

Acarologia

A quarterly journal of acarology, since 1959
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Subscriptions: Year 2022 (Volume 62): 450 €

<http://www1.montpellier.inra.fr/CBGP/acarologia/subscribe.php>

Previous volumes (2010-2020): 250 € / year (4 issues)

Acarologia, CBGP, CS 30016, 34988 MONTFERRIER-sur-LEZ Cedex, France

ISSN 0044-586X (print), ISSN 2107-7207 (electronic)

The digitalization of Acarologia papers prior to 2000 was supported by Agropolis Fondation under the reference ID 1500-024 through the « Investissements d'avenir » programme (Labex Agro: ANR-10-LABX-0001-01)



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SOME ORIBATEI FROM GHANA. XII. THE FAMILY LIODIDAE
(1st. series) ¹.

BY

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INTRODUCTION.

The family Liodidae Grandj. 1954 includes the genera *Platyliodes*, *Teleioliodes*, *Poroliodes* and *Liodes* (GRANDJEAN, 1954, BALOGH, 1961). Two of these, namely *Liodes* and *Teleioliodes*, are represented in my collections from Ghana. The present paper, which is the first of a series of four, deals with three species of the genus *Liodes*; the next paper in this series will contain a description of *Teleioliodes* sp. Subsequently, descriptions will be given of the immature stages of one of the new species of the genus *Liodes* described below.

Liodes Heyden, 1826.

GRANDJEAN (1934, p. 141) has used principally the characters associated with the respiratory system to distinguish the genus *Liodes* from *Poroliodes* and *Teleioliodes*. Other more obvious characters cited by GRANDJEAN (1934) and used by BALOGH (1961) in a key to the identification of the three genera include the presence or absence of lamellar setae (present in *Teleioliodes*, absent in *Liodes* and *Poroliodes*) and the number of pairs of anal setae (three pairs in *Liodes*, 2 pairs in *Teleioliodes* and *Poroliodes*).

Liodes terrestris n. sp. (fig. 1-9).

Collected in Ghana : 14 adults, 9 nymphs, 6 larvae.

Adult. — It was necessary in all cases to dissect the adult specimens to observe the various regions of the body. This dissection consisted of the removal of the notogaster and also the immature scalps (when present). One specimen was

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dissected completely to separate the gnathosoma for observation. The measurements given below were made on dissected specimens; notogastral measurements were made after the removal of all nymphal scalps. The total measurements for body length and width, with notogaster and immature scalps in place, would be slightly larger than the figures given.

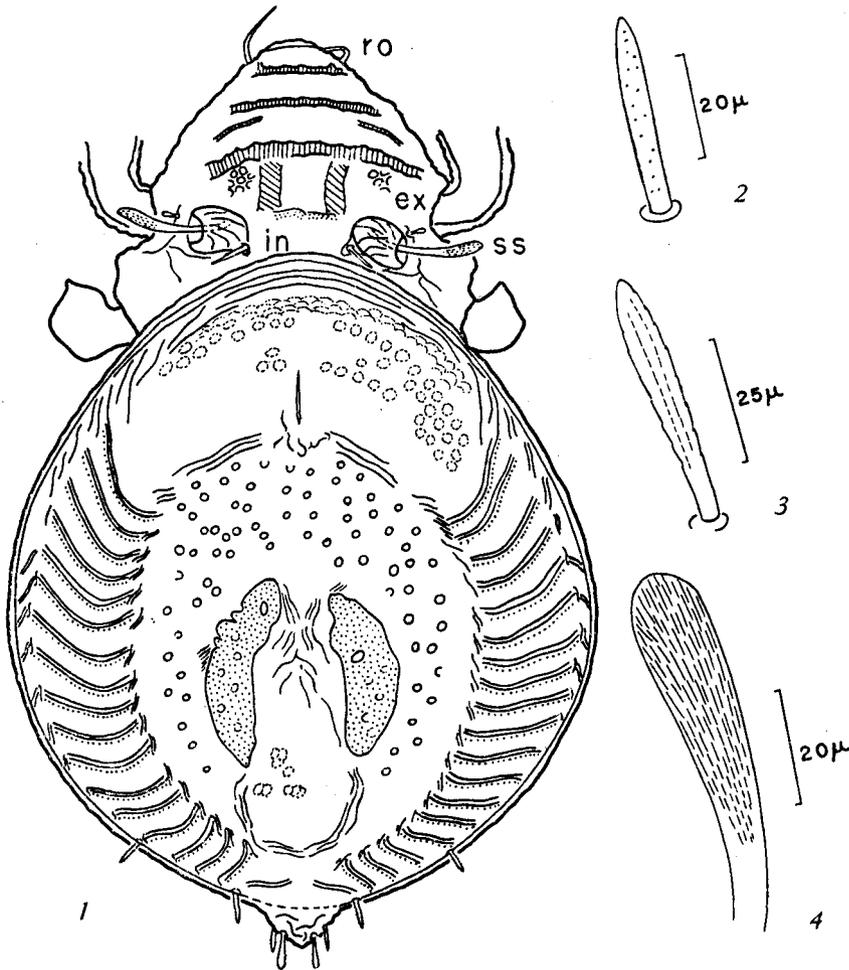


FIG. 1-4. — *Liodes terrestris* n. sp. Holotype, adult.

1 : Dorsal view (tritonymphal scalp present). 2 : Interlamellar seta. 3 : Notogastral seta.
4 : Sensillus. *ro* = rostral setae; *ex* = exopseudostigmatic setae; *ss* = sensillus.

Measurements. — Average length of ventral surface : 1062.6 μ (range : 985.6 μ -1139.6 μ). Average width of ventral surface (measured at widest part) : 666.8 μ (range : 554.4 μ -739.2 μ). Average length of notogaster : 876.0 μ (range : 831.6 μ -924.0 μ). Average width of notogaster (measured at widest part) : 716.9 μ (range : 646.8 μ -770.0 μ).

Type locality. — Shai Hills, Ghana.

Description of holotype. — The prodorsum, ventral surface and legs are covered with a cerotegumental secretion, to which adhere fungal spores and particles of debris. This secretion is pronounced on the anterior margin of the rostrum, lateral margins of prodorsum and on the first pair of legs. Notogaster and legs are red-brown in colour; prodorsum and ventral surface are yellow-brown. The tritonymphal scalp alone is retained on the notogaster in the holotype specimen.

Measurements of holotype. — Length of ventral surface : 1031.8 μ ; width of ventral surface (measured at widest part) : 677.6 μ ; length of notogaster : 831.6 μ ; width of notogaster (measured at widest part) : 693.0 μ ; maximum height of notogaster : 308.0 μ .

Prodorsum. — The cerotegumental secretion extends over the dorsal surface of the rostrum as a thin layer; in this region the cerotegument is thrown into folds producing a reticulated pattern. Rostral setae are inserted on dorso-lateral margins of rostrum; they are strongly curved, smooth, and as long as their mutual distance. Lamellar setae are lacking. The surface of the prodorsum bears three complete transverse ridges (fig. 1); immediately behind the most posterior of these ridges is a pair of short, broad thickenings which extend in an antero-posterior direction towards the base of each pseudostigma; lateral to these thickenings, on each side of the prodorsum, is a region of reticulate microsculpture. Each pseudostigma is large, deeply cup-shaped, with aperture directed laterad, walls with veined microsculpture. The base of the pseudostigma is a thickened plate bearing the insertion of the interlamellar seta. Sensillus is about 120 μ (measured from base of pseudostigma to tip of sensillus), with slender stem and slightly expanded distal portion which is beset with fine barbs (fig. 4). Interlamellar setae are 30-40 μ long, stout thickened structures with minutely roughened surface (fig. 2). Immediately lateral to each pseudostigma is a short, swollen, minutely barbed exopseudostigmatic seta.

Immature scalps. — The holotype has retained only the tritonymphal scalp. Only 3 specimens of the 14 adults collected retained the full complement of immature scalps. The larval, protonymphal and deutonymphal scalps separate easily from the notogaster; the tritonymphal scalp is more firmly attached. Figure 5 shows the appearance of the detached scalps (excluding the tritonymphal) of a paratype specimen from the dorsal aspect. The larval scalp has a series of prominent transverse ridges, which become less distinct peripherally; there is no conspicuous posterior tubercle on the larval scalp. Protonymphal and deutonymphal scalps possess radiating ridges laterally, and each scalp terminates posteriorly in a conspicuous tubercle which bears the insertions of at least 2 pairs of setae.

Figure 1 shows the structural details of the tritonymphal scalp *in situ* on the notogaster of the holotype. The centro-dorsal portion of the scalp is very thin

and transparent, except for two conspicuous, more darkly pigmented, kidney-shaped regions. These regions show some variation in form in paratypes; in several cases they are connected with each other anteriorly. Peripherally the scalp is strongly ridged. Posteriorly there is a pronounced tritonymphal tubercle which bears at least 2 pairs of setae. The anterodorsal region of the scalp bears a microsculpture of rounded figures irregularly arranged.

Notogaster. — Shape is broadly rounded from the dorsal aspect. In lateral view the notogaster is dome-shaped (fig. 9); the ratio of length to height is 2.7 : 1. The microsculpture consists of regularly arranged polygonal figures on the anterodorsal portion, and rib-like depressions laterally which appear to be "imprints" of the conspicuous radial ridges of the tritonymphal scalp. The kidney-shaped regions of the centro-dorsal part of the tritonymphal scalp also leave a faint "imprint" on the notogaster of the adult. Light coloured, rounded alveoli are scattered irregularly over the centro-dorsal part; these alveoli do not contain respiratory macropores. A longitudinal row of small, saccule-like structures is present dorso-laterally on each side of the notogaster; these are possibly respiratory saccules (fig. 8). There are 4 pairs of notogastral setae; these are located on or near the posterior margin. One pair of setae is inserted more dorsally than the others; this pair is normally hidden beneath the tritonymphal tubercle; the setae of this pair are slightly swollen (fig. 3); the remaining setae are short stout structures, resembling the interlamellar setae. The aperture of the lateral abdominal gland is conspicuous on each side of the notogaster. Notogastral fissures *ia*, *im*, *ih*, *ips* and *ip* are also present; the location and orientation of these fissures is shown in fig. 9.

Gnathosoma. — Details of this region are shown in fig. 7. The labio-genal articulation is complete (diarthrous) and is covered by an anterior extension of the hysterosome (tectum). The rutellum has a pantelebasic expansion. Each lateral lip bears 2 adoral setae. The more anterior of these setae (*or*₁) is markedly flattened and fan-shaped; seta *or*₂ is broadly thickened and barbed. The labial jaws (G) are rectangular in shape, and bear the infracapitular setae *a* and *m*; seta *m* is inserted near the postero-lateral margin of the jaw, the insertion being covered by the hysterosomal tectum; this seta is strongly curved; both setae are thickened and smooth. The mid-portion of the hysterosome (H) is strongly sculptured with a vermiform pattern; the lateral margins are more weakly chitinised and have a veined microsculpture. A single pair of hysterosomal setae is present (setae *h*); these setae are rather longer than the other infracapitular setae and are aciculate in shape, with smooth surface.

Palp. — This is entirely similar to that of *Liodes theleproctus* (see GRANDJEAN, 1935, p. 18, fig. 4A).

Ventral region of podosoma. — The cerotegumental secretion covering the ventral surface is not as thick as that covering the prodorsum. Coxisternal regions

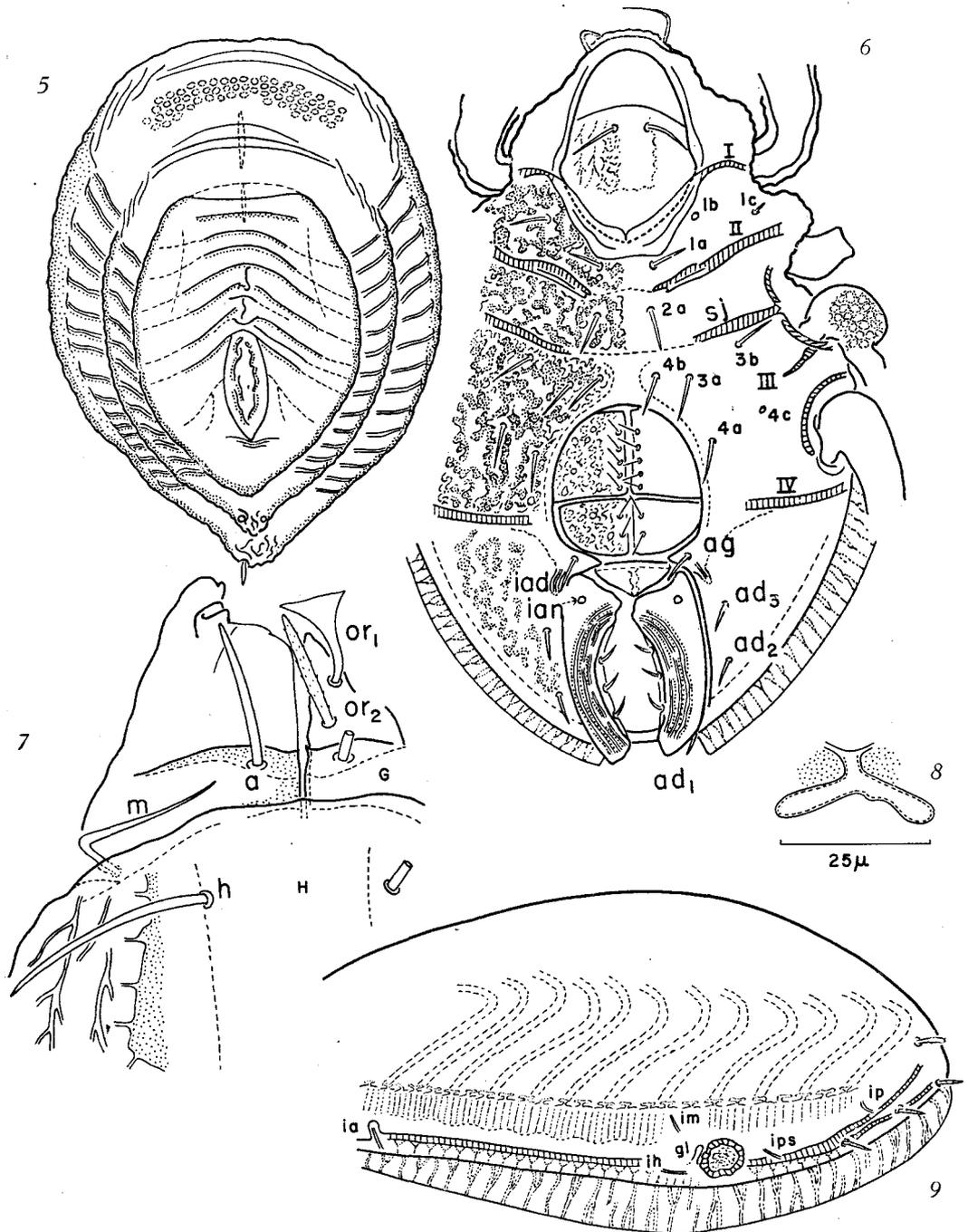


FIG. 5-9. — *Liodes terrestris* n. sp. Adult.

5 : Paratype, immature scalps (excluding tritonymphal), dorsal view. 6 : Holotype, ventral view. 7 : Paratype, gnathosoma, ventral view. 8 : Holotype, notogastral saccule. 9 : Paratype, notogaster, lateral view. I, II, SJ, III, IV = coxisternal apodemes; 1a, 1b, 1c, 2a, 3a, 3b, 4a, 4b, 4c = coxisternal setae; ag = aggenital setae; ad₁, ad₂, ad₃ = adanal setae; iad = adanal fissure; ian = anal fissure; or₁, or₂ = adoral setae; a, m = infracapitular setae; h = hysterosomal setae; G = labial jaw; H = hysterosome; ia, im, ih, ips, ip = notogastral fissures; gl = aperture of lateral abdominal gland.

are yellow-brown in colour, with a well developed vermiform microsculpture. The apodemata and respiratory structures associated with them are well developed; the respiratory structures were observed to follow the same pattern as those of *L. theleproctus*. Apodeme I is short and curved, and is continuous with the posterior border of the camerostome. Apodemes II, III, IV and the sejugal are incomplete in the mid-line; these apodemes, except for III which is very short, extend for an appreciable distance towards the mid-line on each side (fig. 6). Coxisternal setal formula is (3-1-2-3); seta 4*b* is displaced anteriorly, as in *L. theleproctus*. Seta 1*c* is appreciably shorter than the other two setae in this coxisternal region. All coxisternal setae are thickened, and appear to be smooth.

Genito-anal region. — Genital aperture is ovoid, being wider posteriorly than anteriorly. Genital plates are divided by a transverse suture. The plates have a vermiform microsculpture. Genital setae are thin, smooth structures, 7 pairs arranged paraxially, 5 on the anterior plate, 2 on the posterior one. The number of genital setae is constant in all specimens. A single pair of aggenital setae (*ag*) is located postero-lateral to the genital aperture. The preanal plate is triangular in shape, with apex directed posteriorly; the plate carries an extension of the respiratory system. Anal aperture is rectangular in shape; the surface of each anal plate bears a microsculpture of longitudinal ridges paraxially. Three anal setae are located along the paraxial margin of each plate; these setae are short thickened structures. Anal fissure is a rounded pore located antero-laterally on each anal plate. There are three pairs of thickened adanal setae; the setae of the most posterior pair are minutely barbed. Adanal fissure is conspicuous as a slit (*iad*) located just posterior to the aggenital seta on each side; the fissure is aligned obliquely. The ventral plate bears a weak vermiform microsculpture.

Legs. — Details of the chaetotaxy of the legs will be given in a study of the development of this species. All femora possess a conspicuous ventral crista or keel, which has a veined microsculpture. Ventral keel on genu I is weakly developed. All tibiae possess a weakly developed ventral keel; dorsal crests are developed on all tarsi, although these are not conspicuous. Solenidions on genu, tibia and tarsus of legs I-IV are distributed as in *L. theleproctus*, the formula being :

$$(1-2-2) (1-1-2) (1-1-0) (1-0-0)$$

All tarsi are tridactyle, the claws being slightly tinted.

Variations in paratypes. — The chitinised ridges on the prodorsum are variously developed in paratypes, frequently being less distinct than in the holotype. The variation in form of the kidney-shaped areas on the centro-dorsal part of the tritonymphal scalp has been mentioned above. The two areas are united anteriorly and appear as an inverted U-shape, in almost half of the specimens studied. Specimens showing both conditions are present in collections from the same population; the variations are not secondary sexual characters. The development of polygonal figures and light rounded alveoli on the notogaster also varies from

specimen to specimen. Several paratypes possess only two pairs of adanal setae; occasionally these setae have a 3 : 2 distribution. In several paratypes the ventro-sejugal apodeme is strongly developed, the two halves almost touching in the mid-line immediately anterior to the genital aperture. In these cases the sejugal ridge, which overlies the apodeme, may be complete in the mid-line.

Distribution of *L. terrestris*. — Shai Hills (2 adults); Accra-Senchi Rd. (37 mi. N. Accra) (7 adults, 6 nymphs, 3 larvae); Accra Plains thicket (1 adult, 1 nymph, 3 larvae); Accra Plains (Dodowah Rd.) (3 adults, 1 nymph); Achimota thicket (1 adult, 1 nymph).

Remarks. — Species of this genus previously described from Africa include *L. theleproctus* (Herm.), *L. ionicus* (Selln.) (see GRANDJEAN, 1936, pp. 54-56; SELLNICK, 1931, pp. 714-717), *L. capensis* (Berl.) (see BERLESE, 1910, p. 219; JACOT, 1940, pp. 392-393), *L. longipes* (BERL., 1916, p. 334), *L. squamiger* (BERL., 1916, pp. 333-334), *L. lawrencei* (JACOT, 1940, p. 393). Only three of these species, namely *L. theleproctus*, *L. ionicus* and *L. longipes*, correspond in body size to the species described above as *L. terrestris*. The remaining species are considerably larger than these (body size range : 1,300 μ -1,800 μ). Other morphological differences between the two size groups involve the length and form of the sensillus and the appearance of the legs.

L. terrestris differs from *L. theleproctus* and *L. ionicus* in possessing only 4 pairs of notogastral setae instead of 5. *L. terrestris* also differs from *L. theleproctus* in the number of genital setae (7 or 5 + 2 in *terrestris*; 8 or 5 + 3 in *theleproctus*) and in the degree of development of coxisternal apodemes. *L. theleproctus* is arboreal, whereas *L. terrestris*, as the name suggests, is a soil dweller. *L. longipes* possesses a short clavate sensillus, and differs in this respect from *L. terrestris*. Data regarding the number of notogastral setae in *L. longipes* are not available.

Several species of the genus have also been described from the Indo-Pacific region. The majority of these are rather larger than *L. terrestris*. The list includes *L. funafutiensis* (JACOT, 1929, p. 38), *L. lamellatus* (RAINBOW, 1897) (see JACOT, 1929, p. 36), *L. Bäckströmi* (TRÄGÅRDH, 1931, pp. 560-564), *L. hawaiiensis* (JACOT, 1929, p. 31) and *L. swezeyi* (JACOT, 1929, p. 38). *L. bataviensis* (SELLNICK, 1925, pp. 463-464) appears to be very similar to *L. terrestris*, although SELLNICK did not observe any notogastral setae in the species from Java. The relationship between the two species will be more clearly defined after detailed comparisons have been made between specimens of the two groups.

***Liodes segestris* n. sp. (fig. 10-13).**

Collected in Ghana : 1 adult (holotype).

Type locality. — Bole, Ghana.

Description of holotype. — Length of ventral surface : 985.6 μ ; width of ventral surface (at widest part) : 600.6 μ ; length of notogaster : 847.0 μ ; width of

notogaster (at widest part) : 693.0 μ ; height of notogaster : 462.0 μ . The holotype retained the full complement of larval and nymphal scalps. Body and legs are coated with a thick crust of debris ; this is especially abundant on the larval scalp and venter. Larval, protonymphal and deutonymphal scalps are removed easily from the notogaster of the adult ; the tritonymphal scalp adheres firmly and is difficult to remove completely.

The scalps. — Larval scalp has a prominent posterior tubercle which carries the insertions of at least one pair of setae. The thick crust of debris must be removed before details of the microsculpture can be seen. The scalp is delimited into a clear peripheral zone without microsculpture and a central ridged crown. This central part bears a number of weak ridges ; these are much less conspicuous than in the previous species. Figure 15 shows the larval scalp of *L. pyramidalis* which is very similar to that of *L. segestris*.

The three nymphal scalps differ from each other only in their size and in the degree of development of peripheral ridges. All nymphal scalps have a clear transparent central area surrounded by a peripheral mantle which is faintly ridged ; the peripheral ridges become more distinct with each successive nymphal stage.

Prodorsum. — Details of the microsculpture of this region are obscured by the accumulation of debris. Rostral setae are inserted on antero-lateral margins of rostrum ; they are strongly elbowed and minutely barbed. Lamellar setae are lacking. Each pseudostigma is a large cup-shaped structure the walls of which bear a veined microsculpture. Sensillus is about 80 μ long (measured from rim of pseudostigma to tip of sensillus), with a roughened clubshaped head (fig. 11). The interlamellar setae are inserted at the base of each pseudostigma ; these setae are short and thick. A short thick exopseudostigmatic seta is located lateral to each pseudostigma.

Notogaster. — Viewed from the lateral aspect (fig. 10) the notogaster is triangular in shape, being strongly elevated dorso-posteriorly ; the apex of the triangle (*i.e.* the highest elevation) is broadly rounded ; the ratio of length to height is 1.8 : 1. Lateral and posterior margins bear rib-like depressions which correspond to the peripheral ridges of the tritonymphal scalp. A series of 3-4 transverse ridges form the anterior margin. The centro-dorsal elevated part has a conspicuous microsculpture of vermiform ridges. A longitudinal row of small saccule-like structures is present laterally on each side of the notogaster ; these are few in number and much less conspicuous than in the previous species. Notogastral fissures *ia*, *im*, *ih*, *ips*, *ip*, and the aperture of the lateral abdominal gland are seen clearly in lateral view. There are 3 pairs of minute (15 μ) notogastral setae all inserted on the same level on the posterior margin of the notogaster ; these can only be seen clearly when the notogaster is viewed from the posterior aspect (fig. 13).

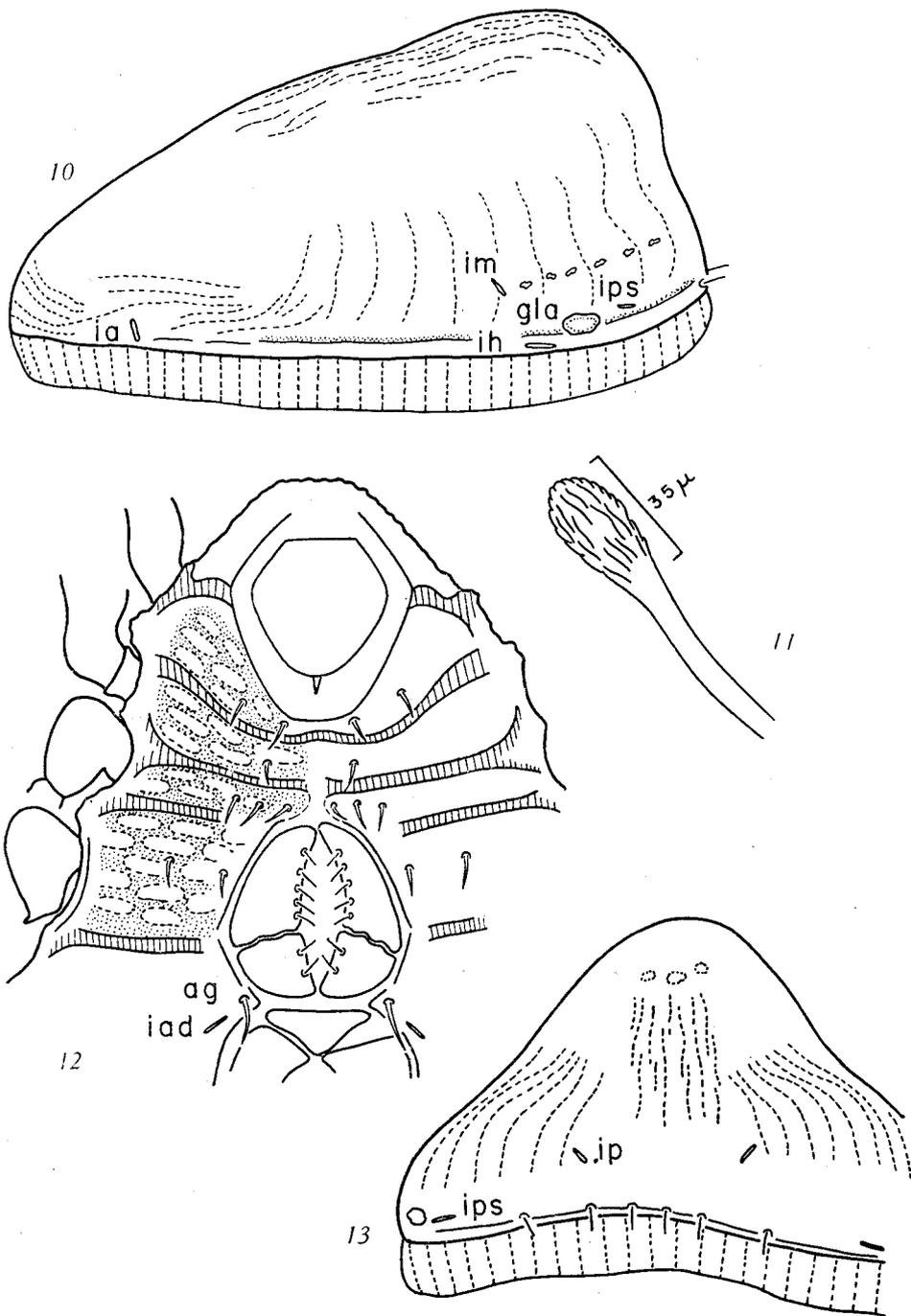


FIG. 10-13. — *Liodes segestris* n. sp. Holotype, adult.
 10 : Notogaster, lateral view. 11 : Sensillus. 12 : Ventral view.
 13 : Notogaster, posterior view. Notations as in fig. 5-9.

Ventral region of podosoma. — The microsculpture of the integument in this region appears to consist of light areas of weak chitination surrounded by more heavily chitinated regions ; this pattern is obscured to some extent by debris adhering to the cerotegument. Coxisternal ridge II is complete in the mid-line (fig. 12) ; the ventro-sejugal ridge passes just anterior to the genital field. Coxisternal ridge III extends more than half the distance from the insertion of leg III to the genital aperture. This arrangement of coxisternal ridges differs from that in the previous species (c. f. fig. 6 & 12). Coxisternal setal formula is (3-1-2-3) ; seta 4*b* is displaced anteriorly ; antiaxial setae on coxisternal regions I were not observed due to the accumulation of debris. All coxisternal setae observed are rather shorter than those in *L. terrestris*.

Genito-anal region. — Details of this region do not differ significantly from those of the previous species ; anal and adanal setae appear to be slightly shorter, but the difference is slight.

Legs. — The areolate microsculpture is less conspicuous than in *L. terrestris*. Femoral keels are well developed on all legs ; genual, tibial and tarsal keels are inconspicuous. Tarsi are tridactyle ; claws are equal in size, tinted blue.

Distribution of *L. segestris*. — Bole (1 adult).

Remarks. — The diagnostic features of this species include the club-shaped sensillus, the strongly elevated notogaster, the presence of vermiform striae on the notogaster, the pronounced development of coxisternal ridges and the presence of 3 pairs of notogastral setae. The species resembles *L. ionicus* (Selln.) in the general form of the notogastral microsculpture. The two species are distinguished on the basis of size (*L. segestris* is smaller than *L. ionicus*), and the number of notogastral setae (3 pairs in *segestris*, 5 pairs in *ionicus*).

***Liodes pyramidalis* n. sp. (fig. 14-18).**

Collected in Ghana : 1 adult (holotype).

Type locality. — Achimota, Ghana.

Description of holotype. — Length of ventral surface : 831.6 μ ; width of ventral surface (at widest part) : 539.0 μ ; length of notogaster : 631.4 μ ; width of notogaster (at widest part) : 585.2 μ ; height of notogaster : 323.4 μ . This species resembles the previous one in general appearance. The body is covered with debris ; the immature scalps show a pattern similar to that of the previous species (fig. 15-16). Details of the prodorsum are similar in both species ; the distinguishing characters are found principally on the notogaster (fig. 14 & 18), ventral region of podosoma (fig. 17) and the legs.

Notogaster. — Almost circular in shape when viewed from the dorsal aspect ; dorso-posteriorly the notogaster is strongly elevated, and in lateral view is

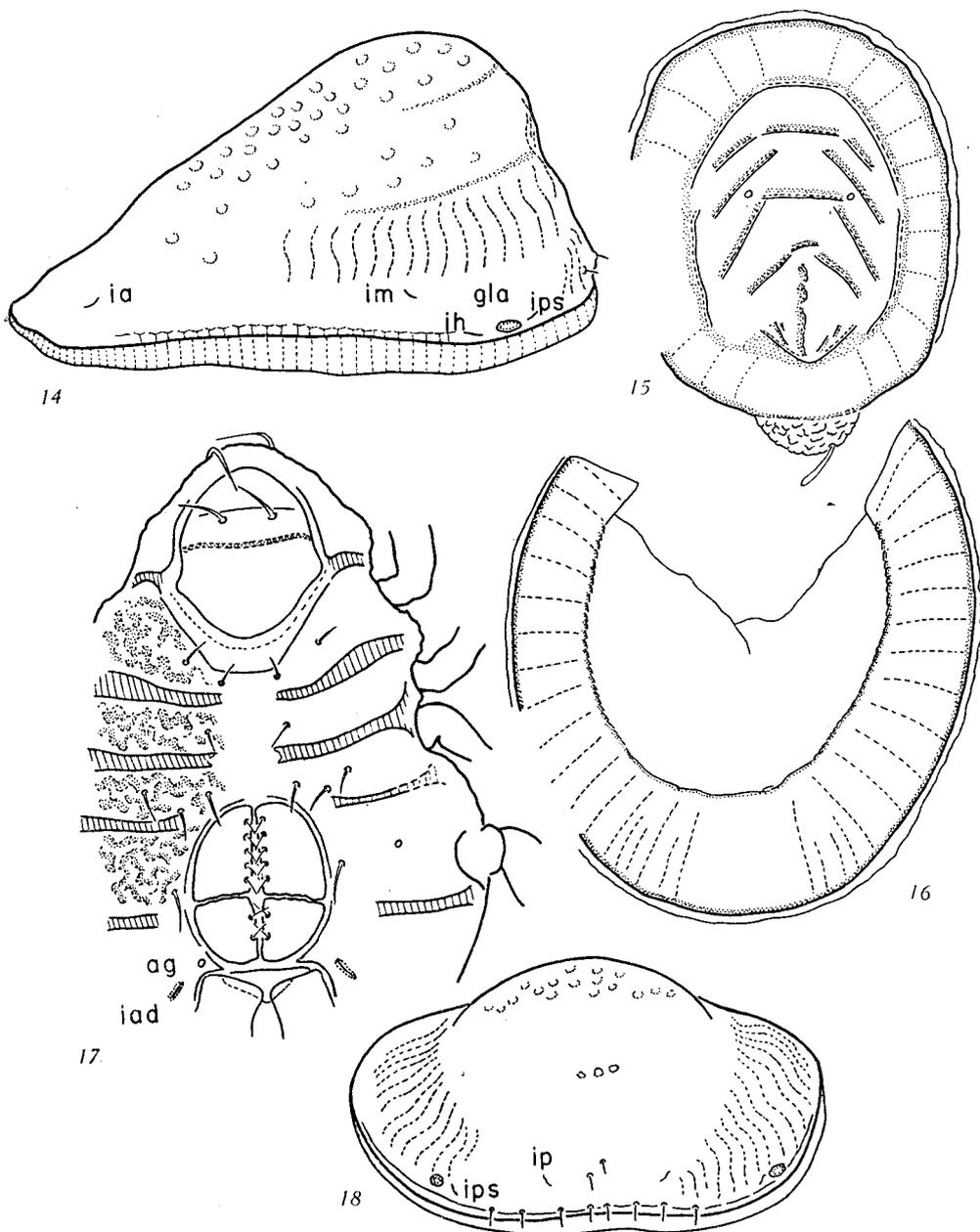


FIG. 14-18. — *Liodes pyramidalis* n. sp. Holotype, adult.
14 : Notogaster, lateral view. 15 : Larval scalp. 16 : Deutonymphal scalp.
17 : Ventral view. 18 : Notogaster, posterior view. Notations as in fig. 5-9.

broadly triangular in shape (fig. 14); ratio of length to height is 1.9 : 1. The microsculpture consists of light rounded areas of weak chitinisation scattered over the centro-dorsal and latero-dorsal parts; peripherally the notogaster is circled by a zone of rounded porose areas. The usual rib-like depressions are also present peripherally. Fissures and aperture of the lateral abdominal gland are present and occupy the usual positions. There are 5 pairs of notogastral setae; these are seen when the notogaster is viewed from the posterior aspect (fig. 18); four of these pairs of setae are inserted at the same level on the posterior rim of the notogaster; the setae of the fifth pair are asymmetrically distributed, and are located dorsal to the others on the posterior face of the elevated part of the notogaster. The saccule-like structures noted in the two species described above were not observed in *L. pyramidalis*.

Venter. — The development of coxisternal ridges on the ventral surface of the podosoma resembles that described for *L. terrestris*, except that ridge III is developed as in *L. segestris*. Coxisternal and anal setae are rather longer than those in *segestris* (i.e. as long as the corresponding setae in *L. terrestris*). The aggenital seta is lacking on the left side in the holotype. The microsculpture of the ventral surface is reminiscent of that of *L. terrestris*.

Legs. — The areolate or reticulate microsculpture is more conspicuous than in the previous species. The ventral keel on each femur is only weakly developed. The three tarsal claws are equal in size and darkly tinted.

Distribution of *L. pyramidalis*. — Achimota (1 adult).

Remarks. — This species differs from *L. terrestris* in the shape of the sensillus, shape of notogaster, number of notogastral setae, absence of saccule-like structures on notogaster and the development of coxisternal ridge III on ventral region of podosoma. It can be distinguished from *L. segestris* on the basis of the notogastral microsculpture, the number of notogastral setae, the development of coxisternal ridges and possibly by the length of coxisternal and anal setae. *L. pyramidalis* appears to be very similar to *L. longipes* (Berl.) particularly with regard to the microsculpture of the notogaster. Detailed comparisons between the two species are necessary to determine the exact relationship.

CONCLUSIONS.

The three species described above demonstrate an evolutionary regression in number of notogastral setae. On purely quantitative grounds they can be separated from each other by this feature. *L. pyramidalis* bears 5 pairs of notogastral setae; in this respect the species resembles *L. theleproctus* and *L. ionicus*; the distribution of the setae is different however in the two species *ionicus* and *pyramidalis*. *L. terrestris* bears 4 pairs of setae; these are appreciably larger than

in *pyramidalis* and *segestris*. *L. segestris* represents a further stage in regression, and possesses only 3 pairs of setae inserted on the posterior rim of the notogaster. *L. terrestris* can be distinguished immediately from the other two species from Ghana by the much flatter notogaster (c. f. the length : height ratios in the three species) and also by the microsculpture of larval, nymphal and adult dorsal surfaces.

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