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THE MITES OF THE SUBFAMILY HAEMOGAMASINAE (ACARI: LAELAPTIDAE)

By Hugh L. Keegan [1]

This paper comprises a general review of the distribution, classification, and external morphology of the parasitic mites of the subfamily Haemogamasinae Oudemans, 1926. It is based largely on material in the United States National Museum, although numerous specimens from other sources were also examined. In the descriptions that follow, all specimens examined are in the National Museum unless otherwise indicated.

None of the Haemogamasinae has been reported as a vector of disease, although several species of related subfamilies of Laelaptidae serve as vectors of virus and rickettsial disease agents, as well as of nematode and protozoan parasites of mammals, birds, and reptiles. Many laelaptid mites, normally parasites of rodents and birds, have been reported to attack man, causing dermatitis. Hill and Gordon (1945) reported that *Euhaemogamasus oudemansi*, along with several other species of mites, may have been responsible for an outbreak of

[1] I am under obligation to many persons who contributed specimens, supplied collecting data, and extended other courtesies that were of great value in preparing this paper. Officials of the United States National Museum furnished facilities for study during the spring of 1946 and in addition lent me its entire collection of Haemogamasinae for nearly 2 years. I am especially indebted to Dr. L. O. Nolf, State University of Iowa, under whose direction this study was made; Dr. E. W. Baker, U. S. Bureau of Entomology and Plant Quarantine, who gave valuable advice, supplied numerous specimens, and obtained photostat copies of several otherwise inaccessible references; Dr. H. E. Ewing, Washington, D. C.; E. W. Jameson, Jr., University of California, Davis, Calif.; Dr. C. L. Remington, Harvard University Biological Laboratories, Cambridge, Mass.; Dr. R. W. Strandtmann, Jr., University of Texas Medical Branch, Galveston, Tex.; Dr. J. M. Linsdale, Museum of Vertebrate Zoology, University of California; H. B. Morlan, U. S. Public Health Service, Thomasville, Ga.; Dr. F. A. Turk, Camborne, England; Dr. C. D. Radford, British Museum, London; and Dr. Arve H. Dahl, State of California Department of Health.

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60 cases of dermatitis that occurred among American troops serving in North Wales during the war. The mites, in this instance, were present in straw-filled mattresses upon which the men were sleeping.

TAXONOMIC POSITION

Mites of the subfamily Haemogamasinae[2] are parasites on small mammals, occasionally free living or on birds. Dorsal shield undivided in both sexes and in larval and nymphal stages. Anterior margin of epistome with simple or branching fimbriae. Body setae more numerous than in other laelaptid mites. Legs with spurs only in genus *Ischyropoda.* Sternal shield with accessory setae in genera *Haemogamasus* and *Ischyropoda.* Genitoventral shield of nymphal stages with accessory setae only in genus *Ischyropoda.* Accessory anal setae present in almost all specimens of most species. Anal shield separate in males of genus *Ischyropoda.* Metapodal shields small. Three genera. Distribution cosmopolitan.

The Haemogamasinae were given status as a subfamily not upon basis of adult characteristics alone, but primarily because larval and nymphal stages, as well as adults, possess only a single dorsal shield. In most other genera of Laelaptidae the dorsal shields develop in such a way that, whether single or divided in the adult, the protonymph possesses an anterior pronotal shield and a posterior pygydial shield, between which are smaller, intermediate shields, which differ in number in various genera. The phylogenetic importance of the nature of the dorsal shield was advanced by Trägårdh (1911), who regarded possession of two shields as a primitive feature, retained in more recent genera only in the nymphal stages. Oudemans erected the family Haemogamasidae in 1926, and although Vitzthum first (1931) agreed with this interpretation he later (1942) reduced the group to status of one of the 13 subfamilies included by him in the Laelaptidae *sensu lato.*

Prior to this study the following genera and species of Haemogamasinae were recognized:

Genus HAEMOGAMASUS Berlese, 1889

1889. *H. hirsutus* Berlese
1892. *H. horridus* Michael
1892. *H. nidi* Michael
1905. *H. americanus* Banks
1914. *H. oudemansi* Hirst
1915. *H. sanguineus* Ewing and Stover
1916. *H. liberiensis* Hirst
1920. *H. arvicolarum* (Berlese)
1925. *H. alaskensis* Ewing
1925. *H. barberi* Ewing
1925. *H. microti* Ewing
1925. *H. twitchelli* Ewing
1926. *H. quadrisetatus* Vitzthum
1931. *H. avisugus* Vitzthum
1931. *H. mandschuricus* Vitzthum
1933. *H. sternalis* Ewing

[2] Order Acari Leach, 1817; suborder Parasitiformes Reuter, 1909; supercohort Mesostigmata Canestrini, 1891; cohort Gamasidea Leach, 1815; subcohort Gamasina Kramer, 1885; family Laelaptidae Berlese, 1892.

Genus ACANTHOCHELA Ewing, 1933

1933. *A. chilensis* Ewing

Genus EUHAEMOGAMASUS Ewing, 1933

1925. *E. reidi* (Ewing)
1925. *E. liponyssoides* (Ewing)
1933. *E. onychomydis* Ewing
1933. *E. oregonensis* Ewing
1933. *E. utahensis* Ewing
1946. *E. sciuropteri* Keegan

Genera and species of Haemogamasinae herein recognized as valid are as follows:

Genus HAEMOGAMASUS Berlese, 1889

1889. *H. hirsutus* Berlese
1916. *H. liberiensis* Hirst
1925. *H. alaskensis* Ewing
1931. *H. avisugus* Vitzthum
1931. *H. mandschuricus* Vitzthum
1951. *H. harperi*, new species

Genus EUHAEMOGAMASUS Ewing, 1933

1872. *E. ambulans* (Thorell)
1892. *E. horridus* (Michael)
1914. *E. oudemansi* (Hirst)
1925. *E. liponyssoides* (Ewing)
1925. *E. barberi* (Ewing)
1926. *E. quadrisetatus* (Vitzthum)
1951. *E. liponyssoides occidentalis*, new subspecies

ISCHYROPODA, new genus

1951. *I. spiniger*, new species
1951. *I. armatus*, new species

The foregoing lists reflect changes in status of several species, deletion of one genus from the subfamily, and addition of four new species and one new genus.

1. Oudemans (1913) and Vitzthum (1931) doubted that *H. americanus* Banks, 1905, and *H. sanguineus* Ewing and Stover, 1915, were actually members of genus *Haemogamasus*. Examination of type material supported their views, as the type of *H. americanus* proved to be a specimen of *Liponissus* and that of *H. sanguineus* to be an undetermined member of the same genus.

2. *E. utahensis* Ewing, 1933, lacks the fimbriate epistome of the Haemogamasinae and, because of its distinctly abbreviated sternal shield, will be redescribed elsewhere as representing a new genus of Laelaptidae.

3. Several instances of synonymy are corrected: (a) *H. horridus arvicolarum* Berlese, 1920, redescribed as *H. arvicolarum* (Berlese) by Turk (1945), is considered a synonym of *E. horridus* (Michael, 1892); (b) *H. sternalis* Ewing, 1933, is considered a synonym of *H. alaskensis* Ewing, 1925; (c) *H. microti* Ewing, 1925, is considered a synonym of E. *barberi* (Ewing, 1925); and (d) *H. nidi* Michael, 1892, *H. twitchelli* Ewing, 1925, *E. reidi* (Ewing, 1925), *E. onychomydis* Ewing, 1933, *E. oregonensis* Ewing, 1933, and *E. sciuropteri* Keegan, 1946, are considered synonyms of *E. ambulans* (Thorell, 1872), which is here transferred from *Eulaelaps* Berlese, 1903, to the genus *Euhaemogamasus*.

4. The genus *Haemogamasus* is distinguished from *Euhaemogamasus* only in that its species possess accessory sternal setae. As each of the following possess only the usual sternal setae, they are here transferred to genus *Euhaemogamasus: H. horridus* Michael, 1892; *H. oudemansi* Hirst, 1914; *H. quadrisetatus* Vitzthum, 1926; and *H. barberi* Ewing, 1925.

5. *H. harperi* and *E. liponyssoides occidentalis* are described as new.

6. The new genus *Ischyropoda* is proposed, and *I. spiniger* and *I. armatus* are described as new species.

7. Original descriptions are given of the male and nymph of *H. alaskensis* and *E. barberi* as well as the nymph of *E. liponyssoides*. The male of the latter species has never before been figured.

8. In my opinion there is not sufficient evidence to indicate that *Acanthochela chilensis* Ewing, 1933, should be placed in the Haemogamasinae. This species was described from four female specimens taken from an opossum at Lota, Chile, in 1929, and it has not been collected since. Condition of the specimens on the type slide is such that it is impossible to determine the structure of the epistome or chelicerae. Because of this, and as there are no males, nymphs, or larvae available for study, it is proposed that the genus and species be transferred to the subfamily Laelaptinae Trägårdh, 1908, where setation of the sternal shield alone would serve as a distinguishing characteristic.

MORPHOLOGY

Each species description in their paper is based upon a study of several aspects of morphology common, in general, to all members of the subfamily.

1. *Dorsal shield.*—Nearly covers dorsal surface in most species; setae, present over entire surface of shield, are usually larger in apical region, where a pair of conspicuously large *apical setae* is present on the anterior margin of the shield; setae may vary in size and number and may be smooth or barbed; several pairs of *dorsal pores* may be present near the margins of the shields; fine reticulations on the shield produce the effect known as *sculpturing*.

2. *Dorsal body setae.*—Those setae lateral and posterior to the dorsal shield; frequently larger and more often barbed than setae of shield; usually largest at posterior body margin, where two or three pairs may be conspicuously long.

3. *Tritosternum.*—Shows little variation; lacinae may be smooth or barbed.

4. *Presternal area.*—Sculptured, with transverse sutures, which in some species possess tiny, posteriorly directed spines.

5. *Sternal shield.*—Usually distinctively sculptured; with at least three pairs of *usual sternal setae* in all genera; species of *Haemogamasus* and *Ischyropoda* possess *accessory sternal setae*, which are nearly always smaller than the usual setae, and vary in size, number, and position on shield; both usual and accessory setae may be barbed; two pairs of *sternal pores* in all species; a third pair may border the posterior margin of the shield in some instances; size and position of pores vary specifically; shape of shield varies considerably; its posterior margin in particular may be nearly straight or invaginated in varying degrees.

6. *Genitoventral shield.*—Usually bulb-shaped, with a rounded posterior margin, but varies in size and shape, and in a few species possesses nearly parallel lateral margins; with a pair of *usual genitoventral setae* and varying numbers of *accessory setae*, which are often distinctly smaller and vary in size and position on the shield; both usual and accessory setae may be smooth or barbed; sculpturing not as distinct as on sternal shield.

7. *Anal shield.*—Roughly triangular in outline, with a rounded anterior margin, but subject to specific variation; its lateral margins may be parallel; three *usual anal setae* always present and always the most posterior setae on shields; *accessory anal setae* vary in number specifically and individually; they also vary in size and position on shield; anal setae may be smooth or barbed.

8. *Endopodal shields.*—Slender; show little variation.

9. *Metapodal shields.*—Small; show little variation.

10. *Ventral body setae.*—Present over ventral surface of body exclusive of shields and coxae; vary in size and number and may be smooth or barbed; usually longest at posterior body margin; there is a pair of *metasternal setae* about equal in size with posterior usual sternal setae.

11. *Peritreme.*—Shape of peritremal shield, particularly its posterior end, which encloses the *spiracle* or *stigma*, varies specifically; location of *pores*, posterior to stigma, also varies specifically.

12. *Epistome.*—Anterior margin of epistome fimbriated; varies in outline specifically; *fimbriae* may be simple or branched and vary in number.

13. *Chelicerae.—Chelae* may possess or lack teeth, and they vary specifically; *fixed chela* may possess a distal and a proximal seta, as well as a proximal brush or fringe of small setae; the distal seta, when stout, is termed an *inflated seta*; when small and slender it is termed a *pilus dentilis*; the pili are usually present on species whose chelae lack teeth.

14. *Maxillary corniculi.*—Vary specifically in outline; that feature and the position and relative size of the four pairs of *maxillary setae*

are the most easily studied aspects of the ventral surface of the gnathosoma (Fig. 41.)

15. *Palpi.*—Each composed of six segments: *coxa*, *trochanter*, *femur*, *genu*, *tibia*, and *tarsus;* pattern of setation appears to be nearly

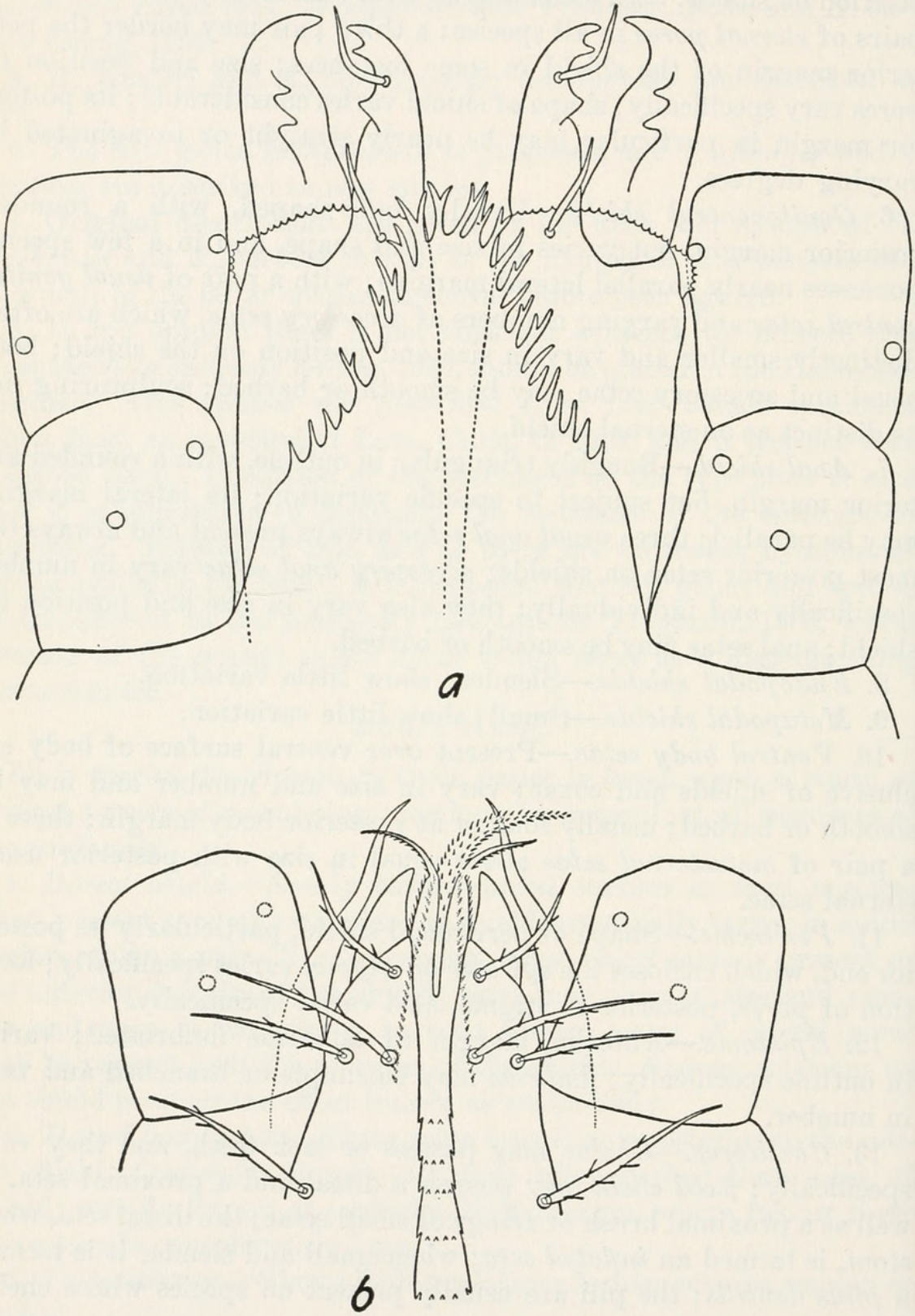

FIGURE 41.—Taxonomically important mouth parts of the Haemogamasinae: *a*, Dorsal view of the gnathosoma of a female of *Euhaemogamasus ambulans* (Thorell) showing epistome and chelicerae; *b*, ventral view of the gnathosoma of a female of *E. ambulans* showing maxillary corniculi and setae.

identical in all species of Haemogamasinae; the large, bifurcate, tarsal seta is a characteristic of the Laelaptidae; all species possess a conspicuously stout seta on ventral surface of coxa; setae may be smooth or barbed and are usually stouter on ventral surface of palp.

16. *Legs.*—Possess six segments as in palpi; vary specifically in nature of setation and to some extent in relative thickness; setae may be smooth or barbed and are usually shorter and thicker on the ventral surface of each leg; length-width ratio of tarsus varies specifically; distal margins of segments with spines in some species; spurs present on legs of species of *Ischyropoda.*

17. *Male.*—Sexual dimorphism apparent in several respects; usually smaller than female and with a relatively larger dorsal shield. In *Haemogamasus* and *Euhaemogamasus* a single *ventral shield* includes regions covered by sternal, genitoventral, anal, endopodal, and metapodal shields of female; in *Ischropoda* the anal shield is separate, as are the endopodal and metapodal shields. Setation and position of pores on ventral shield correspond fairly closely with those of the female of each species; shape of shield varies specifically. Epistome usually as in female, but in some species may differ slightly. Chelae modified in most species; dimorphism especially apparent in movable chela, which, according to Michael (1892), serves to transport the spermatophore from the genital aperture of the male to that of the female. Maxillary corniculi frequently blunt rather than pointed as in the female. Legs may be relatively stouter than in the female and may bear conspicuously stout ventral setae or spurs, especially on leg II; Michael (1892) reported that these enabled the male to clutch the female more firmly during copulation. In spite of sexual dimorphism, the males of each species may be readily determined by characteristics common to both sexes.

18. *Larval and nymphal stages.*—Dorsal shield undivided, but with a slitlike invagination on either lateral margin at the level of coxae IV in several species. Ventral body surface with an anal shield and a ventral shield extending from coxae I to coxae IV; in most species this shield possesses four pairs of setae, which represent the three pairs of usual sternal setae and the single pair of metasternal setae of the adult. The usual genitoventral setae flank the narrow, bluntly pointed, posterior end of the shield in most species; accessory setae are present on the ventral shield only in genus *Ischyropoda;* anal shield as in female but usually with fewer accessory setae. Peritremal shield not fully developed. Epistome, chelae, and maxillae are very much as in adult female and offer most easily studied means of identification. Palpi and legs often relatively stouter than in adults. Setae as in adults but may be relatively smaller and less numerous.

Genus HAEMOGAMASUS Berlese

Haemogamasus BERLESE, Acari, Myriopoda et Scorpiones hucusque in Italia reperta: Mesostigmata, fasc. 52, Nos. 2 and 10, 1889.—EWING, Proc. Biol. Soc. Washington, Vol. 38, p. 137, 1925; Proc. U. S. Nat. Mus., vol. 82, art. 30, p. 2, 1933.—VITZTHUM, Treubia, vol. 8, p. 53, 1926; Zool. Jahrb. (Abt. Syst.), vol. 60, pp. 393–405, 1931. (Genotype: *Haemogamasus hirsutus* Berlese, 1889.)

Sternal shield with accessory setae; legs without spurs; male without a separate anal shield; ventral shield of nymph without accessory setae.

KEY TO FEMALES OF GENUS HAEMOGAMASUS

1. All setae smooth; chelae toothless 2
   With some barbed setae, chelae with teeth 3
2. At least 2 pairs of accessory setae on anterior margin of sternal shield; anterior pair of sternal pores on level of anterior pair of usual sternal setae ..... hirsutus Berlese (p. 210)
   No accessory setae on anterior margin of sternal shield; anterior pair of sternal pores distinctly posterior to anterior pair of usual sternal setae ..... harperi, new species (p. 223)
3. Movable chela with 1 tooth; usual sternal setae no larger than accessory setae ..... avisugus Vitzthum (p. 222)
   Movable chela with 2 teeth; usual sternal setae distinctly larger than accessory setae 4
4. No accessory setae on anterior fourth of sternal shield. ..... mandschuricus Vitzhum (p. 218)
   At least 1 pair of accessory setae on anterior margin of sternal shield 5
5. All usual sternal setae barbed; 2 pairs of accessory setae on anterior margin of sternal shield ..... liberiensis Hirst (p. 221)
   Only anterior pair of usual sternal setae barbed; 1 pair of accessory setae on anterior margin of sternal shield ..... alaskensis Ewing (p. 213)

HAEMOGAMASUS HIRSUTUS Berlese

FIGURE 42

Haemogamasus hirsutus BERLESE, Acari, Myriopoda et Scorpiones hucusque in Italia reperta: Mesostigmata, fasc. 52, No. 2, pp. 117–118, table 125, 1889.—OUDEMANS, Arch. Naturg., vol. 79, Abt. A, Heft 8, pp. 138–146, figs. 82–97, table 2; figs. 1–10, table 8; figs. 6–11, 1913.—HIRST, Journ. Zool. Res., vol. 1, p. 59, 1916.—EWING, Proc. Biol. Soc. Washington, vol. 38, p. 138, 1925.—VITZTHUM, Zool. Jahrb., vol. 60, p. 396, 1931.

Female.—Dorsal shield decidedly pointed posteriorly in available specimens. In addition to the two usual apical setae at least five smaller setae on apical margin. Shield densely covered with setae, which are 9μ to 15μ apart; large and small setae interspersed on shield; smaller setae more numerous and about 45μ in length; larger setae about 90μ in length; all setae smooth. Shield surface granulated in appearance but not sculptured. Setae of unprotected integument of dorsal surface larger than those on shield, longest at posterior body margin, all smooth. Lacinae of tritosternum faintly barbed. Presternal area sculptured but with only faint indications of spines.

Sternal shield with usual sternal setae and about 30 accessory setae (24 to 32 in the five specimens examined). Accessory setae variable in size and larger near the anterior and posterior margins of the shield. Two pairs of accessory setae on anterior margin of shield

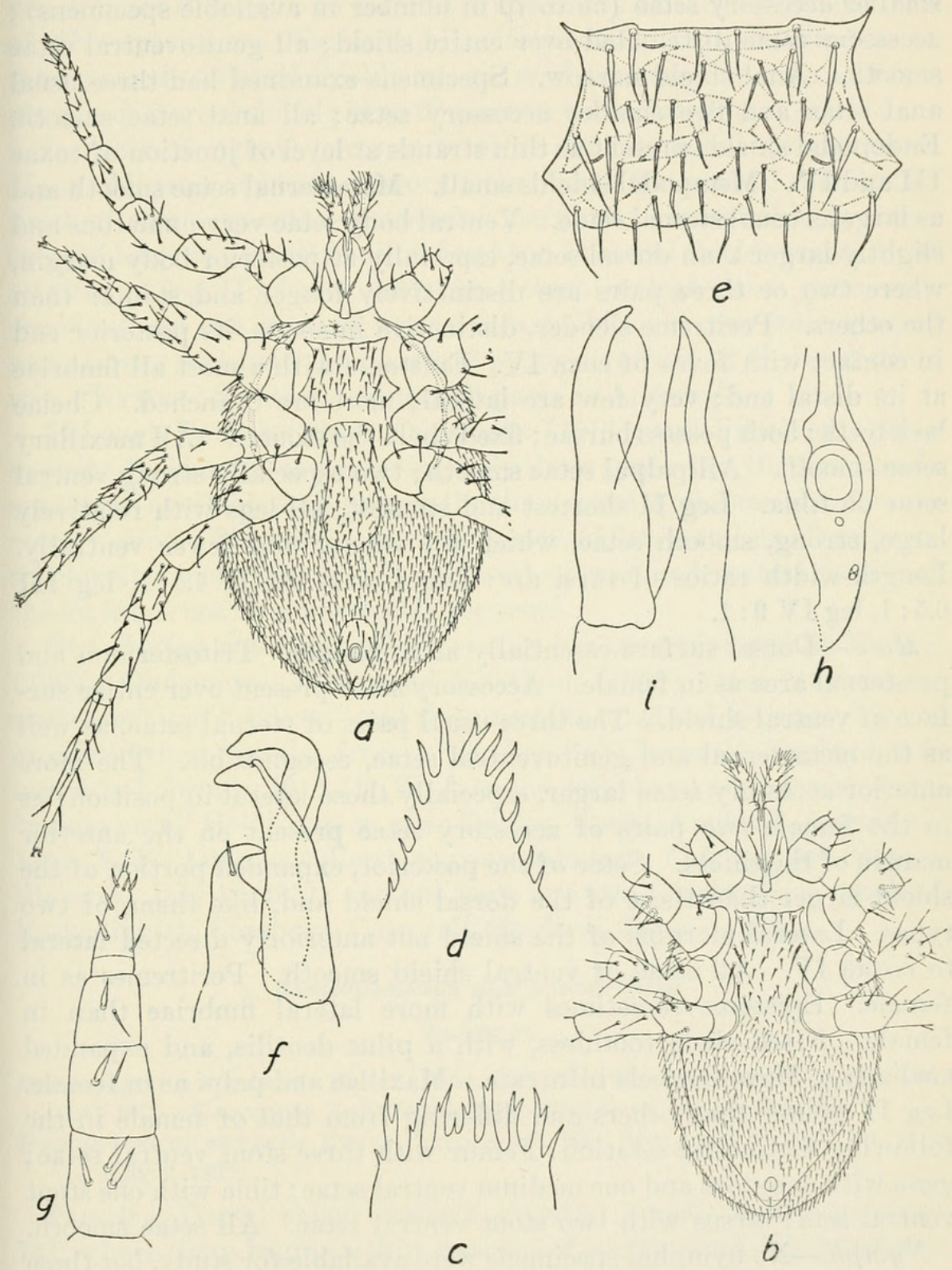

FIGURE 42.—*Haemogamasus hirsutus* Berlese: *a*, Ventral view of female; *b*, ventral view of male; *c*, epistome of female; *d*, epistome of male; *e*, sternal shield of female; *f*, chelicera of male; *g*, ventral view of leg II of male; *h*, posterior end of peritreme of female; *i*, chelicera of female.

near its midpoint. All setae on shield smooth. Anterior pair of sternal pores parallel with anterior margin of shield and at level of anterior pair of usual sternal setae. Genitoventral shield only slightly expanded posteriorly, with usual genitoventral setae and numerous smaller accessory setae (55 to 70 in number in available specimens); accessory setae distributed over entire shield; all genitoventral setae smooth. Anal shield narrow. Specimens examined had three usual anal setae and five smaller accessory setae; all anal setae smooth. Endopodal shields present as thin strands at level of junction of coxae III and IV. Metapodal shields small. Metasternal setae smooth and as large as usual sternal setae. Ventral body setae very numerous and slightly larger than dorsal setae, especially at posterior body margin, where two or three pairs are distinctively longer and stouter than the others. Peritreme slender, distinctive in shape, its posterior end in contact with fovea of coxa IV. Epistome with almost all fimbriae at its distal end; very few are lateral; most are branched. Chelae lack teeth; both possess bursae; fixed chela the stouter. All maxillary setae smooth. All palpal setae smooth; two especially strong ventral setae on tibia. Leg II shortest and stoutest; all legs with relatively large, strong, smooth setae, which are stouter and fewer ventrally. Length-width ratios of tarsi are: Leg I 5:1, leg II 4.5:1, leg III 6.5:1, leg IV 9:1.

Male.—Dorsal surface essentially as in female. Tritosternum and presternal area as in female. Accessory setae present over entire surface of ventral shield. The three usual pairs of sternal setae, as well as the metasternal and genitoventral setae, recognizable. The more anterior accessory setae larger, especially those lateral in position; as in the female two pairs of accessory setae present on the anterior margin of the shield. Setae of the posterior, expanded portion of the shield larger than those of the dorsal shield and, like them, of two types. Lateral margins of the shield not anteriorly directed lateral to coxae IV. All setae of ventral shield smooth. Peritremes as in female. Epistome sometimes with more lateral fimbriae than in female. Fixed chela toothless, with a pilus dentilis, and expanded medially. Movable chela bifurcate. Maxillae and palpi as in female. Leg II stouter than others and differing from that of female in the following distinctive setation: Femur with three stout ventral setae; genu with one stout and one medium ventral setae; tibia with one stout ventral seta; tarsus with two stout ventral setae. All setae smooth.

Nymph.—No nymphal specimens were available for study, but these according to Oudemans (1913), may be distinguished as those of *hirsutus* by similarity of epistome, chelicerae, and setation from those of the adult female. As in the adults, setae are reported to be smooth.

Size.—Four measurable females were 1,162μ, 1,232μ, 1,050μ, and

952μ in length. The single measurable male was 1,078μ in length. Vitzthum (1931) gives the length of the male as 1,150μ and reports that the length of the female varies from 1,100μ to 1,380μ.

Remarks.—Distinctive characteristics of *Haemogamasus hirsutus*, which make it possible to determine specimens of each sex from those of other species, are: FEMALE: All setae smooth; large and small setae interspersed on dorsal shield; two pairs of accessory setae on anterior margin of sternal shield; 24 to 32 accessory setae on sternal shield; anterior pair of sternal pores at level of anterior usual sternal setae. MALE: All setae smoth; accessory setae over entire ventral shield; two pairs of accessory setae on anterior margin of ventral shield; interspersed large and small setae on dorsal and ventral shields; specialized setation of leg II; femur with three stout ventral setae; genu with one stout and one medium ventral setae; tibia with one stout ventral seta; tarsus with two stout ventral setae; structure of chelae distinctive. NYMPH: Setation and mouth parts as in female.

Although Berlese (1889), Oudemans (1913), and Vitzthum (1931) describe H. *hirsutus* as possessing only three anal setae, the five female specimens available each possess the three usual anal setae plus five accessory setae. The condition of interspersed large and small setae on the dorsal shield of the female and on the dorsal and ventral shields of the male has not been previously reported.

Distribution and hosts.—This species has been reported by Berlese (1889), Oudemans (1913), and Vitzthum (1931) from "various insectivores" and "rodents" and their nests throughout Europe. I have examined three females from a "dead mole," Cornwall, England, collected in February 1943 (E. W. Jameson collection); one female from "mouse nest," Hell Coppice, near Oakley, Bucks, England, August 17, 1941 (E. W. Jameson collection); one male from *Talpa alpina*, Ratece, Slovenia, July 12, 1931; and one male and two females from "moles," Reskadinnick, Camborn, Cornwall, England, June 9, 1946.

HAEMOGAMASUS ALASKENSIS Ewing

FIGURE 43

Haemogamasus alaskensis EWING, Proc. Biol. Soc. Washington, vol. 38, pp. 138–139, 1925.—VITZTHUM, Zool. Jahrb. (Abt. Syst.), vol. 60, p. 397, 1931.

Haemogamasus sternalis EWING, Proc. U. S. Nat. Mus., vol. 82, art. 30, p. 3, pl. 1, fig. 2, 1933.

Female.—Dorsal shield entirely covering dorsal surface to coxae III, where there begins a thin crescent of unprotected integument as the shield narrows. Shield densely covered with small, slender, often barbed setae, most of which are between 10μ and 20μ apart and about 40μ in length; pattern of setation broken at apex of shield, and setae in that region larger, farther apart, and more conspicuously barbed.

Especially prominent are the two usual apical setae, which are the largest setae on the shield and are heavily barbed; these are flanked by a pair of smaller, barbed setae, which are larger than most other

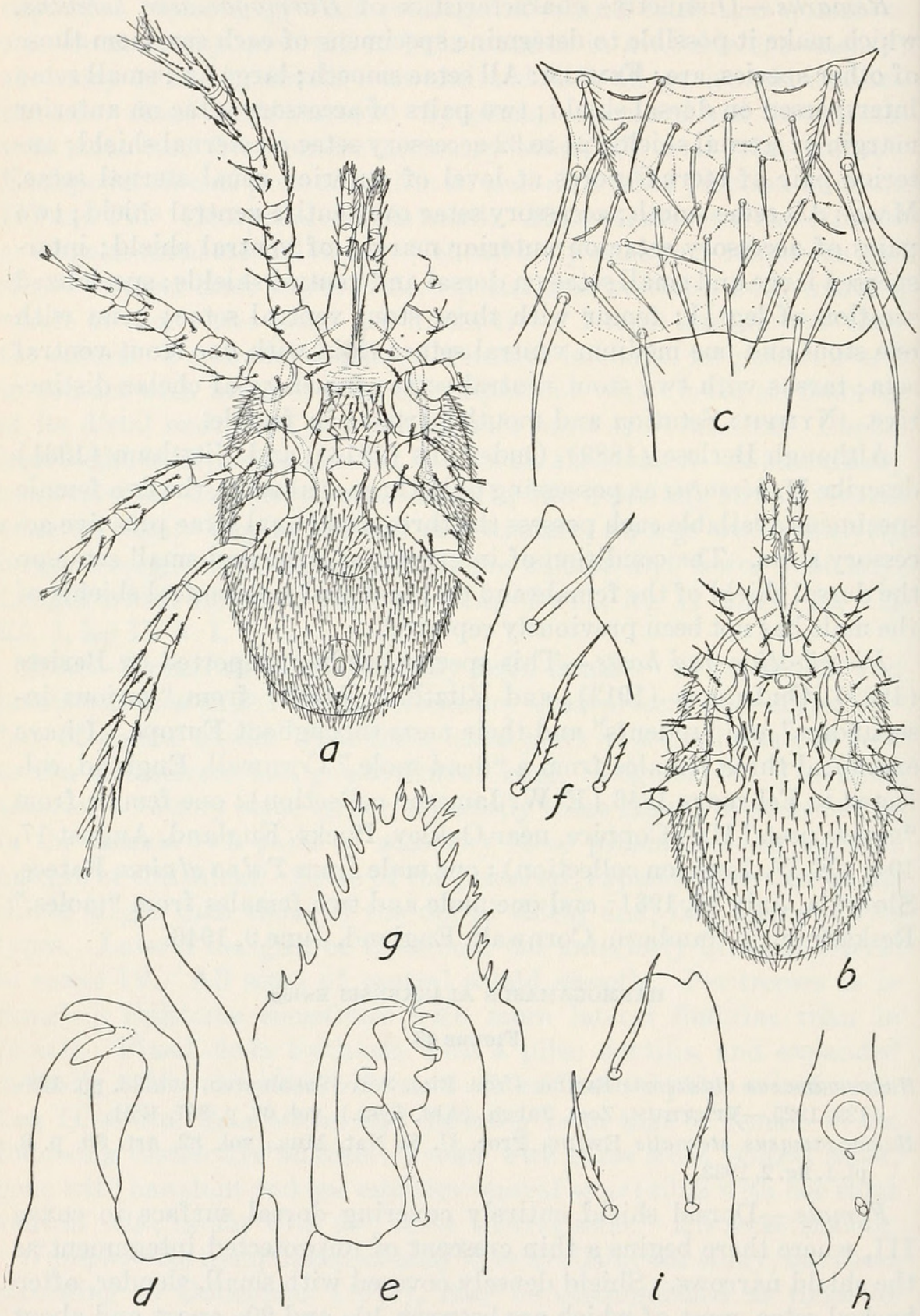

FIGURE 43.—*Haemogamasus alaskensis* Ewing: *a*, Ventral view of female; *b*, ventral view of male; *c*, sternal shield of female; *d*, chelicera of male; *e*, chelicera of female; *f*, cornicula of female; *g*, epistome of female; *h*, posterior end of peritreme of female; *i*, cornicula of male.

setae on the shield. Setae over most of the shield uniform in size but slightly larger at the margins, where they also are more often barbed. Entire shield sculptured, and two marginal pores present at the posterior end. Setae of the unprotected integument of the dorsal surface about twice as large as those on shield; larger and farther apart at the posterior margin. Tritosterum with both lacinae barbed. Presternal area sculptured with about five transverse sutures, each of which possesses minute posteriorly directed spines, which are larger on the more posterior sutures. Sternal shield rectangular, with all margins slightly concave, although variable in this respect; sculptured; with the six usual sternal setae and 10 to 32 smaller, accessory setae. In the series examined the mean number of accessory setae was 23. Accessory setae variable in size; those at the margins of the shield larger; in most specimens the anterior pair of usual setae are the only barbed setae on the shield; in a few specimens some of the larger accessory setae are barbed faintly. Distinctive is the fact that one pair of accessory setae is anterior to the others and on the anterior margin of the shield between the anterior pair of usual setae. This condition exists in all specimens examined. Two pairs of sternal pores on the shield; the more anterior of these nearly parallel with the anterior margin of the shield. Genitoventral shield moderately expanded posterior to coxae IV; sculptured; with the usual pair of genitoventral setae and 24 to 55 smaller, accessory setae; mean number of accessory setae was 42; both usual and accessory smooth in almost all cases; in some specimens a gap exists between the usual genitoventral setae and the more anterior accessory setae; in others with larger numbers of setae they may be present over the entire shield. Anus about equidistant from anterior and posterior margins of anal shield, which is roughly triangular, with a broadly rounded anterior margin and a sharply pointed posterior end; a narrow, pointed cribrum; shield lacks sculpturing and possesses the three usual anal setae and five or six smaller, accessary setae; in a series of 48 examined 13 had six accessory setae and 45 had five; posterior usual seta barbed and the largest seta on shield; it lies almost at the posterior end of the shield proper. Small metapodal shields present; these may vary somewhat in shape but are usually oval; some are nearly rectangular. Endopodal shields are thin strands closely applied to fovea of coxae III and IV. Ventral setae larger than those of dorsal surface, particularly at the margins of the body; these are larger and more heavily barbed near the body margins; those at the posterior margin largest. The pair of usual metasternal setae are smooth in almost all specimens and, with the usual sternal setae, are the largest setae of the ventral surface. Posterior ends of peritremalia fused to fovea of coxae IV; shape of expanded portion of peritreme containing stigma distinctive; tu-

bular portion of peritreme extends to level of midpoint of coxae II. Epistome narrow and pointed with 10 to 12 fimbriae on each lateral margin; some fimbriae simple, others branched doubly or triply. Chelae of about equal length; each nearly straight, bent sharply at tips. Fixed chela with a bifid tip and two teeth; a distal seta immediately posterior to the tip and a proximal seta at the base of the chela. Movable chela bent at nearly a right angle at its distal end and with two teeth. Maxillae distinctive in outline; all but anterior pair of maxillary setae barbed. Palpi only slightly tapering; coxa with an especially strong ventral, medially directed seta, which is barbed on one side; most setae on palpi barbed except those on tarsi; anterior margins of at least coxae, trochanter, and femur serrated. All setae of legs, except terminal tarsal setae, barbed; distal margins of all segments, except tarsi, serrated. Tarsal length-width ratios are: Leg I 5.5 : 1, leg II 4.5 : 1, leg III 6 : 1, leg IV 8 : 1.

Male.—Distinctly smaller and narrower than female. Dorsal shield covers almost entire dorsal surface. Setae on ventral shield correspond to those of female, including the single pair of accessory setae on its anterior margin. Usual genitoventral setae very little larger than accessory setae of genitoventral region; shield greatly expanded posterior to coxae IV and extending laterally and anteriorly to posterior ends of the peritremes; pores on shield correspond to those of the female in size and position. Metapodal and endopodal shields included in ventral shield. Peritreme and epistome as in female. Chelae greatly modified. Fixed chela toothless and without a seta. Movable chela much larger and divided near its proximal end into two branches, the dorsal of these in turn divided into two prongs distally. Maxillae as in female except that lateral horns are more blunt; as in the female, the anterior pair of maxillary setae are smooth. Palpi and legs as in female.

Nymph.—Body relatively shorter than in adults; a slitlike invagination on each side of dorsal shield at level of coxae IV; setation of dorsal shield as in adults except that setae may not be quite so numerous. Tritosternum and presternal area as in adults. Ventral shield extends to level of midpoint on coxae IV and bears four pairs of setae, representing the three pairs of usual sternal setae and the single pair of metasternal setae. The usual genitoventral setae flank the posterior end of the shield. As in adults, the anterior pair of usual sternal setae are barbed and are thicker than the others. Sternal pores located as in adults. Anal shield with only four setae: the three usual anal setae and the most anterior accessory seta; the posterior usual anal seta is the largest and is the only barbed seta on the shield. Ventral body setae as in adults. Peritreme not well chitinized. Epistome, mandibles, and maxillae as in female. Palpi as in adults but relatively stouter. Legs relatively stouter than in adults.

Size.—Thirty-two female specimens examined varied in length from 900μ to 1,150μ and in width from 500μ to 600μ; mean length was 1,001μ; mean width 555μ. Three male specimens measured 775μ, 775μ, and 700μ in length and 425μ, 375μ and 375μ in width. The two measurable nymphs were 525μ and 800μ in length and 350μ and 500μ in width. Ewing's type female measured 1,120μ in length and 700μ in width.

Remarks.—Distinctive features of *Haemogamasus alaskensis*, which serve to distinguish female, male, and nymph from those of other species are: FEMALE: Barbed setae on dorsal shield; single pair of accessory setae on anterior margin of sternal shield; number of sternal setae; number of genitoventral setae; shape of peritreme; shape of epistome, and possession of 10 to 12 multiply branched fimbriae on each lateral margin; fixed chela with a bifid tip and two teeth; movable chela with two teeth; shape of maxillae and smooth anterior maxillary setae; barbed setae on palpi and legs. MALE: Similarity to female in all except secondary sexual characters; single pair of accessory setae on anterior margin of ventral shield; shape of chela; lack of specialized setae on legs. NYMPH: General characteristics of female seen in setation and mouth parts.

Variation in this species is evident in body size, numbers of accessory setae on sternal, genitoventral, and anal shields, and to a slight degree in the shapes of these shields.

Haemogamasus sternalis Ewing, 1933, was described as differing from *alaskensis* only in having the sternal shield poorly sclerotized and festooned behind and in having the sternal setae arranged in irregular, transverse rows. The single female specimen upon which the description was based was taken by Francis Harper, August 12, 1925, from a short-tailed shrew, *Blarina brevicauda talpoides*, at Adirondack Lodge, Essex County, N. Y. Other than the type the only specimen identified as *H. sternalis* in the collection of the U. S. National Museum is a female taken from a pine mouse at Chevy Chase, Md. In view of the variation in shape of the sternal shield and in the number and arrangement of accessory setae on it in specimens of *H. alaskensis* taken from the same and closely related hosts and the same regions, it is my opinion that the two species are synonymous and that *H. alaskensis* Ewing, 1925, is the valid specific name.

Distribution.—*H. alaskensis* has been taken most frequently from the northeastern and northwestern United States and southern Canada. Records from such widely separated areas as Utah, Illinois, and North Carolina suggest that the more numerous northern records may be due, at least in part, to the presence of more active collectors in those regions.

Records.—I have examined material from: *Napaeozapus insignis insignis*, Mount Katahdin, Windy Pitch, Maine, August 27, 1928. *Myotis lucifugus lucifugus*, Mount Katahdin, Basin Ponds, Maine, September 7, 1928. *Microtus pennsylvanicus pennsylvanicus*, West Falmouth, Mass., June 8, 10, and 14, 1936; Edgartown, Mass., April 22, 1933; Squibnocket, Mass., June 11, 1936; Nantucket, Mass., June 13, 1936; Temagami, Ontario, June 28, 1934, and August 17, 1934; Erie County, N. Y., August 29, 1945. *Microtus montanus*, Oconalufty River, N. C., April 18, 1931. *Microtus oregoni*, Quillayute, Wash., May 7, 1930. *Microtus* sp., Uniat, Alaska, June 6 and 18, 1947. *Clethrionomys gapperi ochraceus*, Mount Katahdin, Chimney Bend, Maine, August 27, 1928; Mount Katahdin, Togue Ponds, Maine, August 26, 1928; Mount Katahdin, North Basin, Maine, September 1, 1928. *Clethrionomys gapperi*, Mount Watatic, Ashburnham, Mass., October 12, 1927. *Tamiascuirus hudsonicus* nest, Long Lake, N. Y., July 26, 1926. *Pitymys pinetorum*, Point Abino, Welland County, Ontario, September 4, 1945. *Lepus americanus*, Pancake Bay, Algoma, Ontario, July 12, 1932. *Clethrionomys gapperi*, Wayne County, Pa., July 9, 1945; Crawford County, Pa., September 12, 1945. *Peromyscus maniculatus gracilis*, Temagami, Ontario, September 8, 1934. *Blarina brevicauda talpoides*, Jay Peak, Vt., August 17, 1927; Morgan, Utah, August 31 and September 8, 1932; Ithaca, N. Y., August 30, 1936. *Blarina brevicauda*, Point Abino, Welland County, Ontario, August 28 and 30, and September 4, 7, 11, and 13, 1936. "Meadow Mouse," Nantucket, Mass., August 31, 1936. "Field Mouse," Lake County, Minn., April 22, 1931. Host not given, Takotna, Alaska, June 11, 1935; Urbana, Ill., October 18, 1937. "Pine Mouse," Chevy Chase, Md., June 7, 1932.

Type.—One female (U. S. N. M. No. 947) collected by A. H. Twitchell, July 23, 1924, on *Microtus* sp. at Crater Mountain, Ophir, Alaska.

HAEMOGAMASUS MANDSCHURICUS Vitzthum

FIGURE 44

Haemogamasus mandschuricus VITZTHUM, Zool. Jahrb. (Abt. Syst.), vol. 60, pp. 397–399, figs. 1–4, 1931.

Female.—Most dorsal setae barbed; usual pair of apical setae barbed and flanked by smaller setae, which are also barbed. Setae in apical region larger than those on remainder of shield. Setae on posterior portion of shield 6μ to 20μ apart and about 45μ in length. A pair of pores flank posterior end of shield. Setae of unprotected dorsal integument barbed and larger than those on shield, particularly at the posterior body margin where one or two pairs are distinctly larger than others of the region. Lacinae of tritosternum barbed. Presternal area distinctly sculptured with spines on all sutures. Sternal shield

with usual sternal setae and 14 smaller, accessory setae in the only specimen available for study. The anterior pair of usual sternal setae are the only barbed setae on the shield and are smaller than the other usual setae. Accessory setae on the posterior three-fourths of the shield. Anterior pair of sternal pores parallel with anterior margin

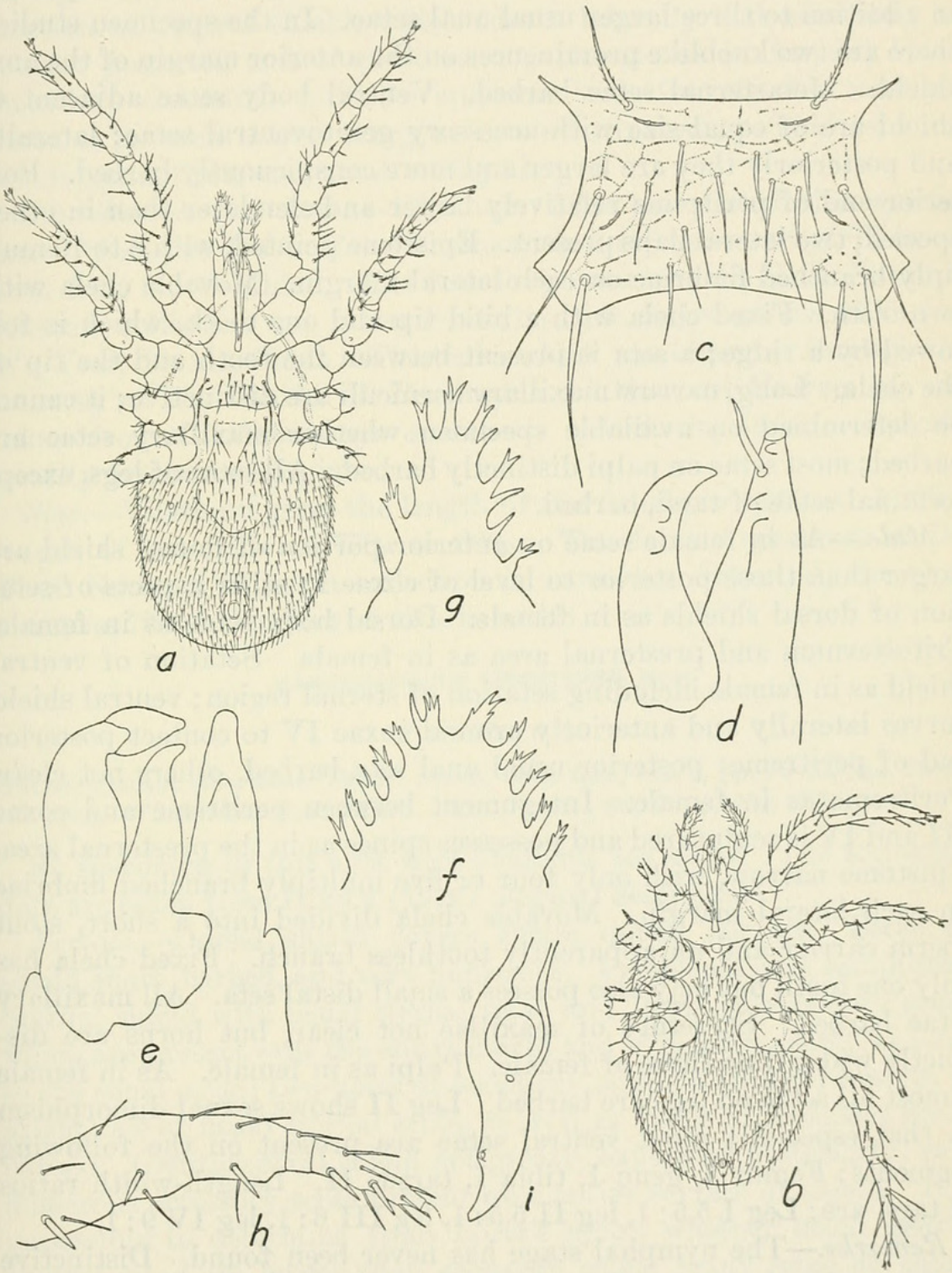

FIGURE 44.—*Haemogamasus mandschuricus* Vitzthum: *a*, Ventral view of female; *b*, ventral view of male; *c*, sternal shield of female; *d*, chelicera of female; *e*, chelicera of male; *f*, epistome of female; *g*, epistome of male; *h*, ventrolateral view of leg II of male; *i*, peritreme of female.

of shield. Genitoventral shield with 55 or 60 accessory setae in addition to the pair of larger usual genitoventral setae; accessory setae about twice as large as setae of dorsal shield; a definite gap between usual genitoventral setae and most anterior accessory setae; usual genitoventral setae and most of accessory setae smooth; some near posterolateral margin barbed. Anal shield with five accessory setae in addition to three larger usual anal setae. In the specimen studied there are two knoblike prominences on the anterior margin of the anal shield. Metasternal setae barbed. Ventral body setae adjacent to shield are of equal size with accessory genitoventral setae; laterally and posteriorly they are larger and more conspicuously barbed. Posterior end of peritreme relatively larger and slenderer than in other species; two lateral flaps present. Epistome pointed, with 8 to 10 multiply branched fimbriae on each lateral margin. Movable chela with two teeth. Fixed chela with a bifid tip and one tooth, which is followed by a ridge; a seta is present between the tooth and the tip of the chela. Long, narrow maxillary corniculi are distinctive; it cannot be determined on available specimen whether maxillary setae are barbed; most setae on palpi distinctly barbed. All setae of legs, except terminal setae of tarsi, barbed.

Male.—As in female setae on anterior portion of dorsal shield are larger than those posterior to level of coxae I; other aspects of setation of dorsal shields as in female. Dorsal body setae as in female. Tritosternum and presternal area as in female. Setation of ventral shield as in female including setation of sternal region; ventral shield curves laterally and anteriorly around coxae IV to contact posterior end of peritreme; posterior usual anal seta barbed, others not clear. Peritreme as in female. Integument between peritreme and coxae III and IV is sculptured and possesses spines as in the presternal area. Epistome narrow, with only four or five multiply branched fimbriae on each lateral margin. Movable chela divided into a short, stout sperm carrier and an apparently toothless branch. Fixed chela has only one tooth but may also possess a small distal seta. All maxillary setae barbed. Structure of maxillae not clear, but horns are distinctly wider than those of female. Palpi as in female. As in female almost all setae on legs are barbed. Leg II shows sexual dimorphism in that especially stout ventral setae are present on the following segments: Femur I, genu I, tibia I, tarsus II. Length-width ratios of tarsi are: Leg I 5.5 : 1, leg II 5.5 : 1, leg III 6 : 1, leg IV 9 : 1.

Remarks.—The nymphal stage has never been found. Distinctive features of each sex are: FEMALE: Most setae of dorsal shield barbed; accessory setae of sternal shield not present on anterior fourth of shield; 55 to 60 accessory setae on genitoventral shield; usual genitoventral shield smooth; 5 accessory setae on anal shield; knoblike

prominences on anterior margin of anal shield; posterior end of peritreme larger and slenderer than in other species; all fimbriae of epistome multiple; 8 to 10 fimbriae on each lateral margin; two teeth on movable chela; fixed chela with a bifid tip, a distal seta and one tooth; maxillary setae barbed; most palpal setae barbed; most setae on legs barbed. MALE: Setation as in female including pattern of setation of ventral shield, which curves laterally and anteriorly to contact posterior end of peritreme; peritreme as in female; blunt maxillary corniculi; spikelike epistome with four or five multiple fimbriae on each lateral margin; specialized, stout, ventral setae on femur, genu, tibia, and tarsus of leg II.

Distribution and hosts.—Vitzthum (1931) reported this species from *Phodopus bedfordiae* (Thomas) and *Dipus sowerbyi* Thomas, both from North China. The female specimen in the U. S. National Museum collection was taken from the mole *Scaptochirus gilliesi* at Wu-Ysai, Shansi, China. The male, which was obtained through the courtesy of Dr. Charles R. Remington, of Harvard University, was taken from *Clethrionomys amurensis mikado* in Japan. Specific locality data were not given.

Size.—Vitzthum gives the length of the female as 1,060μ to 1,080μ; length of the male as 770μ to 800μ. The female specimen in the U. S. National Museum collection is somewhat distorted; the male measures 770μ in length and 420μ in width.

HAEMOGAMASUS LIBERIENSIS Hirst

FIGURE 55, *a*, *b*

Haemogamasus liberiensis HIRST, Journ. Zool. Res., vol. 1, pp. 76–78, figs. 10–11, 1916.—VITZTHUM, Zool. Jahrb. (Abt. Syst.), vol. 60, p. 400, 1931.

No specimens of this mite were available for study. The following data are taken from Hirst's (1916) original description.

Female.—Dorsal shield covers entire dorsal surface. Setae on shield short, barbed, and very numerous. Presternal area sculptured. Sternal shield with usual sternal setae and about 45 accessory setae, which are present over the entire shield and which are nearly as large as the usual setae; two pairs of accessory setae on anterior margin of shield; all of usual sternal setae, as well as many of accessory setae, barbed. Genitoventral shield not greatly expanded posteriorly, with numerous accessory setae present over entire surface of shield. It is impossible to determine from Hirst's figure whether usual genitoventral setae are larger than accessory setae; many setae on shield barbed. Anal shield with three usual anal setae and six or seven accessory setae in type specimen. Endopodal shields not figured or mentioned. Metapodal shields small and oval. Metasternal setae present. Ventral setae very numerous; nearly all are barbed. Structure of

peritreme not clear. Epistome not figured or mentioned. Nearly all setae on legs, except terminal setae on tarsi, are barbed. Distal margins of all leg segments, except tarsi, separated.

Size.—Length of body 876μ; width 560μ.

Distribution and hosts.—The description was based on a single female specimen found on *Mus trivirgatus* at Gonyon, Liberia, by R. H. Bunting on November 20, 1910. Specimen in collection of H. C. Rothschild.

Remarks.—Distinguishing features of this mite are: Most setae on dorsal and ventral surface barbed; a large number of accessory sternal setae present over entire shield; two pairs of accessory setae on anterior margin of sternal shield; six or seven anal setae; fixed chela with bifid tip, two teeth, and a seta; movable chela with two teeth; most setae on legs barbed.

HAEMOGAMASUS AVISUGUS Vitzthum

Haemogamasus avisugus VITZTHUM, Zool. Jahrb. (Abt. Syst.), vol. 60, pp. 396–397, 1931.

No specimens of this mite were available for study. The following data are taken from Vitzthum's (1931) brief original description, which did not include figures.

Female.—Sternal shield with about 14 accessory setae. Usual sternal and metasternal setae not distinguished in length and thickness from accessory setae of sternal shield. Anterior pair of usual sternal setae strongly barbed; the others smooth. Genitoventral shield at its broadest part broader than the distance between coxae IV. Chelicerae of female with toothlike, sharply bent tips. Fixed chela with two teeth; movable chela with one tooth. Dorsal and ventral body setae smooth except along posterior body margin. Most setae on legs barbed.

Male.—Fixed chela of male normally formed with one tooth and a normal pilus dentilus. Proximal half of movable chela very thick; its distal half strongly bent, and deeply split, with a sperm carrier which reaches far beyond its end. Anterior margin of each coxa finely serrated.

Remarks.—Because of the unusually brief description and lack of figures it is difficult to determine the relationship of this mite to others in the genus. However, the fact that the sternal shield of the female possesses only about 14 accessory setae and that these are as large as the usual setae is distinctive. No other member of the genus possesses only one tooth on the movable chela. Vitzthum's description of the chelae of the male most closely fits *H. mandschuricus.*

Size.—Length of female 925μ to 960μ; length of male 775μ to 800μ.

Distribution and host.—On *Riparia riparia* in Germany.

HAEMOGAMASUS HARPERI, new species

FIGURE 45

Female.—Dorsal shield sculptured; bluntly pointed at both ends; relatively narrow; a distinct strip of unprotected integument between the shield and lateral and posterior margins of body; shield widest at level of coxae II. Usual pair of apical setae about equal in size to several of the more anterior setae of apical region and flanked by a pair of much smaller setae. Over the entire shield, posterior to apical region, setae are between 20μ and 40μ apart and at least 80μ in length; those nearest apical region are slightly larger; all setae smooth. Setae of unprotected dorsal integument of equal size with those on shield at corresponding levels; are generally largest on anterior portion of body, although some at posterior body margin may be longer and slenderer; all are smooth. Lacinae of tritosternum barbed. Presternal area well chitinized and sculptured; distinctly concave posterior to base of tritosternum; no spines present. Sternal shield with three pairs of usual sternal setae and several smaller accessory setae, which varied in number from four to seven in 22 specimens examined; the mean number was six; these appear to be arranged in pairs in most specimens; none are on the anterior margin of the shield. Usual setae stout; anterior pair slightly smaller than the others and on anterior margin of shield distinctly mediad to middle pair; bases of all usual setae embossed or elevated from the surface of the shield. Anterior pair of sternal pores nearly parallel with anterior margin of shield; all setae smooth. Genitoventral shield narrow, sculptured, and in most specimens not wider than distance between coxae IV; posterior margin of shield may be nearly straight or even slightly concave. Usual genitoventral setae smaller than usual sternal and metasternal setae. Accessory setae smaller than usual setae and almost entirely in posterior half of shield, smallest at posterior margin; about as large as accessory setae of sternal shield; number varying from 11 to 18 in 18 specimens examined; mean number 14; all setae smooth. Anal shield comparatively narrow; over twice as long as wide; anus almost entirely in posterior half of shield; with three usual anal setae and seven larger accessory setae. In some specimens the posterior usual anal seta may be as large as the smaller accessory setae; all setae smooth. Small endopodal and metapodal shields present. In some specimens there are four or five small, rounded shields lateral to the genitoventral shield; these appear to be in the integument rather than on its surface. Tubular portion of peritreme extends to anterior margin of coxae III; posterior margin of peritreme fused with fovea of coxa IV. Metasternal setae slightly slenderer than but equally as long as usual sternal setae. Ventral body setae smaller but not so far apart as those of dorsal shield; all are smooth. Epistome with

7 to 10 fimbriae on each side; most lateral fimbriae simple; distal fimbriae branched. Both chelae toothless. Fixed chela slenderer. Movable chela grooved and twisted on its longitudinal axis; no setae

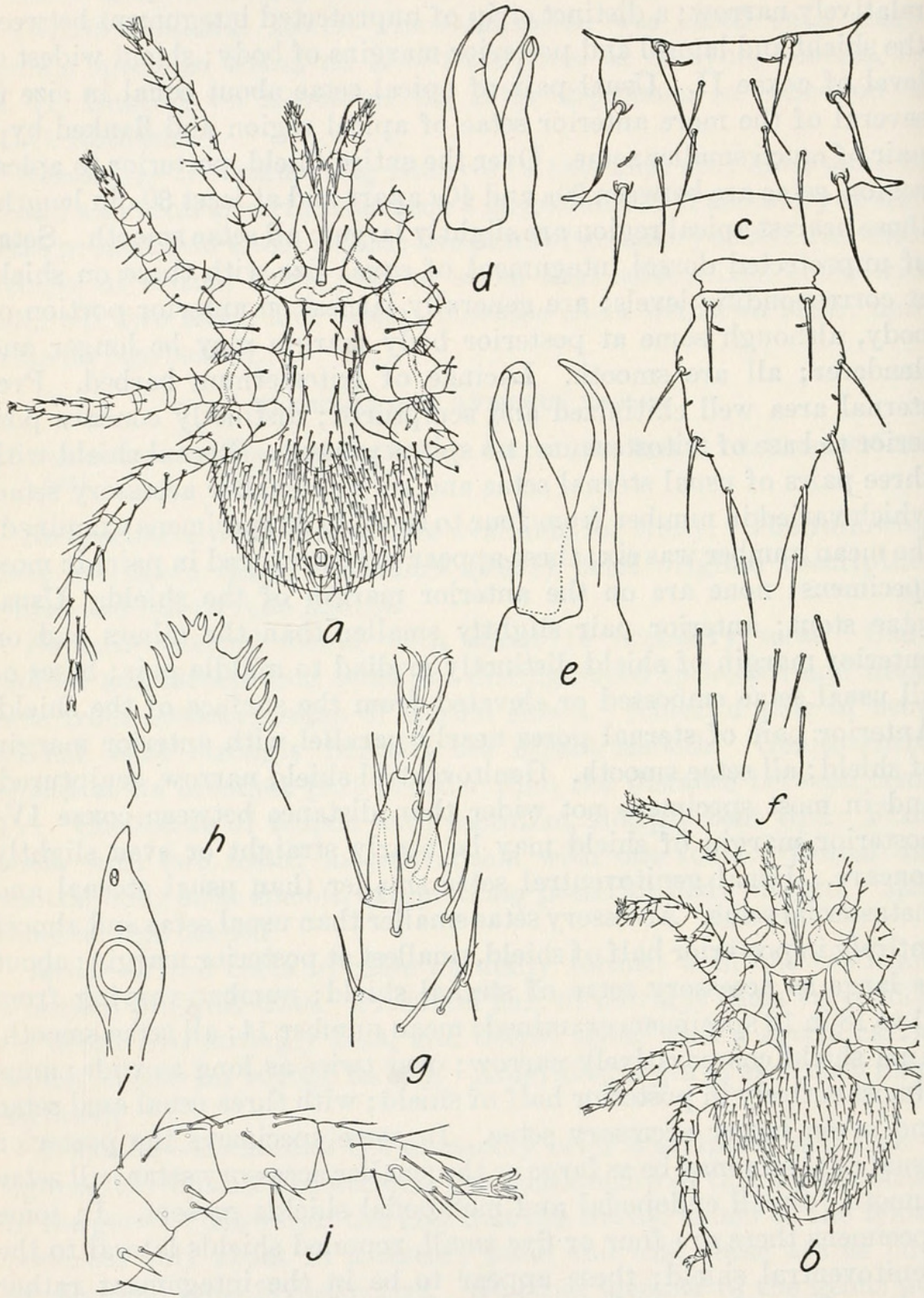

FIGURE 45.—*Haemogamasus harperi*, new species: *a*, Ventral view of female; *b*, ventral view of male; *c*, sternal shield of female; *d*, chelicera of male; *e*, chelicera of female; *f*, ventral shield of nymph; *g*, tarsus of leg II of female; *h*, epistome of female; *i*, posterior end of peritreme of female; *j*, ventrolateral view of leg II of male.

present. Structure of maxillae not clear; maxillary setae smooth. All palpal setae smooth. Legs stout; legs I and IV longest; leg II shorter and comparatively thicker than others; coxa of leg II much larger than those of other legs. Tarsi of all legs relatively shorter than those of most other species and also distinct in being abruptly narrow distally. Length-width ratios of tarsi are: Leg I 4:1, leg II 3.5:1, leg III 4.5:1, leg IV 5:1. Stout setae are present on distal ends of tarsi II, III, and IV; all setae smooth; as in other species, ventral setae are stouter.

Male.—Dorsal shield and its setation, as well as setation of unprotected dorsal integument, as in female. Tritosternum and presternal area as in female. Ventral shield relatively narrow, not covering entire ventral surface posterior to coxae IV and not curving anteriorly lateral to coxae IV. Usual sternal, metasternal, and genitoventral setae present as well as accessory setae of genitoventral region; accessory sternal setae lacking; usual sternal setae as in female; middle pair of usual sternal setae on lateral margin of shield; anterior pair of sternal pores angled posteriorly. A distinct gap between most anterior accessory setae of genitoventral region and usual genitoventral setae. Long, narrow anal region distinctive; setation of this region as on anal shield of female. Endopodal shields fused with ventral shield. Metopodal shields as in female, a distinctive feature. Ventral body setae, peritreme, and epistome as in female. Fixed chela shorter and stouter than in female and with a spatulate tip. Movable chela with an abruptly truncated tip and with a small tooth near its distal end, the bursa larger distally. Legs no thicker than those of female. Leg II differs from that of female in having a strong ventral seta on each of the following segments: femur, genu, tibia, and tarsus; tarsal seta is distinctive in that its thick proximal portion abruptly narrows into a slender distal spike. Tarsus II lacks the short, stout, distal setae of the female and may be relatively shorter than the latter, although this is not the case in all specimens.

Nymph.—Relatively shorter than adults. On one uncrushed specimen the dorsal shield covers the entire dorsal surface. Dorsal setation, tritosternum, and presternal area as in adults. Ventral shield with usual sternal and metasternal setae; usual genitoventral setae flank the narrow posterior end of shield; middle and posterior pairs of usual sternal setae as well as metasternal setae are on lateral margins of shield. Setae are as in adults except that middle and posterior pairs of sternal setae are relatively closer than in the former. The tapering, narrow posterior end of the shield is distinctive. Sternal pores as in female; posterior pair touch the lateral margins of the shield. Anal shield may be relatively shorter than in female; with

three usual anal setae and three larger most anterior accessory setae. Ventral body setae not so numerous as in adults. Peritreme weakly chitinized, differing from adults in that tubular portion extends to level of midpoint of coxae II; lateral flaps present. Epistome as in adults. Chelicerae as in female but relatively shorter. Maxillae not clear. Setation of palpi as in adults. Legs as in adult female but may be relatively shorter.

Remarks.—Distinctive features of *H. harperi*, which make it possible to distinguish female, male, and nymph from those of other species are: FEMALE: All setae smooth; relatively narrow dorsal shield; small number of accessory setae on sternal shield, four to seven in specimens examined; stout usual sternal setae with embossed bases; narrow genitoventral shield with relatively small number of setae, 11 to 18 in available specimens; anal shield relatively narrow; over twice as long as it is wide; with seven accessory setae which are larger than usual anal setae; anus almost entirely in posterior half of shield; both chelae toothless; relatively short tarsi which narrow abruptly distally; short, stout setae on distal ends of tarsi. MALE: Setation as in female; narrow ventral shield, which does not cover entire ventral surface or curve anteriorly lateral to coxae IV; second pair of usual sternal setae on lateral margins of shield; accessory sternal setae absent; long, narrow anal region; femur, genu, tibia, and tarsus of leg II each with a conspicuously strong ventral seta; that of tarsus II about midway between anterior and posterior ends of tarsus. NYMPH: Setation as in adults; ventral shield more gradually tapered posteriorly than in other species; anal shield with six setae; accessory setae larger than usual setae; mouth parts as in female; short, abruptly tapering tarsi as in adults.

Size.—Seven measurable females varied in length from 1,075μ to 1,300μ; mean length was 1,129μ; it was impossible to obtain accurate measurements of width. Eighteen measurable males varied in length from 925μ to 1,025μ; width of the same series varied from 55μ to 600μ; mean length was 968μ; mean width 555μ. Length of measurable nymphs was 975μ and 800μ; width of the latter specimen was 475μ.

Distribution.—Specimens have been taken only in Florida, Georgia, Mississippi, and South Carolina. I have examined specimens from: *Scalopus aquaticus howelli*, Handsboro, Miss., date?; Decatur County, Ga., January, March 11, April 2, 1947; Brooks County, Ga., October 2, 1947. *Scalopus aquaticus australis*, Folkston, Ga., January 10, 1936, Welaka, Fla., May 27, 1947. *Cryptotis parva*, Thomasville, Ga., Jan. 13, 1937. "Mole," Charleston, S. C., July 1930; Decatur County, Ga., January 1947, April 2, 24, 27, 1947, May 6, 1947, July 24, 1947; State College, Miss., October 31, 1937.

Type.—Female (U. S. N. M. No. 1885) collected from *Cryptotis parva* at Thomasville, Ga., by E. V. Komarek, January 13, 1937.

Paratypes.—Three females, three nymphs, from *Scalopus aquaticus australis*, West Folkston, Ga., January 10, 1936, Francis Harper; one female, one male, one nymph, from *Scalopus aquaticus howelli*, Handsboro, Miss., June 9, 1940, G. G. Rohwer. All paratypes in U. S. National Museum collection.

HAEMOGAMASUS KITANOI ASANUMA

Haemogamasus kitanoi ASANUMA, Seibutu, vol. 3, No. 5, pp. 171–176, fig. 3, 1948.

This species came to my attention too late for discussion in this report.

Genus EUHAEMOGAMASUS Ewing

Euhaemogamasus EWING, Proc. U. S. Nat. Mus., vol. 82, art. 30, p. 3. 1933. [Genotype: *Euhaemogamasus ambulans* (Thorell, 1872).]

Differs from *Haemogamasus* only in lacking accessory setae on sternal shield.

KEY TO FEMALES OF GENUS EUHAEMOGAMASUS

1. All setae smooth 2
   With some barbed setae 3
2. Posterior margin of sternal shield invaginated to a level midway between posterior and median pairs of sternal setae; usual pair of apical setae distinctly larger than all other setae on dorsal shield.
   liponyssoides (Ewing) (p. 244)
   Posterior margin of sternal shield nearly straight; usual pair of apical setae little if any larger than other setae of the apical region.
   liponyssoides occidentalis, new subspecies
3. Chelae toothless; 4 conspicuous setae at posterior margin of body; each of these about half as long as body ..... quadrisetatus (Vitzthum) (p. 253)
   Chelae with teeth; setae at posterior body margin only slightly enlarged 4
4. Each chela with 2 teeth 5
   Fixed chela with only 1 tooth 6
5. All setae on dorsal shield smooth; anterior pair of sternal setae on anterior margin of shield flanking its median third; all sternal and maxillary setae smooth; setae on legs not barbed but with rough surfaces; stout, ventral coxal seta is only barbed seta on palp; anterior pair of sternal pores nearly parallel with anterior margin of shield.
   horridus (Michael) (p. 235)
   Many setae on dorsal shield barbed; anterior pair of sternal setae barbed and not on anterior margin of shield; all maxillary setae barbed; almost all setae on legs barbed; many palpal setae barbed; anterior pair of sternal pores not parallel with anterior margin of shield.
   barberi (Ewing) (p. 249)
6. Posterior margin of sternal shield invaginated to a level midway between anterior and median pairs of sternal setae.
   oudemansi (Hirst) (p. 240)
   Posterior margin of sternal shield nearly straight.
   ambulans (Thorell) (p. 228)

EUHAEMOGAMASUS AMBULANS (Thorell)

FIGURES 41, 46

Dermanyssus ambulans THORELL, Öfv. Vet.-Akad. Forh., vol. 2, p. 164, 1872.

Gamasus ovalis KOCH, Kongl. Svenska Vet.-Akad. Handl., vol. 16, No. 5, pp. 121–122, table 5, figs. 3–3a, 1878.

Haemogamasus nidi MICHAEL, Trans. Linn. Soc. London, vol. 5, pp. 314–315, pl. 32, figs. 6, 7, 1892.—HIRST, Bull. Ent. Res., vol. 5, pp. 121–122, 1914.—VITZTHUM, Zool. Jahrb. (Abt. Syst.), vol. 60, p. 401, 1931.

Laelaps ovalis (Koch) TRÄGÅRDH, Zool. Anz., vol. 25, p. 61, 1902.

Haemogamasus michaeli OUDEMANS, Tijdschr. Nederl. Dierkund. Ver., ser. 2, vol. 8, pp. 87–88, 1903; Arch. Naturg., vol. 79, Abt. A, Heft 8, pp. 155–160, figs. 108–140, 1913.

Hypoaspis ambulans (Thorell) TRÄGÅRDH, Fauna Arctica, vol. 4, Lief. 1, p. 33, figs. 55–58, 1904.

Eulaelaps ambulans (Thorell) TRÄGÅRDH, Nat. Unter. Sarekgebirges Swed. Lap., vol. 4, Lief. 4, pp. 435–437, figs. 116–122, 1910.

Haemogamasus reidi EWING, Proc. Biol. Soc. Washington, vol. 38, p. 140, 1925.

Haemogamasus twitchelli EWING, Proc. Biol. Soc. Washington, vol. 38, pp. 142–143, 1925.—VITZTHUM, Zool. Jahrb. (Abt. Syst.), vol. 60, p. 401, 1931.

Euhaemogamasus onychomydis EWING, Proc. U. S. Nat. Mus., vol. 82, art. 30, p. 4, pl. 1, fig. 3, 1933.

Euhaemogamasus sciuropteri KEEGAN, Trans. Amer. Micr. Soc., vol. 65, No. 1, p. 72, figs. 8–9, 1946.

Female.—Described from European specimens. Dorsal shield does not entirely cover dorsal surface; widest at level of coxae III. Usual pair of apical setae clearly largest on shield. Setae sparser in apical region but over remainder of shield between 9μ and 12μ apart laterally and 9μ to 20μ apart anteroposteriorly. They average about 35μ in length but may be larger in apical region and at posterior margin. Usual pair of apical setae and many of the other setae on shield barbed. Five pairs of pores on shield. Dorsal body setae larger and not so closely set as setae on shield, nearly all barbed, larger at posterior body margin. On one specimen a terminal pair is larger, but not so stout, as usual apical setae. Lacinae and base of tritosternum barbed. Presternal area sculptured; sutures with spines. Sternal shield about one a half times as wide as long; posterior margin of shield slightly invaginated. Only anterior pair of sternal setae barbed. Anterior pair of sternal pores nearly parallel with anterior margin of shield. Genitoventral shield flask-shaped, varying somewhat in size and outline. Accessory setae numbered 70–85 in all European specimens examined; usual pair of genitoventral setae anterior to all accessory setae and larger than the latter; more anterior accessory setae larger. All setae on shield smooth. Length-width ratio of anal shield about 1.5 : 1. Usual anal setae and five smaller accessory setae present on all specimens examined. Posterior unpaired usual setae largest on shield, sometimes with a few barbs. Setae smaller than adjacent ventral body setae. Endopodal shields slender. Metapodal

shields rodlike. Metasternal setae smooth, about as large as usual sternal setae. Ventral body setae not so closely set as setae of dorsal

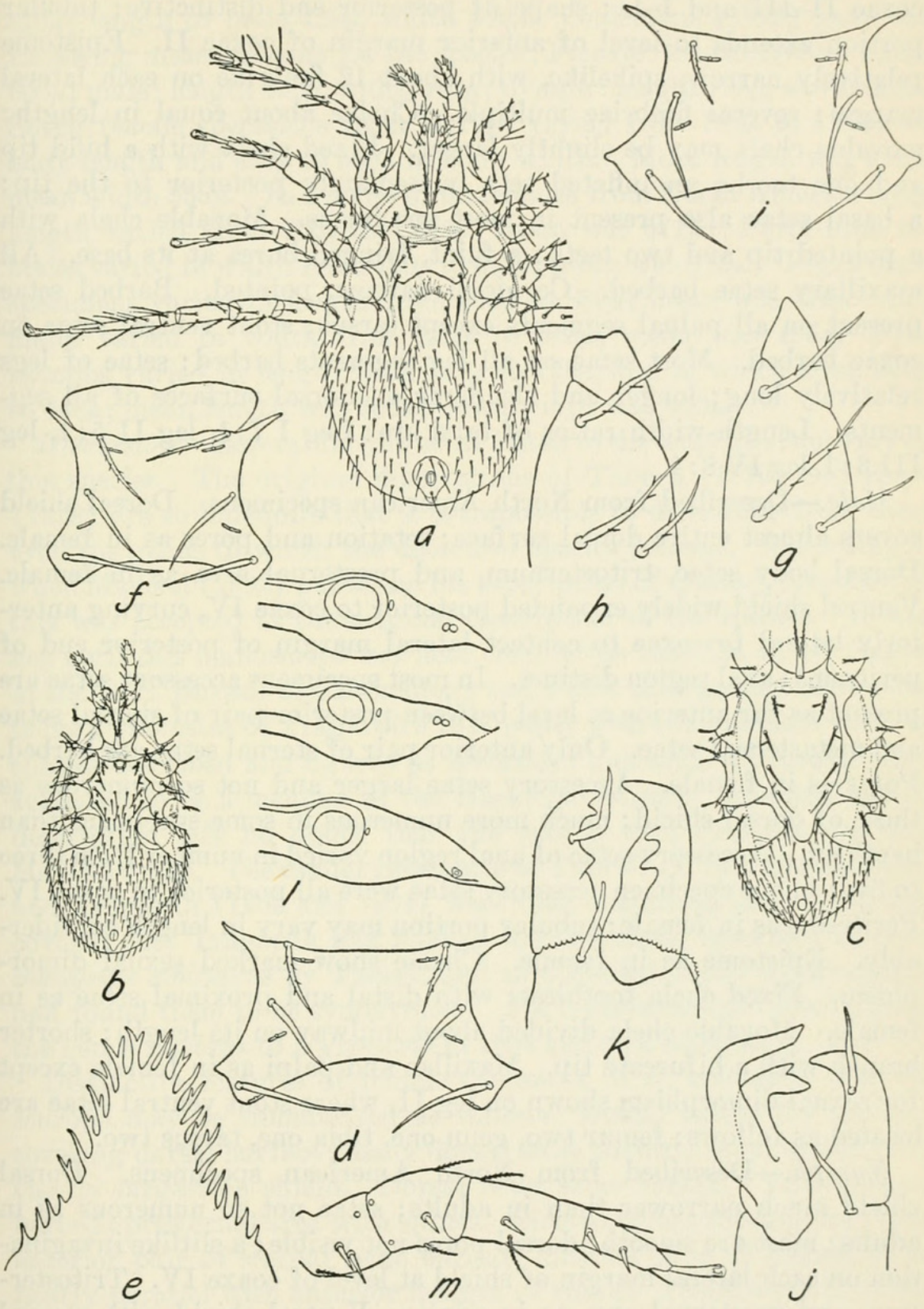

FIGURE 46.—*Euhaemogamasus ambulans* (Thorell): *a*, Ventral view of female; *b*, ventral view of male; *c*, ventral view of nymph; *d*, sternal shield of female from North America; *e*, epistome of female; *f*, sternal shield of female from England; *g*, cornicula of female; *h*, cornicula of male; *i*, sternal shield of female from Japan; *j*, chelicera of male; *k*, chelicera of female; *l*, peritreme of three female specimens; *m*, ventrolateral view of leg II of male.

shield and larger than the latter; nearly all are barbed; largest on posterior body margin. Peritreme with lateral expansions at level of coxae II–III and I–II; shape of posterior end distinctive; tubular portion extends to level of anterior margin of coxae II. Epistome relatively narrow, spikelike, with about 12 fimbriae on each lateral margin; several fimbriae multiple. Chelae about equal in length: movable chela may be slightly larger. Fixed chela with a bifid tip and one tooth; an inflated seta immediately posterior to the tip; a basal setae also present in most specimens. Movable chela with a pointed tip and two teeth; a faint, fringed bursa at its base. All maxillary setae barbed. Corniculi narrow, pointed. Barbed setae present on all palpal segments except tarsus; stout ventral setae on coxae barbed. Most setae on all leg segments barbed; setae of legs relatively long; longer and slenderer on dorsal surfaces of all segments. Length-width ratios of tarsi are: Leg I 7:1, leg II 5:1, leg III 6:1, leg IV 8:1.

Male.—Described from North American specimens. Dorsal shield covers almost entire dorsal surface; setation and pores as in female. Dorsal body setae, tritosternum, and presternal area as in female. Ventral shield widely expanded posterior to coxae IV, curving anteriorly lateral to coxae to contact lateral margin of posterior end of peritreme; anal region distinct. In most specimens accessory setae are present as far anterior as level between posterior pair of sternal setae and metasternal setae. Only anterior pair of sternal setae are barbed. Pores as in female. Accessory setae larger and not so numerous as those of dorsal shield; much more numerous in some specimens than in others. Accessory setae of anal region varied in number from three to five; in one specimen accessory setae were all posterior to coxae IV. Peritreme as in female; tubular portion may vary in length considerably. Epistome as in female. Chelae show marked sexual dimorphism. Fixed chela toothless; with distal and proximal setae as in female. Movable chela divided about midway on its length; shorter branch with a bifurcate tip. Maxillae and palpi as in female except for sexual dimorphism shown on leg II, where stout ventral setae are located as follows: femur two, genu one, tibia one, tarsus two.

Nymph.—Described from North American specimens. Dorsal shield much narrower than in adults; setae not so numerous as in adults; most are smooth; dorsal pores not visible; a slitlike invagination on each lateral margin of shield at level of coaxe IV. Tritosternum and presternal area as in adults. Ventral shield with sternal and metasternal setae; pores located as in adults. Anal shield with three usual anal setae and one smaller accessory seta in most specimens; a few possess another accessory seta near anterior margin of shield. Peritreme not well developed. Epistome, chelae, maxillae, and

palpi as in adults. Legs as in adult female; may be relatively shorter.

Size.—Michael (1892) gave the length of the female as 940μ, width 510μ; length of male 720μ, width 400μ. Oudemans (1913) gave the following measurements for the species: Female: length 1,000μ, width 600μ; male: length 850μ, width 460μ; nymph: length 735μ, width 405μ. Seven female specimens from Europe varied from 882μ to 1,036μ in body length and 490μ to 588μ in body width. Mean length was 952μ, mean width 558μ. In a series of 66 females from North America body length varied from 700μ to 1,078μ; mean was 871μ. Forty-nine females varied in width from 420μ to 672μ; mean was 515μ. Eight male specimens varied in length from 658μ to 882μ; mean was 773μ. Six males varied in width from 327μ to 560μ; mean was 425μ. Five nymphs varied in length from 518μ to 728μ, and in width from 336μ to 448μ; mean length was 605μ; mean width was 400μ.

Discussion.—Several factors contributed to the lengthy synonymy of this species. The original descriptions of Thorell (1872) and Koch (1878) are so indefinite that it is impossible to determine from them even the genus to which the described species belongs. Accordingly, when Michael (1892) published his description of *Haemogamasus nidi* this was accepted as the original description of the species. It was not until this manuscript was near completion that Dr. E. W. Baker, of the U. S. Bureau of Entomology and Plant Quarantine, forwarded to me a photostat of Trägårdh's 1910 paper with the comment that the species described and figured as *Eulaelaps ambulans* (Thorell, 1872) appeared to be a member of the Haemogamasinae. The figures and description left no doubt that the species was synonymous with Michael's *nidi*. The earlier references of Thorell (1872), Koch (1878), and Trägårdh (1902 and 1904) were then examined, and it was discovered that Trägårdh had studied the specimens described as *Dermanyssus ambulans* by Thorell and as *Gamasus ovalis* by Koch and had found them to be synonymous. He transferred the species from the genus *Laelaps* to *Hypoaspis* in 1904 and to *Eulaelaps* in 1910.

Distinctive features of female specimens of *E. ambulans* taken in Europe may be summarized as follows: Dorsal shield not entirely covering dorsal surface; many dorsal setae barbed; usual apical setae clearly largest on shield. Dorsal body setae barbed. Tritosternum barbed; presternal area with spines. Sternal shield rectangular; only anterior pair of sternal setae barbed; anterior pair of sternal pores nearly parallel with anterior margin of shield. Genitoventral shield flask-shaped; 75–80 accessory setae, all of which are posterior to usual genitoventral setae. Five accessory setae on anal shield. Epistome relatively narrow, with about 12 fimbriae on each lateral margin. Fixed chela with a bifid tip, one tooth, and a distal and a proximal seta. Movable chela with two teeth and a basal fringe of tiny setae. Maxillary setae barbed. Most setae on legs barbed.

Also possessing most of these characteristics in common are type specimens of the following North American species: *Haemogamasus reidi* Ewing, 1925; *H. twitchelli* Ewing, 1925; *Euhaemogamasus onychomydis* Ewing, 1933; *E. oregonensis* Ewing, 1933, and *E. sciuropteri* Keegan, 1946. These differ from one another almost entirely in numbers of setae on dorsal, genitoventral, and anal shields and in numbers of dorsal and ventral body setae. When these species were described it was assumed that, as in species of several other subfamilies of Laelaptidae, numbers of genitoventral and anal setae were specifically constant and were useful taxonomic aids. Accordingly, Ewing described *H. twitchelli* as possessing eight anal setae and *H. reidi* as possessing only three. One of the diagnostic features of genus *Euhaemogamasus* Ewing, 1933, was possession of three anal setae. *E. oregonensis* was further characterized as having about 20 genitoventral setae. *E. sciuropteri* was to be separated from other species of the genus by possession of five anal setae and 28–30 genitoventral setae.

First indication of variation in numbers of both genitoventral and anal setae was discovered upon examination of the type specimens of each species. Five of the seven female specimens on the type slide of *H. reidi* possessed 24, 30, 18, 22, and 25 genitoventral setae; six of the seven specimens had 3, 3, 4, 4, 5, and 6 anal setae. The type female of *H. twitchelli* had about 50 genitoventral setae and eight anal setae. The type female of *E. onychomydis* had about 50 genitoventral setae and at least six anal setae. Each of two females on the type slide of *E. oregonensis* had about 45 genitoventral setae and eight and seven anal setae. Hirst (1914) reported that numbers of anal setae of European specimens of *ambulans* varied from seven to nine.

Specimens in the U. S. National Museum collection previously identified as *H. twitchelli*, *H. reidi*, *E. onychomydis*, and *E. oregonensis* include the types of each species and a total of 150 specimens taken from a variety of hosts and habitats from several of the eastern, central, and western United States and southern Canada. The type female of *E. sciuropteri* was deposited in the collection of the Army Medical Museum. Upon examination of this series it was found that, like the types, all possessed the most distinctive characteristics of *E. ambulans*, differing from it, and among themselves, in the following characteristics: Numbers of setae on dorsal, genitoventral, and anal shields and on dorsal and ventral body surfaces; length-width ratio of sternal shield; relative size of genitoventral shield; slight differences in structure of posterior end of peritreme; presence of basal seta on fixed chela. These characteristics were found to vary to the following extent:

SETATION OF DORSAL SHIELD AND DORSAL AND VENTRAL BODY SURFACES: It is difficult to express the relative thickness or sparseness of setation

of these surfaces except by indicating distances of setae from one another. This was found to vary from as little as 4μ to 15μ to as much as 30μ to 60μ. More numerous setae on the dorsal shield and dorsal and ventral body surfaces were usually associated with larger numbers of setae on genitoventral and anal shields. In general, setae of these surfaces were more numerous on western specimens.

NUMBERS OF GENITOVENTRAL SETAE: Varied from 12 to 70 in a series of 104 specimens examined; the mean was 31. Larger numbers were usually found on western specimens. Of 39 specimens with more than 30 genitoventral setae, all but five were taken in western States. However, third from the top of the list with 60 setae is a specimen from New Hampshire. Of the 65 specimens with less than 31 setae, only seven were taken in western States.

NUMBERS OF ANAL SETAE: In a series of 88 specimens numbers of anal setae varied from 3 to 8; the mean was 5.6. Although larger numbers were usually associated with more numerous genitoventral setae, this was not always the case. Examples of such disparity are shown in the following combinations: 20 genitoventral setae with 7 anal setae; 29 genitoventral setae with 7 anal setae; 55 genitoventral setae with 5 anal setae; 45 genitoventral setae with 6 anal setae. Larger numbers were found most often on western specimens.

LENGTH-WIDTH RATIO OF STERNAL SHIELD: In seven European specimens of *E. ambulans* the length-width ratio of the sternal shield varied from 1.2:1 to 1.7:1. In 76 North American specimens this ratio varied from 1.3:1 to 2.4:1. In general, lower ratios were associated with larger numbers of setae. This ratio in most cases represents a variation in the margin separating the presternal area and the sternal shield proper rather than in position of pores and setae. In specimens with higher ratios the anterior pair of sternal setae is on the anterior margin of the shield rather than slightly posterior to it.

In addition to variations previously discussed, North American specimens show slight variations in details of structure of the posterior end of the peritreme and in presence or absence of a basal seta on the fixed chela.

An attempt to separate specimens of this series into distinct species on the basis of possession three, five, or eight anal setae would necessitate separation of specimens from single lots or from identical hosts and localities into several species. It is my opinion that, since the concept of constant seta number upon which *H. reidi*, *H. twitchelli*, *E. onychomydis*, *E. oregonensis*, and *E. sciuropteri* were described has been demonstrated to be erroneous, these species are one and, lacking further means of distinction, should be considered synonymous with *E. ambulans*.

Distribution.—Reported from Greenland by Thorell (1872); Siberia by Koch (1878); Great Britain by Michael (1892), Hirst (1914), and

Turk (1945); Holland by Oudemans (1913); Germany by Hirst (1914); and middle and western Europe by Vitzthum (1931) from birds and from a variety of small mammals but most often from rodents. I have examined specimens from: *Apodemus sylvaticus*, Torrington, Devon, England, March 18 and 22, 1937; Reskadinnick, Camborn, Cornwall, England, March 17, 1946 (E. W. Jameson collection). *Apodemus flavicollis*, North Sarajeve, Bosnien, July 12, 1929. *Sciurus niger rufiventer*, Allegan County, Mich., October 19 and December 26, 1937, February 10, 1938. *Sciurus griseus nigripes*, San Simeon, Calif., May 28, 1931; Santa Lucia Mountains, Calif., date?. *Sciurus carolinensis*, Point Abino, Welland County, Ontario, September 13, 1945. *Neotoma fuscipes macrotis*, San Simeon, Calif., May 29, 1931. *Neotoma fuscipes*, Monterey, Calif., February 14, March 16, 1946. *Neotoma cinerea*, Logan Canyon, Utah, July 13, 1933. *Neotoma* sp., Monterey, Calif., May 27, 28, 1945, July 16, 1938. *Microtus agrestis*, locality? date?. *Glaucomys volans volans*, East Falls Church, Va., February 27, 1934, Seymour, Ill., November 9, 1937. *Glaucomys volans*, Welland County, Ontario, September 1, 1946. *Glaucomys sabrinus macrotis*, Saxtons River, Vt., December 24, 1934, Wayne County, Pa., July 17, 1945. *Glaucomys* sp., MacDonald College, Quebec, November 3, 1940. *Microtus operarius operarius*, Takotna, Alaska, December 1934. *Microtus californicus*, Monterey, Calif., August 21, 1940, December 5, 1938, April 14, 1945. *Microtus* sp., Takotna, Alaska, June 1, 1934, Monterey, Calif., November 15, 1948. *Clethrionomys gapperi ochraceus*, Mount Washington, N. H., July 1, 1928. *Thomomys fuscus*, Colfax, Wash., April 14, 1927. *Thomomys talpoides*, Garland, Colo., July 1940; *Thomomys* sp., Fresno, Calif., July 6, 1932. *Tamiasciurus hudsonicus*, Ithaca, N. Y., March 4, 1939. *Blarina brevicauda*, Point Abino, Welland County, Ontario, September 1, 1946. *Thomomys monticola*, Huntington Lake, Fresno County, Calif., January 27, 1948. *Clethrionomys amurensis mikado*, Sapporo Hokkaido, Japan, November 27, 1945. *Sorex palustris*, Montana, October 17, 1947 (U.S.P.H.S. collection, Hamilton, Mont.). "Alaska short-tailed mouse," Golovin, Alaska, May 19, 1931. "Short-tailed mouse," Golovin, Alaska, May 9, 1931. "Red-shouldered hawk," Halifax, N. C., October 26, 1935. "Blue jay," Ontario, May 16, 1917. "Red squirrel," Ontario, May 11, 1907. "Chipmunk," San Simeon, Calif., June 9, 1931; "Government Camp," Oregon, May 19, 1934. "Pine marten," Big Pines, Santa Lucia, Calif., May 23, 1931. "Gray squirrel," San Simeon, Calif., June 9, 1931, Good Hope Township, Ohio, June 6, 1937; Idyllwild, Riverside County, Calif., December 9, 1948 (Bureau of Vector Control collection, Dept. Public Health, Calif.). "Gray squirrel nest," Patuxent Game Reserve, Bowie, Md., May 22, 1943. "Flying squirrel," Clemson, S. C., December 14, 1940;

Kenwood, Ontario, November 22, 1921. "Townsend mole," Clackamas County, Oreg., May 30, 1932. "In squirrel hole," Urbana, Ill., March 31, 1944. "Raccoon," Bowie, Md., November 2, 1943. "Cottontail rabbit," Allegan, Mich., April 1, 1937. "Bobwhite," Halifax, N. C., January 17, 1933. "In chicken nest," Astoria, Oreg., September 8, 1937.

EUHAEMOGAMASUS HORRIDUS (Michael)

FIGURE 47

Haemogamasus horridus MICHAEL, Trans. Linn. Soc. London, vol. 5, pp. 312–313, pl. 32, figs. 1–5, 1892.—OUDEMANS, Arch. Naturg., vol. 79, Abt. A, Heft 8, pp. 146–155, figs. 98–107, table 11, figs. 11–15, 1913.—HIRST, Journ. Zool. Res., vol. 1, pp. 60–61, 1916.—VITZTHUM, Zool. Jahrb. (Abt. Syst.), vol. 60, pp. 402–403, 1931.

Haemogamasus horridus var. arvicolarum BERLESE, Redia, vol. 14, p. 166, 1920.

Haemogamasus arvicolarum (Berlese) TURK, Ann. Mag. Nat. Hist., ser. 2, vol. 12, pp. 785–820, figs. 119–122, 1945.

Female.—Setae of dorsal shield about 15μ apart and of nearly uniform size, varying between 40μ and 60μ in length; usual apical setae clearly the largest setae on shield. Setae of apical region little larger than others; all setae on shield smooth; five pairs of pores on shield. Setae of unprotected dorsal integument larger than those of shield, particularly at lateral and posterior body margins, where some may be barbed; three or four terminal pairs distinctly larger than other marginal setae. Lacinae of tritosternum barbed; a spine on each side of base of tritosternum about midway on its length. Presternal area sculptured and applied to entire anterior margin of sternal shield; sutures of presternal area with tiny spines. Sternal shield strongly sculptured; slightly longer than wide, with a nearly straight posterior margin; all sternal setae large, stout, and smooth; anterior flank middle third of anterior margin of shield. Anterior pair of sternal pores posterior and slightly lateral to bases of anterior pair of sternal setae; a few anterior sutures of shield with tiny spines; anterior and posterior pairs of seta about equidistant from middle pair. Genitoventral shield strongly sculptured; with a nearly straight posterior margin in some specimens; usual pair of genitoventral setae smooth and smaller than sternal and metasternal setae; accessory setae smaller, smooth and present over most of shield posterior to usual setae; in five available specimens accessory setae number 35, 60, 65, 65, and 70. Anal shield between one and a half and two times as long as it is wide; in addition to the three usual anal setae about 10 smaller accessory setae are present; of five available specimens, two possess 10 accessory setae and three 11; pattern of setation of accessory setae variable; posterior usual seta is largest on shield. Endopodal shields short. Metapodal shields rodlike. Shape of posterior end of peritreme distinctive; tubular portion extends to level of anterior margin of coxae III. Ventral

body setae larger than those of dorsal shield and unprotected dorsal integument; they tend to be larger and more often barbed at the posterior body margin. Metasternal setae at least as large as posterior pair of sternal setae. Epistome distinctive, with a gently rounded

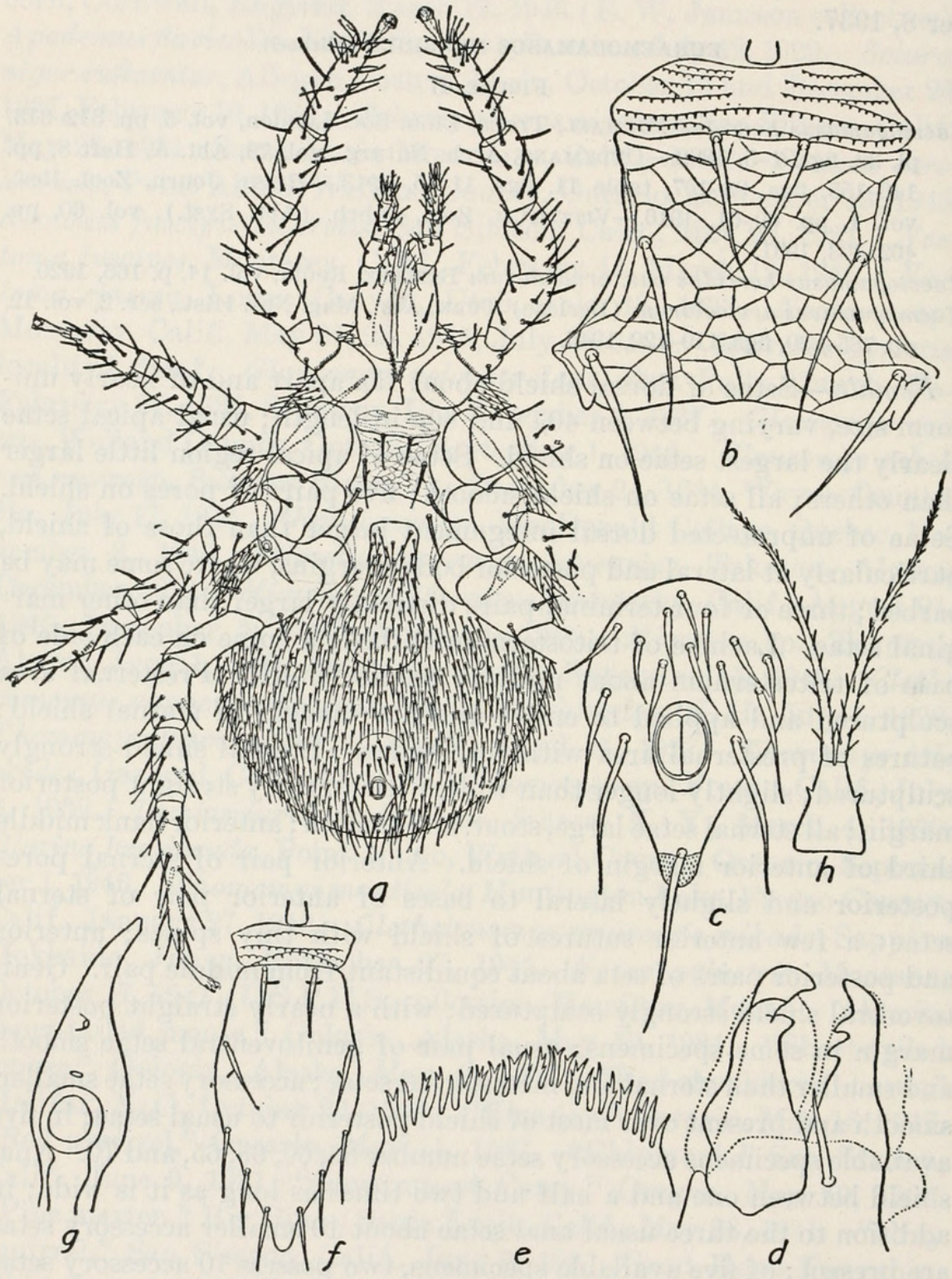

FIGURE 47.—*Euhaemogamasus horridus* (Michael): *a*, Ventral view of female; *b*, sternal shield of female; *c*, anal shield of female; *d*, chelicera of female; *e*, epistome of female; *f*, ventral shield of nymph; *g*, posterior end of peritreme of female; *h*, tritosternum of female.

anterior margin of simple and multiple fimbriae, which are more numerous than in other species. Chelicerae are difficult to determine accurately; both are thick and possess bursae, which may vary in shape. Each chela with two teeth; a seta at base of fixed chela and another between its teeth. Corniculi of maxillae blunt; maxillary setae smooth. Only barbed setae on palps are single, stout ventral seta on each coxa. Seta on legs distinctly more slender dorsally; many of the stout ventral setae with rough surfaces, but none examined were truly barbed; distal margins of most leg segments serrated.

Male.—No male specimens were available for study. According to Oudemans (1913), the male may be identified as that of *horridus* because of the following characteristics: Dorsal setation as in female; dorsal shield covers almost entire dorsal surface. Tritosternum as in female; setation of ventral shield as in female. Lateral margins of shield are not distinct in Oudemans' figure but appear to curve anteriorly lateral to coxae IV. Structure of peritreme not mentioned or figured clearly. Epistome as in female. Chelicerae not clearly figured. Fixed chela with two teeth according to Michael (1892). Maxillae not clearly figured. Legs as in female; without enlarged setae.

Nymph.—Dorsal shield with a slitlike invagination on each lateral margin at level of coxae IV; setation as in female; pores are not visible. Tritosternum and presternal area as in female. Pattern of setation and position of pores on ventral shield as in female; setae on shield smooth; distinctive in that genitoventral setae, in addition to sternal and metasternal setae, are on shield. Anal shield with three usual setae and three most anterior accessory setae. Epistome as in female. Chelicerae as in female. Maxillae not clear. Palpi and legs as in female.

Remarks.—Distinctive characteristics of female, male, and nymph of *E. horridus* are: Female: All setae of dorsal shield smooth; usual apical setae clearly largest on shield; three or four pairs of large terminal setae at posterior body margin; five pairs of pores present; anterior pair of sternal setae flank middle third of anterior margin of shield; all sternal setae smooth; posterior margin of genitoventral shield nearly straight in some specimens; about 10 accessory setae on anal shield; epistome with many slender fimbriae and with a gently rounded anterior margin; chelae stout and possess membranous bursae; each chela with two teeth; maxillary corniculi blunt; all maxillary setae smooth; stout, ventral coxal seta is only barbed seta on palp; setae on legs not barbed, but with conspicuously rough surfaces; setae large; ventral setae stouter; distal margins of most leg segments serrated. Male: Setation of dorsal and ventral surfaces

and structure of epistome as in female; legs as in female, with no enlarged setae or other evidences of sexual dimorphism. NYMPH: Setation, mouth parts, and legs as in female; differs from nymphs of other species in that genitoventral setae are on ventral shield.

Oudemans (1913) figures the adult female of this species as possessing only the three usual setae on the anal shield. However, Michael (1892) figures about 13 accessory setae, and Hirst (1916) reports 14 anal setae from one specimen and 9 on another. Vitzthum (1931) comments that 6 to 11 accessory setae had been reported on specimens of this mite taken in Great Britain.

Although both Oudemans and Vitzthum describe specimens examined by them as possessing only smooth setae, many dorsal and ventral body setae are barbed in specimens that I examined.

Size.—Four females in the U. S. National Museum collection measure 1,372μ, 1,400μ, 1,442μ, and 1,512μ in length. It was impossible to obtain accurate measurements of width. The only nymphal specimen available was 994μ in length. Michael gave the length of the female of this species as about 1,400μ and that of the male as 1,160μ; width of female 770μ; of male 650μ. Vitzthum gives the length of the female as 1,530μ; of the male as 1,270μ.

Distribution and hosts.—Michael's original description was based upon specimens taken from nests of the mole *Talpa europea* in Great Britain. Oudemans reported it from rodent nests in Holland; Hirst from field mice and their nests in Great Britain; and Vitzthum describes this species as a parasite of mice and moles of various species in western Europe. I have examined specimens as follows: from nest of *Apodemus flavicollis*, Ratece, Slovenia, August 14, 1931; *Talpa alpina*, Ratece, Slovenia, July 12, 1931; *Apodemus sylvaticus*, North Bull, Dublin, Eire, October 6, 1946 (E. W. Jameson collection); "mouse nest," Hell Coppice, near Oakley, Bucks, England, August 17, 1941 (E. W. Jameson collection).

Status of H. arvicolarum (Berlese).—Berlese (1920) described *arvicolarum* as a variety of *horridus* on the basis of specimens taken from nests of *Arvicola arvalis* at Ferrara, Italy, and Asuni, Sardinia. These differed from *horridus*, as described by Michael, in the following respects: Somewhat smaller; legs relatively shorter and thicker; terminal body setae no longer than other marginal setae; chelae of female stronger than in *horridus*: leg II of male with enlarged ventral setae. Length of female was given as 1,300μ; that of male as 1,060μ. No figures were given. None of Berlese's material was available for study.

Turk (1945) found the characteristics described by Berlese in a series of specimens taken from the nest of *Apodemus sylvaticus sylva-*

ticus at North Bull, County Dublin, Eire. After comparing these specimens with those taken from nests of mice in England, he concluded that these mites from Eire represented the form described by Berlese and that because of their morphological differences from *horridus* their restricted habitat in nests of voles and field mice, and their distribution in Eire and the Mediterranean area, they represented a distinct species.

In addition to the diagnostic features of *arvicolarum* given by Berlese, Turk included the following points: Length of female 1,300μ; sternal shield as in *horridus;* genitoventral shield as in *H. nidi* rather than *horridus* in being flask-shaped and somewhat expanded posteriorly, rather than with almost straight lateral margins and a truncate posterior margin; anterior portion of shield with two pairs of setae; anal shield larger than in *horridus* and with 14 setae; chelae of female stronger and more elongate than in *horridus;* chelae of male differ in some respects from those of *horridus;* average length of male 1,200μ.

I have seen no male specimens of *horridus* or of *arvicolarum*, but through the kindness of Dr. Turk I was able to examine four female specimens of *arvicolarum* taken from the type locality and habitat. Two of these were engorged, but morphological details of the others were distinct.

These specimens lack distinctly enlarged terminal body setae; chelae are slightly more elongate than those figured by Michael and Oudemans, or of the four specimens of *horridus* examined; anal shield is relatively large; distinctive in possessing 35 and 39 accessory setae on the genitoventral shield and in having the sternal shield slightly wider than long. Although the genitoventral shield of one specimen is expanded posteriorly, that of the other possesses relatively straight lateral margins and a truncate posterior margin.

Morphological variations, individual as well as among local populations, are indicated in the published descriptions of *horridus*. Variations in numbers of anal setae and in occurrence of smooth and barbed body setae have been discussed. Of four specimens typical of *horridus* from Ratece, Yugoslavia, two possess flask-shaped genitoventral shields and two possess the truncated posterior margin and more nearly straight lateral margins.

In my opinion structural differences such as those by which *arvicolarum* was separated from *horridus* by Berlese and Turk are not sufficient in themselves to warrant specific or subspecific status. Studies of morphological variation of *horridus* throughout its range, including Eire, will be necessary before the taxonomic value of such characters can be determined.

EUHAEMOGAMASUS OUDEMANSI (Hirst)

FIGURES 48, 49

Haemogamasus oudemansi HIRST, Bull. Ent. Res., vol. 5, pp. 122–123, pls. 14–16, 1914.—VITZTHUM, Zool. Jahrb. (Abt. Syst.), vol. 60, pp. 401–402, 1931.
Eulaelaps mawsoni WOMERSLEY, Australasian Antarctic Exped. 1911–1914: Scientific Rep., ser. C, Zool. and Bot., vol. 10, pt. 6, p. 19, pl. 12, figs. 4–7, 1937.

Female.—Dorsal shield widest at level of coxae II, not covering entire dorsal surface; with six pairs of pores. Usual pair of apical setae barbed and clearly largest setae on shield. Setae of shield relatively sparse, 30μ to 60μ apart and about 45μ in length; only usual pair of apical setae barbed. Base of each seta of unprotected dorsal integument with a spinelike posterior elongation; these setae slightly larger than those on shield; a few at lateral and posterior body margins barbed. Lacinae of tritosternum heavily barbed. Sutures of presternal area with spines. Sternal shield distinctive in that its posterior margin is invaginated to a level about midway between anterior and middle pairs of sternal setae. Anterior pair of sternal setae barbed. Shield sculptured; anterior pair of sternal pores nearly parallel with anterior margin of shield. Genitoventral shield relatively large and widely expanded posterior to coxae IV; extends more than two-thirds of distance between coxae IV and anal shield; possesses usual genitoventral setae and 10 to 20 accessory setae in a series of 14 specimens examined; mean was 15; all accessory setae are posterior to usual genitoventral setae and are smaller than the latter; usual genitoventral setae are smaller than sternal setae; all setae on shield are smooth. Anal shield nearly four-fifths as wide as long; possesses only the three usual anal setae; two small prominences are on the anterior margin of the shield. Anus about half its length from anterior margin of shield; posterior unpaired seta longest; all are smooth. Endopodal shields lacking. Metapodal shields long irregular rods or ovals. Peritreme distinctive in possession of a fenestra or invagination on median surface of posterior end in most specimens; posterior end of peritreme joined with coxal fovea; tubular portion extends to level of posterior third of coxae II. Metasternal setae smaller than sternal setae and larger than genitoventral setae. Ventral body setae with posteriorly elongate bases; about as large as dorsal setae but may be larger, more often barbed on posterior body margin. Epistome a slender, pointed spike; fimbriae simple on proximal portion of epistome, branched on its distal margin. Chelae about equal in length; fixed chela may be slightly the larger. Fixed chela nearly straight; with a bifid tip and one tooth; a slender seta between tip and tooth. Movable chela with a sharply curved tip and with two teeth. Anterior pair of maxillary setae smooth, the others barbed. Palpi with both barbed and smooth setae; most ventral setae barbed,

including those on coxa. Many barbed setae on legs. Stout ventral setae on leg II, III, and IV are distinctive. Legs relatively long and slender. Length-width ratios of tarsi are: Leg I 8:1, leg II 6:1, leg III 7:1, leg IV 9:1.

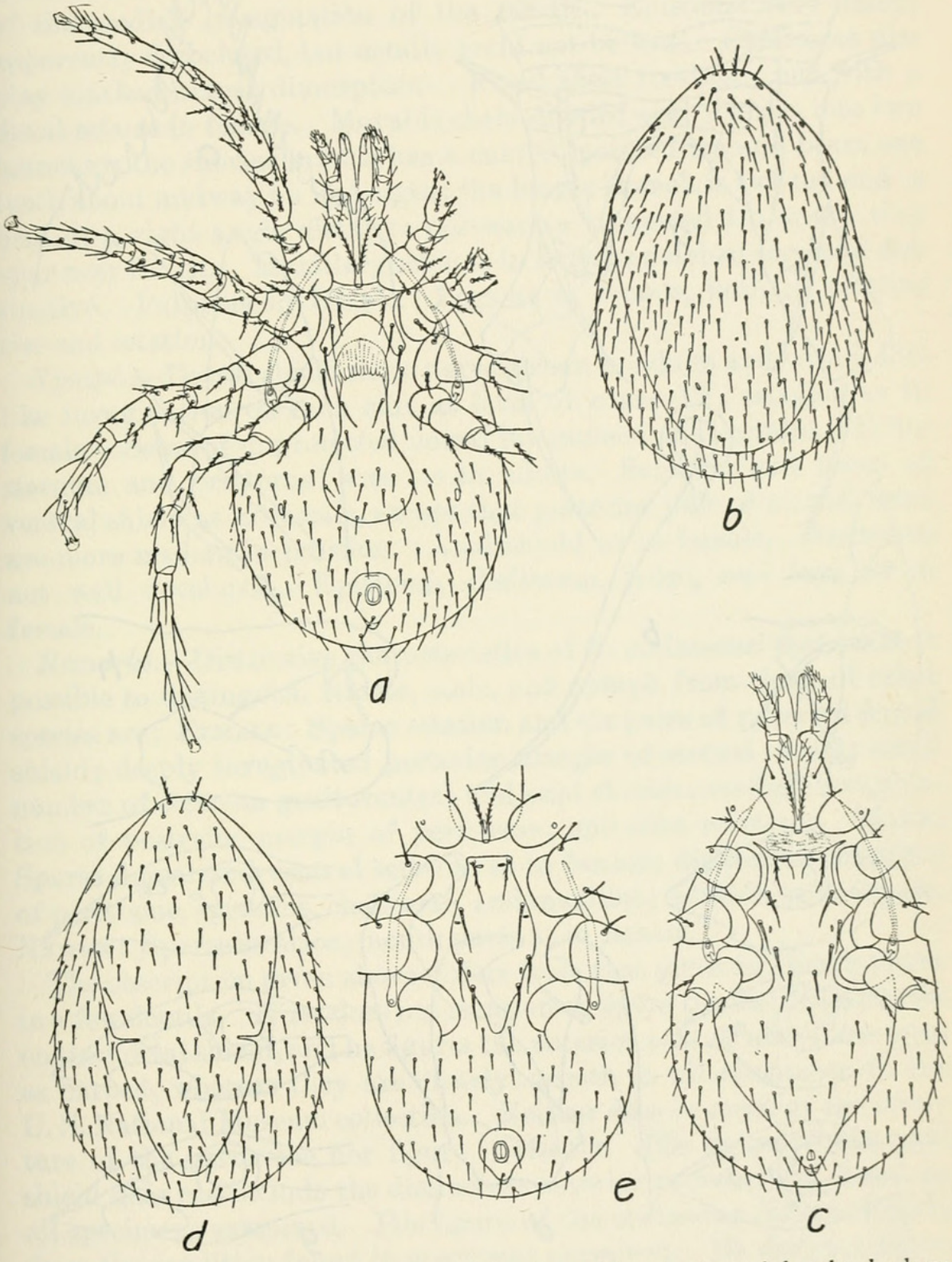

FIGURE 48.—*Euhaemogamasus oudemansi* (Hirst): *a*, Ventral view of female; *b*, dorsal view of female; *c*, ventral view of male; *d*, dorsal view of nymph; *e*, ventral view of nymph.

Male.—Only about two-thirds as large as female and relatively more narrow. Setation and pores of dorsal shield as in female. Setae of unprotected dorsal integument as in female. Ventral shield

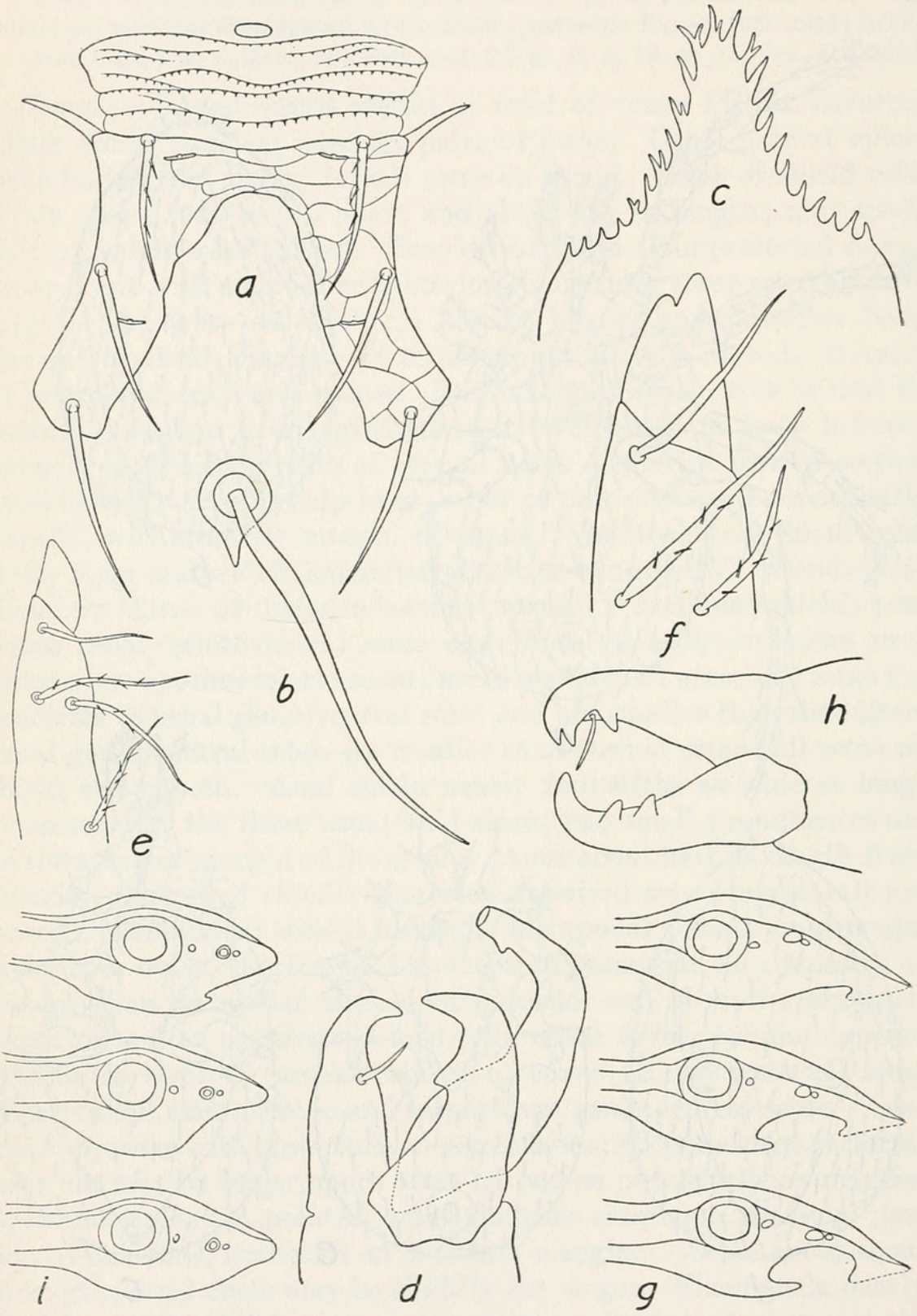

FIGURE 49.—*Euhaemogamasus oudemansi* (Hirst): *a*, Sternal shield of female; *b*, body seta of female; *c*, epistome of female; *d*, chelicera of male; *e*, cornicula of female; *f*, cornicula of male; *g*, peritremes of three female specimens; *h*, chelicera of female; *i*, peritremes of three male specimens.

widely expanded posterior to coxae IV and curved anteriorly lateral to coxae; does not cover entire ventral surface; setation as in female; pores as in female except that middle pair of sternal pores are not horizontal; anal region not abruptly set off from remainder of shield. Peritreme not joined to coxal fovea as in female; only an indication of the median invagination of the female. Epistome very faint; apparently fimbriated, but details could not be seen. Chelicerae display marked sexual dimorphism. Fixed chela toothless, but with a distal seta as in female. Movable chela divided near its base into two branches; the shorter branch has a curved, pointed tip and bears one tooth about midway on its length; the longer branch is twisted and is bent at a right angle distally; possesses a truncated tip and a tiny spur near the tip. Maxillary setae as in female; notched corniculi distinctive. Palpi as in female. Legs as in female, both in relative size and setation.

Nymph.—Dorsal shield more narrow than in adults and with a slitlike invagination on each side at level of coxae IV; setation as in female. Setae of unprotected dorsal integument as in adults. Tritosternum and presternal area as in adults. Setation and pores of ventral shield as in female, except that posterior pair of sternal setae are more median in position. Anal shield as in female. Peritreme not well developed. Epistome, chelicerae, palpi, and legs as in female.

Remarks.—Distinctive characteristics of *E. oudemansi* that make it possible to distinguish female, male, and nymph from those of other species are: Female: Sparse setation and six pairs of pores on dorsal shield; deeply invaginated posterior margin of sternal shield; small number of setae on genitoventral and anal shields; median invagination of posterior margin of peritreme; spikelike epistome. Male: Sparse dorsal and ventral setation as in female; distinctive structure of peritreme, epistome, chelicerae, and maxillae; setation as in female. Nymph: Sparse setation, mouth parts as in female.

The description given above differs from that given in Hirst's paper in a few details. Hirst does not mention or figure the distinctive pores on the dorsal shield, and he figures the anterior pair of maxillary setae as barbed, whereas they are clearly smooth in all specimens in the U. S. National Museum collection. Neither does he mention the structure of the peritreme nor figure it clearly. His figure of the anal shield does not include the distinctive anterior prominences found on all specimens examined. His figure of the chelicerae differs slightly from the condition found in specimens examined. He does not figure or mention the invagination on the lateral margins of the shield of the nympth.

Womersley's *Eulaelaps mawsoni*, as figured in his 1937 paper, is undoubtedly *E. oudemansi*.

Size.—Seven measurable females varied from 770μ to 952μ in body length; the mean was 856. It was impossible to obtain an accurate measurement of body width. Three males were 700μ, 686μ, 658μ in length; the width of the first two specimens was 364μ. Two nymphs measured 630μ and 616μ in length; the latter was 350μ in width. Hirst (1916) gives the length of the female as 1,100μ, the male 760μ, and the nymph 750μ.

Distribution.—Cosmopolitan; reported from England and South Africa by Hirst (1914) and from Maccuarie Island in the Australian Antarctic region by Womersley (1937). There are specimens in the U. S. National Museum collection from France, Holland, Italy, Portugal, and China. It has been taken in the United States at Ward, Colo., and in New York.

Hosts.—This species is apparently a facultative parasite. Hirst (1914) reported it from wild rats and raised numerous specimens on laboratory mice and rats. He also reported the species as taken from a bat in South Africa, from a mole's nest in England, and as free living in England. Specimens examined were found in a variety of habitats: Wheat straw, flax tow, rice straw, rice hulls, in sod, and associated with the clothes moth. It has been taken only three times in the United States: Once from a nest of *Tamiasciurus fremonti* at Ward, Colo., once associated with clothes moths in New York, and once on a rug in the same State. I have examined specimens as follows: On *Tigridia* bulbs, Holland, intercepted at quarantine at Philadelphia, Pa., May 13, 1946; wheat-straw jacket, France or Germany, at Cleveland, Ohio, August 10, 1945; in sod, Scotland, at New York, August 10, 1944; with flax tow, "Pacific area," Cleveland, Ohio, July 24, 1945; in wheat straw, Italy?, at Cleveland, Ohio, December 20, 1944; in straw jackets, Portugal, at Los Angeles, Calif., January 14, 1944; on rye-straw jacket, Scotland, at Buffalo, N. Y., September 29, 1938; in rye-straw packing, Portugal, at Portland, Oreg., July 8, 1944; in rice hulls, China, at Chicago, Ill., September 4, 1924; associated with clothes moth, New York, November 1928; in *Tamiasciurus fremonti* nest, Ward, Colo., July 2, 1940; on rug, New York, April 12, 1930; on *Marrubium vulgare*, Italy, at New York, May 25, 1936; on *Juncus* sp., Portugal, at Boston, Mass., July 5, 1944.

EUHAEMOGAMASUS LIPONYSSOIDES (Ewing)

FIGURE 50

Haemogamasus liponyssoides EWING, Proc. Biol. Soc. Washington, vol. 38, pp. 139–140, 1925.—VITZTHUM, Zool. Jahrb. (Abt. Syst.), vol. 60, p. 402, 1931.

Euhaemogamasus liponyssoides (Ewing) SPENCER, Proc. Ent. Soc. British Columbia, vol. 37, p. 15, 1941.

Female.—Dorsal shield sculptured; widest at level of coxae III. Usual pair of apical setae clearly largest on shield, flanked by two

pairs of smaller setae, one smaller seta between them. Setae of apical region larger than on remainder of shield; about 45μ in length and 9μ to 45μ apart; all setae on shield smooth. Setae of unprotected dorsal integument larger than those on shield, especially at posterior body margin; all are smooth. Lacinae of tritosternum smooth. Presternal area sculptured; sutures with tiny, posteriorly directed spines; in contact with slightly more than median third of the anterior margin of sternal shield. Posterior margin of sternal shield invaginated to a level about midway between posterior and middle pairs of usual sternal setae. Anterior pair of sternal setae on anterior margin of shield at junction of its lateral and median fourths; middle and posterior pairs of setae not on lateral margins of shield; middle pair of setae at least once and a half as far from posterior as from anterior pair, which are the smallest of the three. Anterior pair of sternal pores nearly parallel with another margin of shield. Genitoventral shield sculptured; relatively narrow; only slightly expanded posteriorly; usually about as wide as distance between coxae IV; accessory setae much smaller than usual genitoventral setae and distinctly posterior to the latter; in a series of 36 specimens numbers of accessory setae varied from 19 to 41. Only one specimen had more than 27 setae, and most possessed between 21 and 26; mean number in the series was 23.5. The anterior setae are slightly larger than those at the posterior margin of the shield; almost all setae are in posterior half of shield; all are smooth. Anal shield not quite as long as it is wide; in all but two of the specimens examined seven accessory setae and three usual anal setae were present. Accessory anal setae about as large as usual setae, although the most anterior accessory setae may be smaller than the others. Unpaired, usual anal seta is at posterior margin of shield proper and is largest seta on shield; all are smooth. Anus almost entirely in posterior half of shield. Metapodal shields irregular, almost always longer than wide. Endopodal shields present. Tubular portion of peritreme extends to posterior half of coxae II, posterior end of peritreme fused with fovea of coxa IV; of distinctive shape. Metasternal setae smooth and as large as posterior pair of sternal setae. A pair of longitudinal pores slightly anterior to bases of these setae. Ventral body setae larger than those of dorsal shield, especially at posterior body margin; all are smooth. Epistome narrow; with 7 to 10 usually simple, lateral fimbriae on each side and four or five branched distal fimbriae. Both chelae toothless; of about equal length. Movable chela may be slightly larger. Fixed chela nearly straight but gently curved in its distal third; terminates in a point, which may be filamentous, and bears a pilus dentilis at its base. Movable chela wider, rodike, terminating in a blunt tip, and grooved

and twisted on its longitudinal axis; it possesses membranous margins and is much wider than fixed chela. All maxillary and palpal setae smooth. Length-width ratios of tarsi of legs are: Leg I 6:1, leg II 4:1, leg III 6:1, leg IV, 8:1. All setae on legs are smooth.

Male.—Dorsal shield covers entire dorsal surface; setation as in female. Tritosternum and presternal area as in female. Ventral shield not covering entire ventral surface; expanded posteriorly to lateral margins of coxae IV; tapering gradually to a point in the anal region; bearing sternal, metasternal, usual, and accessory genitoventral setae and usual and accessory anal setae. Setae like those of female in size and position. Sternal pores as in female. Peritreme and epistome as in female. Chelicerae as in female except that proximal seta of fixed chela is lacking. Absence of sexual dimorphism is distinctive. Maxillae and palpi as in female. Relative size and setation of legs as in female; femur, genu, tibia, and tarsus of leg II each possess a conspicuously heavy ventral seta on tarsus with a thick proximal and slender distal portion. Length-width ratios of tarsi are: Leg I 6:1, leg II 4 or 4.5:1, leg III 6:1, leg IV 9:1 or 10:1.

Nymph.—Dorsal shield narrower that in female; setation as in adults; tritosternum and presternal area as in adults. Sternal shield with sternal and metasternal setae. Usual genitoventral setae flank posterior end of shield; setae as in adults in relative size and position, except that middle pair of sternal setae are on lateral margins of shield. Anal shield as in female but with only three usual and five anteriormost accessory setae; as in adults the posterior usual setae is largest on shield. Metapodal shields and ventral setation as in female. Peritreme not well developed. Epistome as in adults, but with fewer fimbriae, most of which are branched. Chelicerae, maxillae, and palpi as in adults. Relative size and setation of legs as in female.

Remarks.—Distinctive characteristics of *E. liponyssoides* that serve to distinguish female, male, and nymph from those of other species are: FEMALE: All setae smooth; lacinae of tritosternum smooth; presternal sutures with spines; posterior margin of sternal shield invaginated to level of midpoint between posterior and middle pairs of sternal setae; genitoventral accessory setae between 19 and 41 in number; in most specimens between 21 and 26; mean number 23.5; 7 accessory setae on anal shield; posterior usual anal seta largest on shield; shape of peritreme distinctive; epistome with 7 to 10 usually simple lateral fimbriae on each margin, and four or five branched distal fimbriae; both chelae toothless; a seta at proximal end of fixed chela. MALE: Dorsal shield covers entire dorsal surface; setation as in female except on leg II, on which femur, genu, tibia, and tarsus each possess

a conspicuously stout ventral setae; that on tarsus II with a thick proximal portion which abruptly narrows into a slender spike; ventral shield expanded posteriorly to lateral margins of coxae IV, from which it tapers to a point at the anal region; peritreme, epistome, and chelicerae as in female except that proximal seta of fixed chela is lack-

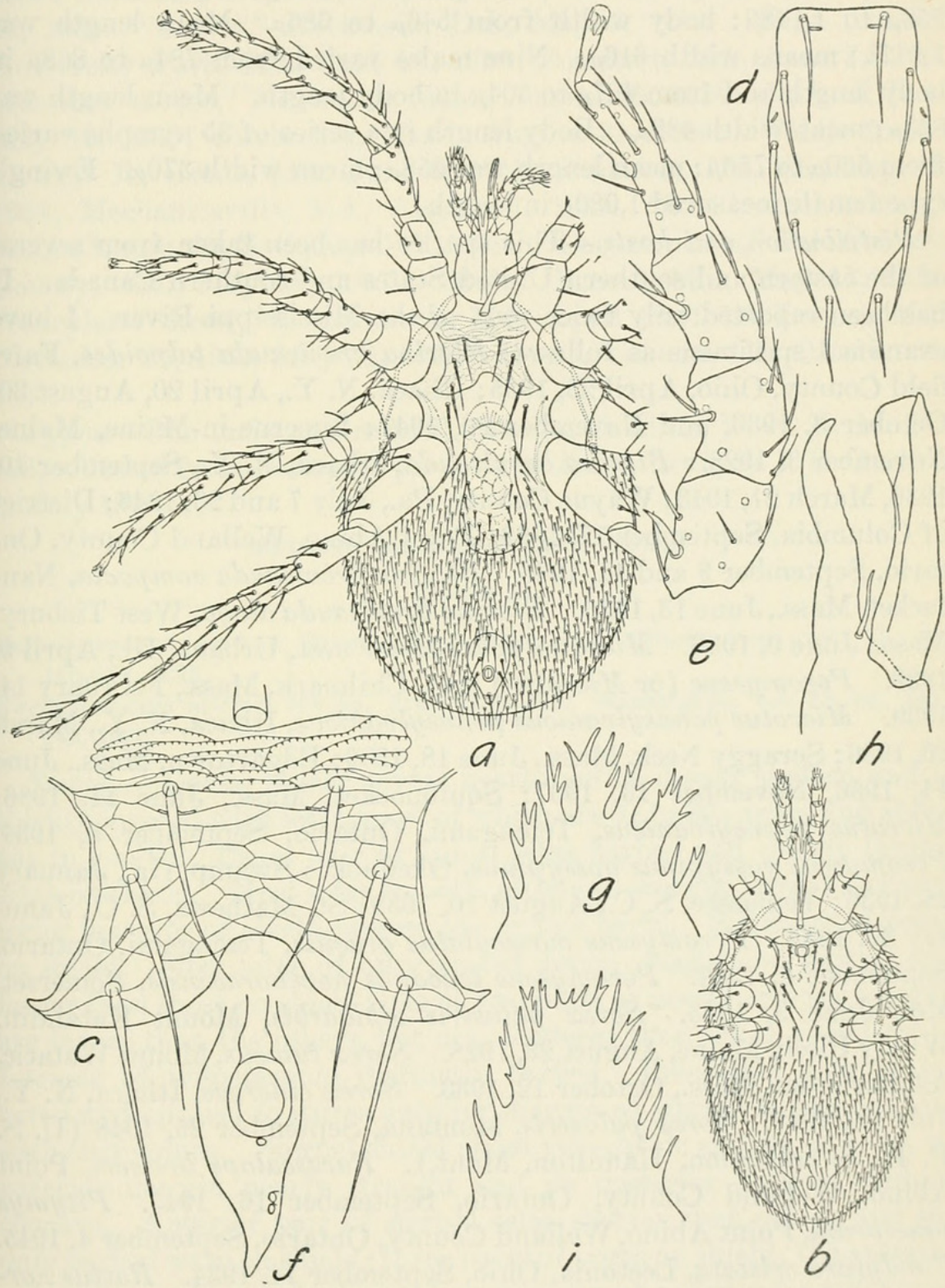

FIGURE 50.—*Euhaemogamasus liponyssoides* (Ewing): *a*, Ventral view of female; *b*, ventral view of male; *c*, sternal shield of female; *d*, ventral shield of nymph; *e*, ventrolateral view of leg II of male; *f*, posterior end of peritreme of female; *g*, epistome of nymph; *h*, chelicera of female; *i*, epistome of female.

ing; maxillae and palpi as in adults. NYMPH: Dorsal shield narrower than in female; setation as in adult female; tritosternum and peritremal area as in adults; setation of sternal shield as in adults; anal shield with three accessory and three usual anal setae; posterior usual seta largest on shield; mouth parts as in female; legs as in female.

Size.—In a series of 32 female specimens body length varied from 952μ to 1,148μ; body width from 546μ to 686μ. Mean length was 1,047μ; means width 616μ. Nine males varied from 784μ to 868μ in body length and from 427μ to 504μ in body length. Mean length was 833μ; mean width 482μ. Body length in a series of 35 nymphs varied from 560μ to 756μ; mean length was 658μ; mean width 370μ. Ewing's type female measured 1,080μ in length.

Distribution and hosts.—This species has been taken from several of the eastern and southern United States and southern Canada. It has been reported only twice west of the Mississippi River. I have examined specimens as follows: *Blarina brevicauda talpoides*, Fairfield County, Ohio, April 23, 1935; Ithaca, N. Y., April 20, August 30, October 3, 1936, and November 29, 1947; Lucerne-in-Maine, Maine, November 3, 1928. *Blarina brevicauda*, Ithaca, N. Y., September 10, 1936, March 21, 1943; Wayne County, Pa., July 7 and 23, 1945; District of Columbia, September 17, 1929; Point Abino, Welland County, Ontario, September 9 and 11, 1946. *Blarina brevicauda compacta*, Nantucket, Mass., June 13, 1936. *Blarina brevicauda aloga*, West Tisbury, Mass., June 9, 1936. *Microtus ochrogaster* nest, Urbana, Ill., April 9, 1939. *Peromyscus* (or *Microtus*) nest, Chilmark, Mass., February 14, 1939. *Microtus pennsylvanicus pennsylvanicus*, Ithaca, N. Y., March 26, 1936; Scraggy Neck, Mass., June 18, 1936; Edgartown, Mass., June 14, 1936, November 13, 1937; Squibnocket, Mass., June 11, 1936. *Microtus pennsylvanicus*, Temagami, Ontario, September 8, 1934. *Peromyscus gossypinus gossypinus*, Okefinokee Swamp, Ga., January 28, 1936; Yemassee, S. C., August 10, 1938; St. Mathews, S. C., January 30, 1935. *Peromyscus maniculatus gracilis*, Temagami, Ontario, September 8, 1934. *Peromyscus leucopus noveboracensis*, Somerset, Md., June 9, 1933. *Sorex palustris albibarbis*, Mount Katahdin, Windy Pitch, Maine, August 23, 1928. *Sorex fumeus*, Mount Watatic, Ashburnham, Mass., October 12, 1933. *Sorex cinereus*, Ithaca, N. Y., July 24, 1947. *Sorex palustris*, Montana, September 25, 1948 (U. S. P. H. S. collection, Hamilton, Mont.). *Parascalops breweri*, Point Abino, Welland County, Ontario, September 16, 1945. *Pitymys pinetorum*, Point Abino, Welland County, Ontario, September 4, 1945. *Condylura cristata*, Leetonia, Ohio, September 14, 1934. *Rattus norvegicus*, District of Columbia, February 28, 1946. *Clethrionomys gapperi rhoadsi*, Mays Landing, N. Y., May 16, 1931. *Sigmodon hispidus hispidus*, Grady County, Ga., January 8, 1947; Thomas County,

Ga., January 29 and 31, 1947 (C. D. C. collection, U. S. P. H. S. Thomasville, Ga.). *Didelphis virginiana pigra*, Decatur County, Ga., March 27, 1947. *Scalopus aquaticus howelli*, Decatur County, Ga., January 1947. "Short-tailed shrew," Riverdale, Md., June 3–4, 1934; Vineyard Haven, Mass., April 20, 1938; Silver Spring, Md., July 17, 1930; Takoma Park, Md., July 15, 1933; University Park, Md., June 27, 1936. "Shrew," Hockessin, Del., May 5, 1939. "Pine mouse," University Park, Md., June 27, 1936; Somerset, Md., June 8, 1938. "Meadow mouse," Menansha, Mass., August 29, 1936; Seaford, Del., May 12, 1936; Nantucket, Mass., August 31, 1936. "White-footed mouse," Riverdale, Md., June 8, 1938; Somerset, Md., January 17, 1934; Mechanicsville, Md., August 7, 1933. "Red-backed mouse," Smoke Mountain, N. C., April 17, 1931. "Cotton mouse," Dale County, County, Ala., May 18, 1937. "Mole," Laurel, Md., May 12, 1939. "Maryland shrew," Chestertown, Md., April 12, 1333; Laurel, Md., November 25, 1952, May 12, 1939. Host?, Urbana, Ill., October 18, 1937.

Types.—One male and several females, on slide, U. S. N. M. No. 948, collected from *Scalops argentatus* at Ames, Iowa, by J. E. Guthrie in July 1916.

EUHAEMOGAMASUS BARBERI (Ewing)

FIGURE 51

Haemogamasus barberi EWING, Proc. Biol. Soc. Washington, vol. 38, pp. 140–141, 1925.

Haemogamasus microti EWING, Proc. Biol. Soc. Washington, vol. 38, pp. 141–142, 1925.

Female.—Dorsal shield covers nearly entire dorsal surface and is thickly covered with setae, most of which are 9μ to 30μ apart and about 45μ in length. Usual pair of apical setae barbed and clearly largest setae on shield. Most setae smooth, although some at lateral and posterior margins of shield possess one or two barbs. Six pairs of pores on shield. Most setae of unprotected dorsal integument barbed and larger than those on shield; one or two pairs at posterior body margin are larger than the others, but are slenderer than usual apical setae. Lacinae of tritosternum distinctly barbed. Presternal area sculptured and applied to entire anterior margin of sternal shield; sutures with tiny spines. Sternal shield about two-thirds as long as wide, its anterior margin nearly straight and its posterior margin slightly concave. Anterior pair of sternal setae shorter than others and the only barbed setae on shield; three pairs of pores on shield; the anterior pair with median ends directed posteriorly at a distinct angle; posterior pair on posterior margin of shield. Genitoventral shield distinctive in being widely expanded posterior to coxae IV. Usual geni-

toventral setae only slightly larger than more anterior accessory setae, the latter present over the entire surface of the shield and slightly larger on the anterior portion of the shield; all setae smooth; outline of bulbous portion of shield varies individually; the large number of

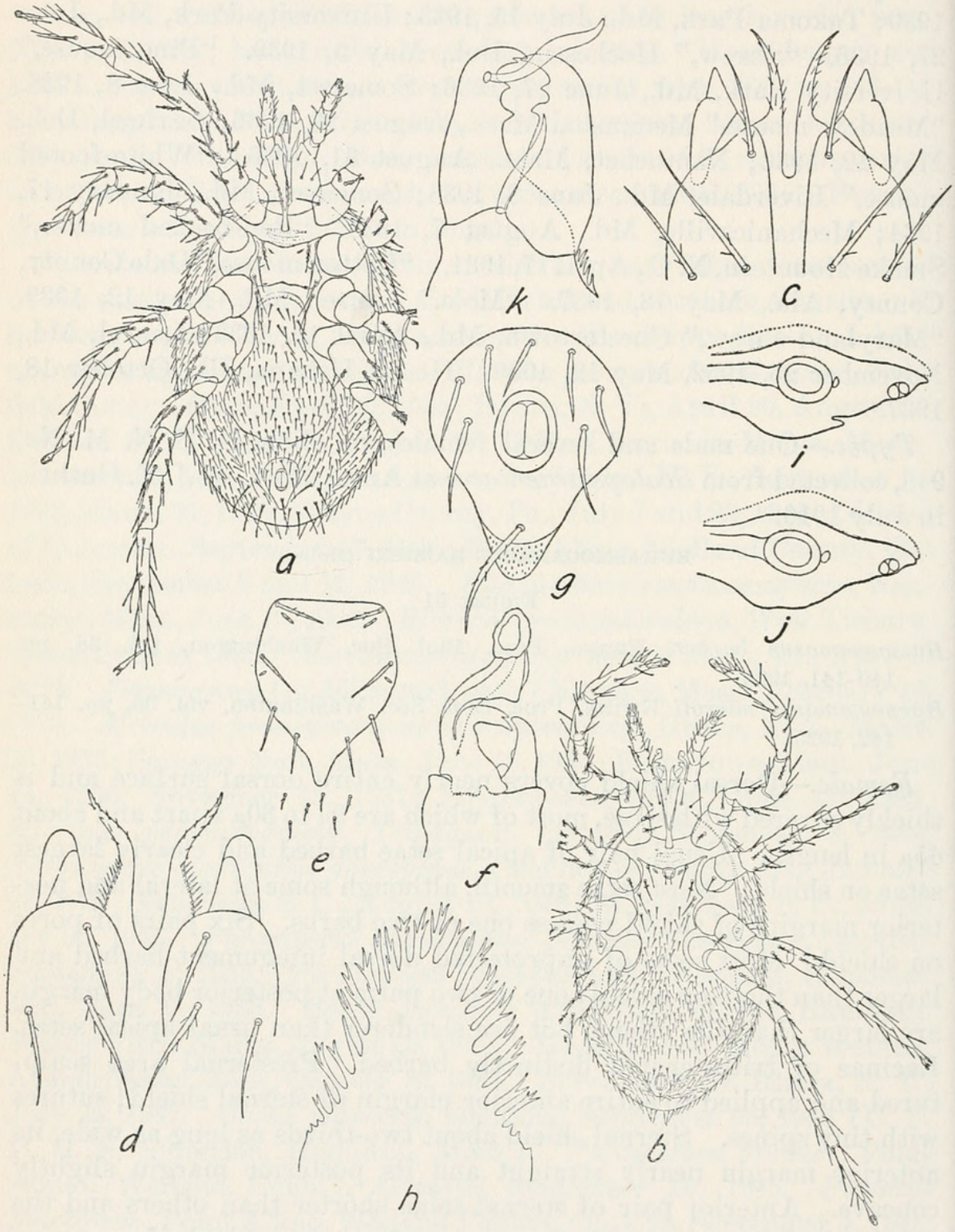

FIGURE 51.—*Euhaemogamasus barberi* (Ewing): *a*, Ventral view of female; *b*, ventral view of male; *c*, corniculi of female; *d*, corniculi of male; *e*, ventral shield of nymph; *f*, chelicera of male; *g*, anal shield of female; *h*, epistome of female; *i*, posterior end of peritreme of female; *j*, posterior end of peritreme of male; *k*, chelicera of female.

accessory setae, over 100 in all specimens examined, is distinctive, these setae larger than those of dorsal shield. Anal shield with three usual anal setae and five smaller, accessory setae; posterior usual seta barbed, largest on shield, and set distinctly anterior to cribum. Endopodal shields slender. Metapodal shields small and spindle-shaped in most specimens. Tubular portion of peritreme extends to anterior margin of coxae II; the median spur and invagination on posterior end of peritreme distinctive; posterior pores on median margin of peritreme. Metasternal setae smooth and about as large as anterior pair of sternal setae. Ventral body setae larger at margins of body, where many are barbed; one or two distinctly larger pairs at posterior body margin. Either lateral margin of epistome with about 12 fimbriae, most of which are multiple; epistome relatively broad. Fixed chela with a bifid tip, two teeth, an inflated laterally placed seta between tip and teeth, and a proximal seta. Movable chela stouter; possesses two teeth and a proximal, ventral, fringe of setae, the extent of which is difficult to determine. All maxillary setae barbed; maxillary corniculi narrow and slightly indented laterally. Many palpal setae barbed. Almost all setae on legs barbed; difference in size of dorsal and ventral setae not so great as in many species. Length-width ratios of tarsi are: Leg I 7 : 1, leg II 6 : 1, leg III 6.5 : 1, leg IV 8 : 1.

Male.—Dorsal shield covers almost entire dorsal surface; setation and pores as in female. Setae of dorsal integament, tritosternum, and presternal area as in female. Ventral shield widely expanded posterior to coxae IV and curved anteriorly lateral to coxae IV. Anal region distinct; accessory setae present as far anterior as level of posterior pair of sternal setae. Deeply angled anterior sternal pores as in female; setation throughout shield as in female. Ventral body setae as in female. Peritreme lacks median spur of female. Epistome as in female. Chelae show sexual dimorphism. Fixed chela lacks teeth but possesses a seta about midway on its length. Movable chela greatly modified; divided midway on its length into two branches, the shorter of which has a curved, distally bifurcate tip and lacks teeth; the larger branch, also toothless, is funnel-shaped and twisted on its longitudinal axis; a bursa and possibly setae present at base of fixed chela. Maxillary corniculi more blunt than in female. Palpi as in female. Setation of legs as in female except on leg II, where two conspicuously stout ventral setae were present on femur, one on genu, one on tibia, and two on tarsus. Legs may be relatively shorter than in female.

Nymph.—The only nymphal specimen is crushed, and an exact description is impossible. The resemblance of the epistome, chelicerae, and maxillae to those of the adult female indicates that it is the nymph of *barberi*. Although the ventral shield is very difficult

to determine, its setae and pores are as in adults; many setae of dorsal and ventral integument barbed; peritreme not well chitinized.

Remarks.—Distinctive characteristics that make it possible to distinguish female, male, and nymph of *E. barberi* from those of other species are: FEMALE: Usual apical setae largest on dorsal shield; many dorsal setae barbed; six pairs of dorsal pores; anterior pair of sternal setae barbed; anterior pair of sternal pores angled posteriorly; genitoventral shield widely expanded posteriorly; with over 100 accessory setae; anal shield with three usual anal setae and five smaller accessory setae; posterior usual anal seta largest on shield and barbed; about 12 multiple fimbriae on each lateral margin of epistome; each chela with two teeth; fixed chela with a bifid tip; all maxillary setae berbed; almost all setae on legs barbed. MALE: Setation of dorsal and ventral surfaces as in female; ventral shield widely expanded posterior to coxae IV and curved anteriorly lateral to coxae IV; anal region distinct; epistome as in female; structure of chelae distinct; all maxillary setae barbed; maxillary corniculi blunt; conspicuously stout ventral setae present on leg II as follows: Femur two, genu one, tibia one, tarsus two. NYMPH: Setation and mouth parts as in female.

Ewing (1925) described *E. barberi* as differing from *microti* only in having the outline of the epistome oval in *barberi* and not in *microti* and the marginal teeth of the epistome large and branched in *microti* and small and single in *barberi*. Results of examination of type material and of specimens from a variety of hosts in Maryland indicate that these species are synonymous and that on the basis of page priority *barberi* is the valid specific name. Outline of epistome and number of simple and multiple fimbriae on epistome may vary slightly among individual specimens, but not sufficiently or consistently enough to indicate a species distinction on that basis.

Size.—Thirty-two female specimens examined varied in length from 952μ to 1,092μ; mean was 1,025μ. It was possible to obtain accurate measurements of body width in only 12 specimens; in these it varied from 588μ to 644μ. Ewing gives the length of one of the type females as 1,050μ; its width as 720μ.

Distribution and hosts.—Ewing's type material of *barberi* was taken on the Maryland shore of the Potomac River near Plummers Island; type material of *microti* was from Bronxville, N. Y. Additional specimens in the U. S. National Museum collection were taken only from the eastern United States and southeastern Canada. I have examined specimens from the following hosts: *Pitymys pinetorum*, Point Abino, Welland County, Ontario, September 16, 1945. "Pine mouse," Willow Groove, Del., June 23, 1939; Petersburg, Va., April 1933;

College Park, Md., April 13 and 14, 1932, May 9, 1929, June 14, 1933; Chevy Chase, Md., June 7, 1932; Cabin John, Md., June 2, 1932; Burnt Mills, Md., March 24 and 29, 1932. "Albemarle meadow mouse," Petersburg, Va., April 6, 1933. "Meadow mouse," Somerset, Md., January 27, 1934. "Mouse nest," Great Falls, Va., December 26, 1926. "Short-tailed shrew," Riverdale, Md., May 27. 1934.

Types.—Two females (U.S.N.M. No. 950), from "nest of small mammal" from Maryland shore of Potomac River, near Plummers Island.

EUHAEMOGAMASUS QUADRISETATUS (Vitzthum)

FIGURE 55, *b*, *c*

Haemogamasus quadrisetatus VITZTHUM, Treubia, vol. 8, pp. 52–56, figs. 35–36, 1926; Zool. Jahrb. (Abt. Syst.), vol. 60, p. 400, 1931.

No specimens of this mite were available for study. The following data are taken from Vitzthum's paper.

Female.—Dorsal shield leaves much of posterior portion of dorsal surface unprotected. Almost all setae of entire animal barbed, but some on dorsal shield may be smooth. Dorsal body setae are larger at posterior body margin, where four of them are outstanding in length, being almost half as long as body of mite. Tritosternum barbed. Presternal area not mentioned or figured clearly. Sternal shield rectangular, with a nearly straight posterior margin; no indication is given whether sternal setae are barbed or smooth. Genitoventral shield flask-shaped, with the usual pair of genitoventral setae and about 30 accessory setae. About five accessory setae on anal shield. Peritreme not figured clearly. Endopodal shields not figured clearly. Metapodal shields small and in usual position. Metasternal setae about as large as those on sternal shield. Ventral body setae not so numerous as those on dorsal surface and larger than the latter. Fixed chela distally bent like a pointed hook; with a spoonlike excavation and a tiny tooth, which may actually be a pilus dentilis. Legs are not figured, but Vitzthum reports that the only smooth setae on them are those on tarsus I and on distal ends of other tarsi.

Size.—Length of female is given as 1,130μ.

Remarks.—Distinctive features seem to be: Almost all setae barbed; two pairs of greatly enlarged posterior body setae, each of these almost half as long as body; sternal shield with an almost straight posterior margin; genitoventral shield with about straight posterior margin; genitoventral shield with about 30 accessory setae; anal shield with 5 or 6 accessory setae; chelae toothless.

Distribution and host.—Taken only from *Mus lepturus*, Java.

Male and nymph.—Unknown.

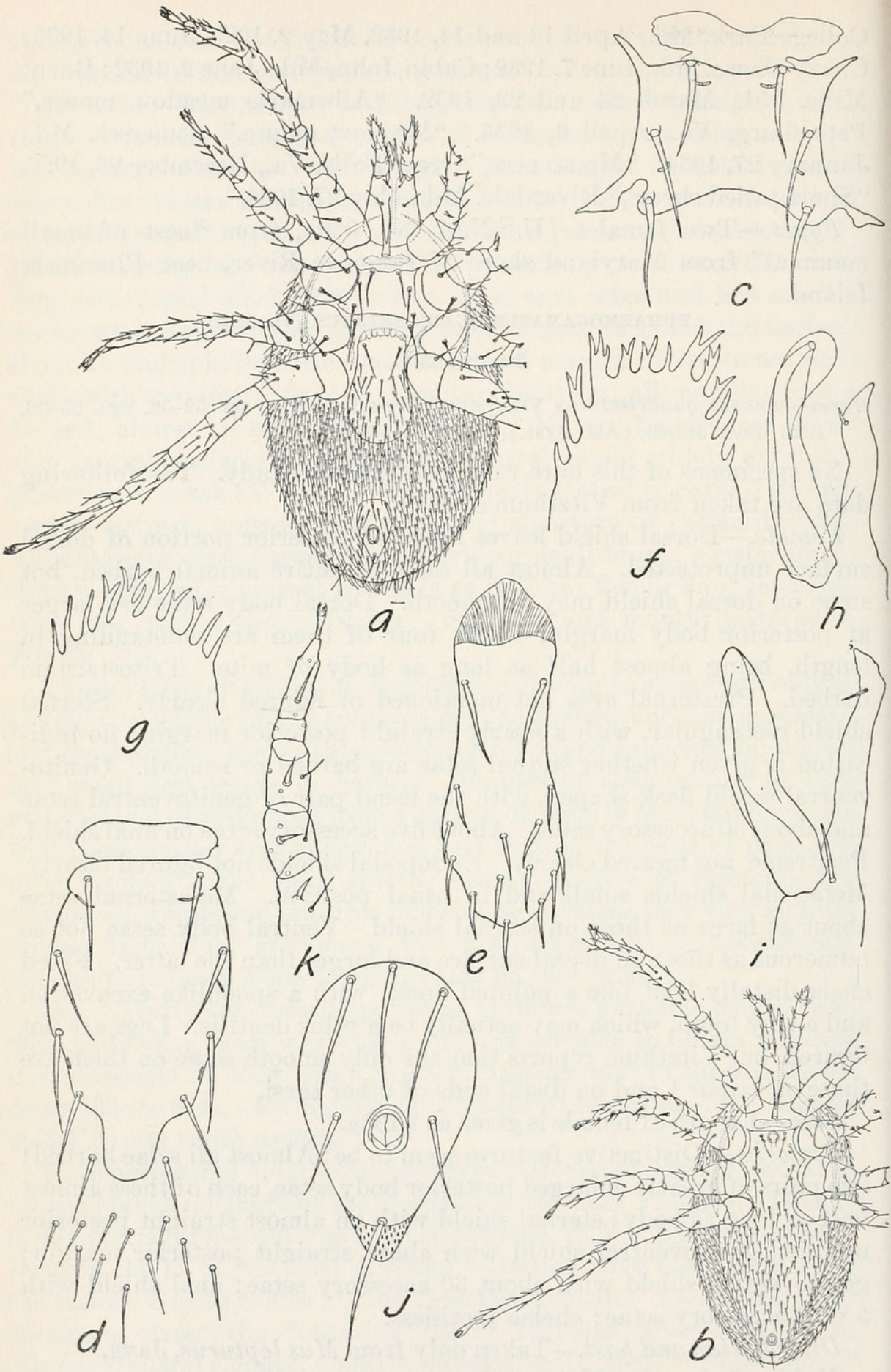

FIGURE 52.—*Euhaemogamasus liponyssoides occidentalis*, new subspecies: *a*, Ventral view of female; *b*, ventral view of male; *c*, sternal shield of intermediate female from Lake County, Oreg.; *d*, ventral shield of nymph; *e*, genitoventral shield of intermediate female from Lake County, Oreg.; *f*, epistome of intermediate female from Lake County, Oreg.; *g*, epistome of female; *h*, chelicera of male; *i*, chelicera of female; *j*, anal shield of nymph; *k*, ventrolateral view of leg II of male.

EUHAEMOGAMASUS LIPONYSSOIDES OCCIDENTALIS, new subspecies

FIGURE 52

Female.—Dorsal shield sculptured; may be broader than in *liponyssoides*. Usual pair of apical setae little, if any, longer than other setae of apical region and only slightly larger than many setae of remainder of shield. Setae over entire shield posterior to apical region 9μ to 46μ apart and of two types: the smaller about 45μ in length, the larger about 80μ long; the smaller ones are more numerous; all setae are smooth. Setae of unprotected dorsal integument about same length as larger setae of shield, longest at posterior body margin; all are smooth. Lacinae of tritosternum barbed. Presternal area with faint indications of spines on sutures. Sternal shield differs from that of *liponyssoides* in having its posterior margin nearly straight rather than invaginated. Genitoventral shield with more numerous accessory setae than in *liponyssoides;* these varied in number from 28 to 35 in a series of 13 specimens; mean was 32. One distorted specimen, not included in the above series, seems to possess about 45 accessory setae. Anterior margin of anal shield nearly straight in some specimens; setation of shield as in *liponyssoides*, with three usual anal setae and seven accessory setae. Endopodal shields distinct. Metapodal shields as in *liponyssoides*. Metasternal setae about as large as posterior pair of sternal setae. Setae of ventral integument slightly farther apart than those of dorsal shield and, like them, of two types; in general they are larger than setae of the dorsal shield and are largest at posterior and lateral margins of body; one larger pair flanks a bare spot posterior to the anal shield; all are smooth. Posterior end of peritreme does not seem to be fused with coxal fovea; tubular portion of peritreme extends to level of posterior third of coxae II. Epistome not pointed as in *liponyssoides;* almost all fimbriae distal in position and not numbering more than 10 or 12. Lateral margins of epistome nearly parallel. Chelicerae as in *liponyssoides* except that fixed chela possesses a distal seta as well as a proximal one. Maxillary and palpal setae smooth. Length-width ratios of tarsi of legs are: Leg I 5:1, leg II 4:1, leg III 4:1, leg IV 8:1. All setae are smooth.

Male.—Setae of dorsal shield more nearly uniform in size than in female; tritosternum and presternal area as in female, although spines on presternal sutures may be more distinct than in the female. Setation of ventral shield as in female; usual sternal setae not on lateral margins of shield; shape of shield as in *liponyssoides*. Endopodal and metapodal shields incorporated in ventral shield. Peritreme and epistome as in female. Ventral body setae as in female. Chelicerae differ from those of female in having fixed chela distinctly shorter than movable chela, relatively thicker, and bearing only a very tiny distal seta. Movable chela rodlike with a slightly curved distal end

and a truncated tip; this chela is surrounded by an irregular bursa. Maxillae and palpi as in female. Setation of legs as in female except that on leg II femur, genu, tibia, and tarsus each bear a conspicuously stout, ventral seta. Length-width ratios of tarsi as in female.

Nymph.—Setae of dorsal shield less numerous than in adults; nearly uniform in size in most specimens; all are smooth. Tritosternum and presternal area as in female. Ventral shield as in *liponyssoides* except that posterior end may be more distinctly set off from remainder of shield. As in female, accessory genitoventral setae are present immediately posterior to usual genitoventral setae. A pair of pores on lateral margins of shield between metasternal and posterior pair of sternal setae. Anal shield with only the three usual anal setae and three most anterior accessory setae; shield may be narrower than in the nymph of *lipondyssoides*; anterior margin of shield rounded. Endopodal shields very slender. Peritreme not well chitinized. Epistome and chelicerae as in adult female. Maxillae as in adults. Palpi may be relatively thicker than in adults. Setation of legs as in female.

Size.—Most females available for study were distorted so that accurate measurements were impossible to obtain. In six specimens body length varied from 1,036μ to 1,400μ; body width from 574μ to 798μ. Mean length was 1,171μ; mean width 730μ. In six measurable male specimens body length varied from 952μ to 1,050μ, body width from 546μ to 588μ. Six measurable nymphs varied in length from 677μ to 826μ. It was possible to obtain only two accurate measurements of body width. One specimen, 826μ long, was 420μ wide; the other was 742μ long and 432μ wide. The latter specimen may have been slightly distorted.

Remarks.—Distinctive characteristics of this subspecies that serve to distinguish female, male, and nymph from those of *liponyssoides* are: FEMALE: Usual pair of apical setae of dorsal shield little if any larger than other setae of apical region; large and small setae interspersed on dorsal shields; lacinae of tritosternum barbed; spines on presternal sutures indistinct; posterior margin of sternal shield nearly straight; genitoventral shield with 28 to 35 accessory setae; anterior margin of anal shield nearly straight; almost all fimbriae of epistome distal in position and not totaling more than 10 or 12 fixed chela with a distal seta as well as a proximal one. MALE: Setae of dorsal shield more nearly uniform in size than those of female; as in female, usual setae little if any larger than other setae of apical region; ventral setation and epistome as in female; fixed chela distinctly shorter and thicker than in female and with a tiny distal seta; movable chela rodlike with a truncated tip and surrounded by an irregular bursa. NYMPH: Some indication of two types of setae on dorsal shield; ac-

cessory setae immediately posterior to usual genitoventral setae; epistome as in adult female; chelicerae as in female.

Measurements indicated that male, female, and nymph of this form are larger than those of *liponyssoides*.

Distribution and hosts.—All specimens of *occidentalis* have been taken from northwestern United States and southwestern Canada. Records: *Mustela saturata*, Linton, Oreg., May 22, 1933. *Scapanus townsendii*, Olympia, Wash., June 25, 1934; Wilsonville, Oreg., May 10, 1938; Lake County, Oreg., November 7, 1934; Clackamas County, Oreg., May 30, 1932; Castle Rock, Wash., March 30, 1927. *Scapanus orarius schefferi*, Vancouver, British Columbia, March 29, 1938. *Scapanus orarius*, Olympia, Wash., August 16, 1926. *Neürotrichus* sp., Netarts, Oreg., March 24, 1930; Portland, Oreg., June 23, 1933. Nest of *Microtus townsendii*, Portland, Oreg., June 23, 1933. *Microtus townsendii*, Portland, Oreg., Dec. 6, 1931. *Sorex trowbridgii*, Calaveras Dam, Alameda County, Calif., April 15, 1945. *Thomomys fuscus*, Colfax, Wash., April 14, 1927. *Blarina brevicauda talpoides*, Morgan, Utah, August 31 and September 8, 1931.

Type.—A female (U. S. N. M. No. 1886) taken from nest of *Microtus townsendii* at Portland, Oreg., on December 24, 1931, by S. G. Jewett, Jr.

Paratypes.—A male on slide with type, two females, one male, two nymphs, from *Scapanus townsendii*, Wilsonville, Oreg., May 10, 1938, H. H. Stage, Bish. No. 17174; three females, one nymph, from *Scapanus townsendii;* Lake County, Oreg., November 7, 1934, H. H. Stage, Bish. No. 17075; two nymphs, from *Scapanus townsendii;* Castle Rock, Wash., March 30, 1927, Leo K. Couch; one male, from *Thomomys fuscus*, Colfax, Wash., April 14, 1927, Leo K. Couch.

Discussion.—The three paratype females and single nymph from *Scapanus townsendii*, Lake County, Oreg., exhibit some characteristics that seem to be intermediate between *liponyssoides* and *occidentalis*. Distinctive features of these specimens are: Dorsal shield relatively narrower than in other specimens of *occidentalis;* setae on shield of nearly uniform size. Sternal shield intermediate in outline between *liponyssoides* and *occidentalis* in that its posterior margin is invaginated to a level slightly anterior to posterior pair of sternal setae; distance between middle pair of setae and anterior and posterior pairs about equal. Genitoventral shield relatively narrower than in either *liponyssoides* or *occidentalis* and with fewer accessory setae: 10, 13, and 13 on the three females on the slide. Anal shield may be relatively shorter than in *liponyssoides* or *occidentalis;* posterior pair of accessory setae only slightly anterior to anus. Ventral body setae slightly smaller than those of dorsal shield. Shape of posterior end of peritreme distinctive. Epistome with five to eight lateral fimbriae on each side.

ISCHYROPODA, new genus

Sternal shield with accessory setae; at least leg II conspicuously stout and with spurs and massive, often blunt, setae especially on tarsus; anal shield of male separate; accessory setae present on ventral shield of nymph.

Genotype: *Ischyropoda spiniger*, new species.

KEY TO FEMALES OF ISCHYROPODA

1. Movable chela toothless; all setae on dorsal shield smooth; leg I with a stout, posteriorly directed coxal spur; genu of leg II with a similar spur. spiniger, new species.
   Both chelae with teeth 2
2. Many setae on dorsal shield barbed; coxa I and genu II without spurs. armatus, new species.

ISCHYROPODA SPINIGER, new species

FIGURE 53

Female.—Body broad but distinctly pointed anteriorly. Dorsal shield relatively short, with a blunt, slightly indented posterior margin; much of dorsal surface unprotected. Usual pair of apical setae situated immediately anterior to shield, smooth and shorter than setae on the shield, and flanked by a pair of smaller setae; all setae of shield smooth, 30μ to 40μ apart, and relatively large, being 80μ to 120μ in length. Shield sculptured. Setae of unprotected dorsal integument smooth and those on the posterior body margin longer and slenderer than those on the shield. Tritosternum barbed. Presternal area sculptured but sutures lack spines. Sternal shield not clearly outlined, its lateral and posterior margins somewhat irregular; usual sternal setae smooth and larger than accessory setae, which number 28, 27, and 23 in specimens available for study and are scattered over the shield in no apparent pattern; these are of various sizes but are larger near margins of the shield; none are present on the anterior margin of the shield; all are smooth. Anterior pair of sternal pores nearly parallel with anterior margin of shield; lateral end of posterior pair of pores in contact with lateral margins of shield; shield sculptured. Genitoventral shield relatively narrow, about three and one-half times as long as wide and with nearly parallel lateral margins and an irregularly rounded, almost truncate posterior margin; possesses usual pair of genitoventral setae and several almost equally as large accessory setae; these numbered 6, 7, and 8 in the three females examined. Anal shield of distinctive shape, with nearly lateral margins and only very roughly triangular; three usual anal setae present, all much smaller than adjacent ventral body setae; the posterior unpaired seta nearer to the anus than to the posterior margin of the shield and not quite half as large as the paired setae. Endopodal shields very slender. Metapodal shields small and oval; in addi-

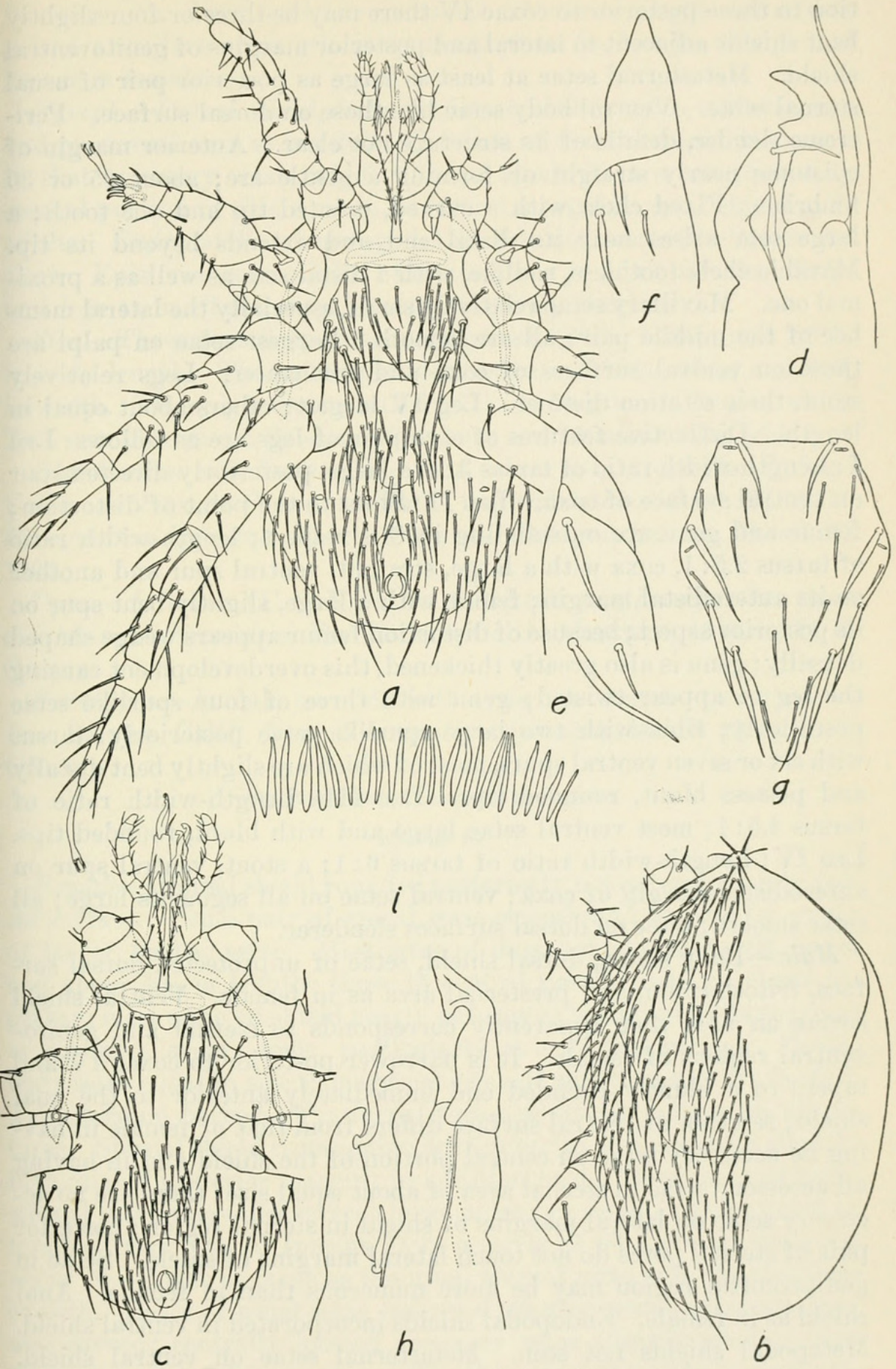

FIGURE 53.—*Ischyropoda spiniger*, new species: *a*, Ventral view of female; *b*, dorsal view of female; *c*, ventral view of male; *d*, chelicera of female; *e*, cornicula of female; *f*, cornicula of male; *g*, ventral shield of nymph; *h*, chelicera of male; *i*, epistome of female.

tion to those posterior to coxae IV there may be three or four slightly bent shields adjacent to lateral and posterior margins of genitoventral shield. Metasternal setae at least as large as posterior pair of usual sternal setae. Ventral body setae like those on dorsal surface. Peritreme slender, details of its structure not clear. Anterior margin of epistome nearly straight or forming a gentle arc; about 25 or 30 fimbriae. Fixed chela with a curved, pointed tip and one tooth; a large seta arises near its distal end and extends beyond its tip. Movable chela toothless, rodlike, with a distal seta as well as a proximal one. Maxillary setae relatively small, especially the lateral member of the middle pair; all are smooth. Largest setae on palpi are those on ventral surfaces of coxa and trochanter. Legs relatively stout, their setation distinct. Leg IV largest; others about equal in length. Distinctive features of each pair of legs are as follows: Leg I: Length-width ratio of tarsus 3 : 1, a large, posteriorly directed spur on ventral surface of coxa. Leg II: Stout to the point of distortion; femur and genu are outstanding in this respect; length-width ratio of tarsus 2.5 : 1, coxa with a large, straight, ventral spur and another on its anterodistal margin; femur with a large, slightly bent spur on its posterior aspect; because of distortion femur appears wedge shaped dorsally; genu is also greatly thickened, this overdevelopment causing the leg to appear twisted; genu with three of four spurlike setae posteriorly; tibia with two large spurlike setae posteriorly; tarsus with six or seven ventral spurs, most of which are slightly bent distally and possess blunt, rounded tips. Leg III: Length-width ratio of tarsus 4.5 : 1; most ventral setae large and with blunt, rounded tips. Leg IV: Length-width ratio of tarsus 6 : 1; a stout, ventral spur on anterodistal margin of coxa; ventral setae on all segments large; all setae smooth; setae on dorsal surfaces slenderer.

Male.—Body shape, dorsal shield, setae of unprotected dorsal surface, tritosternum, and presternal area as in female. Ventral shield covers an area that apparently corresponds to sternal and genitoventral regions of female. It is narrower posterior to coxae IV and tapers to a bluntly rounded end immediately anterior to the anal shield; setation of ventral surface differs from that of female in having no accessory setae on central portion of the shield and in having all accessory setae in sternal area of about equal size; there are no accessory setae on lateral margins of shield in sternal region; posterior pair of sternal pores do not touch lateral margins of shield. Setae in genitoventral region may be more numerous than in female. Anal shield as in female. Endopodal shields incorporated in ventral shield. Metapodal shields not seen. Metasternal setae on ventral shield. Ventral body setae as in female. Peritreme not clear. Epistome as in female. Chelae show sexual dimorphism; exact relationship of structures present to those of female not clear. Fixed chela toothless; with

two setae, one distal and one proximal. Anterior single and middle paired maxillary setae relatively closer than in female. Palpi and legs as in female.

Nymph.—Dorsal shield, dorsal and ventral body setae, tritosternum, and presternal area as in adult. Setation of ventral shield as in male in that accessory setae, which number about 20, are not present in central portion of shield or on its lateral margins. Anal shield as in adults. Endopodal and metapodal shields not seen. Peritreme not clear. Epistome as in adults. Chelicerae as in adult female. Palpi and legs as in adults, may be even relatively shorter.

Size.—Three female specimens measured 1,550μ, 1,540μ, and 1,375μ in body length. The same specimens measured 900μ, 950μ, and 850μ in width. The only male measured 1,175μ in length and 750μ in width. Two nymphs were 1,050μ and 955μ long and 650μ and 625μ wide.

Distribution and hosts.—Has been taken only from Dos Palmos, Calif., on *Perognathus penicillatus angustirostris*, March 23, 1934; *Perognathus spinatus*, March 1934; and *Perognathus* sp., March 25, 1934.

Type.—A female (U. S. N. M. No. 1887) taken on *Perognathus penicillatus angustirostris* at Dos Palmos, Calif., March 23, 1934, by H. S. Gentry.

Paratypes.—A male on slide with type, one female, two nymphs, Dos Palmos, Calif., from *Perognathus spinatus*, March 1934, H. S. Gentry.

ISCHYROPODA ARMATUS, new species

FIGURE 54

Female.—Dorsal shield rounded posteriorly not covering entire dorsal surface. Usual pair of apical setae smooth and flanked by a pair of larger, barbed setae. Most setae of dorsal shield 20μ to 40μ apart and about 40μ in length; those in central portion may be closer together; most setae on shield nearly as large as usual apical setae; some at margins larger; some, particularly at margins, barbed. Dorsal body setae equal in size to marginal setae of shield; many are barbed. Tritosternum barbed. Presternal area sculptured; spines on all sutures. Sternal shield rectangular, with rounded corners and a slightly invaginated posterior margin; in addition to the three pairs of usual sternal setae there are several large accessory setae, which varied in number from 5 to 10 (means 7) in a series of 23 females; these are about two-thirds as large as the usual sternal setae and like them are smooth. Bases of usual setae embossed; sternal pores relatively long and curved; centrally located accessory setae slightly smaller than those more lateral in position. Genitoventral shield bulbous posteriorly and not reduced in size; only setae on anterior half of shield are usual pair of genitoventral setae; accessory setae are smaller and

varied in number from 19 to 28 in a series of 15 specimens; mean was 24. Anal shield with three usual anal setae and two larger accessory setae; posterior usual seta smallest on shield; all setae smooth; usual setae

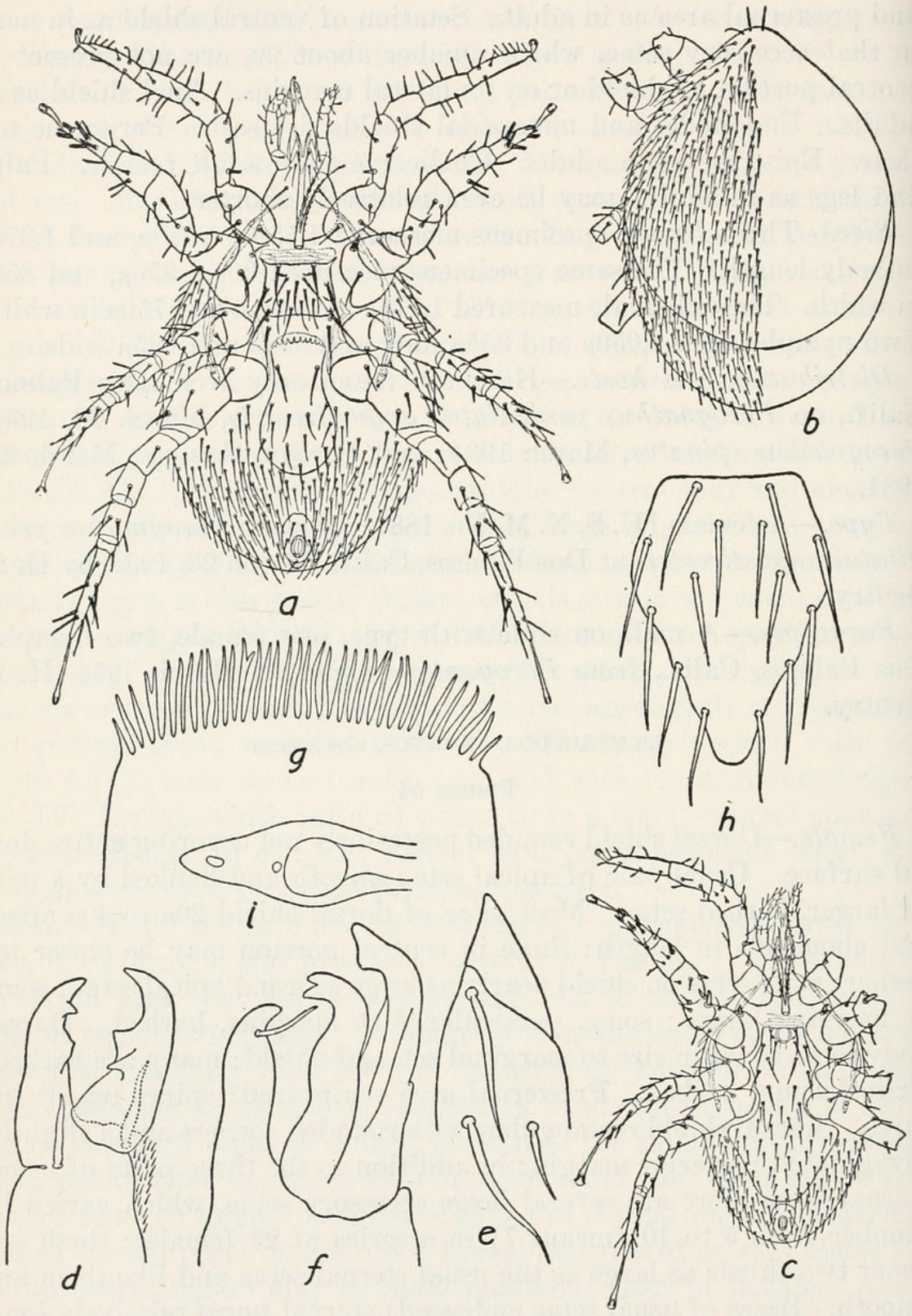

FIGURE 54.—*Ischyropoda armatus*, new species: *a*, Ventral view of female; *b*, dorsal view of female; *c*, ventral view of male; *d*, chelicera of female; *e*, cornicula of female; *f*, chelicera of male; *g*, epistome of female; *h*, ventral shield of nymph; *i*, posterior end of peritreme of female.

smaller than adjacent ventral body setae; two faint prominences on anterior margin of shield; postanal seta closer to cribriform area than to anus. Endopodal shields well developed. Metapodal shields small and irregular in outline. A small, oval pore immediately anterior to each metasternal seta. Ventral body setae slightly smaller than those of dorsal shield, some barbed, largest at posterior body margin. Posterior end of peritreme blunt and not joined to coxal fovea. Epistome with a nearly straight or gently curved anterior margin and with about 30 fimbriae, some branched. Fixed chela nearly straight, with two teeth and a gently curved tip; a proximal seta present. Movable chela also with two teeth; distinctive in having tip bent at a right angle; a large seta and a fringe of small setae at base of chela. Maxillary setae smooth; as in *spiniger* the lateral member of the middle pair is smallest. All palpal setae smooth. Legs relatively longer and slenderer than in *spiniger*; dorsal setae of legs relatively small and slender; ventral setae stout, spurlike. Distinctive features of each leg are: Leg I: Tarsus distinctive in tapering gradually toward its distal end rather than being nearly cylindrical throughout its length; length-width ratio of tarsus 6:1. Leg II: Relatively thicker than others; a stout spur on anterodistal margin of coxa; two spurlike ventral setae on tibia and five or six on tarsus; some, but not all, blunt-tipped as in *spiniger*; length-width ratio of tarsus 4:1. Leg III: Trochanter with two, tarsus with six or seven large, ventral spurlike setae; length-width ratio of tarsus 6:1. Leg IV: Trochanter, femur, genu, and tibia each with one or two spurlike setae; tarsus with six or seven ventral spurlike setae; length-width ratio of tarsus 8:1:

Male.—Dorsal shield covering nearly entire dorsal surface; setae may be more numerous and relatively smaller than on female. Dorsal body setae as in female but sometimes slightly smaller. Tritosternum and presternal area as in female. Ventral shield expanded posteriorly nearly to lateral margins of coxae IV; setation differing from that of female in having only two pairs of accessory setae present anterior to coxae IV. Anal shield as in female. Metapodal shields distinct; adjacent to or in contact with lateral margins of ventral shield. Ventral body setae, peritreme, and epistome as in female. Chelae much like those of the male of *spiniger*, exact details of structure are impossible to determine in specimens available for study. Palpi as in female. Legs differ from those of female in following respects: Femur of leg I with a stout ventral spur near its proximal margin; femur of leg II with two large, blunt, ventral spurs; trochanter of leg III with distal margin prolonged into a spur; trochanter of leg IV with two large spurs, one of which is blunt.

Nymph.—Relatively shorter than adults; dorsal shield, dorsal body setae, tritosternum, and presternal area as in female. Only two pairs

of accessory setae on ventral shield. Anal shield as in adults but lacking accessory setae. Endopodal shields slenderer than in female. Ventral body setae as in female. Metapodal shields more oval than in adults. Peritreme not well developed. Epistome as in adults. Chelae, maxillae, palpi, and legs as in female.

Size.—In 15 measurable female specimens, body length varied from 925 μ to 1,225 μ; body with from 450 μ to 760 μ; mean length was 1,047μ; mean width 657μ. Three male specimens measured 840μ, 850μ, and 875 μ in length; body width in each of these specimens was 500 μ. Three nymphs measured 800 μ in body length; one of these measured 485 μ in width; another was 500 μ in width; one specimen was 850μ in length.

This species differs from *I. spiniger* in many respects, of which the following are outstanding: FEMALE: Many of dorsal setae barbed; sutures of presternal area with spines; less than half as many accessory sternal setae as *spiniger*; sternal shield rectangular with rounded corners; genitoventral shield flask-shaped; with over twice as many accessory setae as *spiniger*; anal shield with only two accessory setae; both chelae with teeth; legs slenderer than in *spiniger* and lacking heavy spur on coxa of leg I and coxa and femur of leg II; tarsus I slender, tapering gradually toward distal end; most setae of legs small and slender. MALE: Dorsal shield covers nearly entire dorsal surface; ventral shield expanded posterior to coxae IV; with only two pairs of accessory setae anterior to coxae IV; special setation of legs. NYMPH: Setation and chelae as in female; only two pairs of accessory setae on ventral shield.

Distribution and hosts.—This species has been taken from Arizona, California, Colorado, and New Mexico on the following: *Thomomys bottae*, Colorado Desert, Calif., February 17, 1934; *Thomomys* sp., Lincoln County, N. Mex., July 16 and 19, 1947; *Dipodomys merriami merriami*, Westmorland, Calif., July 21, 1933; *Dipodomys deserti deserti*, Westmorland, Calif., July 21, 1933; *Dipodomys merriami simiolus*, Dos Palmos, Calif., March 1934; *Peromyscus maniculatus rufinus*, Mogollon Mountains, N. Mex., August 30, 1933; *Peromyscus* sp., Monterey, Calif., December 30, 1948 (Bureau of Vector Control collection, California Department of Public Health); *Neotoma albigula*, Santa Rita Mountains, Ariz., May 18, 1939; *Perognathus* sp., Monterey, Calif., October 21, 1940; *Perognathus californicus*, Monterey, Calif., July 9, 1939; *Perognathus inornatus*, Kern County, Calif., March 26, 1930; *Perognathus xanthonotus*, Kern County, Calif., April 19, 1930; *Onychomys leucogaster arcticeps*, Logan County, Colo., September 30, 1926; *Citellus* burrow, Davis, Calif., August 12, 1948; "spiny pocket mouse," Pasadena, Calif., April 4, 1933 (Bureau of Vector Control collection, California Department of Public Health).

Type.—A female (U. S. N. M. No. 1888) taken on *Thomomys bottae*, Colorado Desert, Calif., February 17, 1934, by H. S. Gentry.

Paratypes.—Three females, one nymph, from *Dipodomys merriami merriami*, Westmorland, Calif., July 21, 1933, collected by H. S. Gentry; two nymphs from *Dipodomys merriami simiolus*, Dos Palmos, Calif., March 1934, collected by H. S. Gentry; one male from *Neotoma albigula*, Santa Rita Mountains, Ariz., May 18, 1939, collected by C. A. Flock.

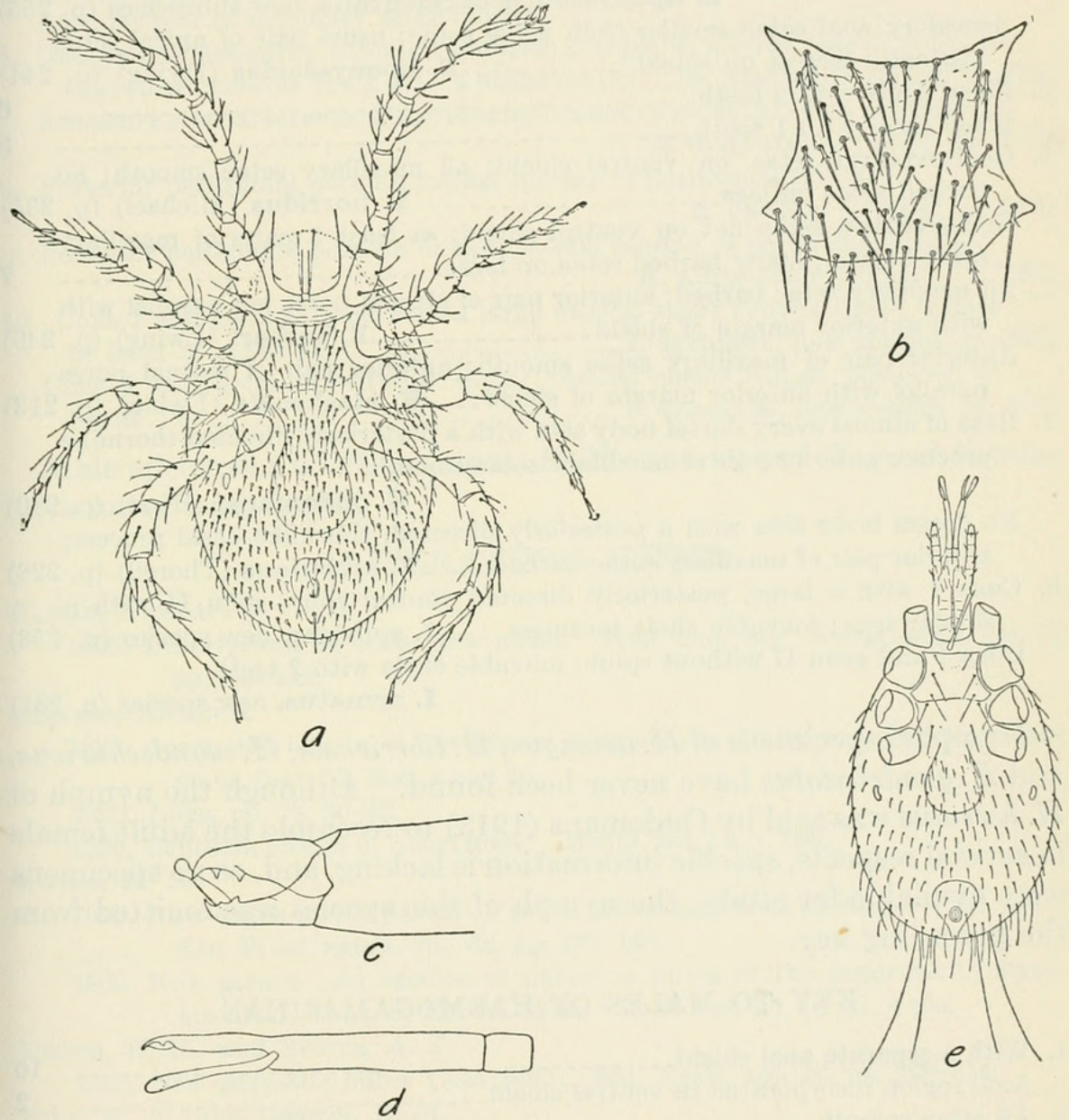

FIGURE 55.—*a-c*, *Hameogamasus liberiensis* Hirst (after Hirst): *a*, Ventral view of female; *b*, sternal plate of female; *c*, chelicera of female. *d*, *e*, *Euhaemogamasus quadrisetatus* (Vitzthum) (after Vitzthum): *d*, Chelicera of female; *e*, ventral view of female.

KEY TO NYMPHS OF HAEMOGAMASINAE

1. Ventral shield with accessory setae 9
   Ventral shield without accessory setae 2
2. Chelae toothless; all setae smooth 3
   Chelae with teeth; with some barbed setae 5
3. Length-width ratio of tarsus II not over 3:1 ..**H. harperi**, new species (p. 223)
   Length-width ratio of tarsus II 4: 1 or greater 4
4. Accessory anal setae larger than usual setae; usual pair of apical setae little if any larger than other setae of apical region.
   E. liponyssoides occidentalis, new subspecies (p. 255)
   Accessory anal setae smaller than usual setae; usual pair of apical setae distinctly largest on shield ..... **E. liponyssoides** (Ewing) (p. 244)
5. Fixed chela with 2 teeth 6
   Fixed chela with 1 tooth 8
6. Genitoventral setae on ventral shield; all maxillary setae smooth; no barbed setae on legs ..... **E. horridus** (Michael) (p. 235)
   Genitoventral setae not on ventral shield; at least 3 pairs of maxillary setae barbed; many barbed setae on legs 7
7. All maxillary setae barbed; anterior pair of sternal pores not parallel with with anterior margin of shield ..... **E. barberi** (Ewing) (p. 249)
   Anterior pair of maxillary setae smooth; anterior pair of sternal pores parallel with anterior margin of shield ..... **H. alaskensis** (Ewing) (p. 213)
8. Base of almost every dorsal body seta with a posteriorly directed thornlike process; anterior pair of maxillary setae smooth.
   E. oudemansi (Hirst) (p. 240)
   No dorsal body seta with a posteriorly directed, thornlike basal process; anterior pair of maxillary setae barbed ..... **E. ambulans** (Thorell) (p. 228)
9. Coxa I with a large, posteriorly directed ventral spur; genu II with a similar spur; movable chela toothless ..... **I. spiniger**, new species (p. 258)
   Coxa I and genu II without spurs; movable chela with 2 teeth
   I. armatus, new species (p. 261)

Nymphal specimens of *H. avisugus*, *H. liberiensis*, *H. mandschuricus*, and *E. quadrisetatus* have never been found. Although the nymph of *H. hirsutus* was said by Oudemans (1913) to resemble the adult female in several respects, specific information is lacking, and, as no specimens were available for study, the nymph of this species was omitted from the preceding key.

KEY TO MALES OF HAEMOGAMASINAE

1. With a separate anal shield 10
   Anal region incorporated in ventral shield 2
2. All setae smooth 3
   With some barbed setae 6
3. Accessory sternal setae present; movable chela bifurcate.
   H. hirsutus Berlese (p. 210)
   Accessory sternal setae absent; movable chela undivided 4
4. Second pair of sternal setae on lateral margins of shield; anal region distinct from remainder of shield ..... **H. harperi**, new species (p. 223)
   Second pair of sternal setae not on lateral margins of shield; anal region not distinct from remainder of shield 5

5. Chelae about equal in length; usual pair of apical setae clearly largest on dorsal shield; setae of dorsal shield nearly uniform in size.
E. liponyssoides (Ewing) (p. 244)

Fixed chela distinctly the shorter; usual pair of apical setae little if any larger than others of apical region; large and small setae interspersed on dorsal shield ..... **E. l. occidentalis**, new subspecies (p. 255)

6. Fixed chela with 2 teeth ..... **E. horridus** (Michael) (p. 235)
Fixed chela with 1 tooth ..... **H. mandschuricus** Vitzthum (p. 218)
Fixed chela toothless 7

7. Anterior pair of maxillary setae smooth 8
Anterior pair of maxillary setae barbed 9

8. One pair of accessory setae on anterior margin of sternal shield; shorter branch of movable chela with a bifurcate tip ... **H. alaskenis** Ewing (p. 218)
Accessory sternal setae lacking; shorter branch of movable chela undivided
E. oudemansi (Hirst) (p. 240)

9. Posterior peritremal pore on medial margin of peritremal shield.
E. barberi (Ewing) (p. 249)

Posterior peritremal pore on or near lateral margin of peritremal shield.
E. ambulans (Thorell) (p. 228)

10. Coxa I and genu II each with a large ventral spur; ventral shield widest at level of coxae II ..... **I. spiniger**, new species (p. 258)
Coxa I and genu II without spurs; ventral shield widest posterior to coxae IV ..... **I. armatus**, new species (p. 261)

Male specimens of *H. avisugus*, *H. liberiensis*, and *E. quadrisetatus* have never been found.

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