However, personnel of the 406th Medical Laboratory succeeded in collecting *H. pentalagi* from the Ryukyu rabbit when the capture of this protected host was permitted in April 1968 by the Japanese Government.

Diagnosis:

This smallest haemaphysalid tick in Japan slightly resembles *H. campanulata*, but may be separated from that species as follows: coxa I has no spur, coxae II-IV have weak, blunt, and



Map 21. Known distribution of *Haemaphysalis pentalagi.*

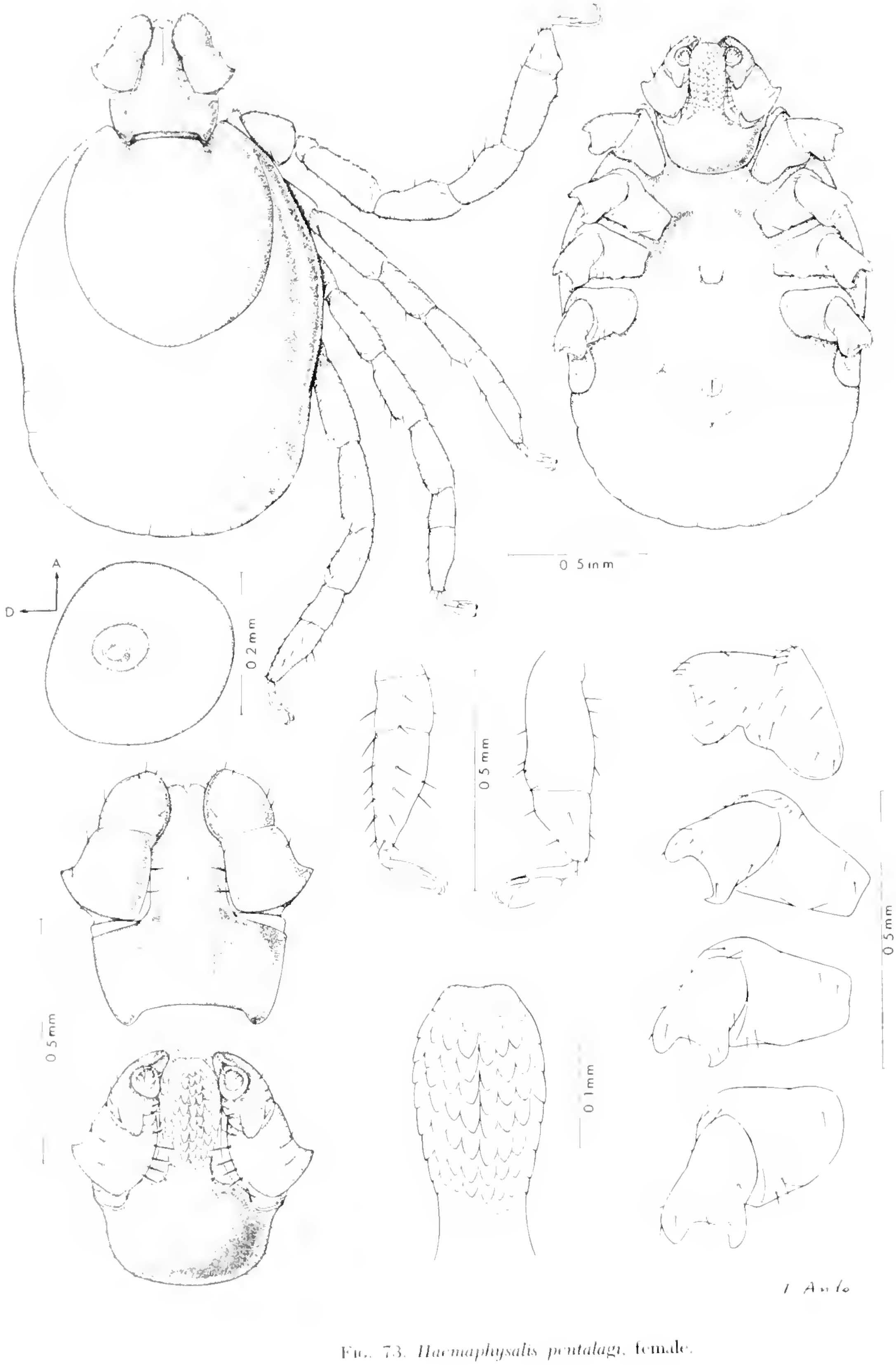


FIG. 73. *Haemaphysalis pentalagi*, female.

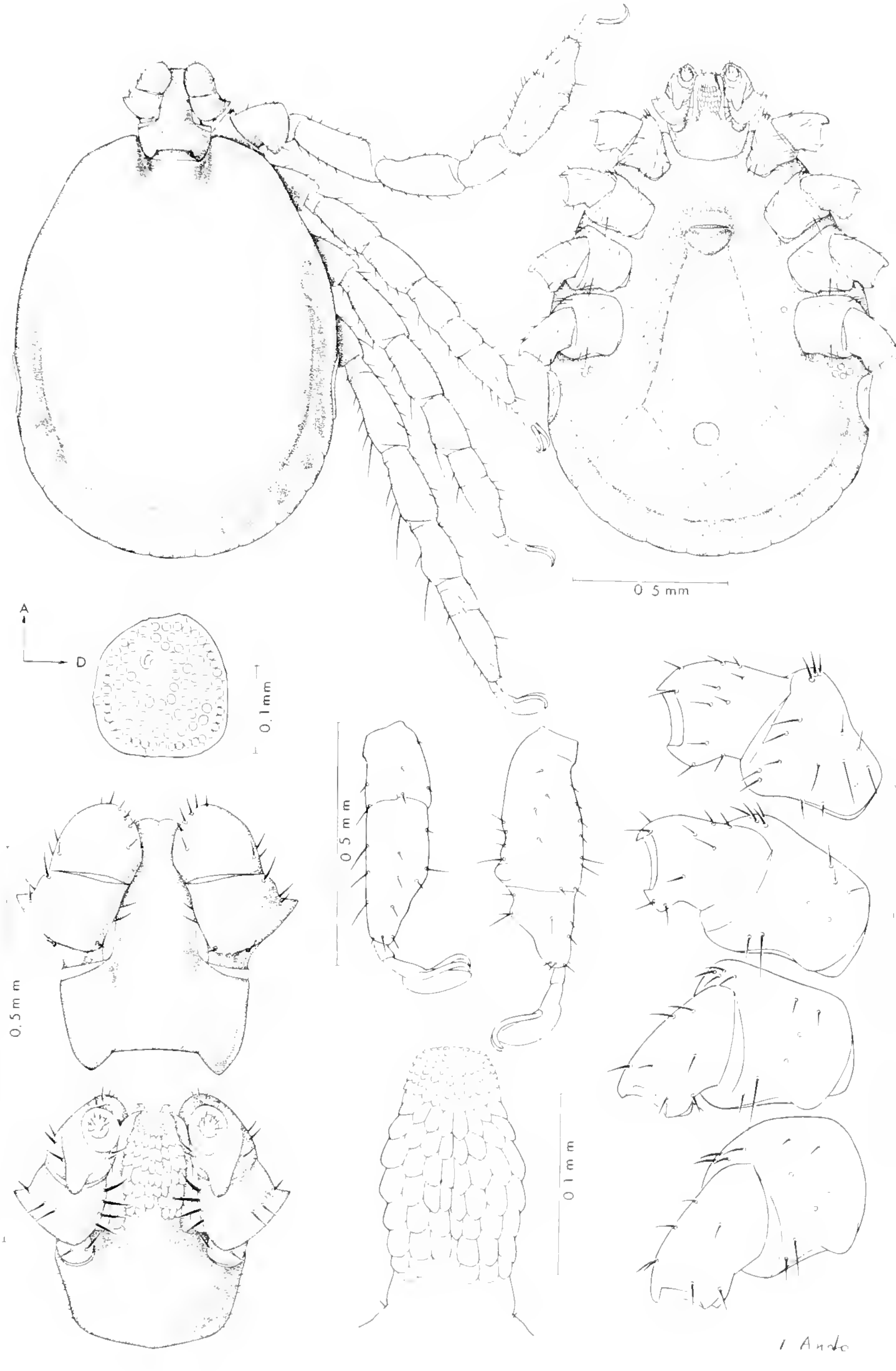


FIG. 74 *Haemaphysalis pentalagi*, male.

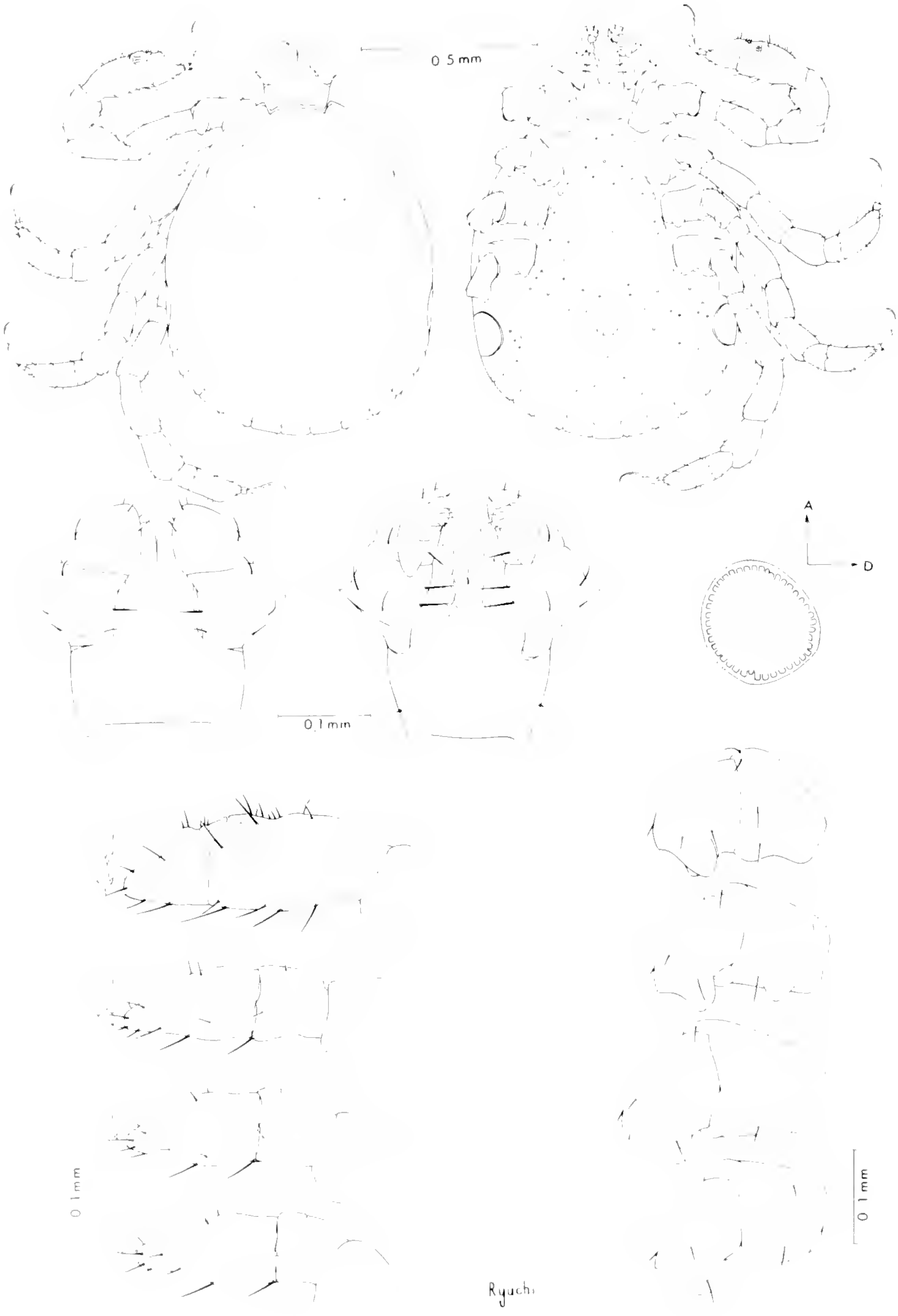


FIG. 73. *Haemaphysalis pentalagi*, nymph

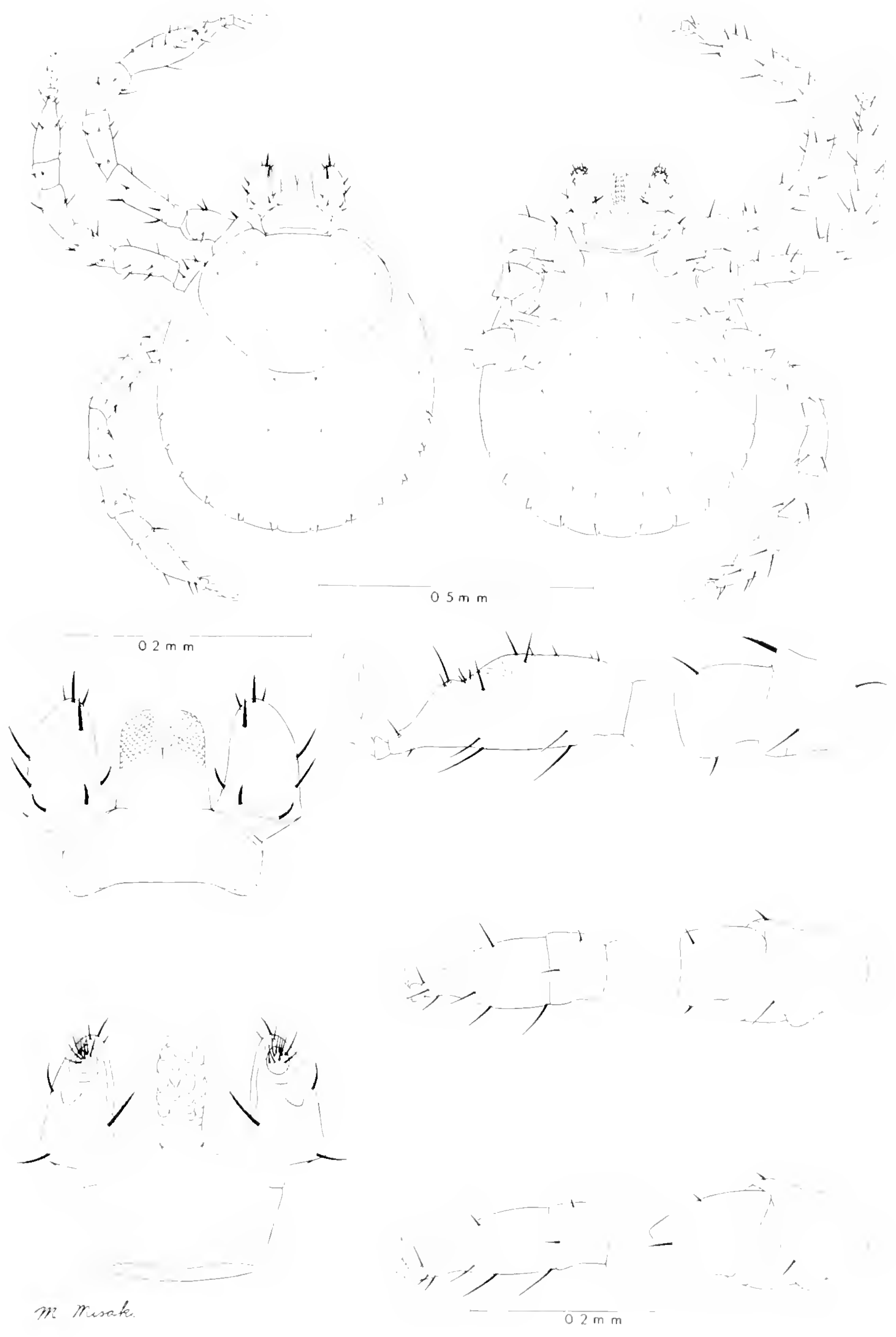


Fig. 76. *Haemaphysalis pentalagi*, larva.

wide spurs which are hardly discernible; there is no dorsal spur on palpal article III; palpal article II has a pointed, externally directed posteroexternal juncture; in the female, the capitulum and scutum are very large in relation to the small body size (engorged, scutal length covers approximately half the body length); the genital aperture is on a level with coxae III; the tarsi are not humped.

Distribution and Hosts:

Known distribution is Amami Oshima in the Ryukyu Islands. Pospelova-Shtrom's record may be from the same island. The only known host is the Ryukyu black rabbit, *Pentalagus furnessi.*

Biology:

Rearing experiments were conducted at the 106th Medical Laboratory.

Laboratory life cycle of *Haemaphysalis pentalagi*
(reared on laboratory white rabbit)

Generation and Stage	Phase	Period in Days	Remarks
P Adult	Feeding	5-7	2 unengorged females (68-J-0311) were placed on host on 16 April 1968.
P Adult	Post parasitic (Preoviposition)	7-10	
P Adult	Oviposition	15-17	Egg number: 386-523
F_1 Egg	Incubation	27-28	492 larvae from 909 eggs.
F_1 Larva	Feeding	5-9	50 live larvae were placed on host on 31 May.
F_1 Larva	Postparasitic (Premolting)	14+	8 nymphs emerged.
F_1 Nymph	Feeding	6-7	
F_1 Nymph	Postparasitic	?	Nymphs died without molting.

The rearing experiment was done from 16 April 1968 to July, and room conditions varied according to outside temperature and humidity.

Disease Relationship:

Unknown.

Haemaphysalis wellingtoni Nuttall and Warburton (Fig. 77)

Haemaphysalis wellingtoni Nuttall and Warburton, 1908:397-398; Asanuma and Kosaka, 1954:104-107, Fig. 1-2; Keegan and Toshioka, 1957:4; Asanuma, 1965a:111-112.

Discussion:

Occurrence of *H. wellingtoni* on the Japanese gray thrush, *Turdus cardis cardis*, was reported by Asanuma and Kosaka (1954). As *Turdus cardis cardis* is a migratory bird which spends the colder months of the year in countries of Southeast Asia, Asanuma and Kosaka believe that the ticks found on Honshu probably had been carried by birds which had recently arrived from warmer areas. This bird is a summer resident in Japan and breeds from April through August. Its distribution includes Hainan, Indochina, and South China. Although specimens were not seen, figures published in the paper by Asanuma and his co-worker are excellent and leave no doubt that the specimens collected were actually *wellingtoni*. Since this species is parasitic on migratory birds, it cannot be regarded as a species which has become established in this area.

Diagnosis:

The male of this tick is distinct from other haemaphysalids in Japan in that palpal article III has a distinct retrograde spur internodorsally and a long ventral spur; palpal article II has 8-9 internoventral setae (Anastos, 1950; Sumatra specimen has 7 setae); the cornua is short and blunt. According to Asanuma and Kosaka (1954) it is close to *H. pavlovsky* Pospelova-Shtrom, 1935, but may be distinguished from that species by the longer ventral spur of palpal article III, absence of a small blunt projection on the suprainternal margin of palpal article II, and the weaker cornua.

Distribution and Hosts:

Anastos (1950) gave the distribution of this tick as Borneo, Malaya, Siam (= Thailand), Andaman Islands, India, New Guinea, Burma, Indonesia, and Indochina. Hosts recorded are goose, turkey, wild fowl, domestic fowl (*Gallus gallus*), buffalo (*Bubalus bubalis*), and dog.

Biology:

Unknown.

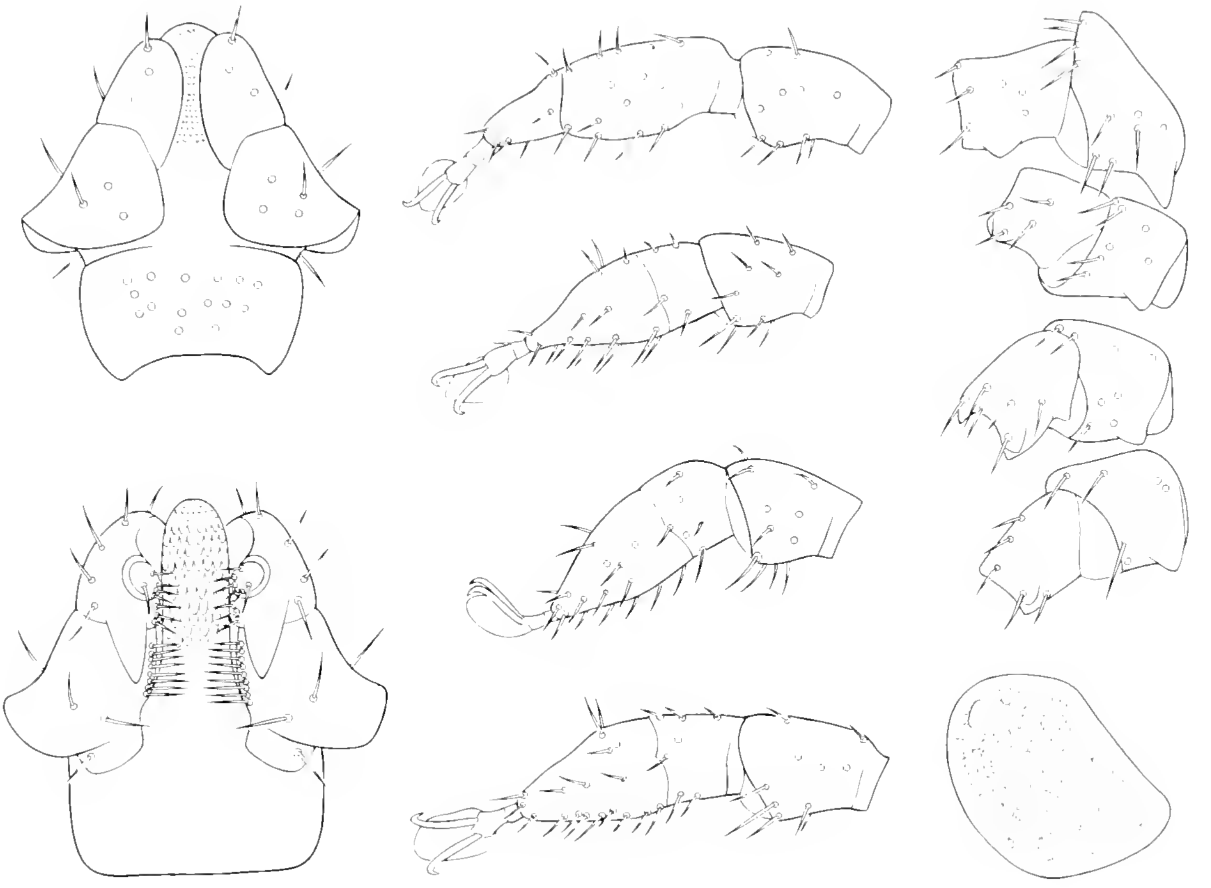


Fig. 77. *Haemaphysalis wellingtoni*, male.

Disease Relationship:

Unknown.

Genus *Ixodes* Latreille, 1795

Inornate. Eyes and festoons absent. Anal groove curved around the anus anteriorly. Spiracular plate round or oval. Sexual dimorphism marked. Venter of male covered with seven plates.

Type Species: *Ixodes ricinus* (Linnaeus, 1758).

Key to the Males of the Genus *Ixodes*[*]

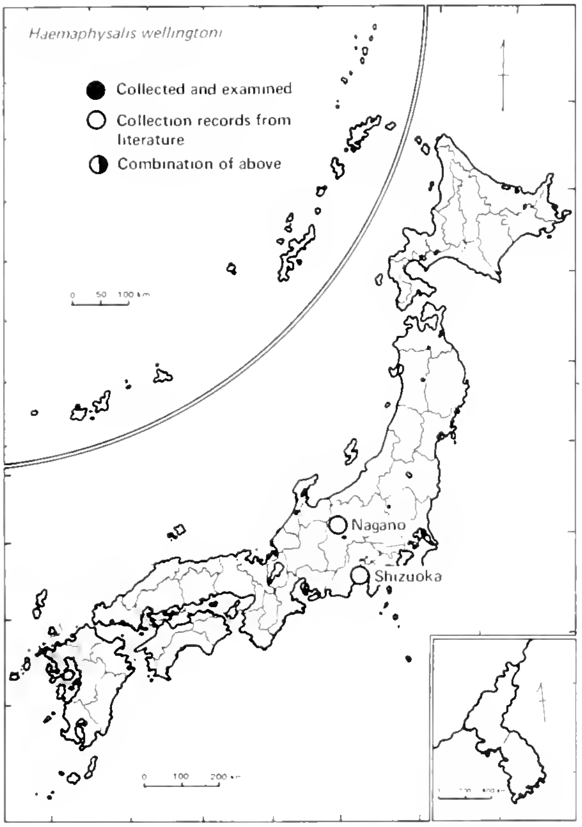
1. Coxae without internal spur 2
   Some coxae with internal spur 4
2. Legs distinctly longer than body; hypostome pointed at tip; on bats (Fig. 116) .... *vespertilionis*
   Legs not distinctly longer than body; hypostome blunt or notched at tip 3
3. Anal grooves convergent; on sea birds (Fig. 105) .... *signatus*
   Anal grooves divergent or parallel; on swallows (Fig. 87) .... *lividus*
4. Coxa I with one spur 5
   Coxa I with two spurs 6
5. Coxa I with a long internal spur; on badger (Fig. 111) .... *tanuki*
   Coxa I with a short, blunt internal spur (Fig. 96) .... *ovatus*
6. Coxa I with a thick, long external spur .... *acutitarsus*
   Coxa I with a blunt, short external spur 7
7. Hypostome with moderate denticles; internal and external spurs of coxa I short, subequal (Fig. 83) .... *granulatus*
   Hypostome with large, strong denticles laterally; internal spur of coxa I longer than external spur 8
8. Spiracular plate ellipsoidal, much longer than wide, usually anglelike contour anteroventrally; mostly from western part of Japan (Fig. 92) .... *nipponensis*
   Spiracular plate oval, longer than wide; mostly from northern part of Japan (Fig. 100) .... *persulcatus*

[*] *Ixodes philipi* is not included in this key.

Key to the Females of the Genus *Ixodes*

1. Coxae without internal spur 2
   Some coxae with distinct internal spur 5
2. Anal groove pointed in front; posterior arms of anal grooves divergent; on bats (Fig. 108) .... *simplex simplex*
   Anal groove rounded in front; posterior arms of anal grooves convergent or subparallel 3
3. Legs distinctly longer than body; hypostome lanceolate; scutum widest behind middle; on bats (Fig. 115) .... *vespertilionis*
   Legs not distinctly longer than body; hypostome blunt at tip; scutum widest at middle or in front of middle; on birds 4
4. Auriculae well developed, on sea birds 13
   Auriculae absent; on swallows (Fig. 86) .... *lividus*
5. Coxa I with one spur 6
   Coxa I with two spurs 8
6. Coxa II with a short external spur; scutum with posterolateral margin slightly concave (Fig. 90) .... *monospinosus*
   Coxa II without an external spur; scutum with posterolateral margin convex 7
7. Coxa I with a long internal spur; on badger (Fig. 110) .... *tanuki*
   Coxa I with a short internal spur (Fig. 95) .... *ovatus*
8. Auriculae well developed 9
   Auriculae absent or poorly developed 11
9. Internal spur on coxa I much longer than external spur; auriculae normal 10
   Internal spur on coxa I nearly equal to external spur; auriculae well developed laterally (Fig. 112) .... *turdus*
10. Internal spur on coxa I sharply pointed, long, usually overlapping on approximately ⅓ of coxa II, postscutal marginal body setae pointed, length approximately 0.08 mm;

mostly from northern parts of Japan (Fig. 99) *persulcatus*
Internal spur on coxa I long, usually overlapping anterior margin of coxa II (Fig. 80); postscutal marginal body setae scaled, forked, length approximately 0.14 mm; mostly from western parts of Japan (Fig. 91) *nipponensis*
11. Coxa I with a thick, long external spur; scutum cordate, nearly as wide as long (Fig. 78) *acutitarsus*
Coxa I with a blunt, short external spur; scutum distinctly longer than wide 12
12. Anal groove slightly pointed in front; genital aperture on level with coxa III (Fig. 79) *angustus*
Anal groove round in front; genital aperture on level with coxa IV (Fig. 82) *granulatus*
13. Dorsum except scutum hirsute, uniformly covered with white hairs; basis capituli subtriangular dorsally; porous areas well separated (Fig. 103) *philipi*
Dorsum except scutum not hirsute; basis capituli rectangular dorsally, much wider than long; porous areas very close to each other (Fig. 104) *signatus*



MAP 22. Known distribution of *Haemaphysalis wellingtoni*.

Ixodes acutitarsus (Karsch) (Fig. 78)

Haemalastor acutitarsus Karsch, 1880:141-142; Neumann, 1899:180.

Ixodes acutitarsus: Neumann, 1901:286; Nuttall and Warburton, 1911:202-203, Fig. 195; Schulze, 1935:234; Kishida, 1930a:2, 1935: 137; Sugimoto, 1936b:1-20, 1936c:585; Asanuma, 1947b:972, Fig. 2766, 1965a:113-116, 1965b:399, Fig. 220; Yajima, 1955:52-53; Keegan and Toshioka, 1957:18-19, Pl. 29; Ohara and Tamura, 1958:23-24.

Eschatocephalus acutitarsus: Neumann, 1901: 290.

Ixodes happinus: Keegan and Toshioka, 1957:31.

DISCUSSION:

Nuttall and Warburton (1911) discussed the synonymy of this species and mentioned that Karsch's type came from Japan. These workers also stated that they had seen two females from Japan and Formosa. Sugimoto (1936b, 1936c) merely cited records of Nuttall and Warburton (1911). Kishida (1930a) reported occurrence of this species on the serow, *Capricornis crispus*, in Gifu, Nagano, and Toyama prefectures, Japan, and later (1935) from cattle on Formosa. Asanuma cited the records given above and added the dog and the cow to the host list in the 1947 edition of the *Illustrated Encyclopedia of the Fauna of Japan*. Keegan and Toshioka (1957) examined two loaned specimens taken from man, one from Wakayama Prefecture and the other from Saitama Prefecture, and identified them as *acutitarsus*. Yajima's (1955) record was from a cow in Iwate Prefecture, and he reported this tick merely as n. sp. and did not provide a specific name. This specimen was identified by Mr. G. M. Kohls as *acutitarsus*. Keegan and Toshioka (1957) referred to this specimen as *Ixodes happinus*, but this is an error since Dr. Yajima had not given a name in his original description, nor used this name in any publication since that time. Ohara and Tamura (1958) reported this tick on man.

DIAGNOSIS:

This tick is said to be the largest in the genus *Ixodes*. Asanuma (1947b) stated that even unengorged females measure as large as 8 mm in length. It may be distinguished from other *Ixodes* spp. by the following characteris-

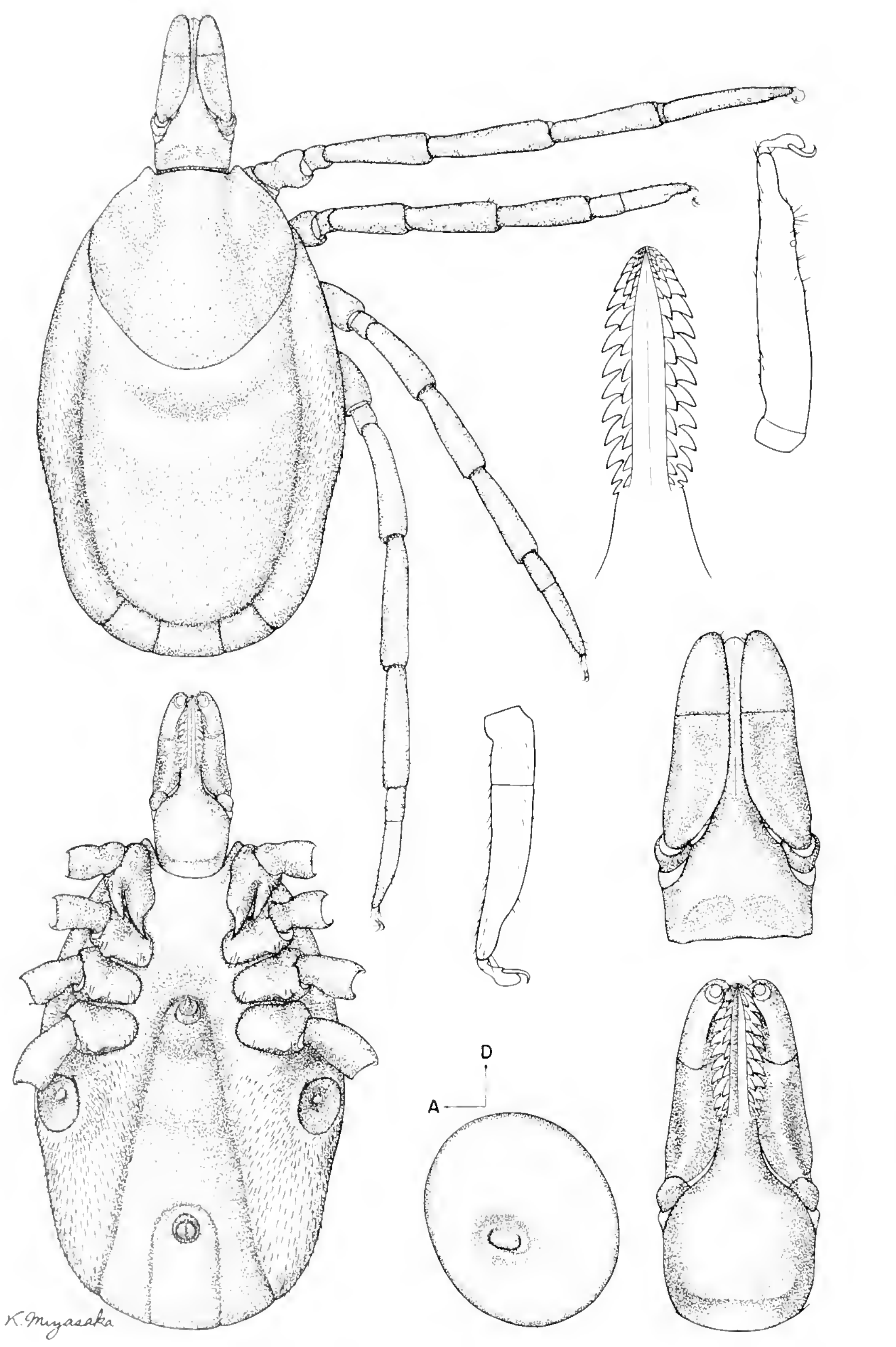
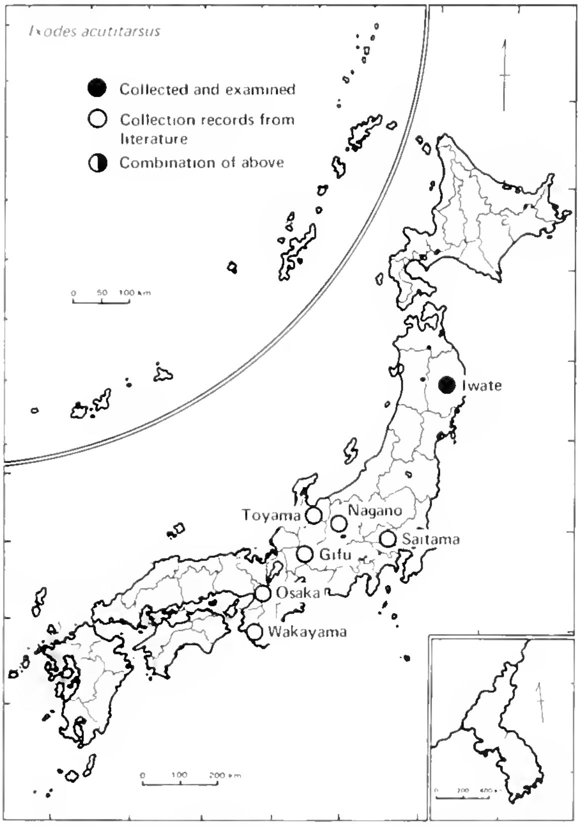


Fig. 78. *Ixodes acutitarsus*, female.

ties: coxa I is deeply incised with two thick, long spurs; there are neither cornua or auriculae on the basis capituli; the anal and genital grooves extend dorsally to reach the distinct lateral groove of the dorsum, thus giving a festoonlike appearance; the legs are slender, the tarsi gradually taper distally, especially in the female.

Distribution and Hosts:

Nuttall and Warburton (1911) recorded collections from Japan, Formosa, and Sikkim from Japanese serow, dog, cow, and human. All specimens were adults; immature forms have never been collected.



Map 23. Known distribution of *Ixodes acutitarsus*.

Biology:

Unknown.

Disease Relationship:

Unknown.

Ixodes angustus Neumann
(Fig. 79-81)

Ixodes angustus Neumann, 1899:136; Asanuma, 1947b:971, Fig. 2763, 1951:1-4, 1957:234, 1965a:113-116, 1965b:398, Fig. 219; Ono, 1966:62-68.

Ixodes sp. 3 and sp. 61 Asanuma and Sekikawa, 1952:111-116; Asanuma, 1955:1240-1242.

Discussion:

In the 1947 edition of the *Illustrated Encyclopedia of the Fauna of Japan*, Asanuma (1947b) recorded the occurrence of this tick in Sakhalin and in 1951 gave a description of females taken from the red-backed mouse, *Clethrionomys rufocanus* (Sundevall, 1846), in Sakhalin. Asanuma and Sekikawa (1952) and Asanuma (1955) reported immature forms of *Ixodes* species on rodents from Hokkaido, and they temporarily numbered these forms as sp. 3 for the larvae and sp. 61 for the nymphs. Later, Asanuma (1957) again reported these forms from Hokkaido and stated that the previously reported sp. 3 and sp. 61 were the immature stages of *Ixodes angustus*.

Diagnosis:

The female of this species is close to *I. granulatus* in the key but may be distinguished from that species in that the anal groove is slightly ogival in front; the genital aperture is on a level with coxae III; the hypostome is shorter than the palps and sharply pointed at the tip, the denticles of the inner file are subequal to those of the outer file and occur on almost the entire dentate length except two or three rows near the tip, while in *granulatus* the denticles of the inner file are much smaller than those of the outer file and do not occur on the proximal two-fifths of the dentate length; the scutum has well-defined, straight carinae, and the lateral margin of the scutum has a distinct angle which separates the anterolateral and posterolateral margins.

According to Asanuma (1951), this species is also allied to *I. soricus*, *I. muris*, *I. jellisoni*, and *I. minor* but may be distinguished from them by the smaller size and wrinkled integument of the postscutal area, the dentition of the hypostome, the absence of cornuae, the larger porous areas, and the strong lateral angle of the scutum.

Distribution and Hosts:

Known distribution of this tick includes North America, Canada, Alaska, Sakhalin, and Argentina. Hosts recorded are rodents, other small mammals, and sometimes humans.

Biology:

Little is known about the biology of this tick. Males are rarely found on host animals, and copulation probably occurs in the nest of the host.

Disease Relationship:

Cooley (1946) reported three positive rec-

FIG. 79. *Ixodes angustus*, female.

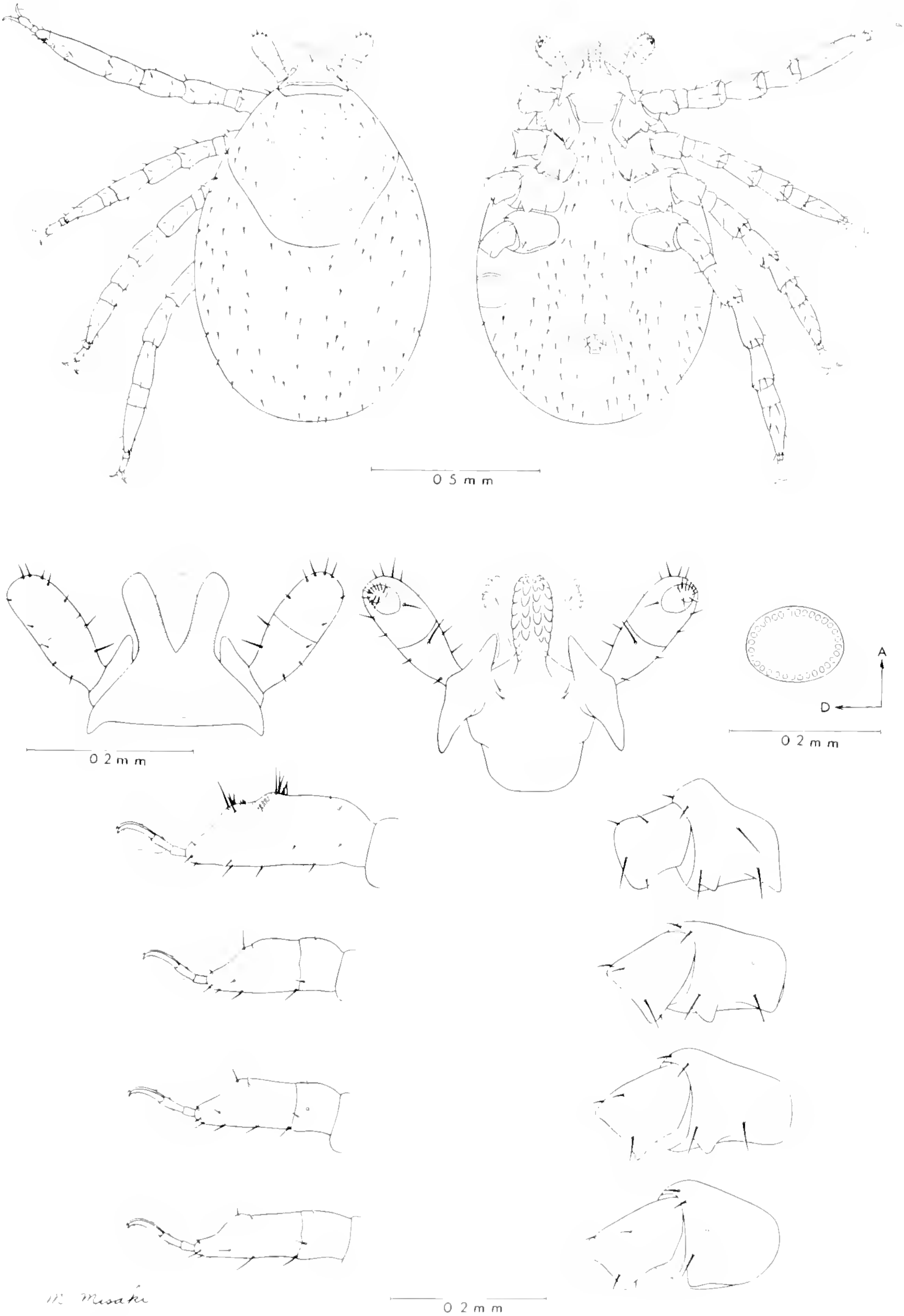


FIG. 80. *Ixodes angustus*, nymph.

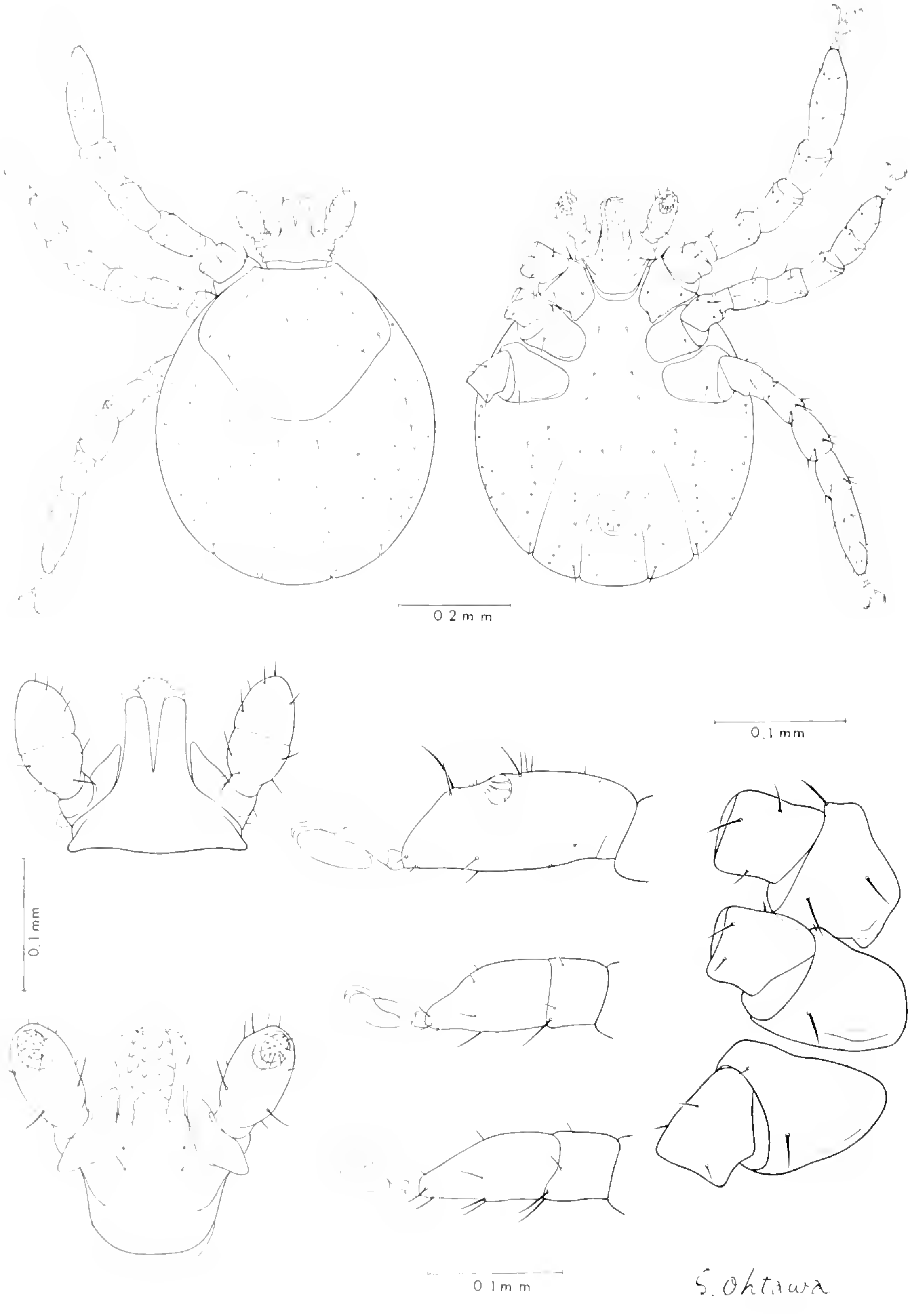
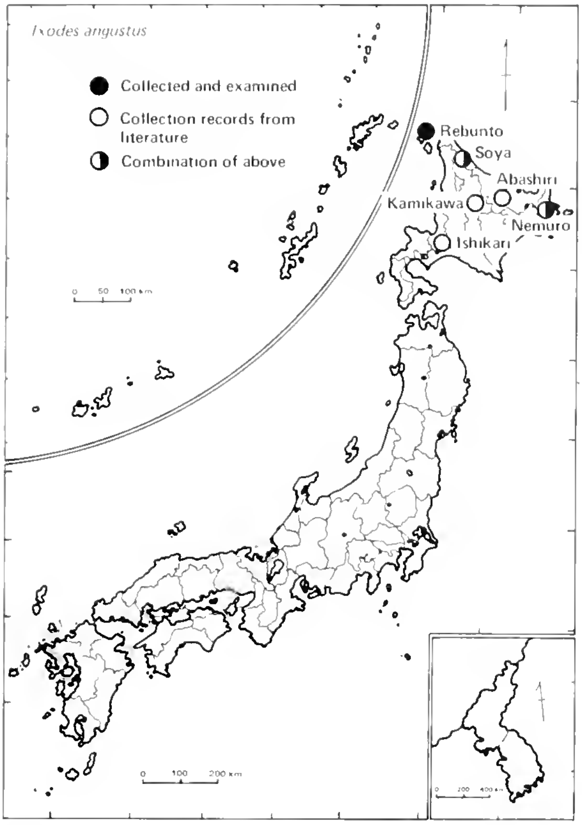


Fig. 81. *Ixodes angustus*, larva.



MAP 24. Known distribution of *Ixodes angustus*.

ords of this tick biting humans in the USA and stated there was no suggestion of disease transmission in these instances.

Ixodes granulatus Supino
(Fig. 82-85)

Ixodes granulatus Supino, 1897:230-238; Asanuma and Kosaka, 1955: 195-196; Keegan and Toshioka, 1957:19, Pl. 19, 30; Arthur, 1957:683-694, Fig. 12-17, 19-24; Kawashima, 1963:103; Asanuma, 1965a:113-120, 1965b: 398, Fig. 218.

Ixodes sp. 4, 51 and sp. 101 Asanuma and Sekikawa, 1952:107-116, Fig. 1, 2, 4, 6, 8, 1953: 99-112, Fig. 9, 10, 15, 16, 17.

DISCUSSION:

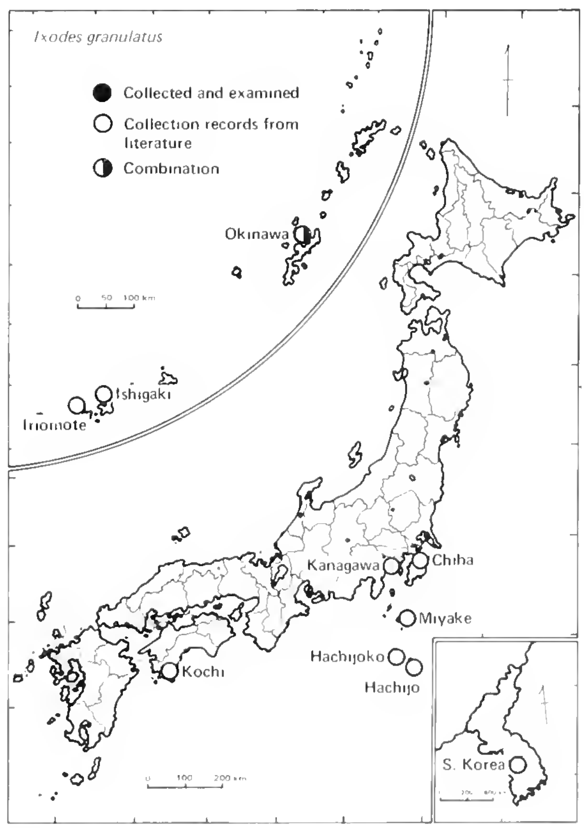
Asanuma and Sekikawa (1952, 1953) reported the occurrence of three unnamed ticks of the genus *Ixodes*, including larval and nymphal forms on rodents on Honshu, Kyushu, Hokkaido, and Shikoku. These unnamed ticks were tentatively numbered as *Ixodes* sp. 4 for larvae, *Ixodes* sp. 51 for nymphs, and *Ixodes* sp. 101 for adults. Keegan and Toshioka (1957) stated that Asanuma (1956a) indicated that these specimens were actually *granulatus*. Arthur (1957) discussed Korean specimens.

DIAGNOSIS:

I. granulatus is easily distinguished from other *Ixodes* species by the following combination of characters: coxa I has two short spurs, the internal spur is slightly longer than the external spur; the cornua is very short in the male and absent in the female; the auriculae are poorly developed; the scutum of the female is finely granulated, longer than wide, covering more than half the length of the dorsum and the scapulae are pointed.

DISTRIBUTION AND HOSTS:

Anastos (1950) cited distribution records from India, Burma, and the East Indies. Kohls (1950) gave a collection record from Luzon Island in the Philippines and (1957b) from Malaya. Collection records indicate that this tick is primarily a parasite of rodents. Asanuma and Kosaka (1955) took a female of this species from the thrush, *Turdus celaenopus celaenopus*, on Miyake (Is.), Tokyo-to. Prior to our survey, material in the 406th Medical Laboratory collections was from the Ryukyu Islands.



MAP 25. Known distribution of *Ixodes granulatus*.

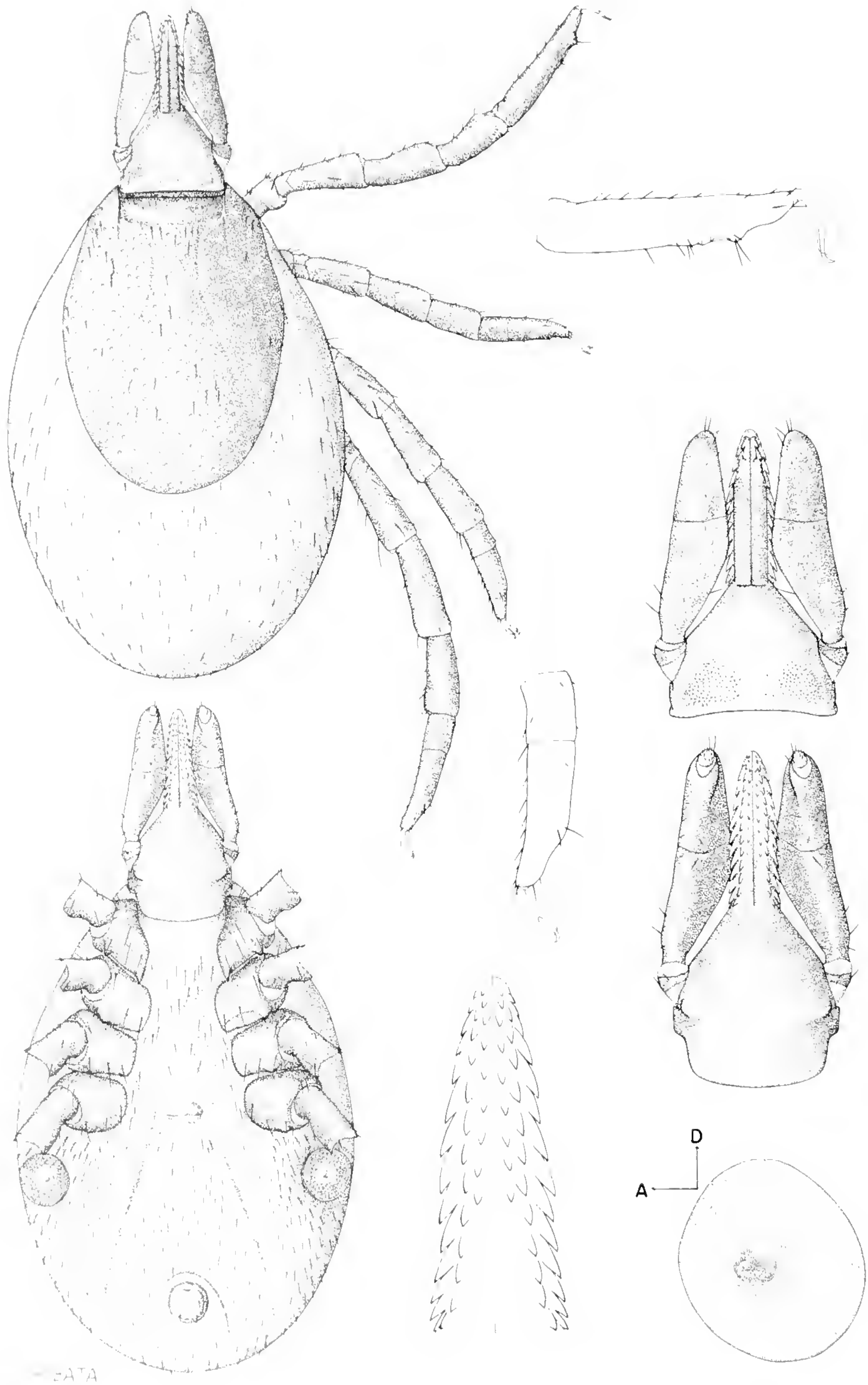


Fig. 82. *Ixodes granulatus*, female.

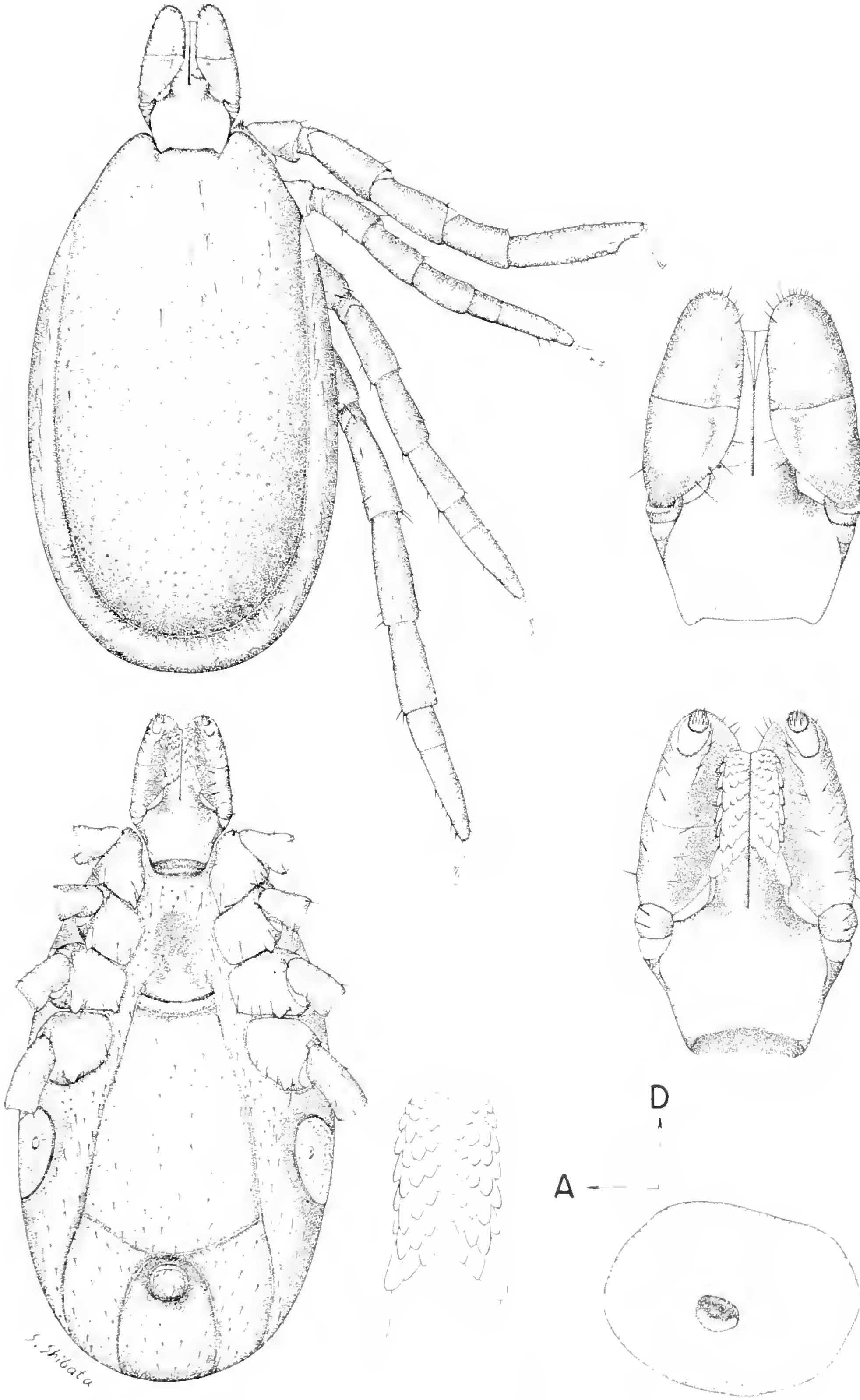


FIG. 83. *Ixodes granulatus*, male.

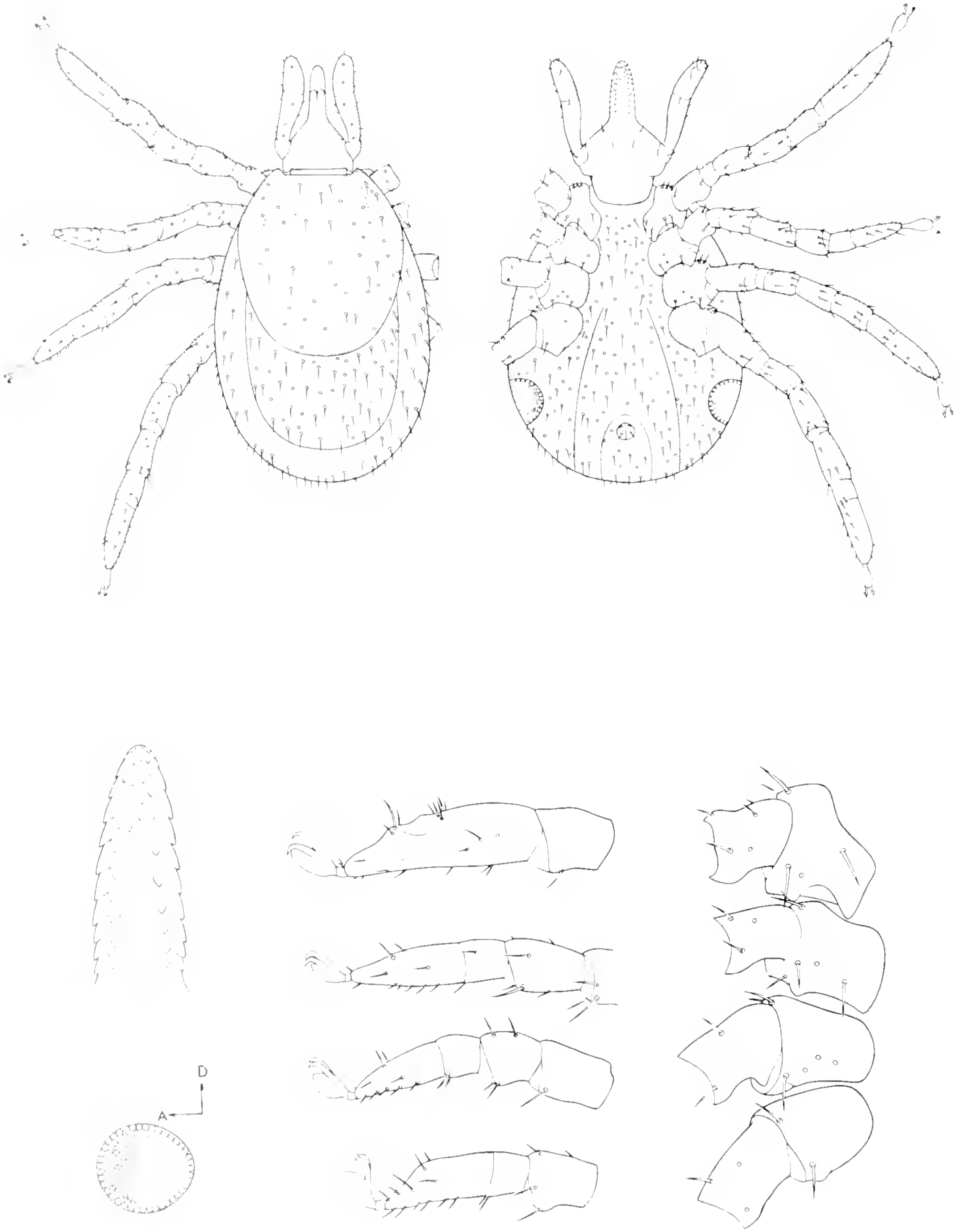


Fig. 84. *Ixodes granulatus*, nymph.

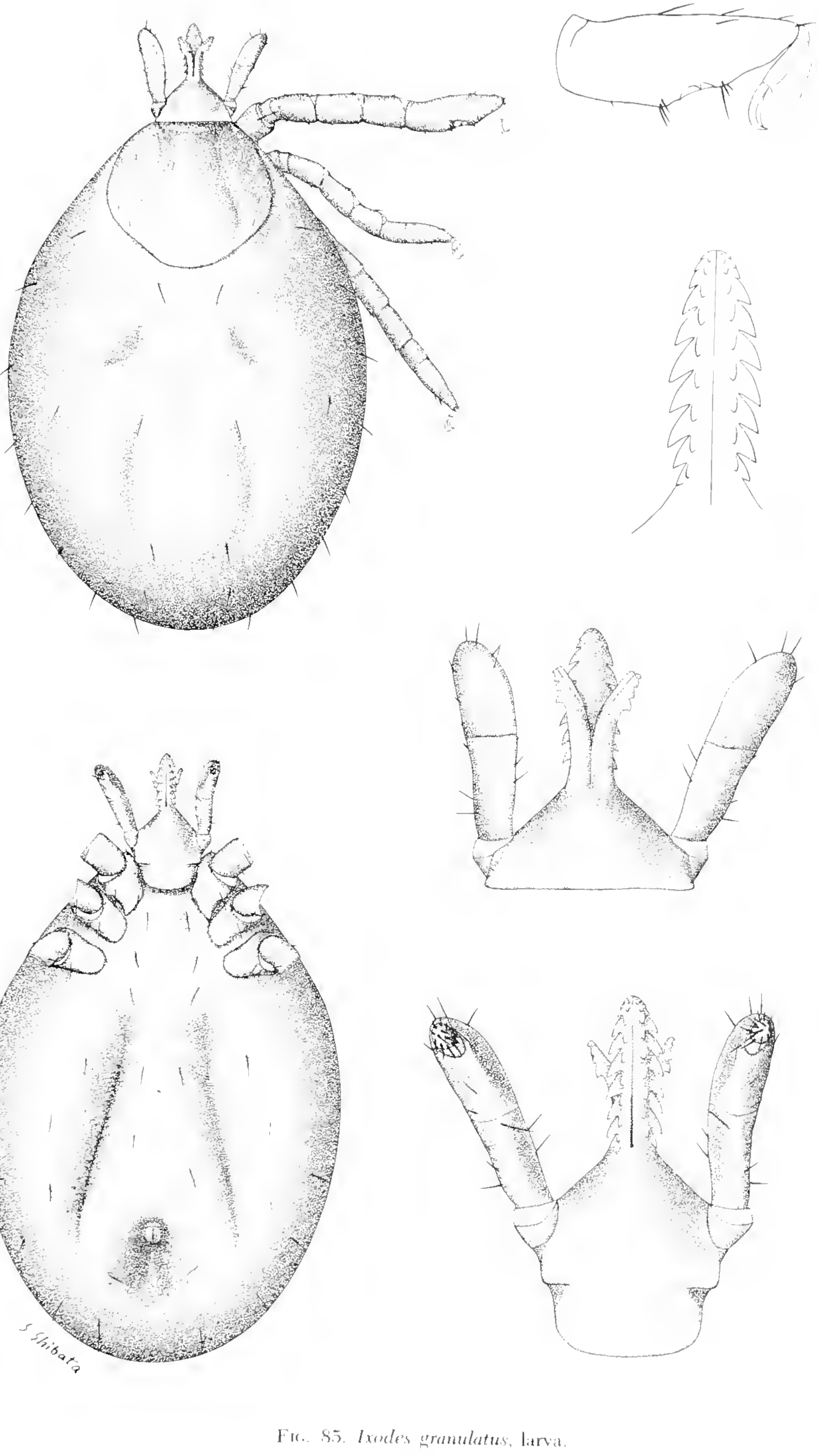


Fig. 85. *Ixodes granulatus*, larva.

Biology:

The following life-cycle data is taken from Nadchatram (1960:220).

The life cycle of the progeny of 3 female *Ixodes granulatus* reared in the laboratory on white rats

	Period in Days
Females detached from host	0
Females oviposited after	12-14
Females continued oviposition for	16-20
Larvae hatched out after	28-32
Larvae were fed after	15-25
Larvae fed for	4- 6
Engorged larvae quiescent after	6- 8
Nymphs emerged after	14-18
Nymphs were fed after	14-42
Nymphs fed for	6-10
Engorged nymphs quiescent after	5- 7
Adults emerged after	16-20
Adults fed after	28-56
Adults fed for	10-14
Total duration to complete life cycle	174-272

Disease Relationship:

Unknown.

Ixodes lividus C. L. Koch (Fig. 86-89)

Ixodes lividus C. L. Koch, 1844:234; Ono, 1967: 217; Uchikawa and Sato, 1969:95-97.

Discussion:

This tick had not been reported from Japan until recently, when Ono (1967) reported it from the nest of the swallow, *Riparia riparia ijimae*, from Hokkaido, and Uchikawa and Sato (1969) collected it from the nest of *Delichon urbica dasypus* in Nagano Prefecture. Three other lots of specimens were collected by 406th Medical Laboratory personnel in Shimane and Gumma prefectures.

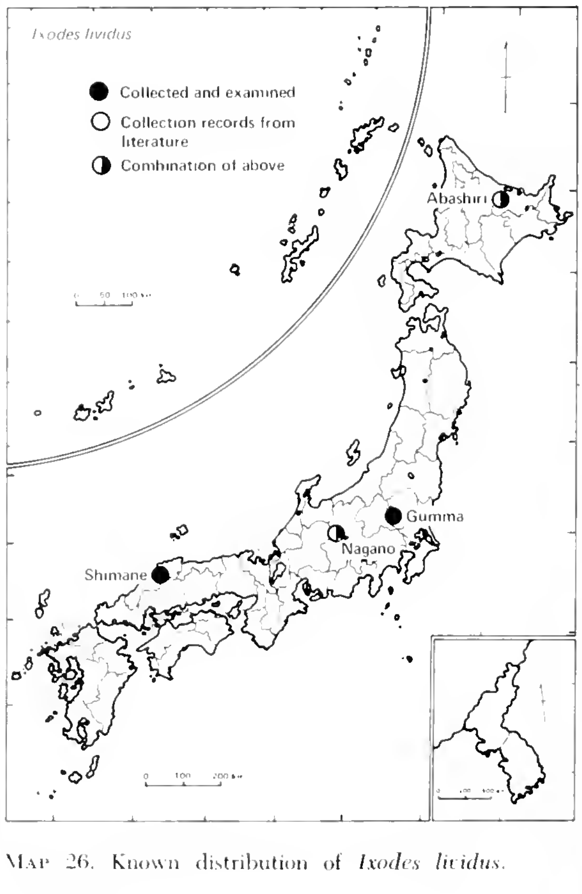
Arthur (1963) discussed synonymy and distribution, and he considers *I. plumbeus*, *I. canisuga*, and two subspecies, *I. l. bavaricus* and *I. l. obotriticus*, both described by Schulze and Schlottke, to be synonyms of *lividus*.

Diagnosis:

This is the only ixodid tick found on swallows in Japan, and while it has no unusual morphological characters, the following points may serve to distinguish it from other species: body oval, the coxae have no internal spurs; in front of the anus the anal groove is round; the posterior arms are almost parallel or slightly divergent; palps broad; the suture between articles II and III sometimes indistinct; cornua absent; auriculae absent. In the female the scutum is cordate, longer than wide, widest anterior to the middle; hypostome blunt at tip with 6-7 distinct lateral denticles. In the male the palps are broad and oval; the hypostome is distinctly notched at the tip with faint indications of scalelike denticles.

Distribution and Hosts:

Arthur (1963) states that this species has an extensive distribution, including Britain, Germany (as two subspecies), France, Kazak SSR, Guryev Province. Arthur suggests this tick may occur wherever sand martins nest. Hosts recorded are swallows, *Riparia* sp., and the Japanese house martin, *Delichon urbica dasypus*.



Map 26. Known distribution of *Ixodes lividus*.

Biology:

Little is known of the biology of this species. Arthur (1963) states that the males do not occur on the host, but their presence in the nests suggests that copulation occurs off the host. In Russia various biological aspects of this species have been studied by Glashchinskaya-Babenko (1956) (see Babenko, 1956). Nuttall and War-

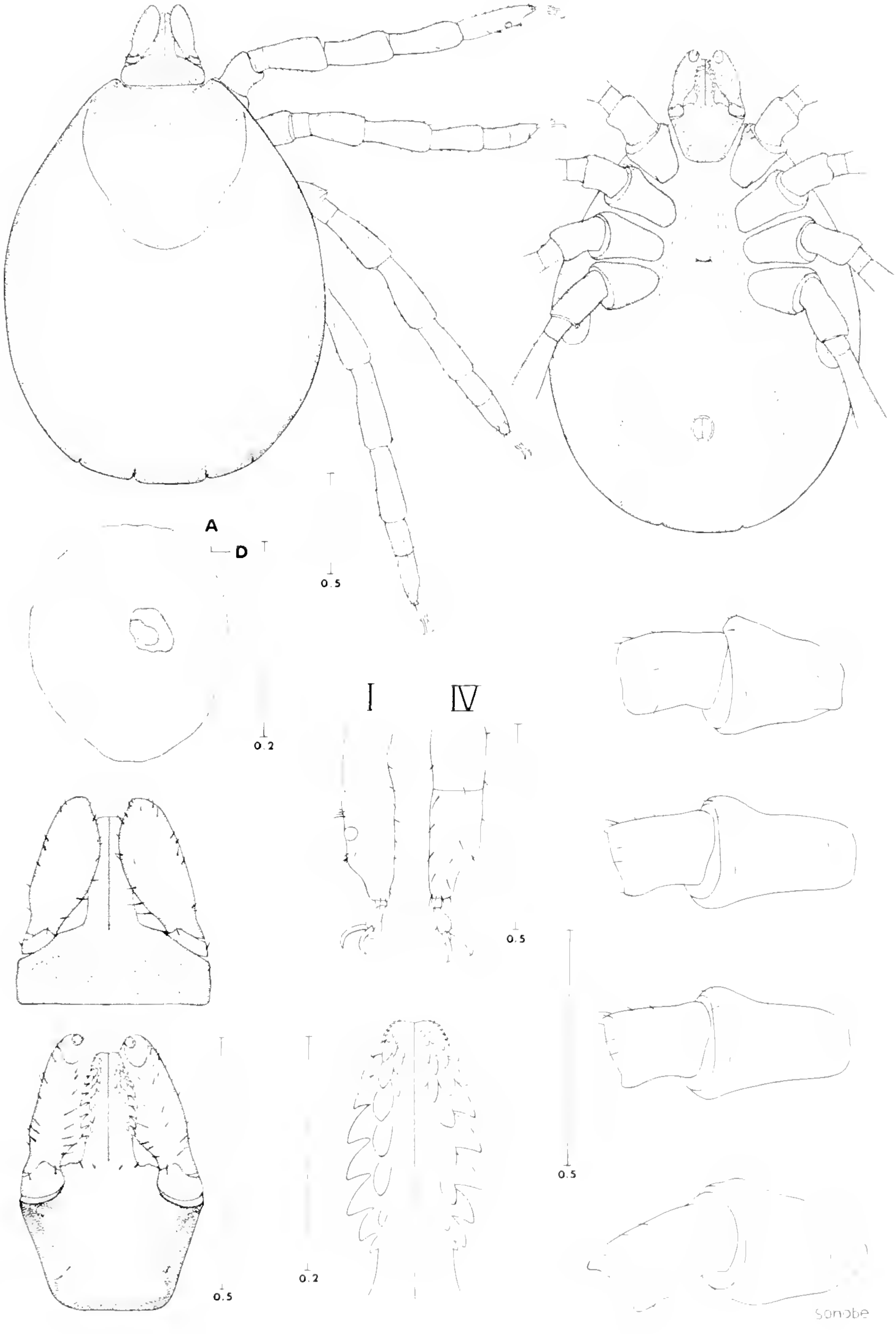


FIG. 86. *Ixodes lividus*, female.

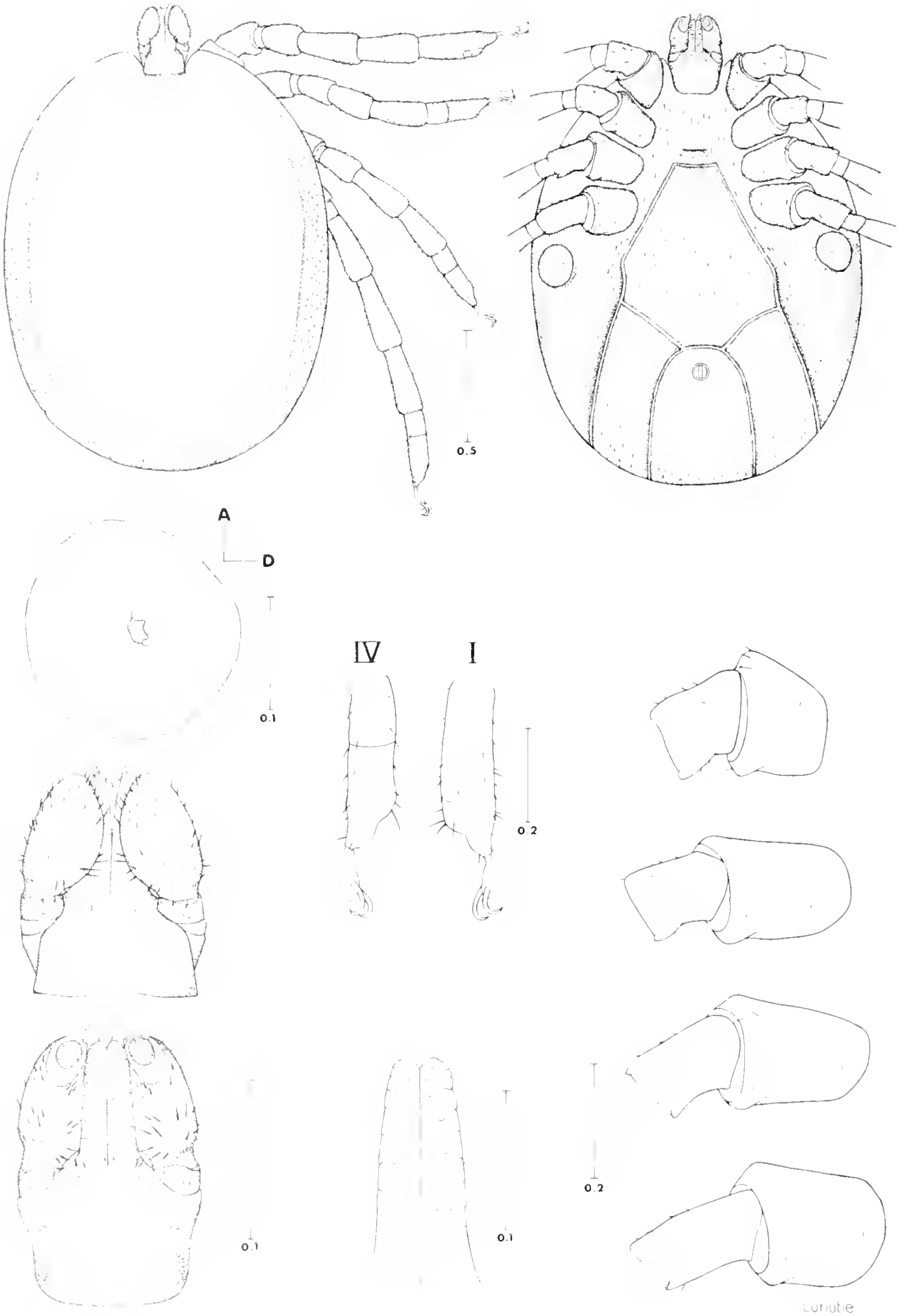


FIG. 87. *Ixodes lividus*, male.

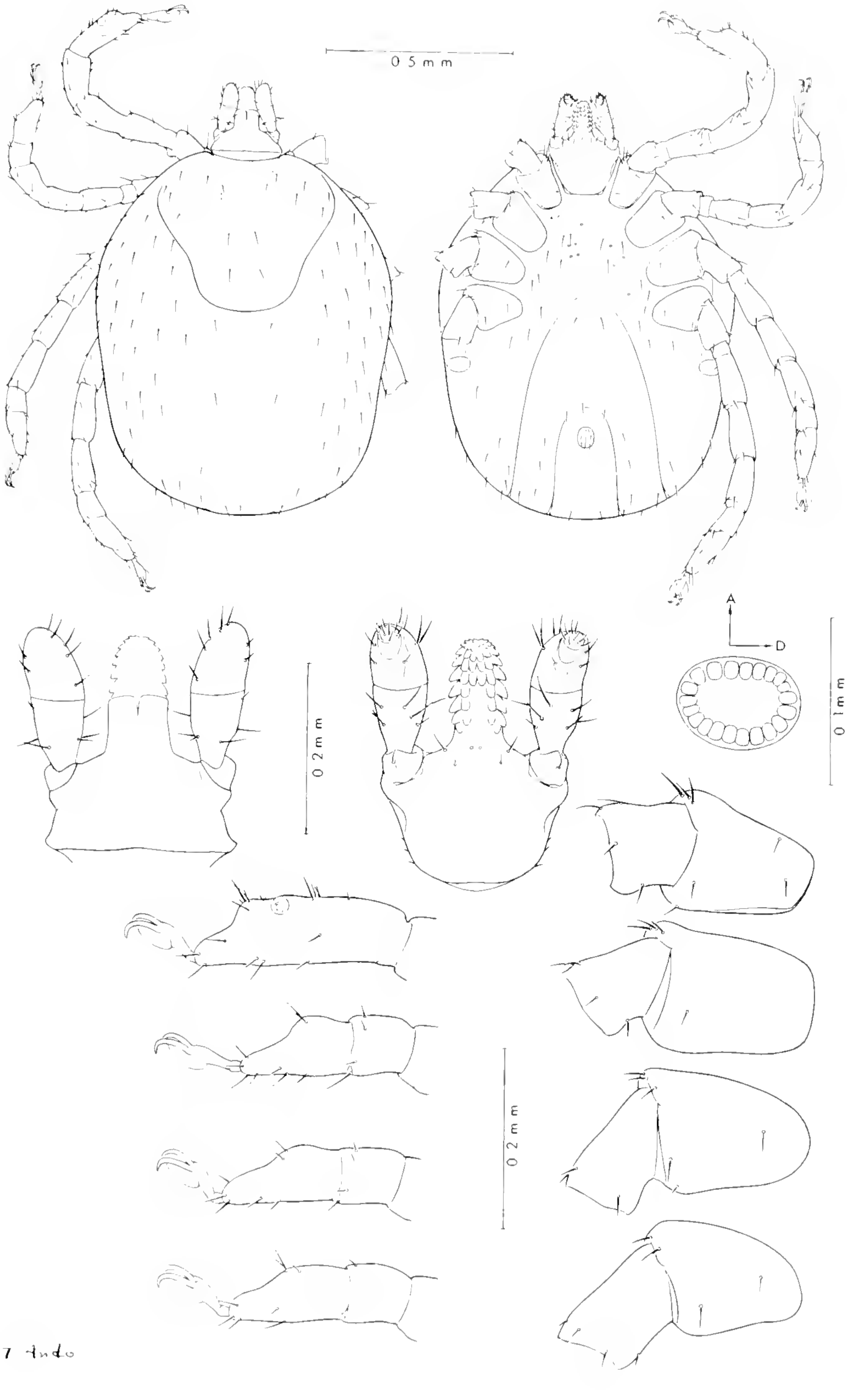


Fig. 88. *Ixodes lividus*, nymph.

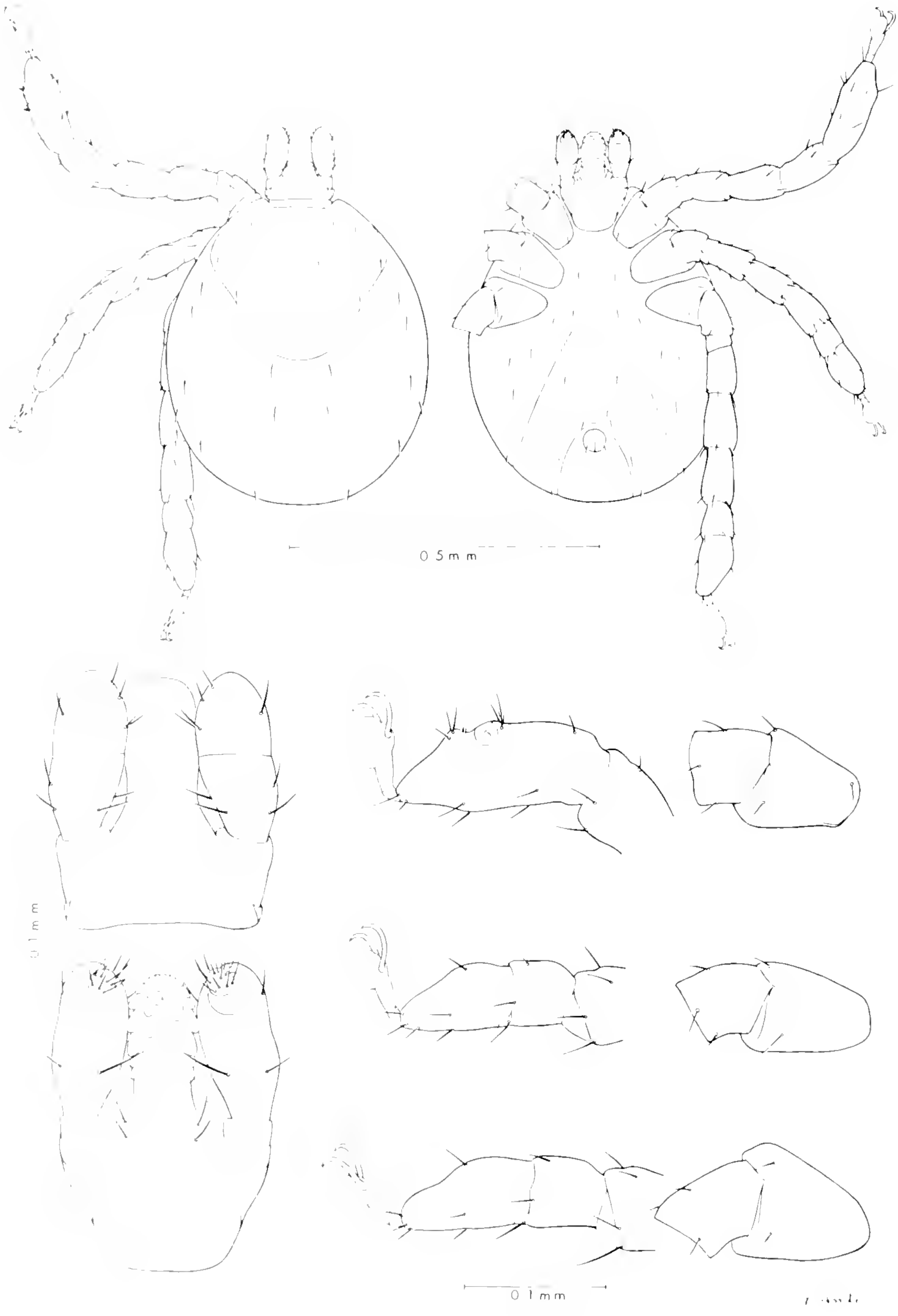


Fig. 89. *Ixodes lividus*, larva.

burton's (1911) comments on the biology of *I. canisuga* apply to *I. lividus*. In the 406th Medical Laboratory eight engorged females laid 257-810 (average 558) eggs, which hatched 25-28 days after the beginning of oviposition. Larvae were placed on rabbits' ears, and 13-17 days later they molted to nymphs.

DISEASE RELATIONSHIP:

Unknown.

Ixodes monospinosus Saito
(Fig. 90)

Ixodes monospinosus Saito, 1967:107-112, Fig. 2-9.

DISCUSSION:

Saito's (1967) description was based on a single female removed from a mountain climber in Niigata Prefecture. Saito illustrated (Fig. 2-9) the dorsal aspect, capitulum, genital and anal regions, spiracular plate, tarsi and coxae (palpi may have been missing). The holotype was not available for study, but the following diagnosis was provided by Saito.

DIAGNOSIS:

The female of *I. monospinosus* is easily differentiated from known ixodids from Japan and other countries by the following series of features: hypostome long, with four dental files on each side; auriculae poorly developed; coxa I with only a spinelike, stout, inner spur, and the posterior margins of coxa I are thickened transversely; coxae II-IV each have only an external spur and a moderately convex ventral surface; scutum and carinae well defined, lateral grooves distinct, large punctations on median-posterior areas, and posterolateral margins slightly concave.

DISTRIBUTION AND HOSTS:

Saito lists man as the host and the specific locality as Mt. Iide, Mitakambara-gun, Niigata Prefecture, Japan. A single female specimen collected by the flagging method in Mie Prefecture was loaned through the courtesy of Dr. Kitaoka and illustrated in this paper.

BIOLOGY:

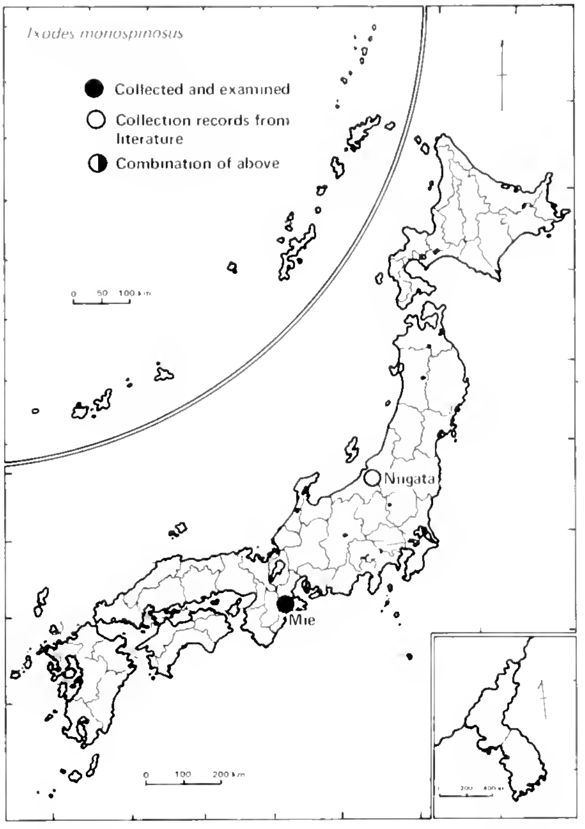
Unknown.

DISEASE RELATIONSHIP:

Unknown.

Ixodes nipponensis Kitaoka and Saito
(Fig. 91-94)

Ixodes nipponensis Kitaoka and Saito, 1967:74-83, Fig. 1-19.



MAP 27. Known distribution of *Ixodes monospinosus*.

Ixodes persulcatus persulcatus: Keegan and Toshioka, 1957:21-22, Pl. 34 (in part).

Ixodes sp. LA and NA Ono, 1962a:24-29, Fig. 1-3, 7, 9, 11, 14, 1962b:155, 1966:62-68, Fig. 1, B.

?*Ixodes ricinus*: Neumann, 1904:452, 1911:12-13; Nuttall and Warburton, 1911:156, 1915:433.

?*Ixodes ovatus* Neumann, 1899:116-118 (in part).

?*Ixodes persulcatus*: Morél, 1963:925-927.

?*Ixodes persulcatus persulcatus*: Saito, 1958:70, 1959b:199-203, 1960a:303-321, 1962a:127-146, 1962b:147-159; Saito and Ohara, 1961:1-32; Saito, Ohara, and Unagami, 1960:323-329.

DISCUSSION:

This species was previously referred to as *I. ricinus* in Japan, and there is evidence that it has been reported as *I. persulcatus*. Kitaoka and Saito (1967) compared a Japanese population with Russian *ricinus* and *persulcatus*, and also with *ricinus* from Scotland and Egypt. They found several morphological differences among these populations and concluded that both *persulcatus* and a species they described, *nipponensis*, occur in Japan. Ono (1962a) described im-

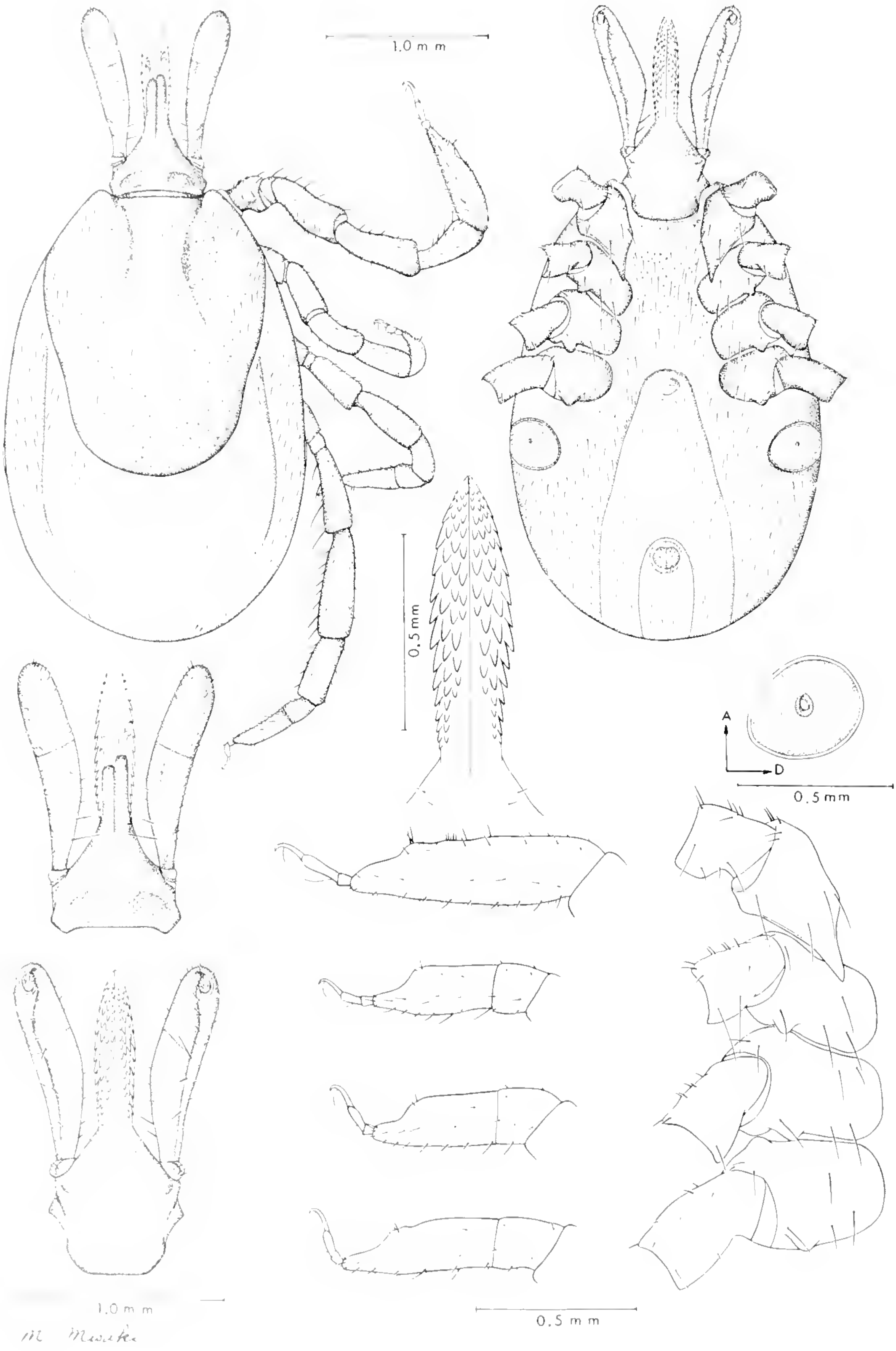


Fig. 90. *Ixodes monospinosus*, female.

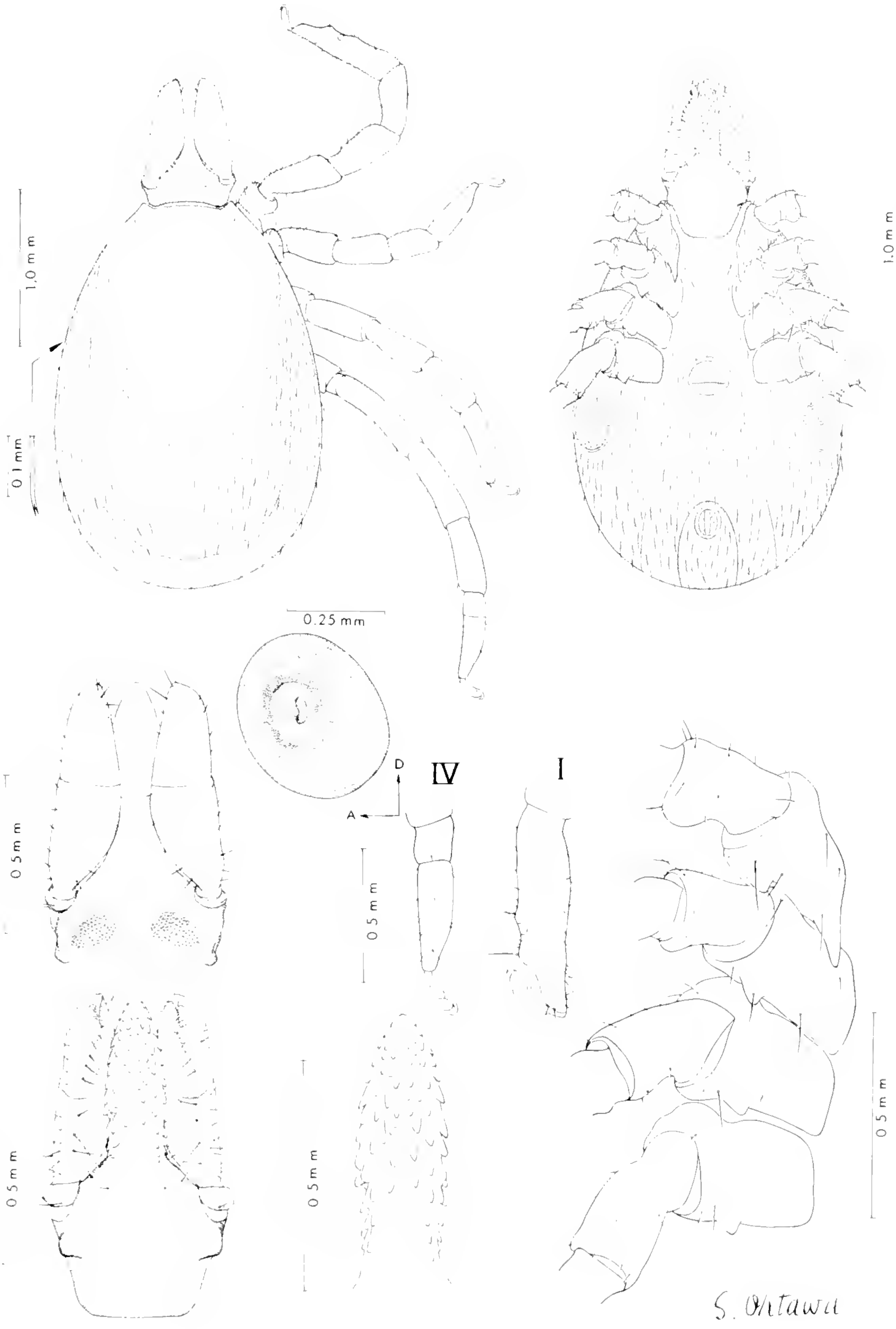


FIG. 91. *Ixodes nipponensis*, female.

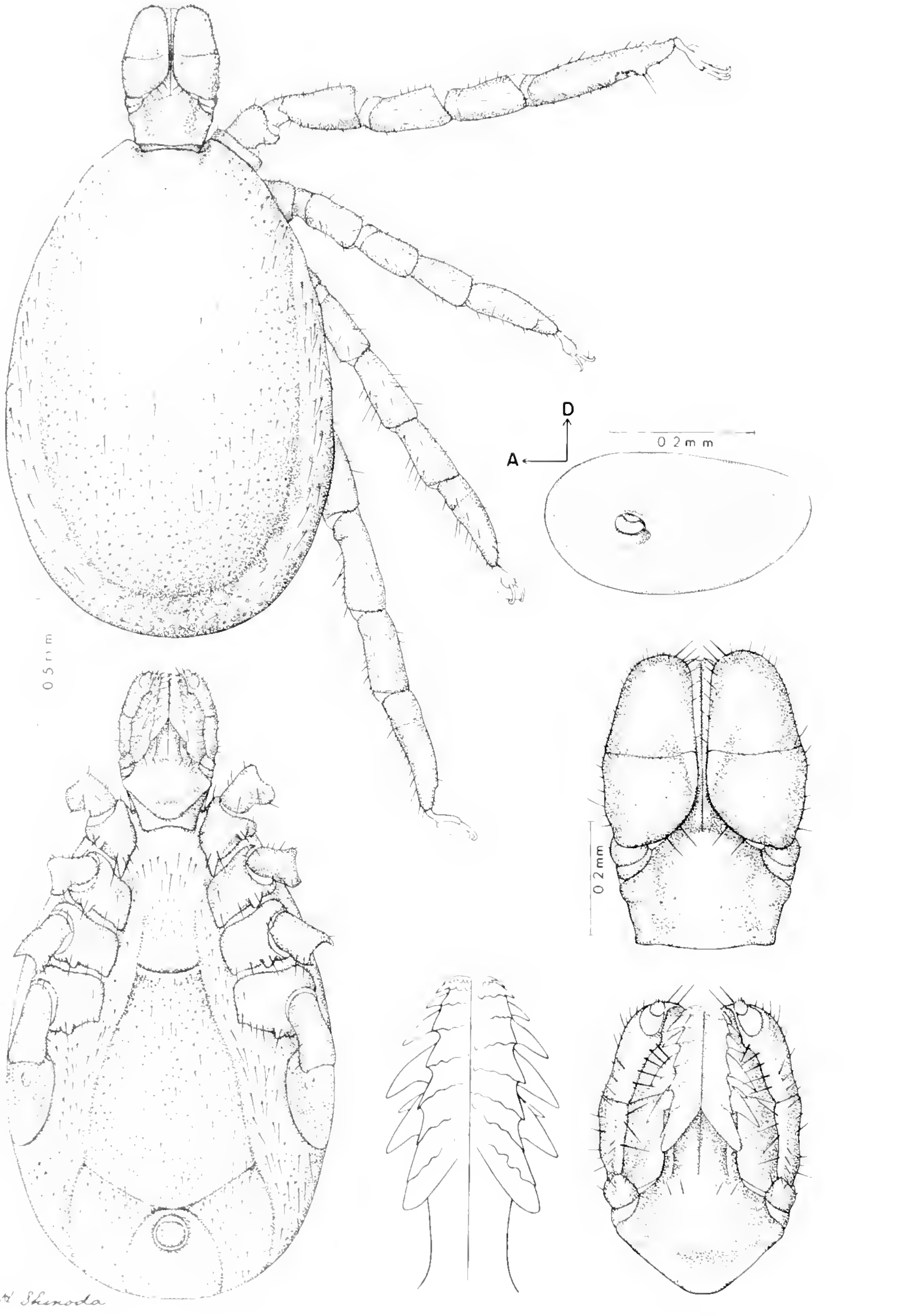


Fig. 92. *Ixodes nipponensis*, male.

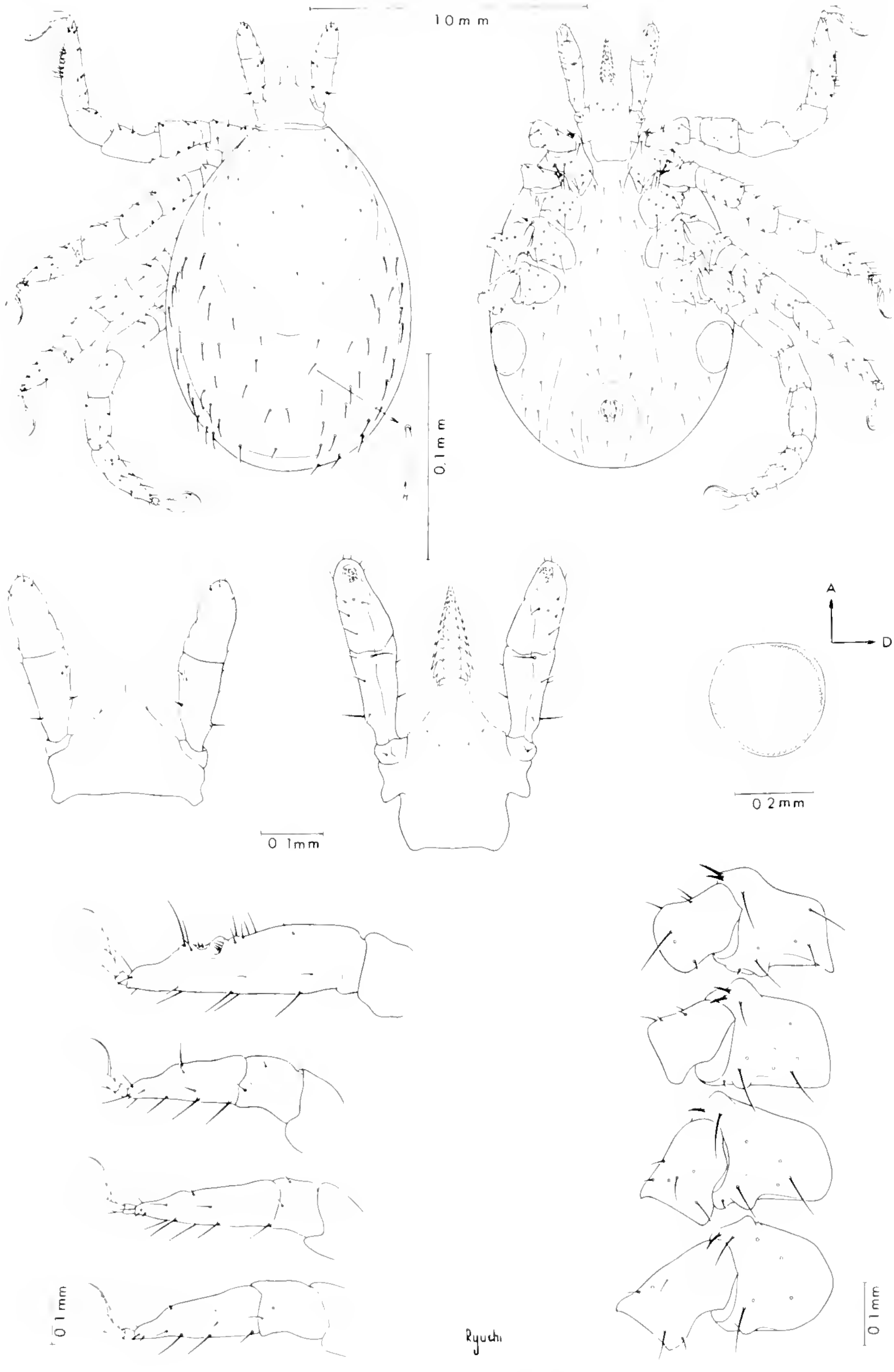


Fig. 93. *Ixodes nipponensis*, nymph.

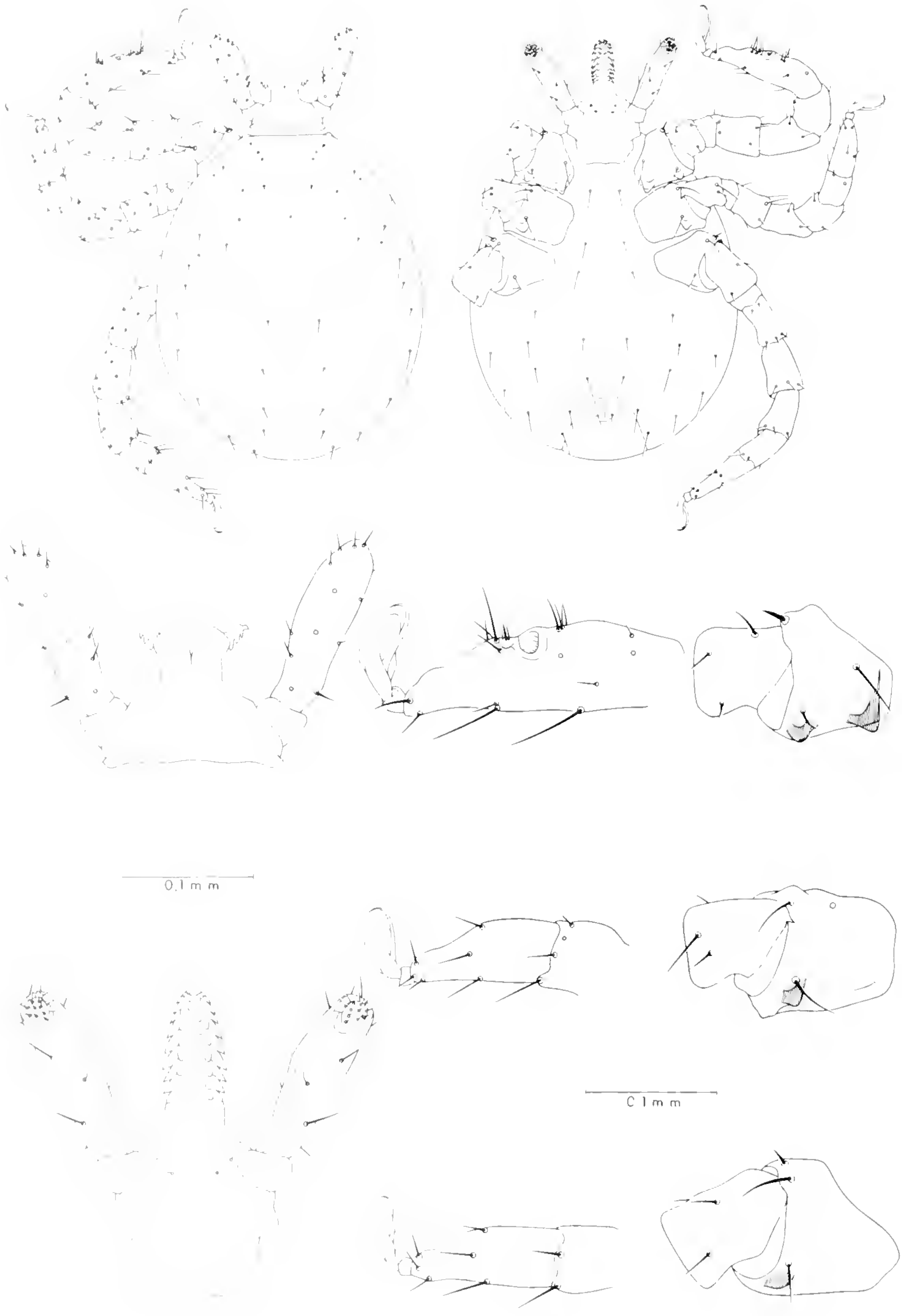


Fig. 94. *Ixodes nipponensis*, larva.

mature ticks, *Ixodes* sp. LA (larva) and *Ixodes* sp. NA (nymph), reared from eggs laid by an undetermined species of *Ixodes*. These immature ticks were similar to *Ixodes* sp. 2 and *Ixodes* sp. 54 of Asanuma and Sekikawa (1952, 1953), but separable from these by a combination of several morphological characters. Ono (1962a) believed that *Ixodes* sp. 2 and sp. 54 were the immature forms of *I. persulcatus* and also expressed doubt about the identity of *I. p. persulcatus*, which had been used by Saito, Ohara, and Unagami (1960).

Kitaoka and Saito (1967) showed that *Ixodes* sp. LA and *Ixodes* sp. NA were larval and nymphal forms of *Ixodes nipponensis*. Though the adults of *nipponensis* are very similar to those of *persulcatus*, the immature forms are separable from each other. Consequently, records of *ricinus* reported by earlier Japanese workers might possibly include *nipponensis*.

The material recorded in Keegan and Toshioka (1957) included only *persulcatus*, but these specimens were reexamined by Yamaguti with the help of Dr. Kitaoka, and they concluded that several lots previously identified as *persulcatus* actually included *nipponensis*. Kitaoka pointed out that the specimen on which the illustration of *persulcatus persulcatus* (Pl. 34) in Keegan and Toshioka (1957) is based, is *nipponensis*.

Diagnosis:

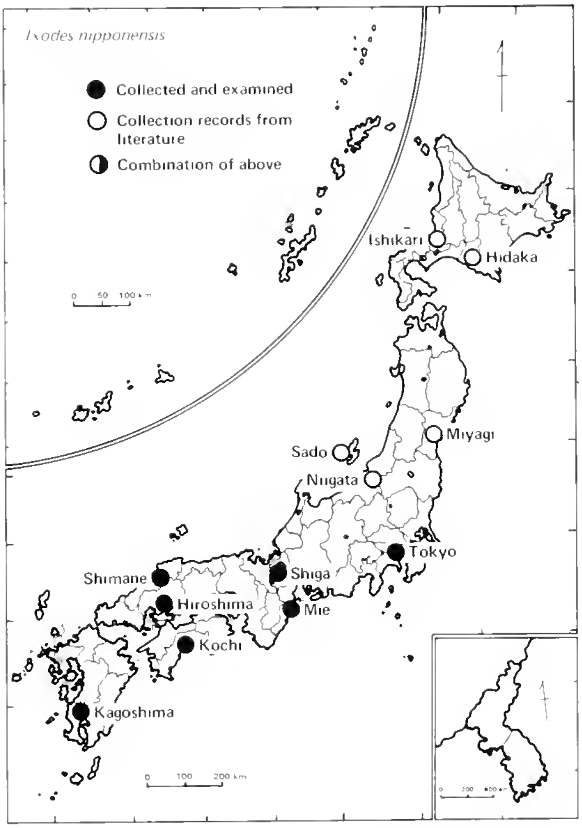
This species is quite similar to *I. persulcatus* but may be distinguished from that species in that the body is smaller and is covered a little more densely with thick setae; coxa I has a slightly shorter spur than *persulcatus*; in the male, the internal spur on coxa I is shorter and reaches the anterior margin of coxa II, while it is long and partially covers coxa II in *persulcatus*; the spiracular plate is much elongated longitudinally and ellipsoidal; in the female, the internal spur on coxa I is shorter and does not cover ⅓ of coxa II; the marginal dorsal setae are forked, thicker and approximately 1.7 times longer than the pointed, simple setae in *persulcatus*. Moreover, Kitaoka and Saito (1967) and Ono (1962a, 1966) compared the differences between immature stages and concluded they were on a specific level. See also diagnosis of *persulcatus*.

Distribution and Hosts:

I. nipponensis has been recorded by Kitaoka and Saito (1967) from Honshu, Kyushu, Shikoku, and Sado Island, and from a few localities in Hokkaido by Ono (1966). Records of the 406th Medical Laboratory include Shiga, Shimane, Mie, Hiroshima, Tokyo, Kagoshima, and Kochi prefectures. Hosts recorded are cattle, horse, dog, badger, hare, weasel, and man. Immature stages are found on small rodents and birds. In a forthcoming publication by Kitaoka detailed information will be given.

Biology:

An engorged female (67-J-0341) laid eggs in the 406th laboratory and the progeny were used for life cycle studies.



Map 28. Known distribution of *Ixodes nipponensis*.

Disease Relationship:

Unknown.

Ixodes ovatus Neumann
(Fig. 95-98)

Ixodes ovatus Neumann, 1899:116-118, Fig. 2, 3 (in part), 1904:452-453, 1911:18; Dönitz, 1905:132; Kishida, 1930a:3; Nakamura and Yajima, 1937:141; Keegan and Toshioka, 1957:29-30; Morél, 1963:925-928.

Ixodes ricinus var. *ovatus*: Nuttall and Warburton, 1911:158.

Ixodes japonensis Neumann, 1904:458-459, 1911:22; Nuttall and Warburton, 1911:208-209, Fig. 200, 201; Kishida, 1930a:3; Nakamura and Yajima, 1937:145-146, Pl. III; Asanuma, 1947b:971, Fig. 2765; Keegan and Toshioka,

Laboratory life cycle of *Ixodes nipponensis*
(reared on rabbits)

Generation and Stage	Phase	Period in Days	Remarks
F_1 Larva	Feeding	5	Larvae were placed on host on
F_1 Larva	Postparasitic (Premolting)	30	5 July 1967.
F_1 Nymph	Feeding	4	
F_1 Nymph	Postparasitic (Premolting)	33	Only 2 nymphs molted to females.

The rearing experiment extended from 5 July 1967 to October and the air-conditioned room temperature did not exceed 25 C.

1957:20-21, Pl. 31, 32; Saito, 1959b:199-203, 1960a:303-321, 1962a:127-146, 1962b:147-159, 1964:59-66; Saito and Ohara, 1961:1-32; Saito, Ohara, and Unagami, 1960:323-329; Saito et al., 1965:143-159; Asanuma, 1956a:91-96, 1957:234, 1965a:113-116, Fig. 7, 8, 1965b: 398, Fig. 217; Ono, 1966:62-68.

Ixodes frequens Ogura and Takada, 1927:201-202, Pl. III; Schulze, 1930:294-303, Fig. 10; Kishida, 1930a:3; Nakamura and Yajima, 1937:146-148, Pl. IV; Yajima, 1942:507-509, Fig. 6; Itagaki, Noda, and Yamaguchi, 1944: 1-97, Pl. 2, 1959:1-118, Pl. 2.

Ixodes carinatus Kishida, 1930a:4-5; Nakamura and Yajima, 1937:140; Keegan and Toshioka, 1957:26, Pl. 41.

Ixodes sp. 6 and sp. 52 Asanuma and Sekikawa, 1952:107-116, Fig. 3, 9, 1953:99-112, Fig. 11, 12; Asanuma, 1955:1240-1242; Ono, 1962a:24-29, Fig. 15, 1962b:155, 1966:62-68.

?*Ixodes shinchikuensis* Sugimoto, 1937:330-331, Pl. VI and IX.

?*Ixodes taiwanensis* Sugimoto, 1936:336-346, Pl. II, 1937a:331-333, Pl. VII and VIII.

DISCUSSION:

In the Japanese literature this tick has been reported as *I. japonensis*, *I. frequens*, and sometimes *I. carinatus*.

Ixodes ovatus was originally described by Neumann (1899) on the basis of material from Amur and Japan. The Japanese material included four female specimens, one from a horse at Akita collected by Taguchi (No. 702), the others from a *Lepus* sp., a horse, and a dog at Saga collected by Yamaguchi (No. 703, 704, 705 respectively, in the Neumann Collection in the School of Veterinary Medicine in Toulouse). According to Nuttall and Warburton (1911), these Japanese specimens contained typical *ricinus*,[a] and subsequently Neumann (1904) redescribed *ovatus* based on two females from a horse and a dog at Saga (No. 704 and 705) as separate from the other two. Nuttall and Warburton (1911) cited Neumann's description (1904), and in accordance with Dönitz's opinion they noted that the differences between the two species were only varietal. It is apparent that Nuttall and Warburton did not see the type specimens. Therefore, they placed *ovatus* as a variety of *ricinus* and treated *japonensis* as a valid species separate from *ovatus*.

Neumann's original description of *I. japonensis* (1904) did not include illustrations. Later, Nuttall and Warburton (1911) provided illustrations (their Fig. 200 and 201) and a redescription of *japonensis* based on Neumann's type specimen collected in the vicinity of Tokyo.

Pomerantzev (1950) considered *ovatus* as a valid species occurring in Japan, but this appears to be merely a citation from Neumann's original record.

Ogura and Takada (1927) described *I. frequens*, but Keegan and Toshioka (1957) suggested, "After a study of hosts and localities, it seems clear that *frequens* is a synonym" (of *japonensis-ovatus*). They also examined the holotype specimen of *I. carinatus* Kishida, 1930 and stated that "the holotype is very much like an example of *japonensis*, although the basis capituli may be relatively wider than in that species." More recently Morél (1963) showed that *I. japonensis*, *I. frequens*, *I. carinatus*, *I. shinchikuensis*, and *I. taiwanensis* were all synonyms of *I. ovatus*. The latter two species were described by Sugimoto on the basis of Taiwan specimens, and Morél (1963) expressed uncertainty regarding their status, probably because of lack of specimens. Although the holotype specimen of *carinatus* was not available for this study, the original illustration by Kishida (1930a) fits the characteristics of *ovatus* and

[a]Morél (1963) showed that these *ricinus* (No. 702 and 703) were actually *I. persulcatus*, but these might or might not include *I. nipponensis* Kitaoka and Saito.

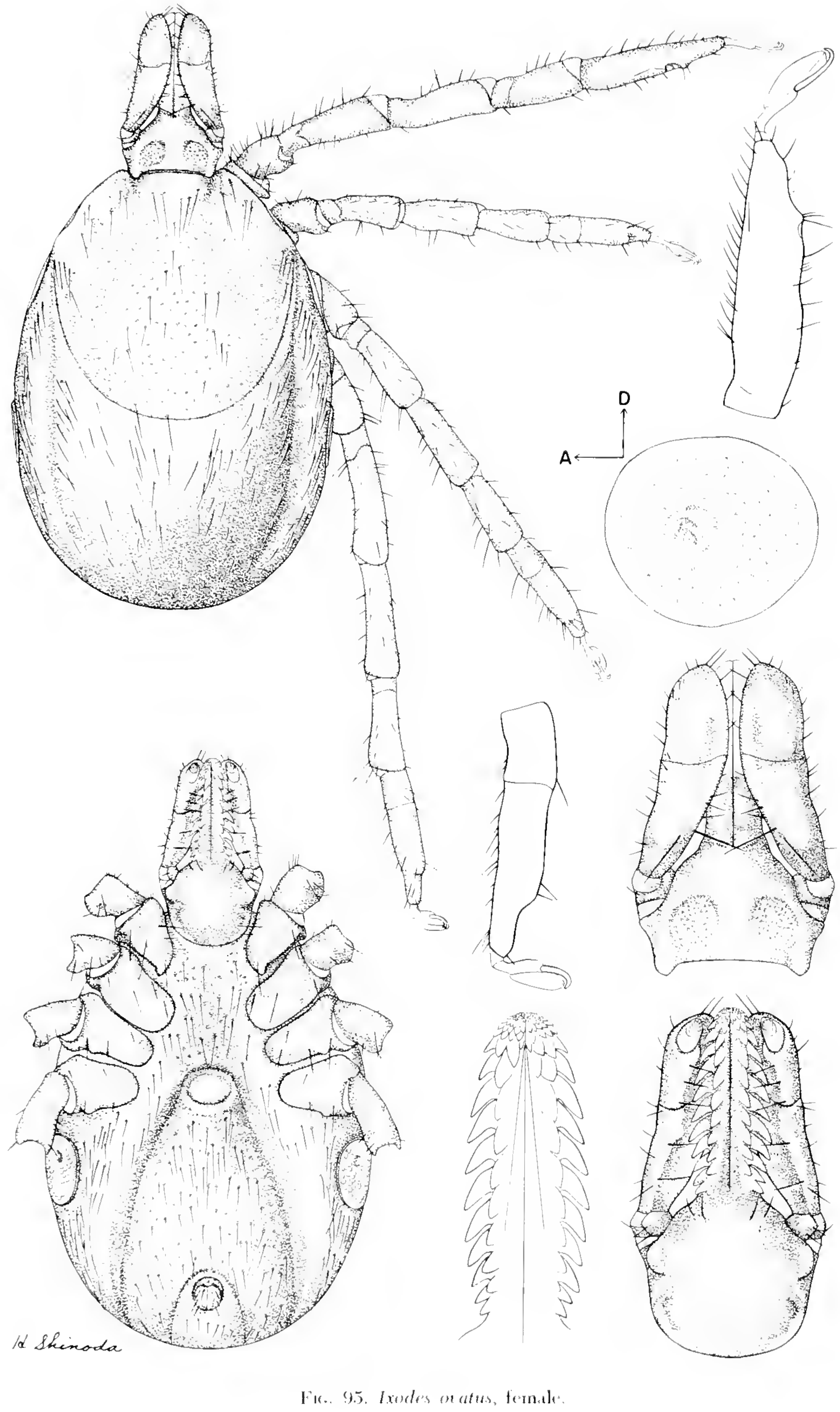


Fig. 95. *Ixodes ovatus*, female.

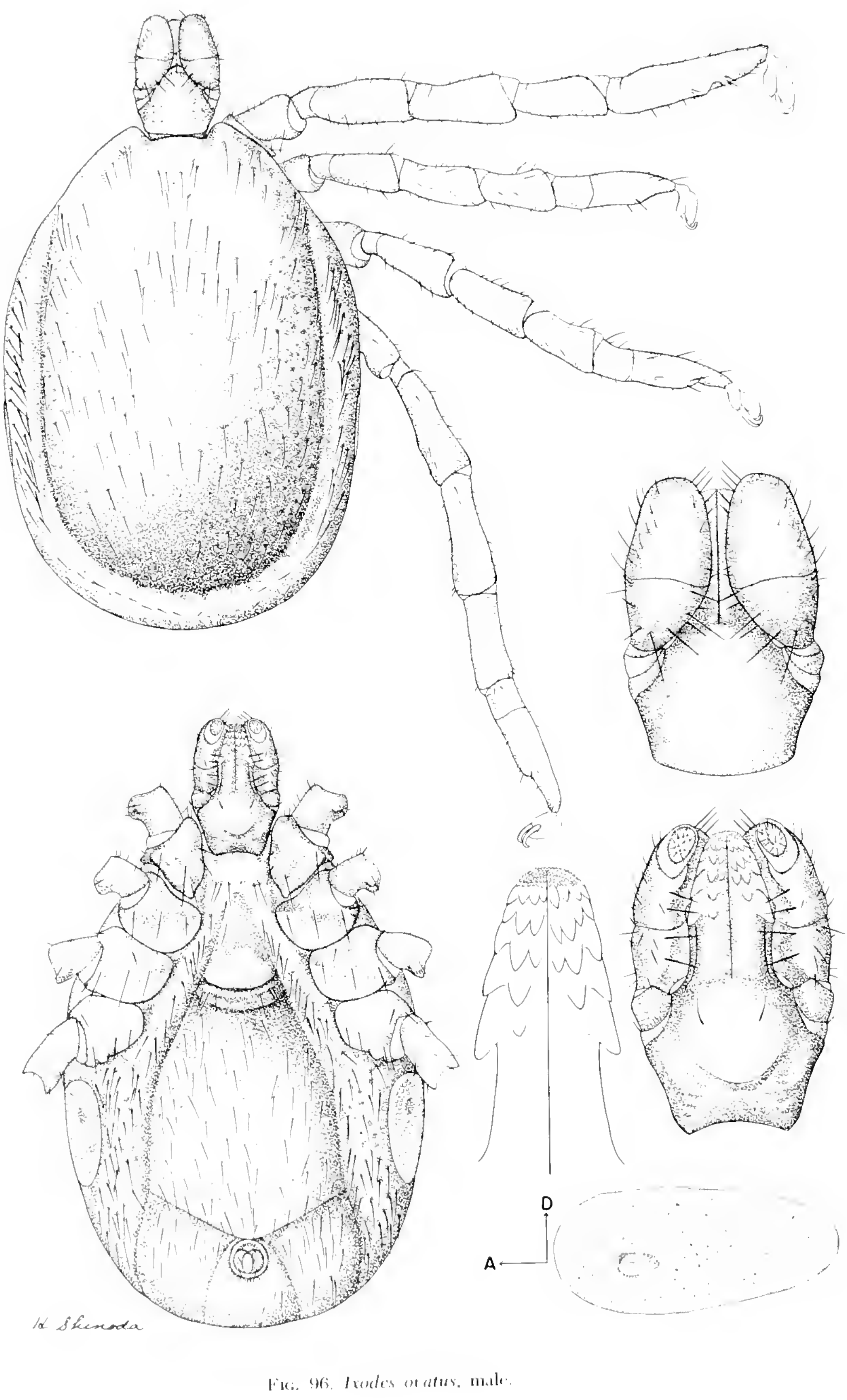


FIG. 96. *Ixodes ovatus*, male.

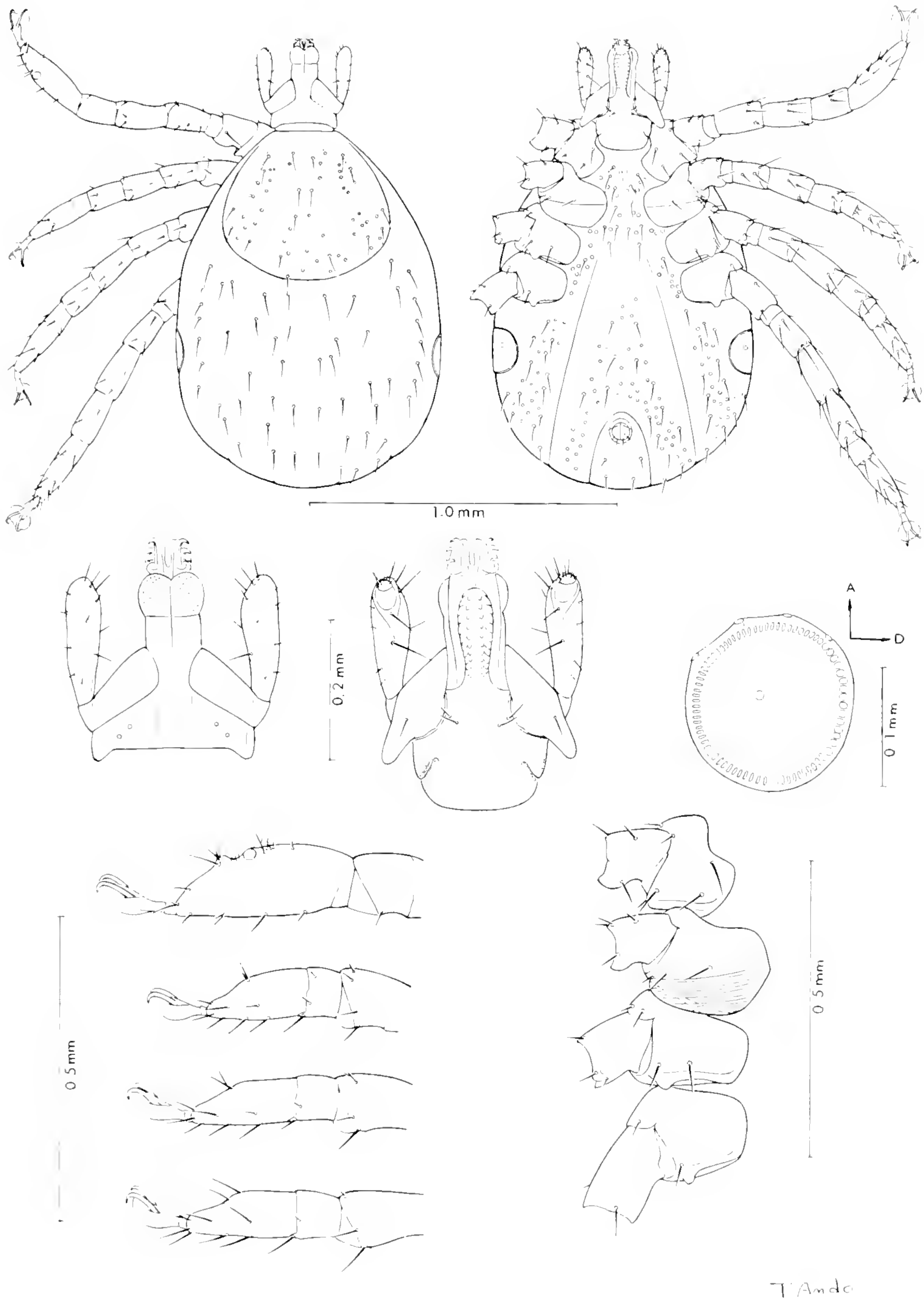
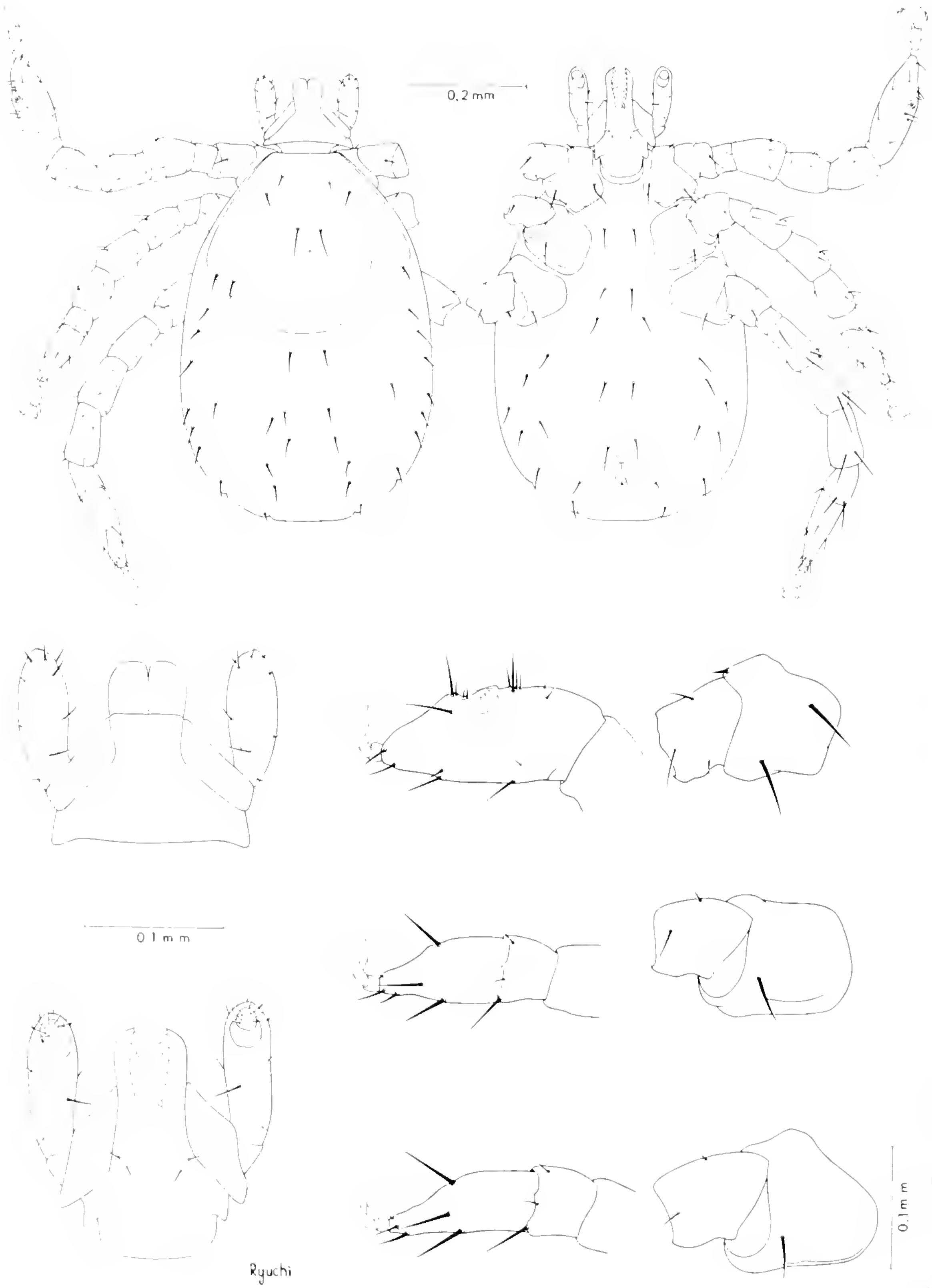


FIG. 97. *Ixodes ovatus*, nymph.


0.2 mm
0.1 mm
0.1 mm
Ryuchi

supports Morél's opinion.

The only report of this species as *ovatus* was given by Kishida (1930a), but he also reported *japonensis* on the same page. Asanuma and Sekikawa (1952, 1953) reported and described larval and nymphal ticks parasitic on rodents, giving them temporary numbers such as *Ixodes* sp. 6 or *Ixodes* sp. 52, because the immature stages had not been properly associated with adult forms. Later Asanuma (1957) showed that these numbered ticks, *Ixodes* sp. 6 and *Ixodes* sp. 52, were larval and nymphal forms of *Ixodes japonensis* (= *I. ovatus*) respectively. Ono (1962a, 1962b, 1966) reported immature ticks from rodents in Hokkaido and gave them the numerical designations used by Asanuma and Sekikawa.

Diagnosis:

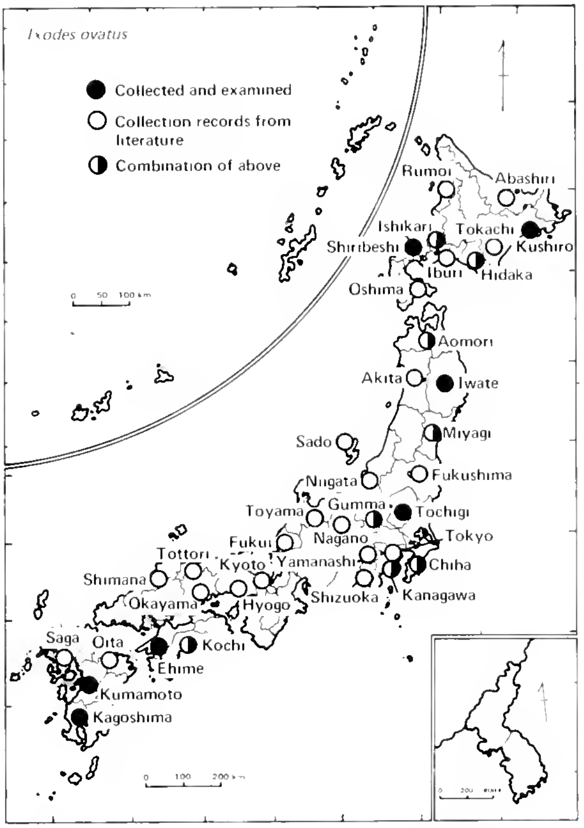
The dorsal aspect of the male of this species is similar to *I. nipponensis* and *I. persulcatus*, but from a ventral view it may be easily distinguished from those two species in that coxae II and III are lacking spurs, and the posterior halves are covered with milky white, membranous, eavelike elevations (= *carinatus* Kishida, 1930), and consequently the posterior margins are smoothly convex; coxa I has a short, blunt internal spur; the spiracular plate is elongate, the L/W ratio is more than 2.0 (approximately 2.3); the dentition of the hypostome occurs on the apical half, the posterior end is on the same level as the suture between palpal articles II and III. In the female, the basis capituli has well-defined cornua and round porous areas; coxa I has a short, blunt internal spur; on coxa II, the spur is absent and the posterior margin is convex with the elevation similar to that of the male.

Distribution and Hosts:

Morél (1963) states that this species occurs in oriental regions, including China, Formosa, Burma, Nepal, Sikkim, and Japan, and that hosts of the adults are large mammals. According to Asanuma (1965a), adults are found on hares in great numbers, especially in spring, but immature forms are not found on hares. Asanuma and Sekikawa (1953) and Saito (1959b) state that immature forms are found on small rodents. Detailed information on the distribution and hosts of this species in Japan is given in Appendix 2.

Biology:

Saito (1960a) studied the life cycle of *Ixodes ovatus* (as *I. japonensis*) with laboratory animals as hosts (Angora rabbits and mice). Eggs hatched in 32-38 days at 30 C, and the preparasitic larval period was about 40 days. Feeding time of larvae varied according to temperature and was from 2-6 days in summer and from 7-10 days in late autumn on Angora rabbits, and from 4-7 days on laboratory mice. The postparasitic period was 24-32 days at 30 C, and newly hatched nymphs attached to the host 14 days later. Nymphs fed on the host for about the same period as, or one or two days longer than, larvae, and they molted into adults 30-37 days after they dropped off the host. The preparasitic period for adults was 20-30 days, and the unfed males began mating immediately after they were put together with females on the host. Females fed on the host for 9-13 days in spring and autumn, 7-10 days in summer, and 12-16 days in winter. The engorged females laid eggs in 5-7 days in summer and in 10-15 days in spring, and the oviposition period varied from 10-40 days, depending on the room temperature. Saito also observed the behavior of mating and oviposition. He stated that summer seemed to be an unfavorable time for feeding of adults in the laboratory.



Map 29. Known distribution of *Ixodes ovatus*.

Disease Relationship:

The relationship of this species to human disease has not been established. Saito (1962b) reported the result of experimental transmission of *Pasteurella tularensis* with *I. japonensis*. The adults of *I. japonensis* (= *I. ovatus*), detached from hares dead of tularemia, were found to be infected and shown to be capable of transmitting *P. tularensis* to Angora rabbits. Attempts to demonstrate transovarian transmission were negative.

Ixodes persulcatus Schulze
(Fig. 99-102)

Ixodes persulcatus Schulze, 1930:294-303, Fig. 3, 5, 6, 8, 9. Morél, 1963:925-928"; Ono, 1966: 62-68, Fig. 1; Kitaoka and Saito, 1967:82.

Ixodes persulcatus persulcatus Schulze, 1930: 294-303, Fig. 3, 5, 6; Asanuma, 1947b:971, Fig. 2764, 1965a:113-116, 1965b:397, Fig. 215; Keegan and Toshioka, 1957:21-22 (in part).

Ixodes sp. 2 and sp. 54 Asanuma and Sekikawa, 1952:107-116, 1953:99-112, Fig. 13 and 14; Asanuma, 1955:1240-1242; Ono, 1962a:24-29, Fig. 4-6, 8, 10, 12, 13, 1962b:155, 1966:62-68, Fig. 1.

?*Ixodes ricinus*: Neumann, 1899:166 (in part), 1904:452, 1911:12-13; Nuttall and Warburton, 1911:156, 1915:433; Ogura and Takada, 1927:199-201, Pl. XI; Kishida, 1930a:2, 1936: 142; Nakamura and Yajima, 1937:142-145, Pl. 11; Yajima, 1942:504-508, Fig. 5; Itagaki, Noda, and Yamaguchi, 1944:1-97, Pl. 1, 1959: 1-118, Pl. 1.

?*Ixodes persulcatus persulcatus*: Saito, 1958:70, 1959b:199-203, 1960a:303-321, 1962a:127-146, 1962b:147-149; Saito and Ohara, 1961:1-32; Saito, Ohara, and Unagami, 1960:323-329.

?*Ixodes ricinus* var. *miyazakiensis* Sugimoto, 1937:603-604, Pl. 1.

Discussion:

This tick had been widely reported in the Japanese literature as *Ixodes ricinus* (Linnaeus, 1785). Schulze (1930), in his original description of *I. persulcatus*, examined two female specimens from Hokkaido and stated that these specimens appeared to be conspecific with a small Amur specimen (one of the type series) showing all the characteristics of *I. persulcatus*. He also stated that specimens described by Ogura and Takada (1927) as *ricinus* from Hokkaido apparently belonged to his new subspecies, *I. p. persulcatus*. Keegan and Toshioka (1957) reported that all the material available at that time was reexamined and identified as *Ixodes persulcatus persulcatus*. Since then, the Japanese population had been thought to include only *persulcatus persulcatus*. Later Asanuma (1965a) expressed doubt that only *persulcatus persulcatus* occurred in Japan and suggested that there may be two or three separate species contained in the Japanese population of the *ricinus* group. Asanuma and Sekikawa (1952, 1953) described immature ticks parasitic on small rodents and gave them temporary numbers, i.e., *Ixodes* sp. 2 for larvae and *Ixodes* sp. 54 for nymphs. They pointed out that these numbered ticks were very similar to immature forms of *ricinus*, but avoided a definitive assignment. Ono (1962a) examined a large number of reared larvae of *Ixodes persulcatus* and considered that *Ixodes* sp. 2 and sp. 54 reported by Asanuma and Sekikawa were the immature forms of *Ixodes persulcatus*.

Keegan and Toshioka (1957) state that *Ixodes ricinus* var. *miyazakiensis* Sugimoto, 1937 appears to be *persulcatus persulcatus*. But in the light of current knowledge, the written description and the illustrations are too poor for taxonomic discrimination, and this material could be *persulcatus or nipponensis*. Since the adults of *persulcatus* are very close to *nipponensis* and the specimens reported as *ricinus* by earlier Japanese workers are difficult to obtain, there are only a few reliable collection records of *I. persulcatus*.

Diagnosis:

This species is closest to *I. nipponensis* in the Japanese fauna and also to *ricinus* in other regions. Kitaoka and Saito (1967) gave a critical comparison of these three species and indicated that adults of *persulcatus* may be distinguished from *nipponensis* by the larger body size as well as by a combination of characters used in the key. In addition, the following characters of immature stages given by Kitaoka and Saito (1967) and Ono (1962a, 1962b, 1966) are useful in separating the three species. In the larvae, the scutal setae are of medium length, while they are apparently shorter than the postscutal setae in both *nipponensis* and *ricinus*; the hypostome of the nymph is blunt at the tip rather than pointed as in *nipponensis;* the postscutal setae are not forked; the auriculae and spurs on the coxae are more distinct in *persulcatus* than in *nipponensis* both in the larval and the nymphal stages. See diagnosis of *nipponensis*.

Distribution and Hosts:

The type material was collected at Amur. Schulze mentions other material from Hokkaido which had been described as *ricinus* by Ogura and Takada (1927). According to Pomerantzev (1950), the distribution of this species is from the Pacific Ocean to the European part of the

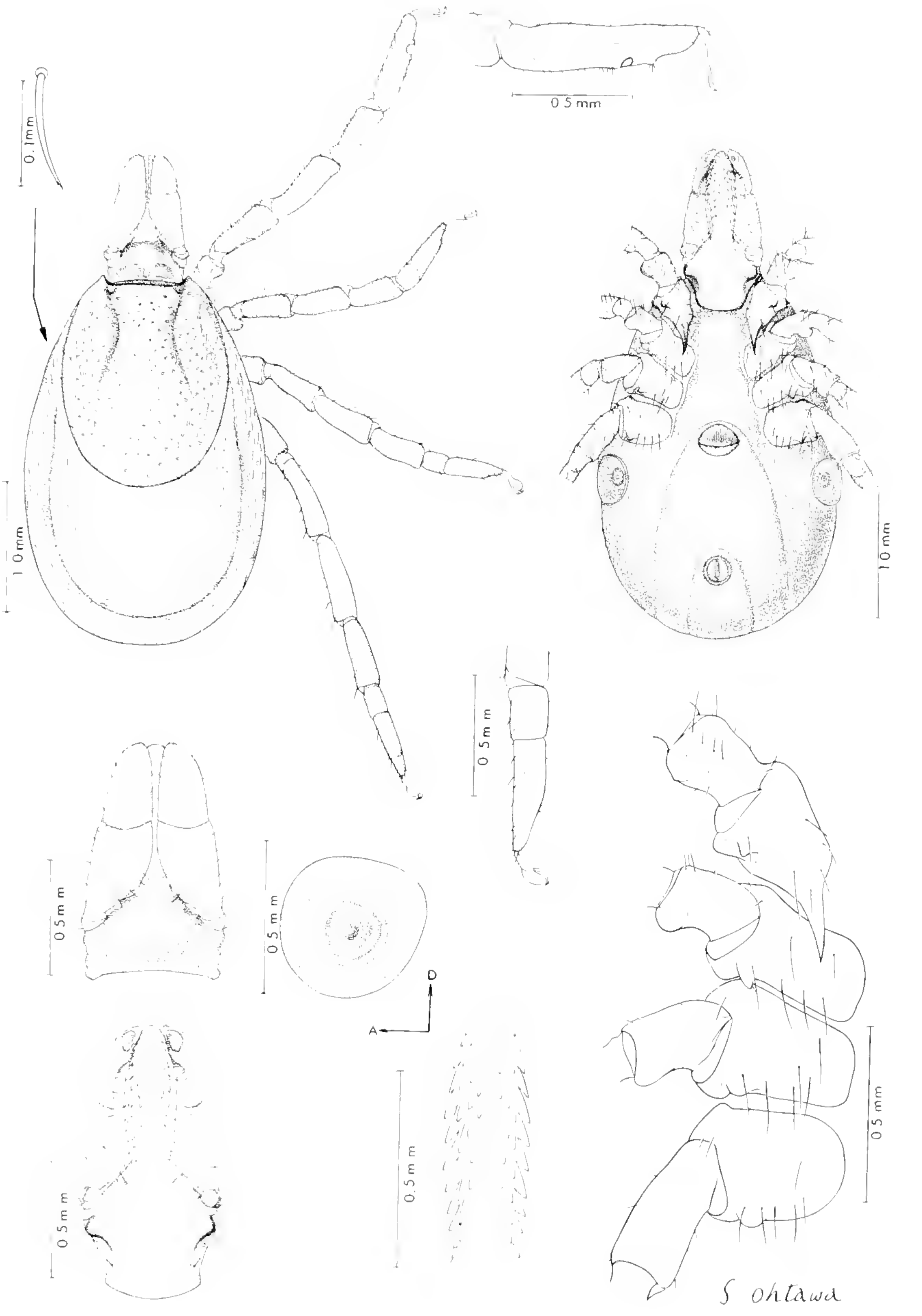


Fig. 99. *Ixodes persulcatus*, female.

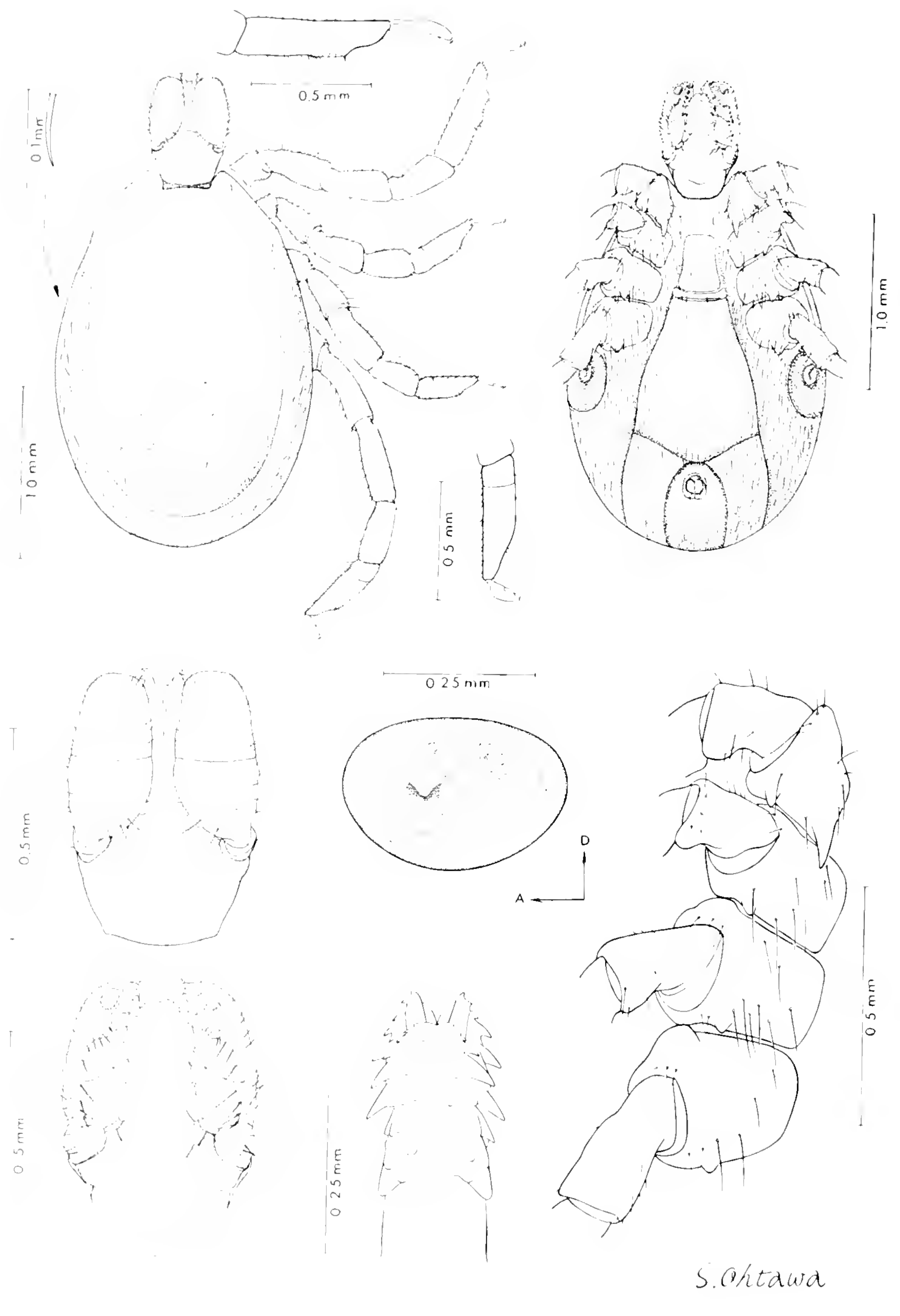


Fig. 100. *Ixodes persulcatus*, male.

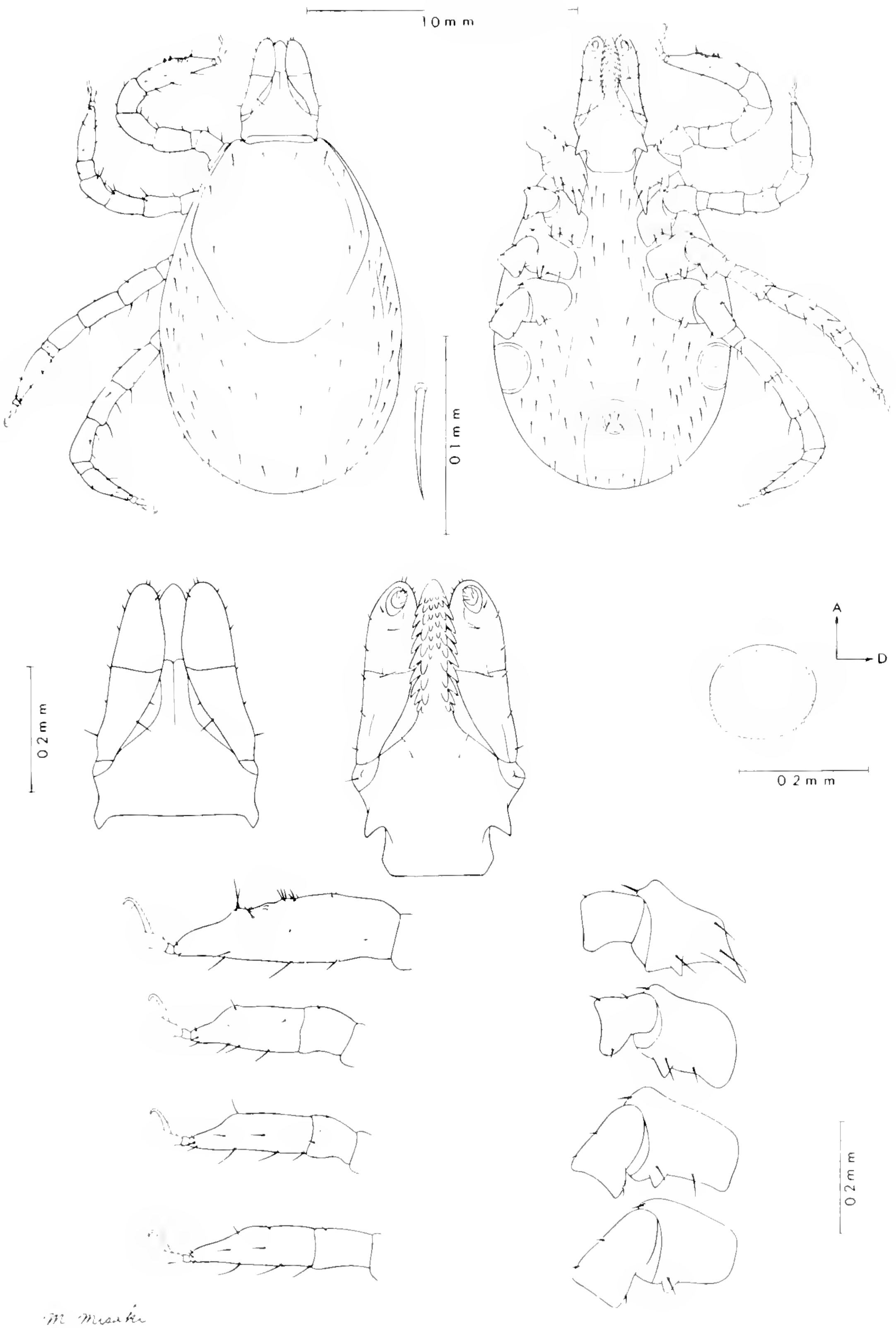


Fig. 101. *Ixodes persulcatus*, nymph.

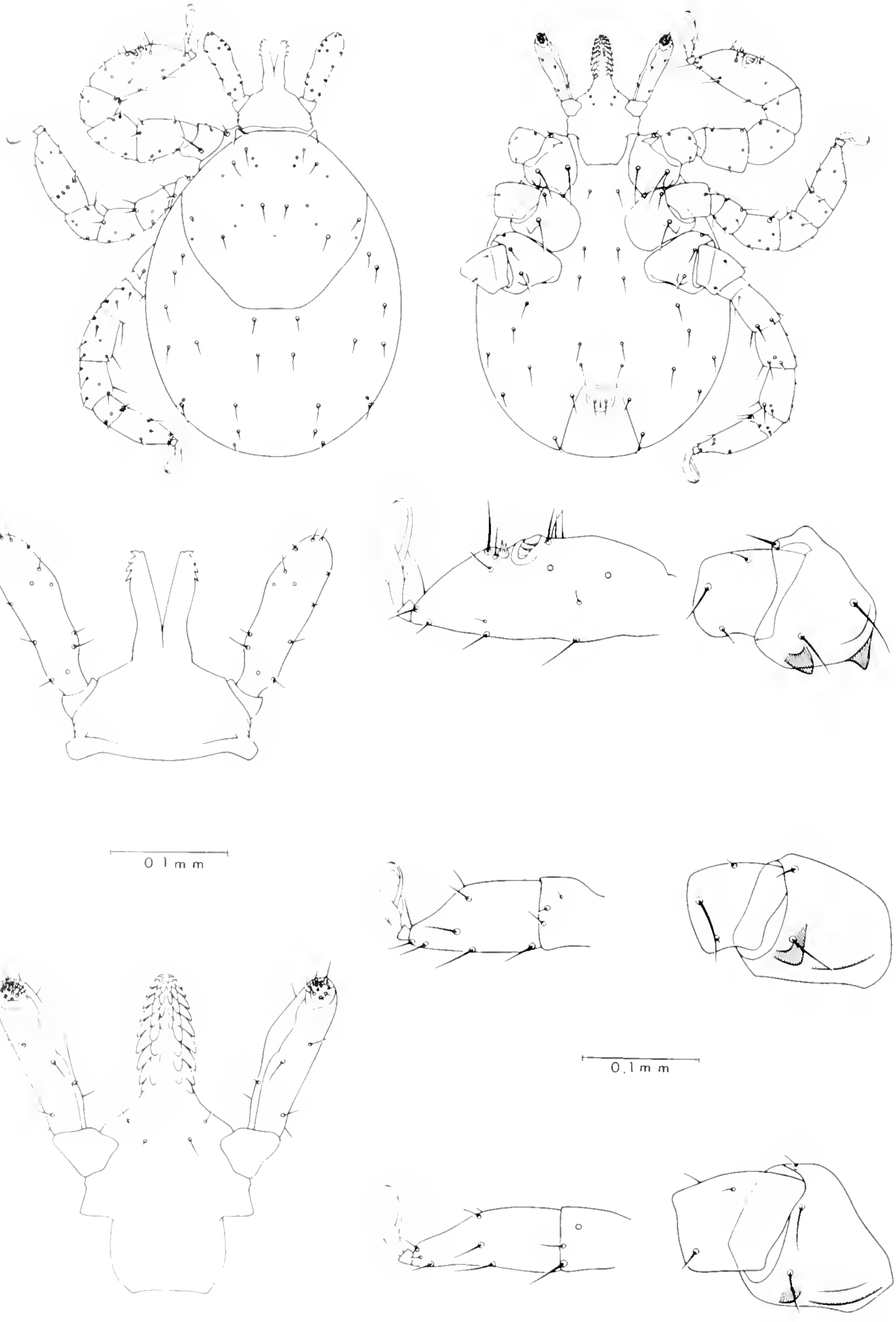
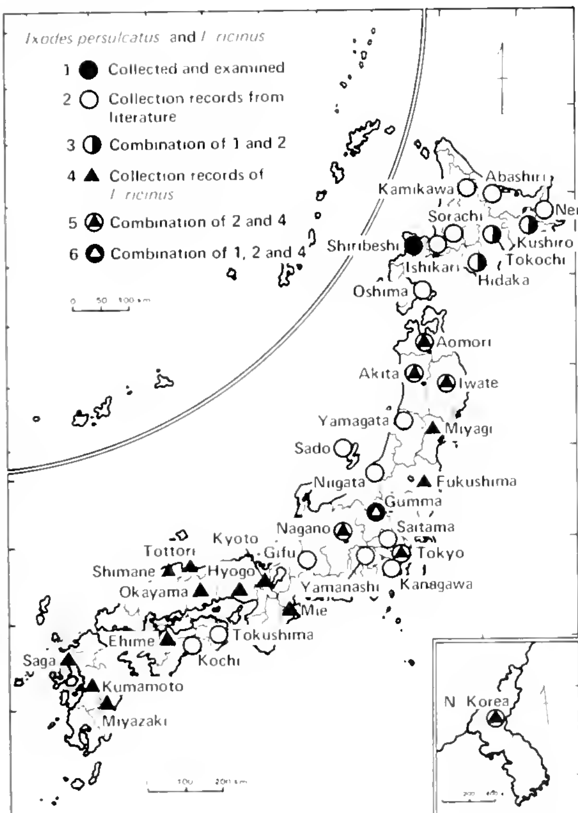


Fig. 102. *Ixodes persulcatus*, larva.

USSR, and also in northern Germany. The distribution in Japan is given in Appendix 2. The only Korean record is from a horse at Kankyohoku, now known as Hamgyong-pukto, by Itagaki et al. (1944, 1959). Kishida (1936) mentions that *I. ricinus* was recorded from North Korea by Akasawa in 1928. We have been unable to confirm this record or to find any paper by Akasawa written in 1928. Asanuma and Sekikawa (1953) listed the hosts of *ricinus* and *persulcatus*, citing the records by Kishida (1930a) and Nakamura and Yajima (1937). They are human, cow, horse, wild rabbit, deer, dog, fox, leopard, weasel, martin, hedgehog, sheep, goat, and rat. Pomerantzev (1950) stated that the main hosts of adults in the USSR are wild ungulates such as deer, elk, roebuck, and the Siberian stag. Hosts of larvae and nymphs are small mammals (Rodentia, Insectivora, Carnivora) and birds. Nymphs are also parasitic on the Amur hedgehog, dormouse, squirrel, hare, and wood-hen. Both adults and nymphs attack man.



MAP 30. Known distribution of *Ixodes persulcatus* and *I. ricinus*.

BIOLOGY:

The biology of *I. persulcatus* has been studied by Russian workers who were concerned with the transmission of spring-summer encephalitis to man. The life cycle was studied in nature by Serdukova, and the information is given by Pomerantzev (1950). The length of the developmental cycle depends upon environmental factors and is said to take three years in the boreal taiga in the USSR in warmer regions; and, in the presence of abundant host animals for all the three active stages, the tick develops in a reduced two-year cycle. *Ixodes persulcatus* is a typical forest inhabitant and is most abundant in mixed deciduous-coniferous forests.

The seasonal occurrence of *persulcatus* in Niigata Prefecture, Japan, was studied by Saito (1959b) through collections from wild animals or from vegetation using the flagging method. The following biological information was quoted from Saito's extensive studies, but as noted in the discussion, this might be applicable to *persulcatus*, provided Saito's material definitely did not include *nipponensis*. Both immatures and adults were found together on hares. The adults were generally found active on the host throughout the year, showing a slight increase in numbers in spring and late autumn. Both nymphs and larvae were most abundant on the host from April through July. Larvae were not collected on hares in winter and midsummer. The immature forms were also rare on *Apodemus speciosus sadoensis* in summer. Using the flagging method, all stages were collected from vegetation, and the peak abundance was from summer to early autumn. Saito (1960a) studied the laboratory life cycle and mating behavior, using chiefly the Angora rabbit as the host animal. Females fed for 13-18 days in spring and autumn and 7-14 days in summer. He found that if females leave the host before becoming fully engorged they weigh less than 70 mg, and they rarely feed on another host. Females laid eggs 5-8 days after engorgement in summer and 9-14 days in spring. Oviposition lasted 10-14 days under various environmental conditions, and larvae hatched out in 30-36 days at 30 C. For larvae the preparasitic period was approximately 30 days, and they fed for periods of from 3-13 days. Nymphs emerged in 17-19 days after larvae had dropped off the host. Ten days later they fed on the host for periods which varied from 4-15 days. Adults emerged in 25-30 days at 30 C. The minimum time for the total life cycle in the laboratory was approximately 4.5 months.

An interesting peculiarity of the behavior of *persulcatus* was observed by Balashov (1954). The dropping of engorged female ticks from the host coincides with the time when the cows were in the pasture. If cows were pastured during the daytime, then the ticks dropped during the daytime, but if cows were pastured during the night, then the ticks dropped at night.

Disease Relationship:

Ixodes persulcatus transmits the virus of spring-summer encephalitis to man in the USSR. Pomerantzev (1950) states that the causal agent of cattle piroplasmosis can be transmitted experimentally. Saito (1962b) studied the transmission of *Pasteurella tularensis* by *I. persulcatus* and found that adult female specimens of *persulcatus*, collected from wild hares which had died of tularemia, were infected with *P. tularensis* and that nymphs and larvae that were experimentally infected with the causal agent of tularemia transmitted it from host to host. He also demonstrated transstadial transmission, both from larvae to nymphs and from nymphs to adults, but he was unable to demonstrate transovarian transmission. The role of *I. persulcatus* as a vector of *P. tularensis* from hares to man has not been established.

Ixodes philipi Keirans and Kohls (Fig. 103)

Ixodes philipi Keirans and Kohls, 1970:725-726, Fig. 1-8.

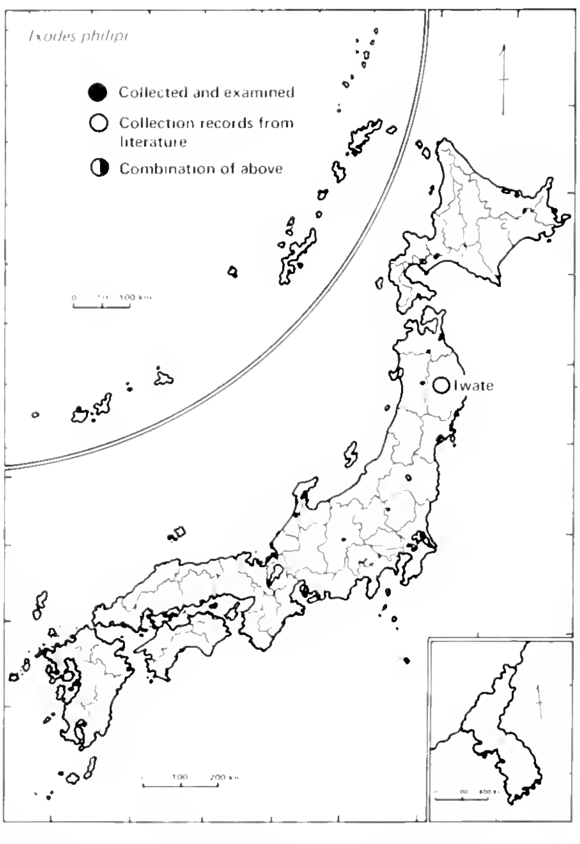
Discussion:

The description of this species was based on two partially replete females collected by H. E. McClure in 1951 at Sanganjima, Iwate Prefecture, Japan. Keirans and Kohls (1970) quoted from a personal communication from Dr. McClure in which he described the collecting area as ". . . high islands of volcanic ash covered with pine and deciduous forests. In the loose soil beneath the trees the Streaked Shearwater, *Puffinus leucomelas*, and the Madeiran Storm Petrel, *Oceanodroma castro*, dig nesting tunnels about arm-length deep." Ticks were collected during an avian blood survey but it isn't certain which of the two species of birds was the host from which the ticks were collected. Japanese ornithologists now refer to the Streaked Shearwater as *Calonectris leucomelas* and the Madeiran Storm Petrel is sometimes called the Madeiran Fork-tailed Petrel. Keirans and Kohls (1970) indicated that the female characters fulfill the criteria for placement of *I. philipi* in the subgenus *Scaphixodes* Schulze, 1941 but because of the lack of males and immature forms they are hesitant to do so. More extensive tick collections from sea birds are essential for ecological and taxonomic studies.

Diagnosis:

We quote directly from Keirans and Kohls (1970): "*Ixodes philipi* n. sp. superficially resembles *I. kohlsi* described by Arthur (1955) from *Eudyptula minor* or from its nest, and keys to *I. kohlsi* in Roberts (1960). However, *I. philipi* is much more hirsute dorsally and has a less elongate scutum. Ventrally *I. philipi* has a smaller, less distinct external spur on coxa IV, and spur on trochanter IV obsolete."

Of the Japanese ticks associated with sea birds *I. philipi* most closely resembles *I. signatus* and keys out to that species. However, females may be distinguished from *I. signatus* by the following diagnostic characters: Dorsum posterior to scutum uniformly covered with white hairs; coxae I-III armed with a more pronounced external spur; anal groove markedly constricted and subparallel posterior to anus giving "keyhole" shape; basis capituli ventrally with broadly rounded posterior margin, with straight lateral margin anterior to auriculae; auriculae broadly triangular or nearly right-angled ridges; porous areas well separated by about half the width of one of them; hypostome untoothed at base, about



Map 31. Known distribution of *Ixodes philipi*.

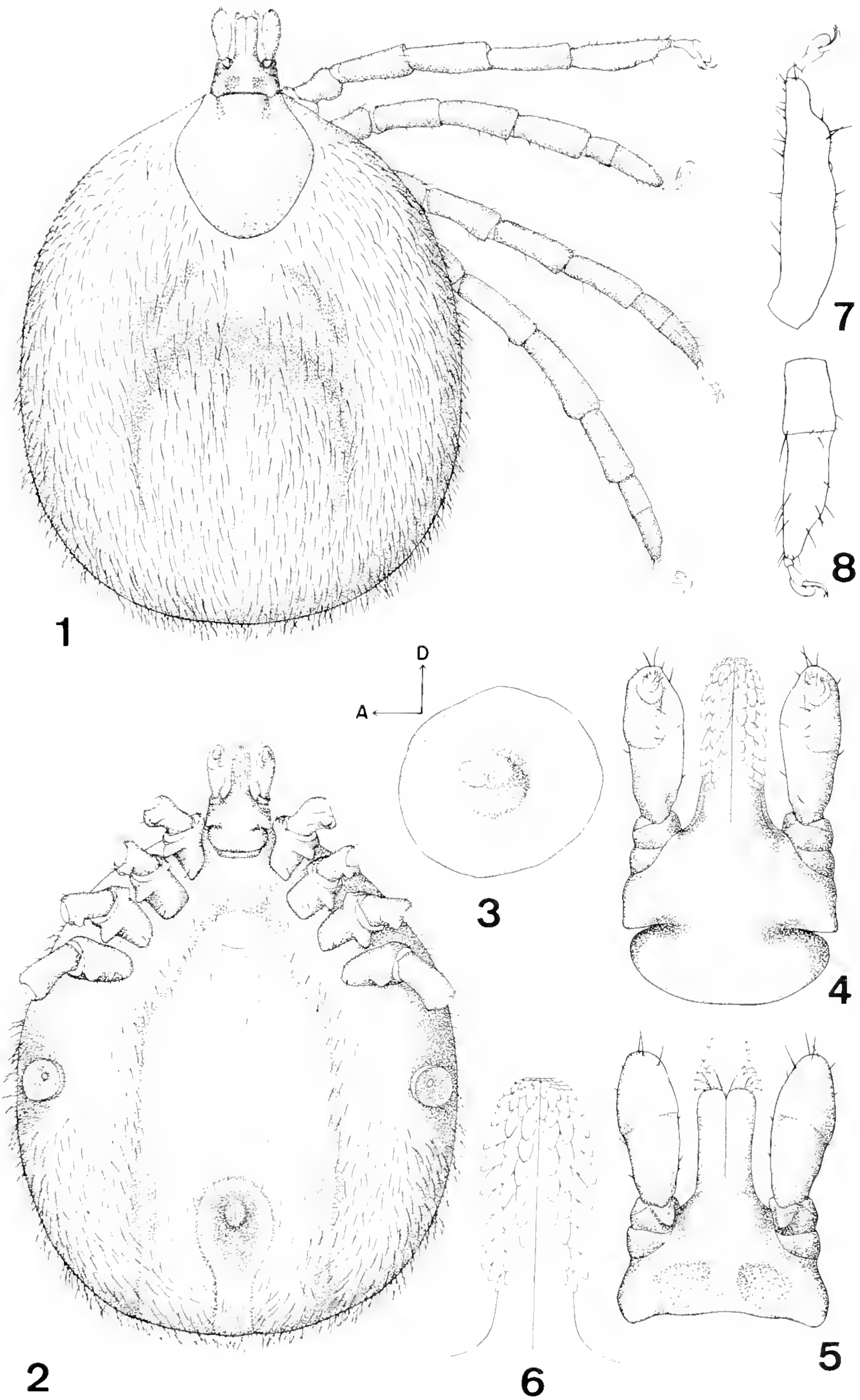


Fig. 103. *Ixodes philipi*, female. (After Kierans and Kohls, 1970)

one fourth as long as the whole length, with more prominent teeth on inner file.

DISTRIBUTION AND HOSTS:

Known only from *Puffinus leucomelas* (Temminch, 1835) or *Oceanodroma castro* (Harcourt, 1851), Sanganjima Island, Iwate Prefecture, Japan.

BIOLOGY:

Unknown.

DISEASE RELATIONSHIP:

Unknown.

Ixodes signatus Birula
(Fig. 104-107)

Ixodes signatus Birula, 1895:357-358, Pl. 1, Fig. 10-13; Nuttall and Warburton, 1911:261-264; Kishida, 1930a:2; Zumpt, 1952:18; Asanuma, Okubo, and Fukuda, 1955:85-86; Asanuma and Fukuda, 1957:147-159; Keegan and Toshioka, 1957:22, Pl. 35 and 36; Asanuma, 1965a:113-116, 1965b:398, Fig. 216.

Ixodes parvirostris Neumann, 1901:284.

Ixodes eudyptidis var. *signata*: Neumann, 1904: 451.

Ixodes eudyptidis signatus: Neumann, 1911:21.

DISCUSSION:

This tick was first reported from Japan by Neumann (1901) as *Ixodes parvirostris*, which he described from eight female specimens taken from the cormorant, *Phalacrocorax pelagicus*, on Yezo, Japan. Yezo is the archaic term for Hokkaido. Nuttall and Warburton made *parvirostris* a synonym of *signatus* in 1911. Kishida (1930a) and Zumpt (1952) cited Neumann's collection record, but gave no new information. Asanuma, Okubo, and Fukuda (1955) reported an infestation of the black-tailed gull, *Larus crassirostris*, by this tick at Kabujima, Aomori Prefecture, Honshu. Additional specimens from the same locality were collected by 406th Medical Laboratory personnel.

DIAGNOSIS:

This species is distinct from other *Ixodes* sp. and may be easily identified using the key. Description of the male by Keegan and Toshioka (1957) is based on material collected from *Larus crassirostris* at Kabujima, Japan:

> *Body* widens abruptly from scapular region; with nearly parallel lateral margins; posterior body margin bluntly rounded; lateral groove distinct. *Capitulum* relatively short and broad, but without the lateral saliences present in the female; cornua lacking; palp article III slightly longer than Article II, both articles II and III relatively shorter and broader than in the female. *Hypostome* about three-fourths as long as palpi, relatively shorter than in female; denticles indistinct. *Scutum*: Cervical grooves distinct, nearly straight, diverging; two longitudinal, nearly straight, slightly diverging grooves posterior to cervical grooves. Between these is a single, indistinct, longitudinal groove with faint cross-bars which extend to the paired longitudinal grooves. A dorso-lateral sclerotized patch on either side of the body at a level between coxae II and III. Posterior margin of scutum irregular in outline, and terminating in a point in most specimens examined. The scutum does not cover the entire dorsal surface within the lateral groove. This is particularly true on the posterior fourth of the body. *Palpi* more noticeably haired than in the female; especially distinctive are a group of short, stout setae on the lateral, dorsal aspect of articles II and III; terminal setae also are more conspicuous. *Legs and coxae* as in female. Coxal spurs on legs III and IV may be relatively larger than in female. *Spiracular plate* oval rather than circular; macula displaced anteriorly; goblets as in female. Genital aperture between coxae II. Genital grooves start to converge at level of anterior margin of anal groove. *Median and adanal plates* not distinct; a slight trace of sclerotization and pigmentation in the areas usually occupied by the adanal shields, and a more extensive pigmented area in the usual location of the ventral shield; this pigmented area has irregular lateral and posterior margins. *Anal groove* rounded anterior to anus; the arms of the groove are curved throughout, and converge posterior to the anus; distance between these arms is greatest a short distance posterior to the anus.

DISTRIBUTION AND HOSTS:

Zumpt (1952) has reviewed the distribution of *signatus* and other species of ticks infesting sea birds. This species has been collected on only a few occasions in other areas. It has been found on the cormorant on Hokkaido, Japan, the Aleutian Islands, and from two locations in California. It was taken once from a seal in the Aleutian Islands and on several occasions from the black-tailed gull in its nesting areas at Kabujima, Aomori Prefecture, Japan.

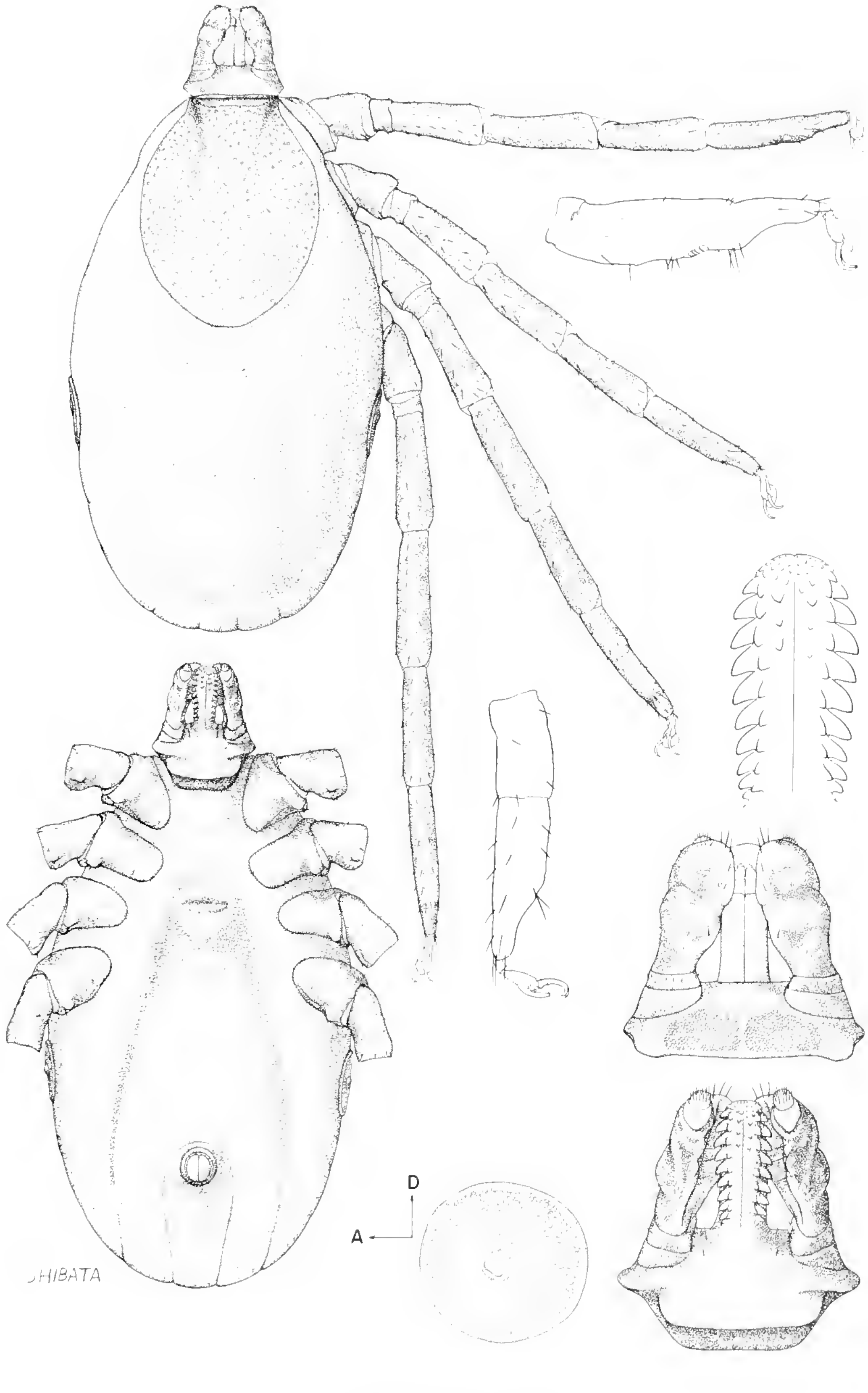


Fig. 104 *Ixodes signatus*, female.

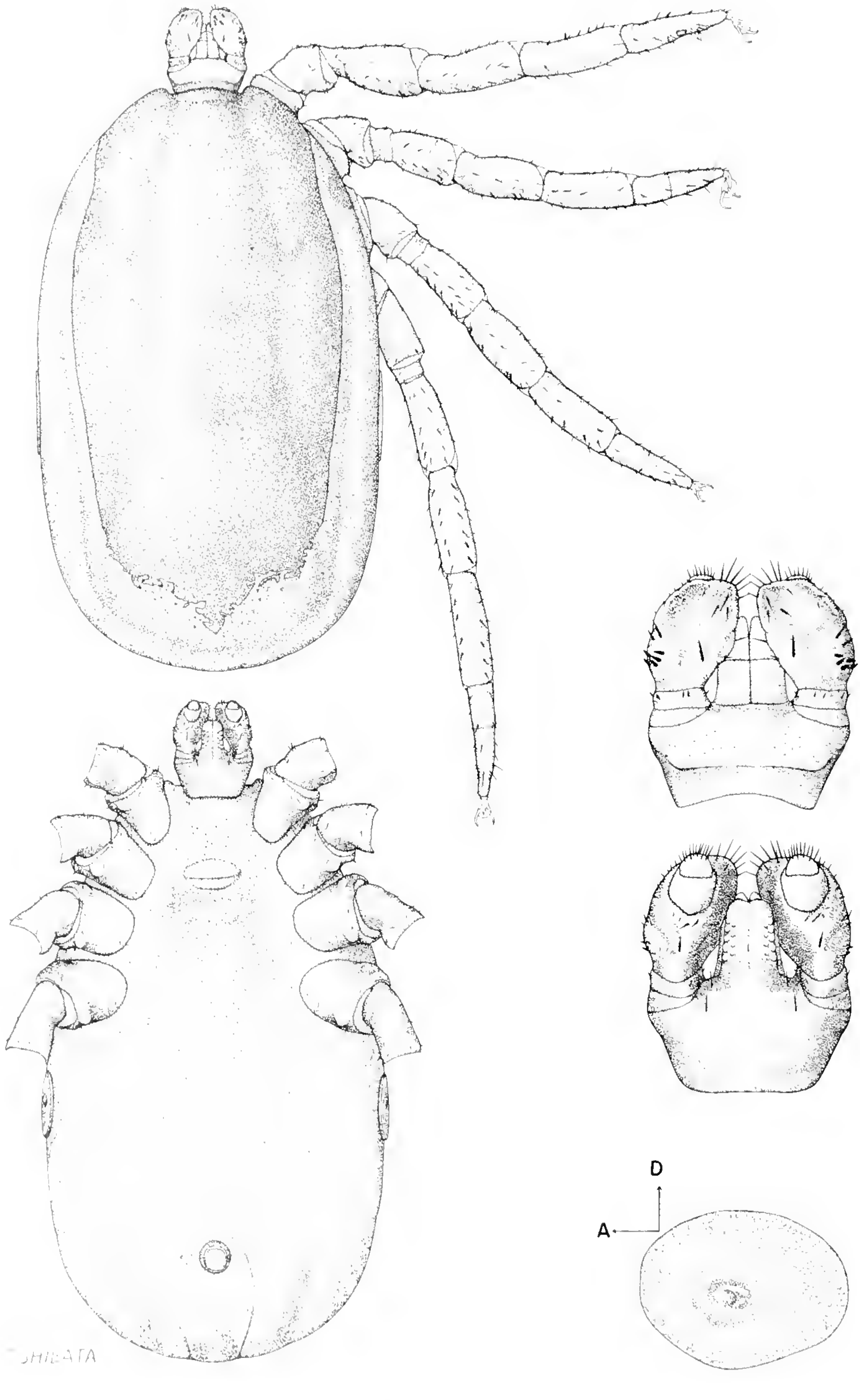


FIG. 105. *Ixodes signatus*, male.

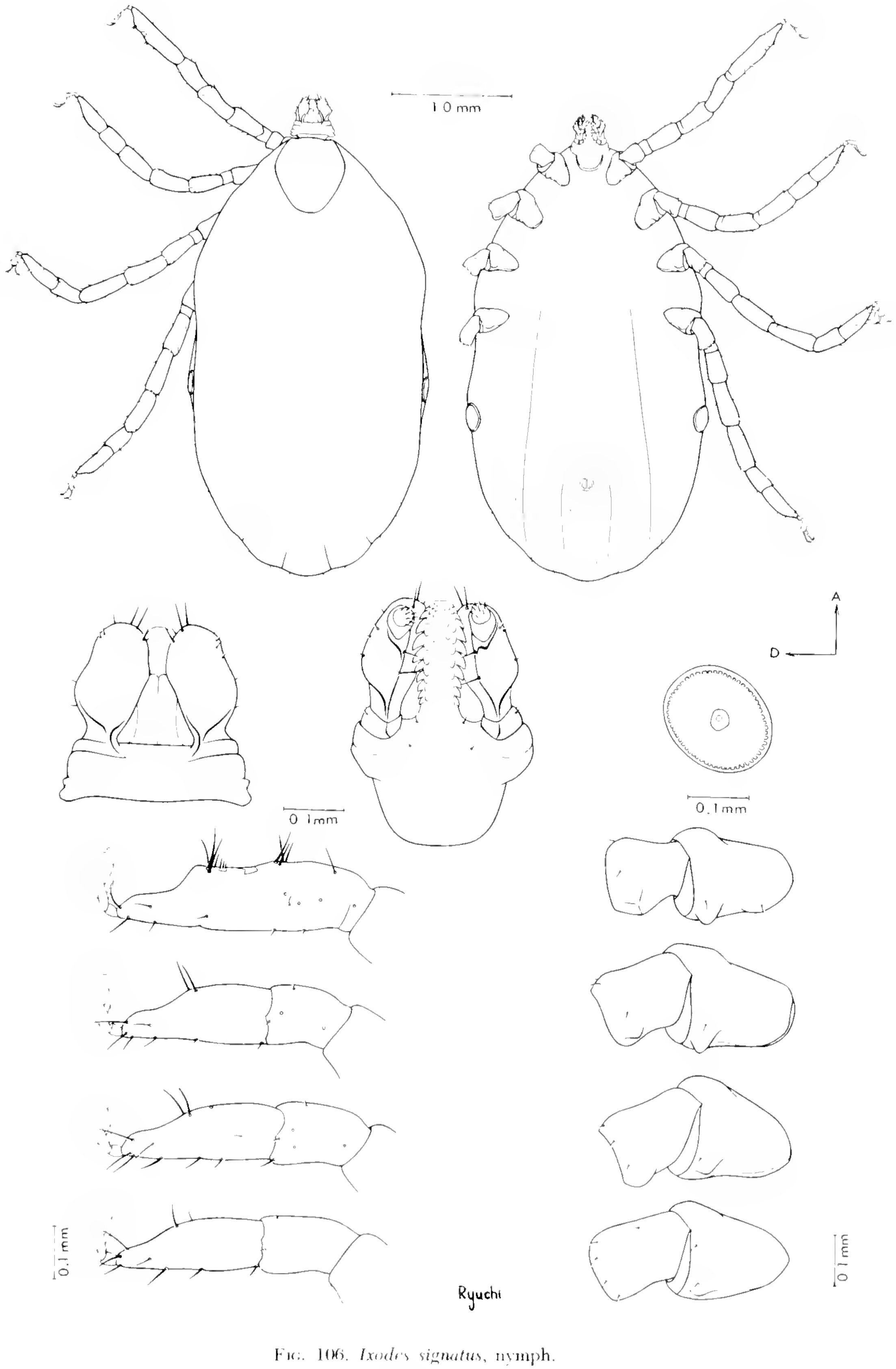


FIG. 106. *Ixodes signatus*, nymph.

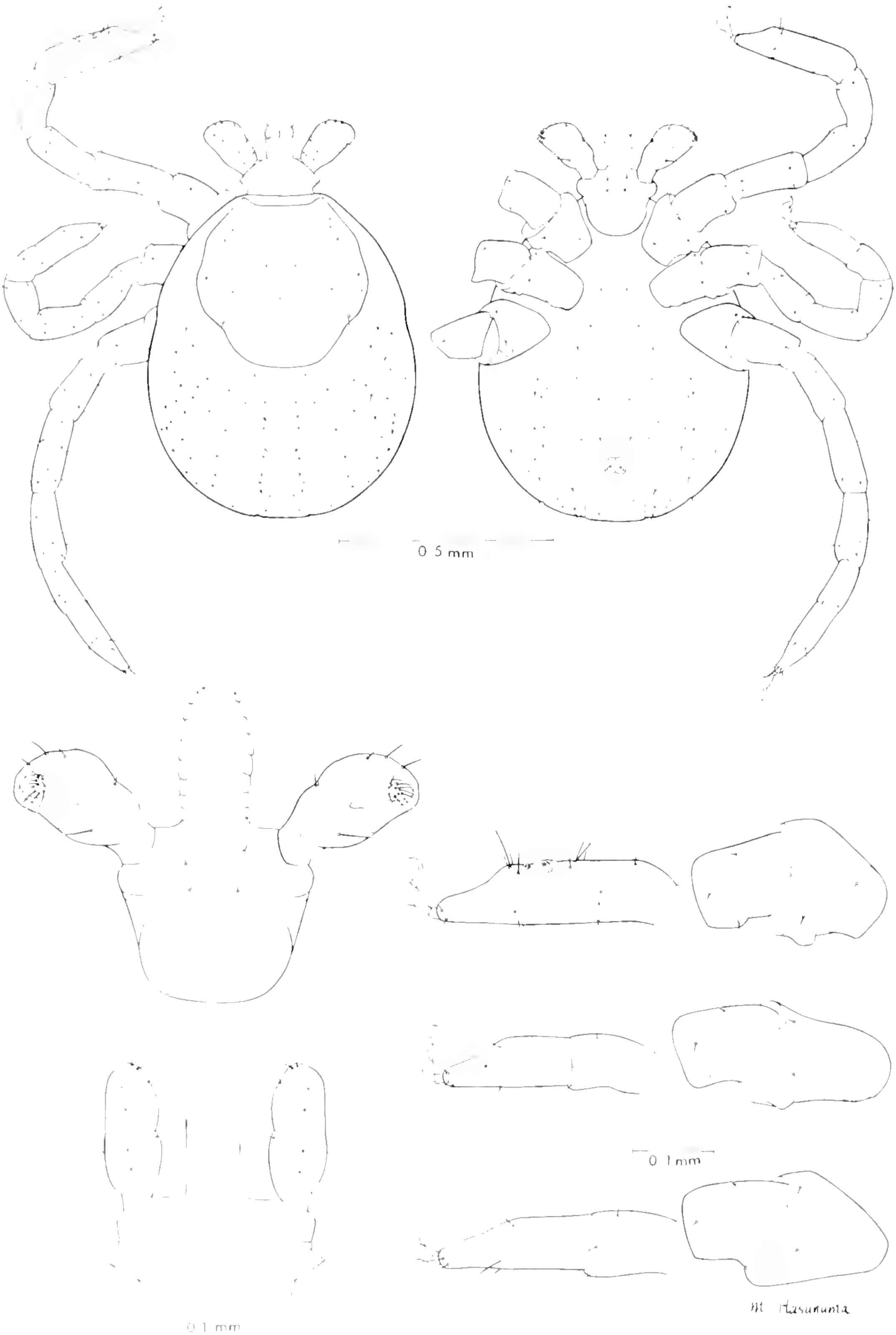
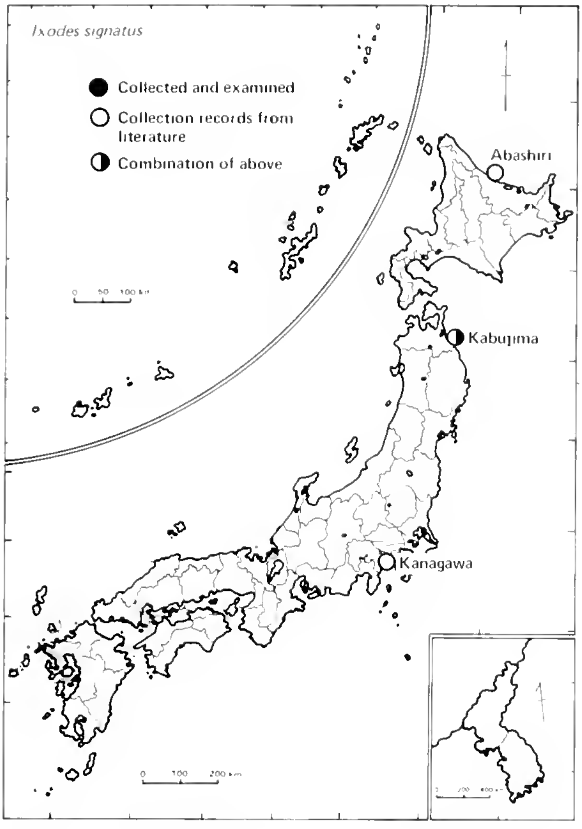


FIG. 107. *Ixodes signatus*, larva.



Map 32. Known distribution of *Ixodes signatus*.

Biology:

Interesting information on the biology of this species has been reported by Asanuma and Fukuda (1957). In each of their field observations they found the ticks parasitic on the host only in May. In 1951, larvae constituted the dominant stage on the host; in 1955 it was nymphs; in 1956, females. No males were found on hosts; and, in addition, no males which had fed on blood were found even in crevices of rocks near the birds' nests. They speculated that the life cycle of this species at Kabujima likely requires 3 years, because the host birds stay and breed there during a limited period of approximately 5 months, from April to early August. Field observations and the duration of each stage in the laboratory strengthen his theory. They also found males copulating with newly emerged females in the crevices of the rocks.

Disease Relationship:

The relationship of *I. signatus* to human disease is unknown. Asanuma and Fukuda (1957) stated that they found a dead black-tailed gull with a heavy infestation of *I. signatus*, but the cause of death was not established.

Ixodes simplex simplex Neumann
(Fig. 108-109)

Ixodes simplex Neumann, 1906:197-198; Kishida, 1930a:3.

Ixodes simplex simplex Neumann, 1906; Arthur, 1956:180, Fig. 24-26, 28-30, 33-43; Keegan and Toshioka, 1957:23-24, Pl. 37; Asanuma, 1965a:113-116.

Discussion:

Arthur (1956) divided *Ixodes simplex* into two subspecies, *I. simplex simplex* and *I. simplex africanus*. The latter has been found in the Rift Valley, Kenya. Kishida (1930a) reported occurrence of this tick on bats in Nagano Prefecture, Honshu, Japan. He did not give the specific names of the bats but gave the common names in Japanese. They are Kikugashira-Koomori and Yama-Koomori, now known by the specific names *Rhinolophus ferrum-equinum* and *Nyctalus lasiopterus*.

Arthur (1956) examined two collections of *simplex* from Japan. Both of these are in the collection of the Rocky Mountain Laboratory. One of these, RML No. 30943, consisted of one female and three larvae from *Myotis macrodactylus* taken 30 September 1952, near Kameaka, Japan. The other, RML No. 22366, consisted of one nymph from *Miniopteris schreibersi*, Kamakura, 24 December 1945. There is a question concerning the location of "Kameaka," given as the locality for collection RML No. 30943. There seems to be no "Kameaka" on Honshu, although there is a Kameoka located in Kyota Prefecture. Keegan and Toshioka (1957) examined one female specimen loaned by Dr. Asanuma which was taken from a bat in Shiga Prefecture.

Diagnosis:

The female is easily distinguishable from the only other bat tick, *I. vespertilionis*, in that the legs normally are long; the anal groove is pointed in front of the anus, with posterior arms diverging; palps relatively short, broad and blunt, broadest near distal end, narrow proximally; without cornua; auriculae as small, blunt ridges. This species is also distinct from other *Ixodes* spp. in that all coxae are without internal or external spurs. Males are unknown.

Distribution and Hosts:

As reported by Arthur (1956), this tick has been taken from bats in Palestine, Greece, France, Japan, China, and Africa. The distribution and hosts in Japan are given in Appendix 2. Larvae and nymphs are also found on bats.

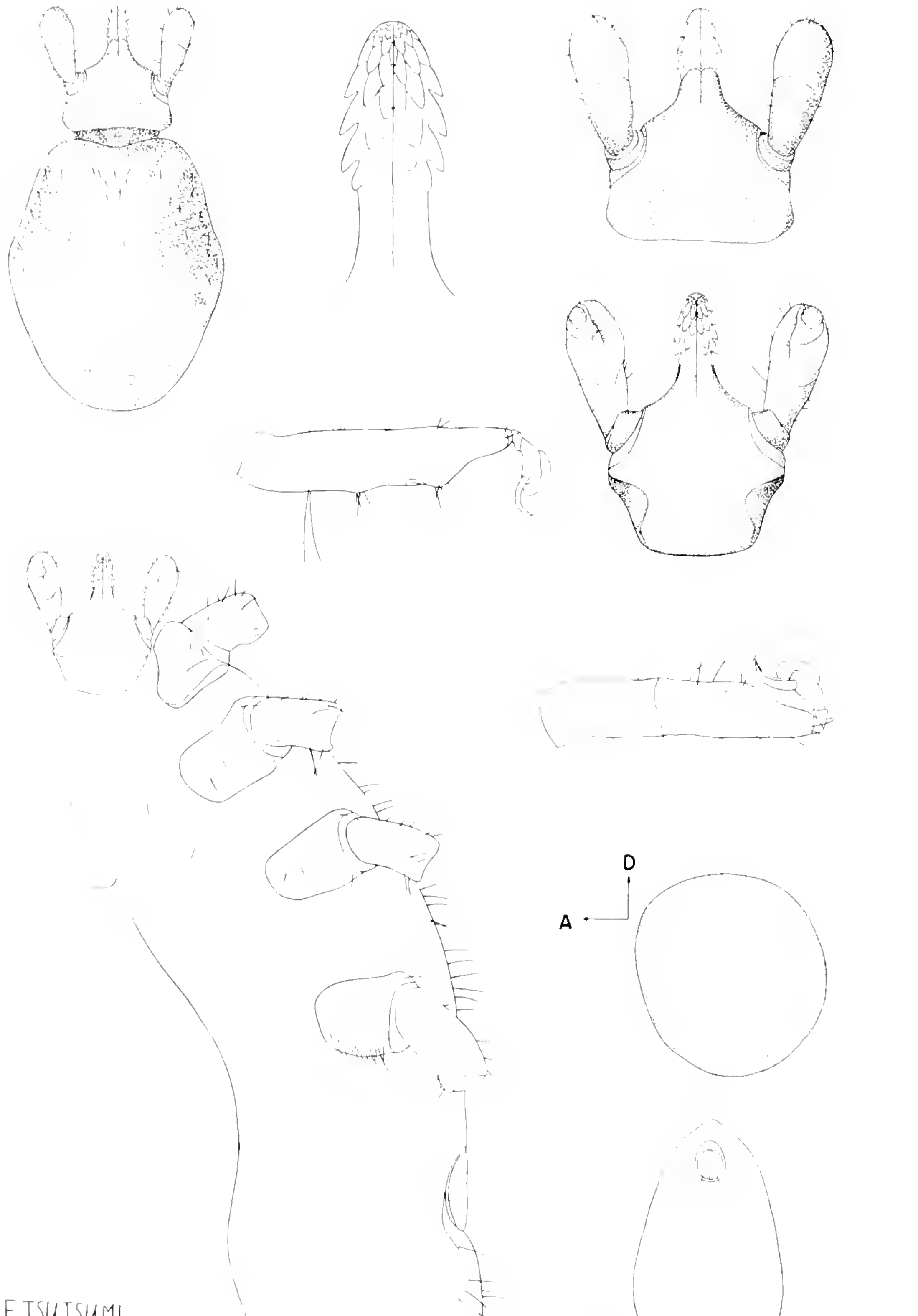


Fig. 108. *Ixodes simplex simplex*, female.

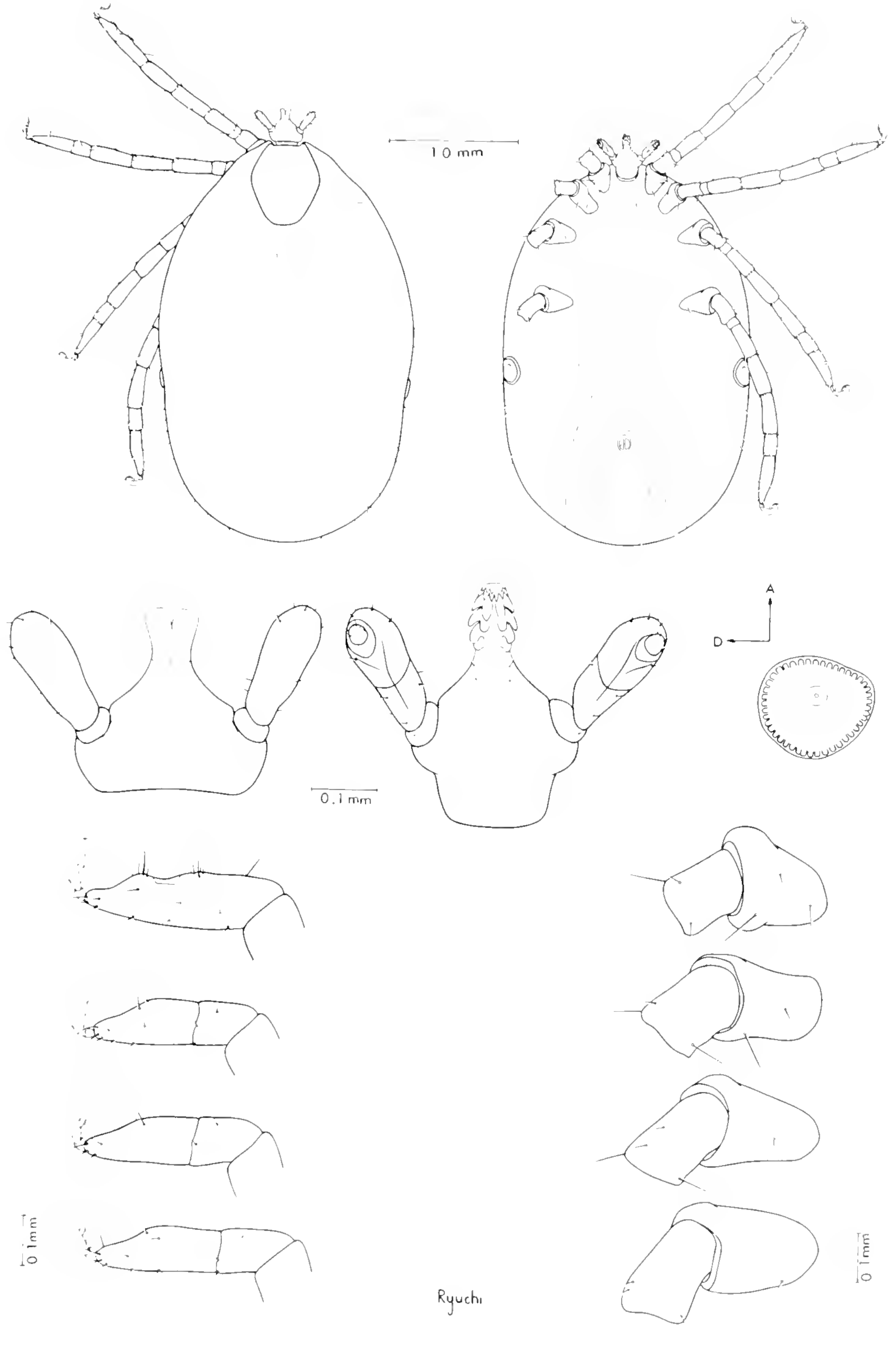
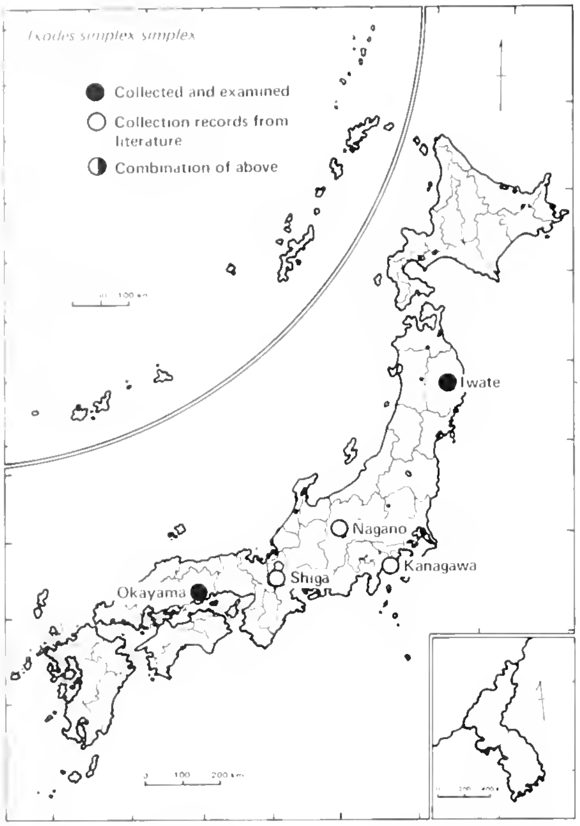


FIG. 109. *Ixodes simplex simplex*, nymph.



MAP 33. Known distribution of *Ixodes simplex simplex*.

BIOLOGY:

Nothing is known concerning the biology. Males probably do not feed, or they may feed very rapidly and then quickly hide themselves.

DISEASE RELATIONSHIP:

Unknown.

Ixodes tanuki Saito
(Fig. 110-111)

Ixodes tanuki Saito, 1964:59-66, Fig. 1-9.

DISCUSSION:

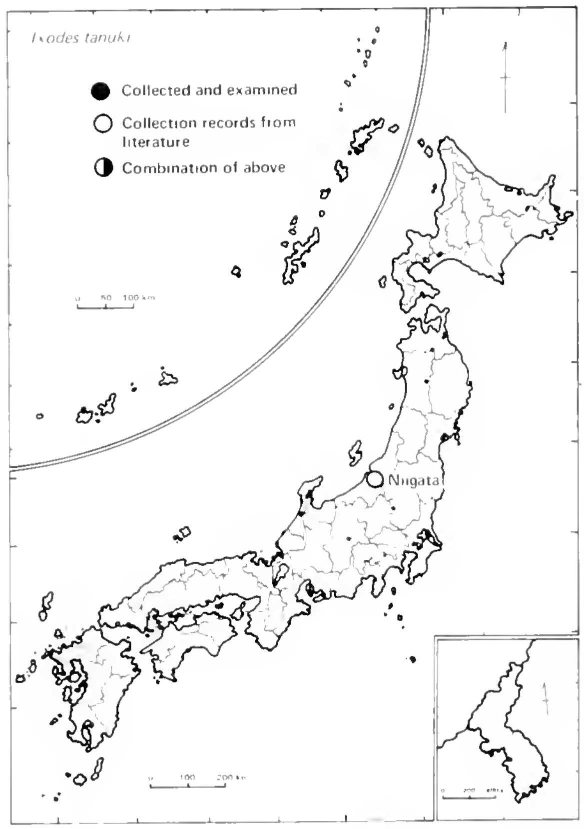
Ticks taken from a badger, *Nyctereutes procyonoides viverrinus*, in Niigata Prefecture, Japan, were described by Saito (1964). He collected one male and three females in 1959 and an additional female in 1963. The specific name "tanuki" was derived from the Japanese common name for the host. Since the specimens were not available for study, the following information is taken from Saito's paper.

DIAGNOSIS:

Saito states that *I. tanuki* may be easily differentiated from other Japanese ixodids by the following characteristics: "In *I. tanuki*, with a long sharp internal spur on coxa I, external spur is absent on coxa I and II each. These morphological features are not observed in the other ticks. *Ixodes ozarkus* Cooley, 1944, of North America, is thought to be resembling *I. tanuki*, but measurements of all parts of *ozarkus* are generally larger than those of *tanuki*. The former has an external spur on coxa I and II each, but these are lacking in the latter. The spiracular plate of *ozarkus* is elongated oval in shape, but oval in *I. tanuki*."

DISTRIBUTION AND HOSTS:

Distribution and hosts of the species are at present limited to the badger in Niigata Prefecture, and there are no reports from other areas. Dogs have been suggested as possible hosts.



MAP 34. Known distribution of *Ixodes tanuki*.

BIOLOGY:

Unknown.

DISEASE RELATIONSHIP:

Unknown.

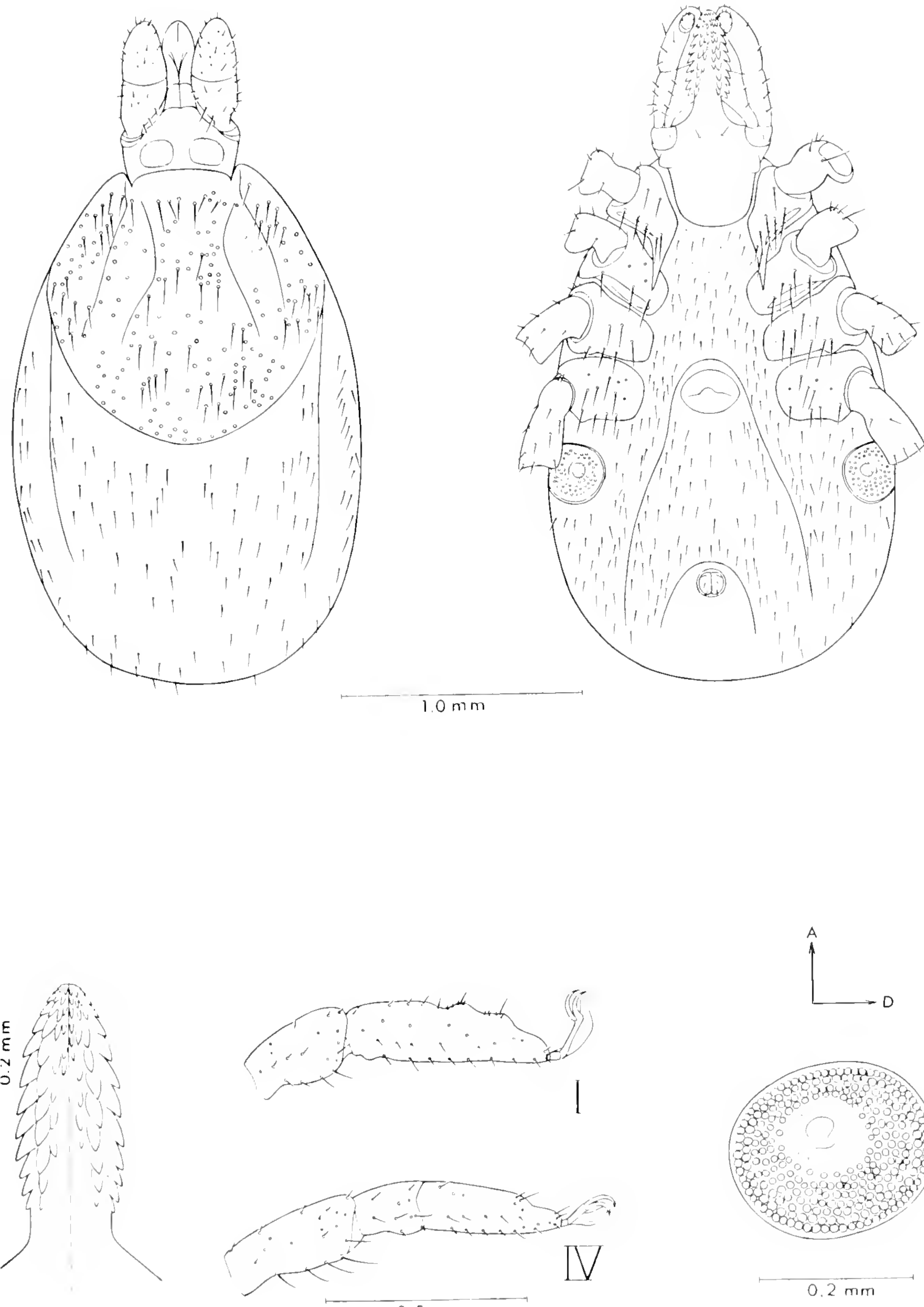


Fig. 110. *Ixodes tanuki*, female.

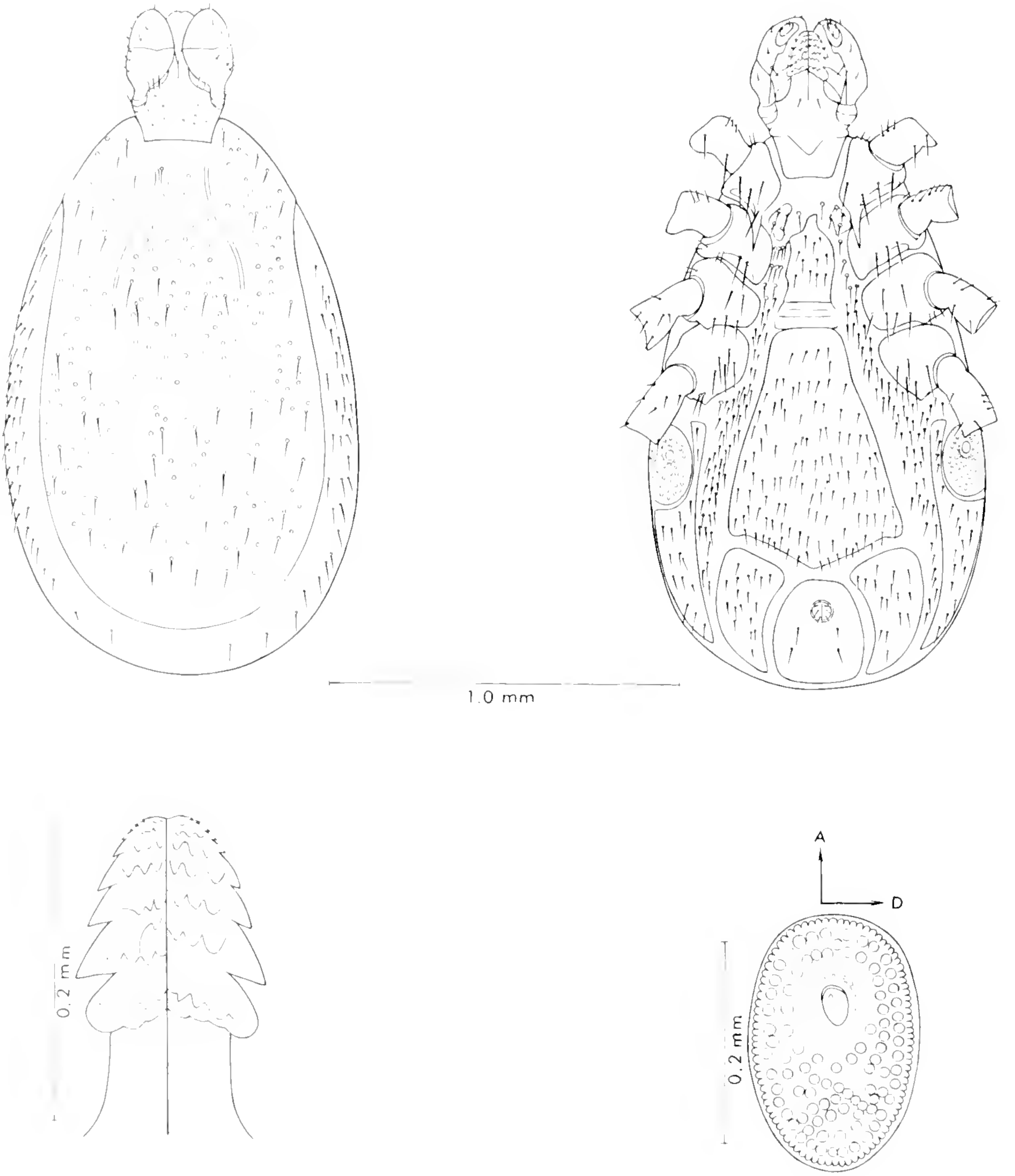


FIG. 111. *Ixodes tanuki*, male.

Ixodes turdus Nakatsuji
(Fig. 112-114)

Ixodes turdus Nakatsuji, 1942:292-294, Fig. 4; Asanuma and Kosaka, 1955: 192-194, Fig. 1-4; Asanuma and Nakagawa, 1955:549; Keegan and Toshioka, 1957:24, Pl. 38; Asanuma, 1965a:113-116.

Ixodes sp. 1 Asanuma and Sekikawa, 1952:107-116.

DISCUSSION:

The description of *I. turdus* Nakatsuji, 1942 was based on seven females taken from the thrush, *Turdus celaenopus celaenopus*, on Hachijo Island. Additional information concerning distribution, hosts, and morphology of the species was given by Asanuma and Kosaka (1955).

DIAGNOSIS:

Asanuma and Kosaka (1955) commented on the close similarity between *I. turdus* and *I. brunneus* Koch, 1844 and were of the opinion that the following characters may serve to distinguish the two species: the scutum is large, long and rhombic, with a fairly distinct lateral angle at the widest part, the postlateral margin is slightly concave (distinct from *brunneus* in this); the auriculae are rectangular, well developed, and project externally (the tip is visible from the dorsal side); the hypostome is 4/4; the anal groove converges posteriorly; the coxae have well-developed external spurs.

DISTRIBUTION AND HOSTS:

This species has been collected only in Japan. Asanuma and Kosaka (1955) have collected this species from a variety of birds, and on a few occasions from *Apodemus speciosus*. The majority of these collections were made in the Izu-Schichito Islands (Seven Islands of Izu) south of Tokyo Bay, and other specimens were taken in Chiba, Shizuoka, and Tochigi prefectures, all on Honshu. Hosts listed by them are given in Appendix 2.

BIOLOGY:

Unknown.

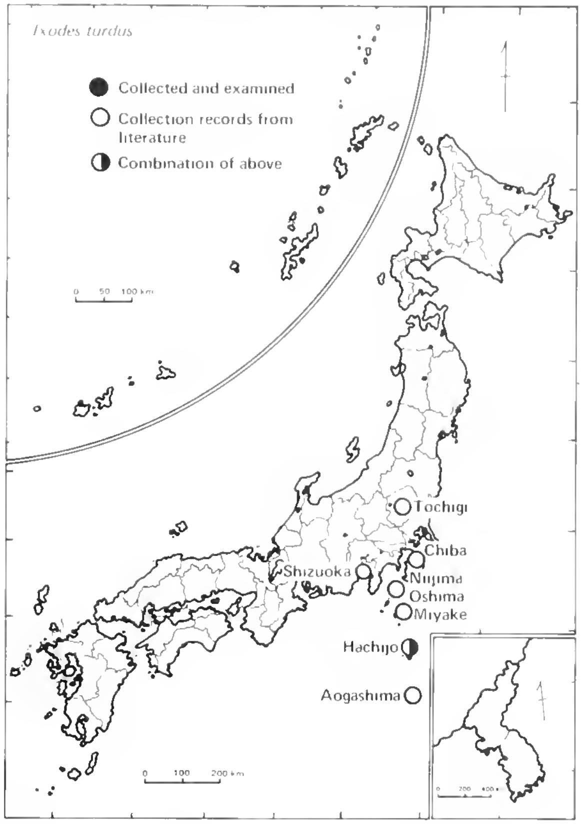
DISEASE RELATIONSHIP:

Unknown.

REMARKS:

During the course of this study, material in the 406th Medical Laboratory Collection (No. 148) was again sent to Mr. G. M. Kohls, who gave the following opinion:

> Very similar to *I. brunneus* Koch; see Cooley and Kohls 1945, p. 205. Differs from *brunneus* in characters of the scutum, the punctations being more numerous in the Japanese specimen, the median posterior area is flattened rather than convex, and the hairs are not quite as heavy as in *brunneus*. Quite likely this is Nakatsuji's (1942) species and if so the description is poor and the figures are inaccurate, especially with regard to hypostome, auriculae, and the cornua. I should like to mention too that the 2 nymphs accompanying the females are very similar to those of *I. californicus* Banks, which is based on nymphs only, and which is definitely *brunneus* (Cooley and Kohls, 1945:215).



MAP 35. Known distribution of *Ixodes turdus*.

Since validity of this taxon remains in question, the name *I. turdus* used in this paper is tentative.

Ixodes uriae White

Ixodes uriae White, 1852:10; Keegan and Toshioka, 1957:30; Asanuma 1961:181, 1965a:116.

Ixodes putus: Kishida, 1930a:2.

DISCUSSION:

Keegan and Toshioka (1957) listed *I. uriae* in the section, Questionable Distribution Records. As noted by them, *I. putus*, which has been synonymized by Cooley and Kohls (1945) under *uriae*, is recorded by Kishida (1930a) as

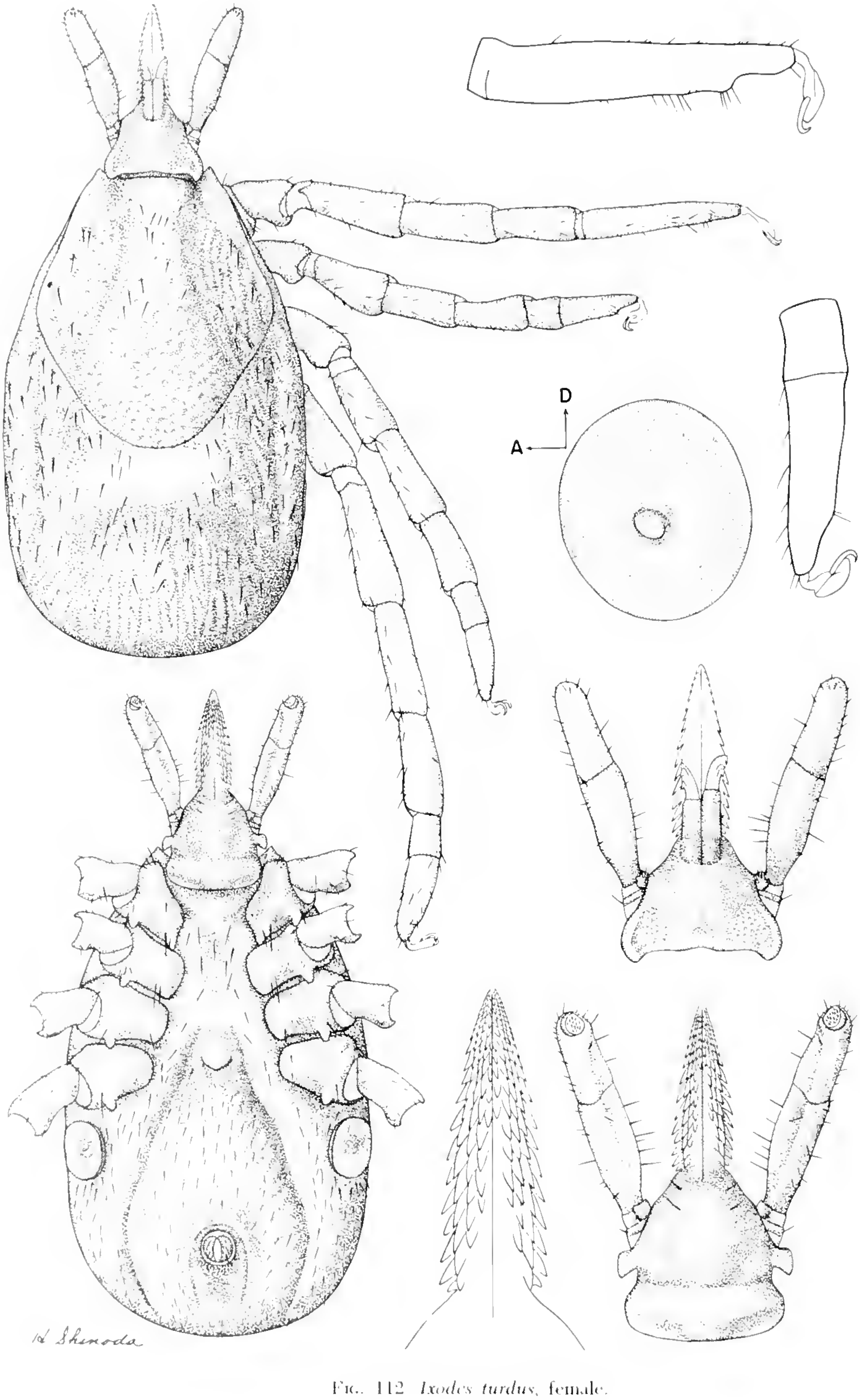


Fig. 112. *Ixodes turdus*, female.

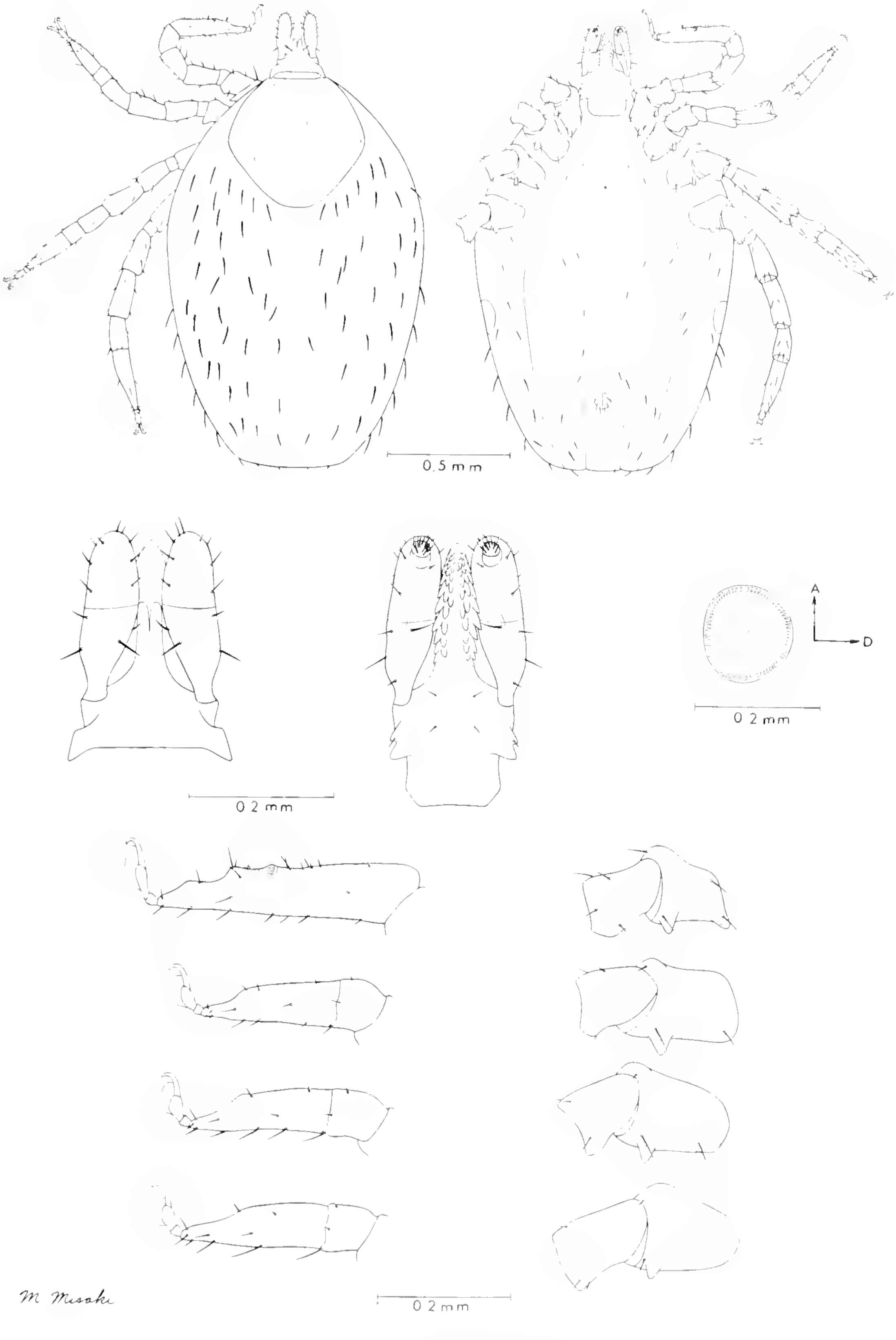


Fig. 113. *Ixodes turdus*, nymph.

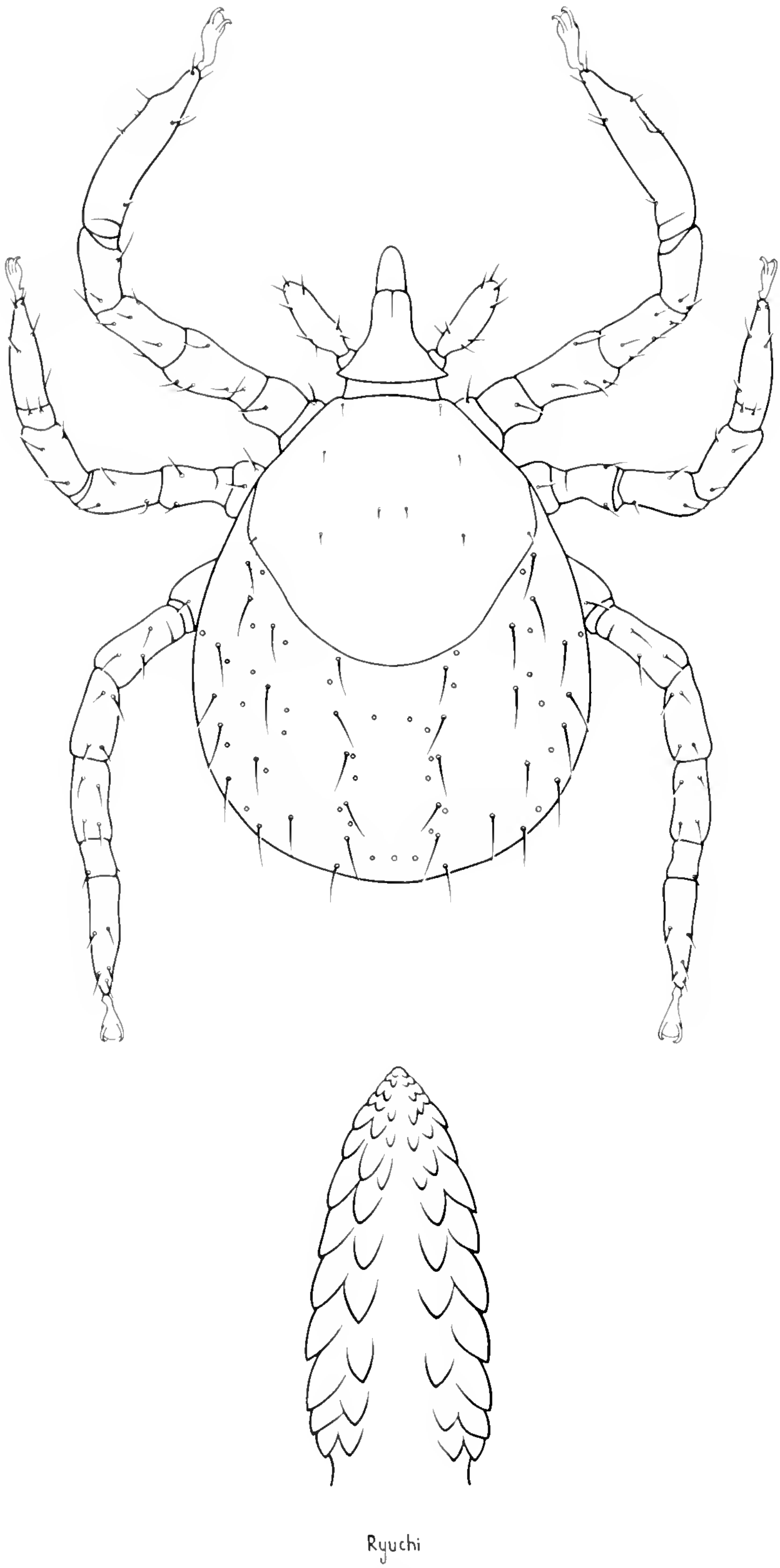


Fig. 114. *Ixodes turdus*, larva.

occurring on a bat, *Nyctalus* sp., in Niigata and Nagano prefectures. Kishida's report of *putus* appears to be highly doubtful in view of the fact that *I. uriae* is primarily a parasite of marine birds. Keegan and Toshioka (1957) expressed doubt about his identification.

Neumann (1902) created the genus *Ceratixodes* for *putus* on the basis of the structure of the capitulum and the peculiar character of Haller's organ. Since then, the genus *Ceratixodes* has been either suppressed or used, depending on the workers. Zumpt (1952), having discussed the status of the genus, considered that the characteristics of *uriae* were sufficient to separate it from *Ixodes*. However, the taxonomic problem related to *Ceratixodes* does not appear to be settled; moreover, Japanese specimens were not available for examination. Therefore, the species is here treated as belonging to the genus *Ixodes, sensu lato*.

Illustrations of this species were included in papers by Nuttall and Warburton (1911) and Pomerantzev (1950). The following information was taken from the literature.

Diagnosis:

This "puffin-tick" has very unique characteristics. The size is very large in both sexes. The male has five distinct tufts of long hairs at the posterior margin of the body; the 3rd palpal segment is conically shaped. In the female the body is covered thickly with white hairs; the 3rd palpal segment is much broader and shorter than the 2nd, and the suture between them is poorly defined, the 1st palpal segment is dorsally prominent.

Distribution and Hosts:

The tick has a wide geographical distribution. The recorded localities for this species comprise many islands or seashores facing oceans encircling both poles. The species is therefore called a "bipolarly distributed" tick.

Zumpt (1952) discussed the distribution, citing the opinions expressed by Schulze (1938). Detailed localities for the tick are given by Nuttall and Warburton (1911), Schulze (1938), Cooley and Kohls (1945), and Zumpt (1952).

The hosts are mainly sea birds inhabiting the areas mentioned above. They are gulls, albatrosses, petrels, shearwaters, and penguins. Pomerantzev (1950) and Nuttall and Warburton (1911) state that it occasionally attacks man. The sole reliable record in the Japanese literature is Asanuma's report (1961, 1965a) which contains the record of a nymph and a larva from a puffin, *Lunda cirrhata*, on Hokkaido.

Biology:

This species is said to be a three-host tick. Males do not feed and are assumed to copulate with the females after they have dropped off from the host. Zumpt (1952) considers that the wide distribution for this species can be attributed to the sticky eggs, which have a long incubation period and can be easily transported from one place to another on the feet of birds. Other biological information can be obtained from Nuttall and Warburton (1911).

Disease Relationship:

Unknown.

Ixodes vespertilionis C. L. Koch (Fig. 115-118)

Ixodes vespertilionis C. L. Koch, 1844:217-230, Fig. 9; Arthur, 1956:180-184, Fig. 1-13; Hoogstraal, 1956:567-573, Pl. 67; Keegan and Toshioka, 1957:25, Pl. 39-40; Asanuma, 1965a:113-116, 1965b:399, Fig. 221.

Discussion:

Arthur (1956) and Hoogstraal (1956) both refer to a single collection (RML No. 32112) of *I. vespertilionis* from *Rhinolophus ferrumequinum* Sawada, "Myiagi," Honshu, 13 May 1952 (record was given in personal correspondence from Kohls to Hoogstraal). The error in spelling (should be "Miyagi") is perpetuated in Arthur (1956) and Hoogstraal (1956). Keegan and Toshioka (1957) examined this single female specimen and gave several records of *vespertilionis* from bats collected on Honshu and Shikoku. Specimens from Hokkaido were borrowed from Mr. K. Hattori, and other study material was collected in Iwate Prefecture and in Korea by 406th Medical Laboratory personnel.

Diagnosis:

This bat tick is very distinctive and may be easily distinguished from other *Ixodes* spp. The legs are thin, much longer than the body, giving a "spidery" effect; all coxae lack spurs; the anal groove is round in front of the anus and the posterior arms are nearly straight or slightly converging. In the male, the palps are clavate and have numerous long setae; the hypostome is pointed at the tip with faint indications of small, scalelike teeth. In the female, the scutum is narrow and much longer than wide, with the widest point just behind the middle (in Nuttall and Warburton, 1911, broadest in the middle; in Pomerantzev, 1950, widest in front of the middle), the basis capituli is dorsally triangular and has a flange externally directed at the postero-

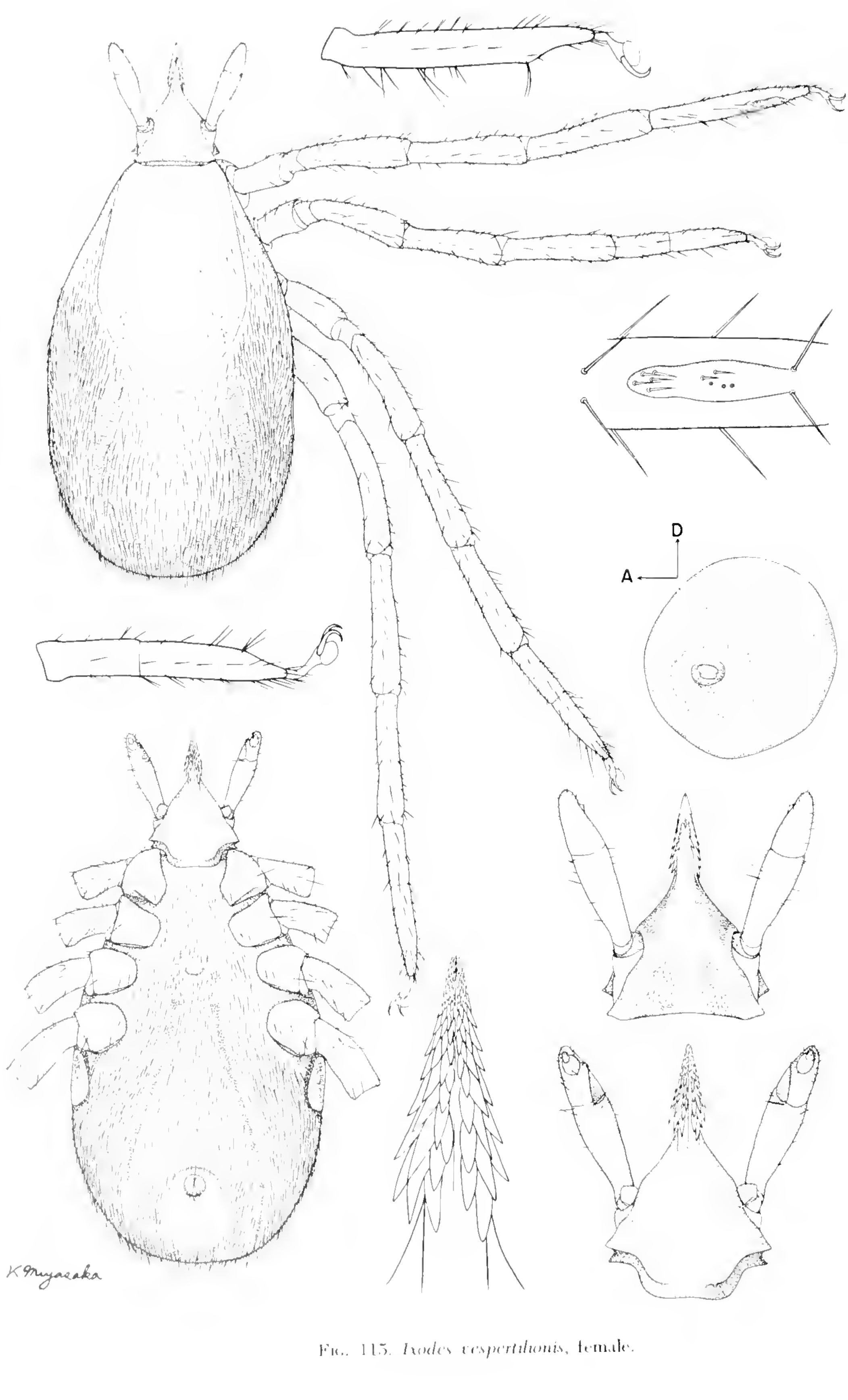


FIG. 115. *Ixodes vespertilionis*, female.

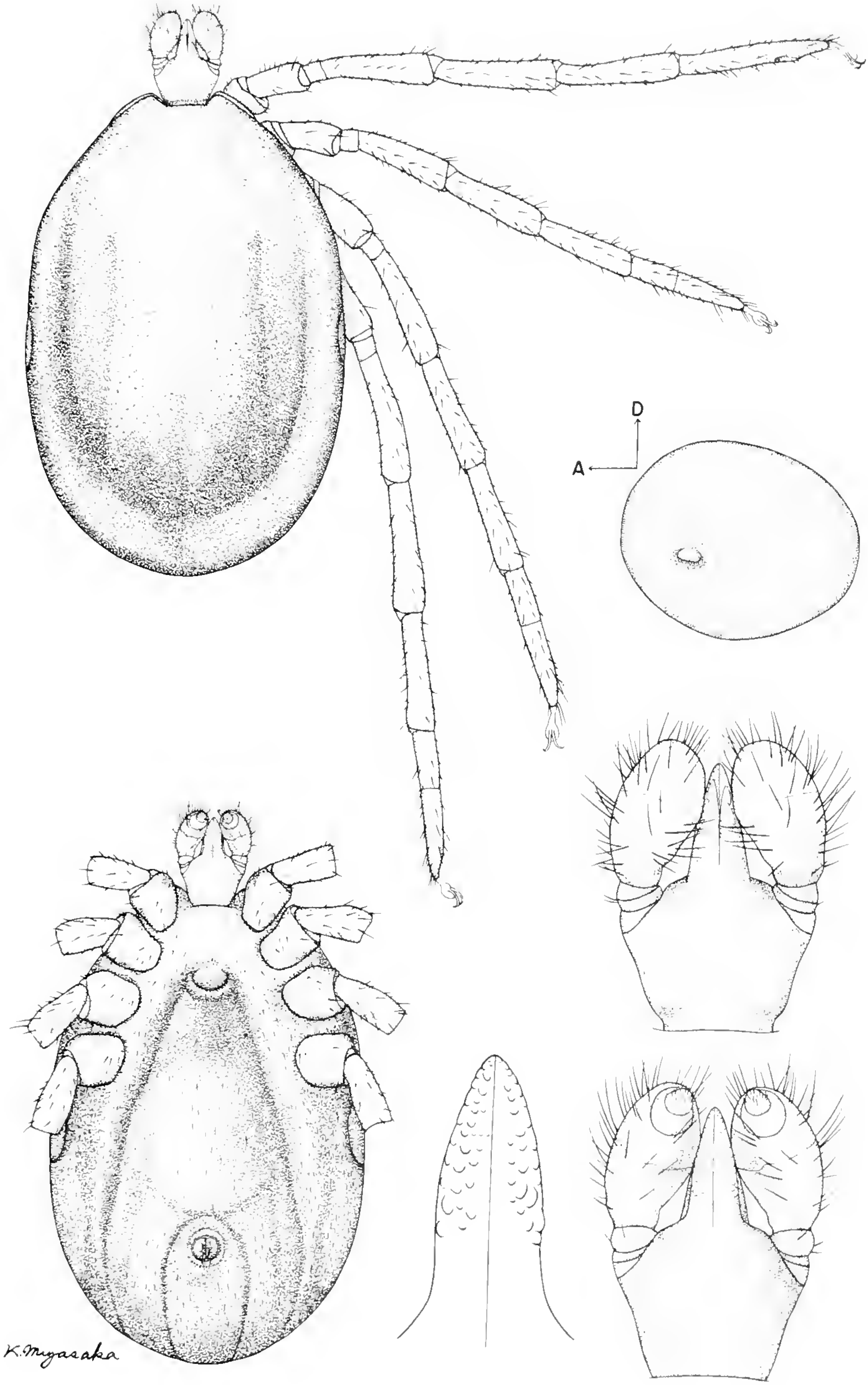


Fig. 116. *Ixodes vespertilionis*, male.

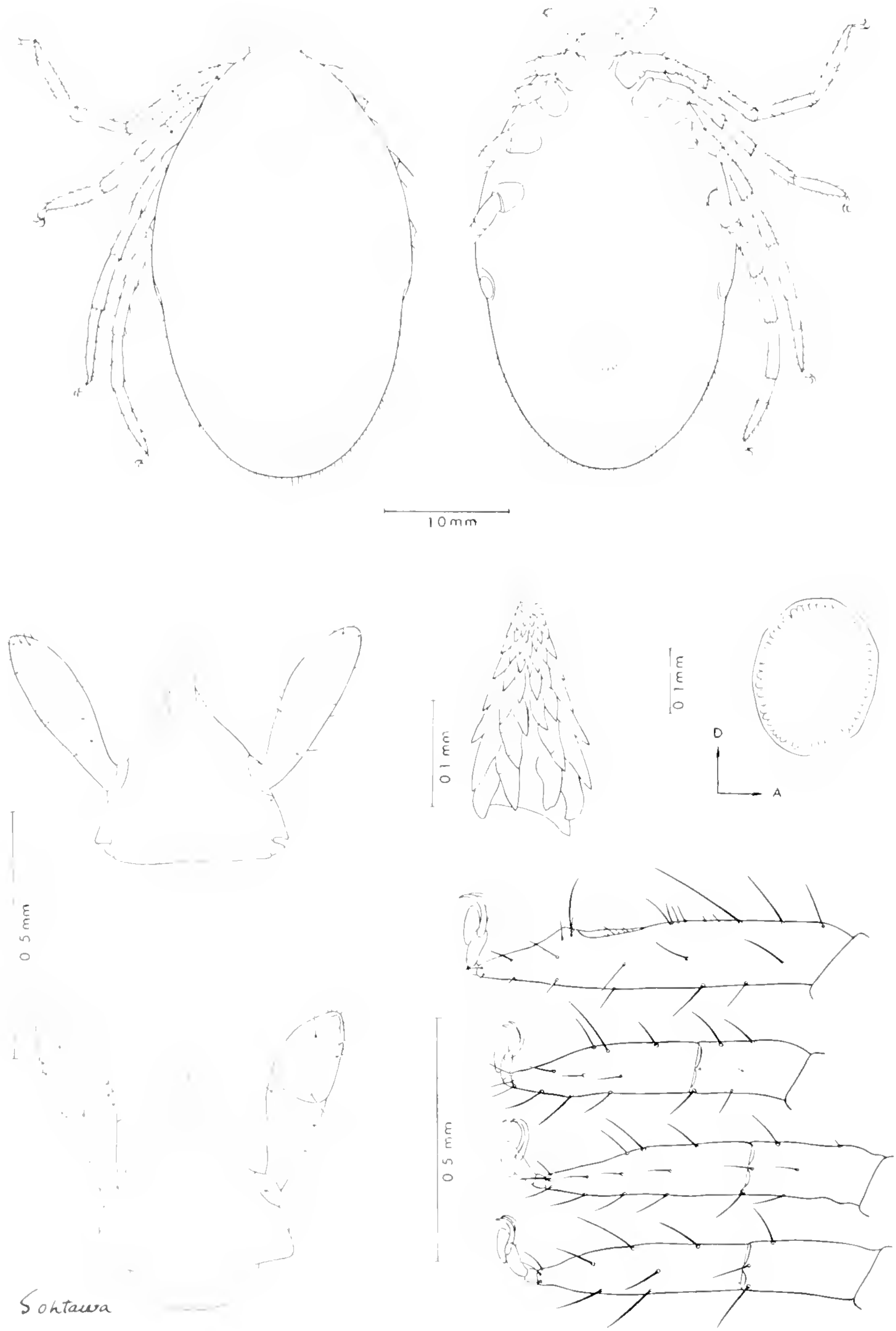


Fig. 117. *Ixodes vespertilionis*, nymph.

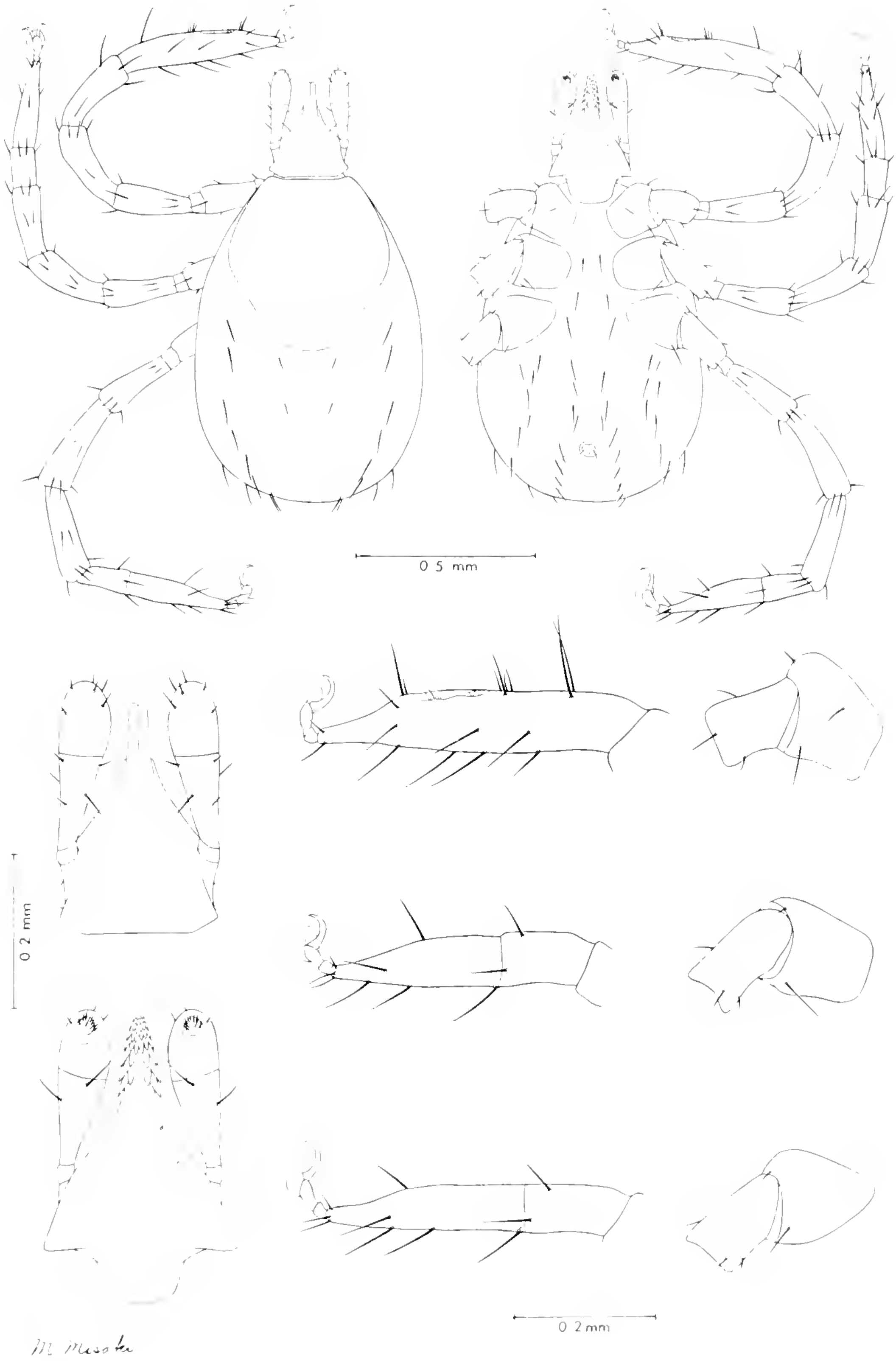
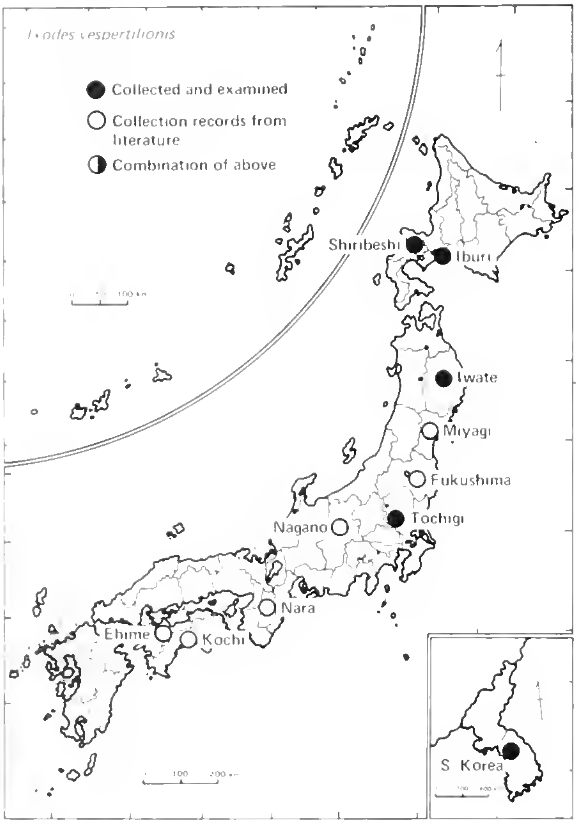


FIG. 118. *Ixodes vespertilionis*, larva

external juncture; the hypostome is lanceolate and has long denticles.

DISTRIBUTION AND HOSTS:

The distribution and hosts of this species in areas other than Japan are presented by Arthur (1956) and Hoogstraal (1956). This species occurs on a variety of bat hosts in Europe, Africa, the Near East, and Japan. Russian workers report the tick from Russia, northern Iran, and western Siberia. Hosts from which *Ixodes vespertilionis* has been taken in Japan are given in Appendix 2.



MAP 36. Known distribution of *Ixodes vespertilionis*.

BIOLOGY:

Nothing is known of the biology of the Japanese population. Excellent reviews of biology, morphology, etc., are given by Arthur (1956) and Hoogstraal (1956): "No males have been found on bats, but they wander over the walls of the caves, particularly where the rocks are creviced. Unfertilized females and unfed immature forms occupy similar niches. It seems likely that the fully fed stages secrete themselves between the stones of the caves to digest blood meals" (Arthur 1956).

Arthur's (1956a) comparison of the data from Switzerland and from Macedonia leads him to believe that, because there is a high reasonable catch of partially and full engorged ticks between October and January and a number of unfed nymphs and females during the summer, feeding is accomplished mainly during the winter months. This picture, possibly modified by the host's seasonal breeding cycle and activity, requires further observation. Nuttall and Warburton (1911) postulated that males may either feed very rapidly and then leave the host, or that they may not feed at all. Neumann (1916) believed that the various degrees of engorgement in which male specimens are found might not necessarily prove that males do feed but rather may be an indication of degree of nymphal feeding. This conclusion is based on the atrophy of the male hypostome in comparison with its robust development in females and in immature stages (Hoogstraal, 1956).

DISEASE RELATIONSHIP:

Unknown.

Genus *Rhipicephalus* C. L. Koch, 1844

Usually ornate. Palpi short. Basis capituli usually hexagonal dorsally. Eyes and festoons present. The males with a pair of adanal and accessory shields. Coxa I bifid. Spiracular plate comma-shaped.

Rhipicephalus sanguineus Latreille, 1806
(Fig. 119-122)

Ixodes sanguineus Latreille, 1806:157

Rhipicephalus sanguineus: Koch, 1844:238-239; Sugimoto, 1937b:610-612; Keegan and Toshioka, 1957:26-27, pl. 42.

DISCUSSION:

Although this tick, known as the "kennel tick," "brown dog tick," or "tropical brown dog tick," is one of the most widely distributed ixodid ticks, present information indicates that it is very rare, at least in Japan, Korea, and the Ryukyu Islands. Sugimoto (1937b) reported that *R. sanguineus* had been taken in Kumamoto Prefecture, Kyushu, but it has not been found by other collectors in that area.

During the course of this study, three lots were examined and identified as *R. sanguineus*. Judging from the 406th Medical Laboratory collection records, it is difficult to determine whether this species has been established in

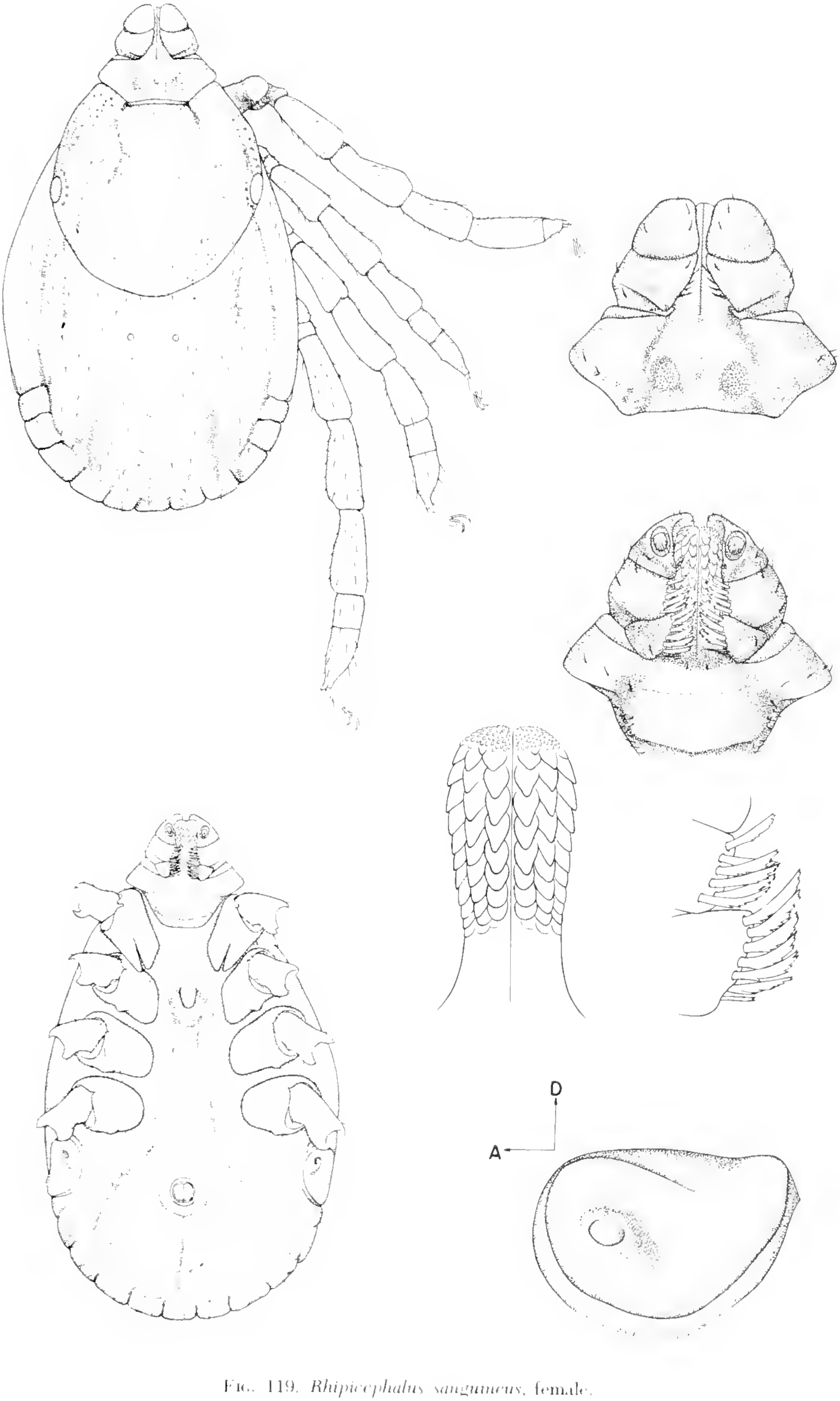


FIG. 119. *Rhipicephalus sanguineus*, female.

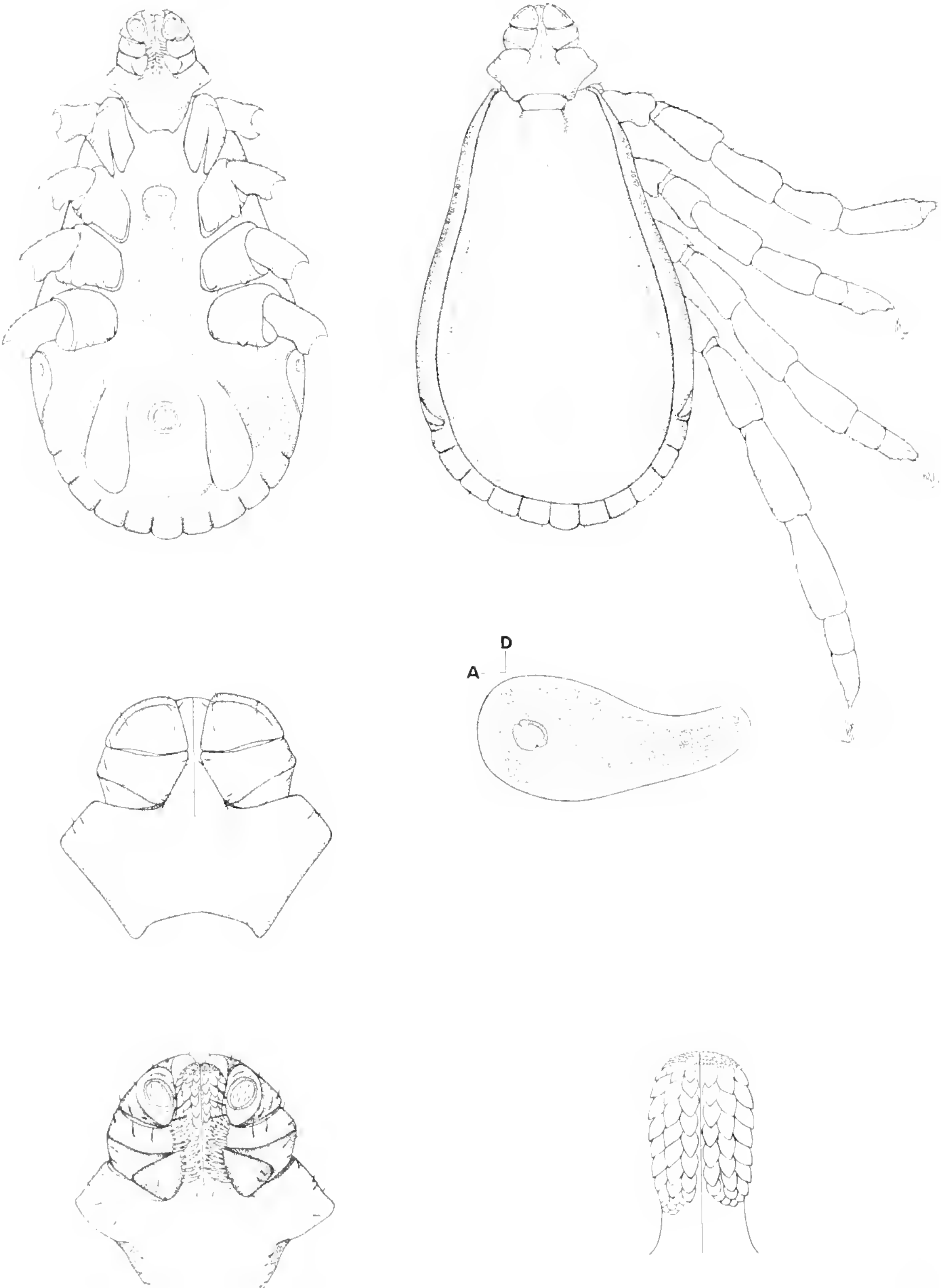


FIG. 120 *Rhipicephalus sanguineus*, male.

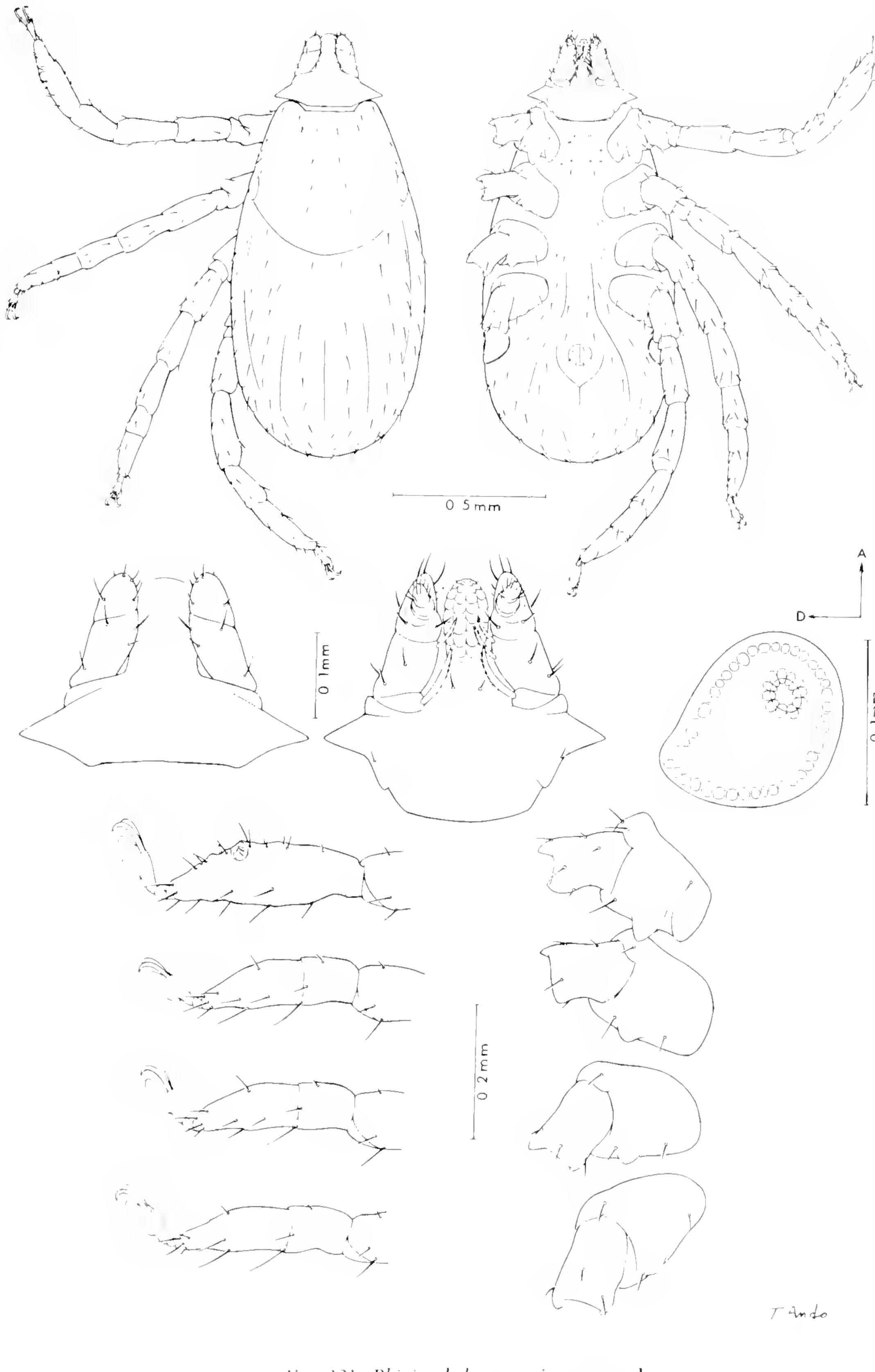


FIG. 121. *Rhipicephalus sanguineus*, nymph.

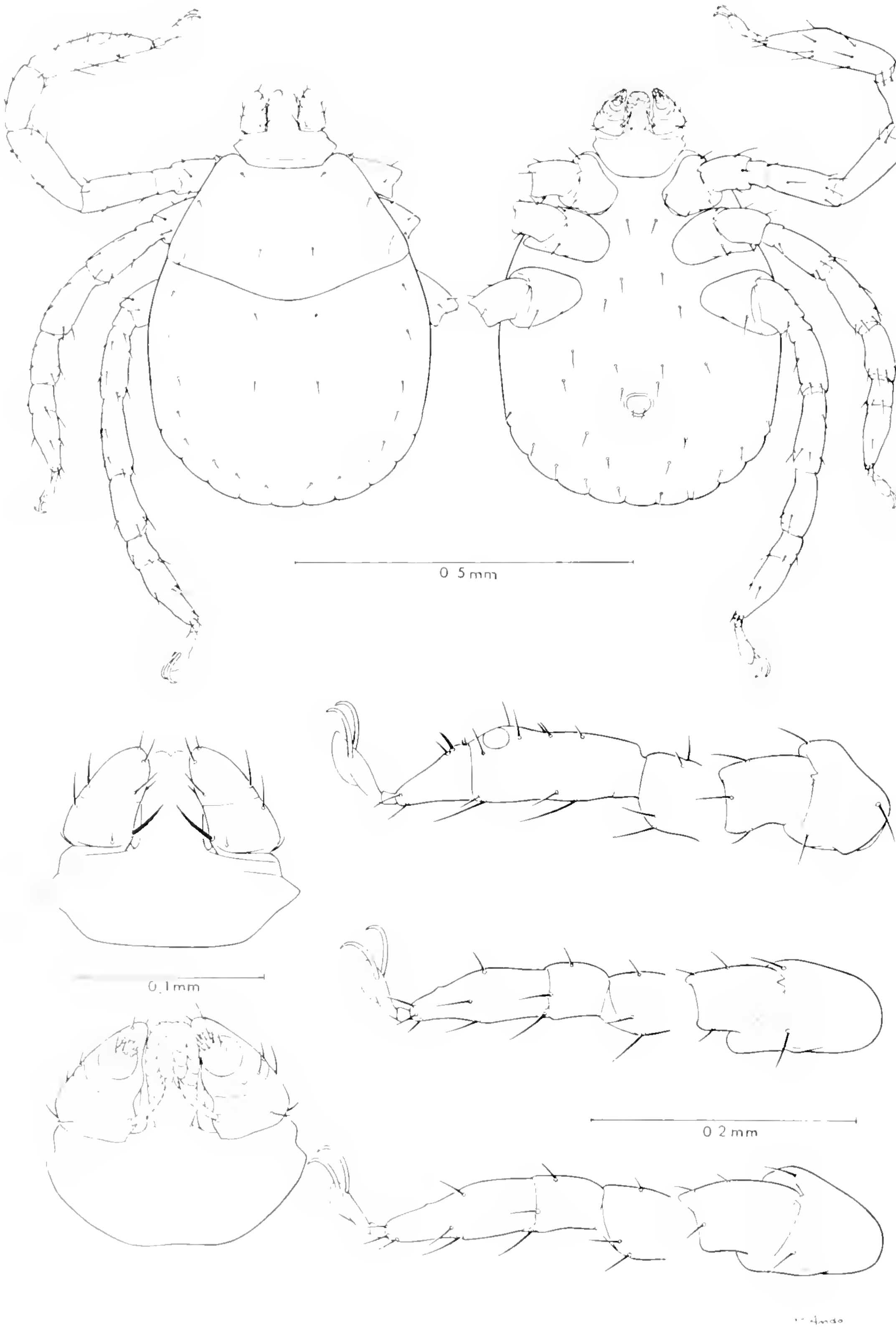


FIG. 122. *Rhipicephalus sanguineus*, larva.

Japan. However, it is readily supposed that it may have been introduced into Japan on pets of U.S. Forces personnel or in household effects.

Feldmann-Muhsam (1952) has suggested that the tick commonly known as *R. sanguineus* is actually not one species, but two. She proposed the specific name *secundus* for the new species, which is distinguished from *sanguineus* s. str. by the nature of the female genital aperture, and in immature stages by the shape of the capitulum. This distinction has not been fully accepted by Hoogstraal (1956).

DIAGNOSIS:

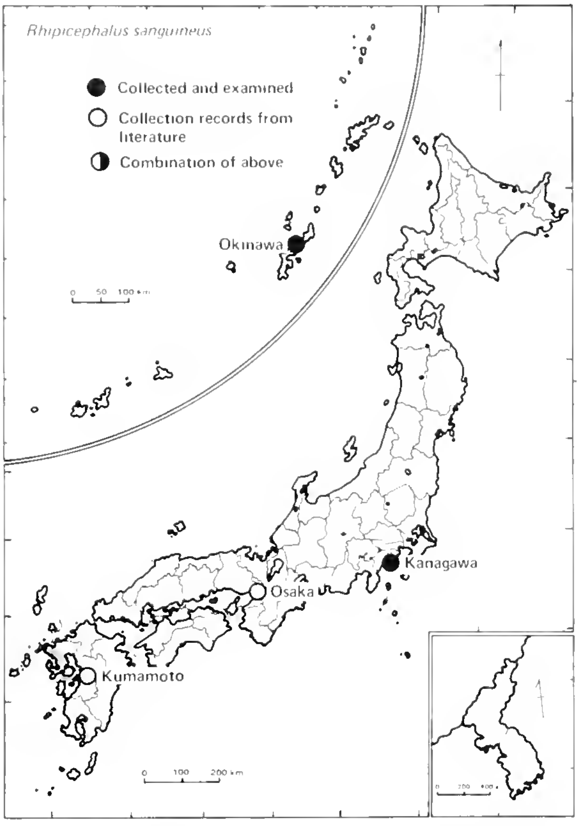
Since there is only one species of the genus *Rhipicephalus* that occurs in this area, it is easily identified.

DISTRIBUTION AND HOSTS:

Leeson (1951) did not include Japan, Korea, and the Ryukyu Islands as part of the distributional area of this species, but the special map published by the American Geographic Society (1954) shows Korea and the Ryukyu Islands as areas where *sanguineus* occurs. Anastos (1950) gave its distribution in the East Indies, and Kohls (1950) discussed its occurrence in the Philippines. As reported by Anastos (1950) and Hoogstraal (1956), *sanguineus* is primarily a parasite of dogs but also attacks a great variety of domestic and wild animals. It has been taken from birds as well as mammals, and in some areas has been known to attack man.

BIOLOGY:

Hoogstraal (1956) has reviewed the literature on the biology and medical importance of this tick. According to Hoogstraal's review, it is said to be a three-host tick, and the life cycle may be completed in as little as 63 days under favorable conditions. If conditions are unfavorable, it may be prolonged for many months. "In Nuttall's laboratory experiments, larvae fed on dogs and rabbits, nymphs on dogs, jackals, and hedgehogs, and adults on dogs and jackals" (Hoogstraal, 1956). He also cited several reports on parasites and predators of this tick. *Hunterellus hookeri* Howard, 1907 (= *Ixodiphagus caucurtei* du Buysson, 1912), a wasp, has been occasionally reported as a parasite of *R. sanguineus* in Africa, Brazil, USA, and other areas of the world. The eggs of this wasp are laid in the body of the nymph and the developing hymenopterous larvae feed on the contents of the engorged nymph and pupate in the body. A predaceous spider, *Teutena triangulosa* Wick, has been observed feeding on both immature and adult forms of this kennel tick in a Corsican house (Sautet, 1936).



MAP 37. Known distribution of *Rhipicephalus sanguineus*.

DISEASE RELATIONSHIP:

The medical importance of this tick has been thoroughly reviewed by Hoogstraal (1956). This species is known to transmit boutonneuse fever, Indian tick typhus, and Rocky Mountain spotted fever in areas where these diseases occur. In addition, it is of importance to veterinary medicine as a vector of canine rickettsiosis and canine piroplasmosis. The relapsing fever spirochaete, *Borrelia theileri*, is transmitted to domestic ruminants by *R. sanguineus*. Opinions differ regarding this tick as a parasite of man.

DOUBTFUL RECORDS

Amblyomma cordiferum Neumann, 1899:218-219; Kishida, 1930b: 134.

Keegan and Toshioka (1957) stated that the specimen was not in Dr. Kishida's collection and a misidentification might have been made. According to Kishida (1930b), one female specimen (lacking capitulum) was collected from

Cyclemys flavomarginata by N. Nakayama. He did not indicate the date and locality, but the host turtle is found on Ishigaki (Is.) and Iriomote (Is.) in the Ryukyus.

Amblyomma geoemydae (Cantor, 1847) is recorded from *Cyclemys flavomarginata* on Iriomote (Is.).

Amblyomma cyprium Neumann, 1899:219-221; Nakatsuji, 1943: 182-184, Fig. 1.

Nakatsuji (1943) reported the collection of one female tick of this species from a turtle, *Geoemyda spengleri*, on Okinawa. The figures published with this report are not adequate for discrimination.

Anastos (1950) stated that there were no authentic records of parasitism of reptiles by *A. cyprium cyprium*; it may be that the specimen reported by Nakatsuji was actually *geoemydae*, which is known to occur on turtles in the Ryukyu Islands (Keegan and Toshioka, 1957).

Haemaphysalis cinnabarina C. L. Koch, 1844: 337; Kishida, 1922a:846-855.

Kishida (1922a) listed both sexes of this species in his keys to the species which occur in Japan. Keegan and Toshioka (1957) stated that the occurrence of this species in Japan is very unlikely. Yajima (1956) listed it as occurring in Aomori Prefecture, but his record may have been derived from Kishida (1922a) (see Appendix 1). Keegan and Toshioka (1957) also quoted Kohls's 1957 personal communication noting that *cinnabarina*, described from Brazil, is a valid name for *chordeilis*, which occurs in North America.

Haemaphysalis papuana Thorell, 1882:62-66, Nakamura and Yajima, 1937:158-159, Fig. 5-9 in Pl. VIII.

Nakamura and Yajima (1937) reported two female specimens collected from a dog at Hamgyong-pukto, North Korea, 26 July 1935. According to Anastos (1950) this is essentially a tropical species, and Kohls (1957b) expressed doubt that this species occurs in Korea and other nontropical regions. The illustrations provided by Nakamura and Yajima (1937) do not look like those given by Anastos (1950) but appear to be similar to those of *H. japonica*.

Haemaphysalis punctata Canestrini and Fanzago, 1878:189.

Haemaphysalis cinnabarina punctata: Neumann, 1907:215-232, Fig. 1-4; Kishida, 1922a:852, Pomerantzev, 1950:92-93.

Kishida (1922a) listed *H. c. punctata* in his key, which seems to be derived from Neumann (1907). Although Pomerantzev (1950) stated that the species had been recorded from Japan, such records do not occur in the Japanese literature. He probably cited Neumann's record. Nuttall and Warburton (1915) expressed doubt as to the correct identification of Neumann's (1907) specimen from a horse in Aomori Prefecture, Japan. There are no specimens in Japanese collections at the present time, and the species has not been collected by Japanese acarologists.

Haemaphysalis shibutamiensis Yajima, 1955.

This is apparently a *nomen nudum*. Although Keegan and Toshioka (1957) state that Yajima described the species in the *Japanese Journal of Sanitary Zoology* 6(1):52-53, the specific name was neither given in the paper nor referred to in later papers by Yajima. Type specimens were not available for examination.

Haemaphysalis watanabei Yajima, 1942. (See under *H. flava*.)

Haemaphysalis hirudo L. Koch, 1877.

There were no figures with the original description, and the description itself was not adequate for determination. See under *H. concinna*.

Hyalomma aegypticum (Linnaeus, 1785); Kishida, 1936:139.

Kishida (1936) reported this species from a cow on Quelpart Island (= Chejudo Island, Korea), and it is the only record of this species from this area. Hoogstraal (1956) indicates that *H. aegypticum* occurs in the Mediterranean area and the Near East. It has been recorded from Russia, many parts of Asia Minor, and Afghanistan. This species is primarily a parasite of tortoises but may attach to other reptiles as well as mammals and birds. Pomerantzev (1950) gave information concerning the distribution and biology of this species. On the basis of this information, there is some doubt concerning the validity of the record from Quelpart Island (Keegan and Toshioka, 1957).

Ixodes acuminatus Neumann, 1901:287; Kishida, 1936:142.

"Kishida (1936) stated that Mr. Akasawa had collected *Ixodes acuminatus* from central Korea in 1928. No specimens have been reported from Korea, Japan, or the Ryukyu Islands since that date, and the species is not represented in existing collections from these areas" (Keegan and Toshioka, 1957).

Ixodes affinis Neumann, 1899:120; Kishida, 1930a:3; Suzuki, 1930:90-92, Fig. 1.

Kishida (1930a) listed *I. affinis* from a rabbit, *Lepus brachyurus angustidens*, at Fukushima City, 15 December 1929, collected by Dr. Ohara. Suzuki (1930) described and illustrated the species using a male specimen which had been taken from a rabbit of the same species. These specimens were not available for study, and unfortunately the reproduction of Suzuki's illustration of the male is not satisfactory for determination of the species.

Ixodes coreensis Kishida, 1933; Kishida, 1936:139.

"Efforts to locate the original description of this species were not successful. Kishida (1936) referred to this tick, giving the type locality as suburbs of Keijo (=Seoul), and the host as *Nyctereutes koreensis*. The species is not represented in any of the collections in Japan, and Dr. Kishida has informed the author that the holotype was lost during the war" (Keegan and Toshioka, 1957).

Ixodes fossulatus Neumann, 1899:120; Kishida, 1930a:2.

Kishida (1930a) listed this species as occurring on cattle and dogs at Sefuri-muri, Kanzaki-gun, Saga Prefecture. Keegan and Toshioka (1957) state that the specimens are not in the collection of Dr. Kishida and no additional specimens have been collected by Japanese workers. *I. fossulatus* is originally an Ecuadorian species.

Ixodes happinus Yajima, 1955; Keegan and Toshioka, 1957:31.

This is a *nomen nudum*. The specific name, *I. happinus*, is not given in any published papers by Yajima. See under *I. acutitarsus*.

Ixodes hayashii Nakatsuji, 1942:287-328, Fig. 3.

"This species description was based upon a single female tick taken from a dog on Miyake Island, 26 July 1937, by K. Hayashi. Figures given of the female include dorsal and ventral aspects of the tick (showing only the posterior portion of the capitulum), hypostome, and tarsus I. Unfortunately these are not adequate for identification of the species. The hypostome, as figured, is unlike that of any of the Japanese *Ixodes*. No specimens of this tick were collected by 406th MGL personnel and the species is not represented in any of the Japanese collections" (Keegan and Toshioka, 1957).

Ixodes lisphilus Kishida, 1930; 1922b:962-964, Fig. 1-2, 1930a:3-4.

This species was described by Kishida (1922b) using nymphal specimens taken from a squirrel, *Sciurus lis*, Nagano Prefecture, Japan, 1 June 1918, by Uchida. However, he (1922b) did not give the specific name but designated it later as a new species (1930a). According to Keegan and Toshioka (1957), the type specimens have been lost and no other material was available for study. Judging from the host and the figures given by Kishida (1922b), the species appears to be similar to *Ixodes persulcatus*.

Ixodes putus (Pickard-Cambridge, 1878). See under *I. uriae*.

Xenoacarus Kishida, 1925.

Palpi short; scutum not heavily sclerotized; postanal median groove extends to posterior body margin; festoons and eyes absent.

Xenoacarus makinoi Kishida, 1925:31.

The original description was not available for translation. Dr. Kishida informed Dr. Seiichi Toshioka that the original description consisted of only a few lines and no illustrations. No specimens were available for study. The generic diagnosis given above and the following species description were taken from a discussion of the species in *Essential Parasitology of the Domesticated Animals*, April 1926, p. 199-200, by S. Yoshida and T. Makino. A figure with this discussion showed a dorsal view of the scutum and capitulum of the female of *makinoi*.

"Male: Unknown.

"Female: Postanal median groove extends to posterior body margin; dorsal surface of basis capituli rectangular and bowed forward anteriorly. Dorsal scutum not heavily sclerotized and monochromatic. Palpi short as in *Haemaphysalis*. Coxa I with a large spur. [One unintelligible phrase preceded this statement.] Festoons and eyes absent. Legs and scutum yellowish in color, even in engorged specimens." This species has been found on leaves or stalks of plants. It has been collected from horses, etc. Paratype collected from Japan: Honshu, Aomori Prefecture, Kamikita-gun, Misawa-mura, Hirosawa pasture, August, 1925 (Keegan and Toshioka, 1957).

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LITERATURE CITED

American Geographical Society. 1954. Atlas of diseases. Plate 12, World distribution of rickettsial diseases - tick and mite vectors. (New York).

Amerson, A. B. Jr. 1968. Tick distribution in the Central Pacific as influenced by sea bird movement. J Med. Ent. 5(3):332-339.

Anastos, G. 1950. The scutate ticks, or Ixodidae, of Indonesia. Entomologica Americana 30(1-4):1-144.

Anonymous. 1964 Survey on ticks in the pasture at Sanbe, Shimane Prefecture, Report of the Institute of Animal Health of Shimane Prefecture. p. 1-10. (Japanese text, mimeographed.)

Arthur, D. R. 1955. *Ixodes kohlsi*, a new species of tick from Australia. *J. Parasitol.* 41 (1):18-23.

Arthur, D. R. 1956. The *Ixodes* ticks of Chiroptera (Ixodoidea, Ixodidae). J. Parasit. 42(2):180-196.

Arthur, D. R. 1957. Studies on exotic ticks (Ixodoidea, Ixodidae) from United States Navy and Army activities. J. Parasit. 43(6):681-694.

Arthur, D. R 1960. Ticks, a monograph of the Ixodoidea. Part V. On the genera *Dermacentor*, *Anocentor*, *Cosmiomma*, *Boophilus*, and *Margaropus*. Cambr. Univ. Press. 251 p.

Arthur, D. R. 1963. British ticks. Butterworth & Co., Ltd., London, 213 p.

Asanuma, K. 1941. *Haemaphysalis concinna*. Zool.

Mag. 53(6):306-307. (Japanese text.)

Asanuma, K. 1942. On the dog tick *Haemaphysalis campanulata*. Gunyoken 11(1):17-26. (Japanese text.)

Asanuma, K. 1944a. Some observations on the quantity of blood sucked by ixodids and on their body weight. (Studies of the egg-laying capacity of Ixodidae. I.) Inst. Res. Sci. Resour. Proc. (6):35-40. (Japanese text.)

Asanuma, K. 1944b. Minimum quantity of sucked blood capable of inducing egg-deposition in ixodids. (Studies on the egg-laying capacity of Ixodidae. II.) Inst. Res. Sci. Resour. Proc. (6):41-46. (Japanese text.)

Asanuma, K. 1944c. Influence of the quantity of sucked blood on the number of eggs laid by ixodids. (Studies on the egg-laying capacity of Ixodidae. III.) Inst. Res. Sci. Resour. Proc. (6):47-54. (Japanese text.)

Asanuma, K. 1944d. Egg-laying habits of ticks. Misc. Rep. Res. Inst. Nat. Resour. (19):21-31.

Asanuma, K. 1947a. Note on the role of blood in ovulation in a tick, *Haemaphysalis bispinosa*, together with remarks on the so-called specific differences in the number of eggs laid by ticks. Studies on the ovipositing ability of ticks, V. Seibutsu 2(1):7-14. (Japanese text.)

Asanuma, K. 1947b. p. 971-974. *In* Uchida et. al., Rev. ed. of illustrated encyclopedia of the fauna of Japan. Hokuryukan Co., Tokyo. 1898 p. (Japanese text.)

Asanuma, K. 1951. Notes on the tick, *Ixodes angustus* Neuman, new to Asia. Misc. Rep. Res. Inst. Nat. Resour. 22:1-4. (Japanese text.)

Asanuma, K. 1954. Studies on ticks and bloodsucking mites infesting rats (*genus Rattus*) in Japan. Part I. Misc. Rep. Res. Inst. Nat. Resour. (36):108-119. (Japanese text. English translation: NAMRU 3-T48.)

Asanuma, K. 1955a. On the ixodids and laeapitids parasitizing mice of Hokkaido, and mode of transmission of pathogens among host mice by the acari. Nihon Iji Shinpo (1611):1240-1242. (Japanese text.)

Asanuma, K. 1955b. Mode of disseminating the causative agent among the rats with various ticks and mites as vectors. Jap. Med. J. (1611):1240-1242. (Japanese text.)

Asanuma, K. 1956a. Tularemia, ticks, and mesostigmatid mites of the Far East. Ann. Prof. Rep., 406th Medical General Laboratory. p. 91-96.

Asanuma, K. 1956b. Personal communication.

Asanuma, K. 1957. Occurrence of the tick, *Ixodes angustus* Neuman, in Hokkaido, Japan, with remarks on its larval and nymphal stages. Jap. J. Saint. Zool. 8(4):234. (Japanese text.)

Asanuma, K. 1958a. New hosts of ixodid ticks. Shawa 33rd Monbusho Sogo Kenkyu Hokoku Shuroko (Med. and Pharmacy). p. 279. (Japanese text.)

Asanuma, K. 1958b Ecology of Ixodidae parasitic on media animals for yato-byo. 2. Rep. Ohara Hosp. 2(1):23. (Japanese text.)

Asanuma, K. 1958c. Yato-byo in Sado Island. 2. Rep. Ohara Hosp. 2(1):38-39. (Japanese text.)

Asanuma, K. 1960. Host and distribution records of the soft tick, *Ornithodoros capensis* Neumann, in Japan. Jap. J. Sanit. Zool. 11(2):94. (Japanese text.)

Asanuma, K. 1961. Blood-sucking acari - 2. Parasitic ticks of sea birds in Japan. Showa 36th Monbusho Kenkyu Hokoku Shuroku (Med. and Pharmacy). p. 181. (Japanese text.)

Asanuma, K. 1965a. Suborder Ixodides, p. 101-128. *In* Sasa, Mites, an introduction to classification, bionomics and control of Acarina. Univ. of Tokyo Press. 486 p. (Japanese text.)

Asanuma, K. 1965b. p. 397-401. *In* Okada et al., New illustrated encyclopedia of the fauna of Japan, Vol. II. Hokuryukan Co., Tokyo. 803 p. (Japanese text.)

Asanuma, K. 1969. Personal communication.

Asanuma, K., and S. Fukuda. 1957. On the life-his- of a tick, *Ixodes signatus*, infesting a black-tailed gull (*Larus crassirostris*) in Japan. Jap. J. Sanit. Zool. 8(3):147-159. (Japanese text.)

Asanuma, K., and K. Kosaka. 1954. Notes on the occurrence in Japan of a tick, *Haemaphysalis wellingtoni*, collected from a Japanese gray thrush, *Turdus cardis cardis*. Misc. Rep. Res. Inst. Nat. Resour. 36:104-107. (Japanese text English translation: NAMRU 3-T35.)

Asanuma, K., and K. Kosaka. 1955. Notes on a tick, *Ixodes turdus* Nakatsuji 1942, found on birds in Japan. Bull. Biogeogr. Soc. Jap. Appendix 16-19: 192-196. (Japanese text. English translation: NAM RU 3-T50.)

Asanuma, K., and H. Nakagawa. 1955. Studies on endemic and medically important arthropods on Niijima Island, Tokyo-to. Ochanomizu Igaku Zasshi 3(6):549. (Japanese text. English summary, p. 680.)

Asanuma, K., K. Okubo., and S. Fukuda. 1955. Infestation of a black-tailed gull (*Larus crassirostris*) with a tick, *Ixodes signatus*, in Kabushima, Aomori Prefecture, Japan, Misc. Rep. Res. Inst. Nat. Resour. 38:85-86. (Japanese text.)

Asanuma, K., and N. Sakurai. 1958. On the seasonal occurrence of the tick, *Haemaphysalis flava*, on wild hares (*Lepus timidus brachyurus*) in the endemic area of yato-byo or tularemia in Chiba Prefecture, Japan (A preliminary report). Misc. Rep. Res. Inst. Nat. Resour. (48):28-39. (Japanese text. English summary. English translation: NAMRU 3-T46.)

Asanuma, K., and N. Sakurai. 1960. Comparison between the infestation of *Ixodes japonensis* and *Haemaphysalis flava* on wild rabbits. 7. Rep. Ohara Hosp. 4(2):26. (Japanese text.)

Asanuma, K., N. Sakurai, S. Ohara, H. Odajima, K. Kosaka, and H. Nakagawa. 1955. On the host and distribution records of a tick, *Haemaphysalis flava*, a dominant parasite of wild hares in Japan. Misc. Ref. Res. Inst. Nat. Resour. (37):127-128. (Japanese text. English translation: NAMRU 3-T49.)

Asanuma, K., and K. Sekikawa. 1952. Studies on ticks of the genus *Ixodes* parasitic on small rodents of the superfamily Muroidea in the Japanese Islands (a preliminary note). I. Misc. Rep. Res. Inst. Nat. Resour. (28):107-116. (Japanese text.)

Asanuma, K., and K. Sekikawa. 1953. Studies on ticks of the genus *Ixodes* parasitic on small rodents of the superfamily Muroidea in the Japanese Islands (a preliminary note). II. Misc. Rep. Res. Inst. Nat. Resour. (31):99-112. (Japanese text.)

Asanuma, K., A. Shishido and M. Kitaoka. 1960. The life of *Rickettsia* in the bodies of larvae and nymphs of *Haemaphysalis bispinosa*. 7. Rep. Ohara Hosp. 4(2):26. (Japanese text.)

Asanuma, K., T. Takeda, and H. Nakagawa. 1961. Some observations on ticks found on birds in the Mt. Fuji area. (Japanese abstract of report before

13 Ann. Meet. Jap. Soc. Sanit. Zool., July 5.) Jap. J. Sanit. Zool. 12(2):139.

Asanuma, Y. 1943. Considerations on the amount of blood sucked by two species of ticks parasitic on dogs. Acta Arachn. 8(4):87-97. (Japanese text.)

Audy, J. R., M. Nadchatram, and B. Lim. 1960. Host distribution of Malayan ticks (Ixodoidea). Malaysian parasites - XLIX. Stud. Inst. Med. Res. Malaya 29:225-246.

Babenko, L. V. 1956. *Ixodes lividus* Koch as a representative of ixodid burrow inhabiting ticks. Mater. Pozn. Fauny Flory SSS R, n. s. Otd. Zool., vypusk 34 (XLIX): Ektoparazity, Fauna, Biol., Prakt. Znachenie (3):21-105.

Balashov, Yu S. 1954. Peculiarities of the day and night rhythm of the dropping of engorged females of *Ixodes persulcatus* from cows. Dokl. Akad. Nauk. USSR, n. s. 98(2):317-319.

Birula, A. 1895. Ixodidae novi vel parm cogniti Musei Zoologici Academiae Caesareae Scientiarum Petropolitinae. Bull. Acad. Sci. St. Petersb. Ser. 5, 2(4):353-364.

Blanchard, R. 1909. L'insecte et l'infection, histoire naturelle et medicalle des arthropodes pathogenes. Fasc. I. Aezriens. Libraire Scientifique et Litteraire; Paris. 160 p.

Bremner, K. C. 1959. Observations on the biology of *Haemaphysalis bispinosa* Neumann (Acarina: Ixodidae) with particular reference to its mode of reproduction by parthogenesis. Aust. J. Zool. 7:7-12.

Canestrini, G. 1887. Intorno ad alcuni acari ed Opilionidi dell'America. Atti. Soc. Veneto-Trent. Sci. Nat. 11:104-105.

Canestrini, G., and F. Fanzago. 1878. Intorno agli acari italiani. Atti R. Ist. Veneto Sci. Lett. Arti (1877-1878), 5. s, 4(1):69-208.

Cantor, T. 1847. Catalogue of reptiles inhabiting the Malay Peninsula and Islands. J. Asiatic Soc. Bengal 16:608.

Cerny, V., and E. Kratochvilova-Kralova. 1963. Development of the tick *Haemaphysalis concinna* in natural conditions of southern Moravia (Czechoslovakia). Zool. Listy 12(3):259-261.

Chikaki, H., and A. Otake. 1956. Ecology of ticks attacking cattle in a pasture. J. Jap. Soc. Applied Zoology 21(2):53-62. (Japanese text. English summary.)

Chikaki, H., A. Otake, and T. Miura. 1956. Consideration of cotton-flannel for the investigating method of *Haemaphysalis bispinosa* Neumann (Acarina: Ixodidae) in the pasture. Jap. J. Ecology 6(1):35-39. (Japanese text. English summary.)

Cooley, R. A. 1946. Note on the tick *Ixodes angustus* Neumann. J. Parasit. 32(2):210.

Cooley, R. A., and G. M. Kohls, 1945. The genus *Ixodes* in North America. Nat. Inst. Hlth. Bull. 184:1-246.

Dhanda, V., and H. R. Bhat. 1968. *Haemaphysalis* (*Haemaphysalis*) *indoflava* sp. n. (Acarina: Ixodidae) from the Himalayan region of Uttar Pradesh and Madras, India. J. Parasit. 54(5):1063-1067.

Dönitz, W. 1905. Die Zecken des Rindes als Krankheitsubertrager. S. B. Ges. Naturf. Fr. Berlin 4:105-134.

Elbl, A., and G. Anastos. 1966a. Ixodid ticks (Acarina, Ixodidae) of central Africa. Volume I. General introduction. Genus *Amblyomma* Koch, 1844. Ann. Mus. R. Afr. Cent., Ser. Svo, s. Sci. Zool. (145). 275 p.

Elbl, A., and G. Anastos. 1966b. Ixodid ticks (Acarina, Ixodidae) of central Africa. Vol. II. Genus *Ixodes* Latreille, 1795. Ann. Mus. R. Afr. Cent., Ser. Suo, s. Sci. Zool. (146). 205 p.

Elbl, A., and G. Anastos. 1966c. Ixodid ticks (Acarina, Ixodidae) of central Africa. Vol. III. Genus *Rhipicephalus* Koch, 1844. Ann. Mus. R. Afr. Cent., Ser. 8vo. s. Sci. Zool. (147). 555 p.

Elbl, A., and G. Anastos. 1966d. Ixodid ticks (Acarina, Ixodidae) of central Africa. Vol. IV. Genera *Aponomma* Neumann, 1899, *Boophilus* Curtice, 1891, *Dermacentor* Koch, 1844. *Haemaphysalis* Koch, 1844. *Hyalomma* Koch, 1844 and *Rhipicentor* Nuttall and Warburton, 1908. Lists and bibliography. Ann. Mus. R. Afr. Cent., Ser. 8vo. s. Sci. Zool. (148). 412 p.

Feldman-Muhsam, B. 1952. On the identity of *Rhipicephalus sanguineus*. Lat. Bull. Res. Council Israel 2(2):187-194.

Fuller, C. 1899. Notes on the Queensland cattle tick and its relationship to the Texas fever tick and the blue tick of Cape Colony, South Africa. Qd. Agric. J. 4:389-394.

Glaschenskaya - Babanko. 1956. (See Babenko, 1956.)

Han, T. W., and Y. Jeon. 1967. Studies on ticks. III. Observations on the life cycle of *Haemaphysalis bispinosa*. Res. Rep. Off. Rural Dev. 10(5):35-42. (Korean text. English summary.)

Han, T. W., and S. K. Kim. 1965. Survey and artificial infection of bovine *Piroplasama* in Korea. Res. Rep. Off. Rural Dev. 8(3):109-120. (Korean text. English summary.)

Han, T. W., Y. Jeon, and S. K. Kim. 1967. Studies on ticks. II. The monthly life flow of ticks in Korean cattle. Res. Rep. Off. Rural Dev. 10(5): 25-33. (Korean text. English summary.)

Han, T. W., S. K. Kim, and Y. Jeon. 1966. The classification and distribution of Korean cattle tick. Res. Rep. Off. Rural Dev. 9(3):91-103. (Korean text. English summary.)

Hara, J. 1963. A case report of the fowl tick, *Argas persicus* (Oken, 1818) which invaded residences (Acarina: Argasidae). Bull. School. Physi. Edu., Juntendo Univ. 6:123-125. (Japanese text. English summary.)

Hirst, S., and L. F. Hirst. 1910. Description of five new species of ticks (Ixodidae). Ann. Magaz. Nat. Hist. 8(6):299-308.

Honma, T., and S. Ohara. 1961. Morphology of yato-byo ticks. II. Internal structure of *Haemaphysalis flava* Neumann 1897. Male. Ann. Report - Ohara Hosp., No. 8. 5(1):1-7. (Japanese text. English summary.)

Hoogstraal, H. 1956. African Ixodoidea. I. Ticks of the Sudan (with special reference to Equatoria Province and with preliminary reviews of the genera *Boophilus, Margaropus, and Hyalomma*). Bureau of Med. and Surgery, Department of the Navy. 1101 p.

Hoogstraal, H. 1961. Redisription of *Haemaphysalis* (*Alloceraca*) *inermis aponommoides* Warburton, 1913 (Ixodoidea, Ixodidae). J. Parasit. 47 (2):317-318.

Hoogstraal, H. 1962. *Haemaphysalis nepalensis* sp. n. from a Himalayan rodent and man and description of the male of *H. aponommoides* Warburton (n. comb.) (Ixodoidea. Ixodidae). J. Parasit. 48(2):195-203.

Hoogstraal, H. 1966. Ticks in relation to human diseases caused by viruses. Ann. Rev. Ent. 11:261-

308.

HOOGSTRAAL, H. 1967a. Tick - borne hemorrhagic fevers, encephalitis, and typhus in USSR and southern Asia. Exper. Parasit. 21(1):98-111.

HOOGSTRAAL, H. 1967b. Ticks in relation to human diseases caused by rickettsia species. Ann. Rev. Ent. 12:377-420.

HOOGSTRAAL, H. 1968. Personal communication.

HOOGSTRAAL, H. 1969a. Letter No. 1013. 28 May 1969. NAMRU 3.

HOOGSTRAAL, H. 1969b. *Haemaphysalis* (*Alloceraea*) *kitaokai* sp. n. of Japan, and keys to species in the structurally primitive subgenus *Alloceraea* Schulze of Eurasia (Ixodoidea, Ixodidae). J. Parasit. 55(1): 211-221.

HOOGSTRAAL, H., AND M. N. KAISER. 1960. *Boophilus kohlsi* n. sp. (Acarina: Ixodidae) from sheep and goats in Jordan. J. Parasit. 46(4):441-448.

HOOGSTRAAL, H., F. H. S. ROBERTS, G. M. KOHLS, AND V. J. TIPTON. 1968. Review of *Haemaphysalis* (*Kaiseriana*) *longicornis* Neumann (resurrected) of Australia, New Zealand, New Caledonia, Fiji, Japan, Korea, northeastern China, and USSR, and its parthenogenetic and bisexual populations (Ixodoidea, Ixodidae). J. Parasit. 54(6):1197-1213.

HOOGSTRAAL, H., AND H. TRAPIDO. 1966. Redescription of the type materials of *Haemaphysalis* (*Kaiseriana*) *bispinosa* Neumann (India), *H.* (*K.*) *neumanni* Dönitz (Japan), *H.* (*K.*) *lagrangei* Larrousse (Vietnam), and *H.* (*K.*) *yeni* Toumanoff (Vietnam) (Ixodoidea, Ixdidae). J. Parasit. 52(6): 1188-1198.

HOOGSTRAAL, H., H. TRAPIDO, AND G. M. KOHLS. 1965. Studies on southeast Asian *Haemaphysalis* ticks (Ixodoidea, Ixodidae). The indentity, distribution, and hosts of *H.* (*Kaiseriana*) *hystricis* Supino. J. Parasit. 51(3):467-480.

HOOGSTRAAL, H., AND N. YAMAGUTI. 1970. *Haemaphysalis* (*H.*) *pentalagi* Pospelova-Shtrom, a parasite of the Japanese black rabbit; rediscription of the male and description of the female, nymph, and larva (Ixodoidea, Ixodidae). J. Parasit. 56(2):367-374.

INATOMI, S., AND N. YAMAGUTI. 1960. On an Argasid tick found at Niimi City. Bull. West Br. Jap. Soc. Sanit. Zool. 15:17-18. (Japanese text.)

ISHIHARA, T., AND S. ISHII. 1956. Studies on piroplasmosis by *Theileria mutans* in Japan. Abst. Proc. Mon. Meet. Staff Natl. Inst. Anim. Hlth. 3:41. (Japanese text.)

ITAGAKI, S., R. NODA, AND T. YAMAGUCHI. 1944. Ticks parasitic on domestic animals of Asia. Jap. Horse-Racing Assn. 97 p. (Japanese text.)

ITAGAKI, S., R. NODA, AND T. YAMAGUCHI. 1959. Studies on the ticks of the domestic animals in the Far East. Jap. Soc. Promotion Sci. 118 p., 27 pl.

Ito, S. 1903. *Ixodes ricinus*. Chugai Iji Shinpo (561), 23(15):1032-1034 (p. 24-26).

ITO, Y., T. KOMATSU, AND A. SUZUKI. 1959. Chronic tularemia and the epidemicological mass survey in Takada City, Iwate Prefecture. 4. Rep. Ohara Hosp. 3(1):25-29. (Japanese text. English summary.)

ITO, T., AND Y. SAITO. 1954 On the rickettsioid microorganisms found in *Steatonussus* sp. and *Argas* sp. parasitic on *Pinistrellus abramus*. Tokyo Ijishinishi 71(10):3-4. (Japanese text.)

KAMO, H. 1962. Parasitic acari in western part of Japan. Showa 37th Monbusho Kenkyu Hokoku Shuroku (Med. and Pharmacy). p. 173. (Japanese text.)

KARSCH, F. 1880. Vier neue Ixodiden des Berliner Museums. Mittheil. d. Munchener Entomol. Vereine. Jahrg. 4:141-142.

KATSURA, S. 1957-1959. Studies on the bacterial and infectious diseases transmitted by ticks in Japan. Showa 32nd, 33rd, and 34th Monbusho Sogo Kenkyu Hokoku Shuroku. p. 265-274 (1957); p. 277-288 (1958); p. 327-336 (1959). (Japanese text.)

KAWASHIMA, K. 1963. Studies on the acarine fauna of the Ryukyu Islands (1). Some records of ticks. Jap. J. Sanit. Zool. 14(2):103. (Japanese text.)

KAWASHIMA, K., H. KAMO, AND I. MIYAZAKI. 1960. A case of human infestation with a hard tick, *Amblyomma testudinarium* Koch, in Japan. Kyushu J. Med. Sci. 11(2):77-80.

KEEGAN, H. L., AND S. TOSHIOKA. 1957. Ixodid ticks of Japan, Korea, and the Ryukyu Islands. Report —406th Medical General Laboratory. 37 p., 42 pl.

KIERANS, J. E., AND G. M. KOHLS. 1970. *Ixodes philipi* n. sp. (Acarina: Ixodidae), a sea bird parasite in Japan. J. Med. Ent. 7(6):725-726.

KISHIDA, K. 1922a. Notes on the ticks of the family Ixodidae parasitic on Japanese mammals (Artiodactyla: Bunodontia). Zool. Mag. 34(408): 846-857. (Japanese text.)

KISHIDA, K. 1922b. Tick from a squirrel. Zool. Mag. 34(410):962-964. (Japanese text.)

KISHIDA, K. 1925. Abstracts of the Seventh meeting of the Tokyo Parasitological Society, No. 2459:31.

KISHIDA, K. 1927. Acarina, p. 985-986. *In* Oka et al., Illustrated encyclopedia of the fauna of Japan. Fig. 1897-1899. Hokuryukan Co., Tokyo. (Japanese text.)

KISHIDA, K. 1929. Supplements to the knowledge of Japanese cattle tick, *Boophilus annulatus caudatus*. Lansania 1(2):19-22. (Japanese text.)

KISHIDA, K. 1930a. Notes on Japanese ticks of the genus *Ixodes* Latreille, 1795. Lansania 2(11):1-5. (Japanese text.)

KISHIDA, K. 1930b. Occurrence of a turtle tick, *Amblyomma cordiferum*, in Loo-choo. Lansania 2(19):134. (Japanese text.)

KISHIDA, K. 1935. Notes on the Acarina-mites and ticks, from the islands of Formosa collected in August 1935. Lansania 7(69):129-144. (Japanese text.)

KISHIDA, K. 1936. Notes on the Acarina-mites and ticks, from the peninsula of Korea and the island of Quelpart collected in August 1936. Lansania 8(79):131-144. (Japanese text.)

KISHIDA, K. 1939a. On the cattle ticks of the Boophyleae from Japan. Zool. Mag. 51(7):538-552. (Japanese text.)

KISHIDA, K. 1939b. Arachnida of Jehol: Order Acarina. Rep. 1. Sci. Exped. Manchoukuo, Sect. 5, Div. 1, Pt. 4, Art. 13. p. 1-49, Pl. 1-5.

KISHIDA, K. 1947. Acarina, p. 972-975. *In* Uchida et al., Rev. ed. of Illustrated encyclopedia of the fauna of Japan. Fig. 2767, 2774, 2775. Hokuryukan Co., Tokyo. 1868 p. (Japanese text.)

KISHIDA, K., AND K. ASANUMA. 1965. Acarina, p. 397. *In* Okada et al., New illustrated encyclopedia of the fauna of Japan. Hokuryukan Co., Tokyo. 803 p. (Japanese text.)

KITAOKA, S. 1961a. Physiological and ecological studies on some ticks. IV. Physiological stage and lipid deposit during the blood-sucking process in the tick. Nat. Inst. Anim. Hlth. Quart. 1(2):85-95.

KITAOKA, S. 1961b. Physiological and ecological studies on some ticks. V. Nitrogen and iron excretion and amount of blood meal ingested during the blood-sucking process in the tick. Nat. Inst. Anim. Hlth. Quart. 1(2):96-104.

Kitaoka, S. 1961c. Physiological and ecological studies on some ticks. VI. Rate of digestion of blood meal and nitrogen, iron, and sterol economy during the ovipositing process in the tick. Nat. Inst. Anim. Hlth. Quart. 1(2):105-112.

Kitaoka, S. 1961d. Physiological and ecological studies on some ticks. VII. Parthenogenetic and bisexual races of *Haemaphysalis bispinosa* in Japan and experimental crossing between them. Nat. Inst. Anim. Hlth. Quart. 1(3):142-149.

Kitaoka, S. 1962. Physiological and ecological studies on some ticks. VIII. Diurnal and nocturnal changes in feeding activity during the blood-sucking process of *Haemaphysalis bispinosa*. Nat. Inst. Anim. Hlth. Quart. 2(2):106-111.

Kitaoka, S. 1967. Some characteristic features of feeding in ticks. Jap. Agric. Res. Quart. 2(4): 18-21.

Kitaoka, S. 1970. *Haemaphysalis* (*Haemaphysalis*) *fujisana* sp. n. (Ixodoidea, Ixodidae), a cattle parasite in Japan. Nat. Inst. Anim. Hlth. Quart. 10(2):25-33.

Kitaoka, S. and T. Morii. 1963. Supplementary tests on the effects of new organophosphorus and other compounds as tickicides against *Boophilus microplus*. Nat. Inst. Anim. Hlth. Quart. 3(1):32-35.

Kitaoka, S., and T. Morii. 1966. The biology of *Haemaphysalis inermis* Birula and *H. concinna* Koch with particular reference to the mode of blood-sucking process. (Abstract 18. Ann. Meet. Jap. Soc. Sanit. Zool. April 29-30, 1966). Jap. J. Sanit. Zool. 17(2):141-142. (Japanese text.)

Kitaoka, S., and T. Morii. 1967a. The biology of *Haemaphysalis* (*Alloceraca*) *ambigua* Neumann, 1901, with description of immature stages. (Ixodoidea, Ixodidae). Nat. Inst. Anim. Hlth. Quart. 7(3):145-152.

Kitaoka, S., and T. Morii. 1967b. Effects of gamma radiation and chemosterilants on the cattle tick, *Boophilus microplus*. Jap. J. Sanit. Zool. 18(2-3): 126-129. (Japanese text.)

Kitaoka S., and Y. Saito. 1967. *Ixodes nipponensis* n. sp. (Ixodoidea Ixodidae). A common cattle tick in Japan. Nat. Inst. Anim. Hlth. Quart. 7(2): 74-83.

Kitaoka, S., and A. Yajima. 1958a. Physiological and ecological studies on some ticks. I. Process of growth by blood-sucking. Bull. Nat. Inst. Anim. Hlth. 34:135-147.

Kitaoka, S and A. Yajima. 1958b. Physiological and ecological studies on some ticks. II. Phase change of ovipositing ability with blood-sucking quantity. Bull. Nat. Inst. Anim Hlth. 34:149-162.

Kitaoka, S and A. Yajima. 1958c. Physiological and ecological studies on some ticks. III. Parasitic duration of *Boophilus caudatus*. Bull. Nat. Inst Anim. Hlth. 35:179-188

Kitaoka, S., and A. Yajima. 1961a. Comparison of effectiveness between pesticides against *Boophilus microplus* by topical application and spraying. Nat. Inst. Anim. Hlth Quart. 1(1):41-52.

Kitaoka, S and A Yajima. 1961b. Bisexual parthenogenic races of *Haemaphysalis bispinosa*. (Japanese abstract of report before 13. Ann. Meet.) Jap. J. Sanit. Zool 12(2):141-142. (Japanese text.)

Koch, C. L. 1844 Systematische Übersicht über die Ordnung der Zecken. Arch. Naturgesch 1:217-239.

Koch, C. L. 1887. Japanesische Arachniden und Myriapoden. Verh. k. k. zoolog-botan. Ges. Wien. 27:786.

Kohls, G. M. 1950. Ticks (Ixodoidea) of the Philippines. Nat. Inst. Hlth. Bull. 192:1-28.

Kohls, G. M. 1957a. Acarina: Ixodoidea. Insects of Micronesia 3(3):85-104. Bernice P. Bishop Museum, Honolulu, Hawaii.

Kohls, G. M. 1957b. Ticks (Ixodoidea) of Borneo and Malaya. Malaysian Parasites — XVIII. Stud. Inst. Med. Res. Malaya 28:65-94.

Kohls, G. M. 1967. Personal communication.

Krijgsman, B J., and S. A. S. Ponto. 1932. De teken van den Oost-Indischen Archipel. Veeartsenijk. Meded. Batavia 79:62 p., 5 maps.

Latreille, P. A. 1802. Histoire naturelle, generale et particuliere des crustaces et des insectes (etc.). 3:468 p. Paris (Cf. p. 67-68).

Latreille, P. A. 1806. Genera crustaceorum et insectorum. I. p. 157.

Leeson, H. S. 1951. The recorded distribution of the tick *Rhipicephalus sanguineus* (Latreille). Bull. Ent. Res. 42(1):123-124.

Linnaeus, C. 1758. Systema Naturae. Regnum Animals, 10th ed.

Lounsbury, C. P. 1905. Habits and peculiarities of some South African ticks. Brit. Assn. Advanc. Sci. Sec. D. S. Afric. 10 p.

Mel'nikova, T. G. 1958. On the development of *Haemaphysalis concinna* ticks under natural conditions of the Crimean State game preserve. Zool. Zh. 37(2):297-300. (Russian text. English translation: NAMRU e-T207.)

Minning, W. 1934. Beitrage zur Systematik und Morphologie der Zeckengattung *Boophilus* Curtice. Z. Parasitenk. 7(1):1-43.

Minning, W. 1935. Zur Kenntnis des genus *Boophilus* Curtice I. Z. Parasitenk. 7(6):719-724.

Minning, W. 1936. Zur Kenntnis des genus *Boophilus* Curtice, II. Z. Parasitenk. 8(3):365-370.

Morel, P. C. 1963. Identite d'*Ixodes ovatus* Neumann, 1899 (Acariens, Ixodidae). Ann. Parasit. Hum. Com. 38(6):925-928.

Nadchatram M. 1960. Notes on rearing Malayan ixodid ticks (Acarina, Ixodidae) with special reference to *Ixodes granulatus* Supino and *Amblyomma geoemydae* (Cantor). Malaysian Parasites — XLVIII: Stud. Inst. Med. Res. Malaya 28:217-224.

Nagahana, M., and K. Matsuo. 1962. Two species of ticks parasitic on the human body. Med. and Bio. 62(5):119-121. (Japanese text.)

Nakamura, T., and A. Yajima. 1937. On morphology and distribution of the family Ixodidae in Japan particularly species parasitizing cattle and horses. Jeuki Chosasho Kenkyu Hokoku (Rep. of Gov. Exp. Sta. for Anim. Hyg.) 17:133-184. (Japanese text.)

Nakamura, T., and A Yajima. 1942a. On the life history of *Haemaphysalis bispinosa* Neumann, 1897. Rep. of Gov Exp. St. for Anim. Hyg. 19:21-23. (Japanese text.)

Nakamura, T., and A. Yajima. 1942b. On the larval stages of four species of ticks of the family Ixodidae. Rep. of Gov. Exp. Sta. for Anim. Hyg. 19:34-39 (Japanese text.)

Nakatsuji, K. 1942. Arachnida from Izu-shitito. Nogaku Shuho, Tokyo Univ. Agric. 1(4):287-328. (Japanese text.)

Nakatsuji, K 1943. Some Arachnida from Is. Okinawa and Is. Amami Oshima. Nogaku Shuho Tokyo Univ Agric. 2(1):182-184 (Japanese text.)

Namba, N. 1953. On the effect of temperature and humidity upon the embryonic development of ticks in pasturage. Res. Bull. Hokkaido Nat. Agric. Exp. Sta. 64:130-135. (Japanese text. English summary.)

Namba, N. 1954. On the behavior of larvae of *Haemaphysalis bispinosa* on plants. Hokkaido Nat. Agric. Exp. Sta. Rep. 66:49-55. (Japanese text. English summary.)

Namba, N. 1958. Ecological studies on *Haemaphysalis bispinosa*, a harmful tick in the pasture of northern Japan. Hokkaido Nat. Agric. Exp. Sta. Rep. 50:1-99. (Japanese text. English summary.)

Namba, N. 1963a. On methods of collecting unfed ticks on vegetation in grazing pastures. Jap. Soc. Grassland Sci. J. 9:21-28. (Japanese text. English summary.)

Namba, N. 1963b. Researches on the distribution of ticks and their habitat in pastures of Hokkaido. Res. Bull. Hokkaido Nat. Agric. Exp. Sta. 80:103-114. (Japanese text. English summary.)

Neumann, L. G. 1897. Revision de la famille des ixodides. 2e memoire. Mem. Soc. Zool. Fr. 10(3-4):324-420.

Neumann, L. G. 1899. Revision de la famille des ixodides. 3e memoire. Mem. Soc. Zool. Fr. 12:107-294.

Neumann, L. G. 1901. Revision de la famille des ixodides. 4e memoire. Mem. Soc. Zool. Fr. 14 (2-3):249-372.

Neumann, L. G. 1902. Notes sur les ixodides. I. Arch. Parasit. 6(1):109-128.

Neumann, L. G. 1904. Notes sur les ixodides. II. Arch. Parasit. 8(3):444-464.

Neumann, L. G. 1905. Notes sur les ixodides. III. Arch. Parasit. 9(2):225-241.

Neumann, L. G. 1906. Notes sur les ixodides. IV. Arch. Parasit. 10(2):195-219.

Neumann, L. G. 1907. Notes sur les ixodides. V. Arch. Parasit. 11(2):215-232.

Neumann, L. G. 1908. Notes sur les ixodides. VI. Arch. Parasit. 12(1):5-27.

Neumann, L. G. 1911. Ixodidae. Das Tierreich, 26. Berlin. 169 p.

Neumann, L. G. 1913. H. Sauter's Formosa Ausbeute. Pediculidae. Siphonaptera, Ixodidae. Supplementa Entomologica herausg. vom Deutschen Entomol. Museum No. 2:134-137. Berlin Dahlem.

Neumann, L. G. 1916. Ixodidei (Acariens): premiere serie. Arch. Zool. exp. gen. 55(12):517-527.

Nuttall, G. H. F., and C. Warburton. 1908. On a new genus of the Ixodoidea together with a description of eleven new species of ticks. Proc. Cambr. Philos. Soc. 14(4):392-416.

Nuttall, G. H. F., and C. Warburton. 1911. Ticks. a monograph of the Ixodoidea. Part II. Ixodidae. Section I. Classification. Section II. The genus *Ixodes*. p. 105-348. Cambr. Univ. Press.

Nuttall, G. H. F., and C. Warburton. 1915. Ticks, a monograph of the Ixodoidea. Part III. The genus *Haemaphysalis*. p. 349-550. Cambr. Univ. Press.

Ogura, K. 1936. The ticks parasitic on the principle domestic animals in Formosa, Japan. Mem. Fac. Sci. Taihoku Imp. Univ. Formosa 19(2):75-85.

Ogura, K. and K. Takada. 1927. The ticks parasitic on cattle and horses in Hokkaido Japan. J. Coll. Agric. Hokkaido Imp. Univ. 18(4):199-206.

Ohara, S. 1954. Studies on yato-byo (Ohara's disease, tularemia in Japan). Rep. I. Jap. J. Exp. Med. 24:69-79.

Ohara, S. 1955. Studies on yato-byo (Ohara's disease, tularemia in Japan). Rep. II. Jap. J. Exp. Med. 25:7-14.

Ohara, S., and K. Ichikawa. 1962. The distribution of yato-byo and its clinical observations. Annual Report of Ohara Hospital No. 11, p. 1-23. (Japanese text. English summary.)

Ohara, S., T. Noguchi, T. Honma and M. Kato. 1959. Morphology of yato-byo ticks I. Internal structure of *Haemaphysalis flava* Neumann, 1897, Female. Ann. Rep. — Ohara Hospital. No. 6. 3(1):8-18. (Japanese text. English summary.)

Ohara, S., and M. Sato. 1953. Tick-borne infection of yato-byo. Rinshoigaku 8:87.

Ohara, S. and S. Tamura. 1958. A case report of a tick infesting the human anus. Bull. West Br. Jap. Sanit. Zool. 14:23-24. (Japanese text, mimeographed.)

Oken, L. 1818. Sogenannte giftige Wanze in Persien. Isis. p. 1567-1570, Pl. 19, Fig. 1-4.

Oliver, J. H. Jr., and C. Bremner. 1968. Cytogenetics of ticks (Acari: Ixodoidea) 3. Chromosomes and sex determination in some Australian hard ticks (Ixodidae). Ann. Ent. Soc. Amer. 61 (4):837-844.

Oliver, J. H., and H. Tanaka. 1968. Personal communication.

Olsufjev, N. G., and V. G. Petrov. 1960. Discovery of *Haemaphysalis concinna* Koch ticks naturally infected by the tularemia agent. Trud. Inst. Zool. Akad. Nauk. Kazakh. USSR. (12):54:56.

Ono, Z. 1962a. Descriptions on the immature forms of *Ixodes* sp. reared in the laboratory of Ohara General Hospital, Fukushima, Japan. Ann. Rep. Ohara Gen. Hospital, No. 11, 6(2):24-29. (Japanese text. English summary.)

Ono, Z. 1962b. Some notes on the ectoparasites found on small rodents and shrews in Maruyama district, Sapporo, Hokkaido. Jap. J. Sanit. Zool. 13(2):155. (Japanese text.)

Ono, Z. 1966. Studies on ticks parasitic on small rodents of the family Muridae in Hokkaido. Rep. Hokkaido Inst. Publ. Hlth. 16:62-68. (Japanese text. English summary.)

Ono, Z. 1967. *Ixodes lividus* (C. L. Koch. 1844). A bird tick new to Japan. Jap. J. Sanit. Zool. 18 (4):217. (Japanese text.)

Pavlovsky, E. N., and V. D. Soloviyev. 1963. *Haemaphysalis concinna* (circulation of the virus of spring-summer encephalitis in the organism of tick-vector *Haemaphysalis concinna*). Rabot. Eksper. Parazit. p. 197-204. Illus. (Russian text. English summary.)

Pickard-Cambridge, O. 1878. An account of the collections made in Kerguelen Land during the transit of Venus Expedition (1874-75). Zoology: Arachnida. *In* Philos. Trans. Roy. Soc. London 168:222. Pl. 13. Fig. 4.

Pomerantzev, B. I. 1950. Fauna of the USSR. Arachnida. 4(2). Ixodid Ticks (Ixodidae). Zool. Inst. Acad. Sci. USSR. New Series No. 41, Moscow. 224 p. (English translation published by Amer. Inst. Biol. Sci., Washington.)

Pospelova-Shtrom, M. V. 1935. On the systematics of ticks of the genus *Haemaphysalis* C. L. Koch. Trav. Fil. Acad. Sci. USSR, Tadzhik. 5:205-217.

Robinson, L. E. 1926. The Genus *Amblyomma*. Ticks, a monograph of the Ixodoidea. Part IV. p. 1-302. Cambr. Univ. Press.

Saito, K., T. Iijima and M. Minai. 1969. Studies on the effect of several insecticides against *Argas japonicus*. Jap. J. Sanit. Zool. 20(1):39-41. (Japanese text. English summary.)

Saito, Y. 1955. On five species of ectoparasites on bats (*Pipistrellus abramus*) collected in Niigata City, Japan. Niigata Igakkai Zasshi 69(1):7-12. (Japanese text.)

Saito, Y. 1958. On the internal organs of larval, nymphal, and adult stages of the tick, *Ixodes persulcatus persulcatus*. Jap. J. Sanit. Zool. 9:70. (Japanese text.)

Saito, Y. 1959a. Studies on the transovarial transmission of *Pasteurella tularensis* in the three tick species (*Ixodes persulcatus persulcatus, Ixodes japonensis*, and *Haemaphysalis flava*). Jap. J. Bact. 14:565. (Japanese text.)

Saito, Y. 1959b. Studies on ixodid ticks, I. On ecology, with reference to distribution and seasonal occurrence of ixodid ticks in Niigata Prefecture, Japan. Acta. Med. Biol. 7(3):193-209.

Saito, Y. 1960a. Studies on ixodid ticks, II. On the rearing and life history of three tick species (*Haemaphysalis flava, Ixodes persulcatus persulcatus*, and *Ixodes japonensis*) in Japan (Acarina: Ixodidae). Acta. Med. Biol. 7(4):303-321.

Saito, Y. 1960b. Studies on ixodid ticks, IV. The internal anatomy in each stage of *Haemaphysalis flava* Neumann, 1897. Acta. Med. Biol. 8(3): 189-293.

Saito, Y. 1962a. Studies on ixodid ticks, VI. Additional report of tick rearing, with a presentation of a new tick container. Acta. Med. Biol. 10(2): 127-146. Illus.

Saito, Y. 1962b. Isolation of *Pasteurella tularensis* from ticks and chiggers parasitic on tularemia-wild hares, with some tularemia transmission experiment. Acta. Med. Biol. 10(2):147-159. Illus.

Saito, Y. 1964. Studies on ixodid ticks, VII. Notes on the ticks infesting badgers in Japan with a description of *Ixodes tanuki* n. sp. Acta. Med. Biol. 12(1):59-66.

Saito, Y. 1967. Studies on ixodid ticks, IX. *Ixodes monospinosus* n. sp. from man in Niigata Prefecture, Japan (Ixodoidea, Ixodidae). Acta. Med. Biol. 15(2):107-112, Fig. 9.

Saito, Y. 1969. Studies on ixodid ticks, X. *Haemaphysalis megaspinosa* n. sp. (Ixodoidea, Ixodidae) from Kanagawa Prefecture, Japan. Acta. Med. Biol. 17(1):87-96.

Saito, Y., M. Kubota, A. Yajima, T. Watanabe, and K. Kamino. 1965. Studies on ixodid ticks, VIII. On *Haemaphysalis bispinosa* Neumann, 1897 in Niigata Prefecture, Japan, with some supplementary observation on bovine piroplasmosis. Acta. Med. Biol. 13(2):143-159. Illus.

Saito, Y., and S. Ohara. 1961. Studies on ixodid ticks V. Further studies on the reactions of the skin of laboratory animals to the bites of immature ticks. Acta. Med. Biol. 9(1):1-32.

Saito, Y. S. Ohara, and T. Unagami. 1960. Studies on ixodid ticks, III. Comparative observation on the histological changes of host tissue caused by tick bite. Acta. Bed. Biol. 7(4)323-329.

Sautet, J. 1936. Invasion domicilaire de *Rhipicephalus sanguineus* et de *Teutana triangulosa*. Role ixodiphage des araignees. Ann. Parasit. hum. comp. 14(2):126-129.

Schulze, P. 1930. Über einige Verwandte von *Ixodes ricinus* L. aus Ostasien. Zool. Anzeiger. 90:294-303.

Schulze, P. 1933. Die Arten der Zeckengattung *Dermacentor* s. l. aus Europa, Asien, und Neu-Guinea. Z. Parasitenk. 6(3):416-431.

Schulze, P. 1935. Zur Zeckenfauna Formosas. Zool. Anzeiger. 112:233-237.

Schulze, P. 1938. Über die "bipolar" Zecke Ceratixodes uriae (White) – *putus* (Pick.-Cambr.). Zool. Anzeiger 123(1-2):12-17.

Sharif, M. 1928. A revision of the Indian Ixodidae with special reference to the collection in the Indian Museum. Rec. Indian Mus. 30(3):217-334.

Sharif, M. 1938. Diseases transmitted by the Indian species of ticks and the possibility of their prevention through biological control. Ind. J. Vet. Sci. 8(4):353-366. (reprinted 1939.)

Shigamori, M., K. Aso, and A. Yajima. 1953. On the Ixodidae in Kumamoto Prefecture, Kyushu, Japan. Nihon Juigakkai Zasshi (Jap. J. Vet. Sci.) 6:290-293. (Japanese text.)

Somov, G. P., and V. I. Shestakov. 1963. On spontaneous infection of *Haemaphysalis japonica douglasi* Nuttal and Warburton ticks with *D. sibiricus* rickettsiae in Primorsk region. J. Microbiol., Moscow 40(12):51-56.

Sugimoto, M. 1935. Note on the Formosan ticks, I. Taiwan no Chikusan 3(9):Suppl. 1-33, 3 Pls. (Japanese text.)

Sugimoto, M. 1936a. Note on the Formosan ticks, II. Taiwan no Chikusan 4(1):1-11. (Japanese text.)

Sugimoto, M. 1936b. Note on the Formosan ticks, IV. Taiwan no Chikusan 4(3):1-20. (Japanese text.)

Sugimoto, M. 1936c. Note on the Formosan ticks. J. Cent. Soc. Vet. Med. 49(7):577-590. (Japanese text.)

Sugimoto, M. 1936d. On a new variety (*Haemaphysalis cornigera* var. *taiwana* n. var.) and a new species (*Ixodes taiwanensis* n. sp.) of ticks from the Formosan domesticated animals. J. Soc. Trop. Agric. Taiwan 8(4):336-346. (Japanese text.)

Sugimoto, M. 1937a. Notes on the ticks in the Formosan mountain reservation for the Aborigines. J. Cent. Soc. Vet. Med. 50(5):303-335. (Japanese text.)

Sugimoto, M. 1937b. Notes on the ticks in Kyushu and Okinawa islands. J. Cent. Soc. Vet. Med. 50 (9):597-615. (Japanese text.)

Sugimoto, M. 1937c. On the nymph and larva of *Amblyomma testudinarium* Koch, 1844. Trans. Nat. Hist. Soc. Formosa 27:160.

Sugimoto, M. 1937d. Studies on the Formosan ticks (9th Report). (On the tick, *Haemaphysalis nishiyamai* Sugimoto, 1935). J. Soc. Trop. Agric. Taiwan 9:287-290 (Japanese text. English summary.)

Supino, F. 1897. Nuovi *Ixodes* della Birmania. (Nota Preventiva). Atti. Soc. Veneto-Trent. di Sci. Nat. 2, III, fasc. 1:230-238.

Suzuki T. 1930. Notes on the male of a tick, *Ixodes affinis*. Lansania 2(16):90-92. (Japanese text.)

Tanaka, H., K. Sato, Y. Sugita, J. Okabe, Y. Sakagami, T. Chikatsune, and T. Yoshida. 1960. On a tick parasitizing the human perianal region. J. Osaka City Med. Cen. 9(3):743-744. (Japanese text. English summary.)

Thorell, T. 1883. Descrizione di alcuni Aracnidi inferiori dell'Arcipelago Malese. Ann. Mus. Civ. Storia Nat. Genoa (1882-83) 18:21-69 (not published in 1882).

Tokishige, H. 1911. Report of investigation on endemic diseases of cattle in Kumamoto Prefecture. J. Cent. Soc. Vet. Med. 24:6-12, 25(3). (Japanese text.)

Toumanoff, C. 1944. Les Tiques (Ixodoidea) de l'Indochine. Institute Pasteur de l'Indochine, Saigon, 220 p.

Trapido, H. 1965. Notes on critical Asian *Haemaphysalis* specimens in European museum collections, with designations of lectotypes and a neotype (Acarina: Ixodidae). Proc. Ent. Soc. Wash. 67: 152-165.

Tsuchie, Y., A. Ishikawa, and M. Okui. 1966. Studies on ticks in pasture (II), (III). Report of the Institute of Animal Health of Shimane Prefecture. 13:1-15. (Japanese text, mimeographed.)

Uchikawa, K., and A. Sato. 1968. Tarsal chaetotaxy of *Argus japonicus* Yamaguti, Clifford, and Tipton, 1968. (Ixodoidea: Argasidae). Jap. J. Sanit. Zool. 19(3):157-161.

Uchikawa, K., and A. Sato. 1969. The occurrence of *Argas japonicus* and *Ixodes lividus* in Nagano Pref., Japan. J. Med. Ent. 6(1):95-97.

Uchikawa, K., A. Sato, and M. Kugimoto. 1967. Studies on the argasid infesting the Japanese House Martin, *Delichon urbica*. Med. J. Shinshu Univ. 12(2):141-155.

Warburton, C. 1908. On some new and obscure species of the genus *Haemaphysalis* of the Ixodidae. Proc. Cambr. Philos. Soc. 14:508-519.

Warburton, C. 1913. On four new species and two new varieties of the ixodid genus *Haemaphysalis*. Parasit. 6(2):121-130.

Warburton, C. 1932. On five new species of ticks (Arachnida, Ixodoidea). Parasit. 24:558-568.

Warburton, C., and G. H. G. Nuttall. 1909. On new species of Ixodidae with a note on abnormalities observed in ticks. Parasit. 2:57-76.

White, A. 1852. Appendix. Journal of voyage in Baffin's Bay, by P. C. Sutherland. 2:210.

Wilson, S. G. 1946. Seasonal occurrence of Ixodidae on cattle in Northern Province, Nyasaland. Parasit. 37:118-125.

Yajima, A. 1942. On the Ixodidae collected from Iwate and Aomori prefectures. J. Assn. Anim. Hyg. 10(6):499-510. (Japanese text.)

Yajima, A. 1950. On the forms of female and each stage of *Haemaphysalis ias* Kishida, 1936. Jueki Chosasho Kenkyu Hokoku 25:197-200.

Yajima, A. 1955. On two new species of ticks (Ixodidae) from Iwate Prefecture. Jap. J. Sanit. Zool. 6(1):52-53. (Japanese text.)

Yajima, A. 1963. On the distribution of the ixodid ticks on the cattle in the pastures in Japan. Jap. J. Sanit. Zool. 14(2):103. (Japanese text.)

Yamaguti, N., C. M. Clifford, and V. J. Tipton. 1968. *Argas* (*Argas*) *japonicus* new species, associated with swallows in Japan and Korea (Ixodoidea, Argasidae). J. Med. Ent. 5(4):453-459.

Yamaguti, N., and S. Inatomi. 1961. On the morphology of larva and nymph of *Argas* species collected in Okayama Prefecture, and some additional observations on its biology. Jap. J. Sanit. Zool. 12(2):142. (Japanese text.)

Zumpt, F. 1940. The *Rhipicephalus* species of the USSR. An account of variability in the *sanguineus* group. Z. Parasitenk. 11:400-409.

Zumpt F. 1950. Preliminary study to a revision of the genus *Rhipicephalus* Koch. Docum Moeambique 60:57-125.

Zumpt, F. 1952. The ticks of sea birds. Australian Natl. Antarctic Res. Expedition Rep. Series B. 1:12-20.

APPENDIX 1

Notations on the Literature Cited

Yajima's (1956) list was often referred to as a source of information by Keegan and Toshioka (1957). Since it is a mimeographed note and has not been published yet, it is excluded in this paper.

Serial reports by Sugimoto entitled "Note on the Formosan ticks, part 1, 2, 3, 4" were published in Taiwan no Chikusan 3(9), 1935, 4(1), 1936, 4(2), 1936, 4(3), 1936, respectively, and these four papers were at the same time published in Bull. No. 118, 1936, Dept. Agric. Govt. Res. Inst., Formosa, Japan. Likewise, another of his papers (1936d) appeared both in the Taiwan no Chikusan 4(11), pp. 1-11, 1936, and in the J. Jap. Soc. Vet. Sci. 16, pp. 1-10, 1937. Furthermore, the paper of 1937a contains two papers (with the same title) published in Taiwan no Chikusan 5(3) 1-25, 1937 and 5(4) 1-15, 1937. His paper (1937c) is also found in J. Jap. Soc. Vet. Sci. 16(1), pp. 11-16.

The paper "Studies on the ticks of the domestic animals in the Far East" by Itagaki, Noda, and Yamaguchi (1959) is an English translation of their 1944 paper, and the contents of both are identical, except that *H. jezoensis* is synonymized under *H. japonica* and spelling of Korean localities is amended so as to be up to date in the later (1959) publication.

APPENDIX 2

Collection Records[10]

Species		Host or Habitat	Area	Prefecture	Locality	Collection or Literature Data
Argas japonicus		*Delichon urbica dasypus* (House Martin)	Japan	Nagano	Agematsu-cho	#66-J-0032, Coll. Toshioka, 17 Jul '66 (42 F, 44 M, 227 N, 39 L, 2 *F*, 2 *M*, 2 *L*)
"	"	" " "	"	"	Matsumoto-shi	Coll. Yamaguti, 7 Jul '66 (5 F, 5 M, 10 N, 10 L).
"	"	" " "	"	"	"	Coll. Sato, 13 Sep '66 (5 F, 5 M, 5 N)
"	"	" " "	"	Iwate	Iwaizumi-cho	#66-J-0043, Coll. Yamaguti, 7 Aug '66, (198 F, 178 M, 130 N, 2 *F*, 2 *M*, 2 *L*)
"	"	" " "	"	Tochigi	Chuzenji	#66-J-0047, Coll. Hatoyama, 24 Aug '66, (10 N)
"	"	" " "	"	Tokyo	Tachikawa AFB	#66-J-0048, Coll. Holubec & Sugiyama, 24 Jun '66, (36 F, 30 M, 153 N, 25 L, 2 *F*, 2 *M*)
"	"	" " "	"	Shimane	Iwamoda-shi	#66-J-0050, Coll. Holubec & Sugiyama, 7 Oct '66, (16 F, 11 M, 47 N)
"	"	" " "	"	Fukushima	Shinobu-Takayu	#68-J-0336, Coll. Suzuki & Sasagawa, 10 Jul '68, (700 F, 600 M, 1,100 N)
"	"	" " "	"	"	Nakanosawa, Inawashiro	#68-J-0337, Coll. Suzuki & Sasagawa, 12 Jul '68, (4 N)
"	"	*Hirundo daurica japonica* (Striated Swallow)	"	Okayama	Niimi-shi	#66-J-0037, Coll. Mizusawa & Hatoyama, 21 Sep '66, (89 F, 57 M, 108 N, 34 L, 2 *F*, 2 *M*, 2 *L*)
"	"	" " "		"	"	Coll. Yamaguti, Sep '60 (5 F, 3 M, 4 N, 7 L)
"	"	" " "	"	Tottori	Yonago-shi	#66-J-0053, Coll. Mizusawa & Hatoyama, 19 Sep '66, (45 F, 62 M, 89 N, 2 *F*, 2 *M*)
"	"	" " "	"	Miyazaki	Takachiho-cho	#66-J-0044, Coll. Toshioka & Suzuki, 13 Sep '66, (63 F, 30 M, 496 N, 5 L, 2 *F*, 2 *M*)
"	"	" " "	"	Gifu	Mitake, Kani-gun	#66-J-0062, Coll. Tanaka, 18 Oct '66, (1 N)
"	"	" " "	"	Okayama	Niimi-shi	Inatomi & Yamaguti, 1960:17; Yamaguti & Inatomi, 1961:142. Coll. Yamaguti, Sep '60, (F, M, N, L)
"	"	*Delichon urbica dasypus* (House Martin)	"	Nagano	Agematsu-cho	Hara, 1963. Coll. Hara (as *persicus*)
"	"	" " "	"	"	Matsumoto-shi, Hakuba-mura, Agematsu-cho, Akashina-cho, Fukushima-cho, Hotaka-cho, Iida-shi, Nagano-shi, Okaya-shi, Otari-mura, Saku-shi, Sakai-mura & Ueda-shi	Uchikawa, 1969:96. Coll. Uchikawa, 20 Mar '67 – 7 Apr '68, (A, N, L)
"	"	Sleeping quarters	Korea	Kyongsang-pukto	Taegu	Yamaguti, Clifford & Tipton, 1968:458. Coll. Tibbets, 20 May '53, (5 F, 1 M, 3 N)

[10] Italicized numbers in parentheses indicate number of specimens sent to Mr. Glen M. Kohls for identification.

Argas japonicus	Swallow nest	Korea	Kyongsang pukto	Shin Chon Di	Yamaguti, Clifford & Tipton, 1968: 458. Coll. Tipton, 9 Jul '55, (2 F, 1 M, 12 N, 2 L)
Argas vespertilionis	*Vespertilio superans* (Frosted Bat)	Japan	Fukushima	Shojo, Bange-cho	#66-1-0012, Coll. Kaneko, autumn '65, (*1 ? F*)
"	" "	"	"	"	#67-1-0218, Coll. Yamaguti, 11 Aug '67 (23 F, 11 M, 18 N; *1 F, 2 M, 1 N*)
"	*Pipistrellus abramus* (Bat)	"	Fukuoka	-	27 Jun '67, (23 F)
"	*Pipistrellus savii velox* (Bat)	"	Hokkaido	Sapporo-shi	Coll. Hattori, 22 Aug '63, (1 F)
"	*Pipistrellus abramus* (Bat)	"	Niigata	Niigata-shi	Saito, 1955:7-12. Coll. Saito, 30 Apr-10 Nov '52, (137)
"	*Myotis* sp. (Bat)	Korea	-	Kumchon	Yamaguti et al., 1968:453. Coll. Hyong Sun Ah, 17 May '57, (9F)
"	*Eptesicus coreensis* (?) (Big Brown Bat)	"	-	Syarin, Heijo	Kishida, 1936:142 (as *Caris vespertilionis* Heijo=Pyongyang)
"	Bats	Japan Korea Ryukyu Islands	-	-	Kishida, 1927:986
"	Man	Japan	Tottori	-	Kamo, 1962:173
Ornithodoros capensis	*Larus crassirostris* (Black-Tailed Gull)		Aomori	Kabujima, Hachinohe-shi	Coll. Toshioka & Akiyama, 18 Aug '55
"	"	"	"	"	Coll. Akiyama, 14 Oct '55
"	"	"	"	"	#66-1-0055, Coll. Toshioka & Sasagawa, 15 Aug '66, (105 F, 1 M, 368 N)
"	"	"	"	"	#67-1-0093, 12 May '67, (242 F, 80 N)
"	"	"	Shimane	Kyojima, Hinomisaki	#55-1-054, Coll. Toshioka & Akiyama, 17 Sep '55, (Approx. 100 A & N)
"	"	"	"	"	#66-1-0054, Coll. Toshioka & Betchley, 9 Jul '66, (96 F, 38 M, 129 N)
"	"	"	"	"	#68-1-0332, Coll. Yamaguti & Blecha, 4 Jun '68, (50 F, 63 M, 276 N, 2 L)
"	"	"	Yamagata	Tobishima, Sakata-shi	#68-1-0335, Coll. Suzuki & Sasagawa, 7 Jul '68, (1 F, 1 M, 1 N)
"	*Calonectris leucomelas* (Streaked Shearwater)	"	Shimane	Ohakajima, Chibu-gun	Coll. Yamaguti, 13 Sep '66, (4 F)
"	Crevices of rocks near nest of *Larus crassirostris* (Black-Tailed Gull)	"	Aomori	Kabujima, Hachinohe-shi	Keegan & Toshioka, 1957:23. Coll. Toshioka & Akiyama, 18 Aug & 14 Oct '55
"	*Larus crassirostris* (Black-Tailed Gull)	"	"	"	Asanuma, 1960:94. Coll. Asanuma, Jul '55
"	*Calonectris leucomelas* (Streaked Shearwater)	"	Tokyo	Aogashima	Asanuma, 1960:94. Coll. Asanuma, 15 Jul '58
"	*Synthliboramphus antiquus* (Ancient Auk)	"	Kanagawa	Hayama-cho	Asanuma, 1960:94. Coll. Asanuma, 14 Mar '58
"	Crevices of rocks near nests of *Larus crassirostris* (Black-Tailed Gull)	"	Shimane	Kyojima	Kohls, 1957a:85-104. Coll. Keegan, 16 Sep '55, (A, N)
Amblyomma geoemydae	*Geoemyda spengleri japonica* (Turtle)	Ryukyu Island	-	Yona, Okinawa	#66-R-0016, Coll. [illegible], 1 Jun '66, (2 M)

Amblyomma geoemydae	*Cyclemys flavomarginata flavomarginata* (Turtle)	Ryukyu Islands	-	Gosa-dake, Iriomote (Is.)	#66-R-0017, Coll. Mizusawa, 19 Jun '66, (*1 F, 10 N, 14 L*)
"	Land tortoise	"	-	Okinawa	#66-R-0006, Coll. Pennington, Oct '66, (*4 N, 28 L*)
"	*Geoemyda spengleri japonica* (Turtle)	"	-	Yona, Okinawa	#68-R-0015, Coll. Mizusawa, Apr '68, (27 N)
"	*Clemmys japonica* (Turtle)	Japan	Kagoshima	Kurugami, Tanegashima	Keegan & Toshioka, 1957:8 (as *A. malayanum*) Coll. Toshioka, 19 Jul '55 (1 F, 1 M, 1 N)
"	*Cyclemys flavomarginata flavomarginata* (Turtle)	Ryukyu Islands	-	Futanaka, Ishigaki (Is.)	Keegan & Toshioka, 1957:8 (as *A. malayanum*) Coll. Keegan & Toshioka, 6 Nov '55, (1 F, 1 M)
"	"	"	-	Hanoshiro, Ishigaki (Is.)	Keegan & Toshioka, 1957:8 (as *A. malayanum*) Coll. Keegan & Toshioka, 27 Oct '55, (1 N)
"	"	"	-	Gosa-dake, Iriomote (Is.)	Kawashima, 1963:103 (as *A. malayanum*) Coll. Kawashima, 14 Aug '62, (9 F, 4 M, 3 N, 1 L)
"	"	"	-	-	Keegan & Toshioka, 1957:8 (as *A. malayanum*) Coll. Keegan & Toshioka, Nov '55, 406 MGL #181, (1 N)
"	*Geoemyda spengleri* (Turtle)	"	-	Yona, Okinawa	Kawashima, 1963:103 (as *A. malayanum*) Coll. Kawashima, 6 Jul '62, (3 N, 13 L)
"	Turtle	"	-	West of Arakawa, Okinawa	Keegan & Toshioka, 1957:8 (as *A. malayanum*) Coll. Hubert, 18 May '55, 406 MGL #25, (6 N)
"	Man	"	-	Mountain near Ishigaki City, Ishigaki (Is.)	Keegan & Toshioka, 1957:8 (as *A. malayanum*) Coll. Keegan & Toshioka 27 Oct '55, (1 N) (Probably a stray from the turtle of 27 Oct '55 collection examined the same day)
Amblyomma nitidum	*Laticauda semifasciata* (Sea snake)	"	-	Ishigaki (Is.)	#66-R-0008, Coll. Toshioka & Keegan, 10 Nov '62, (*1 L*)
"	"	"	-	"	#66-R-0009, Jun '57, (*1 L*)
Amblyomma testudinarium	*Sus scrofa leucomystax* (Wild pig)	Japan	Tochigi		#60-J-045, Coll. Akiyama, Nov '60, (*1 F, 17 M*)
"	"	Ryukyu Islands	Kagoshima	Ashiken, Amami Oshima	#67-J-0246, Coll. Mizusawa, 20 Sep '67, (2 F, *1 M*)
"	"	"	"	Yuwan, Amami Oshima	#67-J-0256, Coll. Mizusawa, 1 Oct '67, (3 F, *1 F, 1 M*)
"	"	"	"	"	#67-J-0272, Coll. Mizusawa, Apr '67, (1 M)
"	"	"	"	"	#68-J-0310, Coll. Mizusawa, 15 Mar '68, (*7 F*)
"	"	"	"	"	#68-J-0318, Coll. Mizusawa, 11 Apr '68, (2 F, 2 M, 4 N, 5 L, *3 N, 5 L*)
"	"	"	"	Ashiken, Amami Oshima	#67-J-0271, Coll. Mizusawa, 19 Sep '67, (*1 N*)
"	"	"	"	Ishigaki (Is.)	#55-R-017, Coll. Keegan & Toshioka, 4 Nov '55, (*1 F, 5 L*)
	Domestic pig	"	"	Yuwan, Amami Oshima	#65-J-0001, Coll. Hajime, 13 Dec '65, (*2 F, 5 M*)

Amblyomma testudinarium	Domestic pig	Ryukyu Islands	Kagoshima	Yuwan, Amami Oshima	#65-J-0002, Coll. Hajime, Nov '65, (*1 M*)
"	"	"	"	Ukenson, Amami Oshima	#67-J-0067, Coll. Lipton & Mizusawa, 18 Mar '67, (1 L, 126 L, *5 F, 5 M, 19 L*)
"	"	"	"	"	#67-J-0073, Coll. Lipton & Mizusawa, 19 Mar '67, (*1 F, 3 M*)
"	"	"	"	"	#67-J-0077, Coll. Lipton & Mizusawa, 13 Mar '67, (*1 F, 1 M*)
"	*Cervus nippon* (Sika Deer)	"	Ibaraki	-	#67-J-0183, Coll. Yamaguti, 22 Mar '67, (*1 M*)
"	"	"	Shizuoka	Misakubo-cho	#67-J-0293, Coll. Suzuki, 4 Dec '67, (*1 M*)
"	Domestic dog	Ryukyu Islands	Kagoshima	Yuwan, Amami Oshima	#67-J-0273, Coll. Mizusawa, Apr '67, (*1 F*)
"	*Pentalagus furnessi* (Ryukyu Rabbit)	"	"	Ukenson, Amami Oshima	#67-J-0069, Coll. Lipton & Mizusawa, 24 Mar '67, (136 L, *107 L*)
"	"	"	"	"	#67-J-0081, Coll. Hajime, 10 Feb '67, (*195 L*)
"	"	"	"	Yuwan, Amami Oshima	#68-J-0314, Coll. Mizusawa, 5 Apr '68, (*1 M*)
"	Vegetation	"	"	Ukenson, Amami Oshima	#67-J-0082, Coll. Lipton & Mizusawa, 23 Mar '67, (*1 L*).
"	"	"	"	"	#67-J-0076, Coll. Lipton & Mizusawa, 23 Mar '67, (*97 L*)
"	"	"	"	"	#67-J-0084, Coll. Lipton & Mizusawa, 24 Mar '67, (*45 L*)
"	"	"	"	Yuwan, Amami Oshima	#68-J-0316, Coll. Mizusawa, 5 Apr '68, (*2 F*)
"	"	"	"	"	#68-J-0317, Coll. Mizusawa, 10 Apr '68, (*1 N, 5 L*)
"	-	Japan	Mie	Mt. Shimaji	#66-J-0031, Coll. Ueno, 28 Jul '57, (*1 F*)
"	Man	"	Hyogo	-	Kawashima, Kamo & Miyazaki, 1960: 77-80
"	"	"	Kyoto	-	Nagahana & Matsuo, 1962: 119-120
"	"	"	Osaka	-	Tanaka, et al., 1960: 69-70
"	Horse	"	Miyazaki	Kamie, Koyu	Itagaki, Noda & Yamaguchi, 1944 & 1959
"	Wild pig	Ryukyu Islands	-	Inoda, Ishigaki (Is.)	Keegan & Toshioka, 1957: 9. Coll. Keegan & Toshioka, 2 Nov '55, 406 MGL #82, (1 M)
"	-	"	-	Inoda, Ishigaki (Is.)	Keegan & Toshioka, 1957: 9. Coll. Keegan & Toshioka, 12 Nov '55, 406 MGL #98, (2 L)
"	Wild pig	"	-	Ohara, Iriomote (Is.)	Keegan & Toshioka, 1957: 9. Coll. Keegan & Toshioka, 406 MGL #207, (1 M)
"	Vegetation	Japan	Osaka	Ikeda-shi	Keegan & Toshioka, 1957: 9. Coll. Hiromatsu, 11 Mar '42
"	Domestic pig	"	Tokyo	-	Kishida, 1922a: 850-851. Coll. Taguma
"	*Microhyla fissipes* (= *M. ornata*) (Frog)	Ryukyu Islands	-	Ishigaki (Is.)	Sugimoto, 1937a: 317-323. Coll. Iwasaki, (1 L)
"	Wild pig	"	-	"	Sugimoto, 1937b: 612-613. Coll. Iwasaki, 5 Feb '37, (1 M)

Amblyomma testudinarium	Wild pig	Ryukyu Islands	-	Iriomote (Is.)	Sugimoto, 1937b 612-613 Coll Ohasi, Mar '37, (1 M)
''	Green frog	''	-	Ishigaki (Is.)	Sugimoto, 1937b 612-613 Coll Iwasaki, (1 F)
''	-	Japan	Miyazaki, Hyogo	-	Nakamura & Yajima, 1937 174
''	Horse	''	Miyazaki	Takanabe	Robinson, 1926 257 Jun & Oct '12 (N 2909a)
''	''	Ryukyu Islands	Kagoshima	Amami Oshima	Robinson, 1926 257 Jun & Oct '12 (N 2919)
Boophilus microplus	Domestic cattle	Japan	Nagasaki	Gonoura, Iki (Is.)	#67-J-0103, Coll Tipton & Minzusawa, 2 May '67, (6 F)
''	''	''	''	Hatsuyama, Iki (Is.)	#67-J-0107, Coll Tipton & Mizusawa, 4 May '67, (*3 M*, *3 N*)
''	''	''	''	Iwazato, Tsushima	#67-J-0118, Coll Tipton & Mizusawa, 6 May '67, (*13 F*, *7 M*, *13 N*)
''	''	''	Kagoshima	Ichinari	#67-J-0124 Coll Tipton & Mizusawa, 10 May '67, (8 F, *2 F*, *5 M*, *4 N*)
''	''	''	''	''	#67-J-0125, Coll Tipton & Mizusawa, 10 May '67, (1 F, *5 F*, *4 N*)
''	''	''	''	''	#67-J-0126, Coll Tipton & Mizusawa, 10 May '67, (7 F, *11 F*, *2 M*, *1 N*)
''	''	''	''	''	#67-J-0128, Coll Tipton & Mizusawa, 10 May '67, (12 F, *8 F*, *2 M*)
''	''	''	''	''	#67-J-0129 Coll Tipton & Mizusawa, 10 May '67, (4 F, *6 F*)
''	''	''	''	''	#67-J-0131, Coll Tipton & Mizusawa, 10 May '67, (19 F, *7 F*, *7 M*, *4 N*)
''	''	''	''	''	#67-J-0132, Coll Tipton & Mizusawa, 10 May '67, (*8 F*, *4 M*)
''	''	''	''	''	#67-J-0134, Coll Tipton & Mizusawa, 10 May '67, (5 F, *21 F*, *8 M*, *4 N*)
''	''	''	''	''	#67-J-0135, Coll Tipton & Mizusawa, 10 May '67, (2 F, *3 F*, *3 M*, *4 N*)
''	''	''	''	''	#67-J-0137 Coll Tipton & Mizusawa, 10 May '67, (30 F, *25 F*, *9 M*, *1 N*)
''	''	''	''	Sakura Jima	#67-J-0138 Coll Mizusawa, 14 May '67, (1 F, *4 F*, *1 M*)
''	''	''	''	''	#67-J-0140, Coll Mizusawa, 14 May '67, (*1 F*)
''	''	''	''	''	#67-J-0141 Coll Mizusawa, 14 May '67, (*17 F*, 5 M)
''	''	''	''	''	#67-J-0142 Coll Mizusawa, 14 May '67, (7 F, 1 M, 1 N, *21*, *10 M*, *1 N*)
''	''	Ryukyu Islands	''	Sumiyo, Amami Oshima	#67-J-0064 Coll Tipton & Mizusawa, 22 Mar '67, (24 F, *30 F*, *23 M*)
	''	''	''	Buren, Amami Oshima	#67-J-0252, Coll Mizusawa, 28 Sep '67, (15 F, 3 M, *10 F*, *6 M*)
	''	''	''	Yuwan, Amami Oshima	#67-J-0261, Coll Mizusawa, 3 Oct '67, (93 F, 3 M, 3 N)

Boophilus microplus	Domestic cattle	Ryukyu *Islands*	-	Miyara, Ishigaki (Is.)	#66-R-0002, Coll. Holubec & Doucette, 2 Nov '66, (87 *L*, *18 M*)
"	"	"	-	"	#66-R-0003, Coll. Doucette & Sugiyama, 2 Nov '66, (55 *L*, 25 *M*)
"	"	"	-	"	#66-R-0004, Coll. Doucette & Holubec, 2 Nov '66, (65 *L*, 43 *M*)
"	"	"	-	Hirai, Ishigaki (Is.)	#67-R-0011, Coll. Tipton, 8 Feb '67, (15 F, 5 M, 2 N)
"	"	"	-	"	#67-R-0013, Coll. Tipton, 6 May '67, (8 F, 3 M)
"	"	Korea	-	Kunuk, Cheju Do	#67-K-0019, Coll. Parsons, 6 May '67, (*1 N*)
"	"	"	Chungchong pukto	Maeng-dong Myon	#67-K-0029, Coll. Cantello & Townsend, 12 May '67, (9 N, *1 F*, *1 M*, *1 N*)
"	"	"	"	Um-Song Kun	#67-K-0030, Coll. Cantello & Townsend, 12 May '67, (3 F, 9 N, *1 M*)
"	"	"	"	"	#67-K-0031, Coll. Cantello & Townsend, 12 May '67, (2 F, 7 N, *1 F*, *1 N*)
"	*Bubalus bubalis* (Asiatic Water Buffalo)	Ryukyu Islands	-	Hirai, Ishigaki (Is.)	#67-R-0010, Coll. Tipton, 9 Feb '67, (11 F, 9 M, 28 N)
"	"	"	-	"	#67-R-0012, Coll. Tipton, 8 Feb '67, (1 F)
"	Domestic sheep	Korea	-	Isodong, Cheju Do	#67-K-0022, Coll. Driggers, 6 May '67, (*1 F*)
Boophilus spp.	Cattle	Japan	Saga Kumamoto Oita	-	Tokishige, 1911 (as *Boophilus annulatus caudatus*) cited by Sugimoto, 1937b
"	Cattle, water buffalo, horse, deer, pheasant	Japan & Ryukyu Islands	-	Southern part of Kyushu	Kishida, 1927:985, (as *B. caudatus* Neumann)
"	Cattle	Korea	S. Keisyo (=Kyongsangnamdo)	Nanrai, S. Keisyo and coast region of S. Korea & Cheju Do	Kishida, 1936:139-142 (as *Palpoboophilus minningi*)
"	"	Japan & Ryukyu Islands	Kumamoto	Aso	Ogura, 1936:75 (as *B. annulatus caudatus*) cited by Sugimoto, 1937c
"	Horse and domestic cattle	Japan & Ryukyu Islands	Fukuoka Kagoshima Nagasaki Kumamoto Hyogo Yamaguchi Okinawa	-	Nakamura & Yajima, 1937:133-184 (as *Uroboophilus caudatus*, *Uroboophilus sinensis*, *P. minningi*) N. and Y. cited Minning's record from Miyazaki Pref. as known distribution
"	Cattle	Japan, Ryukyu Islands & Korea	Hiroshima Miyazaki Kumamoto Kagoshima	-	Kishida, 1939a:538-552 (as *Uroboophilus caudatus*, *U. sharifi*, *U. sinensis*, *Palpoboophilus brachyurus*)
"	"	Japan & Ryukyu Islands	Kagoshima	Tanegashima Okinawa	Kishida, 1929:20 (as *B. annulatus caudatus*) Dec '24
"	Horse, cattle, domestic sheep, Asiatic Water Buffalo	Japan Korea	Nagasaki Kumamoto Kagoshima Kyongi-do Kyongsang pukto Kyongsang namdo		Itagaki, Noda & Yamaguchi, 1944:33-39, 1959:41 (as *B. caudatus*)

Boophilus spp.	Horse, cattle, domestic sheep, Asiatic Water Buffalo	Korea	Cholla-namdo		Itagaki, Noda & Yamaguchi, 1944: 33-39, 1959: 41 (as *B. caudatus*).
,,	Cattle and horse	Japan	Kumamoto	Aso area	Shigemori, Aso & Yajima, 1953: 290-293. (as *Uroboophilus caudatus* and *Palpoboophilus brachyuris*)
,,	Cattle, horse and water buffalo	Ryukyu Islands	-	Ishigaki (Is.), Iriomote (Is.), Yonakuni (Is.), Hateruma, Kobama	Keegan & Toshioka, 1957: 10 (as *Boophilus microplus*)
		Korea	Kyongi-do	Seoul	
,,	Cattle	Japan	Tokyo	-	Nuttall & Warburton, 1915: 433 (as *Boophilus* sp., found with *H. bispinosa* = *H. longicornis*, 16 Oct '11, submitted by Dr. Miyajima).
,,	Horse	,,	Miyazaki	-	Neumann, 1897: 413. (as *Rhipicephalus annulatus caudatus*) (23 F., 2 M).
Dermacentor spp.	Wild pig	,,	Chiba	Kiyosumi-yama	Kishida, 1922a: 847-851. Coll. Aoki, 30 Oct '09 (as *auratus auratus*) (F., M).
,,	Domestic pig	,,	Tokyo	-	Kishida, 1922a: 847-851. (as *reticulatus reticulatus*) (F., M).
,,	,,	Korea	-	-	Kishida, 1922a: 847-851. (as *reticulatus reticulatus*) (F., M).
,,	-	,,	-	Keigen-gun, N. Kankyo (=Hamgyong-pukto)	Kishida, 1936: 142. (as *D. variegatus*). According to Kishida, Mr. Asakawa recorded this species.
,,	Horse	Japan	Iwate	Tamura, Tayāma-mura, Johoji-mura	Nakamura & Yajima, 1937: 162-164 (as *reticulatus*) (F., M).
,,	,,	,,	,,	Terada, Iwate-gun. Okunakayama, Ninohe-gun. Johoji-mura, Ninohe-gun. Arasawa, Ninohe-gun. Futamata Pasture	Yajima, 1942: 499-510. (as *reticulatus*) (F., M).)
,,	,,	,,	Aomori	Sannohe-gun. Kamikita-gun. Shimokita-gun. etc.	Yajima, 1942: 499-510. (as *reticulatus*) (F., M).
,,	,,	,,	,,	Temmabayashi-mura, Kamikita-gun	Itagaki, Noda & Yamaguchi, 1944, 1959. (as *reticulatus*) (28 F., 16 M). Aug & Sep '41 & Oct '42.
,,	,,	,,	Iwate	Takizawa, Iwate-gun	Itagaki, Noda & Yamaguchi, 1944, 1959. (as *reticulatus*) (12 F., 10 M). Oct '41.
	,,	Korea	Hamgyong-pukto	Unggi, Kyonghung	Itagaki, Noda & Yamaguchi, 1944, 1959. as *coreus* (61 F., 34 M). Jun '41 & 29 May-5 Jun '42. Original description of *coreus*, no indication of type.
,,	*Selenarctos thibetanus japonicus* (Asiatic Black Bear)	Japan	Shizuoka	Oshima-mura, Sunto-gun	Keegan & Toshioka, 1957: 10-11. Coll. Asanuma. (2 M). (labelled as *auratus*)
	Wild pig	,,	Kyoto	Shizuhara	Keegan & Toshioka, 1957: 10-11. Coll. Akiyama, 12 Dec '55, 406 MGL #101, closely resembling the above. Illustrated in pl. 14 of K. & T., reproduced. (2 M).
,,	,,	,,	-	-	Keegan & Toshioka, 1957: 10-11. Coll. Toshioka & Akiyama, 29 Feb '56, 406 MGL #194. (2 M).

Dermacentor spp.	Wild pig	Japan	Kyoto	Kyoto-shi	Keegan & Toshioka, 1957: 10-11. Coll. Toshioka, 17 Nov '56, 406 MGL #199, (1 M).
"	Horse	"	Aomori	-	Keegan & Toshioka, 1957: 10-11. Coll. Asanuma, Jun '42, (1 M) (labelled as *reticulatus*)
"	"	"	"	-	Keegan & Toshioka, 1957: 10-11. Coll. Asanuma, Jul '48, (1 F), (labelled as *reticulatus*)
"	"	"	"	-	Keegan & Toshioka, 1957: 10-11. Coll. Yajima, Oct '38, No. 2490 (1 F), (labelled as *reticulatus*)
"	"	"	Iwate	-	Keegan & Toshioka, 1957: 10-11. Coll. Yajima, 14 Sep '19 (1 M) (labelled as *reticulatus*)
"	"	"	"	Okunakayama	Keegan & Toshioka, 1957: 10-11. Coll. Yajima, 16 Oct '38, (5 F, 4 M) (labelled as *reticulatus*). Illustrated in pls. 12 & 13 of K. & T., reproduced.
"	"	Korea	-	Yuki (=Unggi)	Keegan & Toshioka, 1957: 10-11. Coll. Asanuma, Jun '42, (4 F, 3 M) (labelled as *coreus*). Illustrated in pls. 10 & 11 of K. & T., reproduced.
Haemaphysalis campanulata	Man	Japan	Hyogo	Takarazuka	#41-J-002, Coll. Hiromatsu, 15 Jan '41, (33 F, 10 M, 4 N, *1 M*)
"	Domestic dog	"	Kanagawa	Miura	#52-J-004, Coll. Asanuma, Jul '52, (2 F, 14 M, *2 F*)
"	"	"	Chiba	-	#67-J-0188, 12 Jun '67, (1 N, *1 F*)
"	"	"	Tokyo	-	Keegan & Toshioka, 1957: 12. Coll. Yajima, 15 Jul '33, (2 M).
"	"	"	Niigata	Takada-shi	Keegan & Toshioka, 1957: 12. Coll. Yajima, 20 Jul '34, (1 F).
"	"	"	Hokkaido	Kitami, Abashiri	Keegan & Toshioka, 1957: 12. Coll. Kishida, 20 May '21, (1 M)
"	"	"	Tokyo Chiba Niigata Saitama Kanagawa Shizuoka Mie Osaka Hyogo Kochi Miyazaki	- Narita Yokogoshi-mura - - - - - - - -	Itagaki, Noda & Yamaguchi, 1944, 1959
"	"	Korea	Kyonggi-do	-	"
"	Domestic cattle and horse	Japan	Nagasaki Niigata Gumma Ishikawa Yamaguchi	- - - - -	Nakamura & Yajima, 1937: 133-184
"	"	Korea	Hamgyong-pukto Kangwang-do	- -	"
"	-	Japan	Kumamoto	-	Shigemori, Aso & Yajima, 1953: 290-293
"	-	"	-	-	Warburton, 1908: 508-514
"	Dog	"	Kanagawa	Yokohama	Nuttall & Warburton, 1915: 491-492. Coll. Owston, Apr '02, (2 F, 2 M), submitted by Rothschild

Haemaphysalis campanulata	Dog	Japan	Tokyo	-	Nuttall & Warburton, 1915:491-492, Coll. Janson, 1894, (#2886) (1 A)
,,	,,	,,	,,	-	Nuttall & Warburton, 1915:491-492, 18 Jun '14, submitted by Dr. Miyajima (#2991) (1 A)
,,	House rat	,,	,,	-	Nuttall & Warburton, 1915:491-492, 11 Sep '12, submitted by Dr. Miyajima (#2917) (1 A).
Haemaphysalis concinna	-	,,	Hokkaido	Nemuro-shi, Nemuro	Kitaoka, May '64, (*1 F, 3 M*)
,,	Domestic cattle	,,	,,	Atsukeshi, Kushiro	Kitaoka, Jul '66, (*1 F*).
,,	Domestic cattle and horse	,,	,,	Tokachi, Kushiro, Nemuro & Kitami	Ogura & Takada, 1927:202-204
,,	-	Korea	-	-	Kishida, 1936:142.
,,	Horse	Japan	Aomori	Misawa, Kamikita-gun	Yajima, 1942:508.
,,	,,	Korea	-	-	,,
,,	,,	,,	Hamgyong-pukto	Unggi	Itagaki, Noda & Yamaguchi, 1944, 1959
,,	,,	,,	-	-	Keegan & Toshioka, 1957:13, Jul '41 (1 M)
,,	-	Japan	-	-	Koch, 1887:786, (as *hirudo*) (1 F).
,,	Dog	,,	Saga	-	Neumann, 1897:341, 1905:239, 1911:111, (as *hirudo, concinna* var. *kochi* and *concinna kochi*). Coll. Hilgendorf (Berl. Mus.) (3 F) Coll. Yamaguchi, on dog, cited by Nuttall & Warburton, 1915 (2 F)
,,	-	,,	-	-	Nuttall & Warburton, 1915:457, Examined Neumann's (3 F) in Berlin Museum, cited Neumann's record, 1905
Haemaphysalis sp. (*H. cornigera* group)	Domestic cattle	,,	Tokyo	Hachijo Ko-shima	#67-I-0206, Coll. Yamaguti, 13 Jul '67, (*1 F, 1 M*)
Haemaphysalis cornigera or *Haemaphysalis ias*	,,	,,	,,	Miyake (Is.)	Keegan & Toshioka, 1957:13, Coll. Kishida, 2 Oct '34, (1 M) (labelled as *ias*)
,,	,,	,,	,,	,,	Keegan & Toshioka, 1957:13, Coll. Yajima, 29 Jan '54, (1 F, 1 M) (labelled as *ias*)
,,	,,	,,	,,	,,	Keegan & Toshioka, 1957:13, Coll. Yajima, 1 Jul, (1 M) (labelled as *ias*)
,,	,,	,,	,,	Hachijo (Is.)	Keegan & Toshioka, 1957:13, Coll. Asanuma, 29 May '49, (1 F)
,,	,,	,,	,,	,,	Keegan & Toshioka, 1957:13, Coll. Asanuma, May '42, (2 M) (labelled as *ias*)
,,	Dog	,,	,,	Miyake (Is.)	Nakatsuji, 1942:295, (as *ias*)
,,	Domestic cattle	,,	,,	,,	Nakamura & Yajima, 1937:133-184 Coll. Kishida, 2 Oct '35 (as *ias*)
,,	,,	,,	,,	Hachijo (Is.)	Yajima, 1950:197-200, Coll. Sasa, Apr '48, (1 F) (as *ias*)
,,	Birds	,,	-	-	Asanuma, 1965a:112 (N, F)
Haemaphysalis doenitzi	Pheasant	,,	Kagoshima	Akune	#56-I-057, Coll. Toshioka, 10 Jan '56, (5 M, *1 F*)

Haemaphysalis doenitzi	*Phasianus colchicus robustipes* (Pheasant)	Japan	Niigata	Shukunegi, Sado (Is.)	Saito, 1959b 201. Coll. Saito, Sep '56, (1 F, 18 M, 32 N, 74 L)
,,	,,	,,	,,	Umezu, Sado (Is.)	Saito, 1959b 201. Coll. Saito, Sep '57 – Nov '58, (3 F, 5 N, 60 L)
,,	Vegetation	,,	,,	,,	Saito, 1959b 195. Coll. Saito, May-Oct '57, (1 M).
,,	Pheasant	,,	Kagoshima	Akune	Keegan & Toshioka, 1957 18. Coll. Toshioka, 10 Jan 56, (5 M) (as *H.* sp. *incertae sedis*, 1 L).
,,	,,	,,	Niigata	-	Keegan & Toshioka, 1957 18. (1 L)
Haemaphysalis flava	Horse	,,	Aomori	Towada	*#55-J-055. Coll. Akiyama, 13* Oct '55, (*2 F, 1 M, 3 N, 1 L*)
,,	Dog	,,	Tochigi	Kuzuu	#56-J-059, Coll. Toshioka & Akiyama, 23 Feb '56, (*1 F*).
,,	,,	,,	Mie	-	#56-J-062, Coll. Toshioka, 19 Mar '56, (*1 F, 1 M*)
,,	,,	,,	Aomori	Towada	#55-J-016, Coll. Akiyama, 13 Oct '55, (*8 F*)
,,	,,	,,	Kanagawa	Yamakita-cho	#55-J-018, Coll. Akiyama, 4 Nov '55, (*1 F, 1 M*).
,,	,,	,,	Fukushima	Fukushima-shi	#67-J-0145, Coll. Kanno, 5 Dec '66, (*1 F*)
,,	,,	,,	Iwate	Ofunado	#67-J-0144, Coll. Oshishige, 8 Nov '66, (*1 F*)
,,	,,	,,	Kanagawa	Miyagase, Kiyo-Kawamura	#67-J-0089, Coll. Holmbec & Mizusawa, 18 Apr '67, (7 F, 18 M, *1 F*)
,,	,,	,,	Yamanashi	Nohara, Doshi-mura	#67-J-0290. Coll. Sasagawa & Ushin, 9 Nov '67, (15 F, 2 M, 9 N, *3 F, 3 M*)
,,	*Nyctereutes procyonoides viverrinus* (Raccoon Dog)	,,	Miyazaki	Tomisaki	#55-J-015, Coll. Nagayoshi, Jan '55, (*14 F*).
,,	*Vulpes vulpes japonica* (Red Fox)	,,	Kyoto	Hanase-mura	#67-J-0087, Coll. Yamaguti, 8 Apr '67, (8 F, 26 M, *1 F*)
,,	*Sus scrofa leucomystax* (Wild pig)	,,	Mie	-	#67-J-0177, Coll. Yamaguti, 8 Apr '67, (2 M)
,,	,,	,,	Ibaraki	-	#67-J-0181. Coll. Yamaguti, Mar '67, (*1 M*)
,,	,,	,,	Aichi	Tone-mura	#67-J-0294, Coll. Suzuki, 15 Dec '67, (2 F, 19 M, 3 N, *1 F*)
,,	*Cervus nippon* (Sika Deer)	,,	Tochigi	Kinugawa	#56-J-060, Coll. Toshioka & Akiyama, 25 Feb '56, (*2 M*)
,,	,,	,,	Shiga	-	# 67-J-0179, Coll. Yamaguti, Mar '67, (4 M)
,,	,,	,,	Ibaraki	-	#67-J-0182, Coll. Yamaguti, Mar '67, (*5 F, 7 M*)
,,	,,	,,	Mie	-	#67-J-0184, Coll. Yamaguti, Mar '67, (7 M)
,,	,,	,,	Shizuoka	Misakubo-cho, Iwata-gun	#67-J-0292, Coll. Suzuki, 3 Dec '67, (8 F, 70 M, *6 F, 6 M*)
,,	Domestic cattle	,,	Kagawa	Zentsuji	#56-J-063, Coll. Tsuchiyama, Sep '56, (*1 F*)
,,	Vegetation	,,	Tokyo	Hachijo (Is.)	#68-J-0309. Coll. Utsumi, 6 Apr '68, (4 F, 6 M, 14 N, *1 F, 1 M, 2 N*)

Haemaphysalis flava	*Lepus brachyurus angustidens* (Hare)	Japan	Kagoshima	Ogawa, Kokubu-shi	#68-J-0339, Coll. Yamamoto, 16 Jan-3 Mar '68, (9 F, 42 M, 18 N, 6 L).
,,	Horse	,,	Iwate	Okunakayama	(No. 2535), Coll. Watanabe, 16 VIII 1939, (1 F, labelled as *H. watanabei* n. sp.)
,,	Dog, horse, cow, hare, vegetation	,,	Tokyo? Saga? Miyagi?	-	Neumann, 1897:333-336, (11 F, 7 M, 13 N, 1 L type series), presented by Prof. Sato at Tokyo, Yamaguchi at Saga, Miskina at Sendai. Neumann states nymphs were from hare & cow, larvae from cow.
,,	Horse, vegetation, *Lepus* sp. (Hare)	,,	-	-	Neumann, 1905:238, 1911:112, (as *flava* var. *armata* or *flava armata*) cited by N. & W., 1915.
,,	Cattle, horse, dog	,,	Hiroshima Shimane Kyoto?	- Tamba	Dönitz, 1905:105-134. Dönitz expressed doubt concerning Neumann's identification for the specimens in Berlin Museum
,,	-	,,	-	-	Warburton, 1908:510-512. Same specimens as N. & W., 1915. Presented by Dönitz.
,,	Dog	,,	Mie	Ise	Nuttall & Warburton, 1915:408-410, (1 F, 1 M), N. 893. Also cited Neumann's record (1911).
,,	Cattle or horse	,,	Hiroshima	-	
,,	Wild pig	,,	Chiba	Kiyosumiyama, Awa-gun	Kishida, 1922a:852-853, Coll. Aoki, 30 Oct '09, (1 M) (as *H. t.*).
,,	Dog, horse, cattle, wild boar, serow	,,	-	-	Kishida, 1927:985.
,,	-	Korea	S. Zenra (=Chollanamdo)	Kan-toh and Syu-toh	Kishida, 1936:142. According to Kishida, recorded by Mr. Doi of Keijo in 1935. (Kagakukan Hoh, '35, p. 9).
,,	Dog, cattle & horse	Japan (Honshu, Kyushu, & Shikoku)	- -	-	Sugimoto 1936c:580.
,,	-	Japan	Hiroshima, Mie	-	Sugimoto, 1935:23-24, 1937a:308. Cited records of N. & W., 1915.
,,	Cattle and horse	,,	Kumamoto Tokushima	-	Nakamura & Yajima, 1937:157. Other known hosts were also listed
,,	Cattle & dog	,,	Tokyo	Miyake (Is.)	Nakatsuji, 1942:294
,,	Horse and cattle	,,	Aomori Iwate	-	Yajima, 1942:507-509
,,	Horse	,,	Iwate	Okunakayama	Yajima, 1942:500-502, (as *watanabei*) (2 F), Coll. Watanabe, 16 Oct '39
,,	Horse and dog	,,	Aomori Iwate Miyagi	Sambongi, Kamikita-gun Takizawa, Iwate-gun Motoyoshi, Motoyoshi-gun	Itagaki, Noda & Yamaguchi, 1944, 1959
,,	-	,,	Kumamoto	-	Shigemori, Aso & Yajima, 1953:290-293
	[illegible] species listed	,,	Hokkaido and all over Honshu	-	Asanuma, et al., 1955:127-128
,,	Domestic dog, *Selenarctos thibetanus japonicus* (Asiatic Black	,,	Chiba Akita Fukushima	-	Asanuma, 1956:91-92

Haemaphysalis flava	Bear), *Lepus brachyurus* (Hare), *Sciurus lis* (Squirrel), *Phasianus colchicus tohkaidi* (Green Pheasant), *Phasianus soemmerringii scintillans* (Hondo Copper Pheasant)	Japan	Miyagi Yamagata Nagano Kyoto Saitama Shizuoka		
"	Dog	-	-	-	Keegan & Toshioka, 1957: 14. Including Holotype of *H. orientalis* Kishida, 1934, from Tokyo Prefecture.
		Japan (Honshu, Shikoku, Kyushu)			Because of ubiquitous distribution, name of prefectures and collecting data are not given here.
"	Man, domestic dog, *Nyctereutes procyonoides* (Raccoon Dog), *Mustela sibirica itatsi* (Weasel), *Selenarctos thibetanus japonicus* (Asiatic Black Bear), *Lepus brachyurus angustidens* (Hare), *Lepus brachyurus lyoni* (Hare), *Apodemus speciosus sadoensis* (Field mouse), *Phasianus colchicus robustipes* (Green Pheasant), *Garrulus glandarius tokugawae* (Japanese Jay), *Emberiza spodocephala personata* (Japanese Bunting)	Japan	Niigata	Mainland and Sado (Is.)	Saito, 1959b: 193-209. Coll. Saito, '56-'59. Immature forms on small mammals and birds (A, N, L)
"	Cattle, *Lepus brachyurus angustidens* (Hare), *Meles m. anakuma* (Badger), *Nyctereutes procyonoides viverrinus* (Raccoon Dog), *Streptopelia o. orientalis* (Eastern Turtle-dove), *Phasianus colchicus robustipes* (Green Pheasant) and vegetation	"	"	Kakudayama, Sasagamine Pasture, Ohsadorynkan Pasture	Saito et al., 1965: 145-146. Coll. Saito, 11 Sep '62-17 May '65, (F, M, N, L).
Haemaphysalis formosensis	*Sus scrofa riukiuanus* (Wild pig)	Ryukyu Islands	Kagoshima	Ukenson, Amami Oshima	#67-J-0216, Coll. Lipton & Mizusawa, 18 Mar '67, (*1 F*).
"	*Pentalagus furnessi* (Ryukyu Rabbit)	"	"	Yuwan, Amami Oshima	#68-J-0320, Coll. Mizusawa, 5 Apr '68, (*1 M*).
"	"	"	"	"	#68-J-0324, Coll. Mizusawa, 5 Apr '68, (1 N).
"	"	"	"	"	#68-J-0325, Coll. Mizusawa, 5 Apr '68, (1 N).
"	Vegetation	"	"	Ukenson, Amami Oshima	#67-J-0217, Coll. Lipton & Mizusawa, 23 Mar '67, (*1 M*).
"	"	"	"	Yuwan, Amami Oshima	#67-J-0266, Coll. Mizusawa, 6 Oct '67, (*1 M*).
Haemaphysalis fujisana	calves	Japan	Shizuoka	Foot of Mt. Fuji (700 m.) near Fujinomiya	Kitaoka, 1970: 73. Coll. H. Toyota, (A, N, L).
Haemaphysalis hystricis	Domestic pig	"	"	Yuwan, Amami Oshima	#65-J-0003, Coll. Hajime, Nov '65, (*5 F, 3 M*).
"	*Sus scrofa riukiuanus* (Wild pig)	"	-	Iriomote (Is.)	#55-R-021, Coll. Keegan & Toshioka, 10 Nov '55, (*3 F, 5 M*).
"	"	"	-	Iriomote (Is.)	#55-R-022, Coll. Keegan & Toshioka, 5 Dec '55, (*1 F, 1 M, 1 N*).
"	"	"	Kagoshima	Ukenson, Amami Oshima	#67-J-0066, Coll. Lipton & Mizusawa, 13-19 Mar '67, (9 F, 3 M, *9 F, 10 M, 8 N*).
"	"	"	"	"	#67-J-0075, Coll. Lipton & Mizusawa, 13-19 Mar '67, (*3 F, 1 M, 1 N*).

Haemaphysalis hystricis	*Sus scrofa riukiuanus* (Wild pig)	Japan	Kagoshima	Ukenson, Amami Oshima	#67-J-0078, Coll. Tipton & Mizusawa, 13-19 Mar '67, (6 L., 2 M., *6 F., 22 M.*)
"	"	Ryukyu Islands	"	Yamatoson, Amami Oshima	#67-J-0071, Coll. Mizusawa, 21 Mar '67, (4 L., 4 M., 20 N., *1 F., 4 M., 3 N.*)
"	"	"	"	Ashiken, Amami Oshima	#67-J-0245, Coll. Mizusawa, 20 Sep '67, (6 L., *3 F., 20 M.*)
"	"	"	"	Yuwan, Amami Oshima	#67-J-0255, Coll. Mizusawa, 1 Oct '67, (*1 F., 1 M.*)
"	"	"	"	"	#67-J-0257, Coll. Mizusawa, 1 Oct '67, (1 N., *1 F., 4 M.*)
"	"	"	"	Ashiken, Amami Oshima	#67-J-0270, Coll. Mizusawa, 19 Oct '67, (*2 M.*)
"	Dog	"	"	Yuwan, Amami Oshima	#65-J-0004, Coll. Hajime, Dec '65, (*5 F.*)
"	"	"	"	Ukenson, Amami Oshima	#67-J-0218, Coll. Hajime, 13 Aug '67, (*1 M.*).
"	"	"	"	"	#67-J-0219, Coll. Hajime, 13 Aug '67, (*2 F.*)
"	"	"	"	Yuwan, Amami Oshima	#67-J-0274, Coll. Mizusawa, Apr '67, (*3 F., 1 M.*)
"	"	"	"	"	#67-J-0248, Coll. Mizusawa, 10 Sep '67, (*1 F.*)
"	"	"	"	"	#67-J-0263, Coll. Kimura & Mizusawa, 4 Oct '67, (*1 F.*)
"	*Pentalagus furnessi* (Ryukyu Rabbit)	"	"	Ukenson, Amami Oshima	#67-J-0068, Coll. Tipton & Mizusawa, 24 Mar '67, (1 N., *1 N.*)
"	Vegetation	"	"	"	#67-J-0070, Coll. Tipton & Mizusawa, 23 Mar '67, (1 L., 5 N.).
"	"	"	"	Yuwan, Amami Oshima	#67-J-0249, Coll. Mizusawa, 26 Sep '67, (2 L.)
"	"	"	"	"	#67-J-0264, Coll. Kimura & Mizusawa, 4 Oct '67, (*2 M.*)
"	"	"	"	"	#67-J-0278, Coll. Kimura & Mizusawa, 8 Oct '67, (*1 F.*)
"	"	"	"	"	#67-J-0275, Coll. Mizusawa, Apr '67, (*1 M.*)
"	"	"	"	"	#67-J-0308, Coll. Mizusawa, 6 Oct '67, (79 L., *1 F.* reared)
"	*Sus scrofa riukiuanus* (Wild pig)	"	-	Inoda, Ishigaki (Is.)	Keegan & Toshioka, 1957:15. Coll. Keegan & Toshioka, 4 Nov '55, (1 L., 3 M., 1 N., 4 F.)
"	"	"	-	Mountain near Inoda, Ishigaki (Is.)	Keegan & Toshioka, 1957:15. Coll. Keegan & Toshioka, 8 Nov '55, (7 L., 17 M., 26 N., 18 F.)
"	Cow	"	-	Yonakuni (Is.)	Sugimoto, 1937a:313, 1937b:609. Coll. Hika, 6 Oct '36, (1 F.)
"	*Sus scrofa riukiuanus* (Wild pig)	"	-	Otomi, Iriomote (Is.)	Kawashima, 1963:103. Coll. Kawashima, 18 Aug '62, (2 F., 1 M., 2 N., 1 L.)
"	*Sus scrofa* ssp. (Wild pig)	"	-	Mountains near Inoda, Ishigaki (Is.)	Hoogstraal et al., 1965:477 (2 F., 4 M., 6 N., 1 L.), (#RML 34123). Coll. Keegan & Toshioka, 8 Nov '55, (2 M., 1 F., 2 N., 1 L.) (#HH 53261)
"	Shrubs	"	-	Chijuka, Okinawa	Hoogstraal et. al., 1965:477. Coll. Hardcastle, 31 Aug '46, (1 M.), #RML 27531

Haemaphysalis hystricis	Ground	Ryukyu Islands	-	Tanyu-yama, Okinawa	Hoogstraal et al., 1965: 477, Coll. Werner, 13 Jul '51, (2 L), (MCZ)
"	-	Japan	-	-	Neumann, 1901: 261-262, (as *bispinosa*, 2 L)
Haemaphysalis japonica	*Capricornis crispus* (Serow)	"	Nagano	Shimajima	#53-J-005, Coll. Sakaguchi, 29 Nov '53, (*1 M*)
"	"	"	Kanagawa	Tanzawa Mts.	#68-J-0304, Coll. Tsuchiya, 17 Mar '68, (*2 M*)
"	*Cervus nippon* (Sika Deer)	"	Tochigi	Kinugawa	#56-J-034, Coll. Toshioka & Akiyama, 25 Feb '56, (*1 M*).
"	Domestic cattle	"	Hokkaido	Kuttari, Tokachi	#67-J-0198, Coll. Taniguchi, 13 May '67, (19 N, *6 F*, *6 M*)
"	Dog	"	"	Kozawa, Shiribeshi	#67-J-0322, Coll. Toshioka & Sasagawa, 18 Jul '67, (*1 F*)
"	Domestic cattle	"	"	Higashimokoto, Abashiri	#55-J-064, Coll. Toshioka & Akiyama, 13 Aug '55, (*1 M*)
"	*Lepus brachyurus brachyurus* (Hare)	"	Nagano	-	Asanuma, 1958: 279, Coll. Asanuma, '58, (1 N)
"	Horse	"	Aomori	-	Keegan & Toshioka, 1957: 17, Coll. Yajima, May '40, (1 L, 1 M) (labelled as *concinna*).
"	"	Korea	-	-	Keegan & Toshioka, 1957: 17, Coll. Asanuma, Jul '41, (1 M), (labelled as *jezoensis*)
"	"	"	Hamgyong-pukto	Unggi & Kyonghung	Itagaki, Noda & Yamaguchi, 1944, 1959, (as *jezoensis* in 1944, *japonica* in 1959)
"	"	Japan	Hokkaido	Nikappu, Hidaka Memambetsu, Abashiri Abira, Yufutsu, Iburi	"
"	Cattle & horse	"	"	Sapporo & Kushiro	Ogura & Takada, 1927: 206, (as *jezoensis*).
"	-	"	-	-	Warburton, 1908: 512-513, (as *japonnica*). Numerous males, type specimens, found with *flava* at the British Museum (see discussion)
"	Dog, horse, cattle, wild pig, *Capricornis crispus* (Serow)	"	-	-	Neumann, 1911: 112, (as *H. flava flava*)
"	*Capricornis crispus* (Serow)	"	Kumamoto	Hondo	Nuttall & Warburton, 1915: 402-403, (as *H. japonica*) Same specimens as Warburton's types. Coll. The Duke of Bedford
Haemaphysalis kitaokai	*Cervus nippon* (Sika Deer)	"	Mie	Ouchiyama	#54-J-006, Coll. Asanuma, 17 Jan '54, (*3 F*, *2 M*)
"	"	"	"	-	#67-J-0178, Coll. Yamaguti, 8 Mar '67, (*1 M*).
"	"	"	"	-	#67-J-0185, Coll. Yamaguti, 22 Mar '67, (6 L, 8 M, *19 F*, *9 M*)
"	"	"	Shiga	-	#67-J-0180, Coll. Yamaguti, 8 Mar '67, (*4 F*, *2 M*).
"	Domestic cattle	"	Shimane	Sanbe, Oda shi	#66-J-0019, Coll. Sugiyama & Holubec, 6 Oct '66, (*66 F*)
"	"	"	"	"	#67-J-0286, Coll. Yamaguti, 4 Nov '67, (32 L, 11 M, 5 N, *8 F*, *2 M*)
"	"	"	"	"	#67-J-0289, Coll. Yamaguti, 4 Nov '67, (*1 F*)

Haemaphysalis kitaokai	*Capricornis crispus* (Serow)	Japan	Kanagawa	E. Tanzawa Mts.	#68-J-0305, Coll. Tsuchiya, 5 Mar '68, (1 F).
"	Cattle	"	Nagasaki	Nakano-mura, Kita matsuura-gun	Keegan & Toshioka, 1957:16, (as *H. inermis*) Coll. Yajima, 28 Jun '52, (1 F)
"	Deer	"	Mie	-	Keegan & Toshioka, 1957:16, (as *H. inermis*) Coll. Asanuma, 17 Jan '54, (30 F, 27 M).
"	Vegetation	"	Shimane	Sanbe	Iwasaki et al., 1964 (as *H. inermis*). Coll. Tsuchie, Sep '62-Aug '63.
"	"	"	-	-	Sugimoto, 1937a:315, (as *H. inermis*) Probably cited from Neumann (1906)
"	Cattle	"	Shimane	Sanbe	Kitaoka & Morii, 1967a:145-152 (F, M), Nov '62, (as *ambigua*).
"	*Capricornis crispus* (Serow)	"	-	-	Neumann, 1906:217, 1911:109 (1 F) (as *inermis* and *ambigua*, may be the same specimen)
"	"	"	-	-	Nuttall & Warburton, 1915:367-368 (as *inermis*). Cited Neumann's record
"	Horse	"	Fukoka (sic) (= Fukuoka)		Nuttall & Warburton, 1915:367-368 (as *inermis* var. *aponommoides*) (1 F). Berl. Mus. 173, also examined by Hoogstraal, 1969
"	"	"	Fukuoka	-	Keegan & Toshioka, 1957:16, (as *inermis* var. *aponommoides*) Cited from Nuttall & Warburton, 1915.
"	"	"	"	-	Hoogstraal, 1961:317-318 (as *inermis aponommoides*), 1962:195-199 (as *aponommoides*). Cited from Nuttall & Warburton, 1915
"	Cow	"	Shimane	Sanbe	Hoogstraal, 1969:211-221 (as *kitaokai*). Holotype, allotype, and paratypes.
"	*Cervus nippon* (Sika Deer)	"	Mie	-	Hoogstraal, 1969:211-221. Coll. Yamaguti, 22 Mar '67, (9 M, 19 F) Paratypes
"	Horse and *Capricornis crispus* (Serow)	"	-	-	Hoogstraal, 1969:211-221. (2 F) Identified by Neumann as *ambigua* Brit. Mus. #1367, #139. (1 F) Identified by N. & W. as *inermis* var. *aponommoides*. Berl. Mus. 173
Haemaphysalis longicornis	Horse	"	Hokkaido	Kamimokuni Hiyama	#55-J-008, Coll. Toshioka & Akiyama, 17 Aug '55, (2 F)
"	"	"	"	"	#55-J-032, Coll. Toshioka & Akiyama, 17 Aug '55, (1 F, 4 F)
"	"	"	"	Tomioka	#55-J-030, Coll. Toshioka & Akiyama, 2 Aug '55, (9 F)
"	"	"	"	Kamimokuni, Hiyama	#55-J-049, Coll. Toshioka & Akiyama, 17 Aug '55, (1 F)
"	"	"	Nagasaki	Iwazato, Tsushima	#67-J-0120, Coll. Tipton & Mizusawa, 6 May '67, (52 F, 19 M, 9 N, 3 M, 4 N)
"	"	"	"	"	#67-J-0123, Coll. Tipton & Mizusawa, 6 May '67, (9 F, 3 M, 8 N, 1 F, 1 M)
	"	"	Hokkaido	Misaki, Abashiri	#67-J-0189, Coll. Toshioka & Sasagawa, 13 Jul '67, (15 F, 29 N, 8 F)
"	"	Korea	-	Todu-ri, Cheju Do	#67-K-0001, Coll. Munsu, 5 May '67, (3 F, 2 N)

Haemaphysalis longicornis	Horse	Korea	-	..	#67-K-0009, Coll. Munsu, 5 May '67, (*5 F*, *6 M*)
..	Cattle	Japan	Hiroshima	Azumayama	#55-J-009, Coll. Toshioka & Akiyama, 19 Sep '55, (*1 M*)
..	..	..	..	..	#55-J-011, Coll. Toshioka & Akiyama, 19 Sep '55, (*6 F*, *3 M*)
..	..	..	Hokkaido	Higashimokoto, Abashiri	#55-J-025, Coll. Toshioka & Akiyama, 13 Aug '55, (13 F, 9 N, *23 F*).
..	..	..	..	Shintoku, Tokachi	#67-J-0193, Coll. Toshioka & Sasagawa, 15 Jul '67, (4 F, 2 N, *3 F*)
..	..	..	Nagasaki	Oshima-gun, Iki (Is.)	#67-J-0105, Coll. Lipton & Mizusawa, 4 May '67, (6 F, *2 F*)
..	..	..	..	Hatsuyama, Iki (Is.)	# 67-J-0106, Coll. Lipton & Mizusawa, 4 May '67, (22 F, 5 M, 42 N, *1 F*, *6 M*, *6 N*).
..	..	..	..	..	#67-J-0108, Coll. Lipton & Mizusawa, 4 May '67, (6 F, 58 N, *4 F*, *13 N*)
..	..	..	..	..	#67-J-0111, Coll. Lipton & Mizusawa, 4 May '67, (1 F, 7 N, *3 F*, *1 M*, *13 N*).
..	..	..	..	..	#67-J-0112, Coll. Lipton & Mizusawa, 4 May '67, (3 F, 27 N, *2 F*, *2 M*, *21 N*).
..	..	..	..	..	#67-J-0113, Coll. Lipton & Mizusawa, 4 May '67, (9 F, 4 M, 32 N, *23 F*, *40 M*, *7 N*).
..	..	..	..	Takenotsuji, Iki (Is.)	#67-J-0115, Coll. Lipton & Mizusawa, 4 May '67, (2 F, 4 M, 7 N, *2 F*, *3 M*, *8 N*)
..	..	..	..	..	#67-J-0116, Coll. Lipton & Mizusawa, 4 May '67, (1 N, *3 F*, *1 M*, *1 N*).
..	..	..	..	Gonoura, Iki (Is.)	# 67-J-0143, Coll. Lipton & Mizusawa, 2 May '67, (2 F, *1 F*)
..	..	..	..	Iwazato, Tsushima	#67-J-0119, Coll. Lipton & Mizusawa, 6 May '67, (2 F, 11 N, *1 F*, *211 M*)
..	..	..	Kagoshima	Ichinari	#67-J-0127, Coll. Lipton & Mizusawa, 10 May '67, (*1 F*)
..	..	..	..	..	#67-J-0130, Coll. Lipton & Mizusawa, 10 May '67, (1 F, *2 F*).
..	..	..	..	..	#67-J-0133, Coll. Lipton & Mizusawa, 10 May '67, (3 F, *3 F*)
..	..	..	..	..	#67-J-0136, Coll. Lipton & Mizusawa, 10 May '67, (*2 F*)
..	..	..	..	Sakura Jima	#67-J-0139, Coll. Mizusawa, 14 May '67, (*1 F*)
..	..	..	Shimane	Sanbe	#67-J-0152, Coll. Holubec & Sugiyama, 15 May '67, (80 F, 3 M, 28 N, *1 F*)
..	..	..	..	..	#66-J-0023, Coll. Holubec & Toshioka, 13 Jul '66, (*1 F*)
..	..	..	..	..	#66-J-0025, Coll. Holubec & Toshioka, 13 Jul '66, (*1 F*)
..	..	..	..	..	#66-J-0020, Coll. Holubec & Toshioka, 6 Oct '66, (*2 M*, *2 N*)
..	..	..	..	..	#68-J-0327, Coll. Yamaguti & Blecha, 4 Jun '68, (2 F, 4 M, 65 N).

Haemaphysalis longicornis	Cattle	Japan	Shimane	Sanbe	#68-J-0329, Coll. Yamaguti & Blecha, 4 Jun '68, (7 F., 4 M., 4 N).
"	"	"	"	Beppu, Oki (Is.)	#66-J-0026, Coll. Yamaguti, 12 Sep '66, (8 F., 3 M., 32 N., 100 L., *2 F., 2 M*)
"	"	"	"	"	#66-J-0021, Coll. Yamaguti, 12 Sep '66, (*1 F*)
"	"	"	"	Sanbe	#68-J-0330, Coll. Yamaguti & Blecha, 4 Jun '68, (15 F., 2 M., 1 N)
"	"	"	Gumma	Komochi Pasture Takayama-mura, Agatsuma-gun	#66-J-0029, Coll. Yamaguti, 3 Sep '66, (*1 F*)
"	"	"	"	"	#66-J-0022, Coll. Yamaguti, 3 Sep '66, (*1 F*)
"	"	"	Iwate	Koiwai	#67-J-0146, Coll. Saito, 26 Apr '62, (70 N., *1 F*)
"	"	"	"	Sotoyama	#67-J-0211, Coll. Yamaguti, 10 Aug '67, (17 F.)
"	"	"	"	"	#67-J-0212, Coll. Yamaguti, 10 Aug '67, (9 F., 1 N)
"	"	"	"	"	#67-J-0213, Coll. Yamaguti, 10 Aug '67, (8 F., 2 N)
"	"	"	"	Hayasaka	#67-J-0214, Coll. Yamaguti, 10 Aug '67, (2 F., 1 N., 1 L.)
"	"	"	Tokyo	Hachijo Koshima	#67-J-0207, Coll. Yamaguti, 13 Jul '67, (2 F., *1 F*)
"	"	"	"	Aogoashima	#67-J-0209, Coll. Takahashi, 26 Jul '67, (10 F., *1 F*)
"	"	Korea	-	Ido-Ri, Cheju Do	#67-K-0002, Coll. Yi Munsu, 5 May '67, (14 N., *1 M., 1 N*)
"	"	"	-	Ha-Ga, Cheju Do	#67-K-0003, Coll. Driggers, 5 May '67, (*2 F., 3 M., 1 N*)
"	"	"	-	Naedo-Ri, Cheju Do	#67-K-0004, Coll. Driggers, 5 May '67, (*6 M*)
"	"	"	-	"	#67-K-0005, Coll. Driggers, 5 May '67, (2 F., 1 N., *4 F*)
"	"	"	-	"	#67-K-0006, Coll. Driggers, 5 May '67, (3 F., 2 M., *4 F., 1 M*)
"	"	"	-	Hallim, Cheju Do	#67-K-0007, Coll. Parsons, 5 May '67, (2 F., *1 M., 1 N*)
"	"	"	-	Bay-um, Cheju Do	#67-K-0008, Coll. Parsons, 5 May '67, (8 F., 5 N., *1 F., 2 N*)
"	"	"	-	Song-Ga, Cheju Do	#67-K-0010, Coll. Driggers, 5 May '67, (5 F., 3 M., 7 N., *7 F., 1 M., 2 N*)
"	"	"	-	"	#67-K-0011, Coll. Yi Munsu, 5 May '67, (2 F., 4 N., *1 F., 3 M*)
"	"	"	-	"	#67-K-0012, Coll. Parsons, 5 May '67, (1 F., 1 N., *4 F., 1 M*)
"	"	"	-	"	#67-K-0013, Coll. Yi Munsu, 5 May '67, (4 F., 4 N., *1 F., 1 M., 3 N*)
"	"	"	-	Yewol, Cheju Do	#67-K-0014, Coll. Driggers, 5 May '67, (2 F., 1 M., *2 F*)
"	"	"	-	"	#67-K-0015, Coll. Parsons, 5 May '67, (1 F., 1 M., 9 N., *2 F., 1 M., 3 N*)

Haemaphysalis longicornis	Cattle	Korea	-	Nabum-Ni, Cheju Do	#67-K-0016, Coll. Yi Munsu, 5 May '67, (1 F., 2 N., *2 F., 3 M., 1 N.*)
"	"	"	-	Kumik, Cheju Do	#67-K-0020, Coll. Parsons, 6 May '67, (4 F., 2 N., *3 F.*)
"	"	"	-	Kumsong-Ni, Cheju Do	#67-K-0021, Coll. Parsons, 6 May '67, (1 F., *1 M.*)
"	"	"	-	Sogwan, Cheju Do	#67-K-0026, Coll. Parsons, 6 May '67, (3 F., 2 N., *2 F., 2 M.*)
"	"	"	-	Kwason, Cheju Do	#67-K-0028, Coll. Driggers, 6 May '67, (1 M., 2 N., 2 F., *8 F., 1 M., 2 N.*)
"	*Cervus nippon* (Sika Deer)	Japan	Tochigi	Kinugawa	#56-J-061, Coll. Toshioka & Akiyama, 25 Feb '56, (*1 M.*)
"	Dog	"	Hokkaido	Misaki, Abashiri	#67-J-0190, Coll. Toshioka & Sasagawa, 13 Jul '67, (14 F., 5 N., *4 F.*)
"	"	"	"	Kozawa, Shiribeshi	#67-J-0201, Coll. Toshioka & Sasagawa, 18 Jul '67, (35 F., 33 N., *16 F.*)
"	"	"	"	"	#67-J-0203, Coll. Toshioka & Sasagawa, 18 Jul '67, (*1 F.*)
"	"	"	Gumma	Asama	#66-J-0240, Coll. Yamaguti, 3 Sep '66, (*1 F., 2 N.*)
"	"	"	Tokyo	Hachijo Is.	#67-J-0208, Coll. Utsumi, 13 Jul '67, (2 F., *1 F.*)
"	Domestic sheep	Korea	-	Ishidor Farm Cheju Do	#67-K-0023, Coll. Driggers, 6 May '67, (1 N., *5 M.*)
"	"	"	-	"	#67-K-0024, Coll. Driggers & Yi Munsu, 6 May '67, (*1 F., 1 M.*)
"	Vegetation	Japan	Hokkaido	Misaki, Abashiri	#67-J-0191, Coll. Toshioka & Sasagawa, 13 Jul '67, (3 F., 4 N., *1 F.*)
"	"	Korea	-	Ch'onsong-Ni	Hoogstraal et al., 1968: 1204-1206. Coll. Traub, 16 Jun '52, (1 F.), RML #33092
"	Cattle, horse, sheep goat, dog	"	-	Cheju Do and Koje Do	Hoogstraal et al., 1968: 1204-1206. Coll. Parsons and/or Driggers and Yi Munsu. Other data, see Hoogstraal et al., 1968
"	-	Japan	-	-	Hoogstraal et al., 1968: 1204-1206. Lectotype female, paralectotype male & syntypes, (6 F., 2 M.) N. 1425 in Neumann collection
"	Dog, cow	"	-	Kyago & Haragi	Hoogstraal et al., 1968: 1204-1206. (3 F., 2 M.) marked "TYPE" (1 F.) ex cow, Kyago, (1 F.) ex dog, Haragi, in Berlin Museum
"	-	"	Shizuoka	Izu	Hoogstraal et al., 1968: 1204-1206. (1 F.) Brit. Mus. #11, 12, 13, 14
"	Cattle	"	-	Kyushu	Hoogstraal et al., 1968: 1204-1206. Coll. Sugimoto, 14 Jul '33, (4 F., 1 M.) RML #15185
"	Horse	"	Miyazaki	Takanabe	Hoogstraal et al., 1968: 1204-1206. (9 F., 1 M.) N. 2909, Nuttall Collection in Brit. Mus.; same specimens in N. & W., 1915
"	"	"	Tottori	Daisen	Hoogstraal et al., 1968: 1204-1206. (8 F.) N. 2908, Nuttall Collection in Brit. Mus.; same specimens in N. & W., 1915
"	Cattle, horse, dog badger, deer	"	Hokkaido Aomori Iwate Gumma Nagano	-	Hoogstraal et al., 1968

Haemaphysalis longicornis	Cattle, horse, dog, badger, deer	Japan	Tokyo Nara Hiroshima Shimane Nagasaki Kagoshima		Hoogstraal et al., 1968.
"	Cattle, horse, dog	"	-	various provinces	Donitz, 1905: 127-129 (as *H. neumanni*) Type specimens
"	"	"	-	-	Neumann, 1911: 109 (as *H. neumanni*).
"	"	"	-	-	Trapido, 1965: 160; Hoogstraal & Trapido, 1966: 1192 (as *H. neumanni*) (6 F., 2 M), Nr. 1425; Trapido selected 1 F. lectotype from the lot (=syntype of Donitz's *neumanni*). Hoogstraal & Trapido redescribed the lectotype and paralectotype
"	Dog	Korea	-	Keijo (=Seoul)	Kishida, 1936: 139-142. (as *H. neumanni*)
"	Man	Japan	Kyoto	Ginkakuji-cho, Kyoto-shi	Nagahana & Matsuo, 1962: 119-121 (as *H. bispinosa*) (1 F.), 21 Jul '61
"	*Lepus brachyurus brachyurus* (Hare)	"	Nagano	-	Asanuma, 1958: 279 (as *H. bispinosa*) Coll. Asanuma, '58, (F., N)
"	"	"	Hiroshima	-	Keegan & Toshioka, 1957: 11-12 (as *H. bispinosa*) Coll. Asanuma, 9 Sep '48, (18 F.)
"	Cattle	"	Aomori	-	Keegan & Toshioka, 1957: 11-12 (as *H. bispinosa*) Coll. Asanuma, 19 Jul '55, (4 F.)
"	"	"	Kagoshima	Osumi	Keegan & Toshioka, 1957: 11-12 (as *H. bispinosa*) Coll. Toshioka, 14 Jul '55, (3 F.) 406 MGL #1 & (1 F.), 406 MGL #4
"	"	"	Shimane	Sanbe	Keegan & Toshioka, 1957: 11-12 (as *H. bispinosa*) Coll. Toshioka & Akiyama, 18 Sep '55, (15 F., 6 N, 102 L)
"	"	"	Okayama	-	Keegan & Toshioka, 1957: 11-12 (as *H. bispinosa*) Coll. Yajima, 13 Jun '54, (2 F., 2 M)
"	"	"	Hiroshima	Azumayama	Keegan & Toshioka, 1957: 11-12 (as *H. bispinosa*) Coll. Toshioka & Akiyama, 19 Sep '55, 406 MGL #33, (7 F., 5 M, 4 N, 143 L)
"	Cattle and horse	"	Hokkaido	Higashimokoto-mura, Abashiri	Keegan & Toshioka, 1957: 11-12 (as *H. bispinosa*) Coll. Toshioka & Akiyama, 13 Aug '55, 406 MGL #11, (36 F., 9 N, 4 L)
"	Horse	"	"	Hiyama	Keegan & Toshioka, 1957: 11-12 (as *H. bispinosa*) Coll. Toshioka & Akiyama, 17 Aug '55, 406 MGL #7, (137 F., 11 N, 3 L)
"	Vegetation	"	"	Ishikari	Keegan & Toshioka, 1957: 11-12 (as *H. bispinosa*) (1 F.), 5 Jun '55, 406 MGL #10
"	"	"	Tokyo	Oshima	Nakatsuji, 1942: 294 (as *H. bispinosa*)
"	Cattle, horse, sheep, dog, goat	Japan & Korea	Hokkaido Aomori Iwate Miyagi Chiba Hyogo Okayama	-	Itagaki, Noda & Yamaguchi, 1944, 1955 (as *H. bispinosa*)

Haemaphysalis longicornis	Cattle, horse, dog, sheep, goat	Japan & Korea	Shimane Oita Miyazaki Kagoshima Hamgyong-pukto		Itagaki, Noda & Yamaguchi, 1944, 1955 (as *H. bispinosa*)
,,	,,	Korea	Hamgyong-namdo, Kyonggi-do, Kyongsang-pukto, Kyongsang-namdo, Cholla-namdo	-	,,
,,	Cattle, horse, human, wild rabbit	Japan & Korea	-	Honshu, Kyushu & Hokkaido	Sugimoto, 1936c: 580 (as *H. bispinosa*)
,,	Cattle & horse	Japan	Fukuoka, Kumamoto Miyazaki Kagoshima	-	Sugimoto, 1937b: 605 (as *H. bispinosa*) (L., M., N. F.), Jul-Oct '33 and Jul-Nov '36.
,,	-	Korea	-	all over the peninsula	Kishida, 1936: 139-142 (as *H. bispinosa*) According to Kishida, Akasawa recorded bispinosa in 1928.
,,	*Lepus brachyurus angustidens* (Hare), *Meles meles anakuma* (Badger), *Nyctereutes procyonoides viverrinus* (Raccoon Dog), cattle & vegetation	Japan	Niigata	Kakudayama, Sasagamine Pasture & Ohsadorynkan Pasture	Saito, et al., 1965: 145-146, (as *H. bispinosa*) Coll. Saito, 8 Aug '61-23 Apr '65, (L., N., F.)
,,	Cattle, horse, & hare	Japan & Korea	Hokkaido Aomori Iwate Kumamoto	Hakodate, Sapporo, Muroran, Asahikawa, Abashiri Fusan (=Pusan)	Ogura & Takada, 1927: 204-205 (as *H. bispinosa*)
,,	Cattle, horse, goat	Japan & Ryukyu Islands	Hokkaido Iwate Fukushima Ibaraki Gumma Hyogo Shimane Okayama Hiroshima Tokushima Oita Nagasaki Miyazaki Kumamoto Okinawa		Nakamura & Yajima, 1937: 151 (as *H. bispinosa*).
		Korea	Chhungchhong-pukto, Kyongsang-do, Phyongan-do, Hamgyong-pukto, Kangwan-do, Cholla-namdo		
,,	Cattle, horse	Japan	Iwate, Aomori	-	Yajima, 1942: 507-509 (as *H. bispinosa*)
,,	Cattle, horse, hare fox, & vegetation	,,	Kumamoto	-	Shigemori, Aso & Yajima, 1953: 290-293 (as *H. bispinosa*)
,,	Horse	,,	-	-	Nuttall & Warburton, 1915: 453 (as *H. bispinosa*) (F.F., F.M.) N. 129, presented to N. & W. by Dönitz as his *neumanni*
,,	,,	,,	Aomori	-	Nuttall & Warburton, 1915: 453 (as *H. bispinosa*) (F.) N. 2907a, 15 Jul '12, found with *Dermacentor* sp.

Haemaphysalis longicornis	Horse	Japan	Tottori	Daisen	Nuttall & Warburton, 1915:433, (as *H. bispinosa*) (N, I F N, 1908, 2 Aug '12, found with *Ixodes ricinus* (?*I. nipponensis*), also examined by Hoogstraal
,,	,,	,,	Miyazaki	Takanabe	Nuttall & Warburton, 1915:433 (as *H. bispinosa*) (F) N, 1909, 5 Jun - 12 Oct '12, also examined by Hoogstraal
,,	Cattle	,,	Tokyo	-	Nuttall & Warburton, 1915:433, (as *H. bispinosa*) (1 F) N, 2911a, 16 Oct '11, found with *Boophilus* sp., submitted by Dr. Miyajima
Haemaphysalis megaspinosa	*Sus scrofa leucomystax* (Wild pig)	,,	Mie	-	Coll. Yamaguti, 8 Mar '67, (18 M)
,,	*Cervus nippon* (Sika Deer)	,,	,,	-	Coll. Yamaguti, Mar '67, (4 F, 19 M)
,,	,,	,,	Shiga	-	Coll. Yamaguti, Mar '67, (13 M)
,,	,,	,,	Miyazaki	Kitagawa-mura & Aya-machi, Higashi-morokata-gun	Coll. Yajima, 15 Mar '61, (2 F)
,,	,,	,,	Kanagawa	Miyagase	Coll. Kitaoka, 27 Nov '68, (3 FF, 15 M, 84 N, 8 L)
,,	,,	,,	,,	,,	Coll. Kitaoka, 5 Jan-23 Feb '69 (Numerous adults)
,,	*Capricornis crispus* (Serow)	,,	,,	Tanzawa	#68-J-0307, Coll. Tsuchiya, 5 Mar '68, (1 M)
,,	,,	,,	,,	,,	#68-J-0301, Coll. Tsuchiya, 17 Mar '68, (24 F, 28 M)
,,	Vegetation	,,	,,	Nanasawa, Atsugi-machi, Naka-gun	Saito, 1969:87. Coll. Saito, 5 Oct '68, (1 M) Holotype, (1 F) Allotype, (3 F, 3 M), 9 Apr '69
,,	-	,,	,,	Mineyama, Kuribara, Isehara-machi, Naka-gun	Saito, 1969:87. Coll. Saito, 10 Apr '69, (1 M).
Haemaphysalis pentalagi	*Pentalagus furnessi* (Ryukyu Rabbit)	Ryukyu Islands	Kagoshima	Yamatoson, Amami Oshima	#67-J-0063, Coll. Mizusawa, 17 Mar '67, (*1 M*)
,,	,,	,,	,,	Yuwan-dake, Amami Oshima	#68-J-0311, Coll. Mizusawa, 3 Apr '68, (12 F, 4 M, 3 N, 1 L, *1 F, 1 M*)
,,	,,	,,	,,	,,	#68-J-0312, Coll. Mizusawa, 4 Apr '68, (2 F, 6 M, 5 N, *1 F, 5 M, 2 N*)
,,	,,	,,	,,	,,	#68-J-0313, Coll. Mizusawa, 5 Apr '68, (1 M, 30 N, *1 F, 2 M, 5 N*)
,,	,,	,,	,,	,,	#68-J-0315, Coll. Mizusawa, 6 Apr '68, (5 F, 35 M, 3 N, *12 F, 1 N*)
,,	,,	,,	,,	-	Pospelova-Shtrom, 1935:213. Coll. Schmidt '27, (1 M)
,,	,,	,,	,,	-	Keegan & Toshioka, 1957:4-28. Discussed the locality of Pospelova-Shtrom's record.
,,	,,	,,	,,	Yuwan-dake, Amami Oshima	Hoogstraal & Yamaguti, 1970 Coll. Mizusawa, Apr '68, (12 F, 40 M, 23 N, 35 L)
Haemaphysalis [illegible]	*Turdus cardis cardis* (Japanese Grey Thrush)	Japan	Shizuoka	Hokugo-mura, Santo-gun	Asanuma & Kosaka, 1954:104-107. Coll. Toshioka, 29 Apr '54, (1 M)
,,	,,	,,	Nagano	Hada-mura	Asanuma & Kosaka, 1954:104-107. Collected 19 Apr '53, (1 M)
[illegible]	[illegible]	,,	Iwate	Kawai-mura	Coll. Yajima, 8 Aug '49, (*1 F*)

Ixodes acutitarsus	Man	Japan	Osaka	-	Ohara & Tamura, 1958. Collected Aug '58.
"	"	"	Wakayama	Mt. Gomadan	Keegan & Toshioka, 1957: 18. Collected 4 Jul '49. (1 F)
"	"	"	Saitama	Shikanoyu, Chichibu-shi	Keegan & Toshioka, 1957: 18. Coll. Asanuma. (1 F)
"	*Capricornis crispus* (Serow)	"	Gifu, Nagano & Toyama	-	Kishida, 1930a: 1-5.
"	Serow, cattle & dog	"	-	-	Asanuma, 1947b: 972.
"	-	"	-	-	Karsch, 1880: 142. Coll. Hilgendorf. Type. (1 F)
"	-	"	-	-	Neumann, 1911: 16.
Ixodes angustus	*Clethrionomys rufocanus bedfordiae* (Red-backed mouse)	"	Hokkaido	Onneto, Nemuro	Coll. Ono, 9 Sep '56. (1 F)
"	"	"	"	Rebunto, Soya	Coll. Ono, 22 Oct '56. (1 N)
"	Vegetation	"	"	Sarobetsu, Soya	Coll. Ono, 1 Jul '61. (1 F)
"	*Clethrionomys rutilus* (Red-backed mouse)	"	"	Otoineppu	Asanuma, 1957: 234 and Asanuma & Sekikawa, 1952: 111. Coll. Asanuma, Jul '51 as *Ixodes* sp. 3 (larva) and *Ixodes* sp. 61 (nymph). (L, N)
"	*Apodemus speciosus ainu* (Field mouse)	"	"	Toyotomi	Asanuma, 1957: 234 and Asanuma and Sekikawa, 1952: 111.
"	*Clethrionomys rufocanus bedfordiae* (Red-backed mouse) & *Apodemus speciosus ainu* (Field mouse)	"	"	Ishikari, Nemuro, Abashiri, Soya	Ono, 1966: 62-68. Coll. Ono, Jun '55 - Oct '62. (A, N, L)
"	*Clethrionomys rufocanus bedfordiae* (Red-backed mouse)	"	"	Hiroo and Teine	Asanuma, 1955: 1240-1242. (N), as *Ixodes* sp. 61
"	*Clethrionomys rufocanus bedfordiae* (Red-backed mouse), *Apodemus speciosus ainu* (Field mouse), *Apodemus argenteus hokkaidi* (Field mouse)	"	"	Hiroo, Sounkyo, Otoineppu, Toyotomi, Ishikari, Onaobetsu	Asanuma, 1955: 1240-1242. (L) as *Ixodes* sp. 3
Ixodes granulatus	*Rattus rattus* (Rat)	Ryukyu Islands	-	Okinawa	#55-R-028. Coll. Keegan & Toshioka, 20 Oct '55. (*6 F, 1 N, 3 L*)
"	*Suncus murinus riukiuanus* (Shrew)	"	-	"	#R-0007. (*1 F*)
"	*Rattus norvegicus* (Norway Rat)	"	-	Naha-shi, Okinawa	Kitaoka's Collection, 15 May '69. (3 L, 1 N)
"	*Rattus* sp. (Rat)	"	-	Ishigaki (Is.)	Keegan & Toshioka, 1957: 19. Coll. Keegan & Toshioka, 10 Nov '55. RMI #96. (1 N, 23 L)
"	"	"	-	Nishihara, Ishigaki (Is.)	Keegan & Toshioka, 1957: 19. Coll. Keegan & Toshioka, 29 Oct '55. (2 L-406 MGL #75, 4 N-406 MGL #167)
"	Under log	"	-	Ohara, Iriomote (Is.)	Keegan & Toshioka, 1957: 19. Coll. Keegan, 3 Nov '55. 406 MGL #90. (1 N)
"	Rat	"	-	Okinawa	Keegan & Toshioka, 1957: 19. Coll. Hardcastle, May '45. RMI #27522 (3 L)
"	"	"	-	Nago, Okinawa	Keegan & Toshioka, 1957: 19. Coll. Posekany, 25 Apr '45. RMI #27511 (2 L)
"	"	"	-	Takabanare Shima, Okinawa	Keegan & Toshioka, 1957: 19. Coll. Posekany, 15 Jun '45. (1 L, 2 M)

Ixodes granulatus	*Rattus rattus* (Rat)	Ryukyu Islands	-	Okinawa	Keegan & Toshioka, 1957:19. Coll. Posekany, 29 Apr '45, RML #27512 (1 F)
"	"	"	-	"	Keegan & Toshioka, 1957:19. Coll. Posekany, 5 May '45, (2 F-RML #27514, 3 F RML #27513)
"	"	"	-	"	Keegan & Toshioka, 1957:19. Coll. Posekany, 16 May '45, RML #27518 (2 F, 2 M, 1 N)
"	"	"	-	"	Keegan & Toshioka, 1957:19. Coll. Hardcastle, 10 May '45, RML #27516 (4 F)
"	"	"	-	Yamanuwa, Okinawa	Keegan & Toshioka, 1957:19. Coll. Hardcastle, 23 May '45, RML #27519 (3 F).
"	"	"	-	Nago, Okinawa	Keegan & Toshioka, 1957:19. Coll. Hardcastle, May '45, RML #27521 (1 F)
"	"	"	-	Naha, Okinawa	Kawashima, 1963:103. Coll. Kawashima, 25 Jun '62, (1 F)
"	"	Japan	Tokyo	Hachijo (Is.)	Asanuma & Sekikawa, 1952:107-116, 1953:99-112. Coll. Asanuma, Dec '51 & May '52, (A, N, F)
"	"	"	"	Miyaki (Is.)	Asanuma & Sekikawa, 1952:107-116, 1953:99-112. Coll. Asanuma Mar '52, (N, F)
"	*Rattus norvegicus* (Norway Rat)	"	"	Hachijo Koshima	Asanuma & Sekikawa, 1952:107-116, 1953:99-112. Coll. Asanuma, Sep '50 & Aug '51, (N, F)
"	"	"	"	"	Asanuma & Sekikawa, 1952:107-116, 1953:99-112. Coll. Asanuma, May '50 & May '52, (A).
"	"	"	"	Hachijo (Is.)	Asanuma & Sekikawa, 1952:107-116, 1953:99-112. Coll. Asanuma, Mar '50, Aug '51, & May '52, (A, N, F)
"	"	"	"	Miyaki (Is.)	Asanuma & Sekikawa, 1952:107-116, 1953:99-112. Coll. Asanuma, Mar '52, (N, F)
"	"	"	Kochi	Okino Shima	Asanuma & Sekikawa, 1952:107-116, 1953:99-112. Coll. Asanuma, Aug '52, (A)
"	*Apodemus speciosus* (Field Mouse)	"	Tokyo	Miyake (Is.)	Asanuma & Sekikawa, 1952:107-116, 1953:99-112. Coll. Asanuma, Mar '52, (N, F)
"	"	"	Chiba	Ohara	Asanuma & Sekikawa, 1952:107-116, 1953:99-112. Coll. Asanuma, Jan '53, (N)
"	"	"	Kanagawa	Kurihama	Asanuma & Sekikawa, 1952:107-116, 1953:99-112. Coll. Asanuma, Jan '53, (F)
"	Dog & cat	"	Tokyo	Izu-shichito	Asanuma & Sekikawa, 1953:99-112. Coll. Asanuma, (2 A)
"	*Suncus murinus* (Shrew)	Ryukyu Islands	-	Nago, Okinawa	Keegan & Toshioka, 1957:19. Collected 26 May '45, (1 F).
"	*Turdus celaenops celaenops* (Seven Islands Thrush)	Japan	Tokyo	Miyake (Is.)	Asanuma & Kosaka, 1955:195. Collected (F).
"	*Apodemus agrarius* ssp. (Field mouse)	Korea	-	Paedun ni, Pansong, Chindong-ni	Arthur, 1957:683-686. Coll. 37th Med. Co., Jun & Jul '54 (10 M, 30 F)
Ixodes turdus	*Delichon urbica dasypus* (Japanese House Martin)	Japan	Shimane	Hinomisaki	#66-I-0027, Coll. Toshioka, Betchley & Holubec, 9-15 Jul '66, (5 F)

Ixodes lividus	*Delichon urbica dasypus* (Japanese House Martin)	Japan	Gumma	Minakami	#66-J-0028, Coll. Suzuki, 19 Jul '66, (*3 F*)
,,	,,	,,	,, ,,	,,	#68-J-0334, Coll. Suzuki & Sasagawa, 5 Jul '68, (50 L, 20 M, 4 N, *5 F, 5 M, F_1 L*)
,,	*Riparia riparia ijimae* (Eastern Sand Martin)	,,	Hokkaido	Hamamokoto, Abashiri-shi	#67-J-0192, Coll. Toshioka & Sasagawa, 14 Jul '67, (2 L, 4 M, 3 N, *1 F, 3 M*)
,,	,,	,,	,,	,,	Ono, 1967: 217. Coll. Ono, 30 Mar '63, (20 L, 25 M, 1 N)
,,	,,	,,	,,	,,	Ono, 1967: 217. Coll. Ono, 4 Aug '66, (2 L)
,,	*Delichon urbica dasypus* (Japanese House Martin)	,,	Nagano	Hakuba-mura Kitaazumi-gun	Uchikawa & Sato, 1969: 96. Coll. Uchikawa, 30 Dec '67, (1 N).
,,	,,	,,	,,	Otari-mura, Kitaazumi-gun	Uchikawa & Sato, 1969: 96. Coll. Uchikawa, 31 Dec '67 & 7 Apr '68, (2 L, 13 N, 5 L).
Ixodes monospinosus	Vegetation	,,	Mie	Odaigahara, Owase-shi	Kitaoka's collection, Coll. Yokoyama, 27 Apr '69, (1 L)
,,	Man	,,	Niigata	Iide Mts., Kitakanbara-gun	Saito, 1967. (1 L), 28 Jun '67
Ixodes nipponensis	Cattle	,,	Shiga	Otsu	#55-J-033, Coll. Akiyama, 10 Dec '55, (*1 M*)
,,	,,	,,	Shimane	Sanbe	#66-J-018, Coll. Holubec & Sugiyama, 6 Oct '66, (10 L, 10 M, *42 F, 21 M*).
,,	,,	,,	,,	,,	#67-J-0164, Coll. Holubec & Sugiyama, 16 May '67, (*1 F*)
,,	,,	,,	,,	,,	#67-J-0326, Coll. Holubec & Sugiyama, 16 May '67, (*1 F*)
,,	,,	,,	,,	,,	#67-J-0281, Coll. Yamaguti, 4 Nov '67, (*3 F, 1 M*)
,,	,,	,,	,,	,,	#67-J-0282, Coll. Yamaguti, 4 Nov '67, (*1 F*)
,,	,,	,,	,,	,,	#67-J-0287, Coll. Yamaguti, 4 Nov '67, (*5 F, 10 M*)
,,	,,	,,	,,	,,	#68-J-0331, Coll. Yamaguti & Blecha, 4 Jun '68, (*1 F*)
,,	*Cervus nippon* (Sika Deer)	,,	Mie	-	#67-J-0186, Coll. Yamaguti, 22 Mar '67, (*3 F*).
,,	Dog	,,	Hiroshima	Kamedani	#55-J-029, Coll. Akiyama, 12 Nov '55, (*2 F*)
,,	,,	,,	Shiga	Imazu	#55-J-031, Coll. Akiyama, 12 Dec '55, (*1 F, 1 M*)
,,	*Lepus brachyurus angustidens* (Hare)	,,	Tokyo	Ome	#55-J-040, Coll. Toshioka, 14 Jan '56, (*1 F*).
,,	,,	,,	Kagoshima	Ogawa, Kokubu-shi	#68-J-0338, Coll. Yamamoto, 16 Jan-3 Mar '68, (2 L, 9 M, 1 N).
,,	Vegetation	,,	Shimane	Sanbe	#68-J-0328, Coll. Yamaguti & Blecha, 4 Jun '68 (*1 F*).
,,	Dog	,,	Kochi	Higashiharami	#67-J-0341, Coll. Holubec & Sugiyama, 19 May '67, (1 L).
,,	*Lepus brachyurus angustidens* (Hare)	,,	Niigata	Kakudayama Minamikanbara-gun	Kitaoka & Saito, 1967: 74. Coll. Saito, 11 Jan '65, (1 L), parent of holotype
,,	Cattle, horse, dog, badger, hare, weasel, man, small rodents & birds	,,	-	Honshu, Kyushu, Shikoku & Sado I.	Kitaoka & Saito, 1967: 82. Immature stages on small rodents & birds

Ixodes nipponensis	*Clethrionomys rufocanus bedfordiae* (Red-backed mouse), *C. rutilus mikado* (Red-backed mouse), *Apodemus speciosus ainu* (Field mouse), *A. argenteus* (Field mouse)	Japan	Hokkaido	Ishikari & Hidaka	Ono, 1966: 62-68. Coll. Ono, Oct '55 - Aug '62, (N, L), as *Ixodes* sp. NA & LA
,,	Dog	,,	Miyagi	-	Ono, 1962a: 25. Coll. Ohara, (A)
,,	Rodents & shrews	,,	Hokkaido	Matuyama, Sapporo-shi	Ono, 1962b: 155. Coll. Ono, as *Ixodes* sp. LA & NA
Ixodes ovatus	Cattle	,,	,,	Shiranuka, Kushiro	#55-J-026, Coll. Toshioka & Akiyama, 14 Aug '55, (*4 F*)
,,	,,	,,	,,	Kozawa, Shiribeshi	#67-J-0303, Coll. Toshioka & Sasagawa, 18 Jul '67, (*3 F, 2 M*)
,,	,,	,,	,,	,,	#67-J-0231, Coll. Toshioka & Sasagawa, 17 Sep '67, (*1 F*).
,,	,,	,,	Iwate	Taro-cho	#67-J-0096, Coll. Toshioka & Sasagawa, 14 May '67, (1 L, *7 F, 1 M*)
,,	,,	,,	,,	Genbi, Ichinoseki	#67-J-0099, Coll. Toshioka & Sasagawa, 15 May '67, (*3 F*).
,,	,,	,,	Shimane	Sanbe	#67-J-0158, Coll. Holubec & Sugiyama, 15 May '67, (*1 F*)
,,	,,	,,	,,	,,	#67-J-0167, Coll. Holubec & Sugiyama, 16 May '67, (*1 F, 1 M*)
,,	,,	,,	,,	,,	#67-J-0173, Coll. Holubec & Sugiyama, 16 May '67, (*1 F*)
,,	Horse	,,	Hokkaido	Shizunai, Hidaka	#67-J-0302, Coll. Toshioka & Sasagawa, 16 Jul '67, (*7 F, 23 M*).
,,	Dog	,,	Miyagi	-	#55-J-007, Coll. Asanuma, 19 Jul '55, (*3 F, 2 M*).
,,	,,	,,	Aomori	Towada-mura Fuchizawa	#55-J-027, Coll. Akiyama, 13 Aug '55, (*1 F*)
,,	,,	,,	Tochigi	Izuru	#56-J-039, Coll. Toshioka & Akiyama, 24 Feb '56, (*1 F*).
,,	,,	,,	Iwate	Taro-cho	#67-J-0095, Coll. Toshioka & Sasagawa, 14 May '67, (6 L, *2 F*)
,,	,,	,,	,,	Taneyama	#67-J-0098, Coll. Toshioka & Sasagawa, 15 May '67, (16 L, *1 F*)
,,	,,	,,	Gumma	Asama	#67-J-0239, Coll. Yamaguti, '66, (*1 M*)
,,	,,	,,	,,	,,	#67-J-0241, Coll. Yamaguti, 11 Apr '67, (*1 F, 2 M*)
,,	,,	,,	,,	,,	#67-J-0243, Coll. Yamaguti, 25 Apr '67, (*2 F, 2 M*)
,,	,,	,,	Kanagawa	Kiyokawa	#67-J-0091, Coll. Holubec & Sugiyama, 18 Apr '67, (1 N, *1 F, 1 M*)
,,	,,	,,	Chiba	Katsuura, Fusano	#56-J-043, Coll. Toshioka & Akiyama, 28 Feb '56, (*1 F*)
,,	,,	,,	Ehime	Toyoume-mura Tawarazu	#56-J-044, Coll. Keegan & Toshioka, 15 Jan '56, (*1 F*)
,,	,,	,,	Kochi	Higashiharano	#67-J-0187, Coll. Holubec & Sugiyama, 19 May '67, (*2 F*)
,,	,,	,,	Kumamoto	Minamata, Urunoyu	#56-J-041, Coll. Toshioka, 9 Jan '56, (*1 F*)
,,	*Lepus brachyurus angustidens* (Hare)	,,	Kagoshima	Ogawa, Kokubu-shi	#68-J-0340, Coll. Yamamoto, 16 Jan - 3 Mar '68, (*1 F, 1 M*)

Ixodes ovatus	Vegetation	Japan	Hokkaido	Tsukisappu, Ishikari	#55-J 047, Coll. Toshioka & Akiyama, 5 Jun '55, (*I F*)
"	*Apodemus speciosus ainu* (Field mouse)	"	"	Teine, Ishikari	Coll. Ono, 18 Oct '55, (*I F*)
"	*Clethrionomys rufocanus bedfordiae* (Red-backed mouse)	"	"	"	Coll. Ono, 19 Apr '56, (*I N*)
"	Cattle, horse & human	"	"	Hakodate, Sapporo, Muroran, Atsumai	Ogura & Takada, 1927: 201-202 (as *I. frequens*) (F., M).
"	Horse, cattle, dog, hare, & human	"	Akita, Shizuoka, Kyoto, Saga, Tokyo, Kanagawa, Hokkaido	-	Kishida, 1930a: 1-5, as *I. frequens, ovatus, japonensis* & *carinatus*. Record of *frequens* is cited from Ogura & Takada (1927)
"	Cattle & horse	"	Niigata, Akita, Shimane, Hyogo, Gumma, Fukushima, Hokkaido	-	Nakamura & Yajima, 1937: 145-148, as *japonensis* & *frequens*
"	"	"	Aomori, Iwate	-	Yajima, 1942: 507-509, as *frequens*
"	"	"	Aomori, Iwate, Fukushima, Miyagi, Nagano, Hokkaido	-	Itagaki, Noda & Yamaguchi, 1944, 1959, as *frequens*
"	Man, cattle, dog, cat, *Mustela sibirica itatsi* (weasel), *Nyctereutes procyonoides viverrinus* (Raccoon Dog), *Mogera wogura wogura* (Mole), *Lepus brachyurus lyoni* (Hare), *Rattus norvegicus* (Norway Rat), *Lepus brachyurus angustidens* (Hare), *Microtus montebelli* (Korean Meadow Vole), *M. montebelli brevicorpus* (Meadow Vole), *Apodemus speciosus sadoensis* (Field mouse), *Crocidura dsi nezumi* (Shrew), & vegetation	"	Niigata & Kanagawa	Niigata Pref. in Honshu & Sado (Is.); Mt. Ketsu, Iseharacho	Saito, 1959b: 199-203, 1964: 60, Saito et al., 1965: 145-146 (as *I. japonensis*) Coll. Saito, Jul '55 - 17 May '65, (A, N, L). Immature forms on small rodents
"	Rodents & shrews	"	Hokkaido	Sapporo-shi	Ono, 1962b: 155, (as *I.* sp. 6) Coll. Ono, (L)
"	*Clethrionomys rufocanus bedfordiae* (Red-backed mouse), *C. rutilus mikado* (Red-backed mouse), *Apodemus argenteus* (Field mouse), *A. speciosus ainu* (Field mouse).	"	"	Oshima, Ishikari, Hidaka, Abashiri, Tokachi, Rumoi	Ono, 1966: 62-68, (as *I.* sp. 6 & 52) Coll. Ono, Jun '55 - Oct '62, (N, L)
"	*Clethrionomys rufocanus bedfordiae* (Red-backed mouse).	"	"	Teine	Asanuma, 1955: 1240-1242 (as *I.* sp. 52) (N.)
"	*Apodemus speciosus* (Field mouse), *A. argenteus* (Field mouse), *Eothenomys smithi* (Vole), *Mus musculus* (House mouse), *Microtus montebelli* (Korean Meadow Vole)	"	Aomori, Yamanashi, Chiba, Kanagawa, Toyama, Fukui, Shizuoka, Kyoto, Oita	-	Asanuma & Sekikawa, 1952: 107-116, 1953: 99 (as *I.* sp. 6 & 52) (N, L)

Ixodes ovatus	Dog & hare	Japan	Chiba, Akita, Fukushima, Miyagi,	-	Asanuma, 1956: 92-93, (as *I. japonensis*) (A)
"	Man	"	Niigata	-	Keegan & Toshioka, 1957: 20, (as *I. japonensis*) Coll. Saito, 27 Jul '55, (2 F).
"	Cattle	"	Okayama	-	Keegan & Toshioka, 1957: 20, (as *I. japonensis*) Coll. Yajima, 13 Jul '55, (1 F)
"	"	"	Aomori	-	Keegan & Toshioka, 1957: 20, (as *I. japonensis*) Coll. Yajima, 10 Jul '36, (1 F), (labelled as *frequens*).
"	Dog	"	Niigata	Gonzandaira	Keegan & Toshioka, 1957: 20, (as *I. japonensis*) Coll. Saito, 31 Jul '56, (1 M)
"	*Rattus norvegicus* (Norway Rat)	"	"	"	Keegan & Toshioka, 1957: 20, (as *I. japonensis*) Coll. Saito, 26 Jul '55, (1 F).
"	*Lepus brachyurus brachyurus* (Hare)	"	Nagano	Kamikochi	Keegan & Toshioka, 1957: 20, (as *I. japonensis*) Coll. Hiromatsu, 4 Dec '52, (1 F, 10 N)
"	"	"	Kochi	Toki	Keegan & Toshioka, 1957: 20, (as *I. japonensis*) Coll. Hiromatsu, 21 Feb '56, (5 F, 1 M)
"	Man	"	Tokyo	-	Keegan & Toshioka, 1957: 26, (as *I. japonensis*) Coll. Kishida, (1 F), (Holotype of *carinatus* Kishida, 1930)
"	Horse, hare, dog	"	Akita Saga	-	Neumann, 1899: 116-118, Coll. Taguchi (Akita) & Yamaguchi (Saga), (4 F). Type series contained 2 F of *ricinus* (=? *persulcatus* or *nipponensis*)
"	Horse, dog	"	Saga	-	Neumann, 1904: 452-453, 1911: 18 & Dönitz, 1905: 132, (2 F of 4 F above).
"	"	"	"	-	Nuttall & Warburton, 1911: 158, (2 F). As *ricinus* var. *ovatus*, same specimens as Neumann (1904)
"	-	"	Tokyo ?	near Tokyo	Neumann, 1904: 458, 1911: 22, Nuttall & Warburton, 1911: 208-209 (as *I. japonensis*) Coll. Harmand, 1901, (1 F), type specimen, (Paris Museum).
"	Horse, dog	"	Saga	-	Morel, 1963: 925-928, (2 F), same specimens as Neumann (1904) Morel synonymized *japonensis* under *ovatus*
"	-	"	Hokkaido	Shikotsu lake, Iburi	Schulze, 1930: 294-303, (as *I. frequens*) Coll. S. Schoede, 16 Jul '06, (1 M)
Ixodes persulcatus	Cattle	"	"	Shintoku, Tokachi	#67-J-0197, Coll. Taniguchi, 17 May '67, (*6 F, 13 M, 1 N*)
"	"	"	"	Kuttari, Tokachi	#67-J-0199, Coll. Taniguchi, 13 May '67, (*2 F*).
"	"	"	"	Kozawa, Shiribeshi	#67-J-0202, Coll. Toshioka & Sasagawa, 18 Jul '67, (*1 F*)
"	"	"	Gunma	Asama	#67-J-0242, Coll. Yamaguti, 6 Jul '67, (*1 F*)
"	Horse	"	Hokkaido	Shintoku, Tokachi	#67-J-0195, Coll. Taniguchi, 10 May '67, (*1 F*)
"	"	"	"	Shizunai, Hidaka	#67-J-0200, Coll. Toshioka & Sasagawa, 16 Jul '67, (*2 F*).

Ixodes persulcatus	Horse	Japan	Hokkaido	Shiranuka, Kushiro	#55-I-051, Coll. Toshioka & Akiyama, 14 Aug '55, (*2 F*).
"	*Ursus arctos yesoensis* (Bear)	"	"	Shintoku, Tokachi	#67-I-0196, Coll. Taniguchi, 19 Jun '67, (*3 F, 2 M*)
"	Dog	"	"	Kozawa, Shiribeshi	#67-J-0204, Coll. Toshioka & Sasagawa, 18 Jul '67, (*1 F, 1 M*)
"	"	"	Gumma	Asama	#67-J-0244, Coll. Yamaguti, 25 Apr '67, (*1 F*)
"	Man	"	Tokushima	Mt. Tsurugi	Keegan & Toshioka, 1957 21-22. Coll. Tanaka, 16 Jul '56, (2 F., 1 N).
"	Horse	"	Iwate	"	Keegan & Toshioka, 1957 21-22. Coll. Yajima, 27 Jun '38, (1 F., 1 M).
"	Dog	"	Niigata	Ginzandaira	Keegan & Toshioka, 1957 21-22 Coll. Saito, 25 Jul '55, (2 F).
"	*Lepus brachyurus brachyurus* (Hare)	"	Kochi	Aki-shi	Keegan & Toshioka, 1957 21-22 Coll. Hiromatsu, 13 Nov '55 - 10 Mar '56, (F., M)
"	Weasel	"	"	"	Keegan & Toshioka, 1957 21-22 Coll. Hiromatsu, (1 F)
"	Dog, *Lepus brachyurus angustidens* (Hare), *L. brachyurus lyoni* (Hare), cattle, *Nyctereutes procyonoides* (Raccoon Dog), *Microtus montebelli brevicorpus* (Meadow Vole), *Apodemus speciosus sadoensis* (Field mouse), *Rattus norvegicus* (Norway Rat), *Crocidura dsinezumi* (Shrew), *Phasianus colchicus robustipes* (Pheasant), & vegetation	"	Niigata & Kanagawa	Niigata Pref. in Honshu & Sado (Is.); Mt. Ketsu, Isehara-cho	Saito, 1969b 199-203. Coll. Saito, Jul '55 - Feb '59, (A, N, L)
"	Rodents & shrews	"	Hokkaido	Sapporo-shi	Ono, 1962b 155. Coll. Ono, (L) (as *Ixodes* sp. 2)
"	*Clethrionomys rufocanus bedfordiae* (Red-backed mouse), *C. rutilus mikado* (Red-backed mouse), *Apodemus speciosus ainu* (Field mouse), *A. argenteus* (Field mouse)	"	"	Oshima, Ishikari, Hidaka, Sorachi, Kamikawa, Tokachi, Kushiro, Nemuro, Abashiri	Ono, 1966 62-68. Coll. Ono, Jun '55 - Oct '62, (N, L)
"	*Clethrionomys rufocanus bedfordiae* (Red-backed mouse), *Apodemus speciosus ainu* (Field mouse), *A. argenteus hokkaidi* (Field mouse), *Mus musculus yesonis* (House mouse)	"	"	Shintoku, Hiroo, Nohoro, Sounkyo, Otoineppu, Toyotomi, Shiranuka, Teine, Nonaka	Asanuma, 1955 1240-1242, (N, L), as *Ixodes* sp. 2 & 54
"	*Apodemus speciosus ainu* (Field mouse), *A. argentues* (Field mouse), *A. speciosus* (Field mouse), *Eothenomys smithi* (Vole), *Clethrionomys rufocanus* (Red-backed mouse), *Mus musculus yesonis* (House mouse)	"	Hokkaido Aomori Akita Saitama Yamanashi Gumma	- Sugayu Tazawa Chichibu Yamanashi & Yamanaka Oze	Asanuma & Sekikawa, 1952 111, 1953 99 & 105. Coll. Asanuma, May '53 - Jun '53, (N, L), as *Ixodes* sp. 2 & 54
"	-	"	Hokkaido Niigata, Akita Yamagata, Nagano, Gumma Gifu	-	Kitaoka & Sato, 1967 82

Ixodes persulcatus	-	Japan	Hokkaido	Shikotsu lake, Iburi	Schulze, 1930:294-303. Coll. Schoede, 16 Jul '06, (2 F).
,,	Horse & hare	,,	Akita, Saga	-	Neumann, 1899:116, 1904:452; Nuttall & Warburton, 1911:156 (as *I. ricinus*) Nuttall & Warburton cited Neumann's record.
,,	Various animals	,,	-	-	Neumann, 1911:12-13, (as *I. ricinus*)
,,	Horse	,,	Tottori	Daisen	Nuttall & Warburton, 1915:433 (as *I. ricinus*) Found with *H. bispinosa* (=*H. longicornis*), 2 Aug '12.
,,	Cattle, horse & man	,,	Aomori, Hokkaido.	-	Ogura & Takada, 1927:201 (as *I. ricinus*) (F, M)
,,	Human, cattle, horse, hare, deer, dog, fox, roe-deer & leopard (from zoo ?), marten, hedgehog, weasel, sheep, goat	,,	Hokkaido Tokyo, Nagano, Kyoto, Hyogo, Ehime, Saga	-	Kishida, 1930a:2 (as *I. ricinus*)
,,	-	Korea	N. Korea	-	Kishida, 1936:142, (as *I. ricinus*)
,,	Horse ?	Japan	Miyazaki	-	Sugimoto, 1937b:603-604 (7 F), as *ricinus* var. *miyazakiensis*
,,	Horse, cattle, dog	,, Korea	Kumamoto, Miyazaki Okayama, Akita, Gumma, Niigata, Fukushima, Iwate, Shimane, Hokkaido, Hamgyong-pukto	-	Nakamura & Yajima, 1937:142-145, (as *I. ricinus*)
,,	Cattle, horse	Japan	Aomori, Iwate	-	Yajima, 1942:507-508, (as *I. ricinus*)
,,	Cattle, horse, dog	,,	Hokkaido Iwate Aomori Miyagi Fukushima Mie Miyazaki	Kushiro, Kamikawa, Abashiri Takizawa Sanbongi Naruko Bandai-mura Watarai Koyu	Itagaki, Noda & Yamaguchi, 1944, 1959 (as *I. ricinus*)
,,	,,	Korea	Hamgyong-pukto	Unggi, Kyonghung	Itagaki, Noda & Yamaguchi, 1944, 1959 (as *I. ricinus*)
Ixodes philipi	*Puffinus leucomelas* or *Oceanodroma castro*	Japan	Iwate	Sanganjima Island	Kierans and Kohls, 1970:725 (N)
Ixodes signatus	*Larus crassirostris* (Black-tailed Gull)	,,	Aomori	Kabujima, Hachinohe-shi	#55-J-050, Coll. Toshioka & Akiyama, 18 Aug '55, (*50 F, 53 M*)
,,	,,	,,	,,	,,	406 MGL #40, Coll. Akiyama, 14 Oct '55, (96 F, 72 M, 11 N)
,,	,,	,,	,,	,,	#66-J-0323, Coll. Toshioka & Sasagawa, 15 Aug '66, (4 F, 2 M, 6 N, 2 F, *2 M*)
,,	,,	,,	,,	,,	#67-J-0092, Coll. Toshioka & Sasagawa, 12 May '67, (2 F, 2 M, 178 N, 1202 L, *10 F, 1 M*)
,,	*Phalacrocorax pelagicus* (Pelagic Shag)	,,	Yezo (=Hokkaido)	-	Neumann, 1901:284, 1904:451, 1911:21, (8 F), (type, Hamb. Mus.) As *parvirostris* in 1901, *eudyptidis* var. *signatus* in 1904, & *eudyptidis signatus* in 1911

Ixodes signatus	*Phalacrocorax pelagicus* (Pelagic Shag)	Japan	Yezo (= Hokkaido)	-	Nuttall & Warburton, 1911 261-264. As *signatus*, examined Neumann's specimens as well as *signatus* sent them by Birula, and found them identical
,,	,,	,,	,,	-	Zumpt, 1952 18. Merely lists the previous record
,,	*Larus crassirostris* (Black-tailed Gull)	,,	Aomori	Kabujima, Hachinohe-shi	Asanuma, Okubo & Fukuda, 1955 85-86. Coll. Fukuda & Asanuma, May '51 - May '56, (A, N, F)
,,	Crevices in rocks near nests of *Larus crassirostris* (Black-tailed Gull)	,,	,,	Kabujima, Hachinohe-shi	Keegan & Toshioka, 1957 22. Coll. Toshioka & Akiyama, 18 Aug '55, (70 F, 53 M, 3 N), 406 MGL #8. Coll. Akiyama, 14 Oct '55, (96 F, 72 M, 11 N), 406 MGL #40
,,	*Phalacrocorax pelagicus* (Pelagic Shag)	,,	Hokkaido	-	Asanuma & Fukuda, 1957 147-159
,,	*Phalacrocorax capillatus* (Temminck's Cormorant)	,,	Hokkaido, Kanagawa	-	Asanuma, 1965a 116.
,,	Japanese Cormorant	,,	Hokkaido	-	Kishida, 1930a 2. Kishida did not refer to the scientific name of the host. May be citation from Neumann or Nuttall & Warburton
Ixodes simplex	*Pipistrellus abramus* (Bat)	,,	Okayama	-	Coll. Yamaguti, 9 Mar '57, (*1 F*)
,,	*Myotis macrodactylus* (Little Brown Bat)	,,	Iwate	-	Coll. Endo, 26 Jul '67, (*1 N*).
,,	Bat	,,	Nagano	-	Kishida, 1930a 3
,,	,,	,,	Shiga	-	Keegan & Toshioka, 1957 23-24. Coll. Asanuma, (1 F).
,,	*Myotis macradactylus* (Little Brown Bat)	,,	?	near Kameaka	Arthur, 1956 189, 30 Sep '52, (1 F, 3 F), RML #30943.
,,	*Miniopterus schreibersi* (Long-winged Bat)	,,	Kanagawa	Kamakura	Arthur, 1956 189, 24 Dec '45, (1 N), RML #22366.
Ixodes tanuki	*Nyctereutes procyonoides viverrinus* (Raccoon Dog)	,,	Niigata	Asahi-mura, Iwafune-gun	Saito, 1964 59-66. Coll. Saito, 23 Nov '59, (1 F).
,,	,,	,,	,,	Kurokawa-mura, Kitakambara-gun	Saito, 1964 59-66. Coll. Saito, 22 Oct '59, (2 F, 1 M), (1 M Holotype, 1 F Allotype).
,,	,,	,,	,,	Sasagami-mura, Kitakambara-gun	Saito, 1964 59-66. Coll. Saito, 23 Nov '63, (1 F).
Ixodes turdus	*Turdus celaenopus celaenopus* (Seven Islands Thrush)	,,	Tokyo	Izu-shichito	#55-J-024, Coll. Asanuma, 13 Aug '55, (4 N, *1 F*)
,,	*Motacilla cinerea caspica* (Eastern Grey Wagtail)	,,	Yamaguchi	Tokuyama-shi	Kitaoka's Collection, 26 Nov '66, (3 F)
,,	*Turdus celaenopus celaenopus* (Seven Islands Thrush)	,,	Tokyo	Hachijo (Is.)	Nakatsuji, 1942 291-295. Coll. Tono, 25 Dec '40, (7 F).
,,	,,	,,	,,	,,	Keegan & Toshioka, 1957 24. Coll. Asanuma, 12 Dec '55, (1 F, 6 N), 406 MGL # 148
,,	,,	,,	,,	Aogashima	Keegan & Toshioka, 1957 24. Coll. Asanuma, Nov '54, (1 F, 1 N)
,,	*Turdus c. celaenopus* (Seven Islands Thrush) *Turdus chrysolaus chrysolaus* (Japanese Brown Thrush), *Emberiza elegans elegans* (Yellow-throated Bunting), *Emberiza cioides ciopsis* (Japanese Meadow	,,	,, Chiba Tochigi	Aogashima, Miyake (Is.), Oshima, Hachijo (Is.), Hachijo Koshima, Niijima Niihama Nikko	Asanuma & Kosaka, 1955 194 & Asanuma & Nakagawa, 1955 549. 31 May '51, Jan '52, Feb '53, May '53, Jan '54, Feb - Mar '54, Nov '54, (L, N, F)

Ixodes turdus	Bunting), *Emberiza spodocephala personata* (Japanese Bunting)	Japan	Shizuoka	Hokugo-mura, Sunto-gun	
"	*Cettia diphone cantans* (Japanese Bush Warbler), *Cettia diphone ijimae* (Japanese Bush Warbler), *Bambusicola thoracica thoracica* (Chinese Bamboo Pheasant), *Coccothraustes coccothraustes japonicus* (Japanese Hawfinch), *Hypsipetes amaurotis amaurotis* (Brown-eared Bulbul), *Pyrrhula pyrrhula griseiventris* (Japanese Bullfinch), *Phylloscopus ijimae* (Ijima's willow warbler) *Apodemus speciosus* (Field mouse)	"	Tokyo Chiba Tochigi Shizuoka	Aogashima, Miyake (Is.), Oshima, Hachijo (Is.), Hachijo Koshima, Niijima Niihama Nikko Hokugo-mura, Sunto-gun	Asanuma & Seikikawa, 1952:111, as *Ixodes* sp. 1.; Asanuma & Kosaka, 1955:194; Asanuma & Nakagawa, 1955:549. 31 May '51, Jan '52, Feb & May '53, Jan - Mar & Nov '54. (L, N, F)
Ixodes uriae	*Nyctalus* sp. (Bat)	"	Niigata Nagano	-	Kishida, 1930a:2, as *putus*. Doubtful record
"	*Lunda cirrhata* (Tufted puffin)	"	Hokkaido	-	Asanuma, 1961:181; 1965a:116
Ixodes vespertilionis	*Rhinolophus ferrum-equinum nippon* (Horseshoe bat)	"	Tochigi	Izuru	#56-J-037, Coll. Toshioka & Akiyama, 24 Feb '56, (3 N, 5 F, *1 F*)
"	"	"	"	"	#56-J-038, Coll. Toshioka & Akiyama, 24 Feb '56, (*1 M*)
"	"	"	Hokkaido	Chitose, Iburi	#63-J-0014, Coll. Hattori, 9 Oct '63, (*1 N*)
"	*Rhinolophus cornutus cornutus* (Horseshoe bat)	"	"	"	#63-J-0013, Coll. Hattori, 23 Oct '63, (*1 F*)
"	"	"	"	Iwanai, Shiribeshi	#65-J-0015, Coll. Hattori, 7 May '65, (*1 N*)
"	"	"	"	"	#65-J-0016, Coll. Hattori, 7 May '65, (*2 F*)
"	"	"	"	"	#64-J-0017, Coll. Hattori, 12 Jan '64, (*1 F*)
"	"	"	Iwate	Ryusendo, Iwaizumi-cho	#67-J-0094, Coll. Toshioka & Sasagawa, 13 May '67, (*2 F*)
"	*Rhinolophus ferrum-equinum* (Horseshoe bat)	Korea	Kangwan-do	Tabbari cave, Wonju	25 Jun '63, (*1 F*)
"	*Rhinolophus ferrum-equinum nippon* (Horseshoe bat)	Japan	Kochi	Shimizu, Aki-shi	Keegan & Toshioka, 1957:25, Coll. Hiromatsu, 10 May '53, (1 N)
"	"	"	"	Wakiyama cave	Keegan & Toshioka, 1957:25, Coll. Hiromatsu, '53, (2 N)
"	"	"	Nara	Yoshino	Keegan & Toshioka, 1957:25, Coll. Toshioka, 21 Mar '56, (2 F), 406 MGL #204
"	*Rhinolophus cornutus cornutus* (Horseshoe bat)	"	Fukushima	Otakine	Keegan & Toshioka, 1957:25, Coll. Akiyama, 20 Dec '55, (1 F), 406 MGL #133.
"	"	"	Nara	Yoshino	Keegan & Toshioka, 1957:25, Coll. Toshioka, 21 Mar '56, (2 F), 406 MGL #201
"	*Pipistrellus abramus* (Bat)	"	Ehime	Kuroiwa cave, Kamiukena-gun	Keegan & Toshioka, 1957:25, Coll. Morikawa, 21 Jan '56, (1 F)

Ixodes vespertilionis	*Rhinolophus ferrum equinum* (Horseshoe bat)	Japan	Tochigi	Izuru	Keegan & Toshioka, 1957 25 Coll Toshioka & Akiyama, 25 Feb '56 (1 N, 4 F), 406 MGL #191
,,	*Lepus b. brachyurus* (Hare)	,,	Nagano	Hata-mura	Keegan & Toshioka, 1957 25 Coll Hiromatsu, 2 Mar '28, (1 N, 3 F) This record seems to be doubtful
,,	*Rhinolophus ferrum equinum* (Horseshoe bat)	,,	Myiagi (sic) (= Miyagi)	-	Arthur, 1956 184, Hoogstraal, 1956 569, Keegan & Toshioka, 1957 25 Coll Nicholson, 13 May '52, (1 F), RML #32112
Rhipicephalus sanguineus	Dog	Ryukyu Islands	-	Okinawa	#66-R-0005, Coll Doucette & Sugiyama, 19 Oct '66, (*4 F, 1 M*)
,,	,,	,,	,,	Camp Mercy Okinawa	#68-R-0018, Coll Hubert, 30 Sep '68, (2 F)
,,	,,	Japan	Kanagawa	Yokohama-shi	#64-J-0079, Coll Flint, 7 Oct '64 (28 F, 75 M)
,,	,,	,,	Kumamoto	Ogaishi-mura, Aso-gun	Sugimoto, 1937b 610-612, Sep '33, (3 F)
,,	,,	,,	,,	Kumamoto-shi	Sugimoto, 1937b 610-612, 18 Jul '35, (3 F, 5 M)
,,	Man	,,	Osaka	Osaka-shi	Keegan & Toshioka, 1957 26-27 Coll Holland, Sep '56, (1 F)

Numbers in parentheses represent specimens sent to Mr. Glen M. Kohls for confirmation of determinations

APPENDIX 3

List of Maps and Text Figures

APPENDIX 4

Information on Specimens Illustrated

Figure	Species	Remarks
5	*Argas japonicus*	Adult from Coll. #66-J-0037 – From nest of *Hirundo daurica japonica* (Japanese Striated Swallow), Niimi, Okayama Pref., Japan, 21 September 1966, Hatoyama & Mizusawa. Holotype female & allotype male. a-d, female; e-g, male. a, whole body (dorsal & ventral view); b, e, capitulum (ventral view); c, f, genital area; d, g, tarsi I-IV (lateral view). Adapted from Yamaguti et al., (1968).
6	*Argas japonicus*	Larva & nymph from Coll. #66-J-0037 – Same as above. a, b, larva; c, d, nymph. a, whole body (dorsal & ventral view); b, Haller's organ; c, capitulum; d, tarsi I-IV (lateral view).
7	*Argas vespertilionis*	Female from Coll. #67-J-0215 – From *Vespertilio superans* (frosted bat), Shojo, Fukushima Pref., Japan, 11 August 1967, Yamaguti. a-g, female; h, genital area of male. a, whole body (dorsal & ventral view); b, periphery (lateral view); c, posterior quadrant; d, tarsi I-IV (lateral view); e, spiracular plate; f, capitulum (ventral view); g, anal valve.
8	*Argas vespertilionis*	Larva – From *Pipistrellus abramus* (Bat), Fukuoka-shi, Japan, 25 June 1967, Wada's collection.
9	*Ornithodoros capensis*	Adult from Coll. #66-J-0054 – Under rocks near nest of *Larus crassirostris* (Black-Tailed Gull), Kyojima, Shimane Pref., Japan, 9 July 1966, Toshioka & Betchley. a-d, female; e-g, male. a, whole body (dorsal & ventral view); b, e, capitulum (ventral view); c, f, genital area; d, g, tarsi I-IV (lateral view).
10	*Ornithodoros capensis*	Larva & nymph from Coll. #66-J-0054 – From *Calonectris leucomelas* (Streaked Shearwater), Ohakajima, Shimane Pref., Japan, 13 September 1966, Yamaguti's collection (larva); #66-J-0054 (nymph). a, b, larva; c, d, nymph. a, whole body (dorsal & ventral view); b, Haller's organ; c, capitulum (ventral view); d, tarsi I-IV (lateral view).
11	*Amblyomma geoemydae*	Female from 406 MGL Coll. #57 – From *Cyclemys flavomarginata flavomarginata* (Turtle), Futanaka, Ishigaki (Is.), Ryukyu Islands, 6 November 1955, Keegan & Toshioka. Reproduced from Keegan & Toshioka (1957), pl. 4.
12	*Amblyomma geoemydae*	Male from 406 MGL Coll. #57 – Same as above. Reproduced from Keegan & Toshioka (1957), pl. 5.
13	*Amblyomma geoemydae*	Nymph from Coll. #68-R-0015 – From *Geoemyda spengleri japonica* (Turtle), Yona, Okinawa, Ryukyu Islands, April 1968, Mizusawa.
14	*Amblyomma geoemydae*	Larva from Coll. #68-R-0015 – Same as above.
15	*Amblyomma nitidum*	Female from RML Coll. #35991 – From Sea Snake, Naha, Okinawa, Ryukyu Islands.
16	*Amblyomma testudinarium*	Female from Coll. #55-R-017 – From Wild pig, mountains near Inoda, Ishigaki (Is.), Ryukyu Islands, 4 November 1955, Keegan & Toshioka. Reproduced from Keegan & Toshioka (1957), pl. 6.
17	*Amblyomma testudinarium*	Male from 406 MGL Coll. #82 – Same as above, 2 November 1955. Reproduced from Keegan & Toshioka (1957), pl. 7.
18	*Amblyomma testudinarium*	Nymph from Coll. #68-J-0318 – From *Sus scrofa leucomystax* (Wild pig), Yuwan, Amami Oshima, Kagoshima Pref., Japan, 11 April 1968, Mizusawa.
19	*Amblyomma testudinarium*	Larva from Coll. #68-J-0317 – From vegetation, Yuwan, Amami Oshima, Kagoshima Pref., Japan, 10 April 1968, Mizusawa.
20	*Boophilus microplus*	Female from 406 MGL Coll. #73 – From cow, Hateruma (Is.), Ryukyu Islands. Reproduced from Keegan & Toshioka (1957), pl. 8.
21	*Boophilus microplus*	Male – Same as above. Reproduced from Keegan & Toshioka (1957), pl. 9.
22	*Boophilus microplus*	Nymph from Coll. #67-J-0261 – From cow, Yuwan, Amami Oshima, Kagoshima Pref., Japan, 3 October 1967, Kimura & Mizusawa.

23	*Boophilus microplus*	Larva from Coll. #67-R-0011 – From cow, Hirai, Ishigaki (Is.), Ryukyu Islands, 8 February 1967, Tipton.
24	*Dermacentor* sp.	Female – From horse, Unggi, North Korea, June 1942, Asanuma's collection. Reproduced from Keegan & Toshioka (1957), pl. 10.
25	*Dermacentor* sp.	Male – Same as above. Reproduced from Keegan & Toshioka (1957), pl. 11.
26	*Dermacentor* sp.	Female – From horse, Okunakayama, Iwate Pref., Japan, 16 October 1938, Yajima's collection. Reproduced from Keegan & Toshioka (1957), pl. 12.
27	*Dermacentor* sp.	Male – Same as above. Reproduced from Keegan & Toshioka (1957), pl. 13.
28	*Dermacentor* sp. 65	Male from 406 MGL Coll. #101 – From Wild pig, Shizuhara, Kyoto Pref., Japan, 12 December 1955, Akiyama. Reproduced from Keegan & Toshioka (1957), pl. 14.
29	*Haemaphysalis campanulata*	Female from Coll. #52-J-004 – From dog, Miura Peninsula, Kanagawa Pref., Japan, Asanuma. Reproduced from Keegan & Toshioka (1957), pl. 17.
30	*Haemaphysalis campanulata*	Male from Coll. #41-J-002 – From Man, Takarazuka, Hyogo Pref., Japan, 15 January 1941, Hiromatsu. Reproduced from Keegan & Toshioka (1957), pl. 18.
31	*Haemaphysalis campanulata*	Nymph from Coll. #67-J-0188 – From dog, Chiba Pref., Japan, 12 June 1967.
32	*Haemaphysalis campanulata*	Larva from Coll. #67-J-0188-F_1 – Reared from material in Coll. #67-J-0188.
33	*Haemaphysalis concinna*	Female – From cow, Atsukeshi, Hokkaido, Japan, July 1966, Kitaoka's collection.
34	*Haemaphysalis concinna*	Male – Nozukesaki, Nemuro-shi, Hokkaido, Japan, May 1964, Kitaoka's collection.
35	*Haemaphysalis concinna*	Nymph – Reared specimen loaned by Kitaoka.
36	*Haemaphysalis concinna*	Larva – Same as above.
37	*Haemaphysalis* sp. (*H. cornigera* group)	Female – From cow, Hachijo (Is.), Tokyo, Japan, 29 May 1949, Asanuma's collection. Reproduced from Keegan & Toshioka (1957), pl. 19.
38	*Haemaphysalis* sp. (*H. cornigera* group)	Male – Same as above. Reproduced from Keegan & Toshioka (1957), pl. 20.
39	*Haemaphysalis* sp. (*H. cornigera* group)	Nymph – Reared specimen loaned by Kitaoka.
40	*Haemaphysalis* sp. (*H. cornigera* group)	Larva from Coll. #67-J-0206-F_1 – From cow, Hachijo Koshima, Tokyo, Japan, 13 July 1967, Yamaguti.
41	*Haemaphysalis doenitzi*	Female from Coll. #56-J-057 – From pheasant, Akune, Kagoshima Pref., Japan, 10 January 1956, Toshioka. Reproduced from Keegan & Toshioka (1957), pl. 28.
42	*Haemaphysalis flava*	Female from Coll. #55-J-018 – From dog, Yamakita-cho, Kanagawa Pref., Japan, 4 November 1955, Akiyama. Reproduced from Keegan & Toshioka (1957), pl. 21.
43	*Haemaphysalis flava*	Male from Coll. #55-J-018 – Same as above. Reproduced from Keegan & Toshioka (1957), pl. 22.
44	*Haemaphysalis flava*	Nymph from Coll. #67-J-0294-F_1 – Reared from material in Coll. #67-J-0294.
45	*Haemaphysalis flava*	Larva from Coll. #67-J-0294-F_1 – Same as above.
46	*Haemaphysalis formosensis*	Female from Coll. #67-J-0216 – From *Sus scrofa riukiuanus* (Wild pig), Ukenson, Amami Oshima, Kagoshima Pref., Japan, 18 March 1967, Tipton & Mizusawa.
47	*Haemaphysalis formosensis*	Male from Coll. #67-J-0217 – On vegetation, Ukenson, Amami Oshima, Kagoshima Pref., Japan, 23 March 1967, Tipton & Mizusawa.
48	*Haemaphysalis formosensis*	Nymph from Coll. #67-J-0216-F_1 – Reared from material in Coll. #67-J-0216.
49	*Haemaphysalis formosensis*	Larva from Coll. #67-J-0216-F_1 – Reared from material in Coll. #67-J-0216.
50	*Haemaphysalis fujisana*	Female from cow, foot of Mt. Fuji, near Fujinomiya, Shizuoka. Illustrations from Kitoaka (1970).
51	*Haemaphysalis fujisana*	Male from cow, foot of Mt. Fuji, near Fujinomiya, Shizuoka. Illustrations from Kitoaka (1970).

52	*Haemaphysalis fujisana*	Nymph from cow, foot of Mt. Fuji, near Fujinomiya, Shizuoka. Illustrations from Kitoaka (1970).
53	*Haemaphysalis fujisana*	Larva from cow, foot of Mt. Fuji, near Fujinomiya, Shizuoka. Illustrations from Kitoaka (1970).
54	*Haemaphysalis hystricis*	Female from 406 MGL Coll. #92 – From Wild pig, mountain near Inoda, Ishigaki (Is.), Ryukyu Islands, 8 November 1955, Keegan & Toshioka. Reproduced from Keegan & Toshioka (1957), pl. 23.
55	*Haemaphysalis hystricis*	Male from 406 MGL Coll. #92 – Same as above. Reproduced from Keegan & Toshioka (1957), pl. 24.
56	*Haemaphysalis hystricis*	Nymph from Coll. #67-J-0071 – From *Sus scrofa riukiuanus* (Wild pig), Yamatoson, Amami Oshima, Kagoshima Pref., 21 March 1967, Mizusawa.
57	*Haemaphysalis hystricis*	Larva from Coll. #67-J-0071-F_1 – Reared from material in Coll. #67-J-0071.
58	*Haemaphysalis japonica*	Female from Coll. #67-J-0198 – From cow, Kuttari, Tokachi, Hokkaido, Japan, 13 May 1966, Taniguchi.
59	*Haemaphysalis japonica*	Male – From *Capricornis crispus* (Serow), Shimajima, Nagano Pref., Japan, 29 November 1953, Sakaguchi. Reproduced from Keegan & Toshioka (1957), pl. 27.
60	*Haemaphysalis japonica*	Nymph – Same as the lot of Coll. #67-J-0198.
61	*Haemaphysalis kitaokai*	Female from Coll. #54-J-006 – From *Cervus nippon nippon* (Sika Deer), Ouchiyama, Mie Pref., Japan, 17 January 1954, Asanuma. Reproduced from Keegan & Toshioka (1957), pl. 25.
62	*Haemaphysalis kitaokai*	Male from Coll. #54-J-006 – Same as above. Reproduced from Keegan & Toshioka (1957), pl. 26.
63	*Haemaphysalis kitaokai*	Nymph from Coll. #67-J-0286-F_1 – Reared from material in Coll. #67-J-0286.
64	*Haemaphysalis kitaokai*	Larva from Coll. #67-J-0286-F_1 – Same as above.
65	*Haemaphysalis longicornis*	Female from Coll. #55-J-049 – From horse, pasture near Hakodate, Hokkaido, Japan, 17 August 1955, Toshioka & Akiyama. Reproduced from Keegan & Toshioka (1957), pl. 15.
66	*Haemaphysalis longicornis*	Male from Coll. #55-J-009 – From cow, Azumayama pasture, Hiroshima Pref., Japan, 19 September 1955, Toshioka & Akiyama. Reproduced from Keegan & Toshioka (1957), pl. 16.
67	*Haemaphysalis longicornis*	Nymph from Coll. #67-J-0191 – On vegetation, Misaki, Abashiri, Hokkaido, Japan, 13 July 1967, Toshioka & Sasagawa.
68	*Haemaphysalis longicornis*	Larva from Coll. #66-J-0022-F_1 – Reared from material in Coll. #66-J-0022.
69	*Haemaphysalis megaspinosa*	Female from Coll. #68-J-0301-F_1 – Reared from material in Coll. #68-J-0301.
70	*Haemaphysalis megaspinosa*	Male from Coll. #68-J-0301-F_1 – Reared from material in Coll. #68-J-0301.
71	*Haemaphysalis megaspinosa*	Nymph from Coll. #68-J-0301-F_1 – Same as above.
72	*Haemaphysalis megaspinosa*	Larva – Reared specimen loaned by Kitaoka.
73	*Haemaphysalis pentalagi*	Female from Coll. #68-J-0315 – From *Pentalagus furnessi* (Ryukyu Rabbit), Yuwandake, Amami Oshima, Kagoshima Pref., Japan, 6 April 1968, Mizusawa.
74	*Haemaphysalis pentalagi*	Male from Coll. #68-J-0315 – Same as above.
75	*Haemaphysalis pentalagi*	Nymph from Coll. #68-J-0311-F_1 – Reared from material in Coll. #68-J-0311.
76	*Haemaphysalis pentalagi*	Larva from Coll. #68-J-0311-F_1 – Same as above.
77	*Haemaphysalis wellingtoni*	Male – Adopted from Asanuma & Kosaka (1954), pp. 105-106, figs. 1 & 2.
78	*Ixodes acutitarsus*	Female from RML Coll. #27491 – From Man, Mt. Gomadan, Wakayama Pref., Japan, 4 July 1949. Reproduced from Keegan & Toshioka (1957), pl. 29.

79	*Ixodes angustus*	Female – Crawling on a man, Sarobetsu, Soya, Hokkaido, Japan, 1 July 1961, Ono's collection.
80	*Ixodes angustus*	Nymph – From *Clethrionomys rufocanus bedfordiae* (Red-Backed Mouse), Rebunto, Soya, Hokkaido, Japan, 22 October 1956, Ono's collection.
81	*Ixodes angustus*	Larva – From *Clethrionomys rufocanus bedfordiae* (Red-Backed Mouse), Onneto, Nemuro, Hokkaido, Japan, 9 September 1956, Ono's collection.
82	*Ixodes granulatus*	Female from 406 MGL Coll. #75 – From *Rattus rattus* (Rat), Nishihara, Ishigaki (Is.), Ryukyu Islands, 29 October 1955, Keegan & Toshioka. Reproduced from Keegan & Toshioka (1957), pl. 30.
83	*Ixodes granulatus*	Male – From *Rattus coxinga* (Rat), Grass Mt., Formosa, 20 May 1958, Yung Foh Lee.
84	*Ixodes granulatus*	Nymph – Adopted from Asanuma & Sekikawa (1952), fig. 4 & (1953), figs. 9 & 10.
85	*Ixodes granulatus*	Larva – Collected on Grass Mt., Formosa, 20 May 1958, Yung Foh Lee.
86	*Ixodes lividus*	Female from Coll. #67-J-0192 – From *Riparia riparia ijimae* (Eastern Sand Martin), Hamamokoto, Abashiri, Hokkaido, Japan, 14 July 1967, Toshioka & Sasagawa.
87	*Ixodes lividus*	Male from Coll. #67-J-0192 – Same as above.
88	*Ixodes lividus*	Nymph from Coll. #68-J-0334 – From the nest of *Delichon urbica dasypus* (Japanese House Martin), Minakami, Gunma Pref., Japan, 5 July 1968, Suzuki & Sasagawa.
89	*Ixodes lividus*	Larva from Coll. #68-J-0334 – Same as above.
90	*Ixodes monospinosus*	Female – On vegetation, Odaigahara, Mie Pref., Japan, 27 April 1969, Yokoyama (Kitaoka's collection).
91	*Ixodes nipponensis*	Female from Coll. #66-J-0018 – From cow, Sanbe pasture, Shimane Pref., Japan, 6 October 1966, Holubec & Sugiyama.
92	*Ixodes nipponensis*	Male from Coll. #55-J-033 – From cow, Otsu, Shiga Pref., Japan, 10 December 1955, Akiyama. Reproduced from Keegan & Toshioka (1957), pl. 34.
93	*Ixodes nipponensis*	Nymph from Coll. #68-J-0338 – From *Lepus brachyurus angustidens* (Hare), Ogawa, Kokubu-shi, Kagoshima Pref., Japan, 16 January – 3 March 1968.
94	*Ixodes nipponensis*	Larva from Coll. #67-J-0341-F_1 – Reared from material in Coll. #67-J-0341.
95	*Ixodes ovatus*	Female from Coll. #55-J-007 – From dog, Miyagi Pref., Japan, 19 July 1955, Asanuma. Reproduced from Keegan & Toshioka (1957), pl. 31.
96	*Ixodes ovatus*	Male from Coll. #55-J-007 – Same as above. Reproduced from Keegan & Toshioka (1957), pl. 32.
97	*Ixodes ovatus*	Nymph – From *Clethrionomys rufocanus bedfordiae* (Red-Backed Mouse), Teine, Ishikari, Hokkaido, Japan, 19 April 1956, Ono's collection.
98	*Ixodes ovatus*	Larva – From *Apodemus speciosus ainu* (Field Mouse), Teine, Ishikari, Hokkaido, Japan, 18 October 1955, Ono's collection.
99	*Ixodes persulcatus*	Female from Coll. #67-J-0197 – From cow, Shintoku, Tokachi, Hokkaido, Japan, 17 May 1967, Taniguchi.
100	*Ixodes persulcatus*	Male from Coll. #67-J-0197 – Same as above.
101	*Ixodes persulcatus*	Nymph from Coll. #67-J-0197 – Same as above.
102	*Ixodes persulcatus*	Larva from Coll. #67-J-0200-F_1 – Reared from material in Coll. #67-J-0200.
103	*Ixodes philipi*	Female from *Puffinus leucomelas* (streaked sheerwater) or *Oceanodroma castro* (madeiran storm petrel), Sanganjima, Iwate Prefecture.
104	*Ixodes signatus*	Female from Coll. #55-J-050 – Collected in crevices in rocks near nest of *Larus crassirostris* (Black-Tailed Gull), Kabujima, Hachinohe-shi, Aomori Pref., Japan, 18

		August 1955, Toshioka & Akiyama. Reproduced from Keegan & Toshioka (1957), pl. 35.
105	*Ixodes signatus*	Male from 406 MGL Coll. #40 – Same as above, 14 October 1955, Akiyama. Reproduced from Keegan & Toshioka (1957), pl. 36.
106	*Ixodes signatus*	Nymph from Coll. #67-J-0092 – Same as above, 12 May 1967, Toshioka & Sasagawa.
107	*Ixodes signatus*	Larva from Coll. #66-J-0323 – Same as above, 15 August 1966, Toshioka & Sasagawa.
108	*Ixodes simplex simplex*	Female from RML Coll. #30943 – From *Myotis macrodactylus* (Little Brown Bat), near Kameaka, Honshu, Japan, 30 September 1952. Reproduced from Keegan & Toshioka (1957), pl. 37.
109	*Ixodes simplex simplex*	Nymph – From *Myotis macrodactylus* (Little Brown Bat), Iwate Pref., Japan, 26 July 1967, Yamaguti (Endo's collection).
110	*Ixodes tanuki*	Female – Adopted from Saito (1964), p. 62, figs. 1-5.
111	*Ixodes tanuki*	Male – Adopted from Saito (1964), p. 64, figs. 6-9.
112	*Ixodes turdus*	Female from Coll. #55-J-024 – From *Turdus celaenopus celaenopus* (Seven Islands Thrush), Hachijo (Is.), Tokyo, Japan, 12 December 1955, Asanuma. Reproduced from Keegan & Toshioka (1957), pl. 38.
113	*Ixodes turdus*	Nymph from Coll. #55-J-024 – Same as above.
114	*Ixodes turdus*	Larva – Adopted from Asanuma & Sekikawa (1952), p. 112, fig. 5.
115	*Ixodes vespertilionis*	Female from Coll. #56-J-037 – From *Rhinolophus ferrum-equinum nippon* (Horseshoe Bat), Izuru, Tochigi Pref., Japan, 24 February 1956, Toshioka & Akiyama. Reproduced from Keegan & Toshioka (1957), pl. 39.
116	*Ixodes vespertilionis*	Male from 406 MGL Coll. #191 – Same as above. Moulted from a nymph of the lot above. Reproduced from Keegan & Toshioka (1957), pl. 40.
117	*Ixodes vespertilionis*	Nymph from Coll. #66-J-0015 – From *Rhinolophus cornutus cornutus* (Horseshoe Bat), Iwanai, Shiribeshi, Hokkaido, Japan, 7 May 1965, Hattori.
118	*Ixodes vespertilionis*	Larva from Coll. #66-J-0016 – Same as above.
119	*Rhipicephalus sanguineus*	Female from Coll. #66-R-0005 – From dog, Okinawa, Ryukyu Islands, 19 October 1966, Doucette & Sugiyama.
120	*Rhipicephalus sanguineus*	Male from Coll. #64-J-0279 – From dog, Yokohama-shi, Kanagawa Pref., Japan, 7 October 1964, Flint.
121	*Rhipicephalus sanguineus*	Nymph – Reared specimen sent from Texas, USA.
122	*Rhipicephalus sanguineus*	Larva – Same as above.

APPENDIX 5

Corrected Scientific Names of Hosts Recorded in the Literature

Some of the scientific names of hosts cited in the literature require revision in accord with current knowledge of vertebrate taxonomy. Therefore, corrected names were used in Appendix 2. Revisions were based on the following publications:

Yoshinori Imaizumi (1960). Colored illustrations of the mammals of Japan. Hoikusha Publ. Co. Ltd., Osaka, 196 p.

Kenji Nakamura & Shun-ichi Uéno (1963). Japanese reptiles and amphibians in color, Hoikusha Publ. Co. Ltd., Osaka, 214 p.

Keisuke Kobayashi (1965). Birds of Japan in natural colors, Hoikusha Publ. Co. Ltd., Osaka, 231 p. Rev. and Enl. Ed.

The Ornithological Society of Japan (1958). A handlist of the Japanese birds, 4th Rev. Ed.

The English common names were taken from the following publication:

Ernest P. Walker (1964). Mammals of the world, Vols. 1 & 2.

Name cited	Corrected Name	Common Name	Literature	Page in Appendix 2
Apodemus geisha	*Apodemus argenteus*	Field mouse	Asanuma & Sekikawa (1952), (1953)	210, 212, 214
Apodemus sylvaticus ainu	*Apodemus speciosus ainu*	Field mouse	Asanuma & Sekikawa (1952)	207, 208, 210, 211, 214
Apodemus sylvaticus speciosus	*Apodemus speciosus*	Field mouse	Asanuma & Sekikawa (1952)	197, 209, 216
Cervus nippon nippon	*Cervus nippon*	Sika deer	Hoogstraal (1969)	189, 195, 199, 200, 203,
Crocidura russula	*Crocidura dsinezumi*	Shrew	Saito (1959b), (1964), Saito et al (1965)	206, 210, 212, 214
Cyclemys flavomarginata	*Cyclemys flavomarginata flavomarginata*	Turtle	Keegan & Toshioka (1957)	188
Horeites cantans cantans	*Cettia diphone cantans*	Japanese Bush Warbler	Asanuma & Kosaka (1955)	216
Horeites cantans ijimae	*Cettia diphone ijimae*	Japanese Bush Warbler	Asanuma & Kosaka (1955)	216
Ixos amaurotis amaurotis	*Hypsipetes amaurotis amaurotis*	Brown-eared Bulbul	Asanuma & Kosaka (1955), Asanuma & Nakagawa (1955)	216
Lepus timidus angustidens	*Lepus brachyurus angustidens*	Hare	Saito (1959b), Saito et al (1965), Kitaoka & Saito (1967), Asanuma, Sakurai et al (1955)	196, 205, 210, 211, 212, 214
Lepus timidus brachyurus	*Lepus brachyurus*	Hare	Asanuma (1956)	197
Lepus timidus lyoni	*Lepus brachyurus lyoni*	Hare	Saito (1959b), Saito et al (1965)	197, 212, 214,
Meles anakuma	*Meles meles anakuma*	Badger	Saito et al (1965)	197, 205,
Microhyla fissipes	*Microhyla ornata*	Frog	Sugimoto (1937a)	189
Nemorrhaedus crispus	*Capricornis crispus crispus*	Japanese Serow	Neumann (1906), (1911), Nuttall & Warburton (1915)	199, 200, 206, 207
Phasianus versicolor	*Phasianus colchicus robustipes*	Pheasant	Saito (1959b), Saito et al (1965)	195, 214
Phasianus versicolor tohkaidi	*Phasianus colchicus tohkaidi*	Green Pheasant	Asanuma (1956), Asanuma, Sakurai et al (1955)	197
Phylloscopus occipitalis ijimae	*Phylloscopus ijimae*	Willow-Warbler	Asanuma and Kosaka (1955)	216
Sciurus vulgaris lis	*Sciurus lis*	Squirrel	Asanuma (1956), Asanuma, Sakurai et al (1955)	197
Sus leucomystax or *Sus l. leucomystax*	*Sus scrofa leucomystax*	Wild Pig	Asanuma, Sakurai et al (1955), Kishida (1922a)	188, 195, 206,
Syrmaticus soemmeringii scintillans	*Phasianus soemmeringii scintillans*	Hondo Copper Pheasant	Asanuma (1956), Asanuma, Sakurai et al (1955)	197
Ursus thibetanus japonicus	*Selenarctos thibetanus japonicus*	Asiatic Black Bear	Keegan & Toshioka (1957), Asanuma (1956), Saito (1959b)	192, 197
Puffinus leucomelas	*Calonectris leucomelas*	Streaked Shearwater	Keirans and Kohls (1970)	187, 215,

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by

Vernon J. Tipton and Robert C. Saunders*

INTRODUCTION

The information contained in this paper has been assembled for the express purpose of demonstrating lacunae in current knowledge of health problems associated with arthropods in Utah. Obviously it is not definitive, nor is it intended to be, but rather it should serve as a base for future research investigations. It will be modified as additional information becomes available.

Not all of the arthropods in this list are of proven medical importance—in fact many of them are of doubtful importance—but they are included in the list because they are close relatives of species which are of medical significance in other areas and their potential for affecting the health of man has not yet been fully investigated.

Some difficulties are inherent in a review of the history of arthropod-borne diseases, particularly in rural areas. Records are incomplete and their accuracy is suspect. Some arthropod-borne diseases are not included on the standard state report form and thus in many instances are not reported. In rural areas, where many arthropod-borne diseases occur, people may not seek medical care because of tradition or because no care is available. Diagnostic techniques are slow to reach rural areas and receive broad acceptance. Unless the index of suspicion is high, physicians are prone to ignore diagnostic tests necessary for specific discrimination. However, the history of tularemia in Utah provides ample evidence that rural medicine does not necessarily mean archaic methods and techniques. Dr. Richard A. Pearse, a Brigham City physician, published a clinical description of tularemia in humans which is considered to be the first account in the English language (Jellison, 1971). Many of the early epidemiological investigations of tularemia were conducted in the rural community of Delta and were prompted by the astute observations of local physicians.

Colorado Tick Fever:

The work of Becker (1926, 1930) demonstrated that Colorado tick fever (CTF) is a disease entity distinct from Rocky Mountain spotted fever (RMSF) but it was not until 1940 that Topping, Cullyford, and Davis (1940) provided the first detailed clinical description of CTF. Consequently, accurate data on the incidence of CTF prior to 1940 are not available. Records of cases of CTF in Utah from 1940 to 1959 maintained by the Rocky Mountain Laboratory in Hamilton, Montana, are probably the most reliable but may be incomplete because information is based on CTF virus isolated from the blood of Utah residents at Hamilton and undoubtedly there were patients who were hospitalized elsewhere or not at all. Prior to 1960 the accuracy of records of CTF is in question because diagnostic techniques for the arboviruses were in their infancy. Comparatively simple but reliable tests are available but physicians may not utilize them either because of inconvenience or they may not be aware that the CTF virus persists for approximately 90 days after onset. Because of their epidemiological and clinical similarities CTF has been confused with RMSF. In children CTF may cause encephalitis-like symptoms and even death (Eklund, Kennedy, and Casey, 1961) but probably there are few inapparent infections in a population. It is possible that many mild cases have escaped detection and have not been reported. According to Pratt and Rice (1969) there were only 96 cases of CTF reported in Utah during the period from 1956 to 1969 compared with 1,717 cases in Colorado during the same period. However, the low incidence of CTF in Utah may not be a

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true measure of its significance. There is no immunization available and treatment consists of supportive care.

Dermacentor andersoni Stiles is considered to be the most important vector in the epidemiological pattern involving man. However, CTF virus has been isolated from ticks of several other species indicating that they may play an important role in the cycle in nature. Ecological studies aimed at determining epidemiological patterns in nature and particularly the identity of reservoir animals are needed.

The Encephalitides:

Cases of western encephalitis (WE) and perhaps other encephalitides have probably occurred in humans and horses in Utah prior to the outbreak of 1933. However, the etiology and epidemiology of the encephalitides had not yet been elucidated, and one can only speculate about the prevalence of arthropod-borne viral agents in horses and humans prior to that date. In the Register of Deaths at the Salt Lake City Health Department, Bureau of Vital Statistics, brain fever was listed as the cause of death in several instances during the 1847-1865 period. It is possible that at least some of these deaths were due to infections with arboviruses.

The 1933 episode described by Madsen (1934) occurred in two waves, both of which began in the West Point area of Weber County. The first wave began about July, reached a peak about 10 August, and had almost completely subsided by 1 September. Madsen estimated that 1,139 sick horses were involved in the first wave, of which 43.9 percent died. The second wave, which began the middle of September and subsided about 1 November, involved 2,819 horses, of which about 53.2 percent died. The main focus of infection was in Salt Lake, Davis, Box Elder, Cache, and Weber counties in Utah and Franklin County in Idaho, but there were isolated cases in Rich, Summit, Morgan, Utah, and Tooele counties. An outbreak among humans occurred twenty-five years later (in 1958) in the same general locality in northern Utah and represents the largest number of cases reported in Utah for a single year (Jenkins and Donath, 1959). Serological studies revealed a high number of inapparent infections. Thomas and Smith (1959) conducted a survey on infection rates in mosquitoes, birds, and mammals and found that the highest infection rates in chickens and mosquitoes occurred in the geographical center of the human outbreak. In connection with the 1958 outbreak, Rees et al. (1959) concluded:

> (1) There was in Utah in 1958 a recognized outbreak of Western Equine Encephalitis in man; (2) It was accompanied by a tremendous increase in the numbers of *C. tarsalis* mosquitoes; (3) *Culex tarsalis* mosquitoes were avidly feeding on man in considerable numbers during this period; and (4) Some *C. tarsalis* mosquitoes were harboring the Western equine strain of encephalitis virus.

Local physicians reported an extensive outbreak of human encephalitis of unconfirmed etiology in Box Elder County in 1936. In Weber County in 1956 there was a serologically confirmed case of St. Louis encephalitis and in 1957 a fatal case of SLE plus two cases of WE, one of which was fatal. There were 525 cases of equine encephalitis from 1955 to 1969, including 244 cases in the outbreak of 1958. There is no evidence of arbovirus activity in Weber County from 1933 to 1955. During recent years along the Wasatch front there have been occasional cases of a disease, difficult to diagnose but typical of western encephalitis. Physicians do not routinely submit acute and convalescent sera necessary for definitive diagnostic tests. Some additional information is needed on feeding preferences of mosquitoes and the role of passerine birds in the epidemiology of WE in areas where there have been active foci in the past. The fate of arboviruses during periods between epidemics is a perennial problem requiring investigation.

Other arboviruses which have been isolated in Utah include Hart Park-like isolates from *Culex tarsalis*, California encephalitis group isolates from *Anopheles freeborni*, *Culiseta inornata*, *Aedes dorsalis*, *A. nigromaculis*, *Culex erythrothorax*, *Psorophora signipennis*, and *Culex tarsalis* and Cache Valley isolates from *Culiseta inornata* and *Anopheles freeborni* (Holden and Hess, 1959; Crane et al., 1970; and Elbel et al., 1971).

Rocky Mountain Spotted Fever:

Beck (1955) reviewed the history of Rocky Mountain spotted fever (RMSF) in Utah. It is not certain when RMSF first occurred in the state, but probably the disease was prevalent among early settlers. Beck (loc cit.) reproduced a newspaper article, published in 1941, in which Dr. William M. McKay, acting commissioner of health for the state of Utah during that period, speculates that Brigham Young was afflicted with RSMF at the time he entered Salt Lake Valley. Some support for this view is supplied by Byington (in Beck, 1955) who believed that "mountain fever" was the same as RMSF. In the Register of Deaths at the Salt Lake City Health Department, Bureau of Vital Statistics, several deaths are recorded for which the cause is listed as "mountain fever." Although there is insufficient evidence to establish a definitive relationship between the two, the season during which the deaths occurred is consistent with the epidemiology of RMSF. We do not overlook the possibility that "mountain fever" could be Colorado tick fever which also occurs in Utah under similar circumstances. The deaths for which "mountain fever" was listed as the cause occurred as follows: two in July and one in August of 1849; one in June and five in July of 1850; two in early November of 1854; and one in late May and two in September of 1855. In at least one instance the cause of death was given as "intermittent mountain fever." In the majority of cases the victims were adult males.

Dermacentor andersoni Stiles is considered to be the most important vector involved in human cases of RMSF in Utah although there may be other species important in the perpetuation of the disease in nature. Beck (1955) and Coffee (1953) gave data on seasonal and altitudinal distribution as well as life cycles of tick vectors of RMSF.

Jellison (1945) considers the cottontail rabbit, *Sylvilagus nuttalli* Bachman to be an important component of the RMSF biocenose. It is a vagile animal with a fairly high degree of ecological tolerance. Studies of the population dynamics of the ectoparasites of the cottontail rabbit may suggest ecological patterns which help to perpetuate the disease in nature.

From 1915 through 1969 the Utah State Department of Health, Bureau of Vital Statistics, recorded 496 cases of RMSF in Utah among both residents and nonresidents. Cases occurred most frequently during the months of June, July, and August, although others were reported as early as April and as late as November. Among arthropod-borne diseases with endemic foci in Utah, RMSF is second only to tularemia in total number of cases reported in the state.

Plague:

The recorded history of plague in Utah is not dramatic, but nonetheless, plague represents a disease of great potential significance because of the widespread distribution of capable vectors and reservoirs in the state and the increasing number of fishermen and campers who invade the plague biocenose each year. There have been only two confirmed human cases (in 1936 and 1966) and one doubtful case (in 1939) reported in the state.

According to Allred (1952) and Beck (1955), capable vectors of plague are indigenous to every county in the state, and there are 41 proven reservoirs of plague in Utah, of which 36 are species of rodents. Stark lists 43 species of fleas which are classified as "capable (natural)" or "potential (experimental)" vectors. *Xenopsylla cheopis* (Rothschild), the most important vector of plague on a worldwide basis, has not been collected in large numbers in Utah. *Diamanus mantanus* (Baker) has been considered the most significant vector of plague in Utah, but Parker (1971) obtained *Pasteurella pestis* isolates repeatedly from *Malaraeus sinomus* (Jordan), *Opisodasys keeni* (Baker), *Monopsyllus eumolpi* (Rothschild), and *Epitedia stanfordi* Traub. The number of isolates was highest from specimens of *M. sinomus* and *O. keeni* associated with species of *Peromyscus*. Parker believes that plague is not limited to squirrel-flea complexes or to particular vegetative associations and topographic patterns. It is evident that vector efficiency varies considerably and is influenced by several environmental factors. Thus, there may be several species of rodent fleas with the potential to function effectively as vectors of plague as environmental conditions change and meet the requirements for transmission by a particular vector species. A study extending over several years relating population fluctuations of fleas on ground squirrels, on wood rats, and in their nests to environmental changes may be helpful in understanding vector and reservoir capabilities.

Tularemia:

Tularemia is a zoonotic disease which has probably been present in the wild fauna of Utah for hundreds of years. Thus it is tempting to speculate about its importance among the pioneers during the last half of the nineteenth century. A large segment of the male population in pioneer Utah was engaged in agricultural pursuits, particularly clearing of land, which suggests an invasion of an ecosystem in which transmission of tularemia was likely of common occurrence. Before the advent of white settlers, Indians may have been victims of tularemia inasmuch as rabbits, proven reservoirs of tularemia, probably constituted a significant part of their diet.

However, recorded history of tularemia in Utah begins about 1908 as indicated by Francis (1925):

> There has existed in Utah, at least since 1908, a human disease known locally as deer-fly fever. What I believe to be the first clinical reference to human cases of tularemia is contained in a paper read before the Utah State Medical Association, Salt Lake City, October

> 3, 1910, by R. A. Pearse, Brigham City, Utah. Dr. Pearse refers to six cases, which occurred in the month of August, caused by the bite of a fly, on the exposed parts of the body (neck, ear, cheek, wrist, ankle, and hand). After an incubation period of from two to five days . . . In 1919 and 1920, I studied seven cases of deer-fly fever near Fillmore, Millard County, Utah, and found them positive for tularemia, clinically, culturally, and serologically. The cases occurred in June, July and August during the seasonal prevalence of the fly *Chrysops discalis*. The sites of the fly bites were the neck, temple, ear, and posterior surface of the lower third of the thigh. In all cases, suppuration occurred in the glands draining the bitten area. All patients had fever; one died on the twenty-sixth day of illness. I heard of perhaps two dozen other cases in the general community in which I worked. From seventeen jackrabbits, sick or dead, in the community I isolated *Bacterium tularense*, thus establishing the great reservoir of infection.

In an earlier publication, Francis (1922) gives a more specific location of tularemia foci in Utah.

> So far as known there have been but two foci of infection in Utah. The focus here reported is in Millard County, 5 miles (8 kilometers) west of Holden, 5 miles northwest of Fillmore, 25 miles (40 kilometers) southeast of Delta, and 120 miles (193 kilometers) south of Salt Lake City. The other focus has received clinical confirmation and is located near Brigham, a town 20 miles (32 kilometers) north of Ogden in Box Elder County. Both foci have probably existed for at least fifteen years.

Although tularemia does not usually occur in epidemic form, Hillman and Morgan (1937) reported an outbreak of 26 cases among a group of 170 enrollees of a Civilian Conservation Corps camp "located on the treeless plains north of Great Salt Lake." They suggested that the epidemiological evidence available pointed to deer flies as the vectors and jackrabbits as the reservoirs. The cases were diagnosed between 11 and 30 July 1935. There was a noticeable increase in the population of deer flies the week before the onset of the first case. Several men in the camp experienced multiple bites, and lesions on tularemia victims were on uncovered portions of the body. Jackrabbits were numerous; many were dead and several were lethargic.

Locomotive Springs, the site of the Civilian Conservation Corps camp, is in the general area of Tremonton where Pearse had seen cases in 1908 and 1910.

Russian workers have proposed subspecific designations for the causative agents of tularemia which have been accepted by most North American workers. *Francisella tularensis tularensis* of North America is usually associated with rabbits and arthropods while the more cosmopolitan form, *Francisella tularensis palearctica* appears to be transmitted independent of arthropods and has been isolated from aquatic or semiaquatic rodents. An organism isolated from a water sample collected in Utah was given the name *Francisella novicida* (Larson, Wicht, and Jellison, 1955). All three forms have been found in Utah. *Francisella tularensis tularensis* is the principal cause of human tularemia but *Francisella tularensis palearctica*, isolated from muskrats, should be mentioned because of its importance in Utah.

According to the records of the Utah State Department of Public Health, Bureau of Vital Statistics, there have been 986 cases of tularemia in the state during the 45-year period from 1925 through 1969. Approximately three-fourths of these cases occurred during the twenty-year period from 1935 to 1954.

Chrysops discalis has been shown to be an efficient experimental vector of tularemia; it has been known to bite man (Jellison, 1950). For these reasons it has been suspected of being the most important deer fly vector of tularemia in Utah. However, Cox (1965) found *C. discalis* to be less abundant than *C. fulvaster* and *C. aestuans* in study areas near Utah Lake. Moreover, he isolated *F. tularensis* from three of 73 pools of deer flies. Two isolates were obtained from two pools of *C. fulvaster* and one isolate from one pool of *C. aestuans*.

There is a particular need for investigation of seasonal and geographic distribution of species of *Chrysops* and the animals on which they feed, the duration of infection in reservoirs and vector species, and serological surveys of human populations in areas where there are high density populations of deer flies.

Malaria:

Most cases of malaria which have occurred in the state were contracted elsewhere, but Marshall and Rees (1948), in their excellent review of malaria in Utah, have provided substantial evidence that local transmission has taken place, particularly in southern Utah. They point out that most of the early Utah settlers came from the Mississippi Valley where malaria was prevalent. Contact with the outside world was maintained through continuing immigration, returning missionaries, and settlers passing through on their way to California or Oregon. Perhaps the only case of malaria in Utah sufficiently well documented to be considered autochthonous is cited by them as follows: "In April, 1947, a *vivax* infection was reported in a two-year-old child of that area who had never been out of the state." The "area" referred to is southern Utah. *Anopheles freeborni* Aitken is widespread throughout the state and *Anopheles franciscanus* McKracken is widespread throughout the southern half of the state (Nielsen, 1968). Both are considered to be efficient vectors of malaria, especially the former.

In the Register of Deaths at the Salt Lake City Health Department, Bureau of Vital Statistics, there are several entries in which "malignant fever" and "bilious fever" are listed as the cause of death. Early physicians made the distinction among "fever," "mountain fever," "malignant fever," "bilious fever," and "typhoid fever," and although it would be inaccurate to associate malignant fever or bilious fever with malaria, there is a possibility that a persistent fever occurring during the summer months could be malaria.

In a five-year period from 1943 through 1947, 723 cases of malaria were reported in Utah and reflect the impact of returning servicemen on the incidence of disease within the state. There was another less dramatic rise in the incidence of malaria in Utah, associated with the Korean War, during the period from 1951 to 1955 when 75 cases were reported. Nevertheless, with an adequate reservoir of infection, capable vectors, and a susceptible resident population, malaria has not become established in Utah. Rapid diagnosis and treatment of servicemen, improved mosquito control, and an informed public are the principal factors which mitigate the importance of malaria in Utah. The feeding habits of the mosquito vectors in a rural setting may be another factor of some importance. Cattle and horses are the preferred sources of blood meals for some *Anopheles* species.

Miscellaneous:

Relapsing fever is virtually unknown in Utah, although it has been reported on several occasions from surrounding states. Davis (1939) reported a single case which occurred near Salt Lake City in 1928. Both *Ornithodoros parkeri* and *O. turicata*, proven vectors of relapsing fever, occur in the state although their distribution is not completely known.

Coxiella burnetti, the causative agent of Q fever, has been isolated from rodents (*Dipodomys ordii*, *D. microps*, and *Peromyscus maniculatus*) and a tick (*Dermacentor parumapterus*) in the Great Salt Lake Desert in Utah. *C. burnetti* antibodies were demonstrated serologically in *Lepus californicus*, *Onychomys leucogaster*, and *Eutamias minimus* (Stoenner et al., 1959). There is no record of Q fever in

Cases of Selected Arthropod-Borne Diseases in Utah 1915-1969

Year	CTF	WE	Malaria	RMSF	Tularemia
1915				35	
1916				34	
1917				15	
1918				5	
1919				10	
1920				9	
1921				8	
1922				18	
1923				15	
1924				10	
1925		2		6	1
1926				5	4
1927				7	1
1928			1	10	1
1929				11	0
1930				13	4
1931				10	2
1932				22	4
1933				5	6
1934			1	12	6
1935			3	14	37
1936				8	5
1937			2	12	41
1938			10	19	73
1939		2	1	24	44
1940	2	2	5	15	55
1941		5	0	13	45
1942		0	5	8	48
1943		12	313	12	34
1944		5	157	10	23
1945		2	112	9	28
1946		4	93	5	29
1947		6	48	5	36
1948		2	2	4	45
1949	1°	3	2	14	35
1950		5	0	7	40
1951	1°	2	23	18	30
1952	1°	8	38	9	20
1953	1°	6	7	9	40
1954	2°	6	4	4	22
1955	3°	2	3	7	29
1956	3	1°°	0	3	21
1957	4	3°°	1	9	30
1958	0	47	0	0	17
1959	4	38	2	1	10
1960	4	23	0	3	19
1961	2	6	0	1	17
1962	8	8	0	0	16
1963	12	12	0	0	3
1964	12	1	0	1	24
1965	11	0	1	0	10
1966	4	1	3	0	3
1967	11	0	3	0	7
1968	5	0	1	0	5
1969	16	0	3	2	16

°Represents isolations from patients hospitalized at Rocky Mountain Laboratory, Hamilton, Montana.

°°One case of SLE.

humans in Utah, but this may be due to faulty diagnosis or reporting, inasmuch as human cases have occurred in surrounding states.

Mohr (1951), in his paper on the distribution of murine typhus and plague in the United States, gives no records of murine typhus for the state of Utah. The flea index of *Xenopsylla cheopis* on *Rattus* sp. apparently has never been very high in Utah, and probably accounts for the absence of the disease in the state.

Armstrong (1922) reported an epidemic of typhus on the San Juan Indian Reservation during the last half of 1920 and the first half of 1921 in which there were 63 cases of typhus with 27 deaths among approximately 7,000 Indians. The San Juan Indian Reservation is 5,884 square miles in the four-corners area of New Mexico, Arizona, and Utah.

One case of dengue was reported in 1942, but it was probably contracted outside the state.

One doubtful case of rickettsialpox has been reported from Utah (Pratt and Rice, 1969).

In Utah the incidence of bites and stings of arthropods and the number of cases of dermatitis caused by urticating and vesicating insects is unknown. Scattered cases of archnidism have been reported, including at least one death from the sting of a hymenopterous insect. *Latrodectus hesperus* Chamberlin and Ivie and several species of Hymenoptera are the most important venomous arthropods in the state.

Tick paralysis, caused by the bite of female ticks, *Dermacentor andersoni* Stiles, occurs most frequently in an area comprising the northern part of Idaho and adjacent portions of Washington and Montana. Isolated cases have been reported in other sections of the Rocky Mountains where *Dermacentor andersoni* occurs (Philip, 1969). Insofar as we are aware there have been no cases of tick paralysis reported in Utah, but the possibility of its occurrence should not be overlooked.

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LIST OF ARTHROPODS

ARACHNIDA

I. Acarina: Ixodides

A. Argasidae

1. *Argas*
   - *A. cooleyi* Kohls and Hoogstraal, 1960
   - *A. giganteus* Kohls and Clifford, 1968
   - *A. sanchezi* Dugès, 1887
2. *Ornithodoros*
   - *O. concanensis* Cooley and Kohls, 1941
   - *O. cremicus* Cooley and Kohls, 1941
   - *O. kelleyi* Cooley and Kohls, 1941
   - *O. parkeri* (Cooley, 1936)
   - *O. sparnus* Kohls and Clifford, 1963
   - *O. talaje* (Guérin-Mèneville, 1849)
   - *O. turicata* (Dugès, 1876)
3. *Otobius*
   - *O. megnini* (Dugès, 1884)
   - *O. lagophilus* Cooley and Kohls, 1940

B. *Ixodidae*

1. *Dermacentor*
   - *D. albipictus* (Packard, 1869)
   - *D. andersoni* Stiles, 1908
   - *D. hunteri* Bishopp, 1912
   - *D. parumapertus* Neumann, 1901
2. *Haemaphysalis*
   - *H. leporispalustris* (Packard, 1869)
3. *Ixodes*
   - *I. angustus* Neumann, 1899
   - *I. jellisoni* Cooley and Kohls, 1938
   - *I. kingi* Bishopp, 1911
   - *I. marmotae* Cooley and Kohls, 1938
   - *I. muris* Bishopp and Smith, 1937
   - *I. ochotonae* Gregson, 1941
   - *I. pacificus* Cooley and Kohls, 1943
   - *I. sculptus* Neumann, 1904
   - *I. soricis* Gregson, 1942
   - *I. spinipalpis* Hadwen and Nuttall, 1916
   - *I. texanus* Banks, 1908
   - *I. woodi* Bishopp, 1911
4. *Rhipicephalus*
   - *R. sanguineus* (Latreille, 1806)

II. Acarina: Mesostigmata

A. *Dermanyssidae*

1. *Dermanyssus*
   - *D. gallinae* (De Geer, 1778)
2. *Hirstionyssus*
   - *H. bisetosus* Allred, 1957
   - *H. cynomys* (Radford, 1941)
   - *H. eutamiae* Allred and Beck, 1966
   - *H. femuralis* Allred 1957
   - *H. hilli* (Jameson, 1950)
   - *H. incomptus* (Eads and Hightower, 1952)
   - *H. isabellinus* (Oudemans, 1913)
   - *H. latiscutatus* (de Meillon and Lavoipierre, 1944)
   - *H. longichelae* Allred and Beck, 1966
   - *H. neotomae* (Eads and Hightower, 1951)
   - *H. occidentalis* (Ewing, 1923)
   - *H. paraffinis* Herrin, 1970
   - *H. perognathi* Herrin, 1970
   - *H. staffordi* Strandtmann and Hunt, 1951
   - *H. talpae* Zemskaya, 1955
   - *H. thomomys* Allred and Beck, 1966
   - *H. torus* Allred and Beck, 1966
   - *H. triacanthus* (Jameson, 1950)
   - *H. utahensis* Allred and Beck, 1966
3. *Liponyssoides*
   - *L. becki* (Allred, 1957)
   - *L. sanguineus* (Hirst, 1914)
4. *Myonyssus*
   - *M. montanus* Furman and Tipton, 1955

B. Haemogamasidae

1. *Brevisterna*
   - *B. montanus* (Ewing, 1922)
   - *B. utahensis* (Ewing, 1922)
2. *Eulaelaps*
   - *E. stabularis* (Koch, 1836)
3. *Haemogamasus*
   - *H. alaskensis* Ewing, 1925
   - *H. barberi* (Ewing, 1925)
   - *H. nidiformis* Bregetova, 1955
   - *H. occidentalis* (Keegan, 1951)
   - *H. pontiger* (Berlese, 1903)
4. *Ischyropoda*
   - *I. armatus* Keegan, 1951
   - *I. furmani* Keegan, 1951

C. Halarachnidae

1. *Zumptiella*
   - *Z. bakeri* (Furman, 1954)

D. Laelapidae

1. *Androlaelaps*
   - *A. circularis* (Ewing, 1933)
   - *A. crowei* Jameson, 1947
   - *A. debilis* Jameson, 1950
   - *A. fenilis* (Megnin, 1876)
   - *A. geomys* Strandtmann, 1949
   - *A. glasgowi* (Ewing, 1925)
   - *A. hollisteri* (Ewing, 1925)
   - *A. leviculus* Eads, 1951
2. *Hypoaspis*
   - *H. gurabensis* (Fox, 1946)
   - *H. lubrica* Oudemans and Voigts, 1904
3. *Laelaps*
   - *L. incilis* Allred and Beck, 1966
   - *L. kochi* Oudemans, 1936
   - *L. multispinosus* Banks, 1909
   - *L. nuttalli* Hirst, 1915

E. Macronyssidae

1. *Chrioptonyssus*
   - *C. robustipes* (Ewing, 1925)
2. *Ornithonyssus*
   - *O. aridus* Furman and Radovsky, 1963
   - *O. bacoti* (Hirst, 1913)
   - *O. silviarum* (Canestrini and Fanzago, 1877)
3. *Steatonyssus*
   - *S. antrozoi* Radovsky and Furman, 1963

F. Rhinonyssidae

1. *Paraneonyssus*
   - *P. icteridius* Strandtmann and Furman, 1956

G. Spinturnicidae
1. *Paraspinturnix*
P. globosus Rudnick, 1960
2. *Spinturnix*
S. orri Rudnick, 1960

V. Acarina: Oribatei
Carabodidae
Passalozetes
P. linearis Higgins and Woolley, 1962

VI. Acarina: Trombidiformes
A. Trombiculidae
1. *Acomatacarus*
A. arizonensis Ewing, 1942
2. *Chatia*
C. ochotona (Radford, 1942)
C. setosa Brennan, 1946
3. *Cheladonta*
C. crossi Lipovsky, Crossley, and Loomis, 1955
4. *Euschoengastia*
E. cordiremus Brennan, 1948
E. criceticola Brennan, 1948
E. cynomyicola Crossley and Lipovsky, 1954
E. decipiens Gould, 1956
E. fasolla Brennan and Beck, 1955
E. furmani Gould, 1956
E. hoffmanae Gould, 1956
E. lanceolata Brennan and Beck, 1955
E. lanei Brennan and Beck, 1955
E. luteodema Brennan, 1948
E. obesa Brennan and Beck, 1955
E. oregonensis (Ewing, 1929)
E. pomerantzi Brennan and Jones, 1954
E. radfordi Brennan and Jones, 1954
E. rotunda Brennan and Beck, 1955
E. sciuricola (Ewing, 1925)
E. soricinus Gould, 1956
5. *Euschoengastoides*
E. lacerta (Brennan, 1948)
E. hoplai (Loomis, 1954)
E. utahensis (Brennan and Beck, 1955)
6. *Eutrombicula*
E. belkini (Gould, 1950)
7. *Hexidionis*
H. allredi (Brennan and Beck, 1955)
H. doremi (Brennan and Beck, 1955)
8. *Hyponeocula*
H. arenicola (Loomis, 1954)
H. montanensis (Brennan, 1946)
9. *Gahrliepia*
G. americana (Ewing, 1942)
10. *Leeuwenhoekia*
L. americana (Ewing, 1942)
11. *Leptotrombidium*
L. myotis (Ewing, 1929)
L. panamensis (Ewing, 1925)
L. potosina (Hoffman, 1950)
12. *Miyatrombicula*
M. esoensis (Sasa and Ogata, 1953)
M. sargenti (Brennan, 1952)
13. *Neoschoengastia*
N. americana (Hirst, 1921)
14. *Neotrombicula*
N. californica (Ewing, 1942)
N. harperi (Ewing, 1928)
N. jewetti (Brennan and Wharton, 1950)
N. microti (Ewing, 1928)
N. subsignata (Brennan and Wharton, 1950)
15. *Odontacarus*
O. hirsutus (Ewing, 1931)
O. linsdalei (Brennan and Jones, 1954)
O. micheneri Greenberg, 1952
16. *Trombicula*
T. bakeri Ewing, 1946
T. kardosi Loomis, 1954
T. univari Brennan, 1965
17. *Whartonia*
W. perplexa (Brennan, 1947)

B. Myobiidae
Radfordia
R. bachai Howell and Elzinga, 1962
R. lemina (Koch, 1841)
R. subuliger Ewing, 1938

II. Araneida
A. *Loxoscelidae*
Loxosceles
L. unicolor Keyserling, 1887

B. Theridiidae
Latrodectus
L. hesperus Chamberlin and Ivie, 1935

III. Scorpionida
A. Buthidae
Centruroides
C. sculpturatus Ewing, 1928

B. Vejovidae
1. *Anuroctonus*
A. phaiodactylus (Wood, 1863)
2. *Hadrurus*
H. arizonensis Ewing, 1928
H. spadix, Stahnke, 1940
3. *Vejovis*
V. becki Gertsch and Allred, 1965
V. boreus (Girard, 1845)
V. concusus Stahnke, 1940
V. utahensis Williams, 1968
V. wupatkiensis Stahnke, 1940

INSECTA

I. Anoplura
A. Haematopinidae
Haematopinus
H. asini (Linnaeus, 1758)
H. eurysternus (Nitzsch, 1818)
H. suis (Linnaeus, 1758)

B. Hoplopleuridae
1. *Enderleinellus*
E. marmotae Ferris, 1919
E. osborni Kellogg and Ferris, 1915
E. paralongiceps Kim, 1966
E. suturalis (Osborn, 1891)
E. tamiasciuri Kim, 1966

2. *Fahrenholzia*
   F. pinnata Kellogg and Ferris, 1915
   F. reducta Ferris, 1922

3. *Haemodipsus*
   H. lyriocephalus (Burmeister, 1839)
   H. setoni Ewing, 1924
   H. ventricosus (Denny, 1842)

4. *Hoplopleura*
   H. acanthopus (Burmeister, 1839)
   H. arboricola Kellogg and Ferris, 1915
   H. captiosa Johnson, 1960
   H. difficilis Kim, 1965
   H. erratica (Osborn, 1896)
   H. ferrisi Cook and Beer, 1959
   H. hesperomydis (Osborn, 1891)
   H. onychomydis Cook and Beer, 1959
   H. pacifica Ewing, 1924
   H. reithrodontomydis Ferris, 1951
   H. sciuricola Ferris, 1921
   H. trispinosa Kellogg and Ferris, 1915

5. *Neohaematopinus*
   N. citellinus Ferris, 1942
   N. inornatus (Kellogg and Ferris, 1915)
   N. laeviusculus (Grube, 1851)
   N. marmotae Ferris, 1923
   N. neotomae Ferris, 1942
   N. pacificus Kellogg and Ferris, 1915
   N. sciuri Jancke, 1931
   N. sciuropteri (Osborn, 1891)
   N. semifasciatus Ferris, 1916
   N. spilosomae Pratt and Stojanovich, 1961

6. *Polyplax*
   P. alaskensis Ewing, 1927
   P. auricularis Kellogg and Ferris, 1915
   P. borealis Ferris, 1933
   P. serrata (Burmeister, 1839)
   P. spinulosa (Burmeister, 1839)

C. Linognathidae

1. *Linognathus*
   L. africanus Kellogg and Paine, 1911
   L. pedalis (Osborn, 1896)
   L. setosus (von Olfers, 1816)
   L. stenopsis (Burmeister, 1838)
   L. vituli (Linnaeus, 1758)

2. *Solenoptes*
   S. binipilosus (Fahrenholz, 1916)
   S. capillatus Enderlein, 1904
   S. ferrisi (Fahrenholz, 1916)

D. Pediculidae

1. *Microphthirus*
   M. uncinatus (Ferris, 1916)

2. *Pediculus*
   P. humanus Linnaeus, 1758

3. *Pthirus*
   P. pubis (Linnaeus, 1758)

II. Orthoptera

A. Blattidae

1. *Arenivaga*
   A. erratica Rehn, 1907

2. *Blatta*
   B. orientalis (Linnaeus, 1758)

3. *Blatella*
   B. germanica (Linnaeus, 1767)

4. *Panchlora*
   P. nivea (Linnaeus, 1758)

5. *Periplaneta*
   P. americana (Linnaeus, 1758)
   P. australiasiae (Fabricius, 1775)

6. *Suppella*
   S. longipalpa (Fabricius, 1798)

III. Coleoptera

A. Leptinidae

1. *Leptinillus*
   L. validus (Horn, 1872)

2. *Platypsyllus*
   P. castoris Ritsema, 1869

B. Meloidae

1. *Epicauta*
   E. fabricii (LeConte, 1853)
   E. ferruginea (Say, 1823)
   E. normalis Werner, 1945
   E. puncticollis (Mannerheim, 1843)

2. *Lytta*
   L. cyanipennis (LeConte, 1851)

3. *Nemognatha*
   N. lurida LeConte, 1853
   N. lutea LeConte, 1853

IV. Diptera

A. Calliphoridae

1. *Aldrichina*
   A. grahami (Aldrich, 1930)

2. *Bufolucilia*
   B. silvarum (Meigen, 1826)

3. *Calliphora*
   C. coloradensis Hough, 1899
   C. livida Hall, 1948
   C. terraenorae Macquart, 1851
   C. vicina Robineau-Desvoidy, 1830
   C. vomitoria (Linnaeus, 1758)

4. *Cochliomyia*
   C. hominivorax (Coqueral, 1858)
   C. macellaria (Fabricius, 1775)

5. *Cynomyopsis*
   C. cadaverina (Robineau-Desvoidy, 1830)

6. *Eucalliphora*
   E. lilaea (Walker, 1849)

7. *Lucilia*
   L. illustris (Meigen, 1826)

8. *Phaenicia*
   P. sericata (Meigen, 1826)

9. *Phormia*
   P. regina (Meigen, 1826)

10. *Pollenia*
   P. rudis (Fabricius, 1794)

11. *Protocalliphora*
   P. aenea Shannon and Dobroscky, 1924
   P. asiovora Shannon and Dobroscky, 1924
   P. cuprina (Hall, 1948)
   P. hesperia Shannon and Dobroscky, 1924
   P. hirudo Shannon and Dobroscky, 1924
   P. hirundo Shannon and Dobroscky, 1924
   P. metallica (Townsend, 1919)
   P. sialia Shannon and Dobroscky, 1924

12. *Protophormia*
    P. terraenovae (Robineau-Desvoidy, 1830)

B. Ceratopogonidae
  1. *Culicoides*
     C. baueri Hoffman, 1925
     C. cochisensis Wirth and Blanton, 1967
     C. cockerellii (Coquillett, 1901)
     C. crepuscularis Malloch, 1915
     C. freeborni Wirth and Blanton, 1969
     C. haematopotus Malloch, 1915
     C. hieroglyphicus Malloch, 1915
     C. montanus Wirth and Blanton, 1969
     C. obsoletus (Meigen, 1818)
     C. palmerae James, 1945
     C. stellifer (Coquillett, 1901)
     C. usingeri Wirth, 1952
     C. utahensis Fox, 1946
     C. variipennis variipennis (Coquillett, 1901)
  2. *Leptoconops*
     L. kerteszi Hieffer, 1908

C. Chloropidae
  Hippelates
     H. microcentrus Coquillett, 1904
     H. montanus Sabrosky, 1941
     H. pallipes (Loew, 1865)
     H. particeps (Becker, 1912)
     H. pusio Loew, 1872

D. Culicidae
  1. *Aedes*
     A. atropalpus (Coquillett, 1902)
     A. campestris Dyar and Knab, 1907
     A. cataphylla Dyar 1916
     A. cinereus Meigen, 1818
     A. communis (De Geer, 1776)
     A. dorsalis (Meigen, 1830)
     A. excrucians (Walker, 1856)
     A. fitchii (Felt and Young, 1904)
     A. flavescens (Muller, 1764)
     A. hexodontus Dyar, 1916
     A. impiger (Walker, 1848)
     A. implicatus Vockeroth, 1954
     A. increpitus Dyar, 1916
     A. intrudens Dyar, 1919
     A. melanimon Dyar, 1924
     A. nielseni O'Meare and Craig, 1970
     A. nigromaculis (Ludlow, 1907)
     A. niphadopsis Dyar and Knab, 1918
     A. pullatus (Coquillett, 1904)
     A. schizopinax Dyar, 1929
     A. sierrensis (Ludlow, 1905)
     A. spencerii idahoensis (Theobald 1901)
     A. sticticus (Meigen, 1838)
     A. trivittatus (Coquillett, 1902)
     A. varipalpus (Coquillett, 1902)
     A. ventrovittis Dyar, 1916
     A. vexans (Meigen, 1830)
  2. *Anopheles*
     A. earlei Vargas, 1943
     A. franciscanus McCracken, 1904
     A. freeborni Aitken, 1939
  3. *Coquillettidia* (= *Mansonia*)
     C. perturbans (Walker, 1856)
  4. *Culex*
     C. apicalis Adams, 1903
     C. erythrothorax Dyar, 1907
     C. pipiens pipiens Linnaeus, 1758
     C. pipiens quinquefasciatus Say, 1823
     C. restuans (Theobald, 1901)
     C. tarsalis Coquillett, 1896
     C. territans Walker, 1856
     C. thriambus Dyar, 1921
  5. *Culiseta*
     C. impatiens (Walker, 1848)
     C. incidens Thompson, 1868
     C. inornata Williston, 1893
     C. morsitans dyari Coquillett, 1902
     C. silvestris minnesotae Barr, 1957
  6. *Orthopodomyia*
     O. signifera (Coquillett, 1896)
  7. *Psorophora*
     P. signipennis (Coquillett, 1896)

E. Cuterebridae
  Cuterebra
     C. angustifrons Dalmat, 1942
     C. approximata Walker, 1866
     C. grisea Coquillett, 1904
     C. jellisoni Curran, 1942
     C. lepusculi Townsend, 1897
     C. polita Coquillett, 1898
     C. princeps (Austen, 1895)
     C. ruficrus (Austen, 1933)
     C. tenebrosa Coquillett, 1898

F. Gasterophilidae
  Gasterophilus
     G. haemorrhoidalis (Linnaeus, 1785)
     G. intestinalis (De Geer, 1776)
     G. nasalis (Linnaeus, 1758)

G. Hippoboscidae
  1. *Icosta*
     I. americana (Leach, 1817)
     I. hirsuta (Ferris, 1927)
     I. nigra (Perty, 1833)
  2. *Lipoptena*
     L. depressa (Say, 1823)
  3. *Melophagus*
     M. ovinus (Linnaeus, 1785)
  4. *Myophthiria*
     M. fimbriata (Waterhouse, 1887)
  5. *Neolipoptena*
     N. ferrisi (Bequaert, 1935)
  6. *Olfersia*
     O. sordida Bigot, 1885
  7. *Ornithomya*
     O. anchineuria Speiser, 1905
  8. *Ornithoica*
     O. vicina (Walker 1849)

H. Muscidae
  1. *Fannia*
     F. canicularis (Linnaeus, 1761)
     F. scalaris (Fabricius, 1794)
  2. *Haematobia*
     H. irritans Linnaeus, 1785
  3. *Musca*
     M. autumnalis De Geer, 1776
     M. domestica (Linnaeus, 1758)

4. *Muscina*
   - *M. assimilis* (Fallén, 1823)
   - *M. stabulans* (Fallén, 1817)

5. *Stomoxys*
   - *S. calcitrans* (Linnaeus, 1758)

I. *Nycteribiidae*

Basilia
- *B. antrozoi* (Townsend, 1893)
- *B. corynorhini* (Ferris, 1916)
- *B. forcipata* Ferris, 1924

J. Oestridae

1. *Cephenemyia*
   - *C. jellisoni* Townsend, 1941
   - *C. pratti* Hunter, 1916

2. *Hypoderma*
   - *H. bovis* (Linnaeus, 1758)
   - *H. lineatum* (Villers, 1789)

3. *Oestrus*
   - *O. ovis* Linnaeus, 1758

K. Piophilidae

Piophila
- *P. casei* (Linnaeus, 1758)

L. Psychodidae

1. *Lutzomyia*
   - *L. aquilonia* (Fairchild and Harwood, 1961)
   - *L. californica* (Fairchild and Hertig, 1957)
   - *L. oppidana* (Dampf, 1944)
   - *L. stewarti* (Mangabeira and Galindo, 1944)
   - *L. vexator* (Coquillett, 1907)

2. *Psychoda*
   - *P. alternata* Say, 1824

M. Rhagionidae

Symphoromyia
- *S. atripes* Bigot, 1887
- *S. fulvipes* Bigot, 1887
- *S. hirta* Johnson, 1897
- *S. inquisitor* Aldrich, 1915
- *S. johnsoni* Coquillett, 1894
- *S. pachyceras* Williston, 1886

N. Sarcophagidae

1. *Ravinia*
   - *R. acerba* (Walker, 1849)
   - *R. derelicta* (Walker, 1852)
   - *R. errabunda* (Wulp, 1895)
   - *R. latisetosa* Parker, 1914
   - *R. lherminieri* (Robineau-Desvoidy, 1830)
   - *R. planifrons* (Aldrich, 1916)
   - *R. pusiola* (Wulp, 1895)

2. *Sarcophaga*
   - *S. argyrostoma* (Robineau-Desvoidy, 1830)
   - *S. bishoppi* Aldrich, 1916
   - *S. bullata* Parker, 1916
   - *S. cooleyi* Parker, 1914
   - *S. haemorrhoidalis* (Fallén, 1817)
   - *S. perspicax*, Aldrich, 1916
   - *S. sarracenioides* Aldrich, 1916
   - *S. shermani* Parker, 1923
   - *S. sinuata* Meigen, 1826
   - *S. utilis* Aldrich, 1915

3. *Wohlfahrtia*
   - *W. vigil opaca* Coquillett, 1897

O. Simuliidae

1. *Cnephia*
   - *C. jeanae* DeFoliart and Peterson, 1960
   - *C. mutata* (Malloch, 1914)
   - *C. villosa* DeFoliart and Peterson, 1960

2. *Prosimulium*
   - *P. daviesi* Peterson and DeFoliart, 1960
   - *P. exigens* Dyar and Shannon, 1927
   - *P. flaviantennum* (Stains and Knowlton, 1940)
   - *P. fulvum* (Coquillett, 1902)
   - *P. longilobum* Peterson and DeFoliart, 1960
   - *P. onychodactylum* Dyar and Shannon, 1927
   - *P. shewelli* Peterson and DeFoliart, 1960
   - *P. travisi* Stone, 1952
   - *P. uinta* Peterson and DeFoliart, 1960
   - *P. unicum* (Twinn, 1938)

3. *Simulium*
   - *S. arcticum* Malloch, 1914
   - *S. argus* Williston, 1893
   - *S. aureum* Fries, 1824
   - *S. bicorne* Dorogostajskij, Rubtzov, and Vlasenko, 1935
   - *S. bivittatum* Malloch, 1914
   - *S. canadense* Hearle, 1932
   - *S. canonicola* (Dyar and Shannon, 1927)
   - *S. corbis* Twinn, 1936
   - *S. decorum* Walker, 1848
   - *S. defoliarti* Stone and Peterson, 1958
   - *S. griseum* Coquillett, 1898
   - *S. hunteri* Malloch, 1914
   - *S. jacumbae* Dyar and Shannon, 1927
   - *S. latipes* (Meigen, 1804)
   - *S. mediovittatum* Knab, 1915
   - *S. meridionale* Riley, 1887
   - *S. nigricoxum* Stone, 1952
   - *S. petersoni* Stone and DeFoliart, 1959
   - *S. piperi* Dyar and Shannon, 1927
   - *S. pugetense* (Dyar and Shannon, 1927)
   - *S. rugglesi* Nicholson and Mickel, 1950
   - *S. trivittatum* Malloch, 1914
   - *S. tuberosum* (Lundstrom, 1911)
   - *S. venator* Dyar and Shannon, 1927
   - *S. venustum* Say, 1823
   - *S. virgatum* Coquillett, 1902
   - *S. vittatum* Zetterstedt, 1838
   - *S. wyomingense* Stone and DeFoliart, 1959

4. *Twinnia*
   - *T. nova* (Dyar and Shannon, 1927)

P. Streblidae

Trichobius
- *T. corynorhini* Cockerell, 1910
- *T. major* Coquillett, 1899

Q. Syrphidae

Eristalis
- *E. dimidiatus* Wiedemann, 1830
- *E. tenax* (Linnaeus, 1758)

R. Tabanidae

1. *Atylotus*
   - *A. incisuralis* var. *utahensis* Rowe and Knowlton, 1935

2. *Chrysops*
   - *C. aestuans* Wulp, 1867
   - *C. callidus* Osten Sacken, 1875

C. carbonarius Walker, 1848
C. coquilletti Hine, 1904
C. discalis Williston, 1880
C. excitans Walker, 1850
C. frigidus Osten Sacken, 1877
C. fulvaster Osten Sacken, 1877
C. furcatus Walker, 1848
C. indus Osten Sacken, 1875
C. mitis Osten Sacken, 1875
C. niger Macquart, 1838
C. noctifer noctifer Osten Sacken, 1877
C. noctifer pertinax Williston, 1887
C. pachycerus Williston, 1887
C. sackenii Hine, 1903
C. wileyae Philip, 1955

3. *Haematopota*
H. americana Osten Sacken, 1875

4. *Hybomitra*
H. epistates (Osten Sacken, 1878)
H. frontalis (Walker, 1848)
H. opaca (Coquillett, 1904)
H. rhombica (Osten Sacken, 1876)
H. rhombica var. *osburni* (Hine, 1904)
H. rupestris (McDonnough, 1921)
H. sequax (Williston, 1887)
H. sonomensis var. *phaenops* (Osten Sacken, 1877)
H. tetrica var. *hirtula* (Bigot, 1892)

5. *Pilimas*
P. californicus (Bigot, 1892)

6. *Silvius*
S. quadrivittatus (Say, 1823)

7. *Stenotabanus*
S. flavidus (Hine, 1904)
S. guttatulus (Townsend, 1893)

8. *Tabanus*
T. aegrotus Osten Sacken, 1877
T. atratus Fabricius, 1775
T. dorsifer Walker, 1860
T. gilanus Townsend, 1897
T. laticeps Hine, 1904
T. lineola Fabricius, 1794
T. productus Hine, 1904
T. pumilus Macquart, 1838
T. punctifer Osten Sacken, 1876
T. stonei Philip, 1941

V. Hemiptera

A. Cimicidae

1. *Cimex*
C. lectularius Linnaeus, 1758
C. pilosellus (Horvath, 1910)

2. *Oeciacus*
O. vicarius Horvath, 1912

B. Reduviidae

1. *Reduvius*
R. personatus (Linnaeus, 1758)
R. vanduzeei Wygodzinsky and Usinger, 1964

2. *Triatoma*
T. protracta (Uhler, 1894)

VI Hymenoptera

A Apidae

1. *Apis*
A. mellifera Linnaeus, 1758

2. *Bombus*
B. appositus Cresson, 1878
B. bifarius Cresson, 1878
B. centralis Cresson, 1864
B. edwardsii Cresson, 1878
B. flavifrons Cresson, 1863
B. griseocollis (De Geer, 1773)
B. hunti Greene, 1860
B. morrisoni Cresson, 1878
B. nevadensis nevadensis Cresson, 1874
B. occidentalis occidentalis Greene, 1858
B. rufocinctus Cresson, 1863

B. Formicidae

1. *Pogonomyrmex*
P. barbatus barbatus (F. Smith, 1856)
P. californicus (Buckley, 1867)
P. imberbiculus W.M. Wheeler, 1902
P. occidentalis (Cresson, 1865)
P. rugosus Emery, 1895

2. *Crematogaster*
C. mormonum Emery, 1895
C. vermiculata Emery, 1895

3. *Solenopsis*
S. molesta molesta (Say, 1836)
S. molesta validiuscula Emery, 1895
S. salina W.M. Wheeler, 1908
S. xyloni McCook, 1879

C. Mutillidae

1. *Chyphotes*
C. epedaphus Buzicky, 1941
C. similis Baker, 1905

2. *Dasymutilla*
D. californica (Radoszkowski, 1861)
D. caneo (Blake, 1879)
D. fulvohirta (Cresson, 1865)
D. gloriosa (Saussure, 1867)
D. klugii (Gary, 1872)
D. monticola (Cresson, 1865)
D. phaon phaon (Fox, 1899)
D. phaon var. *fimbrialis* Mickel, 1928
D. scitula Mickel, 1928
D. ursula (Cresson, 1875)
D. vesta vesta Cresson, 1865

3. *Dilophotopsis*
D. concolor concolor (Cresson, 1865)

4. *Odontophotopsis*
O. erebus (Melander, 1903)
O. inconspicua (Blake, 1886)
O. melicausa (Blake, 1871)
O. venusta (Blake, 1886)

5. *Pseudomethoca*
P. contumax (Cresson, 1865)
P. contumeliosa Mickel, 1935
P. manca Mickel, 1924
P. propinqua (Cresson, 1865)
P. toumeyi (Fox, 1894)

6. *Sphaeropthalma*
S. abdominalis (Blaker, 1886)
S. ceres (Fox, 1899)
S. dirce (Fox, 1899)
S. marpesia (Blake, 1879)
S. unicolo (Cresson, 1865)

7. *Timulla*
T. grotei (Blake, 1871)

8. *Typhoctes*
   T. peculiaris (Cresson, 1875)

D. Pompilidae

Pepsis
- *P. angustimarginata* Viereck, 1908
- *P. mildei* Stol, 1857
- *P. pallidolimbata pallidolimbata* Lucas, 1895
- *P. thisbe* Lucas, 1895

E. Sphecidae

1. *Astata*
   - *A. bicolor* Say, 1823
   - *A. nevadica* Cresson, 1881
   - *A. nubecula* Cresson, 1865
   - *A. occidentalis* Cresson, 1881
2. *Bembix*
   - *B. americana comata* Parker, 1917
   - *B. americana spinolae* Lepeletier, 1845
   - *B. amoena* Handlirsch, 1893
   - *B. occidentalis* W.J. Fox, 1893
   - *B. rugosa* Parker, 1917
3. *Cerceris*
   - *C. conifrons* Mickel, 1916
   - *C. convergens* Viereck and Cockerell, 1904
   - *C. finitima* Cresson, 1865
   - *C. nigrescens* Smith, 1856
4. *Clypeadon*
   - *C. laticinctus* (Cresson, 1865)
5. *Didineis*
   - *D. nodosa* Fox, 1894
6. *Mimesa*
   - *M. cressonii* Packard, 1867
7. *Philanthus*
   - *P. gibbosus* (Fabricius, 1775)
8. *Prionyz*
   - *P. atratus* (Lepeletier, 1845)
   - *P. parkeri* Bohart and Menke, 1963

F. Vespidae

1. *Ancistrocerus*
   - *A. antilope antilope* (Panzer, 1798)
   - *A. catskill albophaleratus* (Saussure, 1855)
   - *A. catskill catskill* (Saussure, 1853)
   - *A. lineativentris fulvicarpus* Cameron, 1908
   - *A. neocallosus neocallosus* Bequaert, 1943
   - *A. spilogaster* Cameron, 1905
   - *A. tigris tigris* (Saussure, 1857)
   - *A. tuberculiceps sutterianus* (Saussure, 1875)
   - *A. tuberculiceps tuberculiceps* (Saussure, 1853)
2. *Enodynerus*
   - *E. annulatus annulatus* (Say, 1824)
   - *E. annulatus sulphureus* (Saussure, 1858)
   - *E. auranus* (Cameron, 1906)
   - *E. boscii boscii* (Lepeletier, 1841)
   - *E. exoglyphus albovittatus* (R. Bohart, 1939)
   - *E. exoglyphus exoglyphus* (R. Bohart, 1939)
   - *E. foraminatus aequalus* (Cameron, 1906)
   - *E. fusus fusus* (Cresson, 1872)
   - *E. hidalgo hidalgo* (Saussure, 1857)
   - *E. martini* (R. Bohart, 1942)
   - *E. pratensis pratensis* (Saussure, 1870)
   - *E. russatus* (R. Bohart, 1942)
3. *Eumenes*
   - *E. bollii bollii* Cresson, 1872
   - *E. iturbide pedalis* Fox, 1894
   - *E. sculleni* R. Bohart, 1950
   - *E. verticalis tricinctus* Isely, 1917
4. *Leptochilus*
   - *L. erubescens* (R. Bohart, 1940)
   - *L. republicanus* (Dalla Torre, 1889)
   - *L. rubicundulus* (R. Bohart, 1940)
   - *L. rufinodus* (Cresson, 1868)
5. *Mischocyttarus*
   - *M. flavitarsis flavitarsis* (Saussure, 1854)
   - *M. flavitarsis idahoensis* Bequaert, 1933
6. *Odynerus*
   - *O. cinnabarinus* R. Bohart, 1939
   - *O. margaretellus* Rohwer, 1915
7. *Polistes*
   - *P. canadensis* var. *kaibabensis* Hayward, 1932
   - *P. flavus* Cresson, 1868
   - *P. fuscatus centralis* Hayward, 1933
   - *P. fuscatus utahensis* Hayward, 1933
8. *Pseudomasaris*
   - *P. edwardsii* (Cresson, 1872)
   - *P. zonalis* (Cresson, 1864)
9. *Pterocheilus*
   - *P. laticeps* Cresson, 1872
   - *P. micheneri* R. Bohart, 1940
   - *P. pedicellatus* R. Bohart, 1940
   - *P. provancheri* (Huard, 1895)
10. *Stenodynerus*
    - *S. apache* R. Bohart, 1949
    - *S. blandoides blandoides* R. Bohart, 1943
    - *S. blandus blandus* (Saussure, 1870)
    - *S. cochisensis* (Viereck, 1908)
    - *S. minimoferus* R. Bohart, 1949
    - *S. noticeps noticeps* R. Bohart, 1948
    - *S. percampanulatus* (Viereck, 1906)
    - *S. toltecus* (Saussure, 1857)
    - *S. valliceps* R. Bohart, 1948
11. *Symmorphus*
    - *S. meridionalis* (Viereck, 1903)
12. *Vespula*
    - *V. artica* Rohwer, 1916
    - *V. arenaria* (Fabricius, 1775)
    - *V. atropilosa* (Sladen, 1918)
    - *V. austriaca* (Panzer, 1799)
    - *V. consobrina* (Saussure, 1864)
    - *V. maculata* (Linnaeus, 1763)
    - *V. norvegicoides* Sladen, 1918
    - *V. pennsylvanica* (Saussure, 1857)
    - *V. vulgaris* (Linnaeus, 1758)

VII. Lepidoptera

A. Arctiidae

1. *Arachnis*
   - *A. picta* Packard, 1864
2. *Arctia*
   - *A. caja utahensis* (Henry Edwards, 1886)
3. *Apantesis*
   - *A. nevadensis* (Grote and Robinson, 1866)
   - *A. ornata* (Packard, 1864)
   - *A. parthenice* (Kirby, 1837)
   - *A. proxima* (Guerin-Meneville, 1844)

A. williamsi tooele Barnes and McDunnough, 1910
A. williamsi form *determinata* (Neumoegen, 1881)

4. *Diacrisia*
D. vagans (Boisduval, 1852)
D. virginica (Fabricius, 1798)

5. *Ectypia*
E. clio jessica (Barnes, 1900)

6. *Estigmene*
E. oregonsis (Stretch, 1873)

7. *Halysidota*
H. argentata subalpina French, 1890
H. maculata agassizi Packard, 1864
H. oslari Rothschild, 1909
H. tesellaris (J. E. Smith and Abbot, 1797)

8. *Hemihyalea*
H. labecula (Grote, 1881)

9. *Holomelina*
H. fragilis (Strecker, 1878)

10. *Isia*
I. isabella (J. E. Smith and Abbott, 1797)

11. *Leptarctia*
L. californiae form *decia* (Boisduval, 1869)

12. *Nemeophila*
N. plantaginis (Linnaeus, 1758)

B. Lasiocampidae

1. *Malacosoma*
M. americanum (Fabricius, 1793)
M. californicum fragile (Stretch, 1881)
M. disstria Hubner, 1822

2. *Phyllodesma*
P. americana (Harris, 1841)

3. *Tolype*
T. glenwoodi Barnes, 1900

C. Lymantridae

Dasychira
D. vagans grisea (Barnes and McDunnough, 1913)

D. Nymphalidae

1. *Aglais*
A. milberti Godart, 1819

2. *Argynnis*
A. leto Behr, 1862
A. nokomis Edwards, 1862

3. *Basilarchia*
B. lorquini Boisduval, 1852

4. *Nymphalis*
N. antiopa (Linnaeus, 1758)

5. *Vanessa*
V. atalanta Linnaeus, 1758
V. cardui Linnaeus, 1758
V. carye Hubner, 1806

E. Saturniidae

1. *Automeris*
A. io (Fabricius, 1775)

2. *Coloradia*
C. pandora Blake, 1863

3. *Hemileuca*
H. eleganterina (Boisduval, 1852)
H. hera hera (Harris, 1841)
H. nevadensis Stretch, 1872
H. oliviae Cockerell, 1898

4. *Platysamia*
P. euryalus (Boisduval, 1855)
P. gloveri Strecker, 1872

VIII. Mallophaga

A. Gyropidae

Gliricola
G. porcelli (Schank, 1781)
G. ovalis Burmeister, 1838

B. Laemobothriidae

Laemobothrion
L. atrum (Nitzsch, 1818)
L. glutinans Nitzsch, 1861
L. maximum (Scopoli, 1763)
L. simile Kellogg, 1896
L. tinnunculi (Linnaeus, 1758)
L. vulturis (J. C. Fabricius, 1775)

C. Menoponidae

1. *Actornithophilus*
A. lacustris Clay, 1962
A. limarius Clay, 1962
A. luminosae (Kellogg, 1908)
A. mexicanus Emerson, 1953
A. ochraceus (Nitzsch, 1818)
A. paludosus Clay, 1962
A. patellatus (Piaget, 1890)
A. piceus lari (Packard, 1870)
A. piceus piceus (Denny, 1842)
A. stictus (Kellogg & Paine, 1911)
A. totani (Schrank, 1803)
A. umbrinus (Burmeister, 1838)
A. uniseriatum (Piaget, 1880)

2. *Amyrsidea*
A. megalosoma (Overgaard, 1943)
A. perdicis (Denny, 1842)

3. *Ardeiphilus*
A. floridae Tuff, 1965

4. *Austromenopon*
A. aegialitidis (Durrant, 1906)
A. atrofulvum (Piaget, 1880)
A. durisetosum (Blagoveshtchensky, 1948)
A. himantopi Timmermann, 1954
A. limosae Timmermann, 1954
A. micrandum (Nitzsch, 1866)
A. sachtlebeni Timmermann, 1954
A. spenceri Timmermann, 1956
A. squatarolae Timmermann, 1954
A. transversum (Denny, 1842)

5. *Bonomiella*
B. columbae Emerson, 1957

6. *Ciconiphilus*
C. butoridiphagus Carriker, 1964
C. cygni Price & Beer, 1965
C. decimfasciatus (Boisduval & Lacordaire, 1835)
C. pectiniventris (Harrison, 1916)

7. *Colpocephalum*
C. brachysomum Kellogg & Chapman, 1902

C. flavescens (de Haan, 1829)
C. fregili Denny, 1842
C. impressum Rudow, 1866
C. kelloggi Osborn, 1902
C. leptopygos Nitzsch, 1874
C. nanum Piaget, 1890
C. napiforme Rudow, 1869
C. pectinatum Osborn, 1902
C. tausi (Ansari, 1951)
C. turbinatum Denny, 1842
C. unciferum Kellogg, 1896
C. zerafae Ansari, 1955

8. *Comatomenopon*
C. thulae Tuff, 1967

9. *Cuculiphilus*
C. alternatus (Osborn, 1902)

10. *Dennyus*
D. bruneri (Carriker, 1903)
D. spiniger Ewing, 1930

11. *Eureum*
E. spenceri Emerson & Pratt, 1956

12. *Hohorstiella*
H. frontalis Carriker, 1949

13. *Holomenopopn*
H. clypeilargum Eichler, 1943
H. leucoxanthum (Burmeister, 1838)
H. setigerum (Blagoveshtchensky, 1948)
H. transvaalense (Bedford, 1920)

14. *Kurodaia*
K. acadicae Price & Beer, 1963
K. flammei Price & Beer, 1963
K. fulvovasciata (Piaget, 1880)
K. haliacti (Denny, 1842)
K. magna Emerson, 1960
K. painei (McGregor, 1912)
K. subpachygaster (Piaget, 1880)

15. *Machaerilaemus*
M. amercanus (Ewing, 1930)
M. clayae (Balat, 1966)
M. malleus (Burmeister, 1838)
M. melospizae Emerson, 1954

16. *Menacanthus*
M. alaskensis (Kellogg & Chapman, 1902)
M. annulatus (Giebel, 1874)
M. chrysophaeus (Kellogg, 1896)
M. distinctus (Kellogg & Chapman, 1899)
M. eurysternum (Burmeister, 1838)
M. expansus (Osborn, 1896)
M. gonophaeus (Burmeister, 1838)
M. mutabilis Blagoveshtchensky, 1940
M. perforatus (Piaget, 1880)
M. persignatus (Kellogg & Chapman, 1899)
M. picicola (Packard, 1873)
M. robustus (Kellogg, 1896)
M. stramineus (Nitzsch, 1818)

17. *Menopon*
M. pallens Clay, 1949

18. *Myrsidea*
M. anaspila (Nitzsch, 1866)
M. conspica (Kellogg & Chapman, 1902)
M. culcullaris (Nitzsch, 1818)
M. dissimilis (Kellogg, 1896)
M. emersoni Clay, 1966
M. incerta (Kellogg, 1896)
M. interrupta (Osborn, 1896)
M. latifrons (Carriker, 1910)
M. melanorum (Kellogg, 1896)
M. palloris (Carriker, 1903)
M. picae (Linnaeus, 1758)
M. quadrifasciata (Piaget, 1880)
M. quadrimaculata (Carriker, 1902)
M. ridulosa (Kellogg & Chapman, 1899)
M. rustica (Giebel, 1874)

19. *Nosopon*
N. lucidum (Rudow 1869)

20. *Piagetiella*
P. peralis (Leidy, 1878)

21. *Plegadiphilus*
P. plegadis (Dubinin, 1938)

22. *Pseudomenopon*
P. insolens (Kellogg, 1896)
P. par (Kellogg, 1896)
P. pilosum (Scopoli, 1763)
P. quadrii Eichler, 1952

23. *Trinoton*
T. anserinum (J. C. Fabricius, 1805)
T. querquedulae (Linnaeus, 1758)

D. Philopteridae

1. *Acidoproctus*
A. maximus Piaget, 1878

2. *Anaticola*
A. crassicornis cornicephalus (Zavaleta, 1946)
A. crassicornis crassicornis (Scopoli, 1763)
A. crassicornis dafilensis Carriker, 1956
A. crassicornis depuratus (Nitzsch, 1866)
A. crassicornis hopkinsi Eichler, 1954
A. crassicornis mergiserrati (De Geer, 1778)

3. *Anatoecus*
A. cygni emersoni Keler, 1960
A. dentatus affinis Keler, 1960
A. dentatus dentatus (Scopoli, 1763)
A. dentatus ferrugineus (Giebel, 1874)
A. icterodes bipunctatus (Giebel, 1874)
A. icterodes boschadis Keler, 1960
A. icterodes icterodes (Nitzsch, 1818)
A. icterodes marcui Keler, 1960
A. icterodes simmillimus Keler, 1960
A. icterodes tendeiroi Keler, 1960

4. *Aquanirmus*
A. amercanus (Kellogg & Chapman, 1899)

5. *Ardeicola*
A. botauri (Osborn, 1896)
A. cruscula Carriker, 1960
A. expallida Blagoveschtchensky, 1940
A. florida nigra Tuff, 1967
A. goisagi Uchida, 1953
A. rhaphidus (Nitzsch, 1866)

6. *Bruelia*
B. angustifrons (Carriker, 1902)
B. argula (Burmeister, 1838)
B. audax (Kellogg, 1899)
B. bioccllata (Piaget, 1880)
B. brachythorax (Giebel, 1874)
B. cedrorum (Piaget, 1880)
B. deficiens (Piaget, 1885)
B. domestica (Kellogg & Chapman, 1899)
B. ductilis (Kellogg & Chapman, 1899)
B. iliaci brevicolor Ansari, 1956
B. interposita (Kellogg, 1899)
B. limbata (Burmeister, 1838)
B. longa (Kellogg, 1896)

B. longifrons Carriker, 1956
B. nebulosa (Burmeister, 1838)
B. ornatissima (Giebel, 1874)
B. peninsularis (Kellogg, 1899)
B. rotundata (Osborn, 1896)
B. straminea (Denny, 1842)
B. subtilis (Nitzsch, 1874)
B. tenuis (Burmeister, 1838)
B. xanthocephali (Osborn, 1896)
B. zeropunctata antiqua Ansari, 1956
B. zeropunctata zeropunctata Ansari, 1957

7. *Carduiceps*
C. cingulatus cingulatus (Denny, 1842)
C. cingulatus clayae Timmermann, 1954
C. zonarius (Nitzsch, 1866)

8. *Chelopistes*
C. meleagridis (Linnaeus, 1758)

9. *Cirrophthirus*
C. testudinarius (Children, 1836)

10. *Colinicola*
C. docophoroides (Piaget, 1880)

11. *Columbicola*
C. baculoides Paine, 1912
C. macrourae (Wilson, 1941)

12. *Craspedorrhynchus*
C. americanus Emerson, 1960
C. aquilinus (Denny, 1842)
C. dilatatus (Rudow, 1869)
C. haematopus (Scopoli, 1763)
C. hirsutus Carriker, 1956
C. subhaematopus Emerson, 1960

13. *Cuclogaster*
C. heterogrammicus (Nitzsch, 1866)

14. *Cuculicola*
C. splendidus (Kellogg, 1899)

15. *Cuculoecus*
C. coccygi (Osborn, 1895)

16. *Cummingsiella*
C. ambigua (Burmeister, 1838)
C. longirostricola (Wilson, 1937)

17. *Degeerriella*
D. discocephalus aquilarum Eichler, 1943
D. fulva (Giebel, 1874)
D. fusca (Denny, 1842)
D. nisus nisus (Giebel, 1866)
D. nisus vagans (Giebel, 1874)
D. regalis (Giebel, 1866)
D. rufa carruthi Emerson, 1953
D. rufa rufa (Burmeister, 1838)

18. *Falcolipeurus*
F. marginalis Osborn, 1902
F. suturalis (Rudow, 1869)

19. *Fulicoffula*
F. amercana Emerson, 1960
F. comstocki (Kellogg & Paine, 1911)
F. distincta Emerson, 1960
F. longipila (Kellogg, 1896)

20. *Goniocotes*
G. chrysocephalus Giebel, 1874
G. microthorax (Stephans, 1829)

21. *Goniodes*
G. bonasus Emerson, 1948
G. centrocerci Simon, 1938
G. colchici Denny, 1842
G. dispar Burmeister, 1838
G. merriamanus Packard, 1873
G. nebraskensis Carriker, 1945
G. stefani Clay & Hopkins, 1955
G. submamillatus Emerson, 1950

22. *Ibidoecus*
I. bisignatus (Nitzsch, 1866)

23. *Incidifrons*
I. monachus (Kellogg & Paine, 1911)
I. transpositus (Kellogg, 1896)

24. *Lagopoecus*
L. colchicus Emerson, 1949
L. gambeli Emerson, 1949
L. gibsoni Hopkins, 1947
L. obscurus Emerson, 1948
L. perplexus (Kellogg & Chapman, 1899)
L. umbellus Emerson, 1950

25. *Lipeurus*
L. maculosus Clay, 1938

26. *Lunaceps*
L. holophaeus cabenisi Timmermann, 1954
L. limosella clayae Timmermann, 1954
L. numenii (Denny, 1842)

27. *Mulcticola*
M. macrocephalus (Kellogg, 1896)

28. *Ornithobius*
O. goniopleurus Denny, 1842
O. waterstoni reconditus Timmermann, 1962

29. *Oxylipeurus*
O. corpulentus Clay, 1938
O. ellipticus (Keler, 1958)
O. mesopelios colchicus Clay, 1938
O. polytrapezius (Burmeister, 1838)

30. *Pectinopygus*
P. farallonii (Kellogg, 1896)
P. tordoffi, Elbel & Emerson, 1956

31. *Perenirmus*
P. arcticus Cariker, 1958
P. auritus (Scopoli, 1763)
P. gulosus (Nitzsch, 1866)
P. jungens (Kellogg, 1896)
P. mirinotatus (Kellogg & Chapman, 1899)
P. quadripustulatus (Kellogg & Mann, 1912)

32. *Philopterus*
P. agelaii (Osborn, 1896)
P. americanus (Kellogg, 1899)
P. citrinellae curvirostrae (Schrank, 1776)
P. corvi (Linnaeus, 1758)
P. excisus domesticus (Kellogg, 1896)
P. excisus major (Kellogg, 1896)
P. excisus microsomaticus Tandan, 1955
P. fringillae (Scopoli, 1772)
P. garrulae (Piaget, 1880)
P. hanzaki Balat, 1955
P. mirus (Kellogg & Chapman, 1899)
P. ocellatus osborni Edwards, 1952
P. phillipi Emerson, 1953
P. picae (Denny, 1842)
P. rufus (Kellogg, 1899)
P. rutteri (Kellogg, 1899)

33. *Physconelloides*
P. spenceri Emerson & Ward, 1958
P. wisemani Emerson, 1960
P. zenaidurae (McGregor, 1917)

34. *Picicola*
 P. foedus (Kellogg & Chapman, 1899)
 P. orpheus (Osborn, 1896)
 P. snodgrassi (Kellogg, 1896)

35. *Quadraceps*
 Q. alcyonae (Carriker, 1959)
 Q. assimilis major (Kellogg, 1899)
 Q. carrikeri Hopkins & Timmermann, 1954
 Q. connexus (Kellogg & Mann, 1912)
 Q. charadrii hospes (Nitzsch, 1866)
 Q. falcigerus (Peters, 1931)
 Q. fimbriatus (Giebel, 1866)
 Q. griseus (Rudow, 1869)
 Q. hemichrous (Nitzsch, 1866)
 Q. hiaticulae boephilus (Kellogg, 1896)
 Q nigrolimbatus (Mjoberg, 1910)
 Q. phaeonotus (Nitzsch, 1866)
 Q. punctatus sublingulatus Timmerman, 1952
 Q. ravus (Kellogg, 1899)
 Q. semifissus mexicanus Carriker, 1944
 Q. similis (Giebel, 1866)
 Q. zephyra (Timmermann, 1954)

36. *Rallicola*
 R. advenus (Kellogg, 1896)
 R. kelloggi Emerson, 1957
 R. mystax (Giebel, 1874)
 R. ortygometrae subporzanae Emerson, 1957

37. *Rhynonirmus*
 R. scolopacis (Denny, 1842)

38. *Rotundiceps*
 R. cordatus (Osborn, 1896)

39. *Saemundssonia*
 S. conica conica (Denny, 1842)
 S. conica naumanni (Giebel, 1874)
 S. kratochvili Balat, 1950
 S. lari congener (Giebel, 1874)
 S. lobaticeps (Giebel, 1874)
 S. parvigenitalis Ward, 1955
 S. platygaster nitzschi (Giebel, 1866)
 S. platygaster platygaster (Denny, 1842)
 S. scolopacisphaeopodis (Schrank, 1803)
 S. tricolor Carriker, 1956
 S. tringae (O. Fabricius, 1780)

40. *Strigiphilus*
 S. acutifrons Emerson, 1961
 S. aitkeni Clay, 1966
 S. barbatus (Osborn, 1902)
 S. cursor (Burmeister, 1838)
 S. oculatus (Rudow, 1870)
 S. otus Emerson, 1955
 S. speotyti (Osborn, 1896)

41. *Sturnidoecus*
 S. simplex (Kellogg, 1896)
 S. sturni (Schrank, 1776)

E. Ricinidae

1. *Ricinus*
 R. angulatus (Kellogg, 1896)
 R. arcuatus (Kellogg & Mann, 1912)
 R. bombycillae (Denny, 1842)
 R. diffusus (Kellogg, 1896)
 R. inexpectatus Balat, 1966
 R. japonicus (Uchida, 1915)
 R. medius Uchida, 1926
 R. merulae (Durrant, 1906)
 R. microcephalus (Kellogg, 1896)
 R. picturatus (Carriker, 1902)
 R. subhastatus (Durrant, 1906)
 R. sucinaceus (Kellogg, 1896)
 R. serratus (Durrant, 1906)

2. *Trochiloecetes*
 T. lineatus (Osborn, 1896)
 T. prominens (Kellogg & Chapman, 1899)
 T. ochoterenai (Zavaleta, 1943)

F. Trichodectidae

1. *Bovicola*
 B. bovis (Linnaeus, 1758)
 B. caprae (Gurlt, 1843)
 B. crassipes (Rudow, 1866)
 B. equi (Denny, 1842)
 B. limbatus (Gervais, 1844)
 B. ovis (Schrank, 1781)

2. *Eutrichophilus*
 E. setosus (Giebel, 1861)

3. *Felicola*
 F. subrostrata (Burmeister, 1838)

4. *Geomydoecus*
 G. californicus (Chapman, 1897)

5. *Neotrichodectes*
 N. osborni Keler, 1944

IX. Siphonaptera

A. Amphipsyllidae
 Amphisylla
 A. sibirica washingtoni Hubbard, 1954

B. Ceratophyllidae

1. *Amphalius*
 A. necopinus (Jordan, 1925)

2. *Ceratophyllus*
 C. affinis neglectus Smit, 1958
 C. celsus celsus Jordan, 1926
 C. garei Rothschild, 1902
 C. niger C. Fox, 1908
 C. petrochelidoni Wagner, 1936

3. *Dactylopsylla*
 D. (*Foxella*) *ignota apachina* (C. Fox, 1941)
 D. (*Foxella*) *ignota arizonensis* (Hubbard, 1947)
 D. (*Foxella*) *ignota comis* Jordan, 1929
 D. (*Foxella*) *ignota ignota* Baker, 1895
 D. (*Foxella*) *ignota recula* (Jordan and Rothschild, 1915)
 D. (*Foxella*) *ignota utahensis* (Wagner, 1931)
 D. (*Foxelloides*) *minidoka* Prince and Stark, 1951
 D. (*Spicata*) *rara* I. Fox, 1940

4. *Diamanus*
 D. montanus (Baker, 1895)

5. *Malaraeus*
 M. bitterrootensis (Dunn, 1923)
 M. euphorbi (Rothschild, 1905)
 M. sinomus (Jordan, 1925)
 M. telchinum (Rothschild, 1905)
 M. vonfintelis Prince, 1959

6. *Megabothris*
 M. abantis (Rothschild, 1905)

7. *Monopsyllus*
 M. ciliatus kincaidi Hubbard, 1947

M. cyrturus (Jordan, 1929)
M. eumolpi americanus Hubbard, 1950
M. eumolpi eumolpi (Rothschild, 1905)
M. exilis (Jordan, 1937)
M. vison (Baker, 1904)
M. wagneri (Baker, 1904)

8. *Nosopsyllus*
N. fasciatus (Bosc d'Antic, 1801)

9. *Opisocrostis*
O. hirsutus (Baker, 1895)
O. labis (Jordan and Rothschild, 1922)
O. tuberculatus cynomuris Jellison, 1939
O. tuberculatus tuberculatus (Baker, 1904)

10. *Opisodasys*
O. keeni keeni (Baker, 1896)
O. pseudarctomys (Baker, 1904)

11. *Orchopeas*
O. caedens caedens (Jordan, 1925)
O. howardii (Baker, 1895)
O. leucopus (Baker, 1904)
O. neotomae Auguston, 1943
O. nepos (Rothschild, 1905)
O. sexdentatus agilis (Rothschild, 1905)
O. sexdentatus nevadensis (Jordan, 1929)

12. *Oropsylla*
O. idahoensis (Baker, 1904)

13. *Thrassis*
T. acamantis medius Stark, 1970
T. acamantis utahensis (Wagner, 1936)
T. aridis campestris Prince, 1944
T. aridis hoffmani (Hubbard, 1949)
T. arizonensis (Baker, 1898)
T. bacchi bacchi (Rothschild, 1905)
T. bacchi caducus (Jordan, 1930)
T. bacchi consimilis Stark, 1957
T. bacchi gladiolis (Jordan, 1925)
T. francisi barnesi (Stark, 1970)
T. francisi francisi (C. Fox, 1927)
T. pandorae pandorae Jellison, 1937
T. stanfordi (Wagner, 1936)

C. *Hystrichopsyllidae*

1. *Anomiopsyllus*
A. amphibolus Wagner, 1936
A. nudatus (Baker, 1898)

2. *Atyphloceras*
A. echis echis Jordan and Rothschild, 1915
A. multidentatus multidentatus (C. Fox, 1909)

3. *Callistopsyllus*
C. terinus (Rothschild, 1905)

4. *Catallagia*
C. decipiens Rothschild, 1915
C. neweyi Holland and Loshbaugh, 1958

5. *Carteretta*
C. carteri clavata Good, 1942

6. *Conorhinopsylla*
C. standfordi Stewart, 1930

7. *Corrodopsylla*
C. curvata curvata (Rothschild, 1915)
C. curvata obtusata (Wagner, 1929)

8. *Ctenophthalmus*
C. pseudagyrtes pseudagyrtes (Baker, 1904)

9. *Delotelis*
D. telegoni Rothschild, 1905

10. *Epitedia*
E. scapani (Wagner, 1936)
E. stanfordi Traub, 1944
E. testor (Rothschild, 1915)
E. wenmanni wenmanni (Rothschild, 1904)

11. *Hystrichopsylla*
H. dippiei truncata Holland, 1957
H. linsdalei Holland, 1957

12. *Jordanopsylla*
J. allredi Traub and Tipton, 1951

13. *Megarthroglossus*
M. becki Tipton and Allred, 1951
M. divisus divisus (Baker, 1898)
M. procus Jordan and Rothschild, 1915
M. smiti Mendez, 1956

14. *Meringis*
M. dipodomys Kohls, 1938
M. hubbardi Kohls, 1938
M. jamesoni Hubbard, 1943
M. jewetti Hubbard, 1940
M. parkeri (Jordan, 1937)

15. *Nearctopsylla*
N. brooksi (Rothschild, 1904)
N. hyrtaci (Rothschild, 1904)

16. *Neopsylla*
N. inopina Rothschild, 1915

17. *Phalacropsylla*
P. allos Wagner, 1936

18. *Rhadinopsylla*
R. heiseri (McCoy, 1911)
R. sectilis goodi (Hubbard, 1941)
R. sectilis sectilis (Jordan and Rothschild, 1923)
R. fraterna (Baker, 1895)

19. *Stenistomera*
S. alpina (Baker, 1895)
S. hubbardi Egoscue, 1968
S. macrodactyla (Good, 1942)

D. Ischnopsyllidae

1. *Myodopsylla*
M. gentilis (Jordan and Rothschild, 1921)

2. *Sternopsylla*
S. distincta texana (C. Fox, 1914)

E. Leptosyllidae

1. *Ctenophyllus*
C. armatus terribilis (Rothschild, 1903)

2. *Odontopsyllus*
O. dentatus (Baker, 1904)

3. *Ornithophaga*
O. nearctica Holland and Loshbaugh, 1958

4. *Peromyscopsylla*
P. hamifer vigens (Jordan, 1937)
P. hesperomys adelpha (Rothschild, 1915)
P. hesperomys ravalliensis (Dunn, 1923)
P. selenis (Rothschild, 1906)

F. Pulicidae

1. *Cediopsylla*
C. inaequalis inaequalis (Baker, 1895)
C. interrupta Jordan, 1925

2. *Ctenocephalides*
   C. felis felis (Bouche, 1835)
3. *Echidnophaga*
   E. gallinacea (Westwood, 1875)
4. *Hoplopsyllus*
   H. (*Euhoplopsyllus*) *glacialis affinis* (Baker, 1895)
   H. (*Hoplopsyllus*) *anomalus* (Baker, 1904)
5. *Pulex*
   P. irritans Linnaeus, 1758
6. *Xenopsylla*
   X. cheopis (Rothschild, 1903)

G. Vermipsyllidae
   Chaetopsylla
   C. stewarti Johnson, 1955

BIBLIOGRAPHY

ACARINA

Allred, D. M. 1954a. Mites found on mice of the genus *Peromyscus* in Utah. Unpub. dissertation. Univ. of Utah, Salt Lake City, Utah. 163 p. + maps, graphs, and illustrations.

Allred, D. M. 1954b. Mites as intermediate hosts of tapeworms. Proc. Utah Acad. Sci., Arts and Letters 31:44-51.

Allred, D. M. 1954c. Observations on the stylosome (feeding tube) of some Utah chiggers. Proc. Utah Acad. Sci., Arts and Letters 32:61-63.

Allred, D. M. 1954d. Mites found on mice of the genus *Peromyscus* in Utah. I. General infestation. Great Basin Nat. 16:23-31.

Allred, D. M. 1957a. Notes on the life history and bionomics of the wood rat mite, *Brevisterna utahensis* (Acarina). Trans. Amer. Micro. Soc. 76:72-78.

Allred, D. M. 1957b. Mites found on mice of the genus *Peromyscus* in Utah. II. Family Haemogamasidae. Proc. Entomol. Soc. Wash. 59(1):31-39.

Allred, D. M. 1957c. Mites found on mice of the genus *Peromyscus* in Utah. III. Family Dermanyssidae. Amer. Midland Nat. 57:450-460.

Allred, D. M. 1957d. Mites found on mice of the genus *Peromyscus* in Utah. V. Trombiculidae and miscellaneous families. Great Basin Nat. 17:95-102.

Allred, D. M. 1957e. The male, deutonymph, and protonymph of the mite *Eubrachylaelaps circularis* (Ewing) (Acarina: Laelaptidae) with notes on morphological variations. Ann. Entomol. Soc. Amer. 50:206-209.

Allred, D. M. 1957f. A new species of mite, *Hirstionyssus bisetosus*, from the nests of the desert wood rat, *Neotoma lepida lepida* Thomas. Proc. Entomol. Soc. Wash. 59:83-89.

Allred, D. M. 1957g. Setal variations on mites of the species *Brevisterna utahensis* (Ewing) (Acarina). Proc. Utah Acad. Sci., Arts and Letters 34:51-54.

Allred, D. M. 1958. Mites found on mice of the genus *Peromyscus* in Utah. IV. Families Laelaptidae and Phytoseiidae. Pan-Pacific Entomol. 34:17-32.

Allred, D. M. 1961. Parasitic mites on marmots in Utah. J. Parasitol. 47:124.

Allred, D. M. 1965. Clarification of the type data for *Ischyropoda furmani* Keegan. J. Parasitol. 51:604.

Allred, D. M. 1966. Unusual records of mites in Utah. Great Basin Nat. 26:34.

Allred, D. M., and D E. Beck. 1953a. Mite fauna of wood rat nests in Utah. Proc. Utah Acad. Sci., Arts and Letters 30:53-56.

Allred, D. M., and D E. Beck. 1953b. A new species of *Acomatacarus* (Acarina, Trombiculidae) from Utah. Great Basin Nat. 13(3-4):87-90.

Allred, D. M., and D E. Beck. 1966. Mites of Utah mammals. Brigham Young Univ. Sci. Bull., Biol. Series 8(1):1-123.

Allred, D. M., and N. J. Marchett. 1957. Experimental feeding of the mite, *Brevisterna utahensis* (Acarina: Haemogamasidae). J. Parasitol. 43:51-54.

Allred, D. M., and E. J. Roscoe. 1956. Life history of the tick *Dermacentor parumapertus* in Utah. J. Parasitol. 42:516-522.

Allred, D. M., and E. J. Roscoe. 1957. Parasitic mites in desert wood rat nests, with notes on free living forms. Trans. Amer. Micro. Soc. 76:389-403.

Allred, D. M., D E. Beck, and L. D. White. 1960. Ticks of the genus *Ixodes* in Utah. Brigham Young Univ. Sci. Bull., Biol. Series 1(4):1-42.

Ash, D. B. 1963. A seasonal study of mites on deer mice (*Peromyscus maniculatus*) in a chaparral community. Unpub. master's thesis, Brigham Young Univ., Provo. Utah. 33 p.

Bacha, W. J., Jr. 1957. The life history of *Otobius lagophilus*. J. Parasitol. 43:560-565.

Beck, D E. 1955. Some unusual distributional records of ticks in Utah. J. Parasitol. 41:198-201.

Beck, D E., and D. M. Allred. 1955. Seasonal study of the tick *Ornithodoros hermsi*, found in the nest of the desert wood rat, *Neotoma lepida lepida* in Utah. Proc. Utah Acad. Sci., Arts and Letters (1954-1955), 32:131-135.

Bishopp, F. C. 1911. The distribution of the Rocky Mountain spotted fever tick. U. S. Dept. Agr. Bur. Ent. Circ. 136. 4 p.

Bishopp, F. C., and H. L. Trembly. 1945. Distribution and hosts of certain North American ticks. J. Parasitol. 31(1):1-54.

Brennan, J. M., and D E. Beck. 1955. The chiggers of Utah (Acarina: Trombiculidae). Great Basin Nat. 15(1-4):1-21.

Brinton, E. P. 1965. Identification of the adults, nymphs, and larvae of ticks of the genus *Dermacentor* Koch (Ixodidae) in the western United States. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 63 p.

Brinton, E. P., and D E. Beck. 1963a. Hard-bodied ticks of the western United States. Brigham Young Univ. Sci. Bull. Biol. Series 2(3) part 1:1-28.

Brinton, E. P., and D E. Beck. 1963b. Hard-bodied ticks of the western United States. Brigham Young Univ. Sci. Bull., Biol. Series 2(3) parts 2 and 3:1-21.

Brinton, E. P., and G. M. Kohls. 1963. New distributional and host data for the tick *Dermacentor hunteri* Bishopp. Great Basin Nat. 23:166.

Brinton, E. P., D E. Beck, and D. M. Allred. 1965. Identification of the adults, nymphs, and larvae of the genus *Dermacentor* Koch (Ixodidae) in the western United States. Brigham Young Univ. Sci. Bull., Biol. Series 5(4):1-44.

Brown, J. H. 1945. The rabbit tick, *Haemaphysalis leporis-palustris* Packard, as an ectoparasite of man. Can. Entomol. 77:176.

Cooley, R. A. 1938. The genera *Dermacentor* and *Otocentor* (Ixodidae) in the United States with studies in variation. Nat. Inst. Health Bull. 171. 89 p.

Cooley, R. A. 1945. The genera *Boophilus, Rhipicephalis*, and *Haemaphysalis* (Ixodidae) of the New World. Nat. Inst. Health Bull. 187. 54 p.

Cooley, R. A., and G. M. Kohls. 1944. The Argasidae of North America, Central America, and Cuba. Amer. Mid. Nat. Mono. 1. 151 p.

Cooley, R. A., and G. M. Kohls. 1945. The genus *Ixodes* in North America. Nat. Inst. Health Bull. 184. 246 p.

Davis, G. E. 1939. *Ornithodoros parkerii* Distribution and host data: spontaneous infection with relapsing fever spirochetes. Public Health Rpts. 54:345-349.

Despain, W. J. 1968. Elevational occurrence of the ticks *Dermacentor andersoni* and *Dermacentor parumapertus* in Utah County, Utah. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 36 p.

Edmunds, L. R. 1951. A checklist of the ticks of Utah. Pan-Pacific Entomol. 27:23-26.

Elzinga, R. J., and D. M. Rees. 1964. Ability of immature ticks of *Ixodes kingi* and *Dermacentor parumapertus* to survive low temperatures. Proc. Utah Acad. Sci., Arts and Letters 41:213-216.

Fremling, C., and A. Gastfriend. 1955. Seasonal abundance of the tick *Dermacentor parumapertus*. Ecology 36:162-163.

Furman, D. P., and V. J. Tipton. 1955. The genus *Myonyssus* Tiraboschi (Acarina: Dermanyssidae) including a new species from pika. J. Parasitol. 41:179-184.

Bastfriend, A. 1955. New host records for immature stages of the tick *Dermacentor parumapertus*. J. Parasitol. 41:63-65.

Herrin, C. S. 1970. A systematic revision of the genus *Hirstionyssus* (Acari: Mesostigmata) of the Nearctic region. J. Med. Entomol. 7:391-437.

Herrin, C. S., and D E. Beck. 1965. Observations on the biology, anatomy, and morphology of *Otobius lagophilus* Cooley and Kohls. Brigham Young Univ. Sci. Bull., Biol. Series 6(2):1-19.

Higgans, H. G., and T. A. Wooley. 1962. A new species of *Passolozetes* from Utah with notes on the genus (Acarina: Oribatidei). Great Basin Nat. 22:93-96.

Hooker, W. A. 1909. Geographical distribution of American ticks. J. Econ. Entomol. 2:403-428.

Howell, J. F., D. M. Allred, and D E. Beck. 1957 Seasonal population fluctuations of mites in desert wood rat nests in central Utah. Ecology 38:82-88.

Howell, J. F., and R. J. Elzinga. 1962. A new *Radfordia* (Acarina: Myobiidae) from the kangaroo rat and a key to the known species. Ann. Entomol. Soc. Amer. 55:547-555.

Johnson, E. D. 1966. Ticks of the Dugway Proving Grounds and vicinity and their host associations. Proc. Utah Acad. Sci., Arts and Letters 43:49-66.

Jorgensen, C. D. 1957a. Oviposition habits of the tick *Dermacentor parumapertus* Neumann and factors influencing egg development. Great Basin Nat. 17:42-51.

Jorgensen, C. D. 1957b. The Ord kangaroo rat and its physical resistance to the tick *Dermacentor parumapertus* Neumann. Proc. Utah Acad. Sci., Arts and Letters 34:183-184 (Abstract).

Keegan, H. L. 1953. Collections of parasitic mites from Utah. Great Basin Nat. 13:35-42.

Kohls, G. M. 1952. A record of the occurrence of the tick *Ixodes muris* Bishopp and Smith on muskrats in Utah. Great Basin Nat. 12:65-66.

Kohls, G. M., and C. M. Clifford. 1963. *Ornithodoros sparnus* n. sp., a parasite of wood rats, *Neotoma* spp. and deer mice, *Peromyscus* spp. in Utah and Arizona (Acarina: Argasidae). J. Parasitol. 49:857-861.

Kohls, G. M., and C. M. Clifford. 1968. The subgenus *Persicargas* (Ixodoidea, Argasidae, *Argas*). 6. *A.* (*P.*) *giganteus*, n. sp., from wild birds in western United States and Sonora, Mexico. Ann. Entomol. Soc. Amer. 61:1113-1116.

Kohls, G. M., and H. Hoogstraal. 1960. Observations on the subgenus *Argas* (Ixodoidea, Argasidae, *Argas*). 2. *A. cooleyi*, new species, from western North American birds. Ann. Entomol. Soc. Amer. 53:625-631.

Kohls, G. M., and R. R. Parker. 1948. Occurrence of the brown dog tick in the western states. J. Econ. Entomol. 41:102.

Kohls, G. M., H. Hoogstraal, C. M. Clifford, and M. N. Kaiser. 1970. The subgenus *Persicargas* (Ixodoidea, Argasidae, *Argas*). 9. Redescription and new world records of *Argas* (*P.*) *persicus* (Oken), and resurrection, redescription, and records of *A.* (*P.*) *radiatus* Railliet, *A.* (*P.*) *sanchezi* Duges, and *A.* (*P.*) *miniatus* Koch, new world ticks misidentified as *A.* (*P.*) *persicus*. Ann. Entomol. Soc. Amer. 63:590-606.

Merino, J. M. 1967. Ticks of the genus *Haemaphysalis* in the western U. S. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 116 p.

Parker, R. R., C. B. Philip, G. E. Davis, and R. A. Cooley. 1937. Ticks of the United States in relation to disease in man. J. Econ. Entomol. 30: 51-69.

Radovsky, F. J. 1967. The Macronyssidae and Laelapidae (Acarina: Mesostigmata) parasitic on bats. Univ. Calif., Pub. Entomol. 46:1-288. 48 pls.

Robertson, R. G. 1961. A morphological study of some larval ticks of the genus *Dermacentor* with emphasis on structures of possible taxonomic importance. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 30 p.

Rosasco, M. E. 1957. Seasonal abundance of the tick, *Dermacentor parumapertus*, on black-tailed jackrabbit, with notes on other ectoparasites. J. Mammal. 38:485-490.

Talley, G. M. 1957. The incidence of nasal mites in over-wintering red-wing blackbirds in the vicinity of Utah Lake, Utah. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 13 p.

White, L. D. 1959. Identification of larval ticks of the genus *Ixodes* known to occur in Utah. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 64 p.

ANOPLURA

Bell, I. L. 1950. A study of sucking lice (Anoplura) on rodents in Utah. Unpub. master's thesis, Univ. of Utah, Salt Lake City, Utah. 55 p.

EMERSON, K. C. 1970. Personal communication.

IGNOFFO, C. M. 1956. Notes on louse-host associations of the Great Salt Lake Desert with keys to the lice. Great Basin Nat. 16(1-4):9-17.

IGNOFFO, C. M. 1957. New records of mammal-lice associations. Entomol. News 68:162.

JOHNSON, P. T. 1971. Personal communication.

ARANEIDA

CHAMBERLIN, R. V. 1928. Notes on spiders from the La Sal Mountains of Utah. Can. Entomol. 60: 93-95.

CHAMBERLIN, R. V., AND W. IVIE. 1933. Spiders of the Raft River Mountains of Utah. Bull. Univ. Utah 23(4):1-53.

CHAMBERLIN, R. V., AND W. IVIE. 1935. The black widow spider and its varieties in the United States. Bull. Univ. Utah Biol. Ser. 3(1):1-29.

GERTSCH, W. J. 1958. The spider genus *Loxosceles* in North America, Central America, and the West Indies. Amer. Mus. Nov. 1977:1-46.

GERTSCH, W. J. 1970. Personal communication.

LAFFERTY, K. M. 1949. A preliminary study of the spiders of Red Butte Canyon. Unpub. master's thesis, Univ. of Utah, Salt Lake City, Utah. 152 p.

LEVI, H. W. 1959. The spider genus *Latrodectus* (Araneae: Thaeridiidae). Trans. Amer. Micro. Soc. 78:7-43.

LEVI, H. W., AND A. SPIELMAN. 1964. The biology and control of the South American brown spider, *Loxosceles laeta* (Nicolet), in a North American focus. Amer. J. Trop. Med. Hyg. 13:132-136.

COLEOPTERA

ARNET, R. H., JR. 1960. The beetles of the United States. Cath. Univ. Press, Washington, D. C. 1112 p.

GOULD, D. J., AND R. S. BEAL, JR. 1952. New records of *Leptinus testaceus* from North America. Pan-Pacific Entomol. 28:193.

PARKS, J. J., AND J. W. BARNES. 1955. Notes on the family Leptinidae including a new record of *Leptinillus validus* (Horn) in North America (Coleoptera). Ann. Entomol. Soc. Amer. 48:417-421.

SELANDER, R. B. 1951. The blister beetles (Meloidae) of Utah. Unpub. master's thesis, Univ. of Utah, Salt Lake City. Utah. 140 p.

SELANDER, R. B. 1970. Personal communication.

WERNER, F. G., AND R. L. EDWARDS. 1948. *Leptinus americanus* Lec. taken on a shrew (Coleoptera-Leptinidae), Psyche 55 (2):51-54.

WERNER, F. G., W. B. ENNS, AND F. H. PARKER. 1966. The Meloidae of Arizona. Univ. of Arizona Agr. Expt. Sta. Tech. Bull. 175. 96 p.

WOOD, D. M. 1965. Studies on the beetles *Leptinillus validus* (Horn) and *Platypsyllus castoris* Ritsema from beaver. Proc. Entomol. Soc. Ontario 95:33-63.

DIPTERA

ALDRICH, J. M. 1905. A catalogue of North American Diptera. Smithsonian Misc. Collection 46:195-209.

ARNELL, J. H. 1968. The taxonomy, distribution, and biology of the *Aedes varipalpis* mosquito complex in Utah. Unpub. master's thesis, Univ. of Utah, Salt Lake City. Utah. 73 p.

ARNELL, J. H., AND L. T. NIELSEN. 1967. Notes on the distribution and biology of tree hole mosquitoes in Utah. Proc. Utah Mosq. Abate. Assoc. 20:28-29.

ARNOLD, F. D. 1966. An evaluation of the housefly problem in the major populated counties in Utah. Unpub. Ph.D. dissertation, Univ. of Utah, Salt Lake City, Utah. 81 p.

BAIRD, C. R. 1970. Laboratory studies of two species of jackrabbit bot flies. Unpub. master's thesis, Utah State Univ., Logan, Utah. 40 p.

BAIRD, C. R., AND K. J. CAPELLE. 1969. Successful laboratory mating of two species of jackrabbit bot flies. J. Med. Entomol. 6:196.

BEADLE, L. D. 1955. Man-biting habits of *Culex* tarsalis and associated mosquitoes in northern Utah. Proc. Utah Mosq. Abate. Assoc. 8:3.

BEADLE, L. D. 1959. Field observations on the biting habits of *Culex tarsalis* at Mitchell, Nebraska, and Logan, Utah. Amer. J. Trop. Med. Hyg. 8:134-140.

BECK, D E. 1960. Mosquito survey of central Utah Valley, Utah. Proc. Utah Mosq. Abate. Assoc. 13: 18-23.

BECK, D E. 1961. Central Utah County, Utah, mosquito survey studies. Mosq. News 21:6-11.

BENNETT, G. F., AND C. W. SABROSKY. 1962. The Nearctic species of the genus *Cephenemyia* (Diptera, Oestridae). Can. Zool. 40:431-448.

BEQUAERT, J. C. 1954-1957. The Hippoboscidae or louse-flies (Diptera) of mammals and birds. Part II. Taxonomy, evolution and revision of American genera and species. Entomol. Amer. 24-26:1-611.

BULLOCK, H. R. 1952. Culicoid gnats of Salt Lake County. Unpub. master's thesis, Univ. of Utah, Salt Lake City, Utah. 69 p.

CAPELLE, K. J. 1968. Seasonal incidence and species composition of blowflies at Bear River, Utah. 1963-1965. Paper presented at Entomol. Soc. Amer. Meetings, Dallas, Texas, Dec. 2, 1968. Unpublished.

CAPELLE, K. J. 1970. Studies on the life history and development of *Cuterebra polita* (Diptera: Cuterbridae) in four species of rodents. J. Med. Entomol. 7:320-327.

CAPELLE, K. J. 1970. Personal communication.

CARPENTER, M. J. 1965. A study of ovarian cycles and longevity in univoltine and multivoltine species of Rocky Mountain *Aedes* mosquitoes. Unpub. master's thesis, Univ. of Utah. Salt Lake City, Utah. 53 p.

COLLETT, G. C., AND D. M. REES. 1957. A comparison of mosquito collections made with portable (CO2) bait traps and New Jersey type light traps. Proc. Utah Mosq. Abate. Assoc. 10:6-7.

COLLETT, G. C., AND D. M. REES. 1959. Mosquito abatement programs in Utah in 1958. Proc. 46th Ann. Meeting New Jersey Mosq. Exterm. Assoc. p. 61-63.

COLLETT, G. C., AND D. M. REES. 1961. Recent changes in *Aedes nigromaculis* (Ludlow) populations in the Salt Lake City Mosquito Abatement District. Proc. and Papers 29th Ann. Conf. Calif. Mosq. Control Assoc. p. 115.

DEFOLIART, G. R., AND B. V. PETERSON. 1960. New North American Simuliidae of the genus *Cnephia* Enderlein (Diptera), Ann. Entomol. Soc. Amer. 53:213-219.

ELBEL, R. E., G. T. CRANE, L. E. STIPE, G. B. VAN NOSDOL, AND K. L. SMART. 1969. Mosquitoes and arboviruses from Callo, Utah, for the years 1966 and 1967 (Abstract). Proc. Utah Mosq. Abate. Assoc. 22:39.

Graham, C. L. 1962. *Cuterbra* of Utah and neighboring states. Unpub. master's thesis, Utah State Univ., Logan, Utah. 35 p.

Graham, C. L. 1964. Biological studies of three species of *Cutebra* from northern Utah. Unpub. Ph.D. dissertation, Utah State Univ., Logan, Utah. 82 p.

Graham, J. E. 1950. A preliminary study of the gnats or midges of the tribe Tendipedini in northern Utah. Unpub. master's thesis, Univ. of Utah, Salt Lake City, Utah. 48 p.

Graham, J. E. 1957. The need for a professional basis for pest control work in Utah. Proc. Utah Acad. Sci., Arts and Letters 34:31-33.

Graham, J. E., and D. M. Rees. 1955. Granular insecticide carriers used in Utah in Mosquito abatement operations. Proc. and Papers 23rd Ann. Conf. Calif. Mosq. Control Assoc. p. 106-108.

Graham, J. E., and D. M. Rees. 1956. Progress report on the field testing in Utah of some organic phosphorus insecticides for mosquito control. Proc. Utah Mosq. Abate. Assoc. 9:23-25.

Graham, J. E., and D. M. Rees. 1958. Chemical control of mosquitoes in Utah. Proc. and Papers 26th Ann. Conf. Calif. Mosq. Control Assoc. p. 16-19.

Graham, J. E., D. M. Rees, and G. F. Edmunds. 1953. A season of mosquito control with heptachlor. Proc. and Papers 22nd Ann. Conf. Calif. Mosq. Control Assoc. p. 21.

Graham, J. E., D. M. Rees, and L. T. Nielsen. 1958. Trends in mosquito populations in Salt Lake County. Mosq. News 18:98-100.

Graham, J. E., and I. E. Bradley. 1962a. The effects of species on density of mosquito larval populations in Salt Lake County Utah. Mosq. News 22:239-247.

Graham, J. E. and I. E. Bradley. 1962b. An evaluation of some techniques used to measure mosquito populations. Utah Acad. Sci., Arts and Letters 39:77-83.

Grundmann, A. W. 1949. Mosquitoes as pests and vectors of disease in Utah. Proc. Utah Mosq. Abate. Assoc. 2:58-63.

Grundmann, A. W., and J. M. Butler. 1953. Dipterous larvae infesting the intestinal tract of the coyote, *Canis latrans* Say 1823. J. Kansas Entomol. Soc. 26:129-131.

Grundmann, A. W., and J. R. Crook. 1959. Endoparasites of rodents found in Glen Canyon. Univ. Utah Anthropol. Papers No. 40:105-106.

Harmstron, F. C., and A. D. Hess. 1964. Mosquitoes as actual and potential vectors of disease as now known for Utah. Proc. Utah Mosq. Abate. Assoc. 17:25-27.

Hopla, C. E. 1947. A taxonomic study of the adult mosquitoes of Utah County, with notes on the biology and distribution of the more common species. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 97 p.

Ignoffo, C. M. 1961. Biology of *Cuterebra jellisoni* on *Lepus californicus deserticola*. Ann. Entomol. Soc. Amer. 54:509-512.

James, M. T. 1948. The flies that cause myiasis in man. U. S. Dept. Agr. Publ. 631. 175 p. (1947).

Jobling, B. 1938. A revision of the genus *Trichobius* Diptera, Acalypterae, Streblidae). Parasitology 30:358-587.

Jones, D. T. 1941-1943. Utah house flies. Proc. Utah Acad. Sci., Arts and Letters 18-20:105-108.

Knowlton, G. F. 1931. Notes on Utah Diptera. Can. Entomol. 63:152-157.

Knowlton, G. F. 1936. Some Utah flesh flies. Proc. Utah Acad. Sci., Arts and Letters 13:237-239.

Knowlton, G. F., and L. E. Fronk. 1950. Some blood-sucking Diptera of Utah. Utah Agr. Expt. Sta. Mimeo. Ser. 369.

Knowlton, G. F., and F. C. Harmston. 1937. Utah Diptera. Proc. Utah Acad. Sci., Arts and Letters 14:141-149.

Knowlton, G. F., and D. E. Madsen. 1935a. The sheep "tick." Utah Agr. Expt. Sta. Leaflet 67.

Knowlton, G. F., and D. E. Madsen. 1935b. Mosquitoes annoy sheep. J. Econ. Entomol. 28:934-935.

Knowlton, G. F., and D. R. Maddock. 1944. Snipe flies in Utah. J. Econ. Entomol. 37:119.

Knowlton, G. F., and J. A. Rowe. 1934. New blood-sucking flies from Utah (Simuliidae, Diptera). Ann. Entomol. Soc. Amer. 27:580-584.

Knowlton, G. F., and T. O. Thatcher. 1934. Utah horseflies. Proc. Utah Acad. Sci., Arts and Letters 11:291-294.

Knowlton, G. F., F. C. Harmston, and D. E. Harding. 1938. Blood-sucking Utah Diptera. Proc. Utah Acad. Sci., Arts and Letters, 15:103-105.

Knowlton, G. F., F. C. Harmston, and G. S. Stains. 1939. Insects of Utah, Diptera. Utah Agr. Expt. Sta. Mono. Ser. 200 (Tech) part 5. 22 p.

Knowlton, G. F., M. J. Janes, and W. L. Thomas. 1933. Some Utah Diptera. Proc. Utah Acad. Sci., Arts and Letters 10:155-157.

Knudsen, A. B., and D. M. Rees. 1967. The emergence of *Chrysops discalis* Williston on the shore of the Great Salt Lake, Utah. Proc. Utah Mosq. Abate. Assoc. 20:29-33.

Lewis, W. 1949. The taxonomy and notes on bionomics and control of the Tabanidae of Salt Lake County, Utah. Unpub. master's thesis, Univ. of Utah, Salt Lake City. Utah. 81 p.

Linam, J. H. 1961. A mosquito survey of Skull Valley, Tooele County, Utah. Proc. Utah Mosq. Abate. Assoc. 14:26-27.

Linam, J. H., and L. T. Nielsen. 1962. Notes on the taxonomic separation of adult females of *Culex pipiens* L. and *Culex quinquefasciatus* Say. Mosq. News 22:290-293.

Linam, J. H., and L. T. Nielsen. 1963a. Utah mosquitoes—their published history. Proc. Utah Mosq. Abate. Assoc. 16:16-23.

Linam, J. H., and L. T. Nielsen. 1963b. Notes on the identification of some western *Culex* larvae. Proc. 50th Ann. Meeting New Jersey Mosq. Exterm. Assoc. p. 411-415.

Linam, J. H., and L. T. Nielsen. 1964. Utah mosquitoes—their published history. Supplement 1. Proc. Utah Mosq. Abate. Assoc. 17:22-23.

Linam, J. H., and L. T. Nielsen. 1966. Notes on the distribution, ecology, and overwintering habits of *Culex pipiens* Adams in Utah. Proc. Entomol. Soc. Wash. 68(2):136-138.

Marlor, R. L., and D. M. Rees. 1957. The influence of climatological factors on the biting activities of the mosquito *Aedes dorsalis* (Meigen). Proc. Utah Mosq. Abate. Assoc. 10:19-22.

Mukherjee, A. B. 1964. A comparative study of the karyotypes of four genera and nineteen species of mosquitoes present in Utah. Unpub. master's thesis, Univ. of Utah, Salt Lake City, Utah. 52 p.

Neilsen, L. T. 1957. Notes on the flight ranges of Rocky Mountain mosquitoes of the genus *Aedes*. Proc. Utah Acad. Sci., Arts and Letters 34:27-29.

Nielsen, L. T. 1958. Control of snow mosquitoes in the mountains of Utah. Proc. Utah Mosq. Abate. Assoc. 11:33-34.

Nielsen, L. T. 1959a. The mosquitoes of Utah—a revised list. Mosq. News 19:45-47.

Nielsen, L. T. 1959b. Seasonal distribution and longevity of Rocky Mountain snow mosquitoes of the genus *Aedes*. Proc. Utah Acad. Sci., Arts and Letters 36:83-87.

Neilsen L. T. 1962. The Utah Mosquito Abatement Association—a brief history of mosquito control in Utah. Proc. Utah Mosq. Abate. Assoc. 15: 12-15.

Nielsen, L. T. 1968. A current list of mosquitoes known to occur in Utah with report of new records. Proc. Utah Mosq. Abate. Assoc. 21:34-37.

Nielsen, L. T., and J. H. Linam. 1963. New distributional records of the mosquitoes of Utah. Proc. Utah Acad. Sci., Arts and Letters 40:193-196.

Nielsen, L. T., and J. H. Linam. 1964. Additional distribution records for Utah mosquitoes with notes on biology. Proc. Utah Mosq. Abate. Assoc. 17:29-31.

Nielsen, L. T., and J. H. Linam. 1966. Utah mosquitoes—their published history: Supplement II. Proc. Utah Mosq. Abate. Assoc. 19:21-23.

Nielsen, L. T., and D. M. Rees. 1961. An identification guide to the mosquitoes of Utah. Bull. Univ. Utah Biol. Series 12(3):1-58.

Nielsen, L. T., J. H. Arnell, and J. H. Linam. 1967. A report on the distribution and biology of treehole mosquitoes in the western United States. Proc. 35th Ann. Conf. Calif. Mosq. Cont. Assoc., Inc., and Amer. Mosq. Cont. Assoc. p. 72-76.

Nielsen, L. T., J. H. Linam, and D. M. Rees. 1963. New distributional records for mosquitoes in the Rocky Mountain States. Proc. 50th Ann. Meeting New Jersey Mosq. Exterm. Assoc. p. 424-428.

Nielsen, L. T., J. H. Linam, J. H. Arnell, and T. J. Zavortink. 1968. Distributional and biological notes on the treehole mosquitoes of the western United States. Mosq. News 28:361-365.

Ogden, L. J., and J. W. Kilpatrick. 1958. Control of *Fannia canicularis* (L.) in Utah dairy barns. J. Econ. Ent. 51:611-612.

Peterson, B. V. 1953. The black flies (Diptera: Simuliidae) in the canyons in the vicinity of Salt Lake City with notes on their biology. Unpub. master's thesis, Univ. of Utah, Salt Lake City, Utah. 67 p.

Peterson, B. V. 1955. A preliminary list of the black flies (Diptera: Simuliidae) of Utah. Proc. Utah Acad. Sci., Arts and Letters 32:113-115.

Peterson, B. V. 1956. Observations on the biology of Utah black flies (Diptera: Simuliidae). Can. Entomol. 88:496-507.

Peterson, B. V. 1958a. The taxonomy and biology of Utah species of black flies (Diptera: Simuliidae). Unpub. Ph.D. dissertation, Univ. of Utah, Salt Lake City, Utah. 336 p.

Peterson, B. V. 1958b. A redescription of the female and first description of the male, pupa, and larva of *Prosimulium flaviantennus* (S. and K.) with notes on the biology and distribution. Can. Entomol. 90:469-473.

Peterson, B. V. 1959a. New distributional and host records for bat flies and a key to the North American species of *Basilia* Ribeiro (Diptera: Nycteribiidae). Proc. Entomol. Soc. Ontario 90:30-37.

Peterson, B. V. 1959b. Three new black fly records from Utah (Diptera: Simuliidae). Proc. Entomol. Soc. Wash. 61:21.

Peterson, B. V. 1959c. Notes on the biology of some species of Utah black flies (Diptera: Simuliidae). Mosq. News 19:86-90.

Peterson, B. V. 1959d. Observations on mating, feeding, and oviposition of some Utah species of black flies (Diptera: Simuliidae). Can. Entomol. 91:147-155.

Peterson, B. V. 1960a. Notes on some natural enemies of Utah black flies (Diptera: Simuliidae). Can. Entomol. 92:266-274.

Peterson, B. V. 1960b. The Simuliidae (Diptera) of Utah, Part I. Keys, original citations, types and distribution. Great Basin Nat. 20:81-104.

Peterson, B. V. 1970a. The *Prosimulium* of Canada and Alaska (Diptera: Simuliidae). Mem. Entomol. Soc. Can. No. 69:1-216.

Peterson, B. V. 1970b. The identities of three closely related western species of *Prosimulium* (Diptera: Simuliidae). Can. Entomol. 102:118-128.

Peterson, B. V., and G. R. DeFoliart. 1960. Four new species of *Prosimulium* (Diptera: Simuliidae) from western United States. Can. Entomol. 92: 85-102.

Rees, D. M. 1934a. Mosquito records from Utah. Pan-Pacific Entomol. 10:161-165.

Rees, D. M. 1934b. Notes on mosquito fish in Utah, *Gambusia affinis* (Baird and Girard). Copeia 1934 (4):157-159.

Rees, D. M. 1935. Observations on a mosquito flight in Salt Lake City. Bull. Univ. Utah 25(5), Biol. Series 2(6):106.

Rees, D. M. 1939a. Origin of mosquito producing waters in the vicinity of Salt Lake City, Utah. Bull. Univ. Utah 29(5), Biol. Series 3(9):1-13.

Rees, D. M. 1939b. Progress in mosquito control in the vicinity of Salt Lake City. Proc. 26th Ann. Meeting New Jersey Mosq. Exterm. Assoc. 155-160.

Rees, D. M. 1942a. The mosquitoes of Utah. Bull. Univ. Utah Biol. Series 33(7):1-99.

Rees, D. M. 1942b. Supplementary list of mosquitoes from Utah. Pan-Pacific Entomol. 18:77-82.

Rees D. M. 1944. A new mosquito record from Utah (Diptera: Culicidae). Pan-Pacific Entomol. 20:19.

Rees, D. M. 1945a. The utilization of fish by a mosquito abatement district; their effectiveness and limitation. Proc. 32nd Ann. Meeting New Jersey Mosq. Exterm. Assoc. p. 211-216.

Rees, D. M. 1945b. Supplemental notes on mosquito fish in Utah, *Gambusia affinis* (Baird and Girard). Copeia 1945(4):236.

Rees, D. M. 1949. Advances in mosquito work in Utah in 1948. Proc. 36th Ann. Meeting New Jersey Mosq. Exterm. Assoc. p. 58-59.

Rees, D. M. 1952. The effectiveness of mosquito control in Salt Lake City, Utah, as determined by light trap collections. Proc. 39th Ann. Meeting New Jersey Mosq. Exterm. Assoc. p. 105-109.

Rees, D. M. 1954. The *Aedes nigromaculis* mosquito situation in Utah. Proc. Utah Mosq. Abate. Assoc. 7:23-24.

Rees, D. M. 1955. Recent advances in mosquito control in the Rocky Mountain region. Proc. and Papers 23rd Ann. Conf. Calif. Mosq. Control Assoc. and 11th Ann. Meeting Amer. Mosq. Control Assoc. p. 6-9.

Rees, D. M. 1957. Cooperative measures applied in mosquito abatement in Utah during 1956. Proc. and Papers 25th Ann. Conf. Calif. Mosq. Control Assoc. p. 15-17.

Rees, D. M. 1958. Report on the results of control methods applied to biting gnats in the vicinity of Salt Lake City, Utah, (Diptera: Ceratopogonidae). Proc. 10th Intern. Congr. Entomol. 3:741-744.

Rees, D. M. 1964. Mosquitoes—importance in Utah. Utah Water News 12(3):14.

Rees, D. M., and F. D. Arnold. 1953. An outbreak of blowflies in Salt Lake County in 1962. Proc. Utah Acad. Sci., Arts and Letters 30:60-62.

Rees, D. M., and H. R. Bullock. 1954. Culicoid gnats of Salt Lake County, Utah (Diptera: Ceratopogonidae (=Heleidae)). Proc. Utah Acad. Sci., Arts and Letters 31:42-43.

Rees, D. M., and G. C. Collett. 1954. The biology of *Aedes niphadopsis* Dyar and Knab (Diptera: Culicidae). Proc. Entomol. Soc. Wash. 56:207-214.

Rees, D. M., and G. C. Collett. 1955. An air-propelled boat used in mosquito abatement work in Utah. Mosq. News 15:193-195.

Rees, D. M., and G. C. Collett. 1956. Mosquito abatement activities in Utah during 1955. Proc. and Papers 24th Ann. Conf. Calif. Mosq. Control Assoc. p. 6-8.

Rees, D. M., and G. C. Collett. 1959. Factors influencing the encephalitis outbreak in Utah in 1958. Proc. and Papers 27th Ann. Conf. Calif. Mosq. Control Assoc. p. 88-97.

Rees, D. M., and J. E. Graham. 1953. 1952 field tests of heptachlor for mosquito control. Proc. and Papers 21st Ann. Conf. Calif. Mosq. Control Assoc. p. 4-6.

Rees, D. M., and F. C. Harmston. 1946. Observations on the habits of *Anopheles freeborni* in northern Utah and southern Idaho (Diptera: Culicidae). Mosq. News 6:73-75.

Rees, D. M., and L. T. Nielsen. 1947. On the biology and control of *Aedes dorsalis* (Meig.) in Utah. Proc. 34th Ann. Meeting New Jersey Mosq. Exterm. Assoc. p. 160-165.

Rees, D. M., and L. T. Nielsen. 1951. Four new mosquito records from Utah. Pan-Pacific Entomol. 27:11-12.

Rees, D. M., and L. T. Nielsen. 1955. Additional mosquito records from Utah. Pan-Pacific Entomol. 31:31-33.

Rees, D. M., and K. Onishi. 1951. Morphology of the terminalia and internal reproductive organs, and copulation in the mosquito, *Culiseta inornata* (Williston) (Diptera: Culicidae). Proc. Entomol. Soc. Wash. 53:233-246.

Rees, D. M., and B. V. Peterson. 1953. The black flies (Diptera: Simuliidae) in the canyons near Salt Lake City, Utah. Proc. Utah Acad. Sci., Arts and Letters 30:57-59.

Rees, D. M., and J. V. Smith. 1950. Effective control methods used on biting gnats in Utah during 1949 (Diptera: Ceratopogonidae). Mosq. News 10:9-15.

Rees D. M., and J. V. Smith. 1952. Control of biting gnats in North Salt Lake City, Utah, (Diptera: Heleidae). Mosq. News 12:49-52.

Rees, D. M., G. C. Collett, and R. N. Winget. 1969. The *Leptoconops* problem in Utah. Proc. Utah Mosq. Abate. Assoc. 22:16-18.

Rees, D. M., G. F. Edmunds, and L. T. Nielsen. 1953. Additional uses of granular larvicides in mosquito abatement. Proc. and Papers 22nd Ann. Conf. Calif. Mosq. Control Assoc. p. 20-21.

Richards, C. S., L. T. Nielsen, and D. M. Rees. 1956. Mosquito records from the Great Basin and the drainage of the lower Colorado River. Mosq. News 16:10-17.

Richens, V. B. 1965. Larvae of bot flies in the northern pocket gopher. J. Mammal. 46:689-690.

Rowe, J. A. 1953. Mosquitoes and health. Proc. Utah Mosq. Abate. Assoc. 6:12-14 (Mimeo).

Rowe, J. A., and G. F. Knowlton. 1935. The genus *Tabanus* in Utah. Can. Entomol. 67:238-244.

Rowe, J. A., and G. F. Knowlton. 1936. Pangoniinae of Utah (Tabanidae: Diptera). Ohio J. Sci. 36:253-259.

Sabrosky, C. W. 1941. The *Hippelates* flies or eye gnats: Preliminary notes. Can. Entomol. 73:23-27.

Sedman, Y. S. 1952. The Syrphidae of Utah. Unpub. master's thesis, Univ. of Utah, Salt Lake City, Utah. 174 p.

Smith, J. V. 1950. A study of the control of the gnat, *Leptoconops kerteszi* var. *americanus* Carter in North Salt Lake City, Utah. Unpub. master's thesis, Univ. of Utah, Salt Lake City, Utah. 51 p.

Stains, G. S., and G. F. Knowlton. 1940. Three new western Simuliidae (Diptera). Ann. Entomol. Soc. Amer. 33:77-80.

Stains, G. S., and G. F. Knowlton. 1943. A taxonomic and distributional study of the Simuliidae of the western United States. Ann. Entomol. Soc. Amer. 36:259-280.

Stone, A., and B. V. Peterson. 1958. *Simulium defoliarti*, a new black fly from the western United States (Diptera: Simuliidae). Bull. Brooklyn Entomol. Soc. 53:1-6.

Stone, A., C. W. Sabrosky, W. W. Wirth, R. H. Foote, and J. R. Coulson. 1965. A catalog of the Diptera of America north of Mexico. U. S. Dept. Agr. Handbook 276. 1696 p.

Taylor, S. K. 1959. Bionomics of *Culex tarsalis* Coquillett in Utah County. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 36 p.

Trent, D. W. 1960. Observations on the hibernation of *Culex tarsalis* Coquillett in Utah Valley. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 30 p.

Twinn, C. R. 1938. Blackflies from Utah and Idaho, with descriptions of new species (Simuliidae, Diptera). Can. Entomol. 70:48-55.

Wirth, W. W., and F. S. Blanton. 1967. The North American *Culicoides* of the *guttipennis* group (Diptera: Ceratopogonidae). Florida Entomol. 50:207-243.

Wirth, W. W., and F. S. Blanton. 1969a. North American *Culicoides* of the *pulicaris* group (Diptera: Ceratopogonidae). Florida Entomol. 52: 207-243.

Wirth, W. W., and F. S. Blanton. 1969b. New species and records of *Culicoides* from western North America. (Diptera: Ceratopogonidae). Proc. Entomol. Soc. Wash. 71:556-567.

HEMIPTERA

Knowlton, G. F. 1955. Hemiptera of Utah—records. Utah Agr. Expt. Sta. Mimeo. Series 140.

Knowlton, G. F., and E. J. Taylor. 1948. Some predaceous Hemiptera largely from Utah. Proc. Utah Acad. Sci., Arts and Letters 26:135.

NIELSEN, G. L. 1955. A study of the families of Utah Hemiptera. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 46 p.

RYCKMAN, R. E. 1954. *Reduvius senilus* Van Duzee from the lodges of *Neotoma* in San Juan County, Utah. Bull. So. Calif. Acad. Sci. 53(2):88.

USINGER, R. L. 1944. The Triatominae of North and Central America and the West Indies and their public health significance. U. S. Public Health Ser. Public Health Bull. 283. 83 p.

USINGER, R. L. 1966. Monograph of the Cimicidae (Hemiptera-Heteroptera) Thomas Say Foundation Pub. 7. 585 p. + xi.

WYGODZINSKY, P., AND R. L. USINGER. 1964. The genus *Reduvius* Fabricius in western North America (Reduviidae; Hemiptera, Insecta). Amer. Mus. Nov. 2175:1-15.

HYMENOPTERA

BOHART, R. M. 1966. A review of *Aphilanthops* and related genera. Proc. Entomol. Soc. Wash. 68(2): 158-167.

BOHART, R. M., AND A. S. MENKE. 1963. A reclassification of the Sphecinae with a revision of the Nearctic species of the tribes Sceliphronini and Sphecini. Univ. Calif. Publ. Entomol. 30(2):91-182.

BUREN, W. F. 1968. A review of the species of *Crematogaster,* sensu stricto, in North America (Hymenoptera: Formicidae). J. Georgia Entomol. Soc. 3:91-121.

COLE, A. C. 1942. The ants of Utah. Amer. Midland Nat. 28:358-388.

COLE, A. C. 1968. *Pogonomyrmex* harvester ants, a study of the genus in North America. Univ. Tennessee Press, Knoxville, Tennessee. 222 p.

EVANS, H. E., AND R. W. MATTHEWS. 1968. North American *Bembix*, a revised key and suggested grouping. Ann. Entomol. Soc. Amer. 61:1284-1299.

FURGUSON, W. E. 1967. Male sphaerophthalmine mutillid wasps of the Nevada test site. Brigham Young Univ. Sci. Bull. Biol. Series 8(4):1-26.

HAYWARD, C. L. 1932. The paper wasps of Utah, including a description of a new variety of *Polistes canadensis* L. Proc. Utah Acad. Sci. 9:85-101.

INGHAM, C. O. 1959. Ants of the Virgin River Basin, southwestern Utah. Unpub. master's thesis, Univ. of Utah. Salt Lake City, Utah. 140 p.

KLIEWER, J. W. 1952. Biology and control of paper wasps of Salt Lake City and vicinity. Unpub. master's thesis, Univ. of Utah, Salt Lake City, Utah. 36 p.

KNOWLTON, G. F. 1939. Utah Hymenoptera. Utah Agr. Expt. Sta. Mono. Series 200 (Tech.) part 4. 8 p.

KROMBEIN, K. V. 1967. Hymenoptera of America north of Mexico: Synoptic Catalog. USDA Agr. Mono. 2. Supplement 2. 584 p.

KROMBEIN, K. V., et al. 1958. Hymenoptera of America north of Mexico: Synoptic Catalog. USDA Agr. Mono. 2. Supplement 1. 305 p.

MILLER, C. 1961. Taxonomy and distribution of Nearctic *Vespula*. Can. Entomol. Supplement 22. 52 p.

MUESEBECK, C. F. W., K. V. KROMBEIN, H. K. TOWNES, et al. 1951. Hymenoptera of America north of Mexico: Synoptic catalog. USDA Agr. Mono. 2. 1420 p.

REES, D. M., AND A. W. GRUNDMAN. 1940. A preliminary list of the ants of Utah. Univ. of Utah Bull. 31:1-11.

REES, D. M., AND J. W. KLIEWER. 1953. Notes on the biology and control of wasps in Salt Lake City and vicinity. Proc. Utah Acad. Sci., Arts and Letters 30:114-115.

SCHUSTER, R. M. 1958. A revision of the sphaeropthalmine Mutilidae of America north of Mexico II. Entomol. Amer. 37:1-30.

SCULLEN, H. 1965. Review of the genus *Cerceris* in America north of Mexico. Proc. U.S. Nat. Mus. 116:333-548.

SCULLEN, H. 1968. A revision of the genus *Eucerceris* Cresson. Bull. U. S. Nat. Mus. 268:1-97.

LEPIDOPTERA

KNOWLTON, G. F. 1939. Lepidoptera. Utah Agr. Expt. Sta. Mono. Series 200 (Tech.) part 2. 14 p.

SUGDEN, J. W. 1937. Notes on the migrational flights of *Vanessa cardui* in Utah. Pan-Pacific Entomol. 13:109-110.

MALLOPHAGA

BEHLE, WILLIAM E. 1971. Checklist of the birds of Utah. Unpublished manuscript.

ELBEL, R. E., AND K. C. EMERSON. 1956. A new mallophagan from the White Pelican. Entomol. News 67(7):173-176.

EMERSON, K. C. 1950. The genus *Lagopoecus* (Philopteridae: Mallophaga) in North America. J. Kansas Entomol. Soc. 23(3):97-101.

EMERSON, K. C. 1961. The genus *Penenirmus* (Mallophaga) found on North American woodpeckers. J. Kansas Entomol. Soc. 34(1):34-43.

EMERSON, K. C. 1962. A tentative list of Mallophaga for North American birds (north of Mexico). Dugway Proving Ground: 1-217.

EMERSON, K. C. 1964a. Checklist of the Mallophaga of North America (north of Mexico). Part I. Suborder Amblycera. Dugway, Utah, (Mimeo). 171 p.

EMERSON, K. C. 1964b. Checklist of the Mallophaga of North America (north of Mexico). Part II. Suborder Amblycera. Dugway, Utah, (Mimeo). 104 p.

EMERSON, K. C. 1968. The genera and species of the Mallophaga of North America (north of Mexico). Part I. Suborder Ischnocera. Mimeo. 194 p.

ORTHOPTERA

BARNUM, A. H. 1952. The taxonomy of Utah Orthoptera with notes on distribution. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 236 p.

BARNUM, A. H. 1954. The taxonomy of Utah Orthoptera. Great Basin Nat. 14:39-60.

HANSEN, H. O. 1963. The cockroaches of Salt Lake County, Utah. Unpub. master's thesis, Univ. of Utah, Salt Lake City, Utah. 65 p.

KNOWLTON, G. F. 1935. Bed bugs and cockroaches. Utah Agr. Expt. Sta. Leaflet 68.

SCORPIONIDA

GERTSCH, W. J., AND D. M. ALLRED. 1965a. Scorpions of the Nevada test site. Brigham Young Univ. Sci. Bull., Biol. Series 6(4):1-15.

GERTSCH, W. J., AND D. M. ALLRED. 1965b. The scorpions of the *Vejovis boreus* group (subgenus *Paruroctonus*) in North America (Scorpionida, Vejovidae). Amer. Mus. Nov. 2278:1-54.

JOHNSON, J. D. 1968. Scorpions of Utah. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 36 p.

WOOD, H. C. 1863. Description of a new species of scorpion in the Utah territory: *Centrurus phaeodactylus* Wood. Proc. Aca. Nat. Sci. Philadelphia 2:372.

SIPHONAPTERA

ALLRED, D. M. 1951. A preliminary study of the distribution of fleas in Utah known to be capable and potential vectors of plague. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 141 p.

AMOUREAUX, R. L. 1964. Taxonomic study of fleas of the genus *Foxella* (Wagner) in Utah (Siphonaptera: Dolichopsyllidae). Unpub. master's thesis, Brigham Young Univ.. Provo, Utah. 27 p.

BECK, D E., AND D. M. ALLRED. 1950-1951. Further distributional data on Utah Siphonaptera. Proc. Utah Acad. Sci., Arts and Letters 28:113 (Abstract).

EGOSCUE, H. J. 1966a. New and additional host-flea associations and distributional records of fleas from Utah. Great Basin Nat. 26:71-75.

EGOSCUE, H. J. 1966b. A new species of the genus *Stenistomera* (Siphonaptera: Hystichopsyllidae). Bull. So. Calif. Acad. Sci. 67(3):138-142.

EWING, H. E., AND I. FOX. 1943. The fleas of North America. Classification, identification, and geographical distribution of these injurious and disease-spreading insects. USDA Misc. Publ. 500. 142 p.

HOWELL, J. F. 1954. A study of the aspectional variation of Siphonaptera associated with the nests of the Thomas wood rat, *Neotoma lepida lepida* Thomas. Unpub. master's thesis, Brigham Young Univ.. Provo, Utah. 38 p.

HOWELL, J. F. 1957. Fleas associated with nests of the desert wood rat. J. Parasitol. 43:566-573.

HUBBARD, C. A. 1947. The fleas of western North America. Iowa State College Press, Ames, Iowa. 533 p.

JOHNSON, P. T. 1961. A revision of the species of *Monopsyllus* Kolenati in North America. Agr. Res. Ser. Tech. Bull. 1227. 69 p.

JOHNSON, P. T. 1971. Personal communication.

PARKER, D. D. 1958. Seasonal occurrence of fleas on antelope ground squirrels in the Great Salt Lake Desert. J. Econ. Entomol. 51:32-36.

PARKER, D. D., AND J. F. HOWELL. 1959. Host-flea relationships in the Great Salt Lake Desert. J. Parasitol. 45(6):597-604.

SMIT, F. G. A. M. 1958. A new North American bird-flea. Proc. U. S. Nat. Mus. 108(3394):51-57.

STANFORD, J. S. 1931. A preliminary list of Utah Siphonaptera. Proc. Utah Acad. Sci. 8:153-154.

STANFORD, J. S. 1944. More Utah Siphonaptera. Proc. Utah Acad. Sci., Arts and Letters 19-20: 173-178.

STARK, H. E. 1958. The Siphonaptera of Utah. U. S. Dept. HEW Comm. Disease Center, Atlanta, Georgia. 239 p.

STARK, H. E. 1970. A revision of the flea genus *Thrassis* Jordan 1933 (Siphonaptera: Ceratophyllidae) with observations on ecology and relationship to plague. Univ. Calif. Pub. Entomol. 53:vii + 184 p.

TIPTON V. J. 1949. A preliminary study of the siphonapterous ectoparasites found on the mammals of the families Cricetidae and Muridae in Utah County. Unpub. master's thesis. Brigham Young Univ., Provo, Utah. 87 p.

TIPTON, V. J. 1950. New distributional records for Utah Siphonaptera. Great Basin Nat. 10:62-65.

TIPTON, V. J., AND D. M. ALLRED. 1952. New distributional records of Utah Siphonaptera with the description of a new species of *Megarthroglossus* Jordan and Rothschild 1915. Great Basin Nat. 11:105-114.

TRAUB, R., AND V. J. TIPTON. 1951. *Jordanopsylla allredi*, a new genus and species of flea from Utah (Siphonaptera). J. Wash. Acad. Sci. 41:264-270.

COLORADO TICK FEVER

ANONYMOUS. 1970. Colorado tick fever. RML Circular 2. Rocky Mountain Laboratory, Hamilton, Montana. 1 p.

BECKER, F. E. 1930. Tick-borne infections in Colorado. II. A survey of the occurrence of infections transmitted by the wood tick. Colorado Med. 27: 87-95.

EKLUND, C. M., R. C. KENNEDY, AND MARY CASEY. 1961. Colorado tick fever. Rocky Mountain Med. J. 58(6):21-25.

EKLUND, C. M., G. M. KOHLS, AND J. M. BRENNAN. 1955. Distribution of Colorado tick fever and virus carrying ticks. J. Amer. Med. Assoc. 157: 335-337.

TOPPING, N. H., J. S. CULLYFORD, AND G. F. DAVIS. 1940. Colorado tick fever. Public Health Rpts. 55:2224-2237.

ENCEPHALITIS

BROOKMAN, B. 1955. The current status of encephalitis in the west. Proc. Utah Mosq. Abate. Assoc. 8:5.

CRANE, G. T., R. E. ELBEL, D. E. KLIMSTRA, AND K. L. SMART. 1969. Isolation of Hart Park-like and California encephalitis group from mosquitoes of Cedar and Utah valleys, Utah, in 1967 (Abstract). Proc. Utah. Mosq. Abate. Assoc. 22:39-40.

CRANE, G. T., R. E. ELBEL, AND K. L. SMART. 1970. Arbovirus isolations from mosquitoes collected in West Central Utah, 1969. Proc. Utah Mosq. Abate. Assoc. 23:21 (Abstract).

CRANE, G. T., R. E. ELBEL, AND K. L. SMART. 1970. Arbovirus isolations from mosquitoes collected in Central Utah in 1967. Amer. J. Trop. Med. Hyg. 19:540-543.

ELBEL, R. E., G. T. CRANE, L. E. STIPE, G. B. VAN NOSDOL, AND K. L. SMART. 1971. Arbovirus isolations from mosquitoes collected at Callao, Utah, 1966 and 1967. Mosq. News 31:61-68.

GEBHART, L. P., G. J. STANTON, AND S. DE ST. JEER. 1968. Ecology of western equine encephalitis virus in nature. Proc. Utah Mosq. Abate. Assoc. 21:13-15.

GRAHAM, J. E., AND G. C. COLLETT. 1964. Surveillance for western equine encephalitis in Utah. Mosq. News 24:149-153.

GRAHAM, J. E., I. E. BRADLEY, AND G. C. COLLETT. 1960. Some factors influencing larval populations of *Culex tarsalis* and western equine encephalitis in Utah. Mosq. News 20:100-103.

Grundmann, A. W. 1950. Preliminary results of an investigation in Utah of mosquito borne encephalitis. Proc. Utah Mosq. Abatc. Assoc. 3:43-45.

Grundmann, A. W. 1954. The encephalitis problem in Utah. Proc. Utah Mosq. Abate. Assoc. 7:19-21. (Mimeo).

Grundmann, A. W., and G. R. Leymaster. 1954. Equine encephalomyelitis in Utah, a survey of horses and man utilizing serum-neutralization tests. J. Amer. Med. Assoc. 124:40-42.

Hess, A. D., and R. O. Hayes. 1967. Seasonal dynamics of western encephalitis virus. Amer. J. Med. Sci. 253:333-348.

Hess, A. D., and P. Holden. 1957. The natural history of the arthropod-borne encephalitides in the U. S. Ann N. Y. Acad. Sci. 70:294-311.

Holden, P., and A. D. Hess. 1959. Cache Valley virus, a previously undescribed mosquito-borne agent. Science 130(3383):1187-1188.

Jenkins, A. A., and R. Donath. 1959. The 1958 encephalitis outbreak in northern Utah. 1. Human aspects. Mosq. News 19:221-222.

Knowlton, G. F. 1934. Insect transmission of equine encephalomyelitis studies. Utah Agr. Expt. Sta. Bull. 250:47 (Biennial Report).

Knowlton, G. F. 1936. Insect transmission of equine encephalomyelitis. Report of Twelfth Rocky Mt. Conf. of Entomologists, Pingree Park, Colorado. p. 9.

Knowlton, G. F., and J. A. Rowe. 1935. Handling mosquitoes on equine encephalomyelitis investigations. J. Econ. Entomol. 28:824-829.

Love, G. J., and D. B. Francy. 1963. Summary of activities of the encephalitis section during 1962. Proc. Utah Mosq. Abate. Assoc. 16:8-11.

Madsen, D. E. 1934. Equine encephalomyelitis. Proc. Utah Acad. Sci., Arts and Letters 11:95-99.

Madsen, D. E., and G. F. Knowlton. 1935. Mosquito transmission of equine encephalomyelitis. J. Amer. Vet. Med. Assoc. 86:662-666.

Madsen, D. E., G. F. Knowlton, and J. A. Rowe. 1936. Further studies on transmission of equine encephalitis by mosquitoes. J. Amer. Vet. Med. Assoc. 89:187-196.

Rees, D. M., and G. C. Collett. 1959. Factors influencing the encephalitis outbreak in Utah in 1958. Proc. and Papers 27th Ann. Conf. Calif. Mosq. Control Assoc. p. 88-97.

Rees, D. M., L. J. Ogden, G. C. Collett, and J. E. Graham. 1959. The 1958 encephalitis outbreak in northern Utah. 3. Mosquito populations in relation to the outbreak. Mosq. News 19:227-231.

Spendlove, G. A., J. A. Rowe, and C. F. Knowlton. 1953. Mosquitoes and encephalitis. Utah State Agr. Coll. Ext. Circ. 199:1-2.

Thomas, L. A., and J. V. Smith. 1959. The 1958 encephalitis outbreak in northern Utah. 2. Infection rates in birds, mammals and mosquitoes. Mosq. News 19:223-226.

MALARIA

Grundmann, A. W., R. G. Warneck, and H. D. Newson. 1952. Nonhuman malaria in mosquitoes and the English sparrow, *Passer domesticus* Linn. in the vicinity of Salt Lake City, Utah. Mosq. News 12:53-57.

Knowlton, G. F. 1948. Malariology, mosquito control, and aviation. The Sanitarian 10(5):185, 187, 189-190.

Marshall, H. L., and D. M. Rees. 1948. Malaria in Utah. Rocky Mt. Med. J. 45:469-472.

Rees, D. M., and H. D. Newson. 1950. Mosquitoes of Salt Lake County, Utah, infected with nonhuman malaria. Proc. Utah Acad. Sci., Arts and Letters 27:71 (Abstract).

PLAGUE

Allred, D. M. 1952. Plague important fleas and mammals in Utah and the western United States. Great Basin Nat. 12:67-75.

Anonymous. 1936. Human and rodent plague in California, Idaho, and Utah. Public Health Rpts. 51:1019.

Anonymous. 1936. Rodent plague in California and Utah. Public Health Rpts. 51:1138.

Anonymous. 1936. Plague infection discovered in fleas and lice taken from marmots in Montana and in a marmot from Utah. Public Health Rpts. 51: 1159-1160.

Anonymous. 1936. Rodent plague in Beaver County, Utah. Public Health Rpts. 51:1207.

Anonymous. 1936. Plague infection in California and Utah. Public Health Rpts. 51:1257.

Anonymous. 1936. Plague in prarie dogs in Garfield County, Utah. Public Health Rpts. 51:1287.

Anonymous. 1937. Plague infection in fleas in California, Nevada, and Utah. Public Health Rpts. 52:1184-1185.

Anonymous. 1937. Plague infection in Wasatch County, Utah, and Madison County, Michigan. Public Health Rpts. 52:1321.

Anonymous. 1938. Plague infection found in fleas from desert wood rats in Utah. Public Health Rpts. 53:1042.

Anonymous. 1938. Plague infection found in ground squirrel and fleas from ground squirrels in Utah. Public Health Rpts. 53:1318.

Anonymous. 1938. Plague infection in fleas from ground squirrels in Rich County, Utah. Public Health Rpts. 53:1436.

Anonymous. 1940. Bubonic plague in Utah. Public Health Rpts. 55:258.

Anonymous. 1948. Plague infection in Salt Lake County, Utah. Public Health Rpts. 63:1478.

Anonymous. 1949. Plague infection in Utah and Washington. Public Health Rpts. 64:496.

Anonymous. 1949. Plague infection in San Juan County, New Mexico, and Sevier County, Utah. Public Health Rpts. 64:810.

Beck, D E., 1955. Distributional studies of parasitic arthropods in Utah, determined as actual and potential vectors of Rocky Mountain spotted fever and plague, with notes on vector-host relationships. Brigham Young Univ. Sci. Bull. Biol. Series 1(1): 1-64.

Byington, L. B. 1940. Two epizootics of plague infections in wild rodents in the western United States in 1938. Public Health Rpts. 55:1496-1501.

Hampton, B. C. 1940. Plague in the United States. Public Health Rpts. 55:1143-1158.

Hampton B. C. 1945. Plague infection reported in the United States during 1944 and summary of human cases, 1900-1944. Public Health Rpts. 60: 1361-1365.

Marchette, N. J. 1963. *Pasteurella pestis* of low virulence for mice and guinea pigs isolated from *Peromyscus* plague focus in Utah. Amer. J. Trop. Med. Hyg. 12:215-218.

McCoy, G. W. 1911. Studies upon plague in ground squirrel. II. A plague-like disease of rodents. Public Health Bull. 43:53-71.

Mohr, C. O. 1951. Entomological background on the distribution of murine typhus and murine plague in the United States. Amer. J. Trop. Med. Hyg. 31:355-372.

Myklebust, R. J., F. C. Harmston, and D. R. Maddock. 1949. Sylvatic plague investigations in Utah. CDC Publ. Fed. Sec. Agency, Atlanta, Georgia (Mimeo).

Parker, D. D. 1971. Personal communication.

Univ. of Utah. 1963. Summary status report on *Pasteurella pestis*. 1952-1962. Ecol. and Epizool. Ser. 92. Ecol. and Epizool. Res. Dugway, Utah. 110 p.

Wayson, N. E. 1947. Plague-field surveys in western United States during ten years (1936-1945). Public Health Rpts. 62:780-791.

ROCKY MOUNTAIN SPOTTED FEVER

Beck, D E. 1955. Distributional studies of parasitic arthropods in Utah, determined as actual and potential vectors of Rocky Mountain spotted fever and plague, with notes on vector host relationships. Brigham Young Univ. Sci. Bull. Biol. Series 1(1):1-64.

Becker, F. E. 1926. Investigations on Rocky Mountain spotted fever in Colorado. J. Infect. Dis. 39: 81-88.

Coffey, M. D. 1953. Some preliminary studies of Rocky Mountain spotted fever vectors in Utah. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 84 p.

Coffey, M. D. 1954. A study of some Rocky Mountain spotted fever vectors and their hosts in Utah. Great Basin Nat. 14:31-37.

Hampton, B. C., and H. G. Eubank. 1938. Rocky Mountain spotted fever. Public Health Rpts. 53: 984-990.

Herrin, C. S. 1956. *Dermacentor andersoni* and Rocky Mountain spotted fever in national forest recreational sites of Utah. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 51 p.

Jellison, W. L. 1945. The geographical distribution of Rocky Mountain spotted fever and Nuttall's cottontail in the western United States. Public Health Rpts. 60:958-961.

Lundgren, D. L., B. D. Thorpe, and C. D. Haskell. 1966. Infectious diseases in wild animals in Utah VI. Experimental infection of birds with *Rickettsia rickettsii*. J. Bact. 91:963-966.

Parker, R. R., C. B. Philip, and W. L. Jellison. 1933. Rocky Mountain spotted fever. Potentialities of tick transmission in relation to geographical occurrence in the United States. Amer. J. Trop. Med. 13:341-379.

Rucker, W. C. 1912. Rocky Mountain spotted fever. Public Health Rpts. 27:1465-1482.

Rumbeich, A., R. E. Dyer, and L. F. Badger. 1931. The typhus-rocky mountain spotted fever group. Public Health Rpts. 46:470-480.

TULAREMIA

Allred, D. M., G. N. Stagg, and J. F. Lavender. 1956. Experimental transmission of *Pasteurella tularensis* by the tick, Dermacentor parumapertus. J. Infect. Dis. 99:143-145.

Anonymous. 1927. Seasonal incidence and sources of infection of tularemia. Public Health Rpts. 42: 2948-2951.

Anonymous. 1940. Tularemia (rabbit fever). Public Health Rpts. 55;667-670.

Barnes, W. C. 1928. Rabbit fever or tularemia. Sci. Monthly 27:463-469.

Burroughs, A. L., R. Holdenried, D. S. Longanecker, and K. F. Meyer. 1945. A field study of latent tularemia in rodents with a list of all known naturally infected vertebrates. J. Infect. Dis. 76:115-119.

Byfield, G. V., L. Breslow, R. R. Cross, Jr., and N. J. Hersey. 1945. Tick-borne tularemia. Report of 15 cases. J. Amer. Med. Assoc. 127:191-196.

Clement, R. 1927. Tularemia: contamination and transmission by rabbits. Presse med. 35:1608-1610.

Cox, K. B. 1964. Bibliography of Tularemia. Mimeo. 83 p.

Cox, K. B. 1965a. Tularemia and deer flies in the environs of Utah Lake, Utah. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 35 p.

Cox, K. B. 1965b. Tularemia and deer flies in the environs of Utah Lake, Utah. Great Basin Nat. 25(1-2):13-29.

Crawford, M. 1932. Tularemia from ingestion of insufficiently cooked rabbit. J. Amer. Med. Assoc. 99:1497-1498.

Francis, E. 1919. Deer-fly fever, or Pahvant Valley plague. A disease of man of hitherto unknown etiology. Public Health Rpts. 34:2061-2062.

Francis, E. 1921. Tularemia Francis 1921. I. The occurrence of tularemia in nature as a disease of man. Public Health Rpts. 36:1731-1738.

Francis, E. 1922. Tularemia Francis 1921: A new disease of man. J. Amer. Med. Assoc. 78:1015-1018.

Francis, E. 1925. Tularemia. J. Amer. Med. Assoc. 84:1243-1250.

Francis, E. 1926. Tularemia. Hektoen Lecture. Proc. Inst. Med. Chicago. 6:27-37.

Francis, E. 1928a. Symptoms, diagnosis and pathology of tularemia. J. Amer. Med. Assoc. 91:1155-1161.

Francis, E. 1928b. History of Tularemia. DeLamar Lecture, Johns Hopkins Univ., Sch. Hyg. p. 94-115.

Francis, E. 1928c. A summary of present knowledge of tularemia. Medicine 7:411-432.

Francis, E. 1928d. Summary of present knowledge of tularemia. Harvey Lecture, Harvey Soc. N. Y. Series 1927-1928:25-48.

Francis, E. 1929. Arthropods in the transmission of tularemia. Trans. Fourth Int. Cong. Entomol. 2:929-944.

Francis, E. 1937. Sources of infection and seasonal incidence of tularemia in man. Public Health Rpts. 52:103-113.

Francis, E., and G. R. Callender. 1927. Tularemia, the microscopic changes of the lesions in man. Arch. Path. Lab. Med. 3:577-607.

Francis, E., et al. 1922. Tularemia Francis 1921: A new disease of man. USPHS Hyg. Lab. Bull. 130. 87 p.

Francis, E., and G. C. Lake. 1921. Tularemia Francis 1921. III. Experimental transmission of tularemia in rabbits by the rabbit louse *Haemodip-*

sus ventricosus (Denny). Public Health Rpts. 36:1747-1753.

Francis, E., and G. C. Lake. 1922a. Tularemia Francis 1921. IV. Transmission of tularemia by the bedbug, *Cimex lectularius*. Public Health Rpts. 37:83-95.

Francis, E., and G. C. Lake. 1922b. Tularemia Francis 1921. V. Transmission of tularemia by the mouse louse *Polyplax serratus* (Burm.). Public Health Rpts. 37:96-101.

Francis, E., and B. Mayne. 1921. Tularemia Francis 1921. II. Experimental transmission of tularemia by flies of the species *Chrysops discalis*. Public Health Rpts. 36:1738-1746.

Francis, E., and D. Moore. 1926. Identity of Ohara's disease and tularemia. J. Amer. Med. Assoc. 86:1329-1332.

Gebhardt, L. P., and B. D. Thorpe. 1962. A review of tularemia. Univ. Utah Manuscript. 87 p.

Hillman, C. C., and M. T. Morgan. 1937. Tularemia: report of a fulminant epidemic transmitted by the deer fly. J. Amer. Med. Assoc. 108:538-540.

Jellison, W. L. 1950. Tularemia: Geographical distribution of "Deer-fly fever" and the biting fly, *Chrysops discalis* Williston. Public Health Rpts. 63:1321-1329.

Jellison, W. L. 1970. Tularemia in Montana. Montana Wildlife: 1-24.

Jellison, W. L. 1971. Personal communication.

Jellison, W. L., and G. M. Kohls. 1955. Tularemia in sheep and in sheep industry workers in western United States. Public Health Mono. 28. 17 p.

Jellison, W. L., G. M. Kohls, and C. B. Philip. 1951. Tularemia: muskrats as a source of human infection in Utah. Rocky Mt. Med. J. 48:594-597.

Jellison, W. L., and R. R. Parker. 1945. Rodents, rabbits, and tularemia in North America: Some zoological and epidemiological considerations. Amer. J. Trop. Med. 25:349-362.

Junkin, H. D. 1927. Two unusual cases of tularemia. Northwest Med. 26:415.

Knudsen, A. B., D. M. Rees, and G. C. Collett. 1968. Tularemia in Salt Lake County, Utah. Proc. Utah Mosq. Abate. Assoc. 21:15-16.

Larson, C. L., W. Wicht, and W. L. Jellison. 1955. A new organism resembling *P. tularensis* isolated from water. Public Health Rpts. 70:253-258.

Lundgren, D. L., N. J. Marchette, and P. S. Nichols. 1961. Certain immunological responses of wild rodents and laboratory animals following challenge with *Pasteurella tularensis*. Ecol. and Epizool. Series 60, June 30, 1961. Inst. Environ. Res. Univ. Utah.

Lundgren, D. L., N. J. Marchette, and K. L. Smart. 1957. Tularemia in the coyote, *Canis latrans lestes* Merriam. J. Infect. Dis. 101: 154-157.

Marchette, N. J., D. L. Lundgren, P. S. Nicholes, and E. D. Vest. 1961. Studies on infectious diseases in wild animals in Utah. I. Susceptibility of wild animals to experimental tularemia. Zoonoses Res. 1:49-73.

McCoy, G. W., and C. W. Chapin. 1912. Further observations on a plague-like disease of rodents with a preliminary note on the causative agent, *Bacterium tularense*. J. Infect. Dis. 10:61-72.

Parker, D. D. 1957. Attempted transmission of *Pasteurella tularensis* by three species of fleas. J. Econ. Entomol. 50:724-726.

Parker, D. D., and D. E. Johnson. 1957. Experimental transmission of *Pasteurella tularensis* by the flea, *Orchopeas leucopus* (Baker). J. Infect. Dis. 101:69-72.

Parker, R. R., and E. Francis. 1926. Susceptibility of the coyote (*Canis lestes*) to tularemia. Public Health Rpts. 41:1407-1410.

Pearse, R. A. 1911. Insect bites. Northwest Medicine, N. S. 3:81.

Stagg, G., W. S. Tanner, and J. Lavender. 1959. Experimental infections of native animals with *Pasteurella tularensis*. J. Infect. Dis. 99:34-37.

Thorpe, B. D. 1962. Review of tularemia in arthropods and birds. Dept. Bact. Univ. Utah. Unpub. Manuscript 64 p.

Thorpe, B. D., R. W. Sidwell, D. E. Johnston, K. L. Smart, and D. D. Parker. 1965. Tularemia in the wildlife and livestock of the Great Salt Lake Desert Region, 1951 through 1964. Amer. J. Trop. Med. Hyg. 14:622-637.

Vest, E. D., and N. J. Marchette. 1958. Transmission of *Pasteurella tularensis* among desert rodents through infective carcasses. Science 128 (3320): 363-364.

Woodbury, A. M. 1955. Ecological studies of tularemia in Utah. *In* Symposium on ecology and disease transmission in native animals. U. S. Army Chemical Corps, Dugway, Utah. 112 p.

MISCELLANEOUS

Allred, D. M. 1956. Ticks and mites as potential vectors. *In* Symposium on ecology of disease transmission in native animals, p. 66-69. Special Publ. Ecol. Res., Univ. Utah and Army Chemical Corps, Dugway, Utah.

Anonymous. 1958. Morbidity: Utah 1958. Utah State Dept. Health, Bureau of Vital Statistics, Salt Lake City, Utah. 94 p.

Anonymous. 1968. Utah Vital Statistics, 1968. Annual Rpt. State of Utah, Dept. Soc. Services, Division of Health. Salt Lake City, Utah. 126 p.

Armstrong, C. 1922. Typhus fever on the San Juan Indian Reservation, 1920 and 1921. Public Health Rpts. 37:685-693.

Ashley, R. F. 1968. The distribution of overwintering arthropods in a sheep pasture in Utah County, Utah. Unpub. master's thesis. Brigham Young Univ., Provo, Utah. 19 p.

Beck, D E. 1953. A study of some consortes found at a nesting site of the northern Cliff Swallow *Petrochelidon albifrons albifrons* (Rafinesque). Proc. Utah Acad. Sci., Arts and Letters 30:39-42.

Beck, D E., A. H. Barnum, and L. Moore. 1953. Arthropod consortes found in nests of *Neotoma cinerea acraia* (Ord.) and *Neotoma lepida lepida* Thomas. Proc. Utah Acad. Sci., Arts and Letters 30:43-52.

Berge, T. O., and E. H. Lennette. 1953. World distribution of Q fever: Human, animal, and arthropod infection. Amer. J. Hyg. 57:125-143.

Cott, E. H. 1956. Ecological observations on the insect fauna of the Great Salt Lake Desert and their epizootic implications. *In* Symposium on ecology of disease transmission in native animals. p. 69-73. Special publ. Ecol. Res., Univ. Utah and Army Chemical Corps, Dugway, Utah.

Cott, E. H., D. M. Allred, and E. J. Roscoe. 1956. The ectoparasite rearing program. *In* Symposium on ecology of disease transmission in native animals. p. 59-61. Special publ., Ecol. Res., Univ. Utah and Army Chemical Corps, Dugway, Utah.

Davidoff, E. B. 1956. Ectoparasites of birds and mammals. *In* Symposium on ecology of disease transmission in native animals. p. 61-66. Special publ. Ecol. Res., Univ. Utah and Army Chemical Corps, Dugway, Utah.

Davis, G. E. 1939. *Ornithodoros parkeri*: Distribution and host data; spontaneous infection with relapsing fever spirochetes. Public Health Rpts. 54: 1345-1349.

Davis, G. E. 1940. Ticks and relapsing fever in the United States. Public Health Rpts. 55:2347-2351.

Davis, G. E. 1941. *Ornithodoros parkeri* and relapsing fever spirochetes in Utah. Public Health Rpts. 56:2464-2468.

Elzinga, R. J., and D. M. Rees. 1964. Comparative rates of ectoparasite infestation on deer and harvest mice. Proc. Utah Acad. Sci., Arts and Letters 41: 217-220.

Felsenfeld, O. 1965. Borreliae, human relapsing fever, and parasite-vector relationships. Bac. Rev. 29:46-74.

Ho, Beng Chaun, and D. M. Rees. 1963. Ectoparasite-host associations in three areas in Utah and Wyoming. Proc. Utah Acad. Sci., Arts and Letters 40:115.

Horsfall, F. L., and I. Tamm (eds.). 1965. Viral and Rickettsial infections of man. Philadelphia, Lippincott. 1282 p.

Howell, J. F. 1960. Arthropod consortes of a kit fox den. Great Basin Nat. 20:71-77.

James, M. T., and R. F. Harwand. 1969. Herm's Medical Entomology (sixth edition). MacMillan Co., New York, 484 p. + viii.

Jellison, W. L. 1956. Rodent disease and parasites in Washington County, Utah, with particular reference to coccidioidomycosis. Proc. 11th Ann. Meeting INCDNCM, Salt Lake City, Utah. August 30, 31, and September 1, 1956. p. 96-104.

Knowlton, G. F. 1960. Insect conditions in Utah—1959 (Abstract). Proc. Utah Acad. Sci., Arts and Letters 37:151-152.

Knowlton, G. F. 1966. Entomology—observations. Proc. Utah Acad. Sci., Arts and Letters 43:158.

Lundgren, D. L., N. J. Marchette, and P. A. Nicholes. 1961. Studies on the ecology and epizoology of the native fauna of the Great Salt Lake Desert. Ecol. and Epizool. Series 60. June 30, 1961. Inst. Environmental Res. Univ. Utah.

Matheson, R. 1950. Medical Entomology. Comstock Publishing Associates, Ithaca, New York. 612 p.

Myklebust, R. J. 1951 Some studies on the consortes of the Norway rat in Utah County, Utah. Unpub. master's thesis, Brigham Young Univ., Provo, Utah. 73 p.

Parrish, H. M. 1959. Deaths from bites and stings of venomous animals and insects in the United States. Arch. Int. Med. 104:198-207.

Philip, C. B. 1969. Tick paralysis. RML Circ. 4. Rocky Mountain Laboratory, Hamilton, Montana. 2 p.

Pratt, H. D. and P. L. Rice. 1969. Current status of some important arthropod-borne diseases in the United States. Dept. HEW. PHS 30 p.

Rees, D. M., and B. C. Ho. 1961. Arthropods found in Flaming Gorge Reservoir Basin, 1959 Univ. Utah Anthropol. Papers No. 48:100-110, November 1960, pub. 1961.

Roberts, R. S. 1954 Mosquitoes and the disease synovitis (Staphylococcosis) in turkeys. Proc. Utah Mosq. Abate. Assoc. 7:17-19.

Sidwell, R. W., D. L. Lundgren, J. B. Bushman, and B. D. Thorpe. 1964. The occurrence of possible epizootic of Q fever in fauna of the Great Salt Lake Desert of Utah. Amer. J. Trop. Med. Hyg. 13:754-762.

Smart, J. 1948. A handbook for the identification of insects of medical importance. British Museum (Natural History). London. 295 p. + XIII pls.

Stanford, J. S. 1934. Some ectoparasites of Utah birds and mammals. Proc. Utah Acad. Sci., Arts and Letters, 11:247.

Stoenner, H. G., R. Holdenried, D. Lackman, and J. S. Osborn, Jr. 1959. The occurrence of *Coxiella burnetii*, Brucella, and other pathogens among the fauna of the Great Salt Lake Desert in Utah. Amer. J. Trop. Med. Hyg. 8:590-596.

Univ. of Utah. 1955a. Ecology of disease transmission in native animals. Ecol. Res. Dugway, Utah. 16 p.

Univ. of Utah. 1955b. Symposium on ecology of disease transmission in native animals. Ecol. Res. Dugway, Utah. 112 p.

Univ. of Utah. 1955-1956. A study of the ecology of infectious diseases in the native fauna. Ecol. Res. Dugway, Utah. 78 p.

Univ. of Utah. 1957. A study of the ecology of infectious diseases in the native fauna of the Great Salt Lake Desert. Ecol. Res. Dugway. Utah. 49 p.

Univ. of Utah. 1959a. Studies on the ecology and epizoology of the native fauna of the Great Salt Lake Desert. Ecol. and Epizool. Series 41. Ecol. and Epizool. Res. Group, Dugway, Utah. 63 p.

Univ. of Utah. 1959b. Epizoological survey of certain endemic diseases in the southern part of the Great Salt Lake Desert. Ecol. and Epizool. Series 42. Ecol. and Epizool. Res. Group, Dugway, Utah. 18 p.

Univ. of Utah. 1960. Studies on the ecology and epizoology of the native fauna of the Great Salt Lake Desert. Ecol. and Epizool. Series 44. Ecol. and Epizool. Res. Group Dugway, Utah. 67 p.

Univ. of Utah. 1961. Studies on the ecology and epizoology of the native fauna of the Great Salt Lake Basin. Ecol. and Epizool. Series 63. Ecol. and Epizool. Res. Group, Dugway. Utah. 59 p.

Univ. of Utah. 1962. A study of the ecology and epizoology of the native fauna of the Great Salt Lake Desert. Ecol. and Epizool. Series 70. Ecol. and Epizool. Res. Group, Dugway, Utah. 103 p.

Univ. of Utah. 1963. A study of the ecology and epizoology of the native fauna of the Great Salt Lake Desert. Ecol. and Epizool. Series 100. Ecol. and Epizool. Res. Group, Dugway. Utah. 127 p. + 29 figs.

Univ. of Utah. 1964. A study of the ecology and epizoology of the native fauna of the Great Salt Lake Desert. Ecol. and Epizool. Series 108. Ecol. and Epizool. Res. Group, Dugway Utah. 192 p.

Univ. of Utah. 1965. A study of the ecology and epizoology of the native fauna of the Great Salt Lake Desert, 1964. Ecol. and Epizool. Series 117. Ecol. and Epizool. Res. Group, Dugway, Utah. 180 p.

Univ. of Utah. 1966. A study of the ecology and epizoology of the native fauna of the Great Salt Lake Desert, 1965. Ecol. and Epizool. Series 123. Ecol. and Epizool Res. Group, Dugway, Utah. 171 p.

Univ. of Utah. 1967. A study of the ecology and epizoology of the native fauna of the Great Salt Lake Desert 1966. Ecol. and Epizool. Series 141.

Ecol. and Epizool. Res. Group, Dugway, Utah. 313 p.

Univ. of Utah. 1968. A study of the ecology and epizoology of the native fauna of the Great Salt Lake Desert, 1967. Ecol. and Epizool. Series 144. Ecol. and Epizool. Res. Group, Dugway, Utah. 234 p.

Univ. of Utah. 1969. A study of the ecology and epizoology of the native fauna of the Great Salt Lake Desert, 1968. Ecol and Epizool. Series 145. Ecol. and Epizool. Res. Group, Dugway, Utah. 244 p.

Vest, E. D., et al. 1961. Studies on ecology of Q fever in native fauna in the Great Salt Lake Desert. Ecol. and Epizool. Series 66. Summary progress report. Inst. Environ. Biol. Res. Univ. Utah.

Vest, E. D., D. L. Lundgren, D. D. Parker, D. E. Johnston, E. L. Morse, J. B. Bushman, R. W. Sidwell, and B. D. Thorpe. 1965. Results of a five-year survey for certain enzootic disease in the fauna of western Utah. Amer. J. Trop. Med. Hyg. 14:124-135.

Woodbury, A. M. (ed.). 1956. Ecological check lists: The Great Salt Lake series. Ecological Res. Univ. Utah. 125 p. (Mimeo).

Woodbury, A. M. 1964. Disease dissemination among biotic communities of the Great Salt Lake Desert. Univ. Utah. Div. Biol. Sci. Misc. Papers 4. 282 p.

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by

Stephen L. Wood

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NEW RECORDS AND SPECIES OF NEOTROPICAL BARK BEETLES (SCOLYTIDAE: COLEOPTERA), PART V[1]

by

Stephen L. Wood[2]

ABSTRACT

The tribe Carphodicticini, the genera *Carphodicticus*, *Perioeryphalus*, and *Phelloterus*, and 101 species are described as new to science. Notes on the habits of *Cladoctonus boliviae* (Wood), *Mimips mimicus* Schedl, and *Styphlosoma granulatum* Blandford are included; and the female of *Styphlosoma granulatum* Blandford is described. The species new to science include the following: *Phrixosoma crebrum*, *P. frustratum* (Colombia), *P. viriosum*, *Chramesus macrocornis*, *C. orinocensis*, *C. strigilis*, *C. imporcatus*, *C. impolitus*, *C. parcus*, *C. denticulatus*, *C. priscus*, *C. vinealis*, *C. solicitatus*, *C. peniculus*, *Chaetophloeus andinus*, *Liparthrum carapae*, *L. meridensis* (Venezuela), *Pycnarthrum inornatum*, *Pyc. funerium*, *Pyc. perditum* (Honduras), *Pyc. fici* (Honduras, Venezuela), *Pyc. lucidum* (Costa Rica), *Pyc. carinatum* (Peru), *Pyc. subcarinatum* (Venezuela), *Pyc. brosmii* (Venezuela, Colombia), *Gymnochilus alni* (Mexico), *Scolytodes ommateus* (Colombia), *S. punctifer*, *S. hirsutus* (Costa Rica), *S. crassus* (Panama), *S. pannuceus* (Honduras), *S. micidus* (Mexico, Guatemala), *Microborus lectus*, *Scolytus barinensis*, *Scolytopsis orinocanus*, *Carphodicticus cristatus* (Venezuela), *Pseudothysanoes querneus*, *Ps. furvescens*, *Ps. funereus*, *Ps. graniticus*, *Ps. verticillus*, *Ps. cuspidis*, *Ps. tenellus*, *Ps. yuccavorus*, *Thysanoes inornatus*, *Micracisella adnata* (Mexico), *M. serjaniae* (Honduras), *Micracis amplinis*, *Mic. incertus*, *Mic. torus* (Mexico), *Mic. exilis*, *Mic. vitulus*, *Mic. sentus* (Venezuela), *Hylocurus torosus* (South Carolina), *H. dilutus*, *H. dissidens* (Mexico), *H. disparilis* (Honduras), *H. verrucosus*, *H. villifrons*, *H. singularis*, *H. flagellatus*, *Stegomerus mirandus*, *Phacrylus pruni*, *Periocryphalus pullus* (Venezuela), *Hypothenemus nanellus*, *H. ascitus* (Costa Rica), *H. teretis* (Costa Rica, Venezuela), *Cryptocarenus coronatus* (Venezuela), *C. lepidus* (Costa Rica, Guatemala), *Dendrocranulus tardulus*, *D. diversus*, *D. pumilus*, *D. limus* (Costa Rica), *Xyleborus ebenus* (Costa Rica, Panama), *Mimips analogus*, *Mim. uncinatus* (Venezuela), *Mim. fortis* (Costa Rica, Panama), *Mim. bidens*, *Mim. ocularis* (Colombia), *Styphlosoma subulatum* (Venezuela), *Dendroterus eximius*, *Den. sodalis* (Guatemala), *Den. parilis*, *Den. resolutus* (Costa Rica), *Den. defectus* (Costa Rica, Panama), *Den. cognatus* (Mexico), *Phelloterus tersus* (Venezuela), *Ph. anaxeus*, *Ph. atrocis* (Colombia), *Pityophthorus arceuthobii* (Mexico), *Pityoborus hondurensis* (Honduras), *Pit. frontalis* (Mexico), *Pseudopityophthorus singularis*, *Pd. virilis*, *Pd. declivis* (Mexico), *Pd. colombianus* (Colombia), *Gnathophthorus clematis* (Mexico), *G. cracens* (Honduras), *G. rallus*, *G. pertusus* (Venezuela), and *Sphenoceros aztecus* (Mexico).

INTRODUCTION

While preparing a taxonomic monograph of the Scolytidae of North and Central America a large number of species new to science were discovered. Because it will be several years before that work will be concluded, the new names are being published in order to stabilize nomenclature and to facilitate identification. On the following pages 101 species and three genera are described as new to science; a new tribe Carphodicticini is also proposed for the genera *Carphodicticus* Wood, described below, and *Craniodicticus* Blandford. The new species represent the following genera: *Phrixosoma* (3), *Liparthrum* (2), *Chaetophloeus* (1), *Chramesus*

[1]Most of the field work that led to the discovery of these insects was sponsored by the National Science Foundation
[2]Department of Zoology, Brigham Young University, Provo, Utah. Scolytoidea contribution number 42.

(12), *Pycnarthrum* (8), *Gymnochilus* (1), *Scolytodes* (6), *Microborus* (1), *Scolytus* (1), *Scolytopsis* (1), *Carphodicticus* (1), *Pseudothysanoes* (8), *Thysanoes* (1), *Micracisella* (2), *Micracis* (6), *Hylocurus* (8), *Stegomerus* (1), *Phacrylus* (1), *Hypothenemus* (3), *Periocryphalus* (1), *Cryptocarenus* (2), *Dendrocranulus* (3), *Xyleborus* (1), *Mimips* (5), *Styphlosoma* (1), *Dendroterus* (6), *Phelloterus* (3), *Pityophthorus* (1), *Pityoborus* (2), *Pseudopityophthorus* (4), *Gnathophthorus* (4), and *Sphenoceros* (1).

The new species are from the following countries: United States (1), Mexico (25), Guatemala (2), Honduras (8), Costa Rica (12), Panama (1), Colombia (8), Venezuela (38), and Peru (1). One species in each of the following combinations of countries is also included: Mexico-Honduras-Costa Rica; Honduras-Venezuela; Honduras-Costa Rica; Guatemala-Costa Rica; and Colombia-Venezuela.

Except as noted below, the type series were tentatively deposited in my collection presently housed at the Brigham Young University, in order to facilitate preparation of a monograph of the Scolytidae of the Western Hemisphere. Upon completion of that monograph paratypes will be distributed to several major cooperating museums.

SYSTEMATIC SECTION

Phrixosoma crebrum, n. sp.

This species is closely allied to *minor* Wood, but it is distinguished by the much more weakly impressed transverse line on the female vertex and by the finely punctured pronotum with granules restricted to the margins.

Female.—Length 1.8 mm (paratypes 1.5-1.9 mm), 1.9 times as long as wide; color almost black.

Frons as in *minor* except more coarsely reticulate-granulate, line on vertex and laterally, of same pattern but much less strongly impressed. Pronotum as in *minor*, except surface smooth, shining, punctures irregularly shaped, distinctly, shallowly impressed, granules indicated only near base and lateral margins. Elytra as in *minor* except surface more strongly reticulate-granulate, interstrial granules evidently slightly smaller.

Male.—Similar to female except devoid of impressed and sinuate line on vertex.

Type Locality.—Eight km south of Colonia (near Buenaventura), Valle de Cauca, Colombia.

Type Material.—The female holotype, male allotype, and 49 paratypes were collected on 9 July 1970, 30 m elevation, No. 640, from *Rheedia madruño*, by S. L. Wood. The biramose parental galleries were more or less longitudinal.

The holotype, allotype, and paratypes are in my collection.

Phrixosoma viriosum, n. sp.

This species is remotely allied to *obesum* Blackman, but it is distinguished by the much larger size, by the pronotal sculpture, and by the much finer, more numerous interstrial granules.

Female.—Length 2.7 mm (paratypes 2.4-2.7 mm), 1.8 times as long as wide; color almost black.

Frons as in *crebrum* Wood, except very slightly less strongly convex, and line on vertex not at all modified or impressed; vestiture very short, moderately abundant.

Pronotum outline much as in *crebrum* except median area extended posteriorly more than in other species; surface densely, strongly, finely reticulate-granulate, intermixed with abundant, shining, small, irregular, somewhat elongate, rounded granules evidently derived from margins of punctures. Vestiture of rather abundant short, stout recumbent bristles.

Elytra 1.1 times as long as wide, 1.7 times as long as pronotum; sides weakly arcuate on basal two-thirds, rather narrowly rounded behind; striae narrowly, very deeply impressed, longitudinally strigose, punctures very small, rather deep, rather widely spaced; interstriae about four times as wide as striae, strongly reticulate-granulate, with very numerous, confused, narrow crenulate granules, each granule about one-fourth as wide as an interstriae on basal half. Declivity beginning about middle of elytra, gradual, convex; interstriae becoming about half as wide as on disc, granules largely obsolete before middle of declivity. Vestiture of abundant, slender, curved scales of equal length, confused.

Male.—Indistinguishable from female by external characters.

TYPE LOCALITY.—Forty km southeast of Socopo, Barinas, Venezuela.

TYPE MATERIAL.—The female holotype, male allotype, and 96 paratypes were taken at the type locality on 25 January 1970, 150 m elevation, No. 254, from *Rheedia madruño*, by S. L. Wood. The biramose parental galleries were longitudinal.

The holotype, allotype, and paratypes are in my collection.

Phrixosoma frustratum, n. sp.

This species may be remotely allied to *viriosum* Wood, but it is unique in having the striae much more weakly, irregularly impressed, and in having, in the female, a large, subquadrate extension of the anterior margin of the pronotum fitting snugly against the head behind the eye.

FEMALE.—Length 2.8 mm (paratypes 2.7-3.0 mm), 1.6 times as long as wide; color almost black.

Frons as in *viriosum* except granules finer. Pronotum as in *viriosum* except posteromedian area less strongly produced, and surface with very indistinct small punctures indicated and granules smaller, closer. Vestiture of fine and coarse short hair. Anterolateral margin of pronotum with a large, subquadrate extension projecting forward flush with side of head between upper and lower halves of eye and equal in area to upper half of eye.

Elytra as in *viriosum* except striae much less strongly impressed, granules slightly smaller, vestiture much more slender, a central row on each interstriae slightly stouter and very slightly longer on declivity.

MALE.—Similar to female except process on anterolateral margin of pronotum absent.

TYPE LOCALITY.—Eight km south of Colonia (near Buenaventura), Valle de Cauca, Colombia.

TYPE MATERIAL.—The female holotype, male allotype, and 93 paratypes were taken at the type locality on 9 July 1970, 30 m elevation, from *Rheedia madruño*, by S. L. Wood. The biramose parental galleries were longitudinal.

The holotype, allotype, and paratypes are in my collection.

Chramesus macrocornis, n. sp.

This species evidently is allied to *hylurgoides* Schedl, but it is smaller, it has much smaller strial punctures, and the male frons is armed by a pair of very large tubercles.

MALE.—Length 2.3 mm (paratypes 1.9-2.3 mm), 2.1 times as long as wide; color very dark brown, elytra lighter.

Frons deeply concave from epistoma to upper level of eyes; lower lateral margin at level of antennal insertion armed by a pair of very large, triangular, almost hornlike processes; surface minutely reticulate, dull; concavity impunctate, fine, sparse, shallow punctures above upper level of eyes; vestiture short, fine, sparse. Antennal club typical of genus; rather large; apex rounded.

Pronotum 0.85 times as long as wide; widest at base, sides arcuately converging to slight constriction just before broadly rounded, subemarginate, anterior margin; surface subreticulate, shining, entirely devoid of granules and asperities; punctures rather small to moderately large intermixed, rather deep, moderately close except very close near base. Vestiture of very fine, short, inconspicuous hair.

Elytra 1.3 times as long as wide; sides almost straight and parallel on basal two-thirds, broadly rounded behind; striae 1 moderately, others feebly or not at all impressed, punctures moderately large at base, gradually decreasing in size until minute at base of declivity; interstriae smooth, twice as wide as striae at base, punctures mostly uniseriate, finely granulate on basal half. Declivity rather steep, broadly convex; striae not impressed, punctures very fine; interstriae smooth, punctures minute, confused. Vestiture of rather abundant, fine, moderately long hair.

FEMALE.—Similar to male except frons weakly concave, a transverse callus just below middle, surface reticulate, finely, sparsely punctured, tubercles absent; lateral areas of pronotum finely subasperate; strial punctures decrease in size only slightly toward declivity; interstrial granules moderately large to declivity; strial punctures on declivity slightly larger, granules obsolete.

TYPE LOCALITY.—Merida, Venezuela.

TYPE MATERIAL.—The male holotype, female allotype, and 56 paratypes were taken at the type locality on 22 October 1969, 1700 m elevation, from rather old stumps of cut Japanese bamboo, by S. L. Wood. The habits were as in *gracilis* Wood.

Chramesus simplicis, n. sp.

This species evidently is similar to *hylurgoides* Schedl, but it is distinguished by the smaller size, by the more widely separated eyes in the male, by the absence of pronotal punctures, and by the very fine strial punctures.

Male.—Length 2.2 mm (paratypes 1.9-2.5 mm), 2.4 times as long as wide; color black.

Frons deeply, broadly concave from epistoma to upper level of eyes, lower fourth of lateral margin acute, not strongly elevated or dentate; surface minutely rugulose-reticulate, not punctured; vestiture on lateral margins moderately abundant, fine, very long, in concavity very short, sparse. Antennal club typical of genus; moderately large; apex rounded.

Pronotum 0.91 times as long as wide; widest one-third length from base, sides rather strongly arcuate, moderately constricted just before rather broadly rounded anterior margin; surface strongly reticulate; all punctures replaced by narrow, small asperities over entire surface. Vestiture of rather abundant, fine, moderately long hair.

Elytra 1.7 times as long as wide, 2.0 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather broadly rounded behind; striae very feebly, broadly impressed, punctures minute; interstriae smooth, dull, four or more times wider than striae, punctures minute, a few on basal half finely granulate, subasperate near base on interstriae 2-4. Declivity steep, rather narrowly convex; sculpture about as on posterior half of disc. Vestiture of moderately abundant, fine, rather long hair.

Female.—Similar to male except frons moderately convex, vestiture shorter, more evenly distributed; strial punctures larger, rather small; interstriae except 1, each with a row of rather fine granules to base of declivity; punctures of declivital striae smaller than on disc; interstrial granules largely obsolete.

Type Locality.—Carbonera Experimental Forest, about 50 km (airline) northwest of Merida, Venezuela.

Type Material.—The male holotype, female allotype, and 33 paratypes were taken at the type locality on 12 January 1970, 2500 m elevation, No. 213, from native bamboo, by S. L. Wood. The habits were as in *gracilis* Wood.

Chramesus orinocensis, n. sp.

This species is allied to *subopacus* Schaeffer, but it is distinguished by the smaller size, by the less strongly, less extensively impressed male frons with the lateral margins less well developed, and by the larger strial punctures.

Male.—Length 1.7 mm (paratypes 1.6-1.8 mm), 1.6 times as long as wide; color very dark brown, vestiture somewhat lighter.

Frons rather deeply concave from epistomal margin to just below upper level of eyes, then flattened from there to vertex; lateral margins acutely, rather strongly elevated from epistomal area to half distance between level of antennal insertion and upper margin of eye; entire surface strongly reticulate, punctures very small, not clearly indicated; vestiture of fine, long hair, moderately abundant near marginal areas of upper half.

Pronotum 0.80 times as long as wide; essentially as in *subopacus*.

Elytra 1.0 times as long as wide; sides almost straight and parallel on slightly less than basal half, broadly rounded behind; striae slightly impressed, punctures moderately large, distinctly, shallowly impressed; interstriae twice as wide as striae, weakly convex, almost smooth but not shining, punctures fine, abundant, confused. Declivity as in other species; sculpture as on disc. Vestiture of abundant, short, interstrial scales in ground cover, each slightly longer than wide, some with acute points; and interstrial rows of longer, erect scales, each about two and one-half times as long as ground cover, about six times as long as wide.

Female.—Similar to male except frons weakly convex, lateral margins not modified, vestiture short, coarse, uniformly distributed; anterolateral areas of pronotum moderately asperate; basal half of each discal interstriae armed by a row of small granules.

Type Locality.—Campamento Rio Grande, 30 km east of Palmar, Bolivar, Venezuela.

Type Material.—The male holotype, female allotype, and 71 paratypes were taken at the type locality on 12 June 1970, 200 m elevation, No. 568, from Bejuco Trinitario, by S. L. Wood. The host appeared very similar to, if not identical with, *Celtis iguanae*. Specimens were taken from a small, broken branch, from transverse parental tunnels.

The holotype, allotype, and paratypes are in my collection.

Chramesus strigilis, n. sp.

This species evidently is allied to *orinocensis* Wood, but it is distinguished by the larger average size, by the lighter color, by the coarser vestiture and by the strongly, closely serrate lateral margins of the male frons.

MALE.—Length 2.0 mm (paratypes 1.9-2.1 mm), 1.5 times as long as wide; color brown.

Frons deeply, broadly concave from epistomal margin to well above eyes; lateral margins acutely elevated from epistoma to level of antennal insertion, much more strongly elevated and closely, strongly serrate from there to two-thirds distance to upper level of eyes; surface reticulate, a few fine, obscure punctures indicated; vestiture of fine, sparse, short hair.

Pronotum 0.74 times as long as wide; widest at base, sides arcuate and strongly converging to slight constriction just before broadly rounded anterior margin; surface reticulate; posteromedian area rather sparsely, coarsely, shallowly punctured, anteriorly and laterally from this point anterior margins of punctures become increasingly asperate as punctures become smaller and more obscure, a few nonasperate punctures interspersed. Vestiture of rather long, slender scales.

Elytra 1.1 times as long as wide; sides almost straight and parallel on basal half, broadly rounded behind; striae deeply, rather narrowly impressed, punctures rather small, moderately deep; interstriae about three times as wide as striae, rather strongly convex, almost smooth, punctures very fine, confused; a few pointed granules at bases of large, erect scales. Declivity moderately steep, convex; sculpture about as on disc; interstriae 1 weakly elevated. Vestiture of rather abundant interstrial ground scales, each slightly longer than wide; and interstrial rows of longer, erect scales, each twice as long as ground scales and four times as long as wide, spaced within a row by two or more times length of a scale.

FEMALE.—Similar to male except frons weakly convex, shallowly foveate at center, lateral margins not elevated or otherwise modified; pronotal asperities larger but more nearly restricted to anterolateral areas; interstrial tubercles larger, very widely separated posteriorly but extending to declivity at bases of major setae.

TYPE LOCALITY.—Carbonera Experimental Forest, 50 km (airline) northwest of Merida, Venezuela.

TYPE MATERIAL.—The male holotype, female allotype, and 33 paratypes were taken at the type locality on 27 October 1969, 2500 m elevation, No. 89, from an unidentified cut seedling by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Chramesus imporcatus, n. sp.

This species represents a species group new to me. The male frons bears the pair of tubercles on the lateral margins near the antennal insertions as in many other species, but it also bears a pair of sharply elevated carinae on the upper fourth of the lateral margins, their upper limits ending just below the upper level of the eyes. In this species the upper carinae are on the crest of the lateral margins.

MALE.—Length 2.0 mm (paratypes 1.9-2.1 mm), 1.5 times as long as wide; color almost black.

Frons deeply, broadly excavated from epistomal margin to well above eyes; lateral margins below level of antennal insertion strongly, acutely elevated, not pointed, margins above antennal insertion subacutely, weakly elevated then upper third strongly, acutely elevated to just below upper level of eyes; surface deeply reticulate, punctures sparse, small, obscure; vestiture of very fine, short, sparse hair. Antennal club large, typical of genus.

Pronotum 0.79 times as long as wide; widest one-third from base; sides strongly, arcuately converging to moderate constriction just before broadly rounded anterior margin; surface finely reticulate, punctures small, rather shallow, some in anterolateral area finely asperate on anterior margins. Vestiture of elongate, slender scales of moderate abundance.

Elytra 1.0 times as long as wide; sides almost straight and parallel on basal half, broadly rounded behind; striae strongly impressed, punctures rather small, deep; interstriae moderately convex, smooth, almost three times as wide as striae, a median row of narrow, rather high crenulations on each except confused on disc of 2 and part of 3, those in lateral areas more like flattened nodules, minute supplemental punctures also moderately abundant. Declivity rather steep, convex; sculpture about as on disc, granules slightly smaller. Vestiture of very small ground scales, each about twice as long as wide, and longer, erect interstrial scales in rows except confused on 2 and 3 and toward base, each scale about three times as long as ground scales, about six times as long as wide, spaced within a row by length of a scale.

FEMALE.—Similar to male except frons weakly convex, margins simple.

TYPE LOCALITY.—Seven km northwest of Socopo, Barinas, Venezuela.

TYPE MATERIAL.—The male holotype, female allotype, and nine paratypes were taken at the type locality on 13 February 1970, 200 m elevation, No. 323, from a shrub known as Palito de Cruz, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Chramesus impolitus, n. sp.

This species is very closely related to *imporcatus* Wood, but it is distinguished by the smaller size, by the larger strial punctures, by the absence of ground vestiture on the elytra, and by the slight median displacement of the upper ridges on the male frons.

MALE.—Length 1.8 mm (paratypes 1.6-2.0 mm), 1.6 times as long as wide; color almost black.

Frons as in *imporcatus* except upper carinae displaced medially very slightly. Pronotum as in *imporcatus* except punctures more shallow.

Elytra as in *imporcatus* except striae less strongly impressed, punctures larger; interstriae twice as wide as striae except 2 wider; ground vestiture entirely absent, small interstrial punctures also absent.

FEMALE.—Similar to male except frons weakly convex, margins simple.

TYPE LOCALITY.—Campamento Rio Grande, 30 km east of Palmar, Bolivar, Venezuela.

TYPE MATERIAL.—The male holotype, female allotype, and 54 paratypes were taken at the type locality on 12 June 1970, 200 m elevation, No. 581 (some paratypes No. 567), from the shrub Rosa de Montaña (presumably *Brownia* sp.), by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Chramesus parcus, n. sp.

This species differs from all other representatives of the genus known to me by the small size, by the total absence of ground vestiture on the elytra, by the absence of pronotal asperities, and by the presence of a pair of tubercles arming the male frons as in most other species of the genus.

MALE.—Length 1.4 mm (paratypes 1.3-1.4 mm), 1.9 times as long as wide; color rather dark brown, elytra slightly lighter.

Frons rather strongly concave from epistoma to just below upper level of eyes; lateral margins subacutely elevated on lower half, armed at level of antennal insertion by a pair of coarse, pointed denticles; surface very finely reticulate-granulate; subglabrous. Antennal club rather small for this genus.

Pronotum 0.85 times as long as wide; widest one-third length from base, sides moderately arcuate on basal half, a slight constriction just before rather broadly rounded anterior margin; surface reticulate; punctures coarse, shallow, not close. Vestiture restricted to a few coarse setae in lateral and anterior areas.

Elytra 1.2 times as long as wide, 1.5 times as long as pronotum; sides almost straight and parallel on slightly more than basal half, broadly rounded behind; striae not impressed, punctures coarse, rather deep; interstriae smooth, shining, slightly wider than striae, punctures replaced by moderately large, uniseriate, setiferous granules. Declivity rather steep, convex; striae and interstriae narrower than on disc, strial punctures and interstrial granules distinctly smaller. Vestiture of interstrial rows of erect bristles; each bristle slightly wider near its tip, spaced within a row by distances slightly less than length of bristle, between rows by distances slightly greater than length of a bristle.

FEMALE.—Similar to male except frons flattened on lower third, foveate at center, lateral margins unmodified.

TYPE LOCALITY.—Rancho Grande, Aragua, Venezuela.

TYPE MATERIAL.—The male holotype, female allotype, and 27 paratypes were taken at the type locality on 9 April 1970, 1100 m elevation, No. 426, from a *Tabebuia* twig, by S. L. Wood. The biramose parental tunnels were broadly V-shaped, with both egg tunnels diagonal.

The holotype, allotype, and paratypes are in my collection.

Chramesus denticulatus, n. sp.

This species is unique in the genus. It is distinguished from all known species by the small size, by the unarmed male frons, by the finely asperate anterolateral areas of the pronotum, and by the finely dentate declivital interstriae.

MALE.—Length 1.3 mm (paratypes 1.2-1.3 mm), 1.9 times as long as wide; color yellowish brown.

Frons rather deeply concave on a subcircular area from epistoma to upper level of eyes, lateral margins subacute, unarmed; epistomal margin carinately elevated, more strongly on median third; surface reticulate, punctures minute, obscure; vestiture uniformly short, coarse, uniformly distributed setae. Antennal club rather small for this genus.

Pronotum 0.77 times as long as wide; widest near base, sides convergently arcuate to broadly rounded anterior margin; surface reticulate, almost uniformly covered by isolated, rather widely spaced, small subasperate tubercles. Vestiture short, of almost equal numbers of very fine hair and rather broad scales.

Elytra 1.3 times as long as wide, 1.7 times as long as pronotum; sides almost straight and parallel on slightly more than basal half, broadly rounded behind, posterior outline interrupted by declivital teeth; striae moderately impressed, punctures rather coarse, shallow; interstriae subreticulate, weakly convex, as wide as striae; punctures replaced by rows of granules, very fine at base, becoming coarse toward declivity. Declivity rather steep, broadly convex; striae narrower and deeper than on disc; interstriae more narrowly convex, each armed by a row of close, rather small pointed teeth, except almost obsolete on lower half of 2. Vestiture of ground cover formed by two indefinite rows of short, stout setae on margins of each interstriae, and a central row of short, erect scales; each scale about twice as long as wide, spaced within and between rows by slightly more than twice length of a scale; scales about twice as long as ground setae.

FEMALE.—Similar to male except frons weakly concave, epistoma weakly elevated, frontal vestiture of short scales; pronotal asperities larger in anterolateral areas; interstrial teeth on declivity slightly smaller, regularly present on 2.

TYPE LOCALITY.—Twenty km southwest of El Vigia, Merida, Venezuela.

TYPE MATERIAL.—The male holotype, female allotype, and three paratypes were taken at the type locality on 21 November 1969, 50 m elevation, No. 150, from a small stem of a large, cut Bignoniaceae vine (liana), by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Chramesus priscus, n. sp.

This species remotely resembles *denticulatus* Wood, but the relationship is remote. It is distinguished by the unarmed male frons that has the epistomal margin transversely carinate, by the feebly asperate anterolateral areas of the pronotum, by the different vestiture, and by the minute declivital granules.

MALE.—Length 2.2 mm (paratypes 2.0-2.2 mm), 1.9 times as long as wide; color brown, elytra slightly lighter.

Frons rather deeply, broadly concave from epistoma to slightly above eyes; median half of epistoma acutely, transversely carinate, a pair of minute denticles at ends of carina; lateral margins subacute, the fourth immediately above level of antennal insertion thicker, more strongly elevated, not dentate; surface reticulate, punctures very fine, sparse; vestiture fine, long, rather sparse. Antennal club more slender and more sparsely pubescent than in most species.

Pronotum 0.73 times as long as wide; widest at base, sides rather strongly, arcuately converging to slight constriction just before broadly rounded anterior margin; surface strongly reticulate, punctures replaced by fine, sparse granules, finely asperate in lateral areas. Vestiture of fine and stout hairlike setae of moderate abundance.

Elytra 1.3 times as long as wide, 2.0 times as long as pronotum; sides almost straight on basal half, slightly wider near base of declivity, broadly rounded behind; striae weakly impressed, punctures moderately large, rather deep; interstriae twice as wide as striae, weakly convex, minutely irregular, shining, punctures replaced by rows of fine granules, punctures giving rise to ground vestiture mostly too small to see at 80 diameters magnification. Declivity rather steep, convex; striae slightly deeper, interstriae more convex than on disc; interstrial granules rather small, close. Vestiture short, rather coarse, moderately abundant; central row on each interstriae slightly longer and coarser.

FEMALE.—Similar to male except frons weakly convex, weakly, transversely impressed above epistoma, a central fovea present; anterolateral pronotal asperities much larger.

TYPE LOCALITY.—Carbonera Experimental Forest, about 50 km (airline) northwest of Merida, Venezuela.

TYPE MATERIAL.—The male holotype, female allotype, and nine paratypes were taken at the type locality on 9 December 1969, 2500 m elevation, No. 175, from dead mistletoe (possibly *Phoradendron*), by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Chramesus vinealis, n. sp.

This species is very closely allied to *orinocensis* Wood, but it is distinguished as indicated below in the description.

MALE.—Length 1.9 mm (paratypes 1.7-2.0 mm), 1.6 times as long as wide; color very dark brown, almost black.

Frons as in *orinocensis* except acutely elevated part of lateral margin more strongly elevated on its lower half and less strongly elevated on its upper half. Pronotum as in *orinocensis* except punctures distinctly larger, slightly deeper, asperities in lateral areas larger, more numerous.

Elytra as in *orinocensis* except striae slightly more strongly impressed, punctures on 1-3 obsolete, others smaller, not as deep; declivital interstriae each with a row of widely spaced fine granules; interstrial ground scales much smaller; erect scales as in *orinocensis*.

Female.—Similar to male except frons convex, margins simple; striae 1-3 with punctures clearly indicated; interstriae each with a row of fine granules on both disc and declivity.

Type Locality.—Thirty km north of Cañon Zancudo, Zulia, Venezuela.

Type Material.—The male holotype, female allotype, and 136 paratypes were collected at the type locality on 4 June 1970, 10 m elevation, No. 522, from an unidentified vine (liana), by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Chramesus solicitatus, n. sp.

This species might possibly be allied to *rotundatus* Chapuis, but it is distinguished by the smaller size, by the larger tuft of hair on the scape, by the much more deeply excavated male frons, and by other characters.

Male.—Length 1.6 mm (paratypes 1.4-1.6 mm), 1.6 times as long as wide; color brown.

Frons shallowly, broadly concave from epistomal margin to well below upper level of eyes; middle third of lateral margins distinctly, subacutely, not strongly elevated, indistinctly serrate; surface deeply reticulate above, irregularly, indistinctly rugose-reticulate below; vestiture inconspicuous. Antennal scape elongate, apex slightly produced and ornamented by about a dozen hairlike setae equal in length to scape; club moderately small for this genus.

Pronotum 0.73 times as long as wide; widest at base, sides rather strongly, arcuately convergent to broadly rounded anterior margin; surface reticulate, fine and moderately coarse, shallow punctures intermixed; anterolateral areas with a few irregularities, not clearly asperate. Vestiture of moderately abundant, slender scales.

Elytra 1.0 times as long as wide; sides straight and parallel on less than basal half, broadly rounded behind; striae distinctly impressed, punctures moderately coarse, rather shallow; interstriae weakly convex, almost smooth, dull, almost twice as wide as striae, each with a row of rather coarse granules and minute, confused punctures. Declivity rather steep, broadly convex; striae more narrowly impressed, punctures smaller, less distinct; interstriae narrower, less convex, granules smaller and more widely spaced. Vestiture of small, abundant ground scales, each slightly longer than wide, and interstrial rows of long scales, each almost three times as long as ground scales, six to eight times as long as wide, about half as long as distance between scales within a row or between rows.

Female.—Similar to male except frons convex, a transverse callus at level of antennal insertion, central fovea indistinct; scape not ornamented by hair; four or five rather coarse asperities in anterolateral area of pronotum; scales in ground cover of interstriae slender, up to four times as long as wide.

Type Locality.—Campamento Rio Grande, 30 km east of Palmar, Bolivar, Venezuela.

Type Material.—The male holotype, female allotype, and 13 paratypes were taken at the type locality on 12 June 1970, 200 m elevation, No. 569, from an unidentified vine (liana), by S. L. Wood. The parental galleries were oblique to longitudinal.

The holotype, allotype, and paratypes are in my collection.

Chramesus peniculus, n. sp.

This species is allied to *rotundatus* Chapuis, but it is distinguished by the much smaller size, and by the very long interstrial bristles.

Male.—Length 1.2 mm (paratypes 1.2-1.3 mm), 1.5 times as long as wide; color dark brown with pale scales.

Frons rather deeply, broadly concave from epistomal margin to slightly above eyes; lateral margins subacutely elevated, with a rather strongly elevated, subquadrate denticle on margin slightly above level of antennal insertion; surface strongly reticulate, punctures not evident; vestiture sparse, inconspicuous. Antennal scape ornamented at apex by a tuft of perhaps a dozen long hairlike setae as long as scape; club rather small for this genus.

Pronotum 0.70 times as long as wide; widest near base, sides strongly arcuate, converging to moderate constriction just before rather broadly rounded anterior margin; surface strongly reticulate, punctures moderately close, small and rather large intermixed, becoming finely then rather coarsely asperate toward anterolateral areas. Vestiture of moderately abundant, slender and stout, short, semirecumbent bristles.

Elytra 0.90 times as long as wide; sides straight and parallel on less than basal half, very broadly rounded behind; 13 crenulations on basal margin, submarginal row extending to striae 5; striae rather strongly impressed, punctures small, rather shallow; interstriae slightly wider than striae, evidently weakly convex, devoid of granules, punctures very small. Declivity beginning at middle, moderately steep, broadly convex; sculpture about as on disc except striae and interstriae somewhat narrower. Vestiture of ground cover of abundant, short, interstrial scales, each scale about as long as wide; and erect, flattened bristles about four times as long as ground cover, spaced between rows by distances about equal to length of a bristle, within a row by one to three times length of a bristle. Broad strial grooves smooth, except for punctures, and glabrous.

Female.—Similar to male except frons weakly convex, a weak, transverse callus just above level of antennal insertion, an obscure fovea at center; scape not ornamented by hair; anterolateral crenulations on pronotum slightly larger; interstrial bristles wider, more nearly scalelike on basal half of elytra.

Type Locality.—Thirty km north of Cañon Zancudo, Zulia, Venezuela.

Type Material.—The male holotype, female allotype, and 14 paratypes were taken at the type locality on 4 June 1970, 10 m elevation, No. 522, from the same unidentified vine (liana) that contained *vinealis*, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Chaetophloeus andinus, n. sp.

This is the second species of *Chaetophloeus* known to occur in South America. It is allied to *brasiliensis* Blackman, but it may be distinguished by the larger size, by the more deeply emarginate epistoma, by the more deeply excavated and elaborately ornamented male frons, and by the longer, erect, interstrial setae.

Male.—Length 1.9 mm (paratypes 1.3-1.8 mm), 1.5 times as long as wide; color very dark brown, with pale and light brown vestiture.

Frons deeply concave to inner margin of eye from epistomal margin to vertex; epistomal margin very deeply, broadly emarginate, less than three times as wide as deep, a pair of marginal tubercles directed orad near median line; lateral and upper margins ornamented by a dense brush of long hair, tips of some setae on vertex extend beyond epistomal margin. Antennal club large, 1.9 times as long as wide; three sutures weakly procurved, suture 3 two-thirds club length from base.

Pronotum as in *brasiliensis*, with surface sculpture finer, one paired group of three tubercles in anterolateral areas; setae of two types, some slender, short, others scales one and one-half to two times as long as wide except three times as long on anterior margin and in small area near scutellum.

Elytra as in *brasiliensis* except strial punctures slightly smaller; interstriae about three times as wide as striae; erect interstrial scales more numerous, in less definite rows, each erect scale about twice as long as wide on disc, up to five times as long as wide on declivity.

Female.—Similar to male except frons weakly convex; epistomal emargination more than four times as wide as deep; frontal vestiture much shorter, uniformly distributed; pronotum with two paired groups of tubercles.

Type Locality.—Three km east of Lagunillas, Merida, Venezuela.

Type Material.—The male holotype, female allotype, and 26 paratypes were taken at the type locality on 12 January 1970, 1000 m elevation, No. 237, from *Mimosa* twigs and No. 236 and 239 from an unidentified vine, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Liparthrum carapae, n. sp.

This is the first record of this genus from South America. As in *americanum* Wood the male frons of this species is broadly concave, but it differs by the restriction of frontal pubescence to the vertex, by the much finer, less abundant vestiture on pronotum and elytra, by the obsolescent strial punctures, and by the larger size.

Male.—Length 1.1 mm (paratypes 0.8-1.2 mm), 2.4 times as long as wide; color dark reddish brown.

Frons rather deeply concave from eye to eye from epistomal margin to vertex; surface shining, punctures very minute, rather abundant; concavity apparently glabrous, upper margin ornamented by a brush of long hair, tips of some setae reaching middle of concavity. Antennal club rather large, broadly oval, devoid of sutures.

Pronotum 1.0 times as long as wide; sides subparallel, feebly arcuate on basal half, rather broadly rounded in front; moderately declivous on anterior fourth; surface subreticulate, with minute, isolated asperities on median area almost to base, punctures not evident. Vestiture of fine, recumbent hair and a few erect, slender scales.

Elytra 1.4 times as long as wide, 1.4 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather broadly rounded behind; each basal margin armed by six crenulations; striae not impressed, punctures almost totally obsolete, a few feebly impressed near center of disc; interstriae minutely irregular, uniseriately granulate. Declivity steep, convex; as on disc. Vestiture consisting of very fine, rather short, recumbent, strial hair; and rows of erect, interstrial scales, each scale about half as long as distance between rows, each about three times as long as wide on disc, on declivity almost as wide as long.

Female.—Similar to male except frons convex, minutely reticulate-granulate, glabrous; anterior margin of pronotum armed by eight teeth; pronotal asperities much larger; striae more distinctly impressed on declivity.

Type Locality.—Campamento Rio Grande, 30 km east of Palmar, Bolivar, Venezuela.

Type Material.—The male holotype, female allotype, and 230 paratypes were collected at the type locality on 12 June 1970, 200 m elevation, No. 572, *Carapa guianensis*, S. L. Wood. The beetles infested the phloem of branches and bole of the host. The galleries were typical of the genus.

The holotype, allotype, and paratypes are in my collection.

Liparthrum meridensis, n. sp.

This species has the concave male frons of *americanum* Wood, but it may be distinguished from other species of this group by the elevated interstriae 3 and by the absence of scales on declivital interstriae 2.

Male.—Length 0.8 mm (paratypes 0.75-0.85 mm), 2.2 times as long as wide; color very dark brown.

Frons concave from eye to eye, from epistoma to upper level of eyes; surface reticulate, punctures minute, rather abundant; vestiture moderately abundant laterally and above, rather abundant and apparently part of setae remarkably spatulate on their distal halves.

Pronotum 0.86 times as long as wide; widest near base, sides rather strongly arcuate on basal half, narrowly rounded in front; surface subreticulate, with rather abundant, isolated granules or minute asperities on median two-thirds to base.

Elytra 1.4 times as long as wide, 1.6 times as long as pronotum; basal margins armed by six pairs of crenulations; striae not impressed, punctures small, moderately deep; interstriae as wide as striae, smooth, uniseriate punctures feebly vulcanate. Declivity steep, convex; interstriae 1 and 3 distinctly elevated, 2 flat. Vestiture of rather fine, short, recumbent strial and interstrial hair, and interstrial rows of erect scales; each scale about twice as long as wide; declivital interstriae 2 and lower half of 4 devoid of scales.

Female.—Similar to male except frons convex, reticulate, with a few obscure punctures; anterior margin of pronotum armed by four teeth; anterior slope of pronotum armed by about a dozen coarse asperities; strial punctures about twice as large, deep; declivital interstriae 1 and 3 more strongly elevated, about a fourth as high as wide.

Type Locality.—Five km east Lagunillas, Merida, Venezuela.

Type Material.—The male holotype, female allotype, and 71 paratypes were collected at the type locality on 12 January 1970, 1000 m elevation, No. 238, from a composite shrub, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Cladoctonus boliviae (Wood)

Hoplitophthorus boliviae Wood, 1961, Gt. Basin Nat. 21:106 (Holotype, female; Route between Boyuilbe and Charagua via Cueva, Ingri, etc., Bolivia; U.S. Nat. Mus.).

A long series of this species was taken at Campo Capote, 27 km northeast of Montoya, Santander, Colombia, 2-VII-70, 150 m elevation, No. 601, from *Pseudoolmedia*, by me. The apparently monogamous beetles entered the bark through tunnels made by an equally small *Phloeotribus*. In the cambium region they appropriated one or both of the *Phloeotribus* egg galleries and extended or branched from it in constructing their own tunnels that engraved both phloem and xylem. The beetles worked more or less in pairs along one branch of the tunnel while other pairs constructed their tunnels as branches of the tunnel of their companions. Usually about two to four branches were formed from one original *Cladoctonus* entry. Larval mines were in the phloem, but were completely confused with those of the *Phloeotribus*. These tunnels were almost identical to those of *Carphodicticus cristatus* Wood.

Pycnarthrum inornatum, n. sp.

This species, at least superficially, is very similar to *hispidum* (Ferrari) except that all long setae or bristles are absent from the entire body; the vestiture consists only of the very short ground cover of scales.

Female.—Length 1.6 mm, about 2.2 times as long as wide (elytra spread slightly); color very dark brown, elytra lighter.

Frons weakly convex except indistinctly concave on central third; eyes separated above by distance greater than width of an eye; surface reticulate, punctures moderately coarse, rather close, sharply, not deeply impressed; vestiture of minute hair and scales, each not longer than twice diameter of a puncture. Antennal club and flagellum missing on type.

Pronotum about equal in length and width; widest at middle, sides weakly arcuate, broadly rounded in front; surface shining, subreticulate on anterior surface, with minute points moderately abundant, punctures moderately coarse, deep, close, interspaces not wider than distance equal to diameter of a puncture. Vestiture inconspicuous, consisting of short, slender hair and on anterior half some equally short, stout setae intermixed.

Elytra about 1.4 times as long as wide; sides almost straight and parallel on basal two-thirds, rather broadly rounded behind; striae 1 moderately, others not impressed, punctures coarse, deep, rather close; interstriae as wide as striae, subshining, very obscurely subreticulate, punctures small, moderately abundant, confused. Declivity steep, broadly convex; interstriae 2 somewhat impressed, narrower than others. Vestiture consisting of minute strial hair on disc only, and short, confused, subplumose, narrow, interstrial scales equally abundant on disc and declivity; rows of erect bristles found in other species of this genus absent.

Type Locality.—Olanchito, Yoro, Honduras.

Type Material.—The female holotype was collected at the type locality on 7 October 1949, at light, by E. C. Becker.

The holotype is in my collection.

Pycnarthrum funerium, n. sp.

This species is allied to *hispidum* (Ferrari) but may be distinguished by the very small size, by the black color, by the small, shallowly impressed strial punctures, and by the more slender, less plumose setae in the elytral ground vestiture.

Female.—Length 1.4 mm (paratypes 1.3-1.4 mm), 2.2 times as long as wide; color black.

Frons rather strongly, evenly convex to epistoma; surface reticulate, becoming subrugulose below, punctures fine, shallow, obscure; eyes separated by distance greater than width of an eye; vestiture of rather sparse, stout, erect, moderately long, white bristles. Antennal club 2.0 times as long as wide, two sutures indicated.

Pronotum 0.93 times as long as wide; widest at or slightly in front of middle, sides weakly arcuate, very broadly rounded in front; surface strongly reticulate on anterior third, obscurely reticulate behind, subshining, punctures small, close, moderately deep. Vestiture of fine hair and stout bristles intermixed over entire surface, moderately long.

Elytra about 1.4 times as long as wide (elytra spread slightly); sides almost straight and parallel on basal two-thirds, rather broadly rounded behind; striae not impressed, punctures rather small, distinct, very shallow; interstriae almost twice as wide as striae, evidently obscurely subreticulate, median row of punctures uniseriate, very small but almost twice as large as confused supplementary punctures. Declivity rather steep, rather narrowly convex, not at all impressed; essentially as on disc, except strial punctures very slightly deeper. Vestiture consisting of short, interstrial ground vestiture of rather fine (anteriorly) to stout (posteriorly) semirecumbent hairlike bristles, a few exhibit indications of being subplumose, and longer, erect, uniseriate rows of stout, almost scalelike setae, each erect bristle slightly less than twice as long as ground vestiture and about four to six times as long as wide; not longer on declivity.

Type Locality.—La Ceiba, Atlantida, Honduras.

Type Material.—The female holotype was taken at the type locality 10 June 1949, at light, by E. C. Becker. Three female paratypes bear identical data except one was taken on 27 May 1949 and two on 29 May 1949.

The holotype and paratypes are in my collection.

Pycnarthrum fici, n. sp.

This species superficially resembles *hispidum* (Ferrari) but may be distinguished by the deeply concave male frons, by the pale yellow mature body color, by the more narrowly convex elytral declivity, and by the shorter elytral vestiture.

Male.—Length 1.7 mm (paratypes 1.6-1.7 mm), 2.2 times as long as wide; color pale yellow.

Frons rather deeply concave from upper level of eyes to epistomal margin; surface reticulate, finely granulate; eyes rather narrowly separated above, separated by distance equal to 1.5 times width of an eye; vestiture of rather fine, short, moderately abundant setae. Antennal club 1.6 times as long as wide; sutures 1 and 2 distinct, 3 obscurely indicated.

Pronotum proportions and outline as in *hispidum*; surface reticulate on anterior third, obscurely subreticulate behind, punctures uniformly rather small, shallow, close. Vestiture very short, of fine and stout setae intermixed.

Elytra 1.4 times as long as wide; sides almost straight and parallel on basal two-thirds, rather narrowly rounded behind; striae weakly impressed, punctures very shallow, obscurely impressed, of moderate size, interstriae about one and one-half times as wide as striae, surface not regular, perhaps very minutely rugulose, punctures minute, many very minutely elevated particularly along median row. Declivity rather steep, convex; striae and interstriae slightly narrower than on disc, striae more distinctly impressed, punctures less distinct. Vestiture consisting of short, stout, moderately abundant ground cover mostly in indefinite marginal rows on each interstriae, not subplumose, and interstrial rows of erect, stout bristles, each bristle about one and one-third times as long as ground setae, very slightly shorter in length than width of an interstriae, at least six times as long as wide.

Female.—Similar to male except frons moderately convex from upper level of eyes to near epistoma; surface very finely subrugulose.

Type Locality.—Olanchito, Honduras.

Type Material.—The male holotype and four paratypes were collected at the type locality on 21 June (type), 15 and 19 May 1949, at light, by E. C. Becker. The female allotype and 40 paratypes were taken at La Ceiba, Honduras, on various dates from May to July 1949, at light, by E. C. Becker. Eighty-seven paratypes were taken at 5 km west of El Pino (near southeastern shore of Lake Maracaibo), Merida, Venezuela, on 20 October 1969, 10 m elevation, No. 113, from strangler fig, by S. L. Wood. The gallery systems were basically as in *hispidum*.

The holotype, allotype, and paratypes are in my collection.

Pycnarthrum perditum, n. sp.

This species and *lucidum* Wood have the setae on the basal half of the elytra much more slender and the erect bristles longer than in other representatives of the genus. From *lucidum* this species is distinguished by the larger, more widely spaced pronotal punctures, by the more abrupt slope of the elytral declivity, and by the less strongly impressed male frons.

Male.—Length 1.3 mm (allotype 1.6 mm), 2.3 times as long as wide; color dark brown, elytra somewhat lighter.

Frons weakly convex except flattened in median area on lower half; surface reticulate, rather finely, shallowly punctured, a conspicuous median fovea at center; eyes separated above by 1.4 times width of an eye. Antennal club 2.0 times as long as wide; sutures 1 and 2 indicated.

Pronotum proportions, outline and sculpture as in *hispidum* except punctures uniformly rather large, deep, not as close; vestiture of fine hair except intermixed with stouter setae on margins and on anterior fifth.

Elytra 1.5 times as long as wide; sides almost straight and parallel on basal two-thirds, rather narrowly rounded behind; striae 1 feebly, others not impressed, punctures moderately large, rather deep; interstriae as wide as striae, punctures of two sizes, a median row of small punctures and less abundant, very minute punctures on margins of interstriae. Declivity rather steep, convex; striae distinctly impressed, narrower than on disc; interstriae weakly convex. Vestiture of fine strial hair and equally fine, short, recumbent, sparse, interstrial hair, and interstrial rows of longer, erect, slender bristles, each bristle one and one-half times as long as ground vestiture, equal in length to width of an interstriae, stout, more than six times as long as wide.

Female.—Similar to male except frons more strongly convex to epistoma, interstrial bristles more slender.

Type Locality.—La Ceiba, Atlantida, Honduras.

Type Material.—The male holotype and female allotype were taken at the type locality on 26 August 1949, at light, by E. C. Becker.

The holotype and allotype are in my collection.

Pycnarthrum lucidum, n. sp.

This species is allied to *perditum* Wood, but may be distinguished by the concave male frons, by the closer, finer, pronotal punctures, by the less steep elytral declivity, by the larger, deeper strial punctures, and by the less abundant, finer pronotal and elytral vestiture.

MALE.—Length 1.7 mm (paratypes 1.5-1.9 mm), 2.3 times as long as wide; color brown, elytra lighter.

Frons moderately concave from upper level of eyes to epistoma, a shining, transverse callus on median half of epistoma, a pair of calli in lateral areas of concavity just above level of antennal insertion; surface shining, obscurely reticulate; punctures rather fine, deep, rather close; eyes separated by distance equal to width of an eye. Antennal club 1.6 times as long as wide, sutures 1 and 2 distinct, 3 obscurely indicated.

Pronotum proportions and outline as in *perditum;* surface brightly shining except obscurely reticulate on anterior third; minute points present, punctures rather small, deep, close. Vestiture mostly abraded, very fine, a few coarse setae in anterolateral areas.

Elytra 1.4 times as long as wide; sides straight and parallel on basal two-thirds, rather narrowly rounded behind; striae weakly impressed, punctures coarse, close, moderately deep; interstriae slightly wider than striae, almost smooth, shining, punctures very fine, in three obscure ranks, median row very slightly larger. Declivity rather steep, convex; striae narrowly impressed, narrower than on disc; interstriae twice as wide as striae, rather weakly convex. Vestiture consisting of fine, short strial hair and interstrial short ground cover of very fine hair on disc becoming scalelike on declivity, and interstrial rows of erect bristles, each bristle almost twice as long as ground cover, equal in length to width of an interstriae, about six to eight times as long as wide.

FEMALE.—Similar to male except frons rather strongly convex from upper level of eyes to epistoma.

TYPE LOCALITY.—Finca Gromaco on Rio Coto Brus, Puntarenas, Costa Rica.

TYPE MATERIAL.—The male holotype and four paratypes were collected at the type locality on 14 July 1963, 500 m elevation, No. 60, from a broken limb, by S. L. Wood. The allotype and 63 female paratypes were taken at Playón, San José, Costa Rica, 20 m elevation, No. 117, in Cedro amarga, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Pycnarthrum carinatum, n. sp.

This species is very similar to *fici* Wood, but it may be distinguished by the sharply elevated, transverse epistomal carina of the male, and by the longer, very stout interstrial bristles.

MALE.—Length 1.8 mm, 2.1 times as long as wide; color very dark brown, elytra lighter.

Frons deeply concave from just below upper level of eyes to epistoma as in *fici;* epistoma armed by an acutely elevated, transverse carina on median fourth; eyes separated above by 2.2 times width of an eye. Other features of head and pronotum essentially as in *fici.*

Elytra 1.25 times as long as wide; outline as in *fici;* striae weakly impressed, punctures rather small, distinctly not deeply impressed, not at all confluent or rugulose; interstriae shining, almost twice as wide as striae, median row of punctures fine, uniseriate, punctures on margins of each interstriae minute. Declivity rather steep, convex; strial punctures deeper than on disc, very close, shining, not at all confluent or reticulate. Vestiture of fine, short, recumbent strial hair and rows of short, rather slender, subplumose scales on each margin of each interstriae; and interstrial rows of erect very stout bristles, each bristle slightly shorter than width of an interstriae, each about four times as long as wide.

TYPE LOCALITY.—Near Leonpampa, Department Huanuco, Peru.

TYPE MATERIAL.—The unique male holotype was collected at the type locality between 11 and 30 December 1937, 800 m elevation, in jungle, No. 3811, by F. Woytkowski.

The holotype is in my collection.

Pycnarthrum subcarinatum, n. sp.

This species is very closely related to *carinatum* Wood except as noted below.

MALE.—Length 1.9 mm (paratypes 1.6-1.9 mm), 2.1 times as long as wide; color very dark brown, vestiture pale.

Frons as in *carinatum* except epistomal carina weakly developed, shorter, not acutely produced. Pronotum as in *carinatum* except vestiture finer. Elytra as in *carinatum* except erect interstrial setae slightly longer and much more slender, each bristle six or more times as long as wide.

FEMALE.—Similar to male except frons convex, epistomal elevation not indicated.

TYPE LOCALITY.—Eight km southwest of Bumbum, Barinas, Venezuela.

TYPE MATERIAL.—The holotype, allotype, and 10 paratypes were taken at the type locality on 11 February 1970, 150 m elevation, No. 327, from Charo Blanco (*Brosmium* sp.), by S. L. Wood.

Pycnarthrum brosmii, n. sp.

This species is allied to *lucidum* Wood, but it may be distinguished by the much finer pronotal and elytral discal punctures, by the more strongly impressed elytral declivity, and by the flattened male frons.

Male.—Length 2.0 mm (paratypes 1.9-2.1 mm), 2.3 times as long as wide; color reddish brown.

Frons flattened from just below upper level of eyes to epistoma; surface shining, obscurely reticulate, punctures fine, moderately close; vestiture rather sparse, fine, erect, moderately long; eyes very large, coarsely faceted, separated above by a distance equal to width of an eye. Antennal club 1.8 times as long as wide, sutures 1 and 2 indicated.

Pronotum equally as long as wide; widest in front of middle, broadly rounded in front; surface shining, except subreticulate on anterior third, a few minute points, punctures fine, rather deep, moderately close; vestiture of fine, short bristles, a few longer setae in marginal areas.

Elytra 1.3 times as long as wide; sides almost straight and parallel on basal two-thirds, rather broadly rounded behind; striae 1 slightly, others feebly or not at all impressed, punctures rather small, moderately close; interstriae twice as wide as striae, almost smooth, median row of punctures uniseriate, fine, becoming finely then rather conspicuously granulate in progressing from anterior to posterior areas, supplementary punctures on margins of each interstriae minute, irregularly spaced. Declivity rather steep, broadly flattened; strial punctures conspicuously larger and deeper than on disc; interstriae slightly wider than striae, 1 moderately elevated, 2 distinctly impressed, all interstriae with upper half uniseriately, rather finely granulate. Vestiture consisting of ground cover of fine, short, moderately abundant strial and interstrial hair, strial setae absent on declivity, interstrial ground cover on declivity of subplumose scales; and interstrial rows of erect bristles, each bristle slightly more than twice as long as ground cover, about equal in length to width of an interstriae, each at least eight times as long as wide.

Female.—Similar to male except frons moderately convex from upper level of eyes to epistoma.

Type Locality.—Nine km south of Barrancas, Barinas, Venezuela.

Host.—*Brosmium* sp. (Charo amarillo).

Type Material.—The male holotype, female allotype, and six paratypes were collected at the type locality on 1 October 1969, 150 m elevation, No. 23, from Charo amarillo, by S. L. Wood; 12 paratypes bear identical data except 5 November 1969, No. 106; two paratypes are labeled 8 km SW Bumbum, Barinas, Venezuela, 11-II-70, No. 319; two paratypes 10 km SE Miri, Barinas, Venezuela, 8-II-70, No. 299; six paratypes 27 km NE Montoya, Santander, Colombia, 2-VII-70, No. 591; and 24 paratypes 8 km S Colonia (near Buenaventura), Valle de Cauca, Colombia, 9-VII-70, No. 645, all from the same host and collector.

Gymnochilus alni, n. sp.

This species is rather similar to *reitteri* Eichhoff, but may be distinguished by the concave male frons, by the elongate body, by the absence or near absence of sutures on the antennal club, and by the obsolescent strial punctures on the disc.

Male.—Length 2.2 mm (paratypes 2.0-2.2 mm), 2.2 times as long as wide; color light brown to bicolored.

Frons rather shallowly, broadly concave from well above eyes to epistoma; surface strongly reticulate, a transverse arcuate callus at and slightly above level of antennal insertion, punctures fine, shallow, moderately abundant; vestiture fine, very short, sparse. Antennal club 1.3 times as long as wide, sutures not clearly evident except basal portion slightly sclerotized to point where suture 1 normally located.

Pronotum 0.86 times as long as wide; outline, sculpture and vestiture as in *reitteri* except posterior area finely, densely punctured.

Elytra 1.3 times as long as wide; sides almost straight and parallel on more than basal half, narrowly rounded behind; striae 1 distinctly, others feebly or not at all impressed, punctures small, scarcely distinguishable from those of interstriae; interstriae three to four times as wide as striae, obscurely subreticulate, rather finely, densely punctured. Declivity commencing at middle, moderately steep, convex; strial punctures small, distinct; interstriae 1 weakly elevated. Vestiture of short, recumbent, very abundant, fine hair; and sparse interstrial rows of erect bristles, those on even-numbered interstriae only slightly longer than ground vestiture, on disc only, those on odd interstriae slender, equal in length to width of an interstriae on both disc and declivity.

FEMALE.—Similar to male except frons weakly convex, callus present; short interstrial bristles on even-numbered interstriae slightly longer, extending to declivity.

TYPE LOCALITY.—Ten km SE Teziutlán, Puebla, Mexico.

TYPE MATERIAL.—The male holotype, female allotype, and 24 paratypes were taken at the type locality, from *Alnus*, on 2 July 1967, 1600 m elevation, No. 141, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Scolytodes ommateus, n. sp.

This unique species is distinguished from all other species in the genus by the large, very narrowly separated eyes on the vertex, by the strongly impressed lower half of the female frons, by the fine, greatly reduced vestiture, and by the sulcate elytral declivity. It evidently represents a new species group in the genus. It would be placed in *Pycnarthrum* except for the antennal club.

FEMALE.—Length 2.0 mm (paratypes 1.7-2.0 mm), 2.6 times as long as wide; color yellowish to reddish brown.

Frons very strongly concave on upper half, abruptly, rather strongly impressed on lower half; entire surface reticulate, with rather obscure, shallow, rather fine, moderately sparse punctures; vestiture fine, sparse, inconspicuous. Eyes greatly enlarged, approximate above, separated by a distance equal to less than diameter of two facets. Antennal club with suture 1 partly septate, others obsolete.

Pronotum 1.2 times as long as wide; widest on basal fourth, sides almost straight and parallel on basal two-thirds, rather broadly rounded in front; moderately declivous on anterior fourth; surface reticulate, rather fine, shallow, moderately abundant. Vestiture minute, inconspicuous, a few longer hairs on anterior margins.

Elytra 1.5 times as long as wide, 1.5 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather broadly rounded behind; striae not impressed, punctures shallow, moderately large, in somewhat indefinite rows; interstrial punctures slightly smaller than those of striae, not easily distinguished. Declivity steep, convex and rather narrowly bisulcate; declivital punctures fine, confused, indistinct; sutural interspace moderately elevated, a moderately deep, narrow sulcus on interstriae 2; lateral areas convex. Vestiture consisting of minute, fine, strial and interstrial hair, and a few long, erect hairlike setae on and near declivity.

MALE.—Similar to female except frons not impressed, convex.

TYPE LOCALITY.—Eight km south of Colonia (near Buenaventura), Valle de Cauca, Colombia.

TYPE MATERIAL.—The female holotype, male allotype, and 97 paratypes were taken at the type locality on 9 July 1970, 70 m elevation, No. 624, from *Clusia* twigs, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Scolytodes punctifer, n. sp.

This pubescent species is allied to *punctatus* Eggers, but it may be distinguished by the much smaller strial punctures with the interstrial punctures much smaller than those of the striae, by the smooth pronotum surface with smaller punctures, and by the more abundant elytral hair.

MALE.—Length 1.5 mm, 2.0 times as long as wide; color very dark brown, elytra slightly lighter, abundant vestiture pale.

Frons convex, a slight transverse impression just above epistoma; surface obscurely reticulate, punctures rather small, deep, moderately close; vestiture fine, sparse, short. Sutures of antennal club almost obsolete.

Pronotum 0.95 times as long as wide; sides parallel, feebly arcuate on basal half, broadly rounded in front; surface obscurely reticulate behind, distinctly reticulate toward anterior margin, punctures coarse, deep, close. Vestiture fine, abundant, moderately long.

Elytra 1.3 times as long as wide; sides almost straight and parallel on basal two-thirds; striae 1 feebly, others not impressed, punctures rather coarse, deep; interstriae smooth about one and one-half times as wide as striae, punctures rather large, uniseriate except slightly confused on 2. Declivity convex, rather steep; all punctures distinctly smaller, otherwise similar to disc. Vestiture of rather abundant, fine, erect, strial and interstrial hair, and slightly longer, uniseriate rows of slightly coarser, interstrial hair; each long hair about one and one-half times as long as distance between rows.

TYPE LOCALITY.—Volcan Irazu, Cartago, Costa Rica.

TYPE MATERIAL.—The unique male holotype was taken at the type locality on 26 September

1963, 2300 m elevation, No. 207, from a twig of *Oreopanax nubigenus*, by S. L. Wood.

The holotype is in my collection.

Scolytodes hirsutus, n. sp.

This species is allied to *punctifer* Wood, but it may be distinguished by the fine, confused elytral punctures, by the strongly reticulate, dull pronotal surface, and by the much finer pronotal punctures.

MALE.—Length 1.7 mm, 2.1 times as long as wide; color black.

Frons moderately convex, surface strongly reticulate, punctures fine, deep, moderately abundant; vestiture inconspicuous.

Pronotum 0.95 times as long as wide; outline as in *punctifer;* surface strongly reticulate, dull, punctures fine, rather shallow, moderately abundant. Vestiture fine, rather abundant, moderately long.

Elytra 1.2 times as long as wide; outline as in *punctifer;* strial and interstrial punctures equal in size, small, rather shallow, interstrial punctures confused, those of striae distinguished with difficulty. Declivity convex, rather steep; punctures minute, confused. Vestiture of fine, long strial and interstrial hair, and slightly longer uniseriate rows of interstrial hair; each longer hair slightly longer than distance between rows.

TYPE LOCALITY.—Tapanti, Cartago, Costa Rica.

TYPE MATERIAL.—The unique male holotype was taken at the type locality on 2 July 1963, 1300 m elevation, No. 8, from an unidentified vine, by S. L. Wood.

The holotype is in my collection.

Scolytodes crassus, n. sp.

The position of this small, stout species is problematical, but the rows of very fine, strial and interstrial hair suggest a possible relationship to *hirsutus* Wood.

MALE.—Length 1.0 mm, 1.9 times as long as wide; color yellowish brown, apparently not fully colored.

Frons convex, surface obscurely reticulate, shining, punctures rather large, deep, not close; fine, moderately abundant toward epistoma.

Pronotum 0.94 times as long as wide; widest at base, sides indistinctly arcuate, converging very slightly on basal two-thirds, rather narrowly rounded in front; surface smooth and shining, punctures small, rather shallow, moderately close, irregularly spaced. Vestiture of short, very fine, moderately abundant recumbent hair.

Elytra 1.2 times as long as wide, 1.5 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather broadly rounded behind; striae feebly if at all impressed, punctures large, moderately deep, close; interstriae almost as wide as striae, smooth, shining, punctures very fine, uniseriate, close. Declivity convex, rather steep; strial punctures gradually reduced to about two-thirds size on disc; interstriae slightly wider than striae, very feebly convex. Vestiture consisting of uniseriate rows of very fine, recumbent, moderately long strial and interstrial hair; in addition, odd-numbered interstriae on posterior half of elytra bear widely spaced, erect, spatulate bristles of moderate length, about six such bristles on each interstriae.

TYPE LOCALITY.—Barro Colorado Island, Canal Zone, Panama.

TYPE MATERIAL.—The male holotype was taken at the type locality between November 1952 and March 1953, presumably at light, by J. Zetek.

The holotype is in my collection.

Scolytodes pannuceus, n. sp.

This species and *plicatus* Wood are unique in having unusually broad, costiform pronotal asperities. This species is distinguished from *plicatus* by the smaller, shallow strial and interstrial punctures, and by the very different sculpture of the female frons.

FEMALE.—Length 1.7 mm (male 1.5 mm), 2.4 times as long as wide; color yellowish brown.

Frons flattened from epistoma to upper level of eyes, surface minutely, densely pilose over almost entire flattened area; epistomal margin very slightly elevated, smooth, shining, a narrow median extension reaching level of antennal insertion; lateral and upper extreme margins bearing a row of long, yellow hair.

Pronotum and elytra as in *plicatus* except pronotal punctures slightly larger, strial and interstrial punctures much larger and deeper.

MALE.—Similar to female except frons convex, reticulate, punctures moderately large, shallow, rather sparse, subglabrous; pronotal asperities slightly larger; pronotal and elytral punctures distinctly finer.

TYPE LOCALITY.—La Ceiba, Atlantida, Honduras.

TYPE MATERIAL.—The female holotype was taken at the type locality on 7 June 1949, at light, by E. C. Becker. The male allotype bears identical data except that it was taken on 17 June 1949.

The holotype and allotype are in my collection.

Scolytodes micidus, n. sp.

This species is very closely related to *tenuis* Wood, but it may be distinguished by the closely set bristles on all interstriae, by the finer interstrial punctures, and by the glabrous central area on the female frons.

Female.—Length 1.4 mm (paratypes 1.2-1.4 mm), 2.9 times as long as wide; color almost black.

Frons flattened from epistoma to upper level of eyes, median third on lower half smooth, shining, slightly elevated, remaining area coarsely, closely, deeply punctured; punctured area bearing a tuft of long, yellow hair.

Pronotum 1.2 times as long as wide; sides rather strongly constricted on basal half, otherwise as in *tenuis* except posterior area smooth, shining (feebly reticulate in a few specimens).

Elytra 1.8 times as long as wide; outline and sculpture as in *tenuis*. Vestiture consisting of fine, short strial hair and long, erect interstrial bristles; each interstrial bristle slightly longer than distance between rows and between bristles within a row.

Male.—Similar to female except frons convex, deeply, narrowly, transversely impressed above epistoma, surface coarsely, deeply punctured.

Type Locality.—Four miles north of Totolapan, Oaxaca, Mexico.

Type Material.—The female holotype, male allotype, and 28 paratypes were collected at the type locality on 20 June 1967, 1100 m elevation, No. 68, in *Ficus*, by S. L. Wood. One paratype was taken at Palin, Esquintla, Guatemala, 19 May 1964, 300 m elevation, No. 683, S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Microborus lectus, n. sp.

This species is allied to *boops* Blandford, but it is distinguished by the more widely separated eyes and elongate frons, by the more coarsely punctured pronotum, by the more strongly reduced punctures on striae 1 on the lower half of the declivity particularly in the male, and by the much more strongly elevated male declivital interstriae 7 which continues to the apex.

Male.—Length 1.5 mm (paratypes 1.4-1.5 mm), 2.8 times as long as wide; rather dark reddish brown.

Frons moderately convex, a slight summit just above level of antennal insertion, a weak, transverse impression just above epistoma; surface reticulate at sides and above, shining, with sparse, moderately coarse punctures; eyes separated by twice width of an eye.

Pronotum 1.4 times as long as wide; widest at base, sides feebly constricted, almost straight on basal three-fourths, rather broadly rounded in front; surface shallowly reticulate, punctures rather coarse, close, deep, oval. Glabrous.

Elytra 1.8 times as long as wide, 1.5 times as long as pronotum; outline about as in *boops* except apex narrower; striae strongly impressed, punctures large, deep, close; interstriae smooth, shining, strongly convex, as wide as striae, punctures fine, uniseriate, rather widely spaced. Declivity steep, convex; striae strongly impressed except lower half of 1, punctures strongly reduced, minute on 1; interstriae strongly narrowed on left side, moderately so on right, 2 feebly elevated and armed by about three to six small teeth (usually different numbers on right and left sides), 3 and 4 convex but unarmed and continuing to 7, 7 strongly, acutely elevated and continuing to apex. Vestiture confined to declivity, of coarse, rather short hair; a few scales on interstriae 1 and 2.

Female.—Similar to male except pronotum more finely sculptured; elytral declivity sculptured about as on disc except interstrial punctures very finely granulate and punctures on striae 1 much smaller; declivital interstriae 7 only moderately elevated as in female *boops*; scalelike setae on declivity absent.

Type Locality.—Carbonera Experimental Forest, about 50 km (airline) northwest of Merida, Venezuela.

Type Material.—The male holotype, female allotype, and 19 paratypes were collected at the type locality on 14 October 1969, 2500 m elevation, No. 57, from *Clusia* bark, by S. L. Wood. Most of the galleries were at the fracture point between the outer and inner bark of *Clusia* logs from which other bark beetles had previously emerged. Evidently several successive generations were produced without emerging from the host between generations.

The holotype, allotype, and paratypes are in my collection.

Scolytus barinensis, n. sp.

The frons resembles *proximus* Chapuis, the elytra are as in *cristatus* Wood. Sternum 2 resembles *cristatus*, but it is much more steeply elevated and more finely sculptured, and the median elevated process arises at the anterior margin of sternum 2, it is slightly thicker, of rather high uniform height and descends abruptly behind.

MALE.—Length 2.6 mm (paratypes 2.0-2.9 mm), 1.7 times as long as wide; color almost black.

Frons broadly, weakly convex, a slight transverse impression on lower third, a moderately large, rounded, shining tubercle just above middle, tubercle convex and equally precipitous on all sides; surface obscurely reticulate on upper half, fine, moderately deep punctures arranged in obscure, shallow aciculate grooves, punctures on lower half replaced by close, rounded granules of equal size; epistomal margin smooth; vestiture of moderately abundant, very fine, long hair, slightly longer laterally. Antennal club with suture 1 indicated.

Pronotum 0.97 times as long as wide; widest one-third length from base, sides weakly arcuate, converging slightly on basal two-thirds then moderately constricted laterally just before broadly rounded anterior margin; surface smooth shining, punctures on disc slightly oval in shape, rather close, moderately large for this genus, about two to three times larger in lateral areas. Glabrous.

Elytra outline as in *cristatus;* striae and interstriae equally, narrowly, strongly impressed, punctures moderately large, rather deep; interspaces between rows smooth and shining, about as wide as punctures. Glabrous except for a few scattered bristles on or near declivity.

Sternum 2 vertical, rather finely, deeply punctured; armed on slightly more than anterior half by a median process that begins in cleft of anterior margin of segment 2, process rising abruptly to maximum height and continuing at this level to its posterior extremity, rather abruptly terminated behind; abdominal sterna 2-5 with moderately abundant erect, rather long bristles.

FEMALE.—Similar to male except frontal tubercle not as high, granules on lower half of frons more poorly developed to obsolete.

TYPE LOCALITY.—Campamento Cachicamo, 40 km east of Canton, Barinas, Venezuela.

TYPE MATERIAL.—The male holotype, female allotype, and 97 paratypes were taken at the type locality on 8 March 1970, 70 m elevation, No. 356, from a large vinelike tree known locally as Hevecito, by S. L. Wood. The parental tunnels were biramose and transverse; two females were associated with each male.

The holotype, allotype, and paratypes are in my collection.

Scolytopsis orinocanus, n. sp.

This species apparently is allied to *peruanus* Eggers. From the key and description of the female (Eggers, 1937, Rev. de Ent. 7:83) it is distinguished from Eggers' species by the broadly oval or round punctures on the female frons, and the broadly raised median area of the epistoma (not carinate), by the uniformly short, frontal vestiture and, evidently, by the coarser pronotal punctures and shorter elytral setae.

FEMALE.—Length 3.0 mm (paratypes 2.9-3.3 mm), 2.0 times as long as wide; very dark brown to black, pronotum usually darker, scales rather dark.

Frons broadly convex, a distinct, transverse impression above epistoma, median area of impression broadly, distinctly elevated (not carinate); epistoma rather well developed, slightly elevated; surface smooth, shining, with dense, deep, moderately coarse, round or broadly oval punctures; vestiture of short, moderately abundant, coarse setae of almost uniform length.

Pronotum 0.95 times as long as wide; widest one-third length from base, sides rather strongly arcuate, converging only slightly before anterior third, rather broadly rounded in front; surface smooth, shining, with a few very minute, impressed points, punctures rather fine (almost as large as in *puncticollis* Blandford), oval on disc, up to twice as large, subcircular and closer in lateral areas, a row of larger punctures at lateral and basal margins. Glabrous.

Elytra 1.3 times as long as wide, 1.3 times as long as pronotum; slightly narrower than pronotum; sides shallowly emarginate on basal half, rather broadly rounded behind; striae and interstriae on basal half equally, rather deeply impressed, punctures moderately coarse, deep, mostly of about equal size; on posterior half interstriae gradually, less strongly impressed until almost flat toward apex, interstrial punctures also decreasing in depth and clarity posteriorly, central third of each interstriae on posterior half etched, dull, spreading to entire interstriae, then to entire declivital surface near apex; costal margin near apex almost smooth. Vestiture of slender, suberect scales; each scale slightly shorter than distance between rows; very slightly more slender and equal in length to *puncticollis*.

MALE.—Similar to female except flat from vertex to epistoma (no arch), without elevations except a feeble one at epistoma, central area smooth and shining, lateral areas with dense, long pubescence slightly shorter than in other species.

TYPE LOCALITY.—Campamento Rio Grande, 30 km east of Palmar, Bolivar, Venezuela.

TYPE MATERIAL.—The female holotype, male allotype, and 48 paratypes were taken at the type locality on 12 June 1970, 70 m elevation, No. 573, in *Terminalia guianensis*, by S. L. Wood. These monogamous beetles made biramous, longitudinal tunnels similar to those of *Scolytus*.

The holotype, allotype, and paratypes are in my collection.

Carphodicticus, n. gen.

Blandford (1895, Ann. Mag. Nat. Hist., Ser. 6, 15:317) described from Ceylon a peculiar genus, *Craniodicticus*, "of doubtful relationship," which he placed in the Scolytidae but suggested a possible relationship to *Schedlarius* Wood (=*Chapuisia* Dugés). Except for the addition of one other species, *minor* Eggers (1936, Ann. Mag. Nat. Hist., Ser. 17, 10:635), from India, this genus has scarcely been mentioned in the literature. It is very primitive and has several characters suggesting a relationship to the Platypodidae, although it clearly belongs in Scolytidae. Except for the fact that it was taken from a liana ("jungle rope") nothing of its habits is known.

An equally peculiar insect belonging to the same generic group with *Craniodicticus* recently was collected in Venezuela. Both genera have the body elongate, the antennal funicle 5-segmented, the scape simple, the club with two, straight, transverse sutures, the pronotum laterally excised as in primitive Platypodidae, the anterior coxae narrowly separated, the prosternum extending well behind the anterior coxae, the mesosternum feebly inflated, the scutellum small, the tibiae short, rather broad, with four socketed teeth, and the basal margins of the elytra unarmed. These genera do not belong to any previously recognized tribe of Scolytidae; therefore, the new tribal name Carphodicticini is proposed to include them.

DIAGNOSIS.—This genus is rather closely allied to *Craniodicticus*, but it is distinguished by the larger, somewhat asymmetrical antennal club, by the very large, elongate, shallowly emarginate, coarsely faceted eyes, by the very broad oral region, and by entirely different types of characters on the frons and elytral declivity.

DESCRIPTION.—Eyes large, broadly emarginate; antennal scape simple, funicle 5-segmented, club moderately flat, slightly asymmetrical, with two straight, transverse sutures clearly indicated and at least partly septate, a third suture obscurely indicated. Pronotum elongate, laterally excised as in primitive Platypodidae, anterior coxae moderately separated, prosternum extending well behind coxae. Scutellum small, not depressed. Elytral bases unarmed; interstriae 10 obsolete on posterior half. Anterior coxae with raised cusp on anterodistal margin; tibiae short, broad, armed by several teeth on outer margin; tarsi longer than tibiae, segments cylindrical, 1, 2, and 3 about equal in length.

TYPE SPECIES.—*Carphodicticus cristatus* Wood, described below.

Carphodicticus cristatus, n. sp.

The only known member of the family that could possibly be confused with this species is *Craniodicticus mucronatus* Blandford, but the generic characters cited above distinguish it. The very elongate platypodid body form and armature of the elytral declivity are unique.

MALE.—Length 2.2 mm (paratypes 1.9-2.4 mm), 3.4 times as long as wide; color reddish brown.

Frons broad, very strongly convex, protruding abruptly above elevated, shining epistoma, very closely, deeply, rather finely punctured; glabrous except a few short bristles just above epistoma and a broad, dense epistomal brush of long coarse setae; oral area very broad. Eye elongate, broadly, shallowly emarginate, coarsely faceted; about four times as long as wide; more than half of eye below antennal socket. Antennal scape moderately short; funicle 5-segmented; club as described above.

Pronotum 1.4 times as long as wide; widest at basal and anterior angles, basal and anterior margins very broadly rounded, lateral margins on basal half broadly, deeply excised as in Platypodidae; surface smooth, shining, a few minute points, punctures close, deep, moderately coarse. Glabrous, except a few minute, bifid hairs on basal margin.

Elytra 2.0 times as long as wide, 1.5 times as long as pronotum; sides almost straight and parallel on basal three-fourths, then abruptly rounded slightly to projecting scoop formed by declivital costae, broadly, shallowly emarginate behind; bases feebly emarginate at scutellum; scutellum small, oval, attaining elytral surface; striae 1 very feebly impressed, others not impressed, punctures coarse, deep, close; interstriae half as wide as striae, smooth, shining, punctures minute, shallow, irregularly uniseriate. Declivity commencing three-fourths of elytral length from base, steep; striae 1 and 2 rather coarsely punctured; interstriae 1 distinctly elevated, convex, summit smooth, 2 impressed, narrow, obsolete before apex, 3 very strongly, narrowly elevated from just below declivital base to just before apex, crest smooth; punctures on lateral interstriae near declivity rather coarse, not granulate.

Protibiae two-thirds as long as femur, broad, terminal mucro curved toward tarsal insertion, four socketed teeth on lateral margin; tarsi about as long as tibia, segments 1, 2, and 3 cylindrical, about equal in length.

Vestiture confined to declivity outside of concave area, consisting of coarse bristles in interstrial rows.

Female.—Similar to male except frons less strongly protuberant immediately above epistoma.

Type Locality.—Eight km west of Bumbum, Barinas, Venezuela.

Type Material.—The male holotype, female allotype, and 110 paratypes were collected at the type locality on 11 February 1970, 150 m elevation, No. 326, by S. L. Wood.

The large, cut host tree was not recognized by local professional foresters; it may have been a rare *Lauraceae*. The tree had been cut several months and had been largely abandoned by a species of *Phloeotribus*. This species entered through *Phloeotribus* entrance tunnels, followed along an old egg gallery to a convenient point where their tunnels commenced along the cambium, engraving both phloem and xylem tissues. The beetles were monogamous and worked in pairs. The egg tunnels branched occasionally, with a different pair of beetles working on each branch, all using the same original entrance hole. Egg niches were formed along the cambium on each side of the gallery where eggs were deposited individually. The larvae constructed short, irregular mines in the phloem next to the cambium. The wood was exceedingly dry and hot, but the infestation was thriving.

The holotype, allotype, and paratypes are in my collection.

Pseudothysanoes querneus, n. sp.

This species is rather closely related to *quercinus* Wood, but it is distinguished by the more coarsely punctured, rugulose pronotal disc, by the coarser strial punctures, and by the much wider elytral scales.

Male.—Length 1.3 mm (paratypes 1.2-1.5 mm), 2.5 times as long as wide; color black.

Frons convex, a slight transverse impression just above epistoma; surface obscurely, rather coarsely punctured, rugulose; vestiture of moderately abundant, rather short, coarse setae. Antennal scape short, broad, slightly longer than pedicel; club rather small, widest through segment 2, sutures 1 and 2 slightly procurved, 1 marked by setae only at sides.

Pronotum 0.87 times as long as wide; widest on basal third, sides arcuately converging toward broadly rounded anterior margin; anterior margin armed by six low teeth; summit at middle, moderately high; anterior slope asperate; posterior area coarsely, indistinctly punctured, rugulose. Vestiture of moderately abundant, stout setae.

Elytra 1.6 times as long as wide; sides straight and parallel on basal two-thirds, rather narrowly rounded behind; striae not impressed, punctures moderately coarse, rather deep; interstriae as wide as striae, somewhat irregular, punctures rather fine, uniseriate. Declivity steep, convex; striae irregularly, weakly impressed, interstrial punctures with coarse, low granules; most of surface obscurely subgranulose. Vestiture of semirecumbent strial hair, and rows of equally long, erect interstrial scales; each scale about twice as long as wide.

Female.—Similar to male except antennal scape as wide as long, bearing a tuft of very long white hair; teeth on anterior margin of pronotum smaller, some obsolete; interstrial scales slightly longer and more slender, each about three to four times as long as wide.

Type Locality.—Seventeen km (10 miles) east of Pachuca, Hidalgo, Mexico.

Type Material.—The male holotype, female allotype, and 15 paratypes were taken at the type locality on 10 June 1967, at an elevation near 2500 m, No. 5, in *Quercus*, by S. L. Wood. Ten paratypes were taken 8 km (5 miles) west of Tulancingo, Hidalgo, Mexico, 11 June 1967, 2400 m elevation, No. 10, in *Quercus*, by S. L. Wood. Nine paratypes were collected 15 km (9 miles) east of Huatasco, Veracruz, 7-VII-67, 300 m elevation, No. 173, in *Quercus*, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Pseudothysanoes furvescens, n. sp.

This species is in the *phoradendri* group very closely related to *furvus* Wood. From *furvus* it may be distinguished by the absence of granules on the male discal interstriae and by the shorter elytral scales.

MALE.—Length 1.3 mm (paratypes 1.1-1.4 mm), 2.3 (female 2.8) times as long as wide; color black.

Frons convex, transversely impressed above epistoma; surface finely rugulose, punctures not evident; vestiture of sparse, coarse, short setae. Antennal scape elongate; moderately large, oval, widest at middle, suture 1 straight, 2 obscure.

Pronotum as in *furvus*.

Elytral proportions and outline as in *furvus;* striae not impressed, punctures small, shallow; interstriae slightly wider than striae, smooth, punctures very fine, not at all granulate or elevated. Declivity convex, steep; striae as on disc; interstriae each with a row of fine granules. Vestiture consisting only of rows of interstrial scales, each scale about three times as long as wide, slightly shorter than distance between rows, spaced within a row by about one and one-half times length of a scale.

FEMALE.—Similar to male except more slender, 2.8 times as long as wide; frons less strongly convex; anterior margin of pronotum unarmed; strial punctures much smaller, obscure; occasional strial hair present.

TYPE LOCALITY.—Eighteen km (11 miles) north of Huajuapan, Oaxaca, Mexico.

TYPE MATERIAL.—The male holotype, female allotype, and 14 paratypes were taken at the type locality on 15 June 1967, No. 42, from *Phoradendron* branches, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Pseudothysanoes funereus, n. sp.

This species is very closely related to *phoradendri* Blackman, but it is distinguished by the more slender body form, by the more rugulose pronotal disc, by the much smaller strial punctures on both disc and declivity, and by the near absence of interstrial granules.

MALE.—Length 1.4 mm (paratypes 1.3-1.5 mm), 2.4 times as long as wide; body color black.

Head and prothorax as in *phorandendri* except pronotal disc slightly more rugulose.

Elytra 1.5 times as long as wide; sides straight and parallel on basal two-thirds, narrowly rounded behind; striae not impressed, punctures small, shallow, separated by two or more diameters of a puncture; interstriae smooth, at least twice as wide as striae, punctures uniseriate, very small, feebly if at all granulate. Declivity beginning well behind middle, convex; interstrial granules small, regular. Vestiture as in *phoradendri*.

TYPE LOCALITY.—Volcan Colima, Jalisco, Mexico.

TYPE MATERIAL.—The male holotype and six male paratypes were taken at the type locality on 23 June 1965, 2500 m elevation, No. 108, from *Phoradendron longifolium*, by S. L. Wood.

The holotype and paratypes are in my collection.

Pseudothysanoes graniticus, n. sp.

This species is allied to *verdicus* Wood and *viscicolens* Wood, but it is distinguished by the shallowly impressed female frons with setae on the vertex short, and by the more coarsely granulate male declivital interstriae with scales on lower half of interstriae 1 smaller.

FEMALE.—Length 1.9 mm (male 1.8 mm), about 2.7 times as long as wide, color very dark brown.

Frons shallowly concave from epistoma to upper level of eyes, flattened to vertex; surface of concave area smooth, shining, impunctate, finely punctured above, somewhat strigose at sides; epistomal brush conspicuous at sides; flattened area above eyes bearing rather abundant, moderately short, coarse hair. Antennal scape elongate, ornamented by abundant, long hair; club about 2.5 times as long as wide; antenna as long as pronotum.

Pronotum 0.96 times as long as wide; widest at base, sides almost straight, converging feebly on basal half, broadly rounded in front; anterior margin unarmed; summit rather high, at middle; anterior area asperate; posterior area rugose-reticulate, with fine, obscure punctures, fine granules behind summit. Vestiture sparse, of fine and coarse, short hair.

Elytra about 1.6 (slightly spread) times as long as wide, 1.8 times as long as pronotum; striae not impressed except 1 weakly, punctures rather small, deep; interstriae slightly less than twice as wide as striae, almost smooth, uniseriately, finely granulate. Declivity convex, steep; interstrial granules slightly larger, confused on 2 and 3. Vestiture of very fine strial hair and rows of erect interstrial scales; each scale on disc three to four times as long as wide, four to five times as long as wide on declivity, each scale slightly longer than distance between scales within a row or between rows.

MALE.—Similar to female except stouter, about 2.5 times as long as wide (estimated); frons not visible; pronotum distinctly constricted on anterior half, anterior margin armed by ten teeth; strial punctures coarser, interstriae one and one-half times as wide as striae, much more coarsely granulate; elytral scales slightly longer, proportions as on female; scales on lower half of interstriae 1 conspicuously smaller; granules on declivital interstriae 2 and 3 uniseriate.

TYPE LOCALITY.—Forty-three km (26 miles) southeast of Nochixtlan, Oaxaca, Mexico.

TYPE MATERIAL.—The female holotype and male allotype were collected at the type locality on 17 June 1967, No. 55, from *Phoradendron*, by S. L. Wood.

The holotype and allotype are in my collection.

Pseudothysanoes verticillus, n. sp.

This species is very closely allied to *viscicolens* Wood, but it may be distinguished by the more shallowly concave female frons, with a more dense tuft of hair on the vertex, and by the much shorter elytral scales.

FEMALE.—Length 1.6 mm, 2.8 times as long wide; color almost black, pronotal summit reddish brown.

Frons as in *viscicolens* except less deeply concave, tuft of hair on vertex slightly shorter, more dense. Antenna and pronotum as in *viscicolens*.

Elytra 1.7 times as long as wide, 1.8 times as long as pronotum; striae not impressed, punctures rather small, moderately deep; interstriae about twice as wide as striae, punctures uniseriate, finely granulate. Declivity as in *graniticus* Wood, with indistinct granules and punctures on interstriae 2 and 3 confused. Vestiture of fine, short strial hair, and rows of erect, short, interstrial scales; each scale one to one and one-half times as long as wide, half as long as distance between rows, equal in length to distance between scales in a row.

TYPE LOCALITY.—Twenty-seven km (16 miles) north of Ixmiquilpan, Hidalgo, Mexico.

TYPE MATERIAL.—The unique female holotype was taken at the type locality on 10 July 1967, 1900 m elevation, probably from *Phoradendron*, by S. L. Wood.

The holotype is in my collection.

Pseudothysanoes cuspidis, n. sp.

This species is allied to *subulatus* Wood and *spicatus* Wood, but it may be distinguished by the smaller size, by the flattened and grooved female frons, by the coarser punctures on the elytral declivity, and by the slender, rather long elytral setae.

FEMALE.—Length 1.3 mm (paratypes 1.2-1.4 mm), 2.7 times as long as wide; color very dark brown.

Frons transversely flattened, longitudinally concave from epistoma to upper level of eyes, median line narrowly sulcate from level of antennal insertion to upper level of eyes; surface smooth and shining on epistomal area, then finely substrigose becoming more coarsely reticulate-granulate above eyes; vestiture sparse, fine, inconspicuous. Antennal scape elongate; club moderately large, sutures very obscure.

Pronotum 1.0 times as long as wide; sides feebly arcuate, subparallel on basal half, distinctly constricted on anterior half, broadly rounded in front; summit at middle, moderately high; sparsely asperate on anterior slope; finely rugose-reticulate behind, a few minute granules. Vestiture of sparse hair.

Elytra 1.8 times as long as wide, 1.8 times as long as pronotum; sides almost straight and parallel on more than basal two-thirds, rather narrowly rounded behind; striae not impressed, punctures small, shallow; interstriae not smooth, less than twice as wide as striae, punctures fine, obscured by surface sculpture. Declivity convex, steep; interstriae uniseriately, finely granulate. Vestiture of rows of very fine strial hair and rows of slightly longer, coarser, interstrial setae, not at all scalelike; interstrial setae about as long as distance between rows.

Last visible sternum narrowly produced to form a mucronate process.

TYPE LOCALITY.—Ten km (6 miles) northeast of Teziutlan, Puebla, Mexico.

TYPE MATERIAL.—The female holotype and 13 female paratypes were taken at the type locality on 2 July 1967, 1600 m elevation, No. 144, by S. L. Wood.

The holotype and paratypes are in my collection.

Pseudothysanoes tenellus, n. sp.

Presumably this species is allied to *hopkinsi* Blackman, but it is distinguished by the very elongate interstrial scales on the male declivity, by the flattened frons in both sexes with a feeble central impression.

MALE.—Length 1.6 mm (paratypes 1.3-1.6 mm), 2.4 times as long as wide; color almost black.

Frons almost flat from transverse impression just above epistoma to upper level of eyes, convex above, a small median impression at upper level of eyes; smooth and shining near median line, becoming rugose-reticulate in lateral areas, rugose-punctate above eyes; vestiture of sparse, coarse setae. Scape elongate, slender; club longer than scape, broadly oval, two sutures clearly marked, rather strongly procurved.

Pronotum 1.0 times as long as wide; widest at base, sides strongly arcuate, very strongly constricted on anterior half, rather narrowly rounded in front; anterior margin armed by six coarse teeth; summit behind middle; asperate on anterior slope; reticulate-granulate in posterior area, with sparse, fine, obscure punctures, a few granules behind summit. Vestiture of sparse, short, stout setae.

Elytra 1.4 times as long as wide, 1.5 times as long as pronotum; sides almost straight and parallel on basal two-thirds, obtusely angulate behind; striae not impressed, punctures moderately large, deep; interstriae slightly wider than striae, almost smooth, uniseriately, coarsely granulate on posterior third, punctures feebly to not at all granulate to base. Declivity broadly convex, rather steep; striae weakly impressed on upper two-thirds, punctures smaller; uniseriate interstrial granules rather coarse at base, decreasing in size on upper two-thirds, almost obsolete below. Vestiture consisting of rows of interstrial scales, short on disc, each about three times as long as wide, increasing in length toward declivity, very long and delicate on declivity, some about four times as long as distance between rows.

FEMALE.—Similar to male except frons more extensively flattened, more finely sculptured; pronotum similarly, almost equally armed; interstrial granules slightly smaller; declivital scales little longer than those on disc, each about three times as long as wide, those on interstriae 1 and 2 smaller.

TYPE LOCALITY.—Thirty-three km (21 miles) west of Morelia, Michoacan, Mexico.

TYPE MATERIAL.—The male holotype, female allotype, and 17 paratypes were taken at the type locality on 16 June 1965, at 2300 m elevation, No. 64 from *Phoradendron* twigs, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Pseudothysanoes yuccavorus, n. sp.

This species is allied to *hopkinsi* Blackman, but it may be distinguished by the flattened frons with the absence of a central fovea, by the smaller, more slender antennal club, and by the shorter, stouter interstrial scales.

MALE.—Length 1.2 mm (paratypes 1.1-1.3 mm), 2.2 (female 2.5) times as long as wide; color black.

Frons weakly convex, almost flat to upper level of eyes, a weak transverse impression just above epistoma; epistoma shining, remaining area rather coarsely reticulate-granulate, punctures fine, obscure; vestiture of sparse, short, coarse setae. Antennal scape elongate, slender; club small, 1.6 (female 1.8) times as long as wide, sutures very obscure, weakly procurved.

Pronotum 0.92 times as long as wide; subtriangular, widest at base, sides weakly arcuate, converging toward narrowly rounded anterior margin; anterior margin armed by four coarse teeth; summit high, narrow; anterior area coarsely asperate; posterior area rugulose, a few fine granules behind summit; vestiture of sparse, coarse setae of moderate length.

Elytra 1.3 times as long as wide, 1.6 times as long as pronotum; sides almost straight and parallel on slightly more than basal two-thirds, rather broadly rounded behind; striae not impressed, punctures small, moderately deep; interstriae twice as wide as striae, almost smooth, uniseriately, rather coarsely granulate. Declivity rather steep, convex; as on disc. Vestiture consisting of minute, fine strial hair, and erect, interstrial scales; each scale three times as long as wide, separated between rows and within a row by distances slightly greater than length of a scale.

FEMALE.—Similar to male except body form more slender; antennal club longer; anterior margin of pronotum more broadly rounded, unarmed; interstrial granules almost obsolete on disc; interstrial scales slightly longer, very slender, each scale eight or more times as long as wide.

TYPE LOCALITY.—Fifteen km (9 miles) west of Durango, Durango, Mexico.

TYPE MATERIAL.—The male holotype, female allotype, and 45 paratypes were collected at the type locality on 4 June 1965, at 1300 m elevation, No. 1, from dying *Yucca* leaves on a large, healthy plant, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Thysanoes inornatus, n. sp.

This species is distinguished from the closely allied *mexicanus* Wood by the greatly reduced size of strial punctures on the declivity, by the shorter, more widely spaced interstrial scales, by the finer interstrial granules on the declivity, and by the almost glabrous female frons.

FEMALE.—Length 1.6 mm (paratypes 1.4-1.7 mm), 2.7 times as long as wide; color very dark brown.

Frons moderately, rather broadly concave from epistoma to upper level of eyes; surface above concavity reticulate-granulate, becoming reticulate on upper part of concavity, smooth and shining over lower areas; a fovea at center; almost glabrous except near lateral margins of epistoma. Antennal scape bearing numerous long setae.

Pronotum 1.04 times as long as wide; widest one-third length from base, sides arcuate, not converging on basal half, rather strongly constricted in front of middle, moderately rounded in front; anterior margin armed by six teeth; summit at middle; posterior area reticulate to obscurely reticulate-granulate, a few minute, obscure punctures. Vestiture sparse, consisting of a few short, stout setae.

Elytra 1.6 times as long as wide; sides almost straight and parallel on basal three-fourths, rather narrowly rounded behind; striae not impressed, punctures small, shallow; interstriae almost smooth, with obscure lines, almost three times as wide as striae, puncture sparse, uniseriate, very finely granulate. Declivity steep, convex; strial punctures reduced, minute to obsolete; interstrial granules regularly spaced, fine. Vestiture of rows of very minute, fine, strial hair, and rows of erect interstrial scales; each scale three to four times as long as wide, spaced within a row by one and one-half to three times length of a scale, between rows by about one and one-half times length of a scale.

MALE.—Similar to female except stouter, 2.3 times as long as wide; frontal impression smaller, about two-thirds as large, reticulation extending almost to epistomal area; scape sparsely pubescent; teeth on anterior margin of pronotum larger; interstrial scales wider, each two to three times as long as wide.

TYPE LOCALITY.—Volcan Colima, Jalisco, Mexico.

TYPE MATERIAL.—The female holotype, male allotype, and five paratypes were taken at the type locality on 23 June 1965, 2500 m elevation, No. 103, from an unidentified shrub, by S. L. Wood. Eight paratypes bear identical data except they were No. 106, taken from small branches of a *Rhus* near *aromatica*. Ten paratypes were collected at Aguascalientes, Aguascalientes, Mexico, 12 June 1965, 2100 m elevation, No. 43, from *Mimosa* branches, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Micracisella adnata, n. sp.

This species is distinguished from the allied *knulli* Blackman by the presence of six teeth on the anterior margin of the pronotum, by the finely tuberculate, almost unelevated declivital interstriae 3, by the wider interstrial scales, and by the median impression on the female frons.

FEMALE.—Length 1.9 mm (paratypes 1.9-2.0 mm), 2.8 times as long as wide; color very dark reddish brown.

Frons convex, with a narrow, subtriangular, median impression from near upper level of eyes to level of antennal insertion; surface reticulate-granulate, apparently with a few larger granules; vestiture of moderately abundant, coarse, moderately short setae. Eye slightly more than twice as long as wide; antenna as in *knulli*.

Pronotum 1.1 times as long as wide; as in *knulli* except anterior margin armed by six teeth, and posterior area rugulose-reticulate, punctures fine, shallow, obscurely subtuberculate. Vestiture abraded.

Elytra 1.8 times as long as wide, 1.6 times as long as pronotum; outline as in *knulli;* striae not impressed, punctures fine, shallow; interstriae twice as wide as striae, subrugulosely marked by irregular lines, punctures uniseriate, very fine, shallow, obscure. Declivity steep, convex, apex protruding and minutely divaricate, mucro absent; surface on lower two-thirds rugulose-reticulate; striae obscure but visible; interstriae 1 obscurely, very minutely, uniseriately granulate, 2 with a few granules on upper fourth, 3 with larger granules to junction with 9, 7 and 9 with granules similar to 3. Vestiture abraded on disc; on declivity consisting of rows of minute strial hair and rows of suberect, interstrial scales; each scale with a slight arch or curl toward posterior direction, two to four times as long as wide, each almost as long as distance between rows, slightly closer within a row, scales absent on lower half of interstriae 2.

MALE.—Similar to female except (head concealed) strial punctures slightly deeper; declivital interstriae 1 and 3 feebly elevated, 9 distinctly elevated; interstrial scales averaging slightly more slender.

TYPE LOCALITY.—Fourteen km (9 miles) east of Huatusco, Veracruz, Mexico.

TYPE MATERIAL.—The female holotype, male allotype, and one damaged female paratype were taken at the type locality on 7 July 1967, 270 m elevation, No. 173, from *Quercus* twigs, by S. L. Wood.

The holotype, allotype, and paratype are in my collection.

Micracisella serjaniae, n. sp.

This species is allied to *striata* Wood, but it may be distinguished by the much smaller strial punctures, by the less nearly granulate discal interstriae, by the distinctly, uniseriately granulate declivital interstriae, by the absence of a preapical emargination on the costal margin of the elytra and by a distinct sutural emargination at the elytral apex.

FEMALE.—Length 1.3 mm (paratypes 1.2-1.3 mm), 3.0 times as long as wide; color very dark reddish brown, pronotum lighter.

Frons, antenna, and pronotum as in *striata*, except segment 1 of antennal club distinctly shorter.

Elytra 1.8 times as long as wide, 1.7 times as long as pronotum; outline as in *striata* except apex wider and suturally emarginate; striae not impressed, punctures moderately small; interstriae shining, somewhat irregular, one and one-half times as wide as striae, punctures fine, uniseriate, not at all granulate. Declivity steep, convex, produced apically; strial punctures deeper than on disc; interstrial punctures granulate. Vestiture as in *striata* except interstrial scales very slightly larger; each scale about two to three times as long as wide.

MALE.—Similar to female except tuft of hair on scape much smaller; discal interstriae evidently less irregular.

TYPE LOCALITY.—Zamorano, Morazan, Honduras.

TYPE MATERIAL.—The female holotype, male allotype, and 83 paratypes were taken at the type locality on 18 April 1964, at 700 m elevation, No. 547, from *Serjania racemosa*, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Micracis amplinis, n. sp.

This is the largest known species in the genus; it is also distinguished from all other representatives of the genus by the moderately impressed discal striae and by the very broad interstrial scales on the declivity.

MALE.—Length 3.2 mm (paratype 3.3 mm), 3.0 times as long as wide; color reddish brown.

Frons convex, with a moderate, transverse impression just above epistoma; surface finely reticulate-granulate, with rather numerous large, low, rounded granules widely distributed on convex area; epistomal area smooth, shining; glabrous except for a few setae lateral to epistoma. Antennal scape only slightly flattened; suture 1 reaching middle of club.

Pronotum 1.03 times as long as wide; widest on basal third, sides weakly arcuate, slightly constricted on anterior third, rather broadly rounded in front; anterior margin armed by ten coarse serrations; summit in front of middle; anterior area coarsely serrate; posterior area reticulate-subgranulate, dull, a few, small, shining granules to base. A few stout setae in lateral areas.

Elytra 1.8 times as long as wide, 1.8 times as long as pronotum; sides almost straight and parallel on basal three-fourths, strongly, acutely acuminate and mucronate behind; striae impressed except on basal fourth, punctures moderately small, deep; interstriae shining, almost smooth, three times as wide as striae, punctures very minute, almost obsolete, each with two or three large granules at base of declivity. Declivity rather steep, convex, apex produced; entire surface minutely granulose; strial punctures small, deep; interstriae 1 and 3 weakly elevated, punctures on all interstriae as large as those of striae, confused, deep. Vestiture confined to declivity (possibly abraded on disc), of large interstrial scales; each scale about as wide as long, a few as wide as an interstriae.

TYPE LOCALITY.—Five km (3 miles) west of El Salto, Durango, Mexico.

TYPE MATERIAL.—The male holotype and one damaged male paratype were taken at the type locality on 7 June 1965, 2500 m elevation, No. 41, from a *Quercus* branch, by S. L .Wood.

The holotype and paratype are in my collection.

Micracis incertus, n. sp.

This species is allied to *lepidus* Wood, but it is distinguished by the presence of a few shallow punctures on the pronotal disc, by the larger interstrial tubercles on the declivity, and by the distribution.

Female.—Length 2.4 mm (paratypes 2.0-2.4 mm), 3.0 (male 2.8) times as long as wide; color very dark brown.

Frons convex, a moderate, transverse impression just above epistoma; surface finely reticulate-granulate, dull, upper half with rather abundant, shallow punctures of moderate size; a few stout setae in lateral and epistomal areas. Antennal scape moderately triangular, ornamented by rather abundant, long hair; suture 1 not quite reaching middle of club.

Pronotum 1.1 times as long as wide; as in *amplinus* except moderately large, shallow, rather abundant punctures intermixed with shining granules on disc. Vestiture of sparse scales and minute hair.

Elytra 1.8 times as long as wide, 1.7 times as long as pronotum; outline as in *amplinis*; striae not impressed, punctures moderately large; interstriae shining, subrugose, twice as wide as striae, punctures moderately large, uniseriate, their anterior margins finely granulate. Declivity steep, convex, apex produced; surface dull; strial punctures small, deep, reduced toward apex; interstrial punctures on 1 and 2 fine, irregular and reduced on lower half, on 3 and lateral areas moderately large, rounded. Vestiture of rows of interstrial scales, largely abraded on disc, each scale about five times as long as wide, as long as distance between rows.

Male.—Similar to female except frons more strongly convex, punctures replaced by granules; discal interstrial granules smaller except larger near declivity, declivital granules larger, extending to apices of 1 and 2; interstrial scales on upper fourth of declivity longer, some six or eight times as long as wide.

Type Locality.—Thirty-seven km (22 miles) west of Durango, Durango, Mexico.

Type Material.—The female holotype was taken at the type locality on 4 June 1965, at 2000 m elevation, No. 4, from *Quercus* branches, by S. L. Wood. The male allotype and 5 paratypes (in poor condition) were taken 64 km (40 miles) west of Durango on the same day, from the same host and collector, No. 18, at 2500 m elevation. One paratype was taken 5 km (3 miles) west of El Salto, Durango, 7 June 1965, 2500 m elevation, No. 41, from *Quercus* by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Micracis torus, n. sp.

This species is distinguished from the allied *evanescens* Wood by the smaller size, by the stout, hairlike elytral setae, and by the absence of a sharply defined lower margin of the female frontal elevation.

Female.—Length 2.1 mm (paratypes 1.8-2.2 mm), 3.1 (male 2.7) times as long as wide; color dark reddish brown.

Frons planoconvex to vertex, median half on lower half elevated and brightly shining, its margins rounded not sharply defined, remaining area minutely reticulate-granulate; vestiture fine, short, uniformly distributed on upper area, slightly longer toward vertex. Antenna about as in *evanescens* except hair on scape slightly shorter.

Pronotum 1.2 times as long as wide; as in *evanescens* except reticulation in posterior areas finer.

Elytra 1.8 times as long as wide, 1.4 times as long as pronotum; outline as in *evanescens*; striae not impressed, punctures small, shallow; interstriae about three times as wide as striae, almost smooth, punctures very fine, uniseriate. Declivity steep, convex, apex produced; strial punctures reduced, obscure; interstrial punctures small, indistinct. Vestiture of rows of fine, short, strial hair, and rows of longer, coarse, pointed, interstrial hair; slightly longer on declivity, longest interstrial setae equal in length to distance between rows, all setae somewhat confused on declivity.

Male.—Similar to female except body stouter; frons convex, a transverse impression on lower third, elevation absent, surface with several rounded granules.

Type Locality.—Volcan Colima, Jalisco, Mexico.

Type Material.—The female holotype, male allotype, and 17 paratypes were taken at the type locality on 23 June 1965, 2500 m elevation, No. 102, from branches of a leguminose tree, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Micracis exilis, n. sp.

This species is more closely allied to *costaricensis* Wood than to others in the genus, but it is distinguished by the much smaller size, by the more abundant, longer vestiture on the female vertex, by the smaller, smooth, shining area on the female frons, and by the much finer sculpture on the pronotum and elytra.

Female.—Length 1.9 mm (paratypes: females 1.7-1.9 mm; males 1.3-1.7 mm), 3.3 (male 2.7) times as long as wide; color moderately dark yellowish brown, vestiture pale.

Frons rather shallowly concave to upper level of eyes, an acute median carina on upper half; frons smooth and shining on median half below level of antennal insertion, obscurely reticulate and minutely punctured over remaining area; vestiture of short, coarse, subplumose setae over central reticulate area becoming much longer on upper lateral margins and very long on vertex, tips of longest setae on vertex could reach below middle of frons. Antennal scape rather broadly triangular, ornamented by long setae; club moderately large, 1.3 times as long as wide; suture 1 not reaching middle of club.

Pronotum 1.3 times as long as wide; sides straight and parallel on basal two-thirds, rather broadly rounded in front; anterior margin unarmed; summit well in front of middle, asperities fine; posterior area reticulate, punctures sparse, fine, obscurely, minutely granulate. Vestiture of a few coarse setae.

Elytra 1.9 times as long as wide, 1.45 times as long as pronotum; sides straight and parallel on basal three-fourths, rather abruptly rounded then narrowly acuminate at apex; striae not impressed, punctures small, shallow, rather obscure; interstriae slightly more than twice as wide as striae, minutely irregular, punctures small, obscure. Declivity very steep, convex, acuminately produced at apex; surface toward apex very minutely subrugulose; interstriae each with a row of fine granules. Vestiture of short strial hair, and rows of moderately long, coarse, interstrial hair.

Male.—Similar to female except slightly smaller, stouter; frons convex above, a moderate transverse impression on lower third, surface rugose-reticulate, vestiture sparse, short, inconspicuous; scape small, sparsely pubescent; anterior margin armed by six small teeth; declivital setae sometimes abraded and appear as short scales.

Type Locality.—Nine km south of Barrancas, Barinas, Venezuela.

Type Material.—The female holotype, male allotype, and 11 paratypes were taken at the type locality on 2 December 1969, 150 m elevation, No. 163 from Espinito de Sabana (type), No. 155 from *Acalypha* sp., No. 186 from a tree twig, by S. L. Wood. The gallery systems were typical of the genus.

The holotype, allotype, and paratypes are in my collection.

Micracis vitulus, n. sp.

This species is allied to *lignicolus* Wood, but it is distinguished by the large size, by the smaller, less pubescent female scape, by the larger antennal club, by the larger, much deeper strial punctures, by the hairlike elytral vestiture, and by the very different elytral declivity in both sexes. This species superficially resembles some species of *Hylocurus*.

Female.—Length 3.6 mm (paratypes 3.2-3.6 mm), 3.6 times as long as wide; color very dark reddish brown, parts of pronotum often lighter.

Frons as in *lignicolus*. Antennal scape broadly club-shaped, at least twice as long as wide, moderately ornamented by rather long hair; club 1.5 times as long as wide, suture 1 extending beyond middle.

Pronotum 1.2 times as long as wide; outline about as in *lignicolus;* anterior margin unarmed; posterior area strongly reticulate, with rather small, isolated, low, rounded granules. Sparse vestiture limited to margins.

Elytra 2.2 times as long as wide, 1.9 times as long as pronotum; sides straight and parallel on basal three-fourths, strongly produced and narrowly mucronate behind; striae weakly to moderately impressed toward declivity, punctures rather large, deep; interstriae smooth, shining, convex near declivity, as wide as striae, punctures small, uniseriate, granulate at margin of declivity. Declivity moderately abrupt, broadly convex, moderately steep, resembling some male *Hylocurus;* striae more strongly impressed; interstriae all irregularly sculptured, a few granules at base, 1 moderately elevated, granules rather coarse, continuing almost to apex, 2 somewhat convex, moderately impressed, devoid of granules, 3 slightly elevated, rather finely, irregularly subserrate, 4-8 with several granules below base, 9 moderately elevated, joining costal margin. Vestiture confined to declivity, of coarse, moderately abundant, rather long hair in interstrial rows. Basal half of front tibia slightly narrower than in *lignicolus;* posterior face devoid of tubercules.

Male.—Similar to female except frons as in male *lignicolus;* anterior margin of pronotum with about four indefinite, small serrations; a circumdeclivital ring of rather well-developed, blunt tubercles (largest in this genus); declivity more nearly flat, interstriae 1 higher, 2 lower, tubercles reduced except for a few toward base, 9 more acutely elevated.

Type Locality.—Carbonera Experimental Forest, about 50 km (airline) northwest of Merida, Venezuela.

Type Material.—The female holotype, male allotype, and 13 paratypes were taken on 10 November 1969, 2500 m elevation, No. 128, from an unidentified tree seedling, by S. L. Wood. The galleries were typical of the genus.

The holotype, allotype, and paratypes are in my collection.

Micracis sentus, n. sp.

Except for the antenna and protibia this species would be placed in the genus *Hylocurus* because of the coarse elytral sculpture. It is remotely allied to *lignicolus* Wood, but it is distinguished by the coarse spines on the male interstriae 1 and 3 and at the base of the declivity on 1-9.

Male.—Length 2.2 mm, 2.7 times as long as wide; color rather dark reddish brown.

Frons convex, a narrow, transverse impression just above epistoma; surface rather coarsely granulate-punctate, a rather large median tubercle just above level of antennal insertion; vestiture of rather coarse, short bristles over entire surface. Antennal scape moderately long, rather slender; club moderately large, ovate, 1.4 times as long as wide, sutures narrowly, strongly procurved, 1 reaching middle.

Pronotum about as long as wide; sides weakly arcuate and subparallel on basal half, broadly rounded in front; anterior margin armed by 10 coarse teeth; summit slightly in front of middle; posterior area deeply reticulate, with moderately coarse, isolated granules behind summit to base. Vestiture of rather sparse, short scales.

Elytra 1.6 times as long as wide, 1.6 times as long as elytra; sides straight and parallel on basal three-fourths, subacutely angulate behind; striae not impressed, punctures rather small, deep; interstriae shining, almost smooth, almost twice as wide as striae, punctures moderately coarse, uniseriate, widely spaced, replaced at declivital base by rather large, rounded granules. Declivity steep, convex, produced at apex; surface dull, densely rugulose-reticulate; striae almost obsolete; even-numbered interstriae each with two rounded nodules at base of declivity, tubercles on odd-numbered interstriae slightly larger, becoming pointed and rather widely spaced on declivity, those on 1, 3, and 9 extending below middle, only one or two supplemental tubercles at base of 5 and 7; interstriae 2 weakly impressed; costal margin ascending rather strongly at apex. Vestiture of erect, interstrial scales mostly at base of declivity and at tubercles on declivity, sparse on disc; each scale on disc two to four times as long as wide, longer and more slender on declivity.

Type Locality.—El Laurel Experimental Farm, 12 km southwest of Caracas, Venezuela.

Type Material.—The male holotype was taken at the type locality on 1 May 1970, 1300 m elevation, No. 460, from a branch of an unidentified tree, by S. L. Wood.

The holotype is in my collection.

Hylocurus torosus, n. sp.

This species is very closely related to *rudis* LeConte but it is distinguished by characters of the frontal excavation and its protuberances as noted below.

Female.—Length 2.0 mm, 2.7 times as long as wide; color very dark brown.

Frons deeply excavated on median two-thirds from just above epistomal margin to well above eyes, broadly oval in outline, its margins abrupt on all sides; surface etched as in *rudis;* lateral walls of concavity with a pair of large, protruding, subcircular areas, almost as high as wide, pile longer than in *rudis*.

Antenna, pronotum, and elytra as in *rudis*.

Type Locality.—Florence, South Carolina.

Type Material.—The female holotype was taken at the type locality on 12 May 1961, in flight, by V. M. Kirk.

The holotype is in my collection.

Hylocurus verrucosus, n. sp.

This species is allied to *nodulus* Wood, but it is distinguished by the smaller size, by the dull, reticulate elytral declivity with the declivital strial punctures largely obsolete, and by the distinctly elevated declivital interstriae 9 with a large tubercle at the apex of the elevation.

MALE.—Length 1.5 mm (paratypes 1.4-1.8 mm), 2.5 times as long as wide; color black.

Frons convex, a transverse carina on median half just below upper level of eyes; surface reticulate-granulate, a few fine, obscure punctures below, sparse, low, elongate, shining granules above; vestiture inconspicuous. Antennal club as in *nodulus* except middle third of suture 1 totally obsolete.

Pronotum as in *nodulus* except teeth on anterior margin much smaller; posterior area more finely sculptured, with fewer granules. Half of setae on disc scalelike.

Elytra 1.5 times as long as wide; outline as in *nodulus* except for a large tubercle on interstriae 9; disc as in *nodulus* except interstrial nodules slightly narrower, perhaps slightly higher. Declivity slightly steeper than in *nodulus;* surface finely reticulate-granulate; strial punctures obsolete except at base; interstriae 2, 4, 6, and 8 with tubercles only at base, on 1, 3, 5, and 7 tubercles extend about one-third declivital length from base, 3 weakly elevated and with a moderately large tooth at middle, 9 slightly more strongly elevated, its elevation ending at middle of declivity in a coarse, pointed tooth. Vestiture of minute, fine, strial hair, and interstrial rows of scales; scales on basal half of disc short, becoming much longer toward and on upper half of declivity, scales much wider than in *nodulus.*

FEMALE.—Similar to male except frontal carina shorter; interstrial nodules poorly developed; interstrial scales more slender.

TYPE LOCALITY.—Nine km south of Barrancas, Barinas, Venezuela.

TYPE MATERIAL.—The male holotype, female allotype, and 33 paratypes were taken at the type locality on 5 November 1969, 150 m elevation, No. 111, from cut *Inga* branches, by S. L. Wood. The galleries were typical of the genus.

The holotype, allotype, and paratypes are in my collection.

Hylocurus dilutus, n. sp.

This species is allied to *simplex* Blandford and *ruber* Wood, but it is distinguished by the smaller average size, by the smaller interstrial tubercles in both sexes, and by the small, confused, strial punctures on the declivity.

MALE.—Length 2.1 mm (paratypes 2.1-2.5 mm), 2.6 times as long as wide; color rather dark reddish brown.

Frons convex, transversely impressed on lower third; surface obscurely reticulate-granulate, convex area with rather numerous, very large, low, shining granules over more than central half; vestiture fine, sparse, inconspicuous except more abundant along epistoma. Antennal club broadly oval; sutures 1 and 2 strongly procurved, 1 almost reaching middle.

Pronotum 1.1 times as long as wide; as in *simplex* except sides weakly arcuate, anterior margin armed by eight coarse serrations, posterior area more strongly reticulate with isolated granules slightly smaller.

Elytra 1.5 times as long as wide, 1.4 times as long as pronotum; outline as in *simplex;* striae not impressed, punctures moderately large, rather deeply, not sharply impressed; interstriae almost smooth, with a few obscure, transverse lines, evidently narrower than striae, punctures not clearly defined; each interstriae near declivity with about two low, poorly formed granules. Declivity steep, convex, produced at apex; strial punctures small, deep, confused on lower two-thirds; interstriae 1 and 3 weakly elevated, 1 with very small granules on upper two-thirds, 3 with small granules on upper third, 9 rather strongly elevated on basal half, its summit subserrate, a rather broad impression between 9 and costal margin. Subglabrous; very sparse, short, fine hair on some specimens.

FEMALE.—Similar to male except frons flattened on at least median half, transverse impression absent, surface reticulate, dull, with rather abundant, small, deep punctures and fine, short, abundant hair; serrations on anterior margin of pronotum smaller, irregular; strial punctures on disc smaller, not as deep, sharply defined; tubercles on declivity evidently slightly smaller.

TYPE LOCALITY.—Volcan, Colima, Jalisco, Mexico.

TYPE MATERIAL.—The male holotype, female allotype, and 12 paratypes were collected at the type locality on 23 June 1965, at 2500 m elevation, No. 102, by S. L. Wood, from a branch of a leguminose tree.

The holotype, allotype, and paratypes are in my collection.

Hylocurus disparilis, n. sp.

This species is allied to *inaequalis* Wood, but it is distinguished by the exaggerated development of the male circumdeclivital spines.

MALE.—Length 2.2 mm, 2.5 times as long as wide; color very dark brown.

Frons, antenna, and pronotum as in *inaequalis* Wood except circumdeclivital spines longer, particularly on alternate odd-numbered interstriae, spines 1 and 9 conspicuously longer than others; elytral apex much more slender than in allied species. Declivital face with punctures on lower two-thirds of striae 1 and 2 very small, in rows, all other punctures coarse, deep, confused, becoming much larger toward base; interstriae 3 not elevated, armed by two blunt tubercles.

TYPE LOCALITY.—Zamorano, Morazan, Honduras.

TYPE MATERIAL.—The unique male holotype was taken at the type locality on 18 April 1964, 700 m elevation, No. 558, from a branch of *Ficus glabrata*, by S. L. Wood.

The holotype is in my collection.

Hylocurus dissidens, n. sp.

This species is rather closely allied to *aberrans* Wood, but it is distinguished by the slightly smaller spines in the male circumdeclivital ring, by the more strongly convex male declivital face, by the more abundant pubescence on the female frons, and by the more strongly procurved suture 1 on the antennal club.

MALE.—Length 1.9 mm (paratypes 1.9-2.2 mm), 2.7 times as long as wide; color dark reddish brown.

Frons as in *aberrans*. Antennal club with sutures moderately procurved. Pronotum as in *aberrans* except granules on discal area slightly larger, punctures not indicated.

Elytra 1.6 times as long as wide; widest at base of declivity, sides straight on more than basal three-fourths, abruptly, serrately rounded, then obtusely produced at apex; striae not impressed except near declivital margin, punctures moderately coarse, deep; interstriae almost as wide as striae, smooth, punctures small, sparse; each interstriae ending at margin of declivity in a coarse nodule of equal length, 3-9 acutely pointed on their lateral margins and projecting slightly. Declivity abrupt, very steep, broadly convex, produced behind; strial punctures in rows, those near base of declivity larger; interstriae minutely granulate, 1 slightly elevated to apex and bearing about five small granules on middle third, 3 rather weakly elevated on upper two-thirds, with four closely set, acutely pointed teeth on middle third; interstriae 9 acutely elevated, joining costal margin, but with a very small notch at its apex as it joins costal margin. Glabrous except for a few minute, hairlike setae at declivital margin.

FEMALE.—Similar to male except frons shallowly concave on central half, upper two-thirds of concavity with dense, erect, coarse, subplumose setae, surface minutely reticulate-granulate, devoid of larger granules; anterior margin of pronotum more finely serrate; strial punctures slightly smaller; circumdeclivital ring of nodules absent, declivity more strongly convex; declivital face similar, more finely sculptured, all interstriae with a few minute granules near base, 9 rather weakly elevated, ending remotely from costal margin; vestiture rather widely distributed, sparse, coarse, moderately long.

TYPE LOCALITY.—Laguna Santa Maria, Nayarit, Mexico.

TYPE MATERIAL.—The male holotype, female allotype, and 19 paratypes were taken at the type locality on 6 June 1965, 1000 m elevation, No. 197, from a large, square-stemmed vine, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Hylocurus villifrons, n. sp.

This species is remotely allied to *dissidens* Wood, but it is distinguished by the very different female frons, by the very different sculpture of the male declivity, and by other characters described below.

FEMALE.—Length 2.6 mm (paratypes 2.0-2.6 mm), 3.2 (male 2.9) times as long as wide; color very dark reddish brown.

Frons flattened from epistoma to vertex, area above eyes larger and wider than area below; surface entirely concealed by vestiture; vestiture below level of eyes of abundant, coarse, erect, moderately long, subplumose setae, increasing in length and apparently in thickness to upper margin, those on upper margin appearing as coarse, broad, ribbonlike setae each subdivided near its apex into about six hairlike filaments, tips of these large setae extend more than half distance to epistomal margin. Antennal scape short, twice as long as pedicel, not expanded, ornamented by a small tuft of hair; club subcircular; sutures broadly procurved, 1 reaching middle of club.

Pronotum 1.3 times as long as wide; sides almost straight and parallel on basal half, rather broadly rounded in front; anterior margin unarmed; summit well in front of middle; posterior area shining, finely subrugose-reticulate, with fine, isolated granules behind summit almost to base. Vestiture confined to margins.

Elytra 1.9 times as long as wide; sides straight and parallel on basal three-fourths, acutely angulate behind; striae not impressed, punctures moderately coarse, rather deep; interstriae slightly wider than striae, almost smooth, shining, punctures almost entirely obsolete except replaced near declivity by uniseriate, moderately coarse granules. Declivity steep, convex, produced at apex; striae distinctly impressed, punctures not as deep as on disc; interstriae distinctly convex except near apex, each with a row of low, rounded tubercles on upper half, extending well below middle on 3 and 7, 9 moderately elevated and continuing without interruption to costal margin. Vestiture confined to declivity, consisting of short, stout and long, slender scales of moderate abundance.

Male.—Similar to female except averaging shorter and stouter; frons convex and very coarsely deeply punctured on upper half, flattened and very finely sculptured below, vestiture limited to lower area, fine, inconspicuous; anterior margin of pronotum irregularly armed by about six small teeth; interstriae rather strongly convex at base of declivity, granules larger at base, largely obsolete on declivital face; interstriae 9 more strongly, acutely elevated; declivital vestiture evidently more abundant, scales distinctly wider.

Type Locality.—Rancho Grande, Pittier National Park, Aragua, Venezuela.

Type Material.—The female holotype, male allotype, and 21 paratypes were taken at the type locality on 9 April 1970, 1100 m elevation, No. 432, from a species of Guttiferae by S. L. Wood. Five paratypes bear identical data except No. 409, from a Meleaceae; 37 paratypes are from El Laurel, 12 km southwest of Caracas, Venezuela, 1 May 1970, 1800 m elevation, No. 511, from tree branches by S. L. Wood; 13 paratypes are from Colonia Tovar, Aragua, Venezuela, 4 May 1970, 1700 m elevation, No. 499, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Hylocurus singularis, n. sp.

This species is allied to *villifrons* Wood, but it is distinguished by the subcarinate, transverse elevation of the male frons, by the concave, finely pubescent female frons, and by the different elytral declivity.

Female.—Length 2.4 mm (paratypes 2.0-2.4 mm), 3.0 times as long as wide; color dark reddish brown.

Frons rather deeply concave on circular area on about central half, center of impressed area at upper level of eyes; surface almost smooth, shining, finely punctured, vestiture very fine hairlike, rather abundant, of moderate uniform length. Antennal scape short, ornamented by a few setae; club wider than long, sutures broadly procurved.

Pronotum 1.2 times as long as wide; as in *villifrons* except posterior area very slightly more finely sculptured.

Elytra 1.9 times as long as wide; sides straight and parallel on basal three-fourths, acutely acuminate behind; striae feebly impressed, punctures large, moderately deep; interstriae almost smooth, weakly convex, as wide as striae, punctures almost obsolete except subgranulate toward declivity. Declivity steep, convex; surface densely punctate-reticulate, striae obsolete or nearly so on lower three-fourths; interstriae 1, 2, and 3 weakly elevated, with rather large, rounded granules to lower fourth, 5 and 7 with similar granules to middle, 4, 6, and 8 with granules on upper fourth, 9 acutely, moderately elevated, not serrate, its crest fusing with costal margin. Vestiture limited to declivity where tubercles occur, consisting of rather short, stout, interstrial bristles.

Male.—Similar to female except slightly stouter; frons broadly convex, with a thick, calluslike, transverse carina on median half immediately below upper level of eyes, vestiture sparse, limited to lower half; anterior margin of pronotum armed by eight rather coarse teeth; tubercles at basal margin of declivity somewhat larger, those on interstriae 2 and to a lesser extent on 4 fused to form a short, acutely elevated, longitudinal crest; declivital tubercles slightly larger, usually pointed, interstriae 9 slightly higher; declivital bristles flattened, much wider, slightly longer.

Type Locality.—Eight km southwest of Bumbum, Barinas, Venezuela.

Type Material.—The female holotype, male allotype, and 27 paratypes were taken at the type locality on 11 February 1970, 150 m elevation, No. 313, from an unidentified tree seedling (somewhat similar to Guava) by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Hylocurus flagellatus, n. sp.

This species is closely allied to *dimorphus* (Schedl), but it is distinguished by the more elaborately decorated female scape, by the deeply, longitudinally sulcate female frons which bears a remarkable tuft of hair on the vertex, and by the flatter male declivity, with a dense covering of scales and shorter tubercles on the circumdeclivital ring.

Female.—Length 2.3 mm (paratypes: females 2.3 mm, males 1.8-2.0 mm), 3.0 times as long as wide; color very dark brown.

Frons with median half deeply, broadly sulcate from vertex to epistoma to accommodate a long, stiff pencil of apparently reddish fused setae arising on a small, circular area of vertex; surface reticulate, becoming subrugulose laterally; other setae minute, recumbent, yellowish. Antennal scape broadly triangular, dorsal margin bearing a fringe of long, yellow hair, ventral margin near insertion of pedicel bearing a small penicillate tuft of reddish, fused hair considerably longer than length of pronotum, and from ventral margin near base a similar tuft of curiously curved hair equal in length to combined lengths of funicle and club; scape very similar to *dimorphus* but all tufts of hair longer; club 1.3 times as long as wide, sutures rather narrowly procurved, 1 not reaching middle.

Pronotum 1.4 times as long as wide; sides almost straight and parallel on basal two-thirds; anterior margin shallowly notched for reception of tuft of setae on vertex, unarmed; summit well in front of middle; asperities on anterior area low; posterior area reticulate, punctures minute, obscure. Vestiture of rather long, coarse, sparse hair.

Elytra 2.0 times as long as wide; sides straight and parallel on basal three-fourths, rather broadly rounded then subobtusely acuminate behind; striae not impressed, punctures small, shallow, obscure toward declivity; interstriae as wide as striae, minutely somewhat irregular, punctures fine, obscure. Declivity steep, convex; surface minutely granular; striae obsolete; interstriae 1 and 3 feebly elevated, small granules in rows on 1-3, scattered in lateral areas, 9 not separately elevated. Vestiture of fine, sparse hair on disc, of short strial and interstrial scales on declivity, scales rather abundant, each about two to three times as long as wide.

Male.—Similar to female except shorter, stouter; frons convex, without special ornamentation; antennal scape short, simple; anterior margin of pronotum rather narrowly rounded, armed by four teeth; elytra truncate behind, declivity very steep, almost flat; margin of declivity with circumdeclivital ring of interstrial tubercles, each wider than long; declivital striae evidently obsolete, interstriae with fine, evidently confused punctures, vestiture of abundant scales in obscure rows, each scale slightly less than twice as long as wide.

Type Locality.—Rancho Grande, Pittier National Park, Aragua, Venezuela.

Type Material.—The female holotype, male allotype, and five paratypes were taken at the type locality on 9 April 1970, 1100 m elevation, No. 431, from *Nectandra* branches, by S. L. Wood. The gallery systems were typical of the genus.

The holotype, allotype, and paratypes are in my collection.

Stegomerus mirandus, n. sp.

This species is distinguished from the four previously described species by the small, confused, elytral punctures on both disc and declivity and by the hairlike vestiture on the elytral disc with no scales intermixed.

Female.—Length 1.4 mm (paratypes 1.2-1.5 mm), 2.5 times as long as wide; color very dark brown to black.

Frons rather narrow, convex, a small, transverse impression immediately above epistomal margin; surface reticulate, with moderately coarse punctures above, finer below; vestiture of sparse, inconspicuous, fine, long hair. Antennal club large, subcircular, with three moderately procurved sutures obscurely marked by rows of fine, short hair.

Pronotum 1.0 times as long as wide; widest on basal third, sides moderately arcuate on basal half, weakly constricted in front of middle and behind indistinct anterolateral angles, rather narrowly rounded in front; anterior margin armed by six small teeth (variable); anterior slope armed by low asperities; summit at middle; posterior area subreticulate, with small, isolated granules of irregular size to base. Vestiture of sparse, short hair.

Elytra 1.5 times as long as wide, 1.6 times as long as pronotum; sides almost straight and parallel on slightly less than basal two-thirds, rather narrowly rounded behind; disc shining, all punctures small, moderately deep, confused.

Declivity convex, rather steep; punctures slightly smaller than on disc, confused. Vestiture on disc of fine, short, hairlike setae; on declivity of abundant, rather short scales, each scale about four to six times as long as wide.

MALE.—Similar to female except frons flattened on lower half; reticulation on pronotal disc less evident.

TYPE LOCALITY.—El Laurel Experimental Farm, 12 km southwest of Caracas, Miranda, Venezuela.

TYPE MATERIAL.—The female holotype, male allotype, and 57 paratypes were taken at the type locality on 1 May 1970, 1300 m elevation, No. 468, from an unidentified vine, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Phacrylus pruni, n. sp.

This species differs from *bosqui* Schedl and *robustus* Schedl in having either two (male) or no (female) teeth on the anterior margin of the pronotum, in having the frons more strongly convex, and in having clearly defined striae and strial punctures.

FEMALE.—Length 1.7 mm paratypes 1.4-1.8 mm), 2.4 (male 2.2) times as long as wide; color black, with whitish scales.

Frons broadly, evenly convex; surface reticulate-granulate, a few small punctures almost obsolete; vestiture sparse, inconspicuous. Segment 2 of antennal funicle as long as scape, larger than in other species.

Pronotum 0.85 times as long as wide; widest near base, sides arcuately converging to narrowly rounded anterior margin; summit behind middle; asperities on anterior slope narrow, rather small, on median third only; anterior margin unarmed; entire surface finely reticulate-granulate, punctures fine, obscure. Lateral and posterior areas with moderately abundant, short scales and recumbent hair intermixed.

Elytra 1.5 times as long as wide, 1.9 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather narrowly rounded behind; striae not impressed, punctures small, deep; interstriae three times as wide as striae, smooth, shining, punctures abundant, fine confused. Declivity rather steep, rather broadly convex; striae weakly impressed, punctures smaller than on disc; interstriae feebly convex. Vestiture of abundant, confused, short scales of uniform length; each scale slightly longer than wide.

MALE.—Similar to female except anterior submargin of pronotum armed by two closely set teeth; pronotal asperities evidently very slightly larger; scales on elytra and pronotum evidently more abundant and slightly longer.

TYPE LOCALITY.—Carbonera Experimental Forest, about 50 km (airline) northwest of Merida, Venezuela.

TYPE MATERIAL.—The female holotype, male allotype, and 250 paratypes were collected at the type locality on 16 September 1969, 2500 m elevation, No. 21, from *Prunus sphaerocarpa*, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Periocryphalus, n. gen.

This genus belongs to the Cryphalini. While a general description of characters might suggest a relationship to *Ptilopodius* Hopkins or other genera from the Indo-Malayan region, its true affinities probably lie more nearly to, but still remote from *Phacrylus* Schedl and perhaps other South American Cryphalini. The emarginate eye, the 3-segmented antennal funicle, and the complete absence of sutures on the antennal club serve to distinguish it.

DESCRIPTION.—Length about 1.0 mm, about 2.3 times as long as wide; vestiture of scales and hair.

Frons simple, broadly convex; eye oval, emarginate, finely faceted; antennal scape rather short; funicle 3-segmented, segments 2 and 3 both narrow, their combined length shorter than pedicel; club flattened, subcircular in outline, pubescent but totally devoid of indications of sutures, slightly shorter than combined length of scape and funicle. Pronotum wider than long, coarsely asperate on strongly declivous anterior slope, anterior margin armed by coarse teeth; basal and posterior third of lateral margin with a fine, raised line. Elytra rather strongly ascending on costal margin toward apex; finely sculptured. Vestiture of scales and hair. Anterior tibiae with few teeth on outer margin on less than distal third. Presumably the male is of reduced size and flightless.

TYPE-SPECIES.—*Periocryphalus pullus* Wood, described below.

Periocryphalus pullus, n. sp.

This species superficially might be confused with several other Cryphalini, but the emarginate eye, the 3-segmented antennal funicle, the unsegmented antennal club, and the small, stout body serve to distinguish it.

Female.—Length 1.0 mm (paratypes 1.0-1.1 mm), 2.3 times as long as wide; color almost black.

Frons rather strongly convex, weakly impressed above epistoma except on median line; surface minutely, somewhat obscurely rugose-reticulate, punctures rather coarse, moderately close, not clearly defined; vestiture of fine, short, sparse, inconspicuous hair. Eye less than one-third divided by a narrow emargination. Antennal scape rather short, slender; as described above.

Pronotum 0.91 times as long as wide; widest just behind middle, sides moderately arcuate on basal two-thirds, broadly rounded anteriorly but with median fourth slightly produced and armed by four closely set teeth, median pair much larger; summit slightly in front of middle; anterior slope steep, rather coarsely asperate; posterior area subshining or shining, irregularly, very finely reticulate, part of lateral areas smooth, shining, punctures minute, indefinite, a few fine granules behind summit. Vestiture of short, suberect, fine and stout setae of moderate abundance.

Elytra 1.3 times as long as wide, 1.4 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather narrowly rounded behind; striae not impressed, punctures minute, almost obsolete; interstriae minutely irregular, punctures uniseriate, minute, not always clearly defined, slightly larger than those of striae. Declivity confined to posterior third, convex, moderately steep; punctures evidently slightly larger than on disc, largely obscured by vestiture; costal margin distinctly flanged (or elevated) to accommodate rather strongly ascending abdomen. Vestiture of fine, very short strial hair and interstrial rows of erect scales; each scale about four times as long as wide, close; both scales and hair more abundant on declivity.

Protibiae with three small teeth on outer, apical margin.

Type Locality.—Forty km southeast of Socopo, Barinas, Venezuela.

Type Material.—The female holotype and 8 female paratypes were taken at the type locality on 25 January 1970, 150 m elevation, No. 274, from the vine known locally as Bejuco Blanco, by S. L. Wood; four female paratypes bear identical data except the collection No. 267, one additional female paratype is from No. 273, and one female paratype No. 250, from the twig of an unidentified tree. The pith tunnels in tiny stems were very similar to those made by certain *Xylosandrus* species.

The holotype and paratypes are in my collection.

Hypothenemus nanellus, n. sp.

Apparently this species is more closely allied to *pubescens* Hopkins than to other representatives of the genus, but it is easily distinguished by the stouter body, by the more narrowly rounded apices of pronotum and elytra, and by the much larger antennal club.

Female.—Length 1.0 mm (allotype 0.75 mm, female paratype 1.0 mm), 2.2 times as long as wide; color rather dark yellowish brown.

Frons rather weakly convex, a small median pit or impression at upper level of eyes; surface finely rugose-reticulate; sparsely clothed with fine hairlike setae of moderate length. Antennal club large, 1.1 times as long as wide; eye 1.3 times as long as club.

Pronotum 0.9 times as long as wide; widest on basal third, sides moderately arcuate, rather narrowly rounded in front; anterior margin armed by six teeth, teeth spaced by distances not greater than their basal width; summit at middle, slightly impressed behind; posterior surface rather coarsely reticulate, with small setiferous granules of moderate abundance on disc and lateral areas. Vestiture consisting of small erect scales in posterior areas, small bristles in asperate area.

Elytra 1.3 times as long as wide, 1.5 times as long as pronotum; sides straight and parallel on basal half, then gradually arcuately converging toward narrowly rounded apex; striae weakly impressed, punctures small, shallow; interstriae about one and one-half times as wide as striae, feebly convex, subreticulate, punctures granulate, granules in uniseriate rows, rather coarse, moderately close. Declivity beginning at middle, convex; essentially as on disc. Vestiture consisting of uniseriate rows of erect interstrial scales and shorter, inconspicuous strial hair; each scale about twice as long as wide, spaced between rows by slightly more than length of a scale, and within rows by slightly less than length of a scale.

Male.—Similar to female except smaller and eye slightly reduced.

Type Locality.—Turrialba, Cartago Prov., Costa Rica.

TYPE MATERIAL.—The female holotype, male allotype, and four female paratypes were collected at the type locality on 5 July 1963, at an elevation of about 800 m, by S. L. Wood, from dead twigs of a large, unidentified shade tree in a coffee plantation.

The holotype, allotype, and paratypes are in my collection.

Hypothenemus ascitus, n. sp.

This species probably is more closely related to *nanellus* Wood, described above, than to other representatives of the genus, but it is readily distinguished by the larger size, by the narrower elytral scales and the more abundant elytral ground vestiture, by the smaller, oval antennal club, and by other characters.

FEMALE.—Length 1.3 mm (paratypes: males 0.9 mm, females 1.2-1.3 mm), 2.2 times as long as wide; color dark reddish brown, elytra almost black.

Frons convex above, slightly, transversely impressed above epistoma; surface coarsely reticulate above upper level of eyes, punctate and slightly granulate below; a weak median carina on lower third; vestiture sparse, rather short, hairlike, inconspicuous. Antennal club rather small, oval, 1.5 times as long as wide; eye 1.5 times as long as club.

Pronotum 0.9 times as long as wide; as in *nanellus* except teeth on anterior margin spaced by distances at least twice basal width of a tooth, and posterior area densely, not clearly punctured, with scattered granules; vestiture of slender scales and bristles.

Elytra 1.2 times as long as wide, 1.5 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather narrowly rounded behind; striae moderately impressed, punctures rather coarse, deep; interstriae almost as wide as striae, somewhat convex, almost smooth, punctures uniseriate, rather close, minutely subvulcanate. Declivity confined to posterior third, convex, rather steep. Vestiture consisting of uniseriate rows of interstrial scales; each scale about three times as long as wide; and shorter, rather abundant, fine, strial and interstrial hair.

MALE.—Similar to female except smaller, eye partly reduced.

TYPE LOCALITY.—Puerto Viejo, Heredia Prov., Costa Rica.

TYPE MATERIAL.—The female holotype, male allotype, and 10 paratypes were collected at the type locality on 12 March 1964, at an elevation of about 70 m by S. L. Wood, from just below the outer surface of living bark on the bole of a large, standing healthy tree at least 1 m in diameter.

The holotype, allotype, and paratypes are in my collection.

Hypothenemus teretis, n. sp.

This species has scalelike interstrial setae only on the basal half of the elytra; on the posterior half these setae are shorter, hairlike, and may be semirecumbent. In this respect it resembles *dipterocarpi* Hopkins to which it is not closely related. Except for the frons, which is somewhat similar to *parallelus* Hopkins, and the elytra setae, this species resembles *eruditus* Westwood to which it is compared below.

FEMALE.—Length 1.1 mm (paratypes 1.0-1.2 mm), 2.2 times as long as wide; color almost black.

Frons moderately, transversely impressed on lower two-thirds, convex above, with a low, distinct elevation at upper level of eyes occupying median sixth; surface rugose-reticulate, punctures moderately coarse, shallow; vestiture inconspicuous.

Pronotum 0.94 times as long as wide; as in *eruditus*.

Elytra 1.5 times as long as wide; outline as in *eruditus*; striae not impressed, punctures fine, very shallow, seen with difficulty; interstriae subrugulose, at least twice as wide as striae, punctures fine, obscure, uniseriate. Declivity rather steep, convex; striae weakly impressed, otherwise as on disc. Vestiture of rows of very minute strial hair, and rows of interstrial setae; interstrial setae on disc erect, scalelike, each about four to six times as long as wide, these setae on posterior half of elytra represented by shorter, fine, slender, hairlike setae resembling strial setae.

TYPE LOCALITY.—Finca La Lola, Limon, Costa Rica.

TYPE MATERIAL.—The female holotype and two paratypes were taken at the type locality on 10 January 1963, from *Theobroma cacao*, by J. L. Saunders. Other paratypes include: one from Beverley, Limon, Costa Rica, 26 August 1963, 7 m, No. 154, vine; one from Playón, San José, Costa Rica, 22 February 1964, 50 m, No. 449, *Canavalia villosa*; one from 5 km W El Pino, Zulia, Venezuela, 20 October 1969, 10 m, No. 139, *Inga*; five from 20 km SW El Vigia, 22 October 1969, 100 m, No. 81, *Cecropia* petiole, and one 10 December 1969, No. 184, same locality; one from 9 km S Barrancas, Barinas, Venezuela, 5 November 1969, 150 m, No. 101, *Serjania;* two, same locality, 1 October 1969, No. 33; two from 30 km E Palmar, Bolivar, Venezuela, 12 June 1970, 200 m, No. 575, *Sterculia pruriens*; and two from 40 km E Canton, Barinas, Venezuela, 8 March 1970, 70 m, No. 370, tree seedling; all were females and were taken by S. L. Wood.

The holotype and paratypes are in my collection.

Cryptocarenus coronatus, n. sp.

This species is distinguished from *diadematus* Eggers by the larger size, by the very different frontal sculpture, and by several other characters mentioned below.

FEMALE.—Length 3.0 mm (paratypes 2.8-3.1 mm), 2.5 times as long as wide; color reddish brown.

Frons transversely impressed from upper level of eyes to epistomal margin, this area transversely flat, longitudinally concave; impressed area rather coarsely, closely punctured, more nearly granulate at upper limits of impression and on convex area above to vertex; upper margin of impression with a small, median elevation; epistoma distinct, not strongly elevated; vestiture inconspicuous except for epistomal brush.

Pronotum about as in *diadematus* except anterior slope steeper, asperities larger; anterior margin armed by eight to ten coarse teeth. Glabrous except at margins.

Elytra as in *diadematus* except declivity slightly steeper, more strongly convex, declivital interstriae 2 less strongly impressed, more nearly convex; vestiture more abundant, apices of setae wider.

TYPE LOCALITY.—Twenty km southwest of El Vigia, Merida, Venezuela.

TYPE MATERIAL.—The female holotype was taken at the type locality on 21 November 1969, 50 m elevation, No. 150, from a Bignoniaceae vine, by S. L. Wood. Three female paratypes were taken in Venezuela, one from each of the following localities: 8 km SW Bumbum, Barinas, 11-II-70, No. 325, *Nectandra* twig; 40 km SE Socopo, Barinas, 25-I-70, No. 255, from a cut tree seedling; Campamento Rio Grande, 30 km E Palmar, Bolivar, 200 m elevation, 12-VI-70, No. 566, Suipo; all by S. L. Wood. Pith tunnels in small stems were made by this species.

The holotype and paratypes are in my collection.

Cryptocarenus lepidus, n. sp.

This species is rather closely allied to *laevigatus* Blandford, but may be distinguished by the longitudinally carinate tubercle (often a complete carina from epistoma to vertex), by the shorter elytral vestiture, and by the lighter color.

FEMALE.—Length 1.7 mm (female paratypes 1.6-1.9 mm), 2.6 times as long as wide; color rather dark reddish brown (some specimens very dark).

Frons rather weakly, transversely impressed from just above epistomal margin to just below upper level of eyes, convex above, a fine, low carina extending from epistoma to vertex but higher at upper level of eyes (not evident on lower half in several specimens); epistomal margin shallowly, broadly emarginate; surface finely granulate-punctate, with several low, irregular, longitudinal rugae on upper two-thirds; vestiture consisting of rather sparse, fine hairlike setae.

Pronotum 1.0 times as long as wide; widest just behind middle, sides on basal two-thirds rather weakly arcuate, constricted just behind anterior margin, rather broadly rounded in front; anterior margin armed by 11 closely placed teeth (seven to ten in most specimens); summit at middle; posterior area obscurely marked by fine points, lines, and a few punctures, subreticulate laterally. Anterior and lateral areas bearing a few short, stout hairs.

Elytra 1.5 times as long as wide, 1.6 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather narrowly rounded behind; striae not impressed except 1 feebly impressed toward declivity, punctures small, distinct, rather shallow; interstriae about twice as wide as striae, subshining, surface obscurely marked by numerous minute points. Declivity rather steep, convex; striae 1 narrowly rather deeply impressed, 2 rather weakly, irregularly impressed, punctures smaller, less regular than on disc; interstriae 1 weakly elevated, surface more irregular; scattered punctures on all interstriae, a few of them very feebly granulate. Vestiture confined to sides and declivity, consisting of sparse, slender, spatulate bristles and a few minute, strial, hairlike setae.

MALE.—Smaller than female. Only one male, with head and pronotum lost, was available for study.

TYPE LOCALITY.—Beverley, Limon Prov., Costa Rica.

HOST.—A woody vine, probably *Serjania* sp. (type), *Canavalia villosa*, and at least two tree species (paratypes).

TYPE MATERIAL.—The female holotype and seven paratypes were collected at the type locality on 26 August 1963, at an elevation of about 10 m, from a cut woody vine 1-3 cm in diameter. Other paratypes were taken in Costa Rica as follows: 6 from Pandora, Limon Prov., 23 August 1963, 50 m elevation, from a broken branch; 2 from Playón, 22 February 1964, and 2 from Volcan, 11 December 1964, Puntarenas Prov.; 7 from Santa Ana, 30 August 1963, 1300 m elevation and 1 from San Isidro del General, 13 December 1963, 1000 m elevation, San José Prov. One paratype was taken at Palin, Esquintla Prov., Guatemala, 19 May 1964, 1000 m elevation from a broken branch of a large tree. All were collected by S. L. Wood.

The holotype and paratypes are in my collection.

Dendrocranulus tardulus, n. sp.

This species is readily distinguished from *tardus* Schedl by the smaller size and by the distinctly impressed declivital interstriae 2.

MALE.—Length 1.5 mm (paratypes 1.4-1.5 mm), 3.0 times as long as wide; color light brown.

Frons convex above eyes, rather shallowly, transversely impressed below; surface shining, closely, subgranulately punctured; vestiture very fine, long, rather sparse, hairlike.

Pronotum 1.2 times as long as wide; widest just behind middle, sides moderately arcuate, rather broadly rounded in front; summit indefinite, well in front of middle; surface almost smooth, with a few minute points, punctures on disc rather coarse, close, separated by distances about equal to their diameters, becoming somewhat finely asperate in lateral areas. Vestiture consisting of rather sparse, erect hair.

Elytra 1.6 times as long as wide, 1.3 times as long as pronotum; sides almost straight and feebly dilated on basal two-thirds, then slightly narrowed to just before apex, and abruptly rounded to very broadly rounded, almost straight posterior margin; striae not impressed, punctures rather large, deep; interstriae slightly wider than striae, smooth and shining, punctures almost as large and deep as those of striae, separated by distances about equal to twice diameter of a puncture. Declivity steep, almost flat; posterolateral margin subacutely elevated from apex to interstriae 7, interstriae 2 almost flat, impressed, 1 and area lateral to 2 moderately elevated; strial and interstrial punctures somewhat smaller than on disc, those of interstriae very finely granulate. Vestiture consisting of erect, blunt, rather long interstrial bristles.

FEMALE.—Similar to male except frons evenly convex and more closely pubescent; declivital interstriae 2 feebly if at all impressed, weakly convex, 1 and lateral areas less strongly elevated; vestiture finer.

TYPE LOCALITY.—Rio Damitas in the Dota Mountains, San José Prov., Costa Rica.

TYPE MATERIAL.—The male holotype, female allotype, and 10 paratypes were collected at the type locality on 18 February 1964, at an elevation of about 250 m, by S. L .Wood; the holotype and two paratypes were taken from an unidentified vine, the others from Chayote.

The holotype, allotype, and paratypes are in my collection.

Dendrocranulus diversus, n. sp.

This species appears to be somewhat variable, but it may be distinguished from *costaricensis* Schedl and other allied species by the more broadly impressed declivity, the impression reaching interstriae 4.

MALE.—Length 2.7 mm (paratypes 2.0-2.9 mm), 2.5 times as long as wide; color very dark brown.

Frons convex above eyes, rather strongly transversely impressed from upper level of eyes to epistoma; epistomal margin broadly emarginate, upper tooth on mandibles projecting anteriorly and partly filling this emargination; surface reticulate almost to epistomal margin, rather closely, deeply punctured, many punctures granulate; vestiture consisting of rather long, sparse hair.

Pronotum 1.1 times as long as wide; widest just behind middle, sides strongly arcuate from base to rather narrowly rounded anterior margin; posterior surface almost smooth and shining, punctures moderately large, deep, close, each puncture with a very minute lateral granule (almost imperceptible at center), granules increasing in size laterally. Vestiture bristlelike, almost entirely limited to lateral and asperate areas.

Elytra 1.3 times as long as wide, 1.2 times as long as pronotum; sides arcuately narrowed from level of declivital base to level of sutural apex, posterior margin straight or feebly, broadly emarginate over about two-thirds of elytral width; striae 1 feebly, others not impressed, punctures small, close, rather deep; interstriae about twice as wide as striae, surface obscurely etched by minute points and lines, punctures slightly smaller than those of striae and about half as numerous. Declivity rather abrupt, steep, broadly, shallowly concave; posterolateral margin obtusely rounded, strongly elevated from apex to interstriae 4, conspicuously higher than 1; interstriae 1 weakly elevated, 2 wider and impressed, all interstriae with a median row of fine granules; striae 1, 2, and 3 with punctures rather strongly impressed. Vestiture consisting of interstrial rows of erect bristles.

Female.—Similar to male except frons less strongly impressed (flat or weakly concave in some paratypes); in some specimens posterolateral margin of declivity less strongly developed.

Type Locality.—Puerto Viejo, Limon Prov., Costa Rica.

Type Material.—The male holotype, female allotype, and 14 paratypes were collected at the type locality on 12 March 1964, at an elevation of about 70 m, by S. L. Wood, from an unidentified vine. Other paratypes were taken in Costa Rica as follows: 4 at Pandora, Limon Prov., 23 August 1963; 3 at Turrialba, Cartago Prov., 9 March 1964; 16 at Rio Damitas in the Dota Mountains, San José Prov., 18 February 1964; and 5 at Playón, Puntarenas Prov., 22 February 1964; all were taken from unidentified vines by S. L .Wood. Three specimens not included in the type series are from La Lima, Honduras, 5 May 1964, in *Cayaponia microdonta.*

The holotype, allotype, and paratypes are in my collection.

Dendrocranulus pumilus, n. sp.

This species is very closely related to *schedli* Wood, but may be distinguished by the reticulate pronotum, by the smaller elytral punctures, and by the small nodules associated with discal punctures on the pronotum.

Male.—Length 1.3 mm (allotype 1.45 mm), 2.7 times as long as wide; color yellowish brown.

Frons convex above, transversely impressed one-third below upper level of eyes; surface reticulate, punctures coarse, deep; vestiture hairlike, rather sparse. Antennal club with sutures 1 and 2 weakly procurved, 1 near middle of club.

Pronotum evidently 1.3 times as long as wide (partly obscured by glue); widest just behind middle, sides moderately arcuate from base to rather narrowly rounded anterior margin; asperities small, isolated, poorly developed; posterior surface reticulate, punctures coarse, moderately close, each with a minute granule on lateral side; vestiture hairlike, inconspicuous.

Elytra 1.9 times as long as wide, 1.4 times as long as pronotum; sides almost straight and parallel on basal two-thirds then gradually narrowed to broadly rounded posterior margin; striae not impressed, punctures coarse, deep; interstriae equal to or slightly narrower than striae, punctures about two-thirds as large as those of striae and slightly less abundant. Declivity steep, flattened between third striae; strial punctures almost as large and as deep as on disc; interstriae 1 moderately elevated, 2 impressed (at least medially), gradually ascending laterally to interstriae 3; interstrial punctures less abundant than on disc, not at all granulate. Vestiture consisting of rows of erect interstrial bristles (abraded on most of declivity).

Female.—Similar to male except frontal impression feebly developed; elytral declivity weakly, more narrowly impressed.

Type Locality.—Rio Damitas in the Dota Mountains, San José Prov., Costa Rica.

Type Material.—The male holotype and female allotype were collected at the type locality on 18 February 1964, at an elevation of about 250 m, by S. L. Wood, from the stems of an unidentified vine.

The holotype and allotype are in my collection.

Dendrocranulus limus, n. sp.

This species is distinguished from the closely allied *tardus* Schedl by the rather strongly convex elytral declivity, by the less strongly elevated posterolateral margin of the declivity, and by the more widely spaced strial punctures.

Male.—Length 1.8 mm (paratypes 1.7-2.0 mm), 2.7 times as long as wide; color light reddish brown.

Frons weakly convex; surface reticulate and rather coarsely, not deeply punctured, reticulation and punctures reduced toward center on lower half; vestiture rather sparse, consisting of fine, long hair.

Pronotum 1.2 times as long as wide; sides of middle third almost straight and parallel, posterior angles broadly rounded, anterior angles arcuately converging toward broadly rounded anterior margin; dorsal profile arcuate from base, a little more strongly declivous on anterior third; surface shining, with few points, punctures rather coarse, deep, separated by distances equal to width of a puncture, lateral margin of each puncture very finely asperate, tubercles becoming larger laterally. Vestiture hairlike, inconspicuous except laterally and in asperate area.

Elytra 1.6 times as long as wide, 1.3 times as long as pronotum; sides straight and parallel on slightly more than basal two-thirds, broadly rounded behind; striae not impressed, punctures large, deep; interstriae slightly wider than striae, almost smooth, shining, punctures two-thirds as large as those of striae, spaced one to two times diameter of a puncture. Declivity steep, distinctly convex; posterolateral margin acutely elevated from apex to interstriae 7; striae weakly impressed; interstriae weakly convex, punctures reduced and feebly granulate. Vestiture consisting of erect, interstrial bristles.

FEMALE.—Similar to male except frons bearing a rather dense fringe of long yellow hair to well above eyes, except central area glabrous.

TYPE LOCALITY.—Rio Damitas in the Dota Mountains, San José Prov., Costa Rica.

TYPE MATERIAL.—The male holotype, female allotype, and 19 paratypes were collected at the type locality on 18 February 1964, at an elevation of 250 m, by S. L. Wood, from stems of an unidentified vine; 22 paratypes were taken at Playón, Puntarenas Prov., 22 February 1964, at 50 m elevation, by S. L. Wood, from a wild cucurbit vine.

Xyleborus ebenus, n. sp.

This species is very closely related to *sanguinicollis* Blandford; it is readily distinguished from that species by the black pronotum, by the shining elytral declivity, with strial punctures small and clearly impressed. The declivital differences are conspicuous at a magnification of 80 diameters.

FEMALE.—Length 3.8 mm (paratypes: female 3.7-3.9 mm, male 3.1 mm), 2.0 times as long as wide; mature color uniformly black.

Frons as in *sanguinicollis* except punctures reduced in number and size. Posterior area of pronotum as in *sanguinicollis* but more uniformly reticulate, punctures less clearly impressed. General sculpture of elytral declivity as in *sanguinicollis*; both species vary within limits but average dentition about the same; strial and interstrial punctures minute but clearly impressed, general surface between punctures appearing smooth on lower half, small points visible on upper half of declivity.

MALE.—Slightly smaller than female; pronotal asperities reduced, posteromedian part of pronotum gradually elevated to acutely precipitous posterior margin; elytral declivity more gradual, upper denticles absent, lateral margin rather weakly elevated above major spine.

TYPE LOCALITY.—Guapiles, Limon Prov., Costa Rica.

TYPE MATERIAL.—The female holotype and 15 paratypes were collected at the type locality on 22 August 1966, at an elevation of about 100 m, from a recently cut sapling. Other paratypes include: 2 from Turrialba, Cartago, Costa Rica, 9 March 1964, 700 m elevation; 3 from Cerro Campana, Panama, 26 July 1966, 1000 m elevation; 1 from Volcan Chiriqui, Panama, 11 January 1964, 1800 m elevation; 1 from Limon Bay, Canal Zone, Panama, 30 December 1963, sea level; all collected by myself; and 1 from Zant, Limon, Costa Rica, Flora E, Salas No. AB, 30 May 1956, at 57A4B, in Cacao.

The holotype, allotype, and paratypes are in my collection.

Mimips mimicus Schedl

Fig. 1

This species was described (Schedl, 1961, Pan Pacific Ent. 37:227) from specimens taken

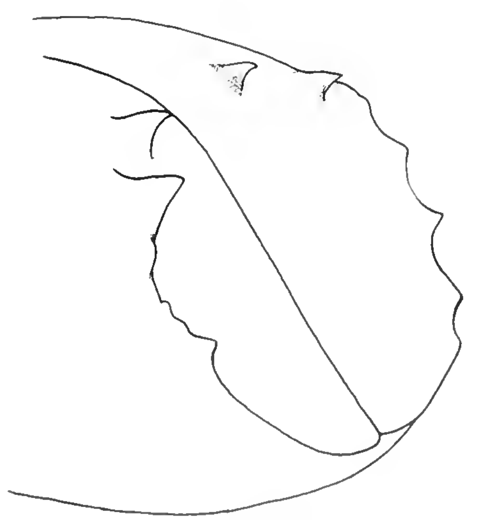

FIG. 1. *Mimips mimicus*: posterolateral aspect of male elytral declivity.

at light in Costa Rica. Since then it has been taken from the following localities. PANAMA: Barro Colorado Island, Canal Zone, 27-XII-63, 70 m elevation, No. 340, tree limb; Ft. Clayton, Canal Zone, 22-XII-63, 30 m elevation, No. 303, tree limb. VENEZUELA: 9 km S Barrancas, Barinas, 5-XI-69, 50 m elevation, No. 115, *Spondias mombin*; 40 km E Canton, Barinas, 8-III-70, 70 m elevation, No. 394, *Spondias mombin*. All were taken by me; apparently they all came from the same host species. Its length is 1.6-2.0 mm.

Mimips analogus, n. sp.

Fig. 2

This species is almost identical to *mimicus* Schedl, but it is distinguished by the male frons and by other characters indicated in the following description.

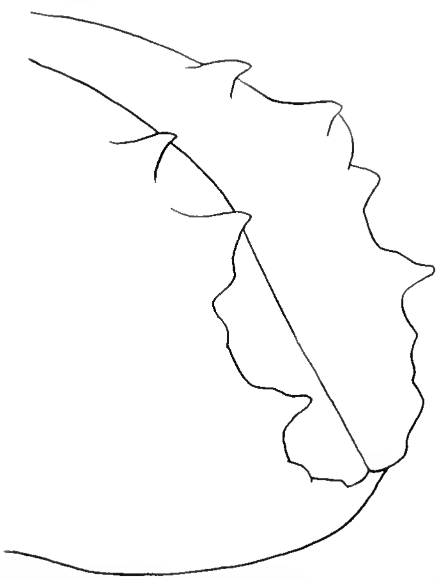

Fig. 2. *Mimips analogus*: posterolateral aspect of male elytral declivity.

Male.—Length 2.0 mm (paratypes 1.9-2.4 mm), 2.4 times as long as wide; color yellowish brown.

Frons rather strongly convex above, lower third strongly, abruptly, transversely impressed; surface rather coarsely punctate-granulate; vestiture sparse, fine, long. Antenna as in *mimicus*.

Pronotum 1.03 times as long as wide; as in *mimicus* except anterior margin unarmed and discal area smooth, shining (partly reticulate in *mimicus*.

Elytra 1.4 times as long as wide; as in *mimicus* except ventrolateral margin of declivity more evenly elevated, basal area of second tooth usually much more strongly developed, and setae on declivital interstriae 1 slender, longer, these setae stout and blunt in *mimicus*; punctures on elytral disc very slightly smaller.

Female.—Similar to female of *mimicus* except frons much more convex, with a slight, transverse impression above epistoma, its surface smoother, more sharply punctured, its vestiture finer, not quite as long; anterior margin of pronotum unarmed; declivities differ as in males.

Type Locality.—Forty km E Canton, Barinas, Venezuela.

Type Material.—The male holotype, female allotype, and 30 paratypes were taken at the type locality on 8 March 1970, 70 m elevation, No. 394, from *Spondias mombin*, by S. L. Wood. They were taken from branches 3-8 cm in diameter; *mimicus* was in branches 2-3 cm in diameter in the same limb.

The holotype, allotype, and paratypes are in my collection.

Mimips fortis, n. sp.

Fig. 3

Evidently this species is allied to *analogus* Wood, but it is easily distinguished by the larger size and by the presence of only two pairs of teeth on the elytral declivity.

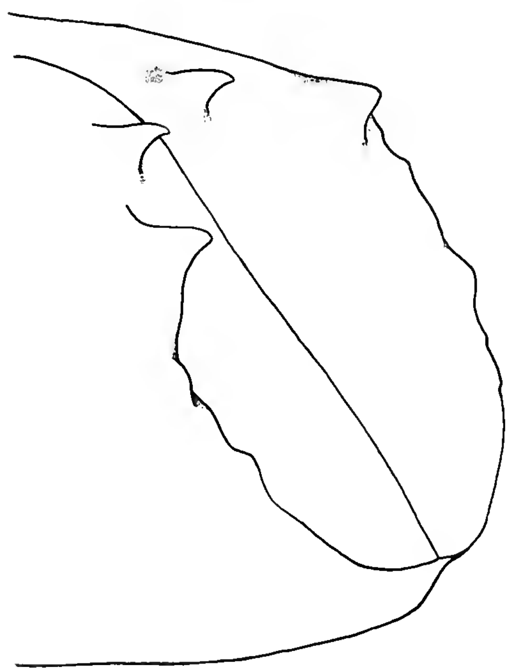

Fig. 3. *Mimips fortis*: posterolateral aspect of male elytral declivity.

Male.—Length 2.5 mm (paratypes 2.3-2.4 mm), 2.6 times as long as wide; color very dark brown.

Frons as in *analogus* except transverse impression much weaker; vestiture sparse, fine. Pronotum as in *analogus* except anterior margin indistinctly serrate, discal punctures slightly larger, not as close.

Elytra 1.5 times as long as wide; disc as in *analogus* but punctures very slightly smaller, deeper; strial and interstrial punctures equal in size. Declivity very steep, truncate, broadly concave; lower two-thirds margined by an elevated, subacute, continuous, slightly undulating ridge, upper third armed by two coarse teeth (directed caudad), one in line with interstriae 2, second in line with interstriae 4; face of declivity shining, with moderately abundant, large, shallow punctures. Vestiture of rather long, fine, interstrial hair, a few supplemental setae near declivity.

Type Locality.—Finca Taboga, about 15 km southwest of Cañas, Guanacaste, Costa Rica.

Type Material.—The male holotype and two male paratypes were taken at the type locality on 8 February 1967, from a fallen tree. One male paratype was taken at Fort Clayton, Canal Zone, Panama, on 22 December 1963, presumably from *Spondias mombin*, by S. L. Wood.

The holotype and paratypes are in my collection.

Mimips bidens, n. sp.

Fig. 4

This species is somewhat intermediate between *chiriquensis* (Blandford) and *fortis* Wood, but it is distinguished by the larger size, and by having only one pair of widely separated declivital teeth.

Male.—Length 2.8 mm (paratypes 2.6-3.0 mm), 2.6 times as long as wide; color reddish brown.

Frons broadly convex, a rather large, low median elevation just below upper level of eyes; surface minutely subaciculate, with isolated, uniformly distributed, moderately large granules; vestiture fine, sparse.

Pronotum as in *fortis* except discal surface subreticulate, punctures fine.

Elytra 1.4 times as long as wide; about as in *fortis* except strial and interstrial punctures rather small, deep, moderately confused from striae 3 to suture. Declivity steep, truncate, broadly excavated; margin acutely, continuously, strongly elevated on lower two-thirds, one coarse, blunt tooth in line with interstriae 4, upper margin between tooth and suture rounded; in declivital face suture moderately elevated, surface shining, punctures rather coarse, impressed, confused. Vestiture of sparse, moderately long, fine, interstrial hair, with supplementary setae in declivital margin.

Female.—Similar to male except frons flattened, feebly impressed above, a feeble median elevation below, surface uniformly covered by small, isolated, setiferous granules, vestiture fine, long, abundant; declivital teeth displaced mesally, in line with striae 2, smaller, located slightly below upper margin of declivity.

Type Locality.—Eight km south of Colonia (near Buenaventura), Valle de Cauca, Colombia.

Type Material.—The male holotype, female allotype, and 102 paratypes were taken at the type locality on 9 July 1970, 30 m elevation, No. 628, in *Icica altisima*, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Mimips uncinatus, n. sp.

Fig. 5

This species evidently is closely allied to *bidens* Wood and *chiriquensis* (Blandford), but

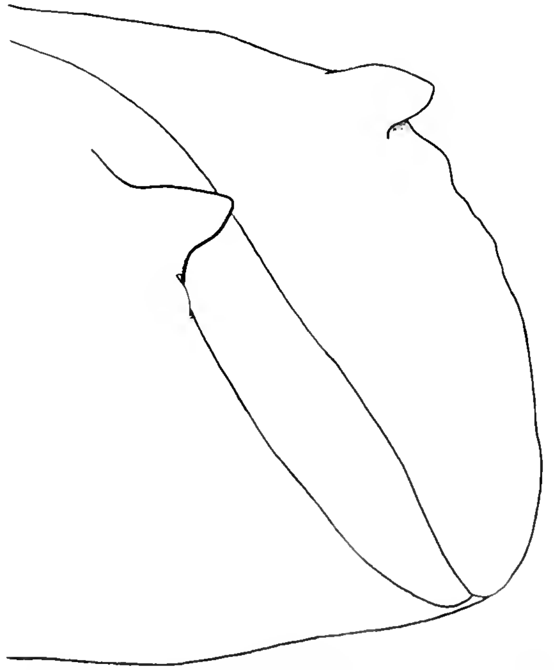

Fig. 4. *Mimips bidens*: posterolateral aspect of male elytral declivity.

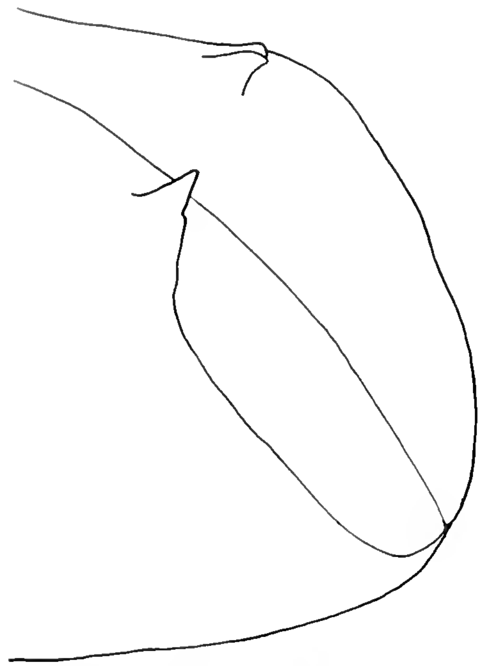

Fig. 5. *Mimips uncinatus*: posterolateral aspect of male elytral declivity.

it differs in the details of the frontal and elytral declivital sculpture.

Male.—Length 1.4 mm (paratypes 1.4-1.7 mm), 2.7 times as long as wide; color reddish brown.

Frons broadly convex: surface minutely aciculate, with small, moderately sparse granules to upper level of eyes, a small, central fovea usually present; vestiture fine, long, moderately abundant. Pronotum as in *bidens*.

Elytra 1.7 times as long as wide; strial and interstrial punctures small, shallow, in rows, of equal size, surface almost smooth, shining. Declivity steep, truncate, broadly concave; lower two-thirds of margin subacutely elevated, ridge ending above in large tooth in line with interstriae 2, tooth directed mesad, slender at its apex and hooked toward suture; declivital margin rounded between teeth; concavity about as in *fortis*. Vestiture of short strial and long interstrial, fine hair, longer, coarser and with supplemental setae at base of declivity.

Female.—Similar to male except median third of vertex transversely etched as on a stridulating organ.

Type Locality.—Colonia Tovar, Aragua, Venezuela.

Type Material.—The male holotype, female allotype, and 15 paratypes were taken at the type locality on 4 May 1970, 1700 m elevation, No. 483, by S. L. Wood, from branches of an unidentified tree. Additional paratypes bear identical data except three are No. 498, two are No. 495, 42 are No. 500, and one is No. 509.

The holotype, allotype, and paratypes are in my collection.

Mimips ocularis, n. sp.

Fig. 6

This small, conservatively sculptured species is not closely related to any described species. It is distinguished by the rather narrowly separated eyes, and by other characters.

Female.—Length 2.0 mm (paratypes 1.7-2.0 mm), 2.8 times as long as wide; color reddish brown.

Frons convex above, flattened toward epistoma; lower third subaciculate, coarse isolated granules in upper and lateral areas, shining, smooth between granules in upper areas; vestiture very fine, long, rather sparse hair. Eyes very large, separated above by a distance almost equal to width of an eye.

Pronotum 1.14 times as long as wide; outline as in *mimicus*; anterior margin finely serrate; posterior area rather coarsely, sharply punctured, with obscure indications of reticulations at margins of punctures, shining. Vestiture of fine hair at margins.

Elytra 1.7 times as long as wide, 1.4 times as long as pronotum; sides straight and parallel on basal three-fourths, broadly rounded behind; strial and interstrial punctures equal in size, small, confused. Declivity steep, narrowly, shallowly concave; margin obtusely rounded on lower two-thirds, summit armed on upper two-thirds by three very small, rounded granules, a

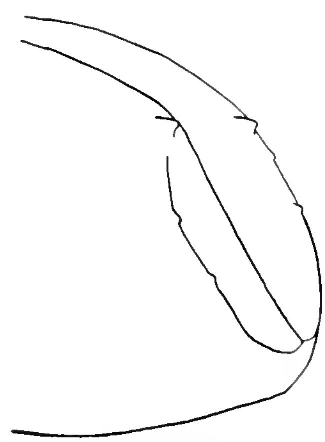

Fig. 6. *Mimips ocularis*: posterolateral aspect of male elytral declivity.

moderately large, pointed tooth in line with interstriae 2, mesad and very slightly above upper granule of lateral margin; concave area shallow, transversely oval, with numerous small, confused punctures. Vestiture of moderately abundant, short, hairlike ground cover, and rather sparse, longer setae, long setae rather stout on declivity.

MALE.—Similar to female except frons more sparsely pubescent.

TYPE LOCALITY.—Eight km south of Colonia (near Buenaventura), Valle de Cauca, Colombia.

TYPE MATERIAL.—The female holotype, male allotype, and 19 paratypes were taken at the type locality on 9 July 1970, 30 m elevation, No. 628, from *Icica altisima*, by S. L. Wood. These specimens were in the same small tree with *bidens*.

The holotype, allotype, and paratypes are in my collection.

Styphlosoma granulatum Blandford

The genus *Styphlosoma* Blandford (1904, Biol. Centr. Amer., Coleopt. 4[6]:232) was named from a unique male specimen from Volcan de Chiriqui, Panama. This genus and species has remained almost unknown since its description except for references to the type. A long series was taken at Finca Taboga, about 15 km southeast of Cañas, Guanacaste Prov., Costa Rica, on 2 February 1967, by R. W. Matthews, from the bark of *Spondias mombin*. Since the remarkable female has not been described the following will aid in the recognition of this species.

FEMALE.—Length 1.3-1.5 mm, 2.4 times as long as wide; color very dark brown.

Frons flat from eye to eye from epistomal margin to vertex; epistomal margin very deeply emarginate, emargination almost attaining upper level of eyes, rather broadly U-shaped, wider than deep, its arms diverging slightly; surface almost smooth, with dense, uniformly distributed, rather coarse, deep punctures over entire flattened area; dorsomesal angle of cutting surface of mandibles greatly extended and curved cephalad into a median, projecting process; this process projecting from fundus of epistomal emargination a distance equal to almost half length of scape; vestiture rather abundant, very short, inconspicuous. Antenna as described and figured by Blandford; funicle clearly 5-segmented; suture 1 moderately procurved, 2 very strongly procurved, segments 1 and 2 smooth and glabrous except for rows of setae at sutures.

Styphlosoma subulatum, n. sp.

This species is very closely related to *granulatum* Blandford, but it is distinguished by the shallowly impressed female frons with finer punctures, by the deeper, narrower female epistomal emargination, by the finer interstrial punctures, and by the slightly narrower declivital impression.

FEMALE.—Length 1.6 mm (paratypes 1.4-1.6 mm), 2.4 times as long as wide; color very dark brown.

Frons as in *granulatum* except feebly planoconcave, upper margin more abrupt; surface reticulate, punctures smaller, obscured in central area; sides of epistomal emargination more nearly parallel; mandibular processes very slightly longer.

Pronotum 1.1 times as long as wide; as in *granulatum* but very slightly more finely sculptured.

Elytra 1.4 times as long as wide; sides almost straight and parallel on basal two-thirds, very broadly rounded behind; striae 1 weakly impressed, strial punctures moderately coarse, rather deep, close; interstriae as wide as striae, smooth, punctures fine, close, in rows except slightly confused toward base (larger and much more strongly confused in *granulatum*). Declivity very steep, appearing somewhat flattened from dorsal aspect; strial punctures smaller than on disc; interstrial punctures about as on disc; interstriae 2 narrowed, strongly, narrowly impressed on central two-thirds of declivity. Vestiture on striae and alternate interstrial setae of short, suberect, rather coarse hair; alternate interstrial setae forming rows of slightly longer scales, each scale about three times as long as wide (alternate arrangement of hair and scales on interstriae of *granulatum* not at all regular).

MALE.—Similar to female except frons with a strongly developed, transverse carina at upper level of eyes, convex above, strongly, transversely impressed below carina, surface coarsely, closely punctured, upper area also reticulate.

TYPE LOCALITY.—Nine km south of Barancas, Barinas, Venezuela.

TYPE MATERIAL.—The female holotype, male allotype, and 51 paratypes were taken at the type locality on 2 December 1969, 150 m elevation, No. 165, from *Astronium graviolens*, by

S. L. Wood. The flattened nuptial chamber is apparently standing on its edge in thick bark, with one axis parallel to the grain of wood, the other perpendicular to the cambium surface, but not reaching the cambium. From its inner angles one to four egg galleries branch, usually two each from the upper and lower angles; these angle diagonally from the nuptial chamber 2-4 mm to the cambium. The egg tunnels then continue along the cambium on a straight or slightly curved course. Eggs are deposited in niches and larval development starts in the cambium. Only newly hatched larvae were present.

The holotype, allotype, and paratypes are in my collection.

Dendroterus eximius, n. sp.

Among described species this one is most nearly allied to *texanus* Wood, although the relationship is not close. It is distinguished by the much more finely punctured pronotum and elytra, and by the impressed female frons.

Female.—Length 2.3 mm (paratypes 1.7-2.1 mm), 2.8 times as long as wide; color reddish brown.

Frons broadly, transversely impressed on lower half, epistoma slightly elevated; surface reticulate above, becoming smooth below, upper area with small, moderately abundant, shallow punctures; vestiture moderately abundant, of rather long, fine hair. Antennal funicle with four strongly compressed segments; club longer than wide.

Pronotum 1.2 times as long as wide; widest on basal half, sides weakly arcuate, narrowly rounded in front; anterior margin armed by about six teeth, median pair much larger; summit at middle; asperities rather coarse, not continued behind summit; posterior area reticulate, punctures very small, shallow, rather sparse. Vestiture rather sparse, hairlike.

Elytra 1.7 times as long as wide, 1.4 times as long as pronotum; sides almost straight and parallel on basal two-thirds, narrowly rounded behind; striae not impressed, punctures rather small, shallow; interstriae wider than striae, rather obscurely reticulate, dull, punctures fine, very sparse except toward declivity. Declivity rather steep, convex; strial punctures minute, weakly impressed; interstrial punctures replaced by fine, uniseriate rows of granules. Vestiture largely confined to declivity, consisting of minute strial hair and rows of much longer, erect interstrial hair; each hair stout, about as long as distance between rows, spaced more closely within a row; all declivital setae diverge very slightly away from suture.

Male.—Similar to female except frons convex, weakly impressed immediately above epistoma, surface very finely, obscurely punctured, vestiture sparse, inconspicuous.

Type Locality.—Lago Amatitlan, Esquintla, Guatemala.

Type Material.—The female holotype, male allotype, and 67 paratypes were collected at the type locality on 10 June 1964, 700 m elevation, No. 707, *Bursera* branch, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Dendroterus parilis, n. sp.

This species is very closely related to *eximius* Wood, but it is distinguished by the more strongly impressed female frons, by the deeper pronotal punctures, by the greatly reduced strial punctures, by the much more numerous. deeper, impressed points on the elytra, and by the much less abundant elytral hair.

Female.—Length 2.0 mm (paratype 1.9 mm), 2.8 times as long as wide; color very dark reddish brown.

Frons as in *eximius* except very slightly more strongly impressed. Pronotum as in *eximius* except discal reticulation stronger, punctures deeper, more sharply impressed.

Elytra as in *eximius* except surface shining, strial punctures minute, shallow, some of them little larger than abundant, sharply impressed, minute points; surface of disc with many shallowly impressed, irregular lines; interstrial punctures on declivity less distinctly granulate. Vestiture about half as abundant as in *eximius*.

Type Locality.—Santa Ana, San José, Costa Rica.

Type Material.—The female holotype and one female paratype were taken at the type locality on 8 November 1963, 1300 m elevation, No. 253, from a *Bursera simarubra* branch, by S. L. Wood.

The holotype and paratype are in my collection.

Dendroterus sodalis, n. sp.

This species is allied to *eximius* Wood, but it is distinguished by the convex, subglabrous female frons, by the subshining pronotum and elytra with sharply impressed, moderately large punctures, and by the weakly impressed declivital interstriae 2.

Female.—Length 1.7 mm (paratypes 1.4-1.8 mm), 2.6 times as long as wide; color dark reddish brown.

Frons broadly convex; surface subshining, small, finely granulate punctures rather close, uniformly distributed; vestiture very short, hairlike, moderately abundant. Funicle 4-segmented.

Pronotum 1.2 times as long as wide; as in *eximius* except teeth on anterior margin much smaller; posterior area subshining, surface subreticulate with many impressed points, punctures moderately large, deep, sparse. Glabrous.

Elytra 1.6 times as long as wide, 1.4 times as long as pronotum; sides straight and parallel on basal two-thirds, rather broadly rounded behind; striae not impressed, punctures moderately large, deep; interstriae almost twice as wide as striae, almost smooth, shining, impunctate except on 1 and on others toward declivity. Declivity steep, broadly convex; strial punctures slightly smaller, not as deep; interstriae 1 abruptly, slightly elevated, 2 impressed, 3 weakly elevated, each with a row of fine rounded granules except absent on lower half of 2. Vestiture of moderately long, coarse, rather widely spaced hair on and near declivity.

Male.—Similar to female except frons more narrowly convex, vestiture less distinct.

Type Locality.—Volcan de Agua, Esquintla, Guatemala.

Type Material.—The female holotype, male allotype, and 43 paratypes were taken at the type locality on 19 May 1964, 1000 m elevation, No. 595, from *Bursera*, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Dendroterus resolutus, n. sp.

This species is distinguished from the closely allied *sallaei* Blandford by the very different frons in both sexes, by the smooth, shining pronotal disc with the punctures much more sharply defined, and by the finer elytral punctures.

Female.—Length 1.9 mm (paratypes 1.5-1.9 mm), 2.7 times as long as wide; color yellowish brown to almost black.

Frons moderately convex on upper two-thirds, lower third broadly, rather strongly, transversely impressed, epistomal margin slightly elevated, a distinct, median tubercle on epistomal margin; surface shining, punctures moderately large, rather deep, sparse in central area, rather dense on lateral and upper margins, extending well above upper level of eyes; vestiture of fine, long hair, sparse at center, rather abundant on margins. Antennal funicle 4-segmented; club 1.3 times as long as wide, sutures straight, 1 partly septate.

Pronotum 1.2 times as long as wide; as in *sallaei* except asperities distinctly larger; posterior area shining, deeply, coarsely, closely punctured. Hairlike vestiture short on disc, longer at sides, moderately abundant.

Elytra 1.5 times as long as wide, 1.3 times as long as pronotum; sides almost straight and parallel on basal two-thirds, broadly rounded behind; striae not impressed, punctures moderately small, deep; interstriae shining, about as wide as striae, punctures rather small, uniseriate. Declivity steep, flattened, striae 1 and 2 moderately impressed, punctures as on disc; interstriae 1 convex, weakly elevated, 2 impressed but weakly convex, 3 weakly elevated; all interstriae with a row of fine, rounded tubercles, those on 2 smaller. Vestiture of rows of stout, moderately long, interstrial hair, much shorter on declivity.

Male.—Similar to female except frons convex to epistoma, punctures rather coarse, uniformly distributed, vestiture sparse, evenly distributed, epistomal tubercle absent.

Type Locality.—Playa del Coco, Guanacaste, Costa Rica.

Type Material.—The female holotype, male allotype, and 28 paratypes were taken at the type locality on 18 October 1963, 15 m elevation, from the bole of *Bursera simarubra*, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Dendroterus defectus, n. sp.

This species is not closely related to other described species of this genus. It is distinguished by the rather large size, by the unarmed anterior margin of the pronotum, by the distinctive frons, by the small strial punctures, and by the sculpture of the interstriae.

Female.—Length 2.5 mm (paratypes 2.3-2.9 mm), 2.4 times as long as wide; color yellowish brown.

Frons broadly impressed from epistomal margin to well above eyes, flat on transverse axis, shallowly concave on longitudinal axis; surface very densely, rather coarsely punctured and evidently very finely granulate except smooth, impunctate and shining on median area along epistoma; vestiture of rather abundant, fine, moderately long hair of uniform length. Antennal funicle 4-segmented; club wider than long.

Pronotum 1.1 times as long as wide; widest at base, sides weakly arcuate, converging slightly on basal half, feebly constricted in front of middle, rather narrowly rounded in front, with a feeble, pseudoemargination on median line; anterior margin weakly elevated, not at all serrate; summit indefinite, behind middle; asperities small, decreasing in size gradually from center, posterior area punctate-subasperate to base, punctures rather small, moderately deep, some reticulation present. Glabrous.

Elytra 1.3 times as long as wide, 1.3 times as long as pronotum; sides almost straight and parallel on basal two-thirds, broadly rounded behind; striae not impressed, punctures small, moderately deep; interstriae shining, twice as wide as striae, surface with many rather deep, irregular, subtransverse lines and moderately large, impressed points, punctures small, slightly irregular. Declivity rather steep, rather broadly flattened; striae slightly impressed, punctures deeper than on disc; flattened between interstriae 4. Almost glabrous, a very few minute, hairlike setae on declivity.

Male.—Similar to female except frons strongly convex above eyes, a very strong, narrow, transverse impression on median three-fourths, area between impression and epistomal margin moderately inflated, glabrous, coarsely punctured; posterior area of pronotum distinctly less subcrenulate.

Type Locality.—Near Rincon de Osa, Puntarenas, Costa Rica.

Type Material.—The female holotype, male allotype, and 47 paratypes were taken at the type locality on 11 August 1966, 50 m elevation, from *Bursera simarubra*, by S. L. Wood. Fifty paratypes were taken at Ft. Clayton, Canal Zone, Panama, 27 July 1966, 70 m elevation, from *Bursera simarubra*, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Dendroterus cognatus, n. sp.

This species is very closely related to *mexicanus* Blandford, but it is distinguished by the more slender form, by the more broadly, evenly rounded, more coarsely punctured male frons, by the more convex female frons with shorter, less abundant vestiture, by the more coarsely punctured pronotum and elytra, and by the more distinctly impressed elytral declivity on which there are numerous minute, impressed points. Future collecting could necessitate the reduction of this form to a subspecies.

Female.—Length 2.0 mm (paratypes 1.8-2.2 mm), 2.8 times as long as wide; color black.

Frons broadly, moderately concave to epistoma; surface rather coarsely, evenly granulate-punctate; vestiture finer, shorter, about half as abundant as in *mexicanus*.

Pronotum 1.23 times as long as wide; about as in *mexicanus* except punctures slightly larger, deeper.

Elytra 1.67 times as long as wide; outline as in *mexicanus* but much more broadly rounded behind; strial punctures coarser and deeper than in *mexicanus*, interstriae narrower than striae. Declivity slightly steeper than in *mexicanus*, very slightly more strongly impressed, sculpture as in *mexicanus* except minute impressed points larger and much more numerous. Vestiture averaging longer and coarser than in *mexicanus*.

Male.—Similar to female except frons as in male *mexicanus* but more broadly, evenly convex, more coarsely punctured, with lateral epistomal calli only moderately to poorly developed.

Type Locality.—Five km (3 miles) west of El Salto, Durango, Mexico.

Type Material.—The female holotype, male allotype, and eight paratypes were taken at the type locality on 7 June 1965, 2500 m elevation, No. 194, from *Bursera*, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Phellotcrus, n. gen.

This genus has the distinctive gallery pattern and habits, and the broad oral region of *Styphlosoma* Blandford and some of the elytral characters of *Dendroterus* Blandford, but it has the antennal club more nearly like *Pityophthorus* Eichhoff, and an acutely elevated lateral and basal margin on the pronotum. It is distinguishable from *Pityophthorus* only by a combination of characters.

Description.—Length 1.3-2.2 mm, body rather stout; color reddish brown, vestiture of hair and or scales.

Frons convex in both sexes, epistomal area very broad, a premandibular lobe usually present at least in female; mandibles enlarged, elongae in female. Eye finely faceted, emarginate. Antennal scape elongate; funicle 5-segmented; club subcircular, sutures 1 and 2 straight, septate at margins only, marked by setae at margins only, apparently suture 3 procurved, marked by setae just below apical margin. Pronotum about as wide as long, anterior half coarsely asperate; summit indefinite, transition from asperate to smooth areas gradual. Elytra striate, discal striae 1-3 usually slightly confused; interstrial punctures very sparse; declivity steep, convex, usually narrowly bisulcate, punctures on striae 1 and 2 large and usually deep; interstriae 3 in male coarsely dentate and with several large teeth or granules in lateral areas, females less strongly sculptured. Tibiae slender, as in *Pityophthorus*.

TYPE-SPECIES.—*Phelloterus tersus* Wood, described below.

BIOLOGY.—The polygamous species of this genus infest trees with thick phloem tissues. Their nuptial chamber is tabular, with the longitudinal axis parallel to the grain of wood and the transverse axis perpendicular to the cambium surface. Compared to other phloem-inhabiting genera the nuptial chamber stands on its edge. From one to five egg galleries branch from the inner margin of the nuptial chamber well before they reach the cambium region. Eggs and larvae occurred only in the cambium region. From one to four females were found with each male.

Phelloterus tersus, n. sp.

This species has minute tubercles on declivital interstriae 1, and declivital interstriae 2 flat and very strongly impressed; the sparse elytral setae are almost hairlike.

MALE.—Length 2.0 mm (paratypes 1.8-2.1 mm), 2.2 times as long as wide; color reddish brown.

Frons very strongly convex, rather strongly, transversely impressed just above epistoma, epistomal margin slightly produced in median area; surface shining, very coarsely, deeply punctured to well above upper level of eyes. Mandibles normal. Eye about twice as long as wide, emarginate; rather finely faceted. Antenna as described for genus.

Pronotum 1.03 times as long as wide; widest one-third length from base, sides moderately arcuate on less than basal two-thirds, narrowly rounded in front; anterior margin serrate; summit indefinite, at or behind middle; posterior area shining, with many minute, impressed points, punctures moderately large, deep, rather close. Glabrous except at margins.

Elytra 1.3 times as long as wide, 1.3 times as long as pronotum; sides almost straight and subparallel on slightly more than basal half, very broadly rounded behind, posterior outline interrupted by coarse denticles; striae 1 feebly impressed, 1-3 moderately confused, punctures rather coarse, deep; interstriae smooth, shining, with rather numerous, minute, impressed points, punctures absent. Declivity very steep, narrowly sulcate; strial punctures very shallow; interstriae 1 abruptly, moderately elevated, with about six widely spaced, fine granules, 2 as wide as 1 or 3, strongly impressed, flat, impunctate, 3 abruptly, rather strongly elevated and armed by five or six widely spaced, coarse, pointed teeth, 4-9 each with one to three denticles of various sizes, some as large as those on 3. Vestiture confined to declivity; of sparse, short, stout, interstrial bristles.

FEMALE.—Similar to male except frons less coarsely punctured, premandibular process on epistomal margin small, rectangular, as long as wide, mandibles slightly elongate; declivital interstriae 2 less strongly impressed, granules on all interstriae much smaller.

TYPE LOCALITY.—Colonia Tovar, Aragua, Venezuela.

TYPE MATERIAL.—The male holotype, female allotype, and 32 paratypes were taken at the type locality on 4 May 1970, 1700 m elevation, No. 507, probably *Eshweilera* log, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Phelloterus anaxeus, n. sp.

This species is closely related to *tersus* Wood, but it is distinguished by the more gradual elytral declivity, in the male interstriae 1 is impressed, less strongly convex and devoid of granules, and by the elongate female mandibles.

MALE.—Length 1.8 mm (paratypes 1.6-1.9 mm), 2.4 times as long as wide; color yellowish brown.

Frons as in *tersus* except transverse impression very weak. Antennal club very slightly wider than long. Pronotum as in *tersus* except ten teeth on anterior margin more clearly defined.

Elytra 1.4 times as long as wide; posterior margin rather narrowly rounded, declivital teeth not interrupting outline; disc as in *tersus* except shorter. Declivity gradual, sulcate; interstriae 1 impressed and convex, unarmed, 2 ascending toward 3 and bearing a row of coarse punctures, 3 elevated and armed by three coarse, widely separated teeth; lateral denticles positioned as in *tersus* but smaller. Vestiture much stouter.

Female.—Similar to male except frons more finely punctured, premandibular epistomal lobe larger, twice as wide as long, mandibles greatly enlarged and elongate; elytral declivity very shallowly sulcate, interstriae 2 convex, denticles as in male but slightly smaller.

Type Locality.—Eight km south of Colonia (near Buenaventura), Valle de Cauca, Colombia.

Type Material.—The male holotype, female allotype, and 49 paratypes were taken at the type locality on 9 July 1970, 30 m elevation, No. 609, from *Sacoglothia procera,* by S. L. Wood. Seventy-four paratypes bear identical data except they were No. 614, taken from *Couma macrocarpa*; three paratypes bear identical data except No. 612, taken from *Licania* sp.; eleven paratypes bear identical data except No. 611, taken from *Lecythia* sp. Forty-eight paratypes were taken 27 km northeast of Montoya (Campamento Capote) on 2 July 1970, 150 m elevation, No. 589, *Eshweilera* (5), No. 586 in Sapotaceae (28), and No. 587 in an unidentified tree limb (15).

The holotype, allotype, and paratypes are in my collection.

Phelloterus atrocis, n. sp.

This species is closely related to *anaxeus* Wood, but it is distinguished by the smaller size, by the conspicuous transverse impression above the epistoma in both sexes, and by details of sculpture on the elytral declivity.

Male.—Length 1.3 mm. (paratypes 1.3-1.6 mm), 2.4 times as long as wide; color yellowish brown.

Frons and antenna as in *tersus*. Pronotum and elytral disc as in *anaxeus*. Declivity moderately steep, rather broadly, shallowly sulcate; as in *anaxeus* except interstriae 2 more deeply impressed. Declivital vestiture with rather abundant ground cover of short, stout, almost scalelike interstrial setae and very fine, short, recumbent, strial hair; a few longer interstrial bristles also arise from the tubercles and lateral areas.

Female.—Similar to female of *anaxeus* except mandibles slightly smaller; impression on elytral declivity not as deep; declivital tubercles absent, a few minute granules present on all interstriae.

Type Locality.—Campamento Capote, 27 km northeast of Montoya, Santander, Colombia.

Type Material.—The male holotype, female allotype, and 122 paratypes were taken at the type locality on 2 July 1970, 150 m elevation, No. 589, *Eshweilera*, sp., S. L. Wood. Eleven paratypes bear identical data except No. 586, in Sapotaceae; 29 paratypes bear identical data except No. 587, in a limb of an unidentified tree. Twenty-five paratypes are from 8 km south of Colonia (near Buenaventura), 9 July 1970, 30 m elevation, No. 609, *Sacoglothia* sp., S. L. Wood. All series were associated in the same branches with *anaxeus*.

The holotype, allotype, and paratypes are in my collection.

Pityophthorus arceuthobii, n. sp.

In Blackman's (1928) classification of the *Pityophthorus* this species would be placed close to *caelator* Blackman, but the relationship to that or to named Mexican species is remote at best. From *caelator* it is distinguished by the very different frons in both sexes, by the much coarser pronotal and elytral punctures in both sexes, and by the shallower sulcus on the elytral declivity which is almost totally devoid of granules on the lateral convexities.

Female.—Length 1.8 mm (paratypes 1.8-2.0 mm), 2.6 times as long as wide; color very dark brown, elytra usually slightly lighter.

Frons planoconvex, with a slight transverse impression on lower third, epistomal margin weakly elevated; surface subshining, rather coarsely, closely punctured, on a hemispherical area; vestiture of fine, rather long hair of equal length almost uniformly distributed over punctured area. Antennal club with suture 1 straight, segments 2 and 3 about equal in width.

Pronotum 1.0 times as long as wide; widest near base, sides almost parallel on slightly less than basal half, weakly constricted on anterior half, rather broadly rounded in front; anterior margin armed by about ten, small, irregularly formed teeth; posterior area reticulate, punctures coarse, deep. Glabrous except at margins.

Elytra 1.6 times as long as wide, 1.7 times as long as pronotum; sides almost straight and parallel on basal two-thirds, then slightly converging, broadly rounded behind; striae 1 narrowly impressed on posterior half of disc; striae moderately confused, punctures large, deep, only moderately close, equal in size and appearance with slightly less abundant, confused, interstrial punctures; surface shining, not completely smooth. Declivity rather steep, broadly, shallowly sulcate; punctures on striae 1 and 2 minute but distinct; interstriae 2 wide, smooth, moderately impressed, 1 sharply, slightly elevated, bearing about six minute granules, 3 gradually, broadly raised, punctures very feebly granulate. Vestiture of sparse, rather short, coarse hair, mostly on sides.

MALE.—Similar to female except frons more strongly convex above, lower half with a rather thick, low, median carina which gradually increases in height to summit just above epistoma, surface subreticulate, less regularly punctured, frontal vestiture sparse, short; granules on elytral declivity scarcely evident.

TYPE LOCALITY.—Ninety-six km (60 miles) west of Durango, Durango, Mexico.

TYPE MATERIAL.—The female holotype, male allotype, and 38 paratypes were taken at the type locality on 5 June 1965, 2500 m elevation, No. 27, from a dying mistletoe, *Arceuthobium globosum*, growing in a 5-needle pine, by S. L. Wood. This is the first representative of the Pityophthorini reported from the Loranthaceae.

The holotype, allotype, and paratypes are in my collection.

Pityoborus hondurensis, n. sp.

This species is distinguished from the closely allied *velutinus* Wood by the less strongly impressed female frons, with the yellowish pubescence finer, shorter and less abundant, by the much smaller pilose areas on the female pronotum, by the more strongly impressed, more abundant, confused punctures on the elytral declivity, and by the more abundant vestiture on the elytral declivity.

FEMALE.—Length 2.0 mm (paratypes 1.8-2.0 mm), 2.6 times as long as wide; color reddish brown.

Frons as in *velutinus* except very slightly less strongly impressed on a narrower area, with fine, sparse punctures; lateral vestiture finer, less abundant, much shorter. Pronotum as in *velutinus* except pilose areas distinctly smaller; posterior area with moderately abundant, small, shallow punctures clearly evident.

Elytra as in *velutinus* except punctures on disc deeper, slightly larger, with a few more interstrial punctures particularly on posterior half; declivital punctures smaller than on disc but much larger and deeper than in *velutinus*, interstriae 1 distinctly elevated, striae and interstrial punctures in somewhat indistinct rows; sparse vestiture on declivity more abundant than in *velutinus*.

MALE.—Similar to female except frons not at all concave, vestiture greatly reduced; pilose areas on pronotum absent; pronotal punctures less distinct; punctures on discal striae slightly larger; declivital interstriae 1 and 3 with minute granules.

TYPE LOCALITY.—Yuscaran, Paraiso, Honduras.

TYPE MATERIAL.—The female holotype, male allotype, and 11 paratypes were taken at the type locality on 23 April 1964, 800 m elevation, from small shaded-out branches of *Pinus caribaca* (No. 518, type) and *P. oocarpa* (No. 519), by S. L. Wood. Galleries were typical of the genus.

The holotype, allotype, and paratypes are in my collection.

Pityoborus frontalis, n. sp.

This species is distinguished from the closely allied *velutinus* Wood by the more deeply concave female frons, with the frontal vestiture finer and pale yellow in color, and by the much larger, deeper strial punctures on the declivity.

FEMALE.—Length 2.0 mm (allotype 2.0 mm), about 2.6 times as long as wide (elytra spread); color rather dark reddish brown.

Frons as in *velutinus* except much more deeply concave on a narrower circular area; vestiture in lateral areas much finer, pale yellow in color. Pronotum as in *velutinus* except reticulation stronger, punctures more clearly evident.

Elytra as in *velutinus* except reticulation stronger, declivity more nearly shining; strial punctures on declivity larger, deeply impressed.

MALE.—As in female except frons not concave, feebly impressed, surface reticulate, vestiture on lateral and upper margins similar but slightly less abundant; pilose areas on pronotum absent.

TYPE LOCALITY.—Thirteen km southeast of El Cameron, Oaxaca, Mexico.

TYPE MATERIAL.—The female holotype and male allotype were taken at the type locality on 21 June 1967, No. 75, from a shaded-out branch of *Pinus*, by S. L. Wood.

The holotype and allotype are in my collection.

Pseudopityophthorus singularis, n. sp.

This species is allied to *tenuis* Wood, but it is distinguished by the coarser pronotal punctures, by the longer elytral setae, by the weakly impressed male frons with slightly longer and more abundant setae, and by the subconcave female frons which lacks a median carina.

Male.—Length 1.6 mm (paratypes 1.3-1.6 mm), 3.0 times as long as wide; color very dark brown (most of type series not fully colored).

Frons flattened, epistoma weakly elevated, surface indistinctly punctured; vertex bearing a sparse brush of about two dozen very long setae with tips reaching to epistoma, a few additional setae in epistomal area. Antenna as in *tenuis*.

Pronotum much as in *tenuis*, with anterior margin more broadly rounded; punctures on disc much larger, impressed points moderately abundant.

Elytra 1.8 times as long as wide; sides almost straight and parallel on basal two-thirds, rather broadly rounded behind; striae not impressed, punctures small, distinct, in rows; interstriae almost smooth, a few minute, impressed points, at least three times as wide as striae, a few punctures toward declivity. Declivity steep, rather broadly convex; punctures of striae 1 minute, in a row, others obsolete; sutural interstriae feebly elevated, 1, 3 and some of lateral interstriae with sparse, minute, setiferous punctures. Vestiture of very minute strial hair, and rows of widely spaced, moderately long, fine interstrial hair on sides and declivity, almost obsolete on disc.

Female.—Similar to male except frons convex above eyes, transversely impressed above epistoma, impression extending dorsad slightly at center, surface very coarsely punctured, vestiture sparse, inconspicuous.

Type Locality.—One km west of Las Vigas, Veracruz, Mexico.

Type Material.—The male holotype, female allotype, and five paratypes were taken at the type locality on 5 July 1967, No. 159, from a *Quercus* branch, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Pseudopityophthorus virilis, n. sp.

This species has the frons ornamented by setae in both sexes; it is remotely similar to *granulifer* Wood but it is distinguished by the smaller size, by the distinctly punctured elytral declivity, and by the presence of granules only on interstriae 1 and 3.

Male.—Length 1.5 mm (paratypes 1.3-1.6 mm), 2.7 times as long as wide; color black.

Frons transversely impressed, flattened from above eyes to epistoma; surface somewhat coarsely punctured above and at sides, evidently impunctate below in median area; vertex ornamented by a rather dense brush, its longest setae exceed epistomal margin, a few additional setae at sides and on epistomal area. Antenna about as in *granulifer*.

Pronotum as in *granulifer* except teeth on anterior margin of pronotum larger, punctures on disc very slightly larger, impressed points much smaller.

Elytra 1.6 times as long as wide; outline as in *granulifer;* punctures on disc confused, not in rows except near declivity, small; surface subshining, with a few irregular lines and impressed points. Declivity steep, convex; interstriae 1 and 3 each bearing a row of fine, rounded granules, three indistinct rows of minute, setiferous punctures between rows of granules, lateral areas similarly punctured. Vestiture almost hairlike at base, becoming scalelike toward declivity, those setae apparently derived from interstriae distinctly longer than those derived from striae; longest scales on declivity rather short, about six times as long as wide.

Female.—Similar to male in all respects, including frontal sculpture and vestiture.

Type Locality.—One km west of Las Vigas, Veracruz, Mexico.

Type Material.—The male holotype, female allotype, and 19 paratypes were taken at the type locality on 5 July 1967, No. 159, from *Quercus* branches, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Pseudopityophthorus declivis, n. sp.

This species is unique in the genus; it is distinguished by the subvertical, impressed elytral declivity on which the striae are clearly indicated by rows of moderately coarse punctures.

Female.—Length 1.8 mm, 2.6 times as long as wide; color very dark brown.

Frons broadly convex above eyes, almost flat below, with epistomal area weakly elevated; surface very coarsely, deeply punctured above and at sides, almost impunctate in median area below; vestiture rather sparse except on epistoma, of fine, long hair. Antennal club moderately large, widest through segment 3.

Pronotum 1.1 times as long as wide; widest near base, sides feebly arcuate and converging very slightly on basal two-thirds, rather broadly rounded in front; anterior margin armed by a continuous, elevated, serrate costa; summit at middle; anterior area rather finely asperate; posterior area rather coarsely, deeply, closely punctured, general surface subreticulate. Subglabrous.

Elytra 1.6 times as long as wide, 1.4 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather broadly bisinuate behind; striae not impressed, punctures rather fine (coarse for this genus), deep; interstriae three times as wide as striae, with very fine, irregular lines, numerous impressed points, impunctate. Declivity subvertical, flattened, confined to less than posterior fifth; striae 1-3 clearly indicated, punctures shallow; surface almost flat except for strongly elevated interstriae 1; very fine punctures on all interstriae except 2. Vestiture confined to posterior third, of very minute strial hair, and rows of erect, moderately long, interstrial bristles of uniform length.

TYPE LOCALITY.—Laguna Santa Maria, Nayarit, Mexico.

TYPE MATERIAL.—The unique female holotype was taken at the type locality on 6 July 1965, 1000 m elevation, No. 203, from a *Quercus* branch, by S. L. Wood.

The holotype is in my collection.

Pseudopityophthorus colombianus, n. sp.

This unique species is the first representative of the genus known from South America; it is distinguished from other species by the very slender form, by the shallowly bisulcate elytral declivity on which the strial punctures are in rows, and by the rather coarse granules on interstriae 3.

MALE.—Length 1.4 mm (paratypes 1.3-1.5 mm), 3.0 times as long as wide; color brown.

Frons flattened from eye to eye, from epistoma to vertex; surface smooth, shining, with fine punctures (evidently only near sides; obscured), central area glabrous; lateral and upper margins with a dense row of long yellow setae, tips of those on vertex reaching epistomal margin. Antennal club rather small; sutures 1 and 2 almost straight.

Pronotum 1.2 times as long as wide; widest on basal third; sides feebly arcuate, converging slightly on basal two-thirds, rather broadly rounded in front; anterior margin armed by more than a dozen small teeth; summit in front of middle; asperities usually in poorly defined subconcentric rows; posterior area almost smooth, punctures moderately coarse, rather sparse. Vestiture of short, sparse hair, except bristlelike in asperate area.

Elytra 1.9 times as long as wide, 1.6 times as long as pronotum; sides almost straight and parallel on basal three-fourths, broadly rounded behind; striae not impressed, punctures rather coarse, moderately deep; interstriae almost smooth, as wide as striae, punctures almost as large as those of striae but almost entirely confined to interstriae 1 and to posterior fourth of disc. Declivity steep, broadly, shallowly bisulcate; strial punctures fine, shallow; sutural interstriae slightly elevated, 2 slightly, rather broadly impressed, 3 gradually, distinctly elevated and bearing a row of three to five moderately coarse granules; lateral areas with occasional smaller granules. Vestiture of moderately abundant, rather long, hairlike setae, some interstrial setae rather coarse.

FEMALE.—Similar to male except frons convex, lower third with a distinct transverse impression, surface rather coarsely punctured, vestiture sparse, inconspicuous.

TYPE LOCALITY.—Piedras Blancas, 10 km east of Medellin, Antioqua, Colombia.

TYPE MATERIAL.—The male holotype, female allotype, and 50 paratypes were collected at the type locality on 15 July 1970, 2500 m elevation, No. 667, from small *Quercus humboldtii* branches, by S. L. Wood. The galleries and habits were as in other species of the genus.

The holotype, allotype, and paratypes are in my collection.

Gnathophthorus clematis, n. sp.

Fig. 7

The only previously known species in this genus, *sparsepilosus* (Schedl), is not closely related to any of the species described here. That species has the frons more unformly sculptured and pubescent than those presented below, but it shares the very slender form and the distinctive antenna and elytral declivity of these four species. Two of the species for which hosts are known breed in vines of the genus *Clematis* and have similar habits.

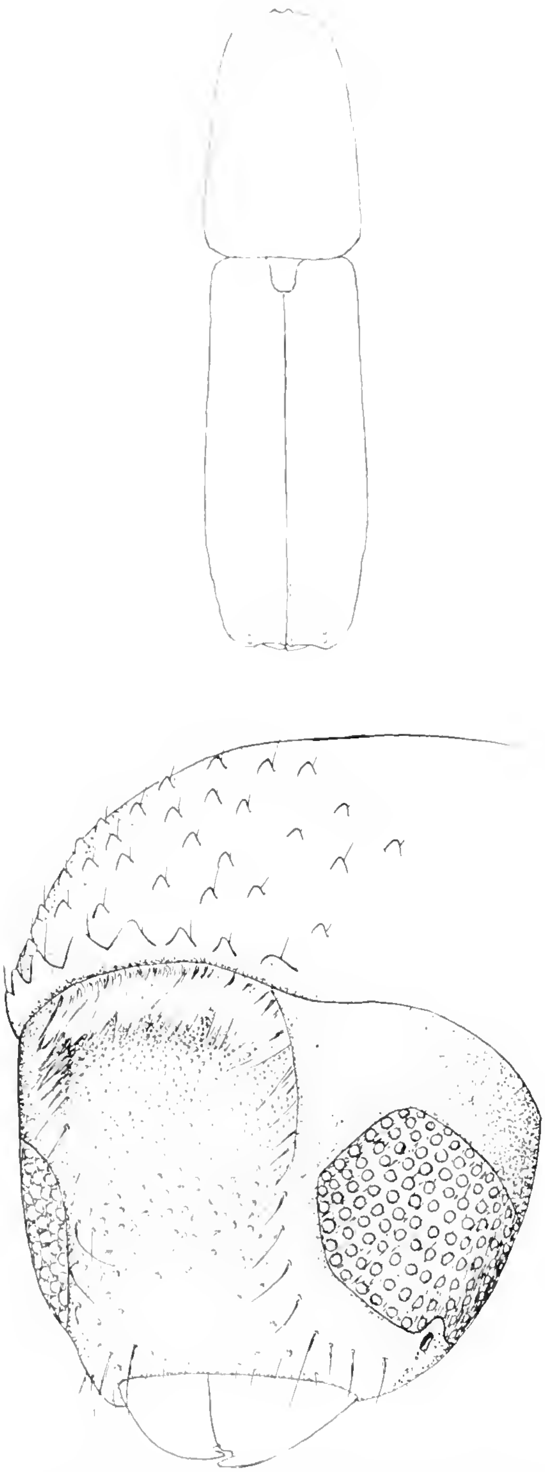

Fig. 7. *Gnathophthorus clematis*: dorsal aspect of outline of female (above); and anterolateral aspect of female head (below).

Female.—Length 1.9 mm (paratypes 1.4-2.0 mm), 3.8 times as long as wide; color light yellowish brown, pronotum and elytral declivity slightly darker.

Frons flattened from just above epistoma to vertex, transversely divided at upper level of eyes by a feeble summit; lower area coarsely, shallowly, closely punctured, with sparse, uniformly distributed, inconspicuous, hairlike pubescence; upper area appearing somewhat spongy, very minutely, densely punctured, with microscopic pilelike pubescence and with a marginal fringe of short hair of uniform length, little if any longer than setae on lower frons. Eye large, emarginate, coarsely faceted. Antennal funicle 5-segmented, last four segments crowded, indistinct; club very large, with three moderately procurved, nonseptate sutures.

Pronotum 1.4 times as long as wide; sides on basal half straight and parallel, constricted slightly in front of middle then weakly arcuate to broadly rounded anterior margin; anterior margin armed by eight widely spaced, coarse teeth; summit on anterior third, indefinite; anterior third rather finely asperate; posterior area smooth, with fine, deep, sparse punctures. Glabrous except for scattered hair near lateral margins.

Elytra 2.4 times as long as wide, 1.8 times as long as pronotum; sides straight and parallel on more than basal three-fourths, broadly rounded behind; declivity confined to posterior one-sixth; striae not impressed, punctures minute, scarcely indicated on surface; interstriae almost smooth, impunctate. Declivity steep, rather strongly excavated; striae obsolete; interstriae 1 moderately elevated, with a row of moderately coarse punctures; area of interstriae 2 strongly impressed, widened at middle; lateral areas strongly elevated on upper two-thirds, summit broadly rounded, with rather coarse, confused punctures, two very feeble granules on upper margin of elevated area. Disc glabrous; moderately abundant, coarse hair on declivity.

Male.—Similar to female except frons convex above, lower half abruptly impressed, subreticulate, punctures rather coarse, vestiture sparse, inconspicuous; granules on elytral declivity larger, pointed.

Type Locality.—Volcan Colima, Jalisco, Mexico.

Type Material.—The female holotype, male allotype, and 106 paratypes were taken at the type locality on 23 June 1965, 2500 m elevation, No. 100, from *Clematis*, by S. L. Wood. Other specimens, not included in the type series are from Tapanti and Volcan Irazu, Costa Rica; and Volcan Chiriqui, Panama. The monogamous beetles construct transverse, biramose galleries in the cambium region; egg niches are small and packed with frass; larval mines are straight, in grooves between the longitudinal fibers, up to 40 mm long, of uniform diameter; fungal growth was noted in the parental tunnels but not in the larval mines.

The holotype, allotype, and paratypes are in my collection.

Gnathophthorus cracens, n. sp.

This species is allied to *clematis* Wood, but it has the frontal pile much longer and covering a large area, and the declivital sulcus is much narrower and armed by several denticles.

FEMALE.—Length 1.2 mm, about 3.8 times as long as wide; color yellowish brown.

Frons as in *clematis* except lower area flat, very finely, sparsely punctured, ending well below upper level of eyes; upper area slightly more extensive, pile long, dense, setae on marginal fringe on upper margin only, much longer, tips reaching middle of pilose area. Pronotum as in *clematis* except anterior margin armed by 10 teeth; punctures on posterior area minute.

Elytra as in *clematis* except declivity narrowly, deeply sulcate; sutural interstriae feebly elevated; lateral areas abruptly elevated from position of striae 2, summit armed by five or six small, laterally compressed teeth.

TYPE LOCALITY.—La Ceiba, Honduras.

TYPE MATERIAL.—The female holotype was taken at the type locality on 15 May 1949, at light, by E. C. Becker.

The holotype is in my collection.

Gnathophthorus rallus, n. sp.

This species is allied to *clematis* Wood, but it is distinguished by the different sculpture of the frons, by the minutely etched pronotal disc, by the larger strial punctures, and by the dark color.

FEMALE.—Length 1.8 mm (paratypes 1.5-1.9 mm), 3.7 times as long as wide; color very dark brown, almost black.

Frons flattened from just above epistoma to vertex; area below upper level of eyes rather finely, shallowly punctured, with inconspicuous, moderately long, hairlike pubescence; upper area twice as large as lower area, pilose as in *clematis*, marginal fringe long, tips of upper setae extend beyond middle of pilose area.

Pronotum as in *clematis* except posterior area reticulately, longitudinally etched, punctures slightly smaller.

Elytra as in *clematis* except strial punctures slightly larger, surface with minute, impressed points, and shallow, irregular, transverse lines; declivity devoid of granules.

MALE.—Similar to female except frons as in male *clematis* with line between convex and impressed areas more nearly carinate.

TYPE LOCALITY.—Merida, Venezuela.

TYPE MATERIAL.—The female holotype, male allotype, and 65 paratypes were taken at the type locality on 29 December 1970, 1700 m elevation, No. 210, 212, from recently cut stems of *Clematis*, by S. L. Wood. The habits were as in *clematis*.

The holotype, allotype, and paratypes are in my collection.

Gnathophthorus pertusus, n. sp.

This distinctive species differs from all others in the genus by the small, median elevations on the male frons at the epistoma and at the upper level of the eyes, and by the peculiar cavity on the female frons. The small size and several other features also serve to distinguish it.

FEMALE.—Length 1.4 mm (paratypes 1.1-1.4 mm), 3.7 times as long as wide; color light yellowish brown.

Frons shallowly concave from just below upper level of eyes to vertex, a somewhat indefinite summit just below impressed area; median third of summit area occupied by a large cavity from upper level of eyes one-third distance to epistoma, inner diameter of cavity apparently larger than its opening on surface, its margins slightly elevated, its inner walls precipitous; surface of concave area subreticulate, impunctate, its upper margin with a fringe of short hair; surface of lower area with a few minute punctures and sparse, short pubescence. Funicular segments, except pedicel, very crowded, evidently partly fused to one another; club with suture 1 weakly procurved, 2 almost straight.

Pronotum 1.4 times as long as wide; widest at base, sides straight and converging very slightly on basal three-fourths, rather narrowly rounded in front; anterior margin armed by about 12 small teeth; summit indefinite, one-third pronotum length from anterior margin; anterior third finely asperate; posterior area almost smooth, punctures not evident.

Elytra 2.2 times as long as wide, 1.7 times as long as pronotum; sides straight and parallel on slightly more than basal two-thirds, then gradually converging, very broadly rounded behind; striae not impressed, punctures minute, almost totally obsolete, visible in subsurface structure; interstriae almost smooth, impunctate. Declivity moderately steep, rather deeply sulcate; striae as on disc; sutural interstriae weakly elevated, 2 narrowly, deeply impressed, 3 abruptly, strongly elevated well above level of 1, its summit armed by about five granules of moderate size. Vestiture largely confined to declivity, of sparse, coarse, moderately long hair.

Male.—Similar to female except frons convex on upper half, broadly, transversely impressed below, a short, median elevation on epistoma and at upper limit of impressed area, cavity and setae absent; longer setae on elytral declivity flattened, scalelike, small setae in ground cover much more conspicuous.

Type Locality.—Twenty km southwest of El Vigía, Merida, Venezuela.

Type Material.—The female holotype, male allotype, and 33 paratypes were taken at the type locality on 21 November 1969, 50 m elevation, No. 150, from a recently cut section of a large Bignoniaceae vine (liana), by S. L. Wood. The woody structure of the liana was layered and each pair of the monogamous beetles constructed transverse, biramous egg galleries at each of a half dozen or more successive layers; the connecting tunnel was more or less straight and was located where each pair of egg galleries branched. Larval mines were rather short and longitudinal. Fungal growth was not evident.

The holotype, allotype, and paratypes are in my collection.

Sphenoceros azteeus, n. sp.

This is the second known species in this genus and the first from North America. It is very closely related to *limax* Schedl, but it is distinguished by the very minutely punctured central area of the female frons, by the indistinctly more slender, angulate, anterior projection of the female pronotum, by the more slender elytral bristles, and by the more finely punctured elytra with fewer interstrial punctures.

Female.—Length 2.0 mm (paratypes 1.8-2.2 mm), about 2.1 times as long as wide; color very dark reddish brown.

Frons exactly as in *limax* except surface of large central area minutely, densely punctured. Antenna as in *limax* except suture 2 more distinctly indicated. Pronotum as in *limax* except anterior projecting angle very slightly more slender, and punctures on disc distinctly smaller.

Elytra as in *limax* except punctures of striae and interstriae very slightly smaller, those of interstriae less numerous. Interstrial scales slightly longer and more slender.

Male.—As in male of *limax* except lateral punctures on pronotal disc smaller; elytra differ as in females.

Type Locality.—Six km (4 miles) west of Tepic, Nayarit, Mexico.

Type Material.—The female holotype, male allotype, and eight paratypes were taken at the type locality on 13 July 1965, 1000 m elevation, No. 240, from cut branches of a large unidentified tree, by S. L. Wood. One paratype is from El Salto, San Luis Potosi, Mexico, 19 June 1953, *Ficus*, S. L. Wood. A series from 8 km east of San Blas, Nayarit, Mexico, 12 July 1965, No. 235, is in very poor condition and is not part of the type series.

This genus was placed by Schedl in the Corthylini; however, the above species is monogamous, the adults construct transverse, biramose tunnels in the cambium region and deposit their eggs in niches, and the larval tunnels are longitudinal and in the phloem. This genus is very closely related to and eventually may be united with certain species of *Neodryocoetes*.

The holotype, allotype, and paratypes are in my collection.

Brigham Young University
Science Bulletin

ECOLOGY OF *SCELOPORUS OCCIDENTALIS LONGIPES* BAIRD AND *UTA STANSBURIANA STANSBURIANA* BAIRD AND GIRARD ON RAINIER MESA, NEVADA TEST SITE NYE COUNTY, NEVADA

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and
James M. Hopkin

BIOLOGICAL SERIES — VOLUME XV, NUMBER 4
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Frontispiece. Rainier Mesa Study Plot.

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ABSTRACT

This paper constitutes the first in a series of terminal reports to the United States Atomic Energy Commission for Contract AT (11-1) 1496. It includes a major study on the ecology and life history of *Sceloporus occidentalis longipes* Hollowell and a comparative study of three populations of *Uta s. stansburiana* Baird and Girard with special emphasis given for the *Uta* population on Rainier Mesa.

The study plot of major concern in this report is located on Rainier Mesa of the Nevada Test Site. Reports for other study plots (Frenchman's Flat—four study areas—and Mercury Valley) will follow in the near future and will include information concerning the ecology and life history of at least the following species: *Coleonyx variegtus*, *Crotaphytus collaris*, *Crotaphytus wislizeni*, *Sauromalus obesus*, *Callisaurus draconoides*, *Sceloporus magister*, *Phrynosoma platyrhinos*, and *Chionactis occipitalis*.

THE ECOLOGY AND LIFE HISTORY OF A POPULATION OF *SCELOPORUS OCCIDENTALIS LONGIPES* BAIRD ON RAINIER MESA, NEVADA TEST SITE, NYE COUNTY, NEVADA

by

Wilmer W. Tanner[1]
James M. Hopkin[2]

Only a few life history studies have been concerned with lizards in the Great Basin, and most of these have not included a detailed study of marked lizards on a study plot. Most studies dealing with autecology have suffered from a lack of quantitative data, which is perhaps a direct result of gathering data over a short period of time. It is true that much information can be accumulated in one year. However, we have found the desert to vary from year to year, primarily the edaphic factors which in turn induce and effect changes in the biotic factors. We believe that in order to examine the fluctuations of the biotic cycles and rhythms in a desert population several years of intensive study are needed if one is to understand the basic aspects of population ecology. Furthermore, the roles of individuals, males and females, and age groups are not easily understood unless at least one generation is followed through a cycle.

There are a few studies of lizard ecology which are complete enough to be cited as examples. A recent one by Tinkle (1967) concerning the life and demography of *Uta stansburiana stejnegeri* in western Texas is based on a large quantity of data gathered over a period of many years. Perhaps the completeness of the *Uta* study lies not only with the thoroughness of the investigator but also from the fact that utas are numerous and therefore a larger number of individuals increased the mass of data available. In our study plots in southern Nevada, we have been more successful with dense populations than with sparse ones.

The work of Fitch began in 1935 and has continued to the present. His publications cover a wide area in vertebrate ecology and

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include detailed reports on *Sceloporus* (1940), *Eumeces* (1954 and 1955), *Crotaphytus* (1956), and *Cnemidophorus* (1958) and a report on lizard reproduction (1970). The studies of Blair (1960), Carpenter (1959-1961), and Zweifel and Low (1966) represent other excellent studies.

The present study was begun in mid-July 1965, and intensive fieldwork was continued through 1967. Since then field work has been done only for short periods during the period of lizard activity. We have been assisted by graduate students in the field and laboratory. Others most closely associated with this study plot were Ronald L. Morris, Philip A. Medica, and Dr. John E. Krogh. Each has provided field notes and suggestions which have aided in preparing the manuscript. Dr. Henry S. Fitch, University of Kansas, visited our study areas during the summer of 1967. In September of 1968, Dr. Jeff Swinebroad of the U.S. Atomic Energy Commission also visited our plots. We appreciate their many suggestions. For all this, we are grateful; however, the analysis of the data and final preparation is that of the authors.

This study was supported by Research Grant number AT (11-1) 1496 between the United States Atomic Energy Commission and Brigham Young University, Provo, Utah. We are grateful for this support and for that given by the Civil Effects Testing Operation (CETO) base at Mercury, Nevada, under the direction of Mr. Erwin Schultz.

It is not the intent in this study to attempt a report which would include all segments of the widespread species *Sceloporus occidentalis*, nor to even suppose that the population found on Rainier Mesa (Fig. 1 and 2) and reported below would properly or completely represent other populations of the subspecies under consideration. However, a general review of the literature is included as a basis for a general understanding of the species.

REVIEW OF THE LITERATURE

The Western Fence Lizard, *Sceloporus occidentalis* Baird and Girard, occurs over a wide range in western North America. It is one of the most commonly seen lizards in areas where it occurs because of its diurnal habits which include basking fully exposed on rocks tree trunks, poles of fences, and on other objects exposed to solar radiation. The range of the species extends from the state of Washington to Baja California and from the California coast through Nevada into the Great Basin area of Idaho and Utah. We agree with Stebbins (1966) that this species does not occur in the low desert valleys but is found in habitats where there is adequate cover consisting of at least sagebrush and where basking areas are available. The ability of this species to absorb sunlight and warm quickly enables it to inhabit areas from sea level near the California coast to altitudes of over 9,000 feet in the mountains of California, Nevada, and Utah.

Taxonomic studies of *Sceloporus occidentalis* have been published by Camp (1916), Smith (1939), and Bell (1954). Bell recognizes six subspecies. It has not been possible to examine populations in other altitudinal ranges, and it is recognized that populations may vary morphologically and ecologically because of differences in altitude, the accompanying differences in the physical and biotic environments, and from the isolation imposed by these factors in desert areas. Because of the morphological variations and the fact that there are several recognized subspecies, we suspect that there may also be within the limits of this species variations in behavior, reproductive activities, size, growth rate, and other life history and ecological patterns. The Great Basin subspecies, *Sceloporus occidentalis longipes* Baird, occupies the largest range of the *occidentalis* subspecies and, except for *S. o. taylori* which is reported to be of equal size, attains a larger individual size than other subspecies.

The subspecies *Sceloporus occidentalis occidentalis* has been studied rather extensively, probably because it occurs convenient to Berkeley, California, and nearby research areas. Fitch (1940) studied *S. o. occidentalis* in the field near Medford, Oregon, and near Berkeley, California, with special emphasis on growth and behavior, and Davis (1967) made a detailed study of growth and size at the Hastings Reservation, Monterey County, California. Thermal relations of *S. occidentalis* have been studied by Dawson and Bartholomew (1956), Wilhoft (1958), Wilhoft and Anderson (1960), Larson (1961), and McGinnis (1965). Talbot and Livezey (1964) and Coleman and Livezey (1968) studied the closely related area of integumental reflectivity. Testicular histology and seasonal changes of the testes of *S. occidentalis* have been studied by Wilhoft and Quay (1961).

Fig. 1. A view of Rainier Mesa from the southwest showing the granitic cap rock exposed on the southwestern edge. Photo taken about 11:00 a.m. by R. L. Colyer, AEC photographer.

Johnson (1965) studied the diet of *S. occidentalis.* Other studies of anatomy and physiology have made use of this species (Ells 1954, and Stebbins and Eakin, 1958).

Sceloporus occidentalis occurs in many kinds of plant associations. The study areas of Fitch (1940) were described as "A stretch of rail fence . . . which passes through an overgrazed pasture . . .; a stretch of rail fence . . . through open woods of Garry oak . . .; and a board fence and a wooden bridge adjacent to pasture land, eucalyptus trees, Monterey cypress, and native chaparral." In the Great Basin, *S. occidentalis* typically occurs in the pinyon-juniper plant formation (Fig. 1 and 2) but also occurs in areas of oak brush (*Quercus gambeli*) and also in nearly pure stands of *Artemisia tridentata* if basking areas are available.

Physical Environment

The high altitude of the Rainier Mesa study plot, 2,286 meters *ca* (7,500 feet) above sea level, gives it a climate very different from the surrounding low valleys (3,500-4,000 feet). The temperatures are much lower and the rainfall considerably higher, as indicated in Figures 3 and 4 (Swan, 1954).

The cap rock of Rainier Mesa is lava (Fig. 2), and the cap is covered by a shallow mantle of soil formed from the lava with the addition of organic matter from decaying plant materials. At the base of pinyons and junipers, there is a deep layer of decayed and decaying needles. There are many rock outcroppings throughout the study plot, and these, along with lava rock fragments and tree trunks, furnish basking areas and shelter for the lizards.

Climatic conditions prevailing at the Nevada Test Site were summarized by Allred et al. (1963) for the years 1959-1961. Their reference to two weather stations at 7,480 feet gives a comparable elevation to the station near the Rainier Mesa study plot (7,490). They report 8.75 inches for 1960 and 6.74 for 1961. Weather Bureau reports for the Rainier Mesa station report precipitation for 1965, 1966, and 1967 to be 12.67, 7.34, and 11.13 inches, respectively

Fig. 2. A view looking north from the northwest corner of the study plot. The U.S. weather tower is seen in the background. Photo by R. L. Colyer.

(June through December). This is considerably more than reported by Allred and indicates the great variability of the climate in this area (Fig. 3). Allred et al. (1963) reported that 36 percent of the precipitation occurred during the summer months (April through September). Available data for 1965-1967 averages 41.3 percent. There may be heavy precipitation occasionally during a given month; however, the most consistently moist period seems to be July and August (Fig. 4). An average of the precipitation for these months for the years 1965-1967 is 1.4 inches per month. The greatest amount recorded for one month is 4.67 inches in November 1965. October and June have been the driest months, with an average of only 0.29 inches each month.

Temperatures are moderate, rarely exceeding 85° F in summer and reaching 0° upon occasion during the winter. On 1 June 1967, temperatures were below freezing and a skiff of snow fell. A freezing storm also occurred on 16 September 1965. Rainier Mesa is therefore subject to the cold fronts which descend across the desert from the northwest and also to the influences in the summer of the hot desert valleys which nearly surround it.

Biotic Environment

The following study covering nearly five years of field work should add to our understanding of the life history, food habits, home range, behavior, and general ecology of this common western lizard as it occurs in a pinyon-juniper community on a high mesa in southern Nevada.

The plant canopy cover on the study plot at Rainier Mesa (Nevada Test Site) is approximately 60 percent, with *Pinus monophylla* the dominant plant. Other woody plants such as *Artemisia tridentata*, *Quercus gambelii*, *Gutierrezia microcephala*, *Juniperus osteosperma*, *Purshia tridentat*, *Ephedra viridis*, *Ribes velutisium*, *Tetradymia canescens*, *Leptodactylon pungeus*, and *Linanthosbrum nuttallii* make up the greater part of the woody plant cover (Fig. 1). The percentage of annuals is not included because

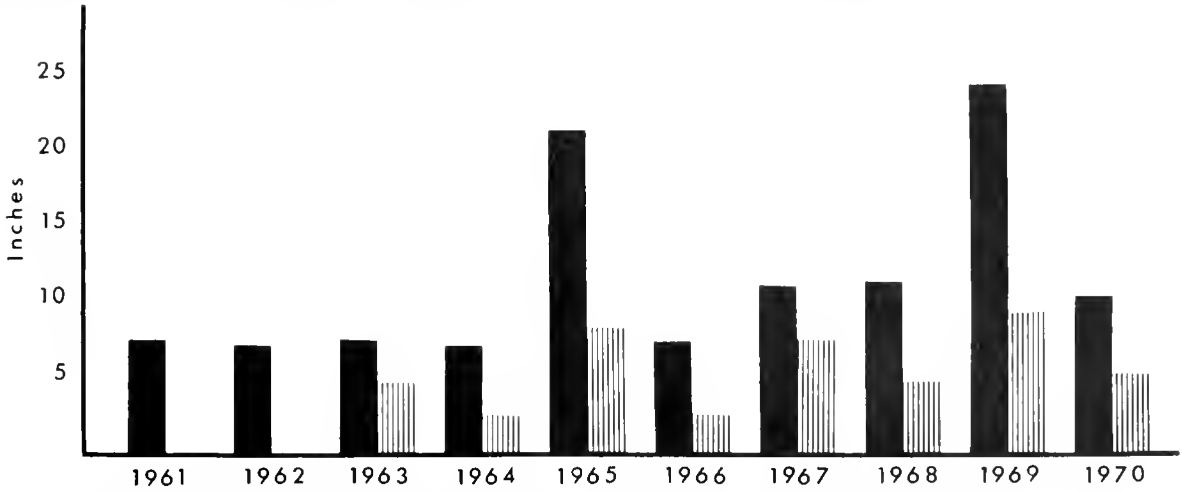

Fig. 3. Precipitation for the ten-year period 1961 to 1970. The dark columns for Rock Valley. Data provided by the U.S. Department of Commerce, courtesy of Mr. Ralph Quiring, Climatologist.

it varies considerably each year depending on the moisture available.

Allred, Beck, and Jorgensen (1963) considered both the plant and animal species of the pinyon-juniper community and comments here will deal only with the more common plant and animal species that seemingly are more directly associated with *Sceloporus occidentalis longipes*. For a complete list of plants and animals see Allred et al. (1963) and Beatley (1965 and 1969). Only two other species of lizards, *Uta s. stansburiana* and *Eumeces skiltonianus utahensis*, were found on the study plot. Both of these species are considerably smaller in size than *S. o. longipes* and therefore they may not exert much competitive pressure on *S. occidentalis*. On the lower foothills of Rainier Mesa, *Sceloporus magister* and *S. occidentalis* overlap their ranges, and in this area of overlap the competition for food, shelter, and basking sites is undoubtedly more intense. No effort has been made to study the area of overlap, but it has been observed in driving through the area that a basking site on a boulder was occupied by a member of one species one day and by the other species only two days later. It is also possible that *Crotaphytus collaris* and *Crotaphytus wislizeni* occur on the fringes of the range of this population of *S. occidentalis*, but no specific observations have been recorded. If these species do overlap, it is almost certain that the two species of *Crotaphytus* prey at least on the hatchling and juvenile of *S. occidentalis*.

Three species of snakes have been collected on or near the study plot. One specimen of *Masticophis taeniatus* was taken on the plot in 1966. Another was sighted 50 to 75 feet northwest of the plot in 1967. A very large *Pituophis melanoleucus deserticola* was captured within 150 feet of the northeast corner of the plot in 1967. Three specimens of *Crotalus mitchelli stephensi* have been sighted on or near the study plot. One large one was captured, marked by scale clipping, and released in 1965. He has not been recaptured. A large individual was seen on the west edge of the plot in 1966 and a female was taken on the plot in 1967.

A survey of the abundance of arthropod species in the area goes beyond the scope of this study, but it is obvious to those who have attempted to rest in the shade of a pinyon on Rainier Mesa that ants are abundant both as to number of species and individuals. There are 28 species of ants known to occur on Rainier Mesa (Cole 1966). Other arthropods known to be common by their frequent appearance in can-traps are beetles (mostly Tenebrionidae), Jerusalem crickets (*Stenopelmatus fuscus*), scorpions, and solpugids. A list of animals collected from within the pinyon-juniper plant community at the Nevada Test Site is indicated by Allred, Beck, and Jorgensen in their report "Biotic Communities of the Nevada Test Site" (1963). Tanner and Jorgensen (1963) listed the reptile species known to occur on the test site.

Of the possible predators of *Sceloporus occidentalis longipes* on Rainier Mesa only one species *Masticophis taeniatus*, is known to feed primarily on lizards. A large *M. taeniatus* in captivity has been observed to eat four adult *S. occidentalis* in a period of less than four hours.

The gopher snake, *Pituophis melanoleucus*, and the Panamint rattlesnake, *Crotalus mitchelli stephensi*, are potential predators, but both species are believed to prefer mammals; and, because of the few individuals observed, it is

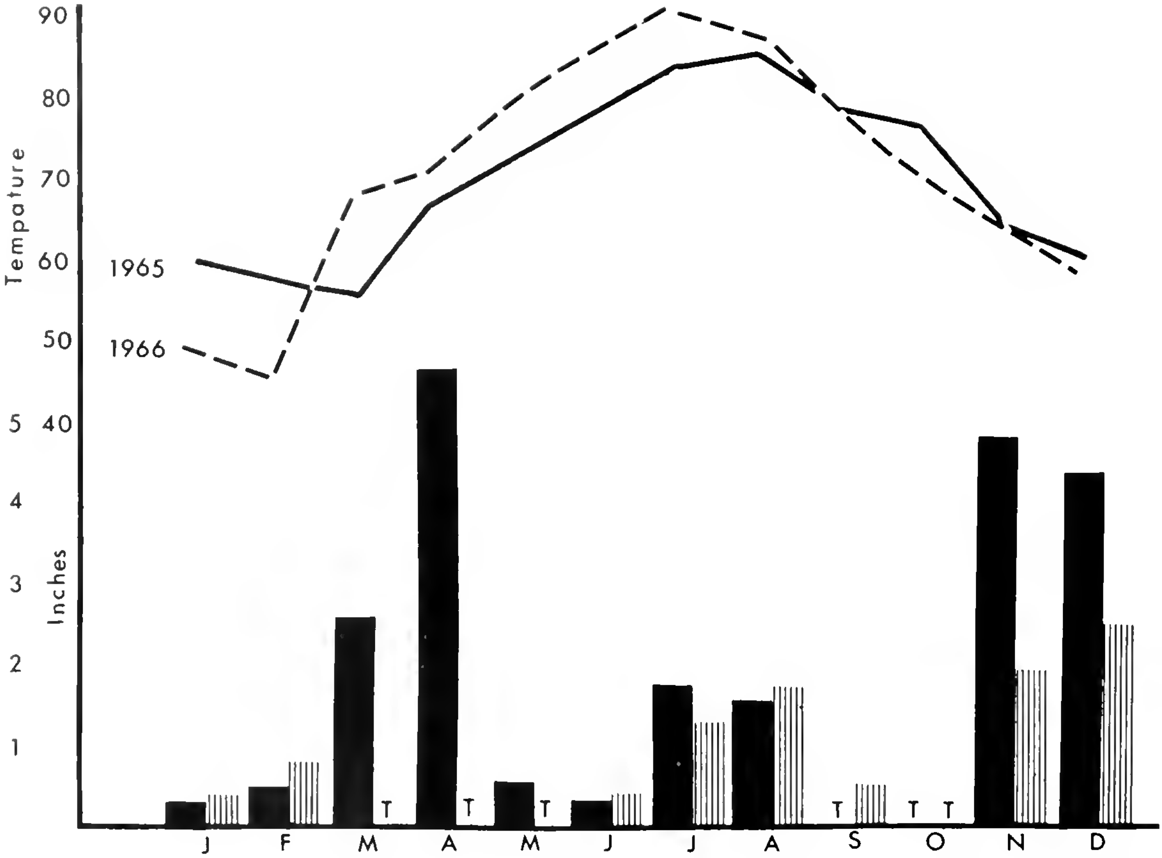

Fig. 4. Precipitation for the year 1965 plotted for each month. Dark columns represent Rainier Mesa and lined columns are for Rock Valley. The symbol T indicates only a trace of precipitation. Solid and broken lines plot the average maximum temperatures for Rainier Mesa for 1965 and 1966.

unlikely that they exert appreciable pressure on the lizard population.

No evidence has been found to indicate that mammals prey on the lizards. However, several species of mammals known to occur in the area (Hayward 1965) have been reported to feed occasionally on lizards in other areas. Coyotes are known to eat western fence lizards (Leach and Frazier 1953; and Ferrel, Leach, and Tillotson 1953). Badgers are also known to eat lizards, although the records are for species other than *S. occidentalis* (op. cit.). Foxes, bobcats, skunks, weasels, and possibly even cougars may occasionally prey upon lizards. A shrew killed and ate one of the lizards while they were together in a can-trap. Perhaps shrews kill lizards in nature especially if the shrew should find the lizard in its hiding place when it is cold and torpid. A shrew was taken alive to the Civil Effects Test Operations laboratory in Mercury, Nevada, and kept alive for about a month. It showed the ravenous appetite for which shrews are famous, but would not kill and eat lizards as long as crickets or other insects were available for food. We therefore doubt that shrews prey on lizards in southern Nevada.

Jerusalem crickets, *Stenopelmatus fuscus*, killed and ate several lizards in can-traps, and others were badly injured by this predacious insect. In *Stenopelmatus*, we have a possible predator of *S. occidentalis* in nature, but we have no evidence to show that this insect would kill and eat lizards under circumstances other than the unnatural confinement of the two animals in can-traps. Ants and scorpions also killed several small lizards while together in can-traps.

There are several species of birds that may prey on lizards. Among them the shrike, hawks, and falcons are known to be present on Rainier Mesa. The roadrunner has been seen in the pinyon-juniper community at lower elevations; however, we have not seen one on the top of Rainier Mesa.

Parasites

Of 145 lizards' stomachs examined, 41 contained round-worm parasites. Many contained only 1 worm, whereas the maximum was 30. The average for those parasitized was 4.09. Only stomachs were examined for worm parasites. The intestines undoubtedly contained additional parasites, but have not been examined. Intestines are still available for examination.

Mites are common on many species of lizards. Only one species of mite is known to infest *S. o. longipes* on Rainier Mesa. *Geckobiella texana* Banks has been taken from lizards during the months of May, June, and July.

Small ticks also have been taken from *S. o. longipes.* During a brief period in August (15-20) of 1966, we noted that about half of all lizards captured had one or more ticks, usually in the region of the neck and shoulders.

METHODS AND PROCEDURES

This study was begun in July of 1965 and continued from 1 June to 1 September each summer through 1968. Limited data were collected in September of 1965, 1968, and 1969. Some sampling was done in October of 1967, 1969, and 1970 and also in April and May of 1967, 1968, 1969, 1970, and 1971. The lizards are in hibernation from late October until early April.

The study plot used for capture and release methods is on Rainier Mesa at an elevation of 2,287 meters (7,480 feet). The plot is 137.25 by 183 meters (450 x 600 feet) and has an area of 2.51 hectares (6.2 acres). It is in a pinyon-juniper community. The plot was staked out in a grid with 15.25 meters (50 feet) between stakes. The stakes sometimes had to be moved slightly because of rocks and trees but were always placed as near as possible to their proper location. When the plot was established it had 10 rows of stakes in each direction, but three rows of 10 were added to the south end of the plot in June 1966. A can-trap was placed at the base of each stake as near to the stake as possible and on the south side. Here again it was sometimes necessary to compromise, but the can was placed as near its proper location as physical circumstances would permit.

There is a weather station about 100 meters north of the study plot and weather data (Fig. 3 and 4) are available for use in this study.

The can-traps mentioned above are metal cylindrical cans about 15 centimeters in diameter and 30 centimeters deep. The cans were set in the ground so that the top of each can is level with the soil surface. The opening of the can is then covered with a small sheet of masonite with two-inch wooden blocks so fastened to it as to form tripod legs which keep the cover two inches above the ground surface. The covers prevent direct sunlight from reaching the animals and also serve to keep out directly falling water from rainstorms which are much more frequent on Rainier Mesa than in the surrounding desert flats. The covers probably attract lizards by offering shelter and thus increase the chances of their capture. The covers may have an effect also in keeping out larger predaceous animals. A lizard is relatively safe in this type of can-trap for up to 56 hours. The cans were checked at least every 48 hours except on two occasions when AEC testing activities prevented us from entering the area. We did lose a few animals in the can-traps as a result of water flowing into the traps during heavy rains and by other animals killing the lizards.

In addition to can-trapping, lizards sighted on or near the edge of the study plot were captured whenever possible. Some were captured by hand, but most were caught with a small noose of braided nylon tied to the end of a fishing pole. This procedure will be called noosing throughout this report.

Captured lizards were marked by toe clipping following the system used by Tanner (1965). Each lizard was also marked by painting a number on its back with a water-base poster paint. This made recognition in the field possible and reduced the necessity for repeated captures since lizards only needed to be captured occasionally to check for growth and weight change. The paint was especially helpful in sighting lizards clinging to tree trunks where they are usually difficult to see.

Records were kept for each lizard including place of capture, toe-clip number, snout-to-vent length (s-v), total length, tail regeneration, weight, sex, and approximate age. From hatching until the first hibernation, a lizard is called an hatchling; from emergence in the spring to the second hiberation, the lizard is called a juvenile; and on emergence from the second hibernation the lizard is considered an adult. When the age of a lizard was in question, a s-v length of 70 mm was arbitrarily considered to be the dividing line between juveniles and adults, although marked juveniles have been known to exceed that length in late August, and a few adult lizards are known to measure less than 70 mm s-v at their emergence from the second hiberation in April and May.

If a lizard was captured by noosing or some other means that would not greatly change body temperature, its cloacal temperature was taken with a Schultheis quick-reading thermometer. If the lizard was captured in a can-trap where it was prevented from regulating its temperature by its usual behavioral means, the temperature was taken only when it would be useful for comparison with lizards free to regulate.

Special notes were made of scars or other abnormal marks, rate of tail regeneration, reproductive condition (i.e., gravid or not gravid during the egg-laying season), and behavioral observations.

A series of more than 200 lizards was collected at season intervals outside the study plot for histological examination of the gonads. Since most of the mating activity occurs during April and May when it is not possible to spend more than perhaps a weekend at the study area, it is especially important to have other means of determining the peak period of mating. Some of the lizards were captured and then frozen, others were taken to Provo alive for fixing and sectioning of the gonads. The latter method was very satisfactory, whereas the testes that were frozen were badly disrupted and did not show cellular detail to the desired degree. The testes were fixed in Bouin's fluid, imbedded, sectioned at 7 microns, and stained by Delafield's hemotoxylin and counter-stained with eosin. All gonads were weighed before fixing, and the fat-bodies associated with the gonads of both sexes were weighed and discarded.

The stomachs of some of the lizards collected for the reproductive sample were examined as to volume and kinds of food they contained. Stomach volume was measured by placing the stomach content in a 10 milliliter graduated cylinder and then adding alcohol to the cylinder from a burette until the stomach content was immersed or at least floating. Both the burette and graduated cylinder were then read to determine the volume of the stomach contents.

Home Range

Home range means the area utilized by a lizard in its daily pursuits during a year and in some individuals a lifetime. *Sceloporus o. longipes* utilizes a relative small home range for a lizard of its size. The home range that is believed to be a maximum estimate for 95 percent of the adult male lizards of this population is 1.67 acres (Fig. 5). The home range maximum estimated for females by the same method

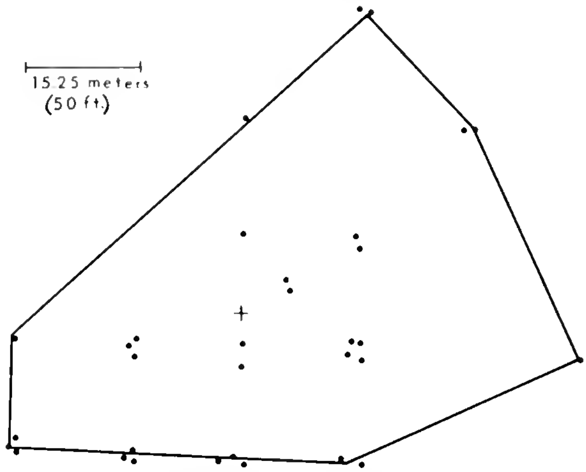

Fig. 5. A polygon representing the actual home range of a male *Sceloporus* as determined by the capture-recapture method for lizard number 2-6. There are 32 captures plotted during three summer seasons, 1965-1967.

is 0.48 acres (Fig. 6). The average home range area as estimated by the minimum polygon method is 0.59 acres for adult males and 0.095 for adult females. As explained above, it is believed that the actual home range area is between these two estimates and probably varies greatly with the individual lizard and the physical and biotic makeup of his home range.

Home range estimates have been made by two methods. They will be referred to as (1) the minimum polygon method and (2) the re-

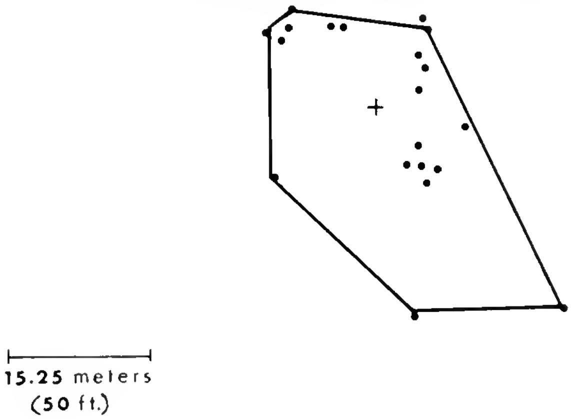

Fig. 6. A polygon showing the outer limits of a female lizard home range, number 1-14, as determined by 20 captures.

capture radius method. The minimum polygon method consists of plotting capture sites on a graph and connecting the outermost sites with lines to form a polygon of three or more straight sides. Only lizards with four or more captures not in a straight line were used in estimating home range. The polygon figure is then divided into rectangles and triangles so that the area of the polygon can be calculated.

For the recapture radius method the geometric center of all the points of capture and observation (considered hereafter as a recapture) is located with the capture points distributed around the point representing the center of activity. A figure for each lizard is produced, as in figures 5 and 6. If many individual lizard capture-recapture figures are superimposed with the center of activity for each set above a single point on a graph (Fig. 7 and 8), a figure of recapture radii for a species or population is theoretically the result. A circle can now be drawn to include 95 percent of the capture recapture points. The radius of this circle is then the observed home range radius theoretically possible for an individual at the 95 percent level. This radius can now be used to calculate the area of a hypothetical circular home range.

It is almost certain that circular home ranges are rare or do not exist in nature, but it is a convenient way to estimate the approximate size of a home range from a few captures. The minimum polygon method may give an indication of the actual shape of the home range if there are a large number of recaptures. The area estimated by the minimum polygon method is probably less than the actual size of the home range area. It is likely that the actual home range, if it could be accurately determined, would have an area between that estimated by the recapture radius method as a maximum and that estimated by the minimum polygon method as a minimum. Furthermore, our data indicates that some lizards have larger or smaller home ranges than do others. This is perhaps an indication of the variations occurring in the terrain of the habitat, availability of food, or other factors such as individual variations in behavior. Turner, Jennrich, and Weintraub (1969) also concluded that the home range is intermediate between the minimum polygon as indicated by Tinkle, McGregor, and Dana (1962) and the recapture radius method as indicated by Jorgensen and Tanner (1963). Furthermore, there is variation in the size and shape of home ranges. This variance is seemingly the

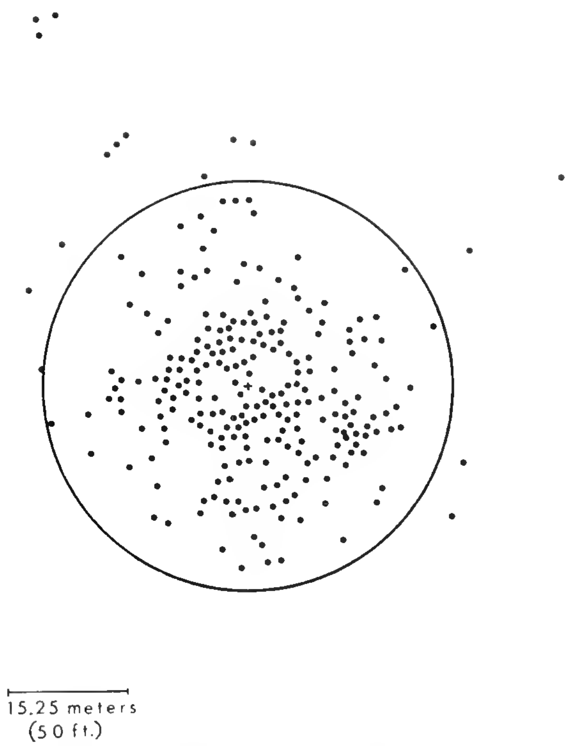

Fig. 8. The observed recapture radii for all females in the population, with the 95 percent level indicated by the circle. There are 26 lizards captured and recaptured 270 times. Each lizard has a minimum of at least three recaptures.

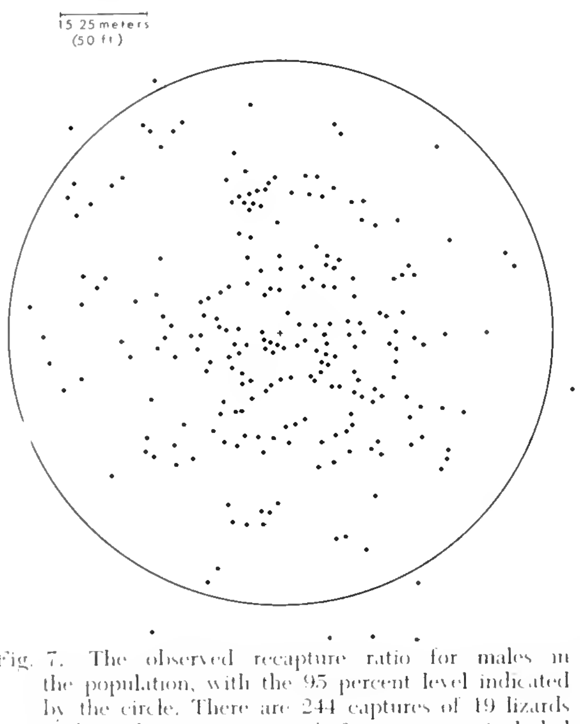

Fig. 7. The observed recapture ratio for males in the population, with the 95 percent level indicated by the circle. There are 244 captures of 19 lizards each with a minimum of 3 recaptures included in the figure.

result of the uneven terrain and the age of individuals (size being a factor), and we believe that there is a variation in the aggressive behavior of individuals, particularly in males, which increases the area under surveillance.

There are records of a distinct change of home range between two summer seasons. Lizard #3-16, an adult female, occupied a home range of about 25 feet in radius during the 1966 and 1967 seasons but was captured 150-200 feet east of that range on 3 June 1968. Another adult female, #19, was captured six times in 1965 in an area about 200 feet into the plot from the east side and 150 feet in from the north. She was not captured or observed during the 1966 season. In August 1967 she was captured approximately 130 feet east of A-5 on the edge of the plot. She was recaptured three days later in the same general area. Apparently, she had moved her center of activity approximately 55 feet between 1965 and her recaptures in 1967. There are no records of a complete change of home range in adult males; however, the males have a much larger home range, and the polygon figure drawn for any one of several of the males would encompass the enlarged home range areas of both of the females that changed the center of activity in their home range or a new home range if two were established.

There is considerable overlap of home ranges, as indicated by polygon figures drawn from capture and recapture data over a three-year period from July 1965 through 1967 (Fig. 9). Based on the considerable overlapping of the polygons for males, one is quite uncertain as

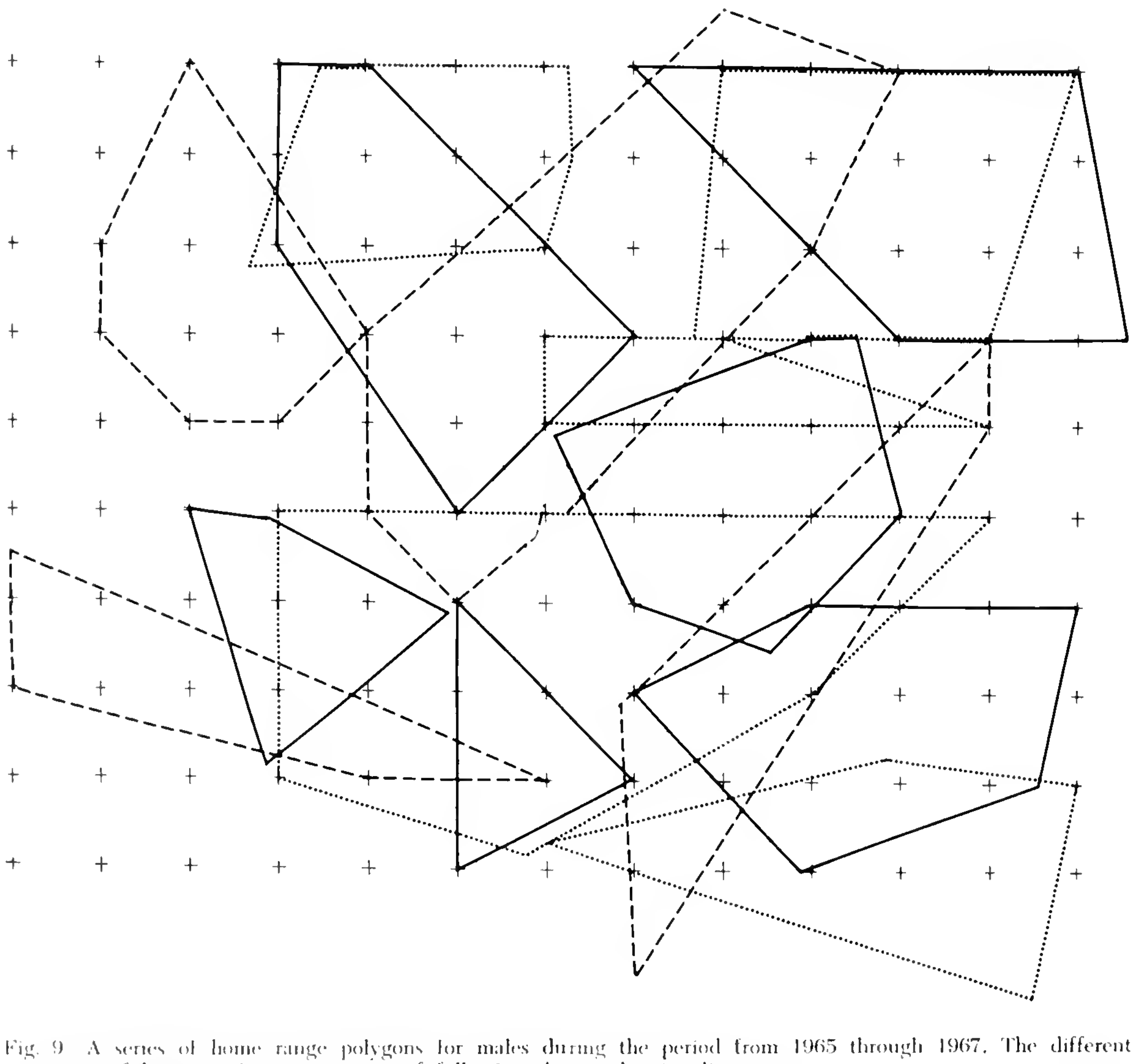

Fig. 9. A series of home range polygons for males during the period from 1965 through 1967. The different types of lines are for convenience of following the overlapping lines.

to the territorial relationships between males. A few tentative conclusions seem justifiable. Males do live in close proximity to other males but do not share the same basking areas and are not found together during the spring and summer months. They occupy relatively large areas, which apparently they cannot constantly protect; thus, other males frequently cross what appear to be boundary lines and are recorded as being in another home range or having a large area of their own which is entered by other nearby males. In a rough terrain where vegetation is plentiful, home ranges may not be as protectable as in desert flats. In spite of the apparent overlapping of home ranges, we note that males do remain in a restricted area for several years. Data does not invalidate the home range, but it does indicate a reduced tendency for males to set up and virgorously protect a large territory to the exclusion of other males. On the basis of the polygons (Fig. 9 and 10) and our field observations, we believe that there is a sort of peck order among males in which the more dominant males essentially rule within their territory, with younger and less dominant males being submissive. Thus the dominant males move freely within a large territory but protect with vigor a smaller area which we refer to as the center of activities and which includes the principal basking and hiding areas within a given home range.

We have not observed any social order among the females, although it may occur. Female lizards are often seen basking together, and a male and a female lizard together on a rock is not an uncommon sight.

The large overlapping home ranges which are not totally defended may account for the few encounters between males observed by us. The home ranges plotted for 16 males, each of which was observed for three years (Fig. 9), shows considerable variation in size and indicates that some males enter three or four other home ranges. One wonders if there is any territorialism, and yet we note some evidence of it in that males are not found together on

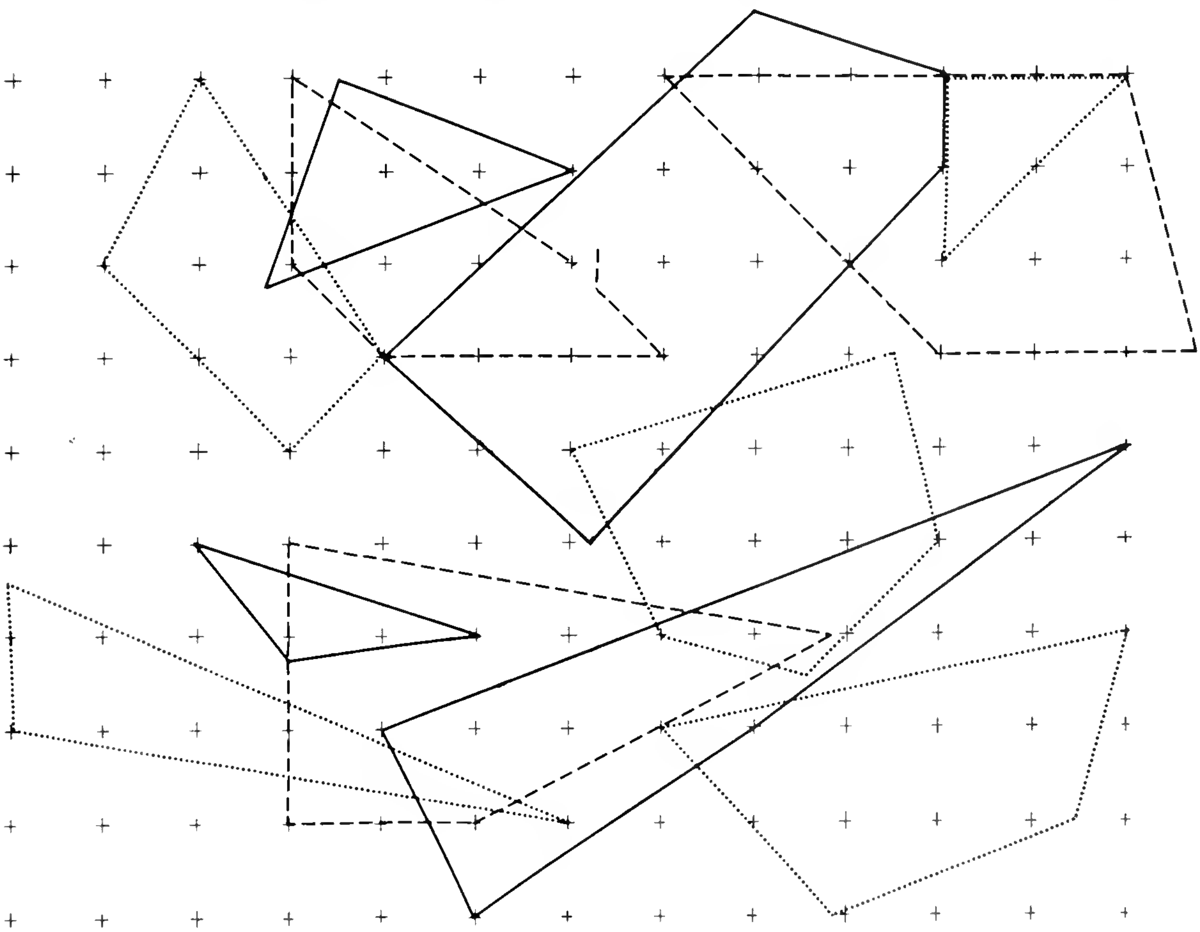

Fig. 10. Home ranges for male *Sceloporus occidentalis*, Ranner Mesa, for the summer of 1967. Twelve home ranges are plotted. The different outlines are used only for convenience of following the boundaries.

the same rock, log, or in the same tree. We have observed a few brief encounters; however, these encounters have not indicated that males go much beyond their center of activity, or basking area, in pursuit of another male. This apparently leaves large areas of the home range free for other males to move, and our polygons indicate a considerable freedom for movement.

At first we surmised that males changed their home range each year. We therefore plotted 12 males' home ranges for 1967 (Fig. 10) and came up with about the same size and variety of polygons as for the three-year plottings. We have concluded that little change occurs except that older males may have large areas. Females, as previously indicated, also have overlapping home ranges. Their home ranges are much smaller (Fig. 11) and give the distinct impression that they may be clustered, although this may be a coincidence.

Males bask side by side, at least in the early spring, as they emerge from hibernation but are not seen together after the mating season begins. Only a few instances of a lizard's defending its territory or challenging the approach of another lizard have been recorded under natural conditions. As an example, on 5 June 1967 an adult male (±3-15) was sighted basking on the can-trap cover at stake H-12. He was noosed, weighed, measured, his location of recapture noted, and was released on a large boulder a few yards away from the stake. As is the custom in this species and almost all lizards, he soon disappeared on the opposite side of the rock, where he was challenged and soon returned across the rock, passed the observer, and rushed into a nearby rockpile. The pursuing lizard, ±6-7, stopped at the edge of the boulder where he displayed by flattening himself laterally (Noble and Bradley, 1955) and bobbed several times. He showed no fear and was noosed. Occasionally as the study plot is being worked, males are temporarily displaced into an adjoining home range. This same type of response may then occur.

The fact that few instances of territorial

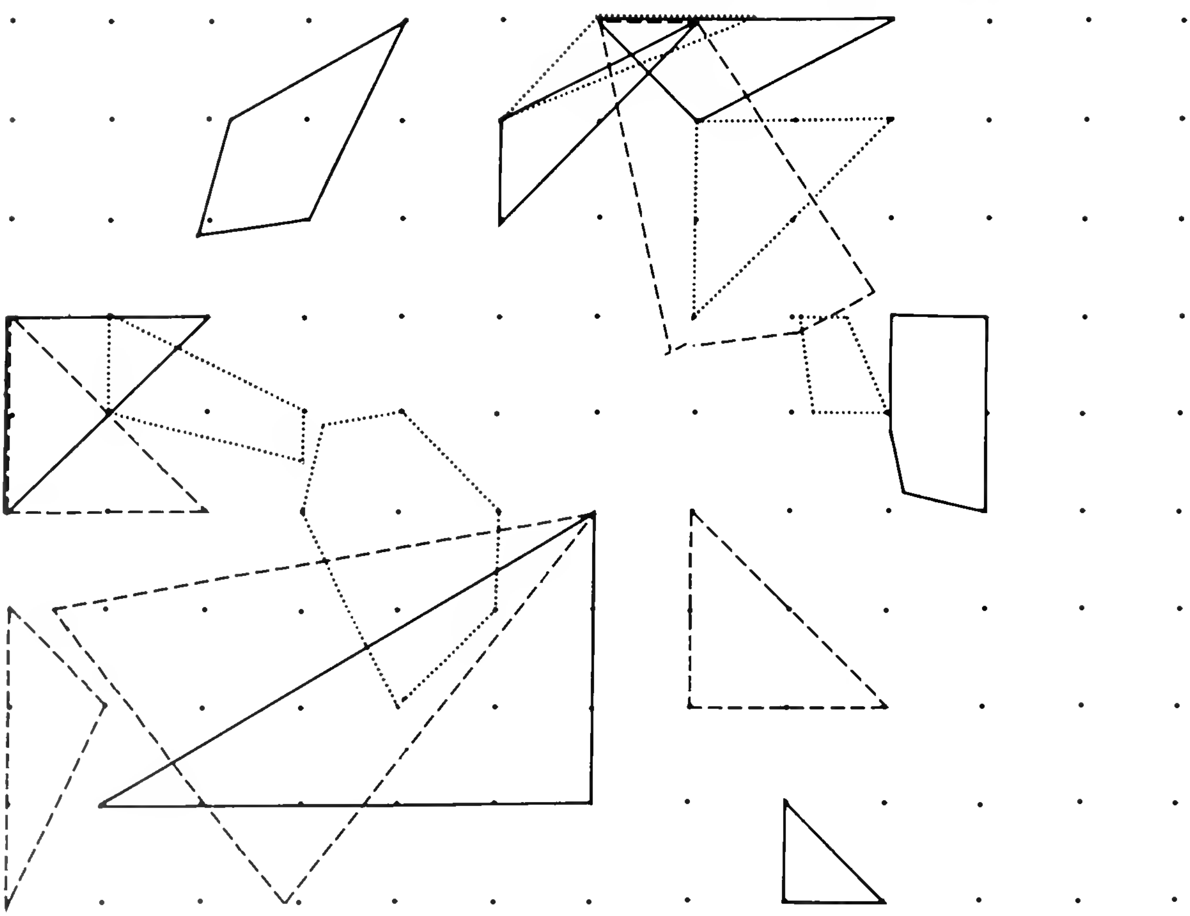

Fig. 11. Home ranges for females *Sceloporus occidentalis*, Raimer Mesa, for the summer of 1967. Seventeen home ranges are plotted. The different outlines are used only for convenience of following the boundaries.

defensive behavior have been observed, in spite of the numerous man-hours spent in the study plot, suggests that the territories (of males) are established and that trespassing by other males may occur, but if observed they may be challenged by a more dominant male. Our data was gathered primarily during June, July, and August, with only limited observaions during April and May during the breeding season when territories may be more meaningful. However, our limited data for the early spring does not appear to be different from that recorded for June, although intensive field work for an extended period of time has not been done.

Attempts have been made to determine how the home range is utilized by a lizard. It appears that *Sceloporus occidentalis longipes* is a rather sedentary lizard, spending most of its time basking in sunlight or loafing in the shade according to its temperature requirements at the time. If a suitable prey is seen, the lizard moves quickly to capture it. If no prey appears, the animal may move only a few feet in several hours. No active foraging or scratching in the soil for prey has been observed. Lizards have been observed to run rapidly for 10 feet or more, snatch an insect or spider, and then run rapidly back to a basking place. A lizard suddenly disturbed and caused to flee in a direction that will lead away from its home range soon becomes confused. Its apparent unfamiliarity with new terrain induces an immediate return to the home range and the familiar area where hiding places are available.

A most interesting phenomenon is the great consistency of nearly all individuals to stay in a given area for three or more years without any indication that they have changed in the least their center of activity. Those few who have made a noticeable change seem to have made the move to a new center of activity early in the spring and certainly before the mating period begins. This consistency of homing is also remarkable inasmuch as some home ranges are made available for readjustments by the death of old lizards. Presumably, these areas are taken up or expanded into by the rising generations of hatchlings and juveniles, but we have no evidence that established adults appreciably expand their home ranges.

Behavior

The home range of an animal is generally defined as the area utilized by an animal in its search for food, mates, and shelter (Tinkle 1967). Capture and observation localities have been recorded for many lizards during the three seasons of intensive study, but accurate mapping of all of the boundaries of each home range has not seemed practical. Figure 9 does give the home ranges of males. A good estimate of the general areas in which a given lizard may be found can be made, usually with reasonable accuracy. The common practice of showing capture locations and connecting the outermost sites with lines gives some idea of home range, but this by no means shows its precise boundaries or the extent to which the various portions of the home range are used (e.g., basking, loafing, foraging, ect.). The latter information is very difficult to obtain because the animals are so sluggish and may remain on a single rock three feet across for several hours. Most attempts at observing daily activities have been frustrating. Watching a single animal for the required amount of time to describe a daily schedule is tedius. Attempts to keep two lizards under observation at one time have not been successful. One can watch a lizard for two to three hours and then take his eyes away for ten seconds only to find the lizard gone when he again turns his eyes to the lizard's location. We have noted upon many occasions that a basking lizard does not take flight until a moving object approaches. Rapid movement is more apt to frighten than a slow-moving object. Therefore, a lizard may respond to a movement of the head that had been motionless since its appearance. When a lizard moves down from a basking place, one loses sight of it between rocks or in vegetation and often cannot spot it again without approaching so closely as to frighten the lizard into taking cover. Brief notes have been made of observations on individual behavior. Examples given below are taken directly from our field book (August 1967).

> *Sceloporus occidentalis* #5-15 (a large female) sighted basking on a small rock northeast of H-12 at approximately 9:50 a.m. (I then continued checking can-traps). At 1:05 p.m. she was at the southwest corner of a nearby large boulder.
>
> I walked too close to her at 1:40, and she moved to the northeast face of the boulder. She had moved less than six feet by 1:50 (i.e., from her 1:05 location).
>
> At 2:24 she moved south 1-2 feet into the sunlight for two to three minutes and then ran across the top of the boulder toward the west. She stopped on the southwest corner of the boulder in a shaded spot.
>
> 2:32 p.m. Moved about one foot—still in the shade.
>
> 2:36 p.m. Moved about six inches into sun
>
> 2:39 p.m. Moved north along west side out of sight.

2:41 p.m. Stopped on the northeast corner of the boulder in the shade.
2:55 p.m. Moved into sun.
2:56 p.m. Moved around to the northeast face of boulder which is in the shade.
3:15 p.m. Moved onto the tree nearest the big boulder on the east.

This lizard is extremely wary, and although I was about 40 feet away she still may have been disturbed by my presence. She was never observed to eat or show interest in food during these observations.

There was ample time for her to warm up and feed prior to the first sighting at 9:50 a.m. She may also have fed between 9:50 a.m. and 1:05 p.m. The following is another note covering three hours of observation of #5-13 on 5 August 1967.

Two days later another behavioral note was made of the same lizard:

19 July 1967—arrived at the plot at 7:00 p.m. in an attempt to observe lizards preparing to spend the night.

S. occidentalis #5-15 sighted in tree 30 feet northwest of 11-12 at 7:15 p.m.

8:00 p.m. The sun is going down and #5-15 is still hanging, head down, on the trunk.
8:26 p.m. She turned around so her head is up.
8:35 p.m. She moved (I heard her. It is too dark to see her). I shined a light on the tree to find that she had moved up about one foot.
9:00 p.m. It is much too dark to follow her if she moves. The flashlight shows her to still be clinging to the tree trunk. Apparently she is going to spend the night in the tree.

On 20 July a female lizard #3-17 was observed to take shelter under a rock and remained there as darkness fell. She was well under the rock when it was necessary to use a light to see her.

On 7 August a lizard #5-20 was observed under the edge of a flat rock at 8:07 p.m. No attempts were made at obtaining close observation or observation by a flashlight in hopes that she would remain as she was and might be seen emerging the following morning. At 6:25 a.m., 8 August, the sun was not up and the temperature was 58 F at the nearby weather station. The sun appeared at 6:30 a.m. At that time the soil temperature was 14.4 C. By 8:45 a.m. the soil temperature was 20.2°. At 8:50 a.m. the head and foreleg of a lizard were seen emerging from under the rock where #5-20 was seen the previous evening. It was not until 9:20 a.m. that the lizard emerged completely and was seen to be #5-20. At 9:55 a.m. she moved up to the top of the rock and basked, even though direct sunlight was interrupted somewhat by cloud cover. She was observed again at 10:32 a.m., 12:18 p.m., and 1:15 p.m. still basking but having moved about two to four feet at each observation.

The behavior of adult lizards toward each other if they chance to meet in the course of normal activities is of interest. Soon after emerging from hibernation males set up a home range or center of activity and become antagonists. Thus, an encounter between males results in a bobbing contest with the blue belly patch exposed by each. This display of bobbing and flattening of the body to expose the blue may last for only a few moments or may be carried on for several minutes. We did not observe a physical combat. In all cases, one of the antagonists fled. In contrast, encounters of females and of females with males did not produce any outward excitement except during the mating season when males would go into their bobbing of head and body push-ups. Only rarely did we observe such activities on the part of females.

The aggressive displays of males toward each other is not the same as in the case of the supposed courtship displays of the male toward the female. In the former, a greater flattening of the body, an arching of the back, and an exposure of the blue on the belly is most apparent. Although males through their bobbing before a female do expose the blue, it does not appear to be done with the same intensity. The aggressive behavior of males as well as the sex recognition response seems to be tied to a sight recognition of the body color and/or color patterns.

Heat Requirements and Temperature Relations

The ability of *Sceloporus occidentalis longipes* to absorb sunlight and warm the body to its active (optimal) temperature while the air remains cool is noticeable. The range of body temperature for all active lizards measured was 21.6° to 37.0° C. The average for adult males is 33.0 and adult females 32.9 (Table 1). These temperatures were recorded for lizards that had been free to regulate their temperature and

Table 1. Range of temperatures recorded for active lizards (*Sceloporus*) on the Rainier study plot.

	Minimum	Maximum	Average
Male Adults	21.2	36.2	32.9
Female Adults	21.6	37.0	32.9
Male Juveniles	19.2	36.9	34.0
Female Juveniles	22.2	36.2	34.0

were captured by means that would not greatly alter their body temperatures. The time at which temperature was taken was recorded, and usually the temperature of the air and substrate were recorded for the same time (as nearly as one thermometer would permit). Occasionally, body temperature was taken on a lizard in a can-trap for comparison purposes. Usually a lizard found in a can had been there overnight. Although the cans are only a foot deep the temperature at the bottom of the can is usually much cooler than the air or the soil surface. It is not unusual for the temperature of a lizard in a can-trap to be 10-20 degrees below that of a lizard free to bask and absorb solar energy. On 7 June 1967 two lizards from can-traps showed temperatures of 17 and 17.4° at approximately 10:30 a.m. A lizard noosed nearby at 10:15 a.m. had a body temperature of 32.4°. During the three summer months we found that most lizards emerging from their overnight hiding places have body temperatures varying between 15 and 20°, and this accounts for the low temperatures recorded from lizards noosed soon after they appear on rocks.

Temperature observations made on lizards found in cans and then noosed between one-half and one hour later indicate that at this study plot body temperatures can be increased or lowered 10 to 15 degrees in a short period of time. As an example: A juvenile female (62 mm) =1-2-9 was found in a can-trap at 11:03 a.m. Cloacal temperature at that time was 24.3 degrees. She was released and after being free to bask was noosed at 11:47 a.m. At this time the cloacal temperature was 35.6 degrees. In 44 minutes the body temperature had increased to near the maximum temperature voluntarily tolerated by this population. At 12:45 the lizard was sought for a further temperature observation and was again found in the can-trap and with a cloacal temperature of 25.4. It is not known how long it had taken the lizard to lose that much heat, but it is known to be less than an hour.

We have observed that early in June and after the middle of August the lizards are more often seen on the ground. During the warmer part of the summer, lizards are seen in trees more often than earlier in the spring or later in the summer and fall. It is also significant that can-trap captures drop off noticeably during the warmer part of the summer.

On Rainier Mesa the air temperature seldom if ever exceeds 32° C which is within the activity range of *S o. longipes*. The lizards warm themselves to the desired body temperature and then simply move into a shaded area. This is not possible for other lizard species in the nearby desert flats where air temperatures may and soil surface temperatures do exceed tolerance. They must go underground or find heavy shade where it is cooler. Many observations of such actions have been noted. During late June and through July and early August the fence lizards spend a great deal of time in trees. They typically move from areas of sunlight to shade to maintain their desired body temperature and feed on insects that are on the trunk and branches of the tree. Our observations as reported above definitely indicate the possibility that lizards probabaly do spend the night in trees during the warmest part of the summer. They may return to the ground to spend the night in the safety of crevices in the rocks; but, if they do, they appear to go directly to the trees in the morning with very little, if any, basking on the ground or on rocks.

S. o. longipes exhibits a distinct change in color with changing temperature and light conditions. Lizards emerging from their hiding places on cool mornings appear to be nearly a solid black. During the warmer part of a summer day they are lighter in color and the dark pattern markings on the back can be seen in contrast to the lighter ground color.

Basking lizards, usually observed in the morning hours, are darker in color than those which have reached their optimum temperature and do not need to remain continuously in the direct sunlight. Lizards observed in shade or broken shade or those taken from can-traps are invariably lighter in ground color than those observed while basking. Although some exceptions may occur, it is thought that the darkening of the skin is brought about by a combination of low body temperature in the presence of light and that it serves a useful function in increasing absorption of solar radiation so that the lizards removed from can-traps (while they are still cool and still have the light color pattern) and placed on a rock for basking require only a few minutes to change to the darker or "basking" color phase. Although there is a minimum of conditions that effect such changes (such as air temperature, intensity of light, body temperature), lizards permitted to bask for about five minutes have developed the basking color phase.

The length of time a lizard basks or retains the basking color phase varies with the season and the fluctuations of daily weather. In April and into May basking may be an all-day activity. However, as the days become longer and warmer there is a reduction in the time that one may expect to see them in full light on the top or side of a rock or tree trunk. A lizard usually does not leave its basking area but merely seeks the shaded side of a rock or the shade of an overhanging bush. We soon discovered that basking lizards were more easily noosed than those who were warm and in shaded areas. The highest temperatures recorded came from backing lizards. Those noosed later in the day from partially shaded areas were usually between 30° and 34°C.

REPRODUCTION

Male Cycle: We have not been able to collect large series during the months of April and May, but did collect *Sceloporus occidentalis* from Rainier Mesa during the first week of April 1968 and on 12 April 1969. The temperature was 7.2°C at noon (4 April) and there was snow in patches on the north side of trees and rocks. The April samplings produced only male lizards, indicating that males emerge from hibernation earlier than the females. Woodbury and Woodbury (1945) state that the males of *Sceloporus graciousus* emerge about two weeks earlier than the females and establish territories during that period. If this is the case with *S. occidentalis*, they may have just emerged, for there was no indication that territories had been established. It was found that several males were basking side by side; and, on turning over a small rock to capture a lizard known to have taken shelter under it, a total of four male lizards was found.

The males, on emerging from hibernation, have greatly enlarged testes when compared to the size of the testes during the summer months. They are sufficiently enlarged as to be easily detected by palpation. The testes of some lizards collected in April and early May constituted as much as 4-5 percent of total body weight. Histological examination of the testes of lizards taken in April show spermatogenesis with many spermatids, but no spermatozoa.

On 5 May 1968 a series of seven lizards was collected, including one female. The testes or the May series were larger but made up a smaller proportion of the body weight because the lizards were older and had a greater average body weight. The testes and epididymi in this series contained many mature spermatozoa; in fact, the epididymi were greatly enlarged and compacted with spermatozoa. Mating therefore must occur in late April and May, with some late mating possibly occurring in early June. No mating has been observed in June, although some courting behavior was observed.

In adult male lizards the testes decrease in size from their maximum in April to a minimum during July and August (Fig. 12). The testes begin to enlarge in late August and continue to enlarge until the lizard goes into hibernation. The limited data available for late September and October indicates that an increase in the size of the testes continues to the time of hibernation. An examination of the histological slides of the gonads shows a progressive thickening of the seminiferous tubules from late August into October. In early September, tubules have approximately 9 or 10 circles of cells; however, by early October several more rows have been added, and it appears that most of the cells which are to be used in the formation of mature spermatozoa the next spring are formed. We note 14-16 rows of cells in the tubules in mid-April. The maximum size is reached in April, although a late spring such as 1969 may push this part of the cycle into early May. We did not find mature spermatozoa in the epididymus until early May (1968). Assuming that 1968 was at least an average spring if not earlier than most, we believe mating occurs primarily during the month of May. For exceptional years it may occur in late April or be continued into early June.

Correlated with the enlargement of the testes is the enlargement of the fat-bodies. This paral-

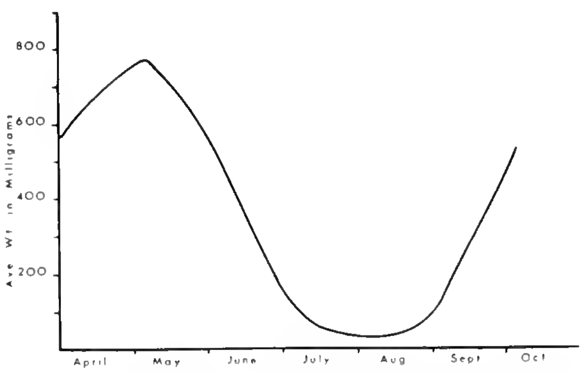

Fig. 12. The weight of testes plotted in milligrams. These data were obtained from lizards taken in April and through the summer and into October. A discrepancy of about 0.5 milligram occurs between the October and April weights.

lel development begins in late August and continues into April. As the testes reach their maximum size, so also do the fat-bodies. They begin their decrease at this point and are greatly reduced by the end of the mating season. There is a general belief that fat-bodies function as a storage of energy for the development of reproductive products. This may be true in some species of lizards; however, our data indicates that the fat-bodies remain large until the spermatozoa begin to mature. At this time, the epididymus becomes enlarged and the testis begins to lose volume. Our investigations have not been extensive enough to preclude the possibility of some energy flow from fat-bodies to gonad; however, the anatomical changes and physiological responses have indicated that much of the stored energy is used by males during the mating period. It is during this time that both the testes and fat-bodies begin to decrease in volume and the epididymi are filled with mature spermatozoa. After the first of June, the volume of viable sperm is greatly reduced and the testes rapidly become smaller. July through early August is a period of testicular quiescence, and the fat-bodies are small if at all present. By late August an increase in the size of the testes is observable, and the fat-bodies are again beginning to develop. Thus a new cycle has begun.

Female Cycle: As noted above, males emerge earlier in the spring than do females. We have observed that until approximately the first of May considerably more males are seen than females. Our observations indicate that few females appear until late April or early May. This delay seemingly permits the males to establish or reestablish a territory before the emergence of the females.

The earliest spring date for the examination of the female cycle is 5 May 1968. At this date, two adults (s-v 74 and 77) were examined. They had follicles measuring 5.3 and 2.7 mm in diameter, respectively. Data available do not indicate the extent of egg yolking, if any, nor the amount of yolking, if any, that may occur in late September and shortly before or by the time they enter hibernation. However, we have determined that yolking is not extensive in the fall nor in females we have examined in early spring. It is soon after emergence in late April, during May and June, and until the time of egg laying in early July that a continuous yolking and growth of the eggs occur.

We also note that some follicles which are included in those clustered around the ovary do not yolk. These are usually retained as small follicles; however, in some females a few may begin yolking and remain in the ovary after the yolked eggs are laid. Such a phenomena caused us to speculate that perhaps more than one clutch is laid per year. We have found no data to support such a supposition, neither by sacrificing lizards continuously during June through mid-August nor from our data gathered from marked individuals in our study plot.

In the females the fat-bodies increase in size during the fall months and are large when they emerge from hibernation in the spring. The reduction in size occurs during the period of egg yolking. We have concluded that the energy stored in fat-bodies is used primarily to provide a rapid yolking of the eggs and is perhaps occurring at the same time the males are expending considerable energy in the protection of territories as well as in the quest for mates and mating. The reduction in the size of fat-bodies occurs simultaneously in the two sexes, and by July both the gonads and the fat-bodies have been greatly reduced in size. Although we have not calculated the weight differentials for the fat-bodies during the year, they appear to have a cycle which is not only similar to but parallels the seasonal changes observed in the gonads (Fig. 12).

Two methods of determining the time of egg laying were used. Whenever female lizards were captured on the study plot, they were palpated to determine whether or not they were gravid. If eggs could be detected, the fact was recorded. If a female was captured during the season of egg laying and was found not gravid, a note stated that she was not gravid. In this way succeeding captures gave fairly precise information as to the time of egg laying. Time of egg laying is known within two days for several females. For others, the time between captures is longer, and only close approximation of the date is possible. The other method used to give an indication of laying time was the capture of lizards from outside the plot to be sacrificed for examination of the reproductive tract or placed in terraria until their eggs were laid. For example, from a group of four gravid females captured 14 June 1967, two were sacrificed for examination and two that appeared to be nearer to laying were placed in terraria and fed until they laid their eggs. Of the two that were opened, one had 15 oviducal ova and the other had 12. Of the remaining two, one laid 13 eggs on 28 June 1967. These eggs were placed in a glass jar containing about an inch of moist silica sand, and a mason jar lid with the central disc inverted was tightly screwed on it. This provided a container that would retain moisture but was not completely air tight. The jar containing the eggs was then placed on a shelf in the laboratory where all eggs hatched 25 August 1967. The room temperature although not constant ranged between 70-75 F. The weights and measurements of the eggs are shown in Table 2. The other lizard did not lay her eggs until 14 July 1967. The clutch consisted of 14 eggs and weighed 7.48 grams, with an average weight of 0.535 grams each. This compares with 0.630 grams each in the previously mentioned clutch. The second female apparently retained her clutch much longer than she would have in nature. It may also be that she was undernourished at a time when nutrition was critical in the development of the eggs since she did not adequately feed during her confinement. None of the eggs hatched, although each showed the pink area that indicates a developing embryo at the time of laying.

Table 2. Number and weight of ova at time of laying (1967) for three clutches laid in the laboratory.

Number of eggs in clutch	Weight of clutch	Average weight per egg
13	8.19	0.630
14	7.48	0.53
10	4.22	0.42
Aver. 12.33	6.63	0.538

The earliest date recorded for egg laying in the field was for lizard #5-14, captured 5 June 1967. At the time of capture this lizard was gravid. When recaptured on 10 June 1967, palpation revealed no eggs. During this time, she had also suffered a slight injury. A cactus spine had punctured her lower eyelid and was still in the lid when captured. The spine did not damage the eye but did indicate that she may have been digging in the loose soil around a cactus plant for the purpose of laying eggs. This same lizard laid eggs sometime after 24 June 1966. The 1966 season was, in general, about two weeks later than the 1967 season. Aside from the case of lizard #5-14, the earliest records of egg laying in the field for 1966 and 1967 were 14 June and 24 June, respectively. There are two records for each date. The latest record (#3-16) of a female still gravid is 10 July 1967, and the eggs were laid before her next capture on 12 July.

Fat-bodies taken from female lizards during the April to September period show a gradual increase in size and weight beginning about one month after egg laying (in August) and continuing until the next spring (late April to early June), when the fat-bodies are gradually reduced in size until the eggs are laid. At the time of egg laying, the fat-bodies are small or completely spent. The reduction in size is correlated with the yolking of the eggs and apparently serves as a ready source of material for yolking. The fat-body buildup begins again after egg laying and is a parallel development with the gonadal cycle.

A comparison of the fat-body cycle in males and females indicates that in males the stored energy is used during the mating period for such activities as aggressive defense of his territory and perhaps seeking females and mating. During these activities, males may not feed normally; thus, the stored energy is available to provide for or insure reproduction. In contrast, the more passive female, during this time, is a ravenous feeder and thus uses not only stored fat-body energy but also food energy to yolk the eggs. The above explanations, although perhaps not a complete analysis of fat-body function, fit generally our data and observations.

Twenty female lizards were collected near the study plot on 13 June 1968. Sixteen were gravid and four appeared not to be gravid. Three of the later four, however, were yolking small eggs of approximately 3-4 mm in diameter and the fourth contained what appeared to be 9-10 atretic follicles. Those considered to be gravid were fed in the laboratory. Nine laid eggs up to 12 July 1968. It is suspected that females kept in the laboratory hold their eggs longer than would be the case in nature.

Based on the data concerning egg laying and ovulation, it appears that the female cycle compares favorably to that of the male in that the yolking of eggs begins at approximately the time of the formation of mature spermatozoa in the male. Assuming that there is some delay in fertilization, the female cycle is at the appropriate stage for mating during late April and especially so during the month of May. Accordingly, ovulation takes place in late May and early June, with the first records of egg laying on 14 June 1966 and 24 June 1967. Egg laying in 1968 corresponded closely to that of 1967. Thus, we may expect that eggs will be laid between 10 June and 10 July. In a small population such as the study plot on Rainier Mesa, seasonal fluctuations will affect these dates; however, we have found that, for a single season, egg laying is completed in about three weeks; the dates given above represent the extremes.

Size of individual eggs and the numbers in a clutch

Sixty-five ova were measured soon after they were laid in the laboratory in 1967. The average length for all was 13.96 mm with an average diameter of 8.165 mm. Three clutches were weighed soon after they were laid. A total of 37 eggs averaged 0.538 g (Table 2).

Clutch size has been determined by retaining gravid females in the laboratory until the eggs have been laid and by sacrificing obviously gravid females and counting the yolking or oviducal eggs. These methods were necessary because eggs in nature are most difficult to find. Although we have looked for eggs in the field, we have not found a single clutch. The largest clutch layed contained 15 and the smallest 7 eggs. There is a correlation between the number of eggs produced and the size of the female. Small females are presumed to be the younger ones in the population and to produce fewer eggs their first reproductive year. Two lizards 83 and 85 mm s-v, laid 14 and 15 eggs, two, 76 and 77, respectively laid 11 and 10, and two, 72 and 73, each laid 9 eggs (1967). Data concerned with clutch size, dates of egg laying (in the laboratory) and the size of some females are presented in Table 3.

Data summarized from 15 clutches laid and from oviducal eggs examined in sacrificed lizards indicate that we might expect an average of 11 to 12 eggs to be laid by each adult resident

Table 3. Clutch size and date laid. Females were from Rainier Mesa, near the study plot, and all eggs were layed at the Mercury base (CETO) laboratory.

Eggs in clutch	Size of female	Date eggs were layed
14	83	28 June 1967
15	85	29 June 1967
11	78	25 June 1968
11	76	27 June 1968
10	77	30 June 1968
9	73	26 June 1968
9	72	30 June 1968
14	82	30 June 1968
10	- -	4 July 1968
15	- -	4 July 1968
7	- -	13 July 1968
9	- -	14 July 1968
15	- -	16 June 1969
10	- -	17 June 1969
9	- -	17 June 1969
168		

Table 4. Population structure based on marked lizards 1965-1967.

Year	Marked males Adults	Marked males Juve.	Marked females Adults	Marked females Juve.	Total	Hatchlings marked
1965[1]	14	17	22	19	72	0
1966[2]	29	4	40(31)	6	79	76
1967[3]	26	19	31	23	99	25

[1]Study plot not opened until 12 July
[2]First hatchling marked 13 August
[3]First hatchling marked 23 August

female on the study plot. Although we have found a yearly variation in the numbers of females in the study plot, as noted in Table 4, we believe that these fluctuations in numbers can be explained partly on the basis of our inability to mark the total population and also from the fact that there is some immigration and emigration. In 1965 we marked the first lizards on 13 July while we were setting up the plot. By mid-July most of the large adults are in the Pinyon or Juniper trees; they thus spend less time on the ground and were not caught as often in our can-traps; also while in the trees they are much more difficult to see or catch.

The fact that some immigration and emigration occur, particularly among juveniles and females, may influence numbers present during a summer season. We invariably marked more adult females than males during each year. Those marked lizards found from 30 to 50 yards from the edge of the plot were with one exception females or juveniles. Furthermore, in 1966 we recaptured 17 of each sex that were marked in 1965; however, only 11 other males were marked while 23 unmarked adult females were marked. We also noted that a number of females were seen in the plot (1966) for only a short time, usually during the egg laying season. For example, #4-7 and #4-17 were marked at stations J-7 (edge of plot) and B-9 (50 feet inside plot) on 2 and 12 June 1966; it was noted that each was gravid. They were not seen again until 29 and 27 June 1967 at which time they were caught at J-9 and A-8 (west and east edge of plot), and again both were noted to be gravid. Other examples of gravid females captured on the plot once or twice during a short period of time, usually less than a week, are as follows: 3-19, 4-5, 4-8, 4-16, 5-11, 5-12, and 5-17. This would account for nearly half of the increase in females observed on the plot in 1966. We, of course, expect that some of the females living on the plot may have left the plot for egg laying. However, we know reasons, we observed more adult females than males on the plot. Assuming that the territorialism of males keeps them within a home range and thus with much less shifting about, we can arrive at a near balance between males and females by subtracting 9 from the 40 adult females known to be on the plot at some time during the summer, giving us a near balance of 29 males to 31 females. In 1967 we did not find a large number of females (3) coming onto the plot during June. Our only explanation of this is that there was a large population of juveniles in 1967 and few in 1966. Whether this increase in population at this level of the population affected their nesting habit is only speculation.

If we assume that the adult female population on the study plot ranges from 25 to 35 females, then we may estimate that during an average year approximately 30 clutches of eggs will be laid. In other words, between 300 and 400 eggs are produced to insure a continuous population on a six to seven-acre area.

Hatchlings

The term hatchling is used to designate that part of the life of a lizard from the time of its hatching in August and September until it enters hibernation for the first winter. In order to designate them as separate entities, the next spring they are referred to as juveniles.

The earliest record of a hatchling in the field is 9 August 1966. (There were no hatchlings found on the plot in 1965; plot closed 9 September.) Two more were taken 13 August, and newly hatched lizards were still being captured when the can-traps were closed 4 September 1966. In 1966 we marked 77 hatchlings. The first hatchling recorded for 1967 was marked on 23 August, which seems to corroborate an earlier statement that the season was later in 1967 than in the previous year. New hatchlings continued to appear until September 11 when the plot was closed. In 1967 we marked 26 hatchlings. A brief sampling trip to the plot on 7 October 1967 produced 12 hatchlings during a 24-hour period with the can-traps open. One of the hatchlings measured only 29 mm snout to vent and weighed 0.72 g, indicating that hatching does continue into late September during favorable years.

In 1966 there were less precipitation and slightly warmer temperatures (Fig. 4), factors which not only lead to an earlier date for hatching but also a longer period, thus increasing the of none. For this and perhaps other less obvious possibility for eggs laid toward the end of the nesting season to be successfully hatched.

The minimum size recorded for a hatchling in the field was s-v 26 mm and a weight of 0.33 g. From several clutches hatched in the laboratory, the smallest was 22 mm s-v, and with a weight of 0.48 g. The largest hatchling known to have been less than 24 hours old was hatched in the laboratory, measured 28 mm s-v, and weighed 0.90 g. Part of this weight can be accounted for by the fact that the umbilical cord was still attached. It is seemingly a fact that hatchlings less than 24 hours old and from eggs hatched in the laboratory are generally smaller in snout-vent length and heavier in weight than the hatchling lizards captured in the field. This suggests that young hatchlings with a quantity of yolk still in the mid-gut may remain relatively inactive for a few days before digging out to the surface; during this time, those hatched in the field may grow in length and decrease in weight. At least, such a conclusion seems plausible based on the weights and measurements of hatchlings hatched in the laboratory in contrast to those examined at the study plot. The size and weight of 20 hatchlings measured shortly after hatching are listed in Table 5. A summarization of measurements for hatchlings observed on the study plot is recorded in Table 6. In order to indicate gen-

Table 5. Size and weight of laboratory hatchlings—measurements taken 24 hours after hatching.

Number and clutch	S-V length	Total length	Weight	Date hatched
First Clutch				
1	24	51	0.58	8-22-69
2	24	47	0.51	8-22-69
3	26	55	0.76	8-22-69
4	25	56	0.69	8-23-69
5	25	54	0.63	8-23-69
6	25	52	0.63	8-23-69
7	26	54	0.68	8-23-69
8	24	52	0.54	8-23-69
9	25	53	0.71	8-23-69
Second Clutch				
1	23	49	0.58	8-23-69
2	24	50	0.67	8-23-69
3	25	51	0.72	8-24-69
4	24	50	0.54	8-24-69
5	26	55	0.67	8-24-69
6	25	54	0.76	8-24-69
7	27	56	0.77	8-24-69
8	24	54	0.72	8-24-69
9	24	49	0.61	8-24-69
Third Clutch				
1	23	48	0.38	8-26-68
2	22	48	0.37	8-26-68
Averages	24.55	51.90	0.626	

Table 6. A summary of measurements taken from hatchlings marked on the Rainier Mesa study plot 1966-70.

Number	S-V	Total	Weight	Date
15	26(29.73)34	52(64.36)73	.33(.653)93	9 Aug. thru 16 Aug. 1966
18	27(28.83)30	57(63.05)71	.65(.787)96	19 Aug. thru 23 Aug. 1966 (5 days)
23	27(29.43)35	57(65.52)79	.55(.788)1.23	25 Aug. thru 29 Aug. 1966 (5 days)
23	27(30.0)37	55(65.52)83	.50(.886)1.60	31 Aug. thru 4 Sept. 1966
4	29(29.5)30	63(65.5)68	.67(735).80	23 Aug. thru 29 Aug. 1967
9	29(30.66)32	60(67.11)72	.60(862)1.11	7 Sept. thru 11 Sept. 1967
12	29(32.58)36	63(71.5)80	.68(1.06)1.66	7 Oct. 1967
14	30(33.36)39	63(73.79)87	.62(1.18)1.97	4 and 5 Oct. 1968
8	30(34.13)38	65(73.0)80	.78(1.33)1.75	9 and 10 Oct. 1970

eral growth rates, averages for different periods are reported. Data on the growth of hatchlings before their first hibernation is limited. In all cases of hatchling lizards captured in the field, the exact time of hatching is unknown. Often a hatchling is not captured until it is nearly a full gram in weight, which is not surprising considering their small size and the heavy cover at the study plot. The fact that we closed the plot by or before 10 September limited our observations of hatchlings. Other data, however, provides a basis for determining growth (Table 6), and from these data we offer the growth curve (Fig. 11 and 12). The length of time available for late summer and fall growth varies. Some years permit feeding until mid-October. In 1967, 1968, and 1970, small series were taken between 4 and 10 October; however, on 17 and 18 October 1969, no lizards were seen. Only a few hatchlings recaptured in the season of their hatching showed a gain in weight or length. The need to close the plot in early September at the height of hatching gave only limited time for observation. Of those marked in 1966, 21 (27.6 percent) were observed the next spring. There were several hatchling recaptures in 1966 in which no change in length, but a loss of weight, occurred. One lizard showing weight gain was numbered 6-16 and was the first hatchling captured in 1966. Her capture dates, measurements, and weights are listed in Table 7. Unfortunately, this lizard was not seen the next spring, as was the case for many other marked hatchlings. Although years vary, it is obvious from the data available that there is a high hatchling mortality each year in this population and presumably in the species.

Since few other lizards were recaptured showing a weight gain in the season of hatching to give concrete data, we conclude from measurements taken that the lizards hatch with snout-vent measurements of 24-28 mm, total length of 45-60 mm, and body weights of 0.35-0.90 g. They may, if hatched early, attain s-v length of 38 mm or more and a weight of 1.6 g before they hibernate, presumably, by mid-October. The young remain active later in the autumn than the adults and emerge from hibernation about as early in the spring. Of 15 lizards captured on 7 October 1967, 12 were hatchlings with s-v length of 29-38 mm and weights of 0.68-1.66 g, 2 were marked juveniles, 1 male and 1 female, and 1 a marked adult male. On 9 and 10 October 1970, 7 hatchlings (s-v 30-38 and weight 0.78-1.75) and 6 juveniles were examined.

In 1965 we marked 76 hatchlings. Of these, 12 were recaptured in 1966. Twenty-one of those marked as hatchlings were recaptured in 1967. This is a 27.63 percent survival of those marked. However, we marked an additional 45 as juveniles in 1967. If we assume the same percentage of survival for these, we can account for approximately 250 hatchlings on the plot in 1966. An attempt to estimate the hatchlings on the plot per year has not been entirely successful. Table 8 gives our estimations based on hatchlings marked the next spring and summer.

The variation in the estimated yearly output of hatchlings is a direct result of the variations in climate. Few summer seasons provide the same weather conditions. There are early falls, late springs, and an occasional cloudy wet summer (Fig. 3 and 4) which provide some of the fluctuations observed in the populations. Such climatic conditions may induce factors which increase or decrease food sources which in turn may increase or decrease the numbers of eggs

Table 7. Measurements and weights for hatchling number 6-16.

Date	S-V	Total length	Weight
8-9-66	28 mm	65 mm	.69
8-17-66	28 mm	65 mm	.65
8-29-66	30 mm	66 mm	.90
9-4-66	33 mm	73 mm	1.00

Table 8. Estimation of hatchlings produced on study plot for four years.

Year	Hatchlings marked	Juveniles marked	Estimated number of hatchlings
1964	- -	- -	150
1965	0	36	42
1966	76	10	250
1967	25	45	194
1968	15	22	- - -

produced as well as the time of hatching and the success of the yearly hatch.

In 1965 the senior author spent 6 and 9 September at the Rainier Mesa study plot in an attempt to find hatchlings. Although there are undoubtedly some human errors in the dates of hatchling emergence and the yearly numbers observed, the fact still remains that there is considerable variation. Our observations indicate that no two years are the same, with extremes such as 1965 and 1966 occurring at least in high elevation desert habitats.

Juveniles

The period of greatest growth for young lizards begins with their emergence from their first hibernation, as can be seen in Table 9. As indicated previously, lizards emerging from their first hibernation are referred to as juveniles. A lizard remains in this age group until it enters the second hibernation.

As they emerge from the first hibernation, many have not yet reached a snout-vent length of 35 mm, and all are less than 40 mm. By early June, half of the juveniles have reached 40-45 mm, and this growth continues at a rapid rate during June, July, and August. By late August or early September, a few have attained a snout-vent length of 70 mm and are small adults in size. It is also important to note that by this date even the smallest juvenile is approaching a snout-vent length of 55 mm and this generation of the population ranges between 53 and 71 mm in the snout to vent length. During late August and September, their growth continues but at a slower rate. This reduction in growth rate is particularly true for larger individuals, and this tends to produce a more uniform size for this age group in October.

The data for the variations indicated above and for figures 13 and 14 are based primarily on observations made during the summers of 1965, 1966, and 1967, but with data obtained in 1968, 1969, and 1970 used to supplement the previous years, particularly that for late fall and

Table 9. Measurements and weight for juveniles in May and June compared with August and September.

	Minimum	Maximum	Average
	May and June		
Snout-vent	32 mm	54 mm	43.9 mm
Total length	72 mm	118 mm	99.0 mm
Weight	0.7 g	6.0 g	2.36 g
	August and September		
Snout-vent	52 mm	71 mm	67.4 mm
Total length	100 mm	165 mm	140.6 mm
Weight	4.9 g	14.0 g	8.7 g

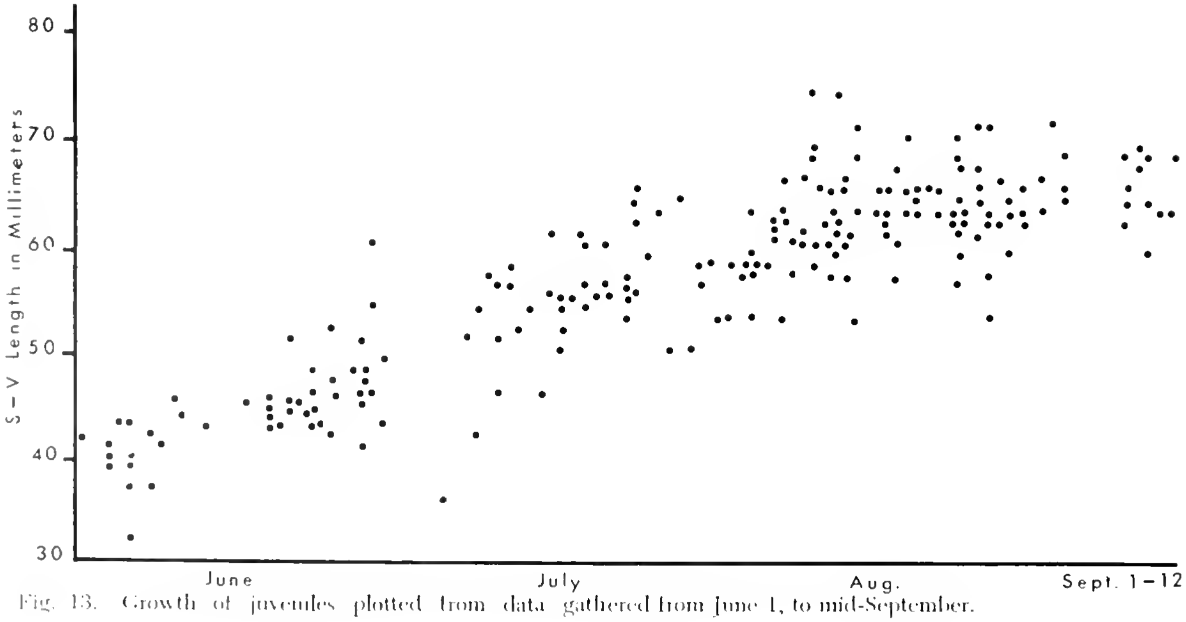

Fig. 13. Growth of juveniles plotted from data gathered from June 1, to mid-September.

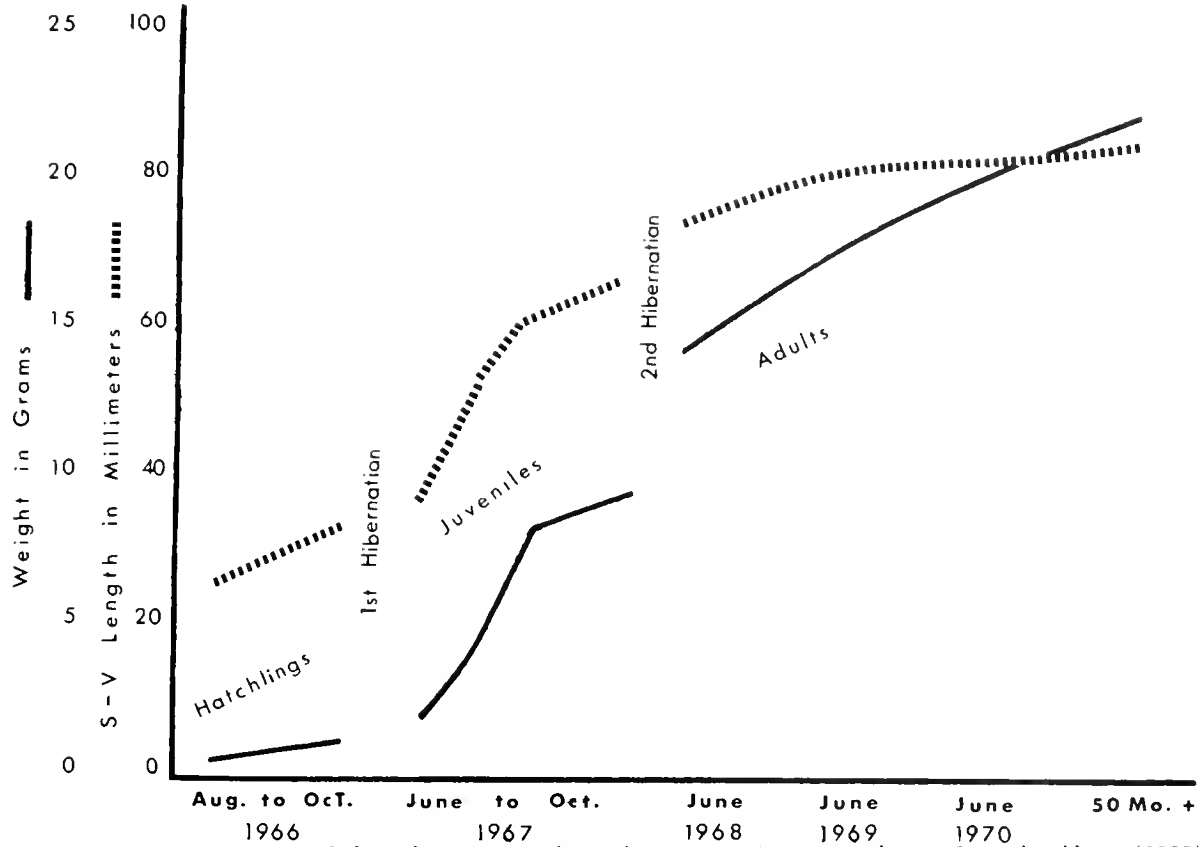

Fig. 14. A summarization of data showing growth in the Rainier Mesa population from hatchling (1966) to juveniles and adults through 1967 to 1970. The broken line indicates snout to vent lengths and the solid line growth as determined by weight in grams. The discrepancies following the first and second hibernations represent growth during April and May.

early spring. Because this data represents a summarization of three years, there may be a greater variation in size than would be encountered during any one year. The effect of an early or late autumn or spring would either favor or retard growth during the early periods of the hatchling and juvenile growth cycle. However, by mid-September, or by the end of approximately one full year, the lizards of this population have reached the size of small adults. It is further believed that with few exceptions, none of which we are aware of, the juveniles, now young adults, will reproduce the next spring for the first time.

A further examination of figures 13 and 14 indicates that the growth curve after emergence from the first hibernation would be about 35 mm s-v and would slope steadily upward into mid-August at which time a flattening of the curve occurs. It is also obvious that the average size at this time is approximately 64-65 mm. We are unable to note any significant difference in the rate of growth between the males and females.

In Table 10 a summarization of growth and rate of growth is given for 25 juveniles examined during the summer of 1967. Although the records are not complete for each individual for each month listed, there are data available to indicate that these individuals had a net growth of 428 mm in s-v length and 130.76 g weight in a total of 1633 days. For this year, at least, the approximate daily growth from 1 June to 10 September was 0.2530 mm in s-v length, with a weight increment of 0.08052 g.

In terms of percentage of growth, lizards 7-13 had a 50 percent increase in s-v length, 14-15 had 70 percent, 16-19 a 65 percent, and 17-20 a 68 percent. Data available for other years also indicate a snout-vent increase ranging between 50 and 70 percent, with the approximate averages ranging between 60 to 65 percent. The variation in the percentage of s-v growth from 1 June until 10 September is approximately 50 to 70 percent for 1967.

A series of hatchlings secured between 9 and 16 October 1970 had s-v lengths of 30(34.13)38 (Table 6). The series of 10 juveniles taken in

June 1967 (1-15, Table 10) measure out at 32(40.1)43, whereas a series of 8 taken in June (1-15) 1968 measured 34(44.6)50. On the basis of these and confirming data for other years, we conclude that most hatchlings hibernate before reaching 40 mm in s-v length and emerge in April (1-15, depending on year) at about this same length. We recognize that these figures will vary from year to year and suspect that few juveniles reach 50 mm in s-v before mid-June. During favorable springs, growth begins in April and continues to accelerate during May. Juvenile growth is rapid and uninterrupted until they reach at least 60 to 65 mm. Thus

Table 10. Growth during summer (1967) for marked lizard with a known age. First figure—snout-vent length; second figure—weight in grams.

Specimen number	June 1-15	June 16-30	DATES OBSERVED July	August	September	Total growth	Days of growth	% Day
7-13	42-2.60		55-5.51	60-7.44	64-8.54	22-5.94	100	.220 .0594
8-17		51-3.79	60-8.81	67-9.75	69-10.45	18-5.94	75	.240 .0792
10-11	43-2.69	48-3.74		64-8.81		21-6.12	89	.236 .0688
14-15	37-1.58	43-2.62	53-4.67	57-6.38	63-9.09	26-7.51	94	.276 .0799
16-18	44-2.59		53-4.58	62-8.34		18-5.75	65	.277 .0884
16-19	40-2.26	45-3.31	60-7.61	65-9.98	66-10.54	26-8.28	91	.286 .0909
17-20	37-1.80	42-2.40	51-3.70	59-7.70	62-8.63	25-6.83	95	.263 .0719
18-19	32-0.70		44-2.50			12-1.80	33	.363 .0545
18-20	42-2.42		51-4.25			9-1.83	39	.231 .0469
19-20	41-2.42	46-3.28				5-0.86	19	.263 .0453
1-2-3	43-2.64			59-7.06	66-9.65	23-7.01	88	.261 .0796
1-2-7		45-3.00		62-8.14	63-9.31	18-6.31	88	.205 .0717
1-2-9		44-2.95		61-7.46		17-4.51	55	.309 .0820
1-2-10		45-3.12		61-7.86	64-9.84	19-6.72	84	.227 .0800
1-2-12		43-2.83		46-3.50	57-7.15	14-4.32	69	.203 .0626
1-2-13		45-3.24		65-9.18		20-5.94	55	.363 .1080
1-2-15		45-2.74	55-5.56	58-6.68	63-9.75	18-7.01	83	.217 .0845
1-2-17		43-2.26		63-8.10		20-5.84	62	.323 .0942
1-2-18		44-3.29		63-9.13		19-5.84	67	.283 .9872
1-2-20		44-2.52		62-8.80		18-6.28	62	.290 .1012
1-3-4		46-3.27		65-9.21		19-5.94	49	.387 .1204
1-3-9		46-2.98	54-5.59	61-7.93	63-9.30	17-6.32	78	.218 .0810
1-3-10		51-5.16	56-5.89	65-9.95		14-4.79	53	.264 .0904
1-3-14			52-4.82	62-7.89		10-3.07	40	.250 .0767
25	32(40.1) 44 1.58(2.17) 2.69	42(45.7) 51 2.66(3.73) 5.16	44(53.7) 60 2.5(5.27) 8.81	46(61.19) 67 3.5(8.09) 9.98	57(63.63) 69 7.15(9.3) 10.54	428(17.12s-v) 130.76 (5.23)	1633 days	growth per day s-v 0.2530 wt. 0.08052

from June to September 15 the juvenile lizard increases its s-v length by about 65 percent and it is about four times as heavy.

As with adults, juveniles spend considerable time basking in the spring and fall and during the early morning hours throughout the summer. Temperatures taken indicate that this age group may maintain a higher average body temperature for more hours of the day than is the case for adults (Table 6). By controlling the temperatures through basking, and with an abundance of food as indicated below, the rate of metabolism is perhaps greater, thus providing for the rapid growth rate observed in juveniles. We also note that the greatest rate of growth (in 1967) occurred during June, July, and the first part of August but with a noticeable slowing down during late August, September, and October (Fig. 13 and 14 and Table 10).

Sexual maturity is reached by September or October just before the juveniles enter their second hibernation. We note that in males the gonads are increasing in size as indicated in figure 10 and that such males do produce mature sperm the next spring. Although most juveniles measured during September and October are not yet 70 mm in s-v length a few have reached the size of small adults, and most reach 70 mm by or before June of the next spring.

Adults

Lizards that are sexually mature are considered to be adults. This stage in the life cycle is reached in most males as they enter the second hibernation. We have no data to indicate that any remain as juveniles after they emerge from the second hibernation. Size is also a factor and, although we have previously indicated a size of 70 mm s-v to signify adulthood, some juveniles, particularly males, emerge as sexually mature individuals with a size slightly less than 70 mm.

Two males taken on 9 April 1968 had s-v lengths of 64 and 67 mm; yet both had greatly enlarged testes and were considered to be breeding males. By late April and certainly before eggs are laid in June, few if any sexually mature lizards are less than 70 mm in s-v length.

Adults reach a s-v size varying between 70 and 92 and in total length from 150 to 199 mm. Lizards of this size have a variation in extreme weights of approximately 10.0 to 31.0 g. The longest lizard measured was a female; however, the heaviest was a male.

Many adults (18 percent in 1967) have regenerated tails. This remarkable phenomenon of regeneration permits the lizard to duplicate almost perfectly the lost part, at least insofar as size and outward appearance is concerned. The real value of the tail to these lizards is perhaps not entirely known, but the fact that it is regenerated so completely and at a rapid pace suggests that its presence is of value. Tinkle (1967) in his considerations of tail regeneration in *Uta* believes that tail breakage is a part of an escape mechanism as well as an organ for balance. Similar functions for the tail are perhaps also true for *Sceloporus*. We note that the tail may also be used by these lizards for the storage of food. At least lizards deprived of food lose considerable substance from the tail before there is a noticeable reduction in the vigor of the individual. Other functions may yet become apparent.

The rate of regeneration is variable. Our data suggests a more rapid rate during the summer when the rate of metabolism is generally high and the days are longer.

Figure 14 indicates a growth curve for five years. The curve includes a large number of individuals for the first two years but a continually reducing number thereafter. These curves are also based on averages. Size variation among individuals of a given age group even after two years is considerable and is known to vary at least 10 mm in s-v length. The fact that averages of age groups show a continuous, although slower, increase in size suggests that we might expect most individuals to continue to grow as long as they are in good health.

We have noted that the older lizards seem to hibernate before the hatchlings and juveniles. However, two adult lizards taken in October 1968 and 1970 were not healthy. The latter, #7-15, was marked as a hatchling on 17 August 1966 and recaptured for the last time on 16 October 1970. At the last capture it was 85 mm. in s-v length and at least 50 months old. Although vigorous, it was emaciated and in poor health. An autopsy revealed an obvious intestinal infection.

Our study did not cover sufficient years for us to state with certainty the longevity of the oldest individuals of this population. It does indicate that not many live beyond the fifth year and relatively few are known to have reached an age of five years. Data for lizards marked as hatchlings or juveniles (where an age can be estimated within a few weeks) have given us several females known to have been gravid for four consecutive years. Such individuals would be at least six years old and we suspect some to be older. There is, therefore, sufficient data to demonstrate a longevity of five to six years but with a progressive and rapid thinning of individuals of the age groups older than four years.

Young adults breed and lay the first clutch of eggs when they are 21 to 23 months old. This is in contrast to *Uta* who lay eggs the first year. Thus, when lizards are approximately two years old, their first generation of hatchlings are emerging (August and September). We have indicated that a pressure is seemingly exerted on the adults by the large numbers of hatchlings and juveniles which appear in the population each year. If such pressures are assumed to be responsible for maintaining a relatively uniform balance in the size of the population, we would expect that any reduction in the numbers of the younger age groups would be reflected by slight variations in the numbers of older lizards in the population. Such general conclusions fit well except for 1965 and 1966, two years in which considerable variation in numbers occurred in the younger age groups (Table 8). However, we did not record a noticeable reduction in the numbers of the older age groups in the spring of 1966, and the largest number of hatchlings was observed that summer (1966) than for any other year. This may not necessarily be the result of more and or larger adults; however, it does suggest an inherent population resilience which permits the population to maintain an adult breeding population capable of withstanding adverse conditions for short periods of time and thus to maintain a breeding population.

In Table 11 the approximate date of egg laying and the differential in weight of females before and after egg laying is given. We attempted to correlate these weights and measurements with those taken from actual clutches laid and measured in the laboratory. Although we can see some similarity in weights, it is not possible to estimate accurately the number of eggs laid based on the difference in weights of a female before and after the eggs are laid in the field. Several factors interfere, such as the difference in the size of eggs, the loss of fluid at the time of laying and general reduction in body weight which may have resulted from energy spent in "nesting" or the reduction of or abstinence from feeding during the period immediately preceding and following the laying of eggs. In two instances (Table 11), females weighed two and seven days between egg laying have shown a loss in weight of more than 11 grams. We do not have records of entire clutches weighing more than 8.26 grams, and it is therefore considered to be more reasonable to assume that the three plus grams in weight loss resulted from other causes as indicated above. However, both females were large and may have laid more than 14 or 15 eggs, which is the largest number observed by us in any one clutch. If larger clutches are laid this may also account for the discrepancies in weight. Fitch (1970) reports the largest clutch for this species to be 13 eggs.

Population Structure

The structure of the population varies from year to year (Table 4). Theoretically, one would suppose that the numbers of hatchlings, juveniles, and adults could be estimated if the approximate population structure is known for a few years. This may be possible within broad limits if the adaphic factors of the environment were less variable. However, with the considerable variation not only in annual rainfall but also with the considerable fluctuation in temperature, particularly in some of the more critical months, estimations are seemingly not sufficiently meaningful to be worth the effort, particularly if one attempts to evaluate the entire population. Perhaps the most stable part of the population is the adults; at least we have found less variation each summer in the number of

Table 11. Field data showing weight differentials of female lizards before and after eggs are layed.

Toe number	Date gravid	Weight gravid	Date not gravid	Weight after laying	Days between	Difference in weight	S-V length
3-17-18	6-18-67	29.23	6-27-67	20.79	9	8.44	90
3-16	7-10-67	25.80	7-12-67	16.88	2	8.92	80
4-10	6-20-67	28.86	6-27-67	17.21	7	11.65	86
4-14	6-18-67	25.56	6-24-67	17.83	6	7.73	87
4-18	6-20-66	21.01	6-22-66	15.02	2	5.99	83
1-5	6-7-67	19.27	6-29-67	14.61	22	4.66	83
5-15	6-7-67	20.74	7-12-67	17.68	35	3.06	80
5-20	6-16-67	23.67	6-28-67	18.99	12	4.68	85
6-9	6-20-67	19.79	7-12-67	15.08	22	4.71	80
1-2-19	6-22-67	29.92	6-24-67	18.02	2	11.72	89

adults, with a greater variation in the number of surviving juveniles and hatchlings.

Based on our can-trap counts, five small terrestrial vertebrates occur on the study plot. Lizards are most often caught in the following order: *Sceloporus*, *Uta*, and *Eumeces*. Two mammals are occasionally caught, with *Peromyscus* most often seen, but with a shrew seen occasionally. Only a few snakes have been seen and we have not made a bird census. Thus, by walking through the plot, the most common small vertebrates seen would be lizards.

The size of the lizard population varies not only as to numbers but also as to age group. Thus, if one is to determine the biomass of *Sceloporus* on the plot he should be specific as to the date because there is a continual growth of juveniles and adults plus the usual adding of hatchlings in late summer which provides for a constant fluctuation of the biomass.

In Tables 12, 13, and 14, the average weight for adults known to be resident on the plot during 1966 and 1967 is tabulated. It is noted that both males and females averaged heavier in 1967. We account for this primarily because of the differential in the dates of the survey. In 1966 the weights were mostly taken in early June, whereas in 1967 they were taken in late June and early July. The differences are particularly noticeable for the females. This is understandable if we realize that nearly half of them were gravid when weighed in 1967.

Food Habits

The stomachs of 150 lizards were opened and their contents examined. Of those with large quantities of food in the stomachs, the volume

Table 12. Biomass of *Sceloporus* on Rainier Mesa study plot for July 1966.

Sex	M	F
Number	29	31
Avg. in grams	19.48	19.66
Biomass	584.40	609.46
Total biomass	1193.86	

Table 13. Biomass of *Sceloporus* on Rainier study plot for June 1967.

	Adults		Juveniles	
Sex	M	F	M	F
Number	26	31	19	24
Avg. in grams	19.97	22.09	3.08	2.73
Biomass	519.22	684.79	58.52	65.55
Totals	1204.01		124.07	
Total biomass	1328.08			

Table 14. Biomass of *Sceloporus* on Rainier Mesa study plot for August 1967.

	Adults		Juveniles		Hatchlings
Sex	M	F	M	F	
Number	26	31	19	24	47
Avg. in grams	20.56	21.03	8.67	8.18	0.735
Biomass	534.56	651.93	164.78	196.32	34.55
Totals	1186.49		361.10		34.55
Total biomass	1582.14				

was measured. We have not attempted to express the food items in terms of percent of volume or in terms of numbers found, but do indicate in general terms the food items observed and the volume and weights occurring in what appeared to be filled stomachs.

The major source of food for *Sceloporus* on Rainier Mesa is ants. Perhaps this should be expected since there are 28 species of ants known to occur there (Cole, 1966). Ants are also extremely abundant as individuals, especially in the organic matter under the pinyons and junipers. Every stomach examined which contained food material contained several ant heads. Some of the fullest stomachs contained only ants. One stomach contained ants with a volume of 1.34 ml, and in this one 68 ant heads were counted.

It appeared in several instances that lizards had found the winged reproductive forms of one of the ant species swarming and had gorged themselves to capacity. There is little doubt but that ants make up a large percent of the diet of *S. o. longipes* on Rainier Mesa. At least we found the sclerotized parts of ants (e.g., head, legs, and thorax) to be abundant in the digestive tracts of all lizards examined.

Beetles of several species and in a wide range of sizes are eaten by these lizards. Ladybird beetles and weevil are the more common ones observed in stomach contents.

Lepidoptera larvae and perhaps some beetle larvae were commonly found. Some of these were relatively large, and, since they are soft-bodied and readily digested, they are undoubtedly a major food source when available.

Flies are abundant on Rainier Mesa, and several species have been found in the stomach contents. Lizards have been observed to catch flies, but because of their relatively soft bodies as compared to ants and beetles, and since there was often a lapse of time between the lizards' capture and the time they were examined, we are not certain of their identification. Based on the feeding activities as we observed them in the field, we anticipate that flies would constitute a greater percent than we found in the stomach contents. We have observed lizards to run after flying insects and to actually jump for them, and yet, in spite of our seeing the lizards eat flies more frequently than any other insect except ants, they have not proved to be a major food item based on stomach contents.

Several species of Hemiptera, both adult and immature, were found in the stomachs. They, like beetles, varied greatly in size. Bugs were recognized in the stomachs at least as often as flies. They are more easily identified than flies because of the sclerotized portions of the forewings and the head and mouthparts which seem to resist digestion.

Orthoptera are common on Rainier Mesa. Camel crickets are commonly found in can-traps, and other crickets and grasshoppers are also seen but are not common. Jerusalem crickets are abundant and are occasionally found in the stomachs. The adults with their large, heavily sclerotized heads and powerful mandibles are probably not eaten by *S. o. longipes*. They may be too large and vigorous to be subdued and eaten. As previously mentioned, immature lizards have been killed and eaten by Jerusalem crickets in can-traps .Crickets in general are large prey for *S. o. longipes* and they are chewed, shaken, and crushed to a great extent before they are swallowed.

Several other orders of insects undoubtedly are eaten by the lizards in small numbers, among them Neuroptera, Isoptera, and Homoptera.

Spiders were found in several stomachs, but, again, their soft bodies are quickly digested and easily broken up, making an accurate count difficult. One scorpion was found in a lizard stomach.

As previously mentioned (in connection with home range), *Sceloporus occidentalis longipes* does not appear to move about foraging for food. More commonly they bask or loaf in the shade and eat whenever an arthropod comes close enough to attract their attention. They appear to eat almost anything of suitable size that moves enough to attract their attention and with almost no discrimination. The fact that they eat tenebrionid beetles and also that a feather and a piece of red plastic ribbon were found in stomachs tends to corroborate the idea. They often ingest small rocks and such items of plant matter as sagebrush leaves (*Artemisia tridentata*) and fragments of needles of the pinyon and juniper trees. A *Sceloporus occidentalis longipes* collected near Milford, Beaver County, Utah, was noticeably thin and refused to eat when food was offered. It died and examination showed a large lump in the abdomen. The abdomen was opened and an ingested pinyon needle punctured the intestine, blocking it. In front of the needle was a pile-up of sclerotized insect parts which made the lump easily detectable by palpation. *Opuntia* spines and other threatening objects were found in the stomachs of *Sceloporus* from Rainier Mesa showing again that the lizards are not, in our opinion, discriminating in their selection and not dexterous in their capture and ingestion of food.

DISCUSSION AND CONCLUSIONS

Few studies of high altitude populations of saurians have been done in western North America. Stebbins (1944) and Stebbins and Robinson (1946) studied *Sceloporus graciosus gracilis* at 6,000 feet elevation at the Chaos Jumbles area in Lassen National Park. This study revealed certain modifications in the basic ecology of this population of *Sceloporus graciosus gracilis* such as: (a) a larger percentage of adults in the population; (b) a greater longevity; (c) a reduced number of predators, both as to numbers of species and individuals; (d) a much shorter annual period for activity; and (e) fewer young.

Most of their comparisons were made with *Sceloporus occidentalis* (Fitch 1940), and we are presently studying *Sceloporus graciosus graciosus* in central Utah and *Sceloporus undulatus* in southeastern Utah, both of which will serve as comparative studies.

The present reports on *Sceloporus* and *Uta* from Rainier Mesa have certain facets that are similar to those presented by Stebbins and Robinson (*loc cit*). In the case of *Sceloporus occidentalis*, we note the following differences when contrasted with the study of Fitch (1940):

1) A substantial increase in the maximum size of adults. This may be the result of various factors other than altitude. We are dealing in Nevada with a different subspecies and such differences as size may represent genetical variations in the gene pool coming from their adapta-

tions to a dryer, as well as a more elevated, environment.

2) A slightly longer life span with the majority of adults 3-4 years old, but with some living for six years. In June 1967, 57 percent of the population were breeding adults (22 months or older). This percentage was much higher in 1966 (85.71), owing to a very poor reproduction in 1965. We consider 1967 to be more nearly average but recognize that there will usually be a yearly fluctuation in all age groups.

3) A shorter season for normal activity. In southern Nevada at 7,500 feet, cool weather limits adults and most juveniles by or before November, and spring rarely comes before 1 April.

4) A larger number of eggs are laid. We have had laid in the laboratory or have observed oviducal clutches totaling 15 eggs and, on the basis of weights before and after egg laying, which exceed the maximum for a clutch of 15, suspect that the larger females lay more.

5) Growth is rapid, particularly during the first full summer or as juveniles. We note that juveniles on Rainier Mesa grow from about 14 mm to an average length of 70-73 mm in 22 months, most (51 percent) occurring from 1 June to mid-August while they are at an age of 9-12 months. Even more remarkable is the gain in weight from approximately 2 to about 9 g in the same length of time. The months of June, July, and August are seemingly ideal weatherwise, and there is an abundance of food —two factors which seemingly contribute heavily to the rapid growth rate.

6) Diet consists largely of ants but with beetles, bugs, flies, and other available arthropods included. We do not believe that ants are any more desirable to these lizards than other small anthropods. The fact that they are available in abundance is the important factor. Ants are represented on the mesa by 28 species (Cole 1966) and have been noted to occur in all nitches where the lizards live. Therefore, a lizard may be relatively sedentary, feeding on those food items (ants primarily) as may chance to come nearby.

7) Home ranges of males are relatively large; however, they apparently are not defended in their entirety. Our data suggest that the area really defended is much smaller and consists of that part of the home range used primarily for basking and hiding. Other parts of the home range may be used for foraging or for other purposes which are not clear to us. Female home ranges are much smaller and, in contrast to males, may be altered by changing the center of activity. We have not observed any defensive behavior on the part of females.

8) During the warmer parts of the summer, there is a considerable reduction in the amount of time lizards bask. Males climb into trees near rocks or other objects used for basking and may remain in the trees at least overnight and perhaps longer. Lizard activity on the ground is reduced to such an extent that it becomes obvious in the numbers of lizards found in can-traps. Although accurate percentages are not available, we did find a greater percentage of juveniles than adults in the can-traps during the warm periods. Although we did not attempt to record the lengths of time the lizards spent in trees, our observations do indicate that the trees are used mostly from mid-July to early August and that adult catches in the traps gradually increase as the evenings begin to cool from mid-August into September. We did not note any difference between males and females. Both used the trees; however, there was a larger percentage of males in the trees in early July.

An examination of figure 4 indicates that the daily maximums are above the mid-eighties during much of the period in which the lizards are in the trees. Although we did not check carefully the differential in air temperatures on the surface and in the trees, it is seemingly true that temperature regulation would be more easily controlled a few feet above the surface. We have concluded that the true climbing behavior is done primarily for the purpose of temperature regulation. A tree may afford full or part shade or sun as needed, but, more appropriately during the warmer periods of the year, air circulation permits for a proper temperature balance.

9) On the basis of laboratory hatchlings and those caught in the field, it appears that hatchlings have an initial or early growth coming largely from yolk remaining in the mid-gut. This increase in s-v length is accompanied by a decrease in weight. We note a difference of approximately 15 percent in the s-v length of laboratory hatchlings (22-26) and have yet to find in the field one less than 26 mm in s-v length.

10) The climatic factors of this desert study area dictate to a great extent much of the ecological variaion which we have noted. Populations in this general area rarely have the same weather conditions for two years. We have concluded that each year is in some way different, more rain, dry, cool springs, late or early falls, cloudy (reducing radiation and thus affecting

growth and or embryonation of the eggs) or a combination of these and others.

In general this study demonstrates that the western fence lizard is an adaptable reptile. Because of its basking habits, which permit it to warm early in the morning even on cool days, this lizard increases its rate of metabolism permitting a longer period of activity than would otherwise be possible. This allows longer periods when feeding is possible, permitting an increase in the rate of egg yolking, (thus, an earlier laying of eggs) insuring reproduction. Its utilization of available arthropods gives it a food supply during the season of its activity. The latter, particularly the utilization of ants, is of considerable importance in the lizard's ability to survive in high altitude habitats.

Because this species occupies many diverse habitats, has a wide geographic distribution, and consists of several subspecies, we would hope that future ecological studies might be made in a more northern habitat. Such comparative data would give a more precise understanding of the ecology of this species and perhaps indicate if longitude has an effect similar to what appears to be the case for altitude.

LITERATURE CITED

ALLRED, DORALD M. AND D ELDEN BECK. 1962. Ecological distribution of mites on lizards at the Nevada Atomic Test Site. Herpetologica 18:47-51.

ALLRED, DORALD M., D ELDEN BECK, AND CLIVE D. JORGENSEN. 1963. Biotic communities of the Nevada Test Site. Brigham Young University Science Bulletin, Biol. Series, 2(2):1-52.

BEATLEY, J. C. 1965. Ecology of the Nevada Test Site I. Geographic and ecologic distributions of the vascular flora (annotated checklist). UCLA 12-553. Lab. of Nuclear Med. & Rad. Biol., Univ. of Calif., Los Angeles. 69 p.

BEATLEY, J. C. 1969. Vascular plants of the Nevada Test Site, Nellis Air Force Range, and Ash Meadows (Northern Mojave and Southern Great Basin Deserts, South-central Nevada). UCLA 12-705. Lab. of Nuclear Med. & Rad. Biol., Univ. of Calif., Los Angeles. 122 p.

BELL, E. L. 1954. A preliminary report on the subspecies of the western fence lizard, *Sceloporus occidentalis*, and its relationships to the eastern fence lizard *Sceloporus undulatus*. Herpetologica 10:31-46.

BLAIR, W. FRANK. 1960. The rusty lizard: a population study. Austin, University of Texas Press. 178 p. 31 fig.

BOGERT, C. M. 1949. Thermoregulation in reptiles, a factor in evolution. Evolution 3(3):195-211.

CAMP, CHARLES LEWIS. 1916. The subspecies of *Sceloporus occidentalis* with description of a new form from the Sierra Nevada and systematic notes on other California lizards. Univ. of Cal. Pub. in Zool., 17(7):63-74.

CARPENTER, C. C. 1959. A population of *Sceloporus undulatus consobrinus* in southcentral Oklahoma. Southwest. Nat., 4:110-111.

CARPENTER, C. C. 1961. Patterns of social behavior of Merriam's Canyon Lizard (*Sceloporus m. merriami-Iguanidae*). Southwest. Nat., 6:138-148.

COLE, ARTHUR C., JR. 1966. Ants of the Nevada Test Site. Brigham Young University Science Bulletin. Biol. Series, 7(3):1-27.

COLEMAN, PHILLIP R. AND ROBERT LIVEZEY. 1968. Infrared reflection of the integument of live *Sceloporus occidentalis occidentalis* Baird and Girard from three habitats. Journal of Herpetology 1(1-4): 71-75.

COWLES, RAYMOND B. 1939. Possible implications of reptilian thermal tolerance. Science 90 (2342): 465-466.

CUNNINGHAM, JOHN D. 1966. Additional observations on the body temperature of reptiles. Herpetologica 22(3):184-189.

DAVIS, JOHN 1967. Growth and size of the western fence lizard *Sceloporus occidentalis*. Copeia 1967 (4):721-731.

DAWSON, W. R. AND G. A. BARTHOLOMEW. 1956. Relation of oxygen consumption to body weight, temperature, and temperature acclimation in lizards *Uta stansburiana* and *Sceloporus occidentalis*. Physiological Zoology 29:40-51.

ELLS, H. A. 1954. The gross and microscopic anatomy of the liver and gall bladder of the lizard *Sceloporus occidentalis biseriatus* Hallowell.

FERREL, CAROL M., HOWARD R. LEACH, AND DANIEL F. TILLOTSON. 1953. Food habits of the coyote in California. Calif. Fish and Game, 39(3):301-341.

FITCH, H. S. 1940. A field study of the growth and behavior of the fence lizard. Univ. Calif. Publ. Zool., 44:151-172.

FITCH, H. S. 1954. Life history and ecology of the five-line skink, *Eumeces fasciatus*. Univ. Kans. Publ. Mus. Nat. Hist., 8:1-156.

FITCH, H. S. 1955. Habits and adaptations of the Great Plains Skink *Eumeces obsoletus*. *Ecol.* Monogr., 25:59-83.

FITCH, H. S. 1956. An ecological study of the collared lizard (*Crotaphytus collaris*). Univ. Kans. Publ. Mus. Nat. Hist., 8:213-274.

FITCH, H. S. 1958. Natural history of the six-lined racerunner (*Cnemidophorus sexlineatus*). Univ. Kansas Publ. Mus. Nat. Hist., 11(2):11-62.

FITCH, H. S. 1970. Reproductive Cycles in Lizards and Snakes. Univ. Kansas Publ. Mus. Nat. Hist., 52:1-247.

JOHNSON, RAY CLIFFORD. 1965. The diet of the Pacific fence lizard, *Sceloporus occidentalis occidentalis* (Baird and Girard) from northern California. Herpetologica, 21(2):114-117.

LARSON, MERVIN W. 1961. The critical thermal maximum of the lizard *Sceloporus occidentalis occidentalis* Baird and Girard. Herpetologica 17(2): 113-122.

Leach, H. R. and W. H. Frazier. 1953. A study of the possible extent of predation of heavy concentrations of valley quail with special reference to the bobcat. Calif. Fish and Game 39(4): 527-538.

McGinnis, Samuel M., Jr. 1965. Thermal ecology of *Sceloporus occidentalis*. Unpublished PhD. Dissertation Univ. of Calif., Berkeley.

Noble, G. K. and H. T. Bradley. 1933. The mating behavior of lizards; its bearing on the theory of sexual selection. Ann. N. Y. Acad. Sci., 35:25-100.

Smith, Hobart M. 1939. The Mexican and Central American lizards of the genus *Sceloporus*. Field Museum of Natural History. Zool. Series, Vol. 26. 397 p.

Stebbins, Robert C. and R. M. Eakin. 1958. The role of the "third eye" in reptilian behavior. Am. Mus. Novit. No. 1870:1-40.

Swan, L. W. 1952. Some environmental conditions influencing life at high altitudes. Ecology, 33(1): 109-111.

Talbot, H. E. and R. L. Livezey. 1964. Integumental reflectivity of live *Sceloporus occidentalis occidentalis* from four habitats. Herpetologica 19(4):269-274.

Tanner, W. W. and Clive D. Jorgensen. 1963. Reptiles of the Nevada Test Site. Brigham Young University Sci. Bull., Biol. Series, 3(3):1-31.

Tanner, W. W. 1965. A comparative population study of small vertebrates in the uranium areas of the upper Colorado River Basin of Utah. Brigham Young University Sci. Bull., 7(1):1-31.

Tinkle, Donald W. 1967. The life and demography of the side-blotched lizard, *Uta stansburiana*. Misc. Publ. Mus. of Zool. Univ. of Mich., 132:1-177.

Turner, F. B., R. I. Jennrich, and J. D. Weintraub. 1969. Home ranges and body size of lizards. Ecology 50(6), pp. 1076-1081.

Turner, F. B., G. A. Hoddenbach, P. A. Medica, and Joseph R. Lannom. 1970. The Demography of the lizard, *Uta stansburiana* Baird and Girard, in southern Nevada. J. Anim. Ecol. 39, 505-519.

Wilhoft, D. C. 1958a. Observations of preferred body temperature and feeding habits of some selected tropical iguanas. Herpetologica 14(3): 161-164. 1958b. The effect of temperature on thyroid histology and survival in the lizard *Sceloporus occidentalis*. Copeia, 1958:265-276.

Wilhoft, D. C. and J. D. Anderson. 1960. Effect of acclimation on the preferred body temperature of the lizard, *Sceloporus occidentalis*. Science, 131: 610-611.

Wilhoft, D. C. and W. B. Quay. 1961. Testicular histology and seasonal changes in the lizard *Sceloporus occidentalis*. Journal of Morphology, 108 (1):95-106.

Woodbury, Marian and Angus M. Woodbury. 1945. Life-history studies of the sagebrush lizard *Sceloporus g. graciosus* with special reference to cycles in reproduction. Herpetologica 2(7):175-195.

Zweifel, Richard G. and Charles H. Lowe. 1966. The ecology of a population of *Xantusia vigilis*, the desert night lizard. Am. Mus. Novit. No. 2247:1-57.

NOTES ON THE LIFE HISTORY OF *UTA S. STANSBURIANA* BAIRD AND GIRARD

by

Wilmer W. Tanner[1]

In July of 1965, a study plot was established on Rainier Mesa for the purpose of examining the basic biology of the western fence lizard, *Sceloporus occidentalis* Baird and Girard. The area selected is in a loose stand of pinyon-juniper with *Artemisia* and *Quercus* interspersed (Fig. 1). A more complete list of animals is presented by Allred et al. (1963) and a list of plants by Allred et al. (1963) and Beatley (1965 and 1969).

Associated with *Sceloporus* in this pinyon-juniper community are two other species, *Eumeces s. utahensis and Uta s. stansburiana* The population density of these species is relatively low when contrasted with *Uta* in the lower valleys of southern Nevada and *Eumeces* in areas of California and Utah. In spite of the lower density and the fact that the major effort at this study plot was to investigate *Sceloporus*, some ecological data have been gathered which add to our understanding of *Uta*. Particularly, we have been able to add information concerning longevity and growth. Unfortunately little information was obtained for *Eumeces*.

The data were gathered by the following graduate student assistants: James M. Hopkin, Ronald L. Morris, Phillip Medica, and Dr. John E. Krogh. The work was performed under contract AT (11-1) 1496 between the U.S. Atomic Energy Commission, Division of Biology and Medicine, and Brigham Young University.

Data pertaining to *Uta* were gathered for the most part during the summer months of 1965-1967. During these years seventy-eight in-

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Fig. 1. A loose stand of Pinyon-Juniper with *Artemisia* and *Quercus* interspersed. Study plot Rainier Mesa. Photo by R. L. Colyer A.E.C. Photographer.

dividuals were marked. In 1968-1970, lizards were observed and data gathered, but none was marked. Forty of those marked were recaptured at least once and some were recaptured several times over a period of four years.

The numbers assigned to the digits are as follows: inner right front, no. 1; inner left front, no. 6; outer right hind, no. 11; outer left hind, no. 16 (Tanner, 1965). Ages are given to the nearest month. In some instances these dates may be off as much as a month because we cannot determine the exact date of hatching; however, these slight discrepancies do not alter the age significantly. Table 1 presents data which indicate size and longevity in this population.

In 1965 we marked only 23 *Uta*. This reflects our late start in marking lizards at this plot during the initial year (18 July 1965). However, of this group, seven were recaptured and attained at least 50 mm (av. 52.2) in snout to vent length and reached at least three years of age. We have few records of Uta less than 24 months old attaining a snout to vent length of 50 mm. The extremes of size range from 21 mm in small hatchlings to 56 mm in old adults. Based on marked lizards, three age groups can be recognized in April and May. The first year or last year's hatchlings are 35-40 mm, the second year, 20-22 months old, are usually 42-47 mm but with a few 48-50 mm, and the older adults, nearing three years, 50-55 mm. There may be more overlapping of size in some years than in others. Size in the spring reflects the growth permitted and attained by hatchlings during the late summer and fall months. By mid-June the larger juveniles may overlap the smaller individuals of the second age group, and the larger individuals now two years old are indistinguishable from the older lizards. During July, August, and September, only two age groups are easily recognized: hatchlings just emerging and adults. Some of the younger adults, one or two years old, are still only 45-49 mm in snout to vent length, and we suspect that few reach 50 mm until they are past two years of age, that is, by August or September of the second summer (Table 1).

Records for marked two-year-old *Uta* on Rainier Mesa indicate that they have a snout to vent length of 46-52 mm with those less than 50 mm being the exception rather than the rule. We suspect that some of the adults caught in August are of this age group. The following examples indicate that some individuals do reach 50 mm by the time they are 13 months old: No. 3, F, 28 July 49 mm; 25 August 52 mm; No. 4, M, 23 July 48 mm; 29 August 51 mm; No. 5, M, 30 July 45 mm; 15 August 47 mm. We believe, however, that the majority of lizards reaching 50 mm or more are in their second year, that is, they are 13 plus months of age. An apparently rapid growth by a few young individuals and a longer life span has made this population unique when compared with *Uta* populations in the lower valleys. Our records of age groupings seem to justify the categorizing of lizards which are 50 mm or more in s-v length as old adults, that is, two or more years old.

A more precise record of size and growth during September and October is needed. We suspect that all age groups grow during these fall months, albeit the older ones at a slower rate. We observe hatchlings from late August to early October to be 28-40 mm, and by early June of the next year they have grown to 40-44 mm. Six male hatchlings were marked in late July and early August and recaptured in late August or early September. Table 2 indicates the growth in these individuals.

Although there is variation in the rate of growth, the data for 1966 and 1967 do indicate a relatively similar rate for those which show growth. Where there is some growth, such individuals may represent those with a chance for survival. If we consider the natural vicissitudes under which most hatchlings emerge perhaps the problem of food getting is a major problem, at least in the low valleys where it is hot and dry. However, the fact that some may survive for 20 or more days (1-19, Table 2) without growth may also suggest that even within the first few weeks those that will not survive the first winter are indicated. Furthermore, many hatchlings do not survive more than a few weeks, making it difficult to mark more than part of the hatchlings before they die. The heavy mortality of hatchlings may be a function of feeding, cold weather, predation, a late hatching date, or a combination of these and other factors. In 1965 this plot was closed on 2 September. Although we were most careful in our observations for hatchlings, we did not see one; yet, in early June of 1966, we marked five *Uta* that were in the size range of hatchlings from the preceding summer. Even though a few were marked the next spring, they represented a small proportion of a normal hatch as we observed it in 1966 and 1967. In 1966 we marked 33 hatchling *Uta* on Rainier Mesa. Only seven (21.2 percent) were recaptured in 1967. However, nine juveniles were marked in June 1967; that is, their size (42-46 s-v) corresponded to those marked in 1966 and recaptured in 1967. A decrease in the number of surviving hatchlings does effect the percent of juveniles and old adults in a population. In June of 1966 we had

Table 1. Data for *Uta* recaptured in two or more years (1965-1968) at Rainier Mesa study plot.

Toe No.	Date marked	Snout to vent mm	Weight in grams	Times recaptured	Age in months	Sex	Maximum size	Weight in grams	Last date captured
4	28-7-65	46	4.0	3	35	M	51	3.50	24-6-67
6	5-8-65	50	3.0	8	48	F	52	3.98	10-8-68
7	5-8-65	44	3.0	1	36	F	50	5.10	6-8-67
10	7-8-65	54	5.0	2	37	F	54	3.94	23-8-66
12	9-8-65	47	2.0	12	36	M	52	4.24	12-8-67
13	11-8-65	44	3.0	3	48	F	51	3.69	1-8-68
16	15-8-65	50	4.0	1	35	M	52	4.40	6-6-67
1-13	23-7-66	50	3.0	2	35	F	51	4.41	3-6-67
2-5	11-8-66	30	.62	1	13	F	49	3.32	28-8-67
2-7	13-8-66	24	.32	1	11	M	45	2.96	3-6-67
2-14	25-8-66	31	.80	1	11	F	43	2.62	18-6-67
2-18	29-8-66	23	.45	3	23	F	49	4.35	3-6-68
3-9-10	4-9-66	26	.50	3	12	M	48	3.47	26-8-67
3-11	4-9-66	31	.60	3	11	F	46	2.80	10-7-67
3-19	5-6-67	50	2.70	3	36	M	51	4.17	4-8-68
4-5	5-6-67	42	2.20	5	36	M	52	5.11	8-7-69

Table 2. Observed growth in *Uta* hatchlings Rainier Mesa, 1966.

Toe No.	First capture	S-V length	Last capture	S-V length	Time in days	Growth in mm
1-11	17-7-66	23	4-9-66	32	49	9.0
1-14	27-7-66	24	4-9-66	34	38	10.0
1-16	9-8-66	26	23-8-66	29	14	3.0
1-18	9-9-66	26	29-8-66	29	20	3.0
1-19	9-8-66	29	29-8-66	29	20	0.0
2-6	13-8-66	29	29-8-66	32	16	3.0

in this population approximately 65 percent old adults, whereas in 1965 and 1967 our sample indicated only 38 and 36 percent, respectively.

We interpret these percentages to mean that this population has the ability to respond to a low reproduction by carrying over a larger percentage of the older adults. It is also noteworthy that the percentage of older lizards dropped considerably in 1967, as a result perhaps of greater competition from the increased number of juveniles and because of the imbalance of old individuals in the population.

During the months of September and October, weather conditions progressively limit lizard activity. By October, daily maximums have dropped into the 70 or 60 degree range and the nights are cold with average daily minimums for October ranging from 32-47 degrees for the years 1965-1970. For October 1965-1970 the average daily temperature ranged from 51-66°F. On 9-10 October 1970 maximums at 3:00 p.m. were 60° and 58°F. At these temperatures, only three *Uta* (two hatchlings and one adult) were seen during four hours of observation (2:00-4:00 p.m.).

Data on the rate of growth indicate that most hatchlings continue to grow as long as weather conditions permit them to be active. On Rainier Mesa during the fall months, only the approximate amount of daily activity can be determined. Each year is apparently different, and growth rates are reflected by such conditions as (1) a late spring in which full activity is not possible until mid or late April. An example of a late spring is 1969 in which a foot of snow covered the study plot on 5 April. On 8 April 1968, the temperature was 45°F at 12:30 p.m.; however, two lizards were seen. We have noted that there is as much as two weeks' difference in the time of egg-laying which is primarily because of a late or early spring. (2) Summers are at times cool on the mesa. In 1965 and 1969 cloudy days and rain kept temperatures down and delayed egg-laying and particularly hatching in 1965. Should either of these weather variations occur, hatchlings appear late in the summer and a reduced period for growth occurs before hibernation. We have not experienced a late spring followed by an early fall nor have we seen an early fall followed by a late spring. Here as in most desert areas, particularly in steppe deserts, there is considerable variation not only in amounts of rainfall but also in temperature fluctuations. (See figure depicting weather data in the preceding study of *Sceloporus*.)

The largest hatchlings measured in late September and up to mid-October ranged between 37-40 mm in s-v lengths. Therefore in favorable years when considerable activity occurs in September and October, utas may achieve a subadult size and thus be sexually mature at an earlier date the next spring.

Shortly after setting up the study plots at NTS we noted that larger adults and a larger percentage of large adults were present in the Rainier Mesa *Uta* population (Fig. 2). The fact that three populations separated by only 20 or 30 miles occur in different valleys and show a variation in the average size of individuals seemed to warrant additional study. We are aware that size variation in populations is not unique in utas (Tinkle, 1967; Pack and Tanner, 1970); however, these populations are in different types of desert habitat and at different elevations. At the outset, we can recognize that the valley populations (Mercury and Yucca) are more nearly the same average size than either is to the Rainier utas. Furthermore, the valley populations have a longer period for activity (April through November) than those on the mesa. According to Tanner and Jorgensen (1963), some activity was noted in Yucca Flat during the warmer days of all months. This is not the case on Rainier Mesa where there is little or no activity from late October to early April. However, little difference in growth of hatchlings is noted in the populations and, therefore, we suspect that other factors are more important than the length of the period of seasonal activity. Such factors as availability of food during most or all of the seasonal activity period, higher humidity, lack of competition (only two other species of lizards), and lack of predation may mean that the mesa population, when active, grows faster, and our data suggest that a larger percentage, when active, grows faster, and that a larger percentage of the population lives longer.

The edaphic factors seemingly contribute to a greater food supply. More rain in the summers produces a greater plant cover which in turn

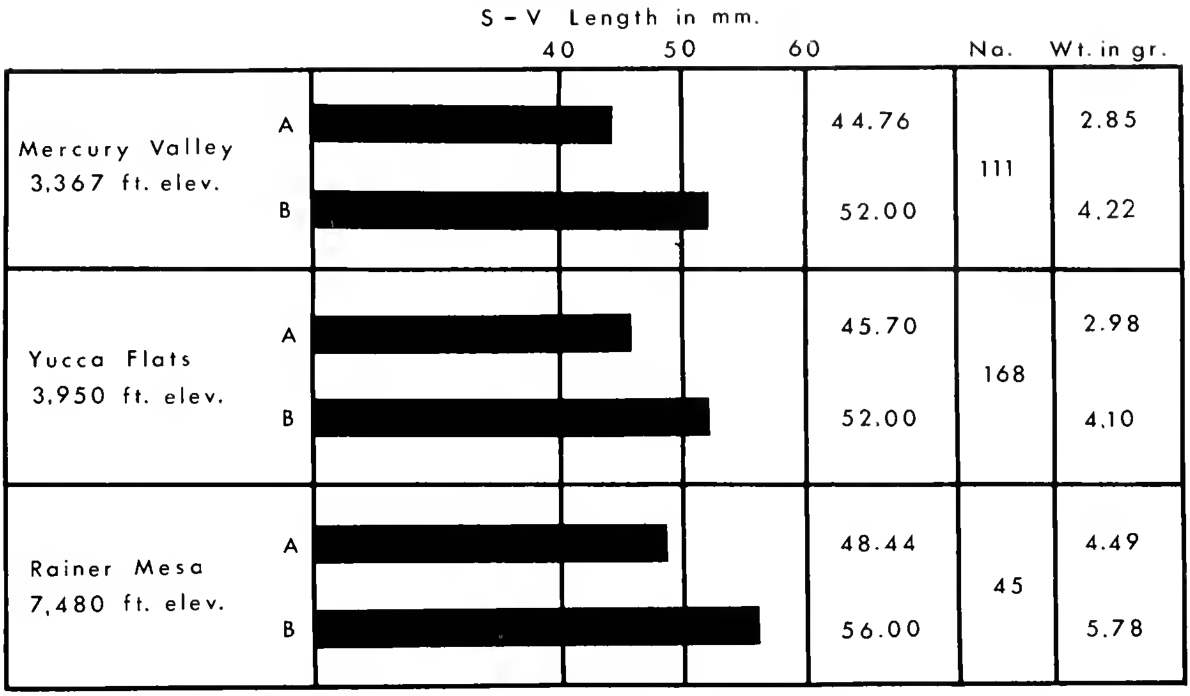

Fig. 2. A bar graph showing the average and maximum size of three populations of *Uta stansburiana* on the Nevada Test Site. Maximum size is based on adult males.

supports more insects. In early September of 1967, Dr. Vasco M. Tanner and I spent one week collecting insects in an attempt to supplement information published previously under contract AT (11-1) 786 (Allred and Beck, 1964; Tanner, 1965). Our efforts were centered in Frenchman's Flat and on Rainier Mesa. There was still enough residual moisture on the Mesa to keep the late summer shrubs and hebaceous plants green, and in the open areas between the pinyons some plants were still in bloom. In contrast the flats were dry with the plants in a state of dormancy. Under these conditions, we found far more insects, of all kinds and particularly small beetles and leaf hoppers, on the mesa. Considering the availability of food at this important season when the hatchlings are active, one is inclined to place great weight on the availability of food as a factor in growth rate and size.

There is also a higher average daily humidity on the mesa than at the low valley flats. We have reasoned that this may affect the lizards in such biotic communities by reducing the evaporation and thus permitting the habitat and its biota as well as the lizards to be active. In the low desert flats, the heat is intense with soil surface temperatures up to 140°F at midday; soil moisture is very low and relative humidity may fall to a level of less than 10 percent during the heat of the day. Physical conditions permit lizard activity on the mesa during all or most of the day, but often prevent full activity in the low valleys. From the first of June until at least mid-September, daytime maximum temperatures on the mesa range from 65 to 85°F. This permits lizards to be active throughout the day. In contrast, few lizards are active in Frenchman's or Yucca Flat from noon until 5:00 p.m. and often during July and August until much later.

We have therefore reasoned that the mesa utas are able to be active for nearly as many hours during four months as the low valley utas are in six months. Our reasoning is based on the fact that the valley utas are active during most of June, July, and August, only during the cooler morning and evening hours; whereas the mesa population is active from soon after sunup to sundown and with an abundance of food. If days of activity and not hours determine growth and thus size, then the valley utas should grow faster and perhaps become larger (in snout to vent length) than those on the mesa. This, however, is not the case. Hatchlings marked in August are about the same size in June in all three study plots. We are inclined to assume that the hours of full activity for mesa utas must be considered and not the number of days or months. Particularly during July and

August, mesa utas have more time (6-10 hours per day) than do utas in the low valley which have fewer hours of full activity per day during the summer months when residual heat keeps the surface soil hot during most of the sunlight hours.

The entire problem of growth and size is seemingly one of metabolism in which the amount of food available and the length of time at which individuals can be at or near full activity in getting food play an important role in the populations under consideration. We believe that the larger size of individuals in the population and the apparently more rapid and sustained growth of the mesa utas is the result of an abundance of food and a greater number of hours during the summer when full activity is possible.

In contrast, the utas in the low valleys are not active or have a greatly reduced activity during the hot middays of most of June, July, August, and part of September. Furthermore, the attendant heat reduces the available soil moisture and humidity which in turn affects the plants, slowing their growth and forcing them into dormancy. This reduces the available food, based on our sweeping samples. Such untoward conditions become intense in late August and September and are undoubtedly responsible for much of the late summer mortality in hatchlings, at least in the lower valleys. Table 3 shows the data for hatchlings marked in 1965 and 1966 at the Mercury study plot.

We saw no hatchlings in 1965 on Rainier Mesa. In Table 4 the data for hatchlings marked in 1966 are reported.

The data summarized in Tables 3 and 4 indicate a few discrepancies when compared with our discussion above. First, there appears to be a greater daily growth for hatchling utas at Mercury Valley than on Rainier Mesa. This inconsistency is understandable if we note that hatchlings appear approximately three weeks earlier there than on the mesa. Thus there is included in these data a longer period for growth. Our conclusion that there is a more rapid growth on the mesa is based in part, then, on the facts that the average size for hatchlings in these plots is about equal to the mesa hatchlings, in spite of the fact that they hatch later (first hatchlings 1966—Mercury Valley, 25 June; Rainier Mesa, 17 July) and have fewer days included in the data. The difference in average size for those recaptured the next spring or summer (0.024 mm) can be explained only on the basis that the Rainier Mesa population is rarely active from November 1 to April 1, whereas utas in the low valleys are at times active during each of these months and presumably continue to grow but at a reduced rate.

Table 3. Data for hatchlings marked in 1965 and 1966 on the Mercury Valley study plot.

	Number	Average size (mm)	Rate of growth (g)	Percent recaptured
Marked 1965				
(July 8-Sep. 6)	201	25.18		
			Day 0.196	
Recaptured 1965	38	28.19	Week 1.372	18.91
Recaptured 1966	26	44.59		12.93
Marked 1966				
(June 25-Aug. 31)	185	25.62		
			Day 0.202	
Recaptured 1966	37	28.32	Week 1.414	20.00
Recaptured 1967	17	43.0		9.19

Table 4. Data for hatchlings marked in 1966 on the Rainier Mesa study plot.

	Number	Average size (mm)	Rate of growth (g)	Percent recaptured
Marked 1966				
(July 17-Sep. 4)	33	25.51		
			Day 0.178	
Recaptured 1966	8	31.00	Week 1.250	24.24
Recaptured 1967	5	44.40		15.15

Our data were not gathered to determine precisely the size for one-year-old lizards; however, the information available does indicate that individuals of the three populations are approximately of equal size at one year in the longevity cycle. Rainier Mesa utas average larger after the first year.

The question of genetic differences in these populations has not been explored, nor have we extended our efforts into a study of meristic variables. However, there are obvious reasons, size for example, to recognize that these populations may be establishing some gene pool differences, unless we reason that all differences thus far noted are the result of more and perhaps more readily available food during a critical time in the life cycle.

In 1963 Tanner and Jorgensen, using the data obtained at the Yucca Flat study plot, estimated the density of utas to be 3.3 adults and 5.0 juveniles per acre in June (15-30). In 1967 we employed a fencing technique in which one-quarter-acre plots were fenced with hardware cloth. This was done just before dark after lizard activity had ceased. We set up three fenced plots (over a period of 10 days) and caught all lizards found inside the enclosure. The fenced areas were selected at random about 200 yards from the study plot. The fence was four feet high with the bottom buried in several inches of soil. Table 5 gives a summary of our results with reference to *Uta*. Data for other species will appear in our report on the Frenchman's Flat study plot. We tried the fencing technique in Mercury Valley in mid-July hoping to obtain exact data on hatching and hatchlings. This did not succeed because the mesh of the wire was too large to hold the small hatchlings. However, for adults of all species of lizards on NTS we believe that the small fenced plot will give rather reliable density information in a matter of a few days.

Table 5. *Uta* density in Frenchman's Flat as determined by three 1/4-acre fenced study plots (10-20 June 1967).

Species	Number	Adults	Juveniles	Est. no. per acre	Est. biomass
Uta stansburiana	8	8	0	10.40	23.09 g

Population density for *Uta* on Rainier Mesa has not been estimated for June as in Yucca (1962) and Frenchman's Flat (1967). However, on the basis of capture-recapture data for 1965, it is indicated to be approximately 4.5 lizards per acre (25 uta on 6.2 acres or a biomass of approximately 20.20 per acre). Data for 1966 and 1967 reflect a slight reduction. This we expected and explain on the basis of a low reproduction on the mesa for 1965. An average for four years based on capture-recapture data (1965, 1966, 1967, and 1968) sets the biomass per acre at 19.98 grams. The one discrepancy is that the 1968 survey is based on an August rather than on a June-early July weight. This may influence the weights to be slightly higher but should not be any more disruptive than the yearly variations.

Thus far we have made only limited comparisons between populations of utas on the test site. These, however, have indicated a difference in snout to vent size, an adjustment to high altitudes to permit a more rapid growth rate, variation in longevity, and a variation in population density. We may expect other ecological variations to occur and assume that a more detailed study of each study plot community will offer additional reasons for some of the differences thus far noted in the populations of utas.

We expect the data from our Mercury Valley plot to be similar to that being presented by Turner (1970) for the Rock Valley plot, since they are at approximately the same elevation and only three miles apart. A comparison of data gathered from the several populations of utas occurring in the low valleys of NTS and that presented for other populations should be made with a high altitude population such as that on Rainier Mesa (7,500 feet). The data now available on the ecology of the genus *Uta* should permit an analysis of the species *stansburiana*, at least of its three subspecies, *stansburiana*, *stjnegeri*, and *uniformis*.

DISCUSSION AND CONCLUSIONS

An extensive population study of utas at an altitude above 4,500 feet has not been done before. Therefore, all comparisons refer to uta populations in habitats with a different set of physical and perhaps biotic factors. A study by Stebbins (1944) and Stebbins and Robinson (1946) considered *Sceloporus graciosus gracilis* in the Chaos Jumbles habitat at 6,000 feet in Lassen National Park, California. Some of their conclusions are similar to those to be made for utas on Rainier Mesa, namely that:

1) Utas live longer at higher altitudes, and thus there is a different population structure than that reported for populations at lower elevations.

Rainier Mesa is somewhat unique since it is a high but rather narrow isolated uplift in an otherwise relatively dry desert. From Yucca Flat to the east, the mesa rises abruptly from about 5,000 to its summit at about 8,000 feet. We recognize that a more massive mountain or plateau area may not have a population of utas at 7,500 feet. In spite of these unusual physical conditions, we believe that this high altitude population does offer important clues to population structure and altitude distribution in *Uta*.

In previous studies, Tinkle (1967) found that in Texas adult utas 19 or more months of age made up only approximately 5-10 percent of the population (percentage will vary from year to year in all populations). Tinkle (1967) and Pack and Tanner (1970) found the percentage in the upper Colorado Basin of Colorado and Utah to be 20-25 percent, and Turner et al. (1970) indicated approximately 25 percent (1966-30.4%, 1967-17.4%, 1968-29.3%) for Rock Valley in southern Nevada. Tanner and Jorgensen (1965) indicate about 50 percent for old adults in Yucca Flat. In this study the percentages range from 36 to 65 percent. Fifty percent for Yucca Flat seems high. By noting the annual variations in the population studied, we must recognize that one cannot just drop in on a population for a year and expect to get a true picture of its population structure for more than that one year. The studies cited above show clearly that year to year variation in population structure occurs. The Yucca Flat population may, in a given year, have a large carry-over; however, it is not likely that several years would indicate an average of much above 30 percent. The Texas study areas were at 2,900 feet; those from Colorado, Utah, and southern Nevada (Rock Valley) are between 4,000 and 4,500 feet; Yucca Flat is at about 4,600 to 4,800 feet and Rainier Mesa study plot at 7,480 feet. It is of some interest to note that as the elevation increases so also does the percentage of older adults in the population. On the basis of the studies thus far reported, it would appear that in *Uta* altitude has a very significant effect on the life span and that it affects the population structure to such an extent that in some (Texas) the older adults are so limited in numbers as to contribute little to the annual reproduction of the population (Tinkle, 1967). However, in the other population studies done at moderate to high elevations, the 20-25 and 36-65 percentages of older adults do contribute to the annual reproduction and are an important factor in the population structure.

It is not clear to us just why altitude may effect longevity. It has been suggested that the following may be factors which influence it:

a) A possible reduction in the yearly activity period.

b) A shorter period of intense heat during the activity season or perhaps a longer period of optimum temperatures.

c) Less competition from other utas (less dense population) and from other species.

d) An inherent genetical difference which has resulted from adaptation to the varied habitats.

These factors and others with various combinations may aid in answering the question; however, it would seem pertinent also to investigate a population on the northern edge of the species distribution to ascertain if there is a longitudinal as well as an altitudinal increase in longevity.

2) Utas attain a larger size than those occurring in the populations of the adjacent lower valleys.

This generalization may not be true in all sections of the wide distribution of the genus *Uta*. We note that the *Uta* of western Colorado and southeastern Utah are noticeably smaller than those from western Texas, in spite of the increase in altitude. It has been suggested that size is dependent on the availability of food. This may be a factor; however, it is our belief that variation in size is associated with local groups and may be related to populations within subspecific groups.

A speculation based on the above observations suggests that the average size of adults in a population such as on Rainier Mesa may be used to determine the approximate percentage of adults in the population. Variations in the yearly cycle should be considered and the survey made at a given time such as during the first week of egg-laying or a week after the first oviducal eggs appear. If such percentages can be derived a biomass can seemingly be readily determined.

3) With a larger average size for adults in the Rainier Mesa population there are more eggs per clutch. Turner et al. (1970) also found this to be generally true in Rock Valley, and it apparently is a fact to be considered in the estimation of lizard fecundity. Our data do not provide information on the numbers of clutches laid, however, we do find the increase in the number of eggs per clutch to appear significant. Twelve clutches laid by females taken at the Mercury Valley plot produced clutches ranging from 2(3.31)4 eggs per clutch (females ranged from 42-47 mm s-v), whereas five clutches from Rainier Mesa ranged from 4(4.85)6 eggs per clutch (females range from 48-51 mm, s-v). Turner (*loc. cit.*) shows only averages (Table 7), all of which are less than four eggs per clutch.

It would appear that in our eagerness to understand the basic ecology of this species we have not taken into account sufficiently the fact that ecological variations in habitat introduce new parameters into the basic ecology of populations. Therefore, we should not expect utas belonging to different subspecies and located in vastly different habitats such as eastern Utah, southern Nevada, or western Texas, to behave the same ecologically anymore than we should expect them to exhibit the same morphological characteristics. An analysis of data thus far presented by many authors (Jorgensen and Tanner, 1963; Tanner, 1965; McKinney, 1971; Tinkle, 1961; Tinkle, McGregor, and Dana, 1962; and Turner, 1970) and the data available for this study suggest very strongly that it is not desirable to consider in detail the demography of *Uta stansburiana* unless one subdivides this species into its various subspecies. Behavorial, ecological, and morphological characters appear to have produced basic variations in the biology of subspecies, some of which provide for variations even within the populations of a subspecies. Perhaps, therefore, if in future studies subspecies variations are recognized, such factors as size and longevity would be considered as variables based on adaptation to habitat factors. If subspecies and or populations are to be considered as incipient species we would expect variations to occur.

LITERATURE CITED

Allred, D. M., D E. Beck, and C. D. Jorgensen. 1963. Biotic Communities of the Nevada Test Site. Brigham Young Univ. Sci. Bull., Biol. Ser., 2(2):1-52.

Allred, D. M., and D E. Beck. 1964. Arthropod associates of plants at the Nevada Test Site. Brigham Young Univ. Sci. Bull., Biol. Ser., 5(2):1-16.

Beatley, J. C. 1969. Vascular plants of the Nevada Test Site, Nellis Air Force Range, and Ash Meadows. UCLA 12-705. Lab. Nuclear Medicine and Radiation Biology, Univ. Calif., Los Angeles. 122 p.

———. 1971. Ecologic and Geographic distributions of the vascular plants of southern Nye County, and adjacent parts of Clark, Lincoln, and Esmeralda Counties, Nevada. (Supplement to UCLA 12-705.) Lab. Nuclear Medicine and Radiation Biology, Univ. Calif., Los Angeles. 49 p.

Jorgensen, C. D., and W. W. Tanner. 1963. The application of density probability function to determine the home range of *Uta stansburiana stansburiana* and *Cnemidophorus tigris tigris*. Herpetogica 19(2):105-15.

McKinney, C. O. 1971. Individual and intrapopulational variations in the push-up display of *Uta stansburiana*. Copeia 1971(1):159-60.

Pack, L. C., Jr. and W. W. Tanner. 1970. A taxonomic comparison of *Uta stansburiana* of the Great Basin and the Upper Colorado River Basin in Utah with a description of a new subspecies. Great Basin Nat. 30(2):71-90

Tanner, W. W., and C. D. Jorgensen. 1963. Reptiles of the Nevada Test Site. Brigham Young Univ. Sci. Bull., Biol. Ser., 3(3):1-31.

Tanner, W. W. 1965. A comparative population study of small vertebrates in the Uranium areas of the Upper Colorado River Basin of Utah. Brigham Young Univ. Sci. Bull., Biol. Ser., 7(1):1-31.

Tinkle, D. W. 1961. Population structure and reproduction in the lizard *Uta stansburiana stejnegeri*. American Midland Nat., 66(1):206-234.

———. 1967. The life and demography of the side-blotched lizard, *Uta stansburiana*. Mus. Zool., Univ. Mich., Misc. Publ. 132:1-182.

Tinkle, D. W., Don McGregor, and Sumner Dana. 1962. Home range ecology of *Uta stansburiana stejnegeri*. Ecology, 43(2):223-29.

Turner, F. B., G. A. Hoddenbach, P. A. Medica, and J. R. Lannoin, Jr. 1970. The demography of the lizard, *Uta stansburiana* Baird and Girard, in Southern Nevada. J. Anim. Eco. 39, 505-519, June 1970