ADULTS AND IMMATURES OF *YOSHIOBODES IRMAYI* (ACARI: ORIBATIDA: CARABODIDAE) FROM NORTH AMERICA

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REDESCRIPTION
LIFE CYCLE
ECOLOGICAL NICHES
PARTHENOGENESIS
DISTRIBUTION
YOSHIOBODES IRMAYI

SUMMARY: *Yoshiobodes irmayi* (Balogh and Mahunka), a Neotropical species of oribatid mite, is redescribed from adults collected in eastern United States; larvae, protonymphs, deutonymphs and tritonymphs are described for the first time. This species prefers hardwood leaf litter with smaller numbers found in rat nests, conifer leaf litter, tree holes, and rotten wood, respectively. All adults from both field collections and cultures were females, suggesting that it is the third thelytokus species known in the Carabodidae; this may help explain the wide distribution of the species.

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RÉSUMÉ : *Yoshiobodes irmayi* (Balogh et Mahunka), une espèce néotropicale d'oribates, est décrit encore une fois des adultes ramassées de l'est des États-Unis; les larves, protonymphes, deutonymphes et tritonymphes sont aussi décrits pour la première fois. Cette espèce préfère les échantillons des feuilles de bois dur avec des quantités moins nombreuses trouvées dans des nids de rats, des échantillons de feuilles de conifères, des trous d'arbres, et du bois pourri, respectivement. Toutes les adultes des deux échantillons et des cultures étaient des femelles, qui suggère que c'est la troisième espèce de thélytoquie connue dans le Carabodidae; ceci pourrait nous aider à expliquer la vaste distribution de l'espèce.

Most North American species of Carabodidae are restricted to the Nearctic region. Of the 24 known species of *Carabodes* from the continent, three are truly Holarctic (REEVES, 1992). Three other species are listed in the oribatid catalog (MARSHALL *et al.*, 1987) as Holarctic, but REEVES (1990, 1991) has shown that two of these, *Carabodes coriaceus* C. L. Koch and *C. areolatus* Berlese, are not present in North America. The third species, *C. minusculus* Berlese, has been recorded only once in North America (SENGBUSCH, 1957); the one specimen I have seen from the Sengbusch collection labeled as *C. minusculus* is not this species and its presence in North America is doubtful. One Palearctic species of *Odontocepheus*, *O. elongatus* (Michael), has been introduced into North America from Europe (REEVES, 1995). Few known Neotropical species reach the Nearctic; in the Carabodidae only one species, *Kalloia simpliseta* Mahunka, from Florida, and undetermined species of two genera, *Austrocarabodes* from Texas and *Cubabodes* from Florida, have been reported from United States (MARSHALL *et al.*, 1987).

The genus *Yoshiobodes* contains eight species: six are Oriental, one is Australian, and only one, *Y.*

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irmayi (Balogh and Mahunka), is Neotropical, being described from specimens collected in Bolivia and Brazil. The presence of this species in North America was not anticipated, but comparison of a specimen of *Y. irmayi* from St. Lucia (on loan from the Hungarian Natural History Museum) to North American material showed them to be conspecific. A redescription of adults of *Y. irmayi* from North American specimens is provided, and the larvae, protonymphs, deutonymphs and tritonymphs are described for the first time.

All immatures were obtained from cultures provided with the mossy maple polypore, *Oxyporus populinus* (Fr.) Donk, multicolor gill polypore, *Lenzites betulina* (Fr.) Fr., or chicken mushroom, *Laetiporus sulphureus* (Fr.) Murr. Culture chambers were either glass Stender dishes (4.5 cm diameter, 2.5 cm depth) provided with 2-3 layers of filter paper in the bottom, or plastic petri dishes (5.0 cm diameter, 1.5 cm depth) provided with a charcoal/plaster (ratio 1:9) bottom. All were kept at room temperature. Reproduction was greatest on chicken mushroom in Stender dishes with filter paper bottoms. In cultures maintained for two years or more immatures were found burrowing in the partially decayed filter paper. The addition of yeast to these cultures may have influenced this latter behavior. The adults originally introduced into these cultures were from South Carolina and Florida.

Terminology and abbreviations are those developed by F. GRANDJEAN, as summarized by BALOGH & MAHUNKA (1983). All measurements are given in micrometers (μm), and are taken from specimens mounted temporarily on cavity slides. Specimen measurements are as follows: total length (tip of rostrum to posterior edge of notogaster); width (widest part of notogaster). All of the above measurements are expressed as a mean (n=10 unless otherwise noted) followed by the range in parentheses.

Scanning electron micrographs (SEMs) were made from mites stored in 70% ethyl alcohol, ultrasonically cleaned to remove cerotegument, air dried, placed onto tape on 1/2 inch (1.27 cm) aluminum stubs, and coated with 20 nm AuPd in a Hummer IV sputter coater before observation in an AMR1000 Scanning Electron Microscope.

Yoshiobodes irmayi (Balogh and Mahunka 1969)

Figs. 1-15

DIAGNOSTIC CHARACTERS

Prodorsal surface foveate between lamellae. Lamellar seta long, barbed, inserted under lateral edge of lamella. Interlamellar seta like notogastral setae, leaf-like, spiculate. Sensillus fan-shaped. Anterior region of notogaster with longitudinal rows of tubercles, tubercles arranged in circular patterns behind setal row *c*. Fifteen pairs of notogastral setae, 4 pairs in medial rows, 5 pairs in lateral rows, 4 pairs along posterior margin, and 2 pairs in humeral region.

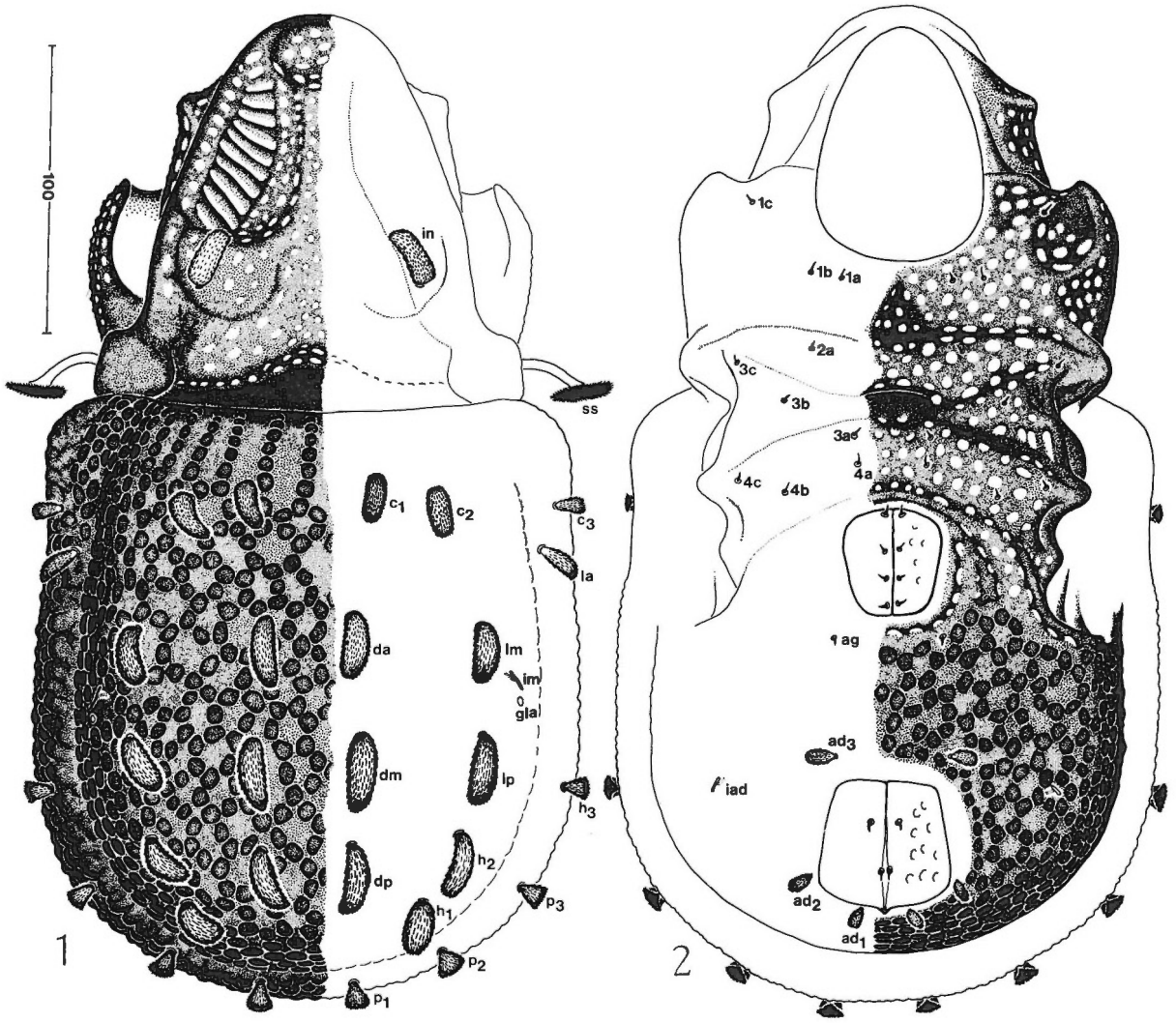
ADULT

Measurements. Total length: ♀ 344 (280-385). Width: ♀ 189 (140-205).

Integument. Brown. Birefringent. Cerotegument thin, transparent.

Prodorsum (Figs. 1, 8–11). Mostly foveate-reticulate, dorsal surfaces of lamellae and bothridia granulate. Rostral setae (*ro*) short (nearly equal to distance between insertions), fusiform. Lamellar setae (*le*) approximately twice as long as *ro*, minutely barbed, inserted under lateral edge of lamellae. Rostral and lamellar setae hidden in dorsal view (see Figs. 10, 11). Interlamellar setae (*in*) like notogastral setae, short, wide (approximately 2.5 times longer than wide), leaf-like, spiculate, directed anteriad, inserted on basal portion of lamellae. Sensillus (*ss*) with fan-shaped, barbed, dorsally directed club. Dorsosejugal depression deep, slit-like, widest medially.

Notogaster (Figs. 1, 8, 9, 12, 14). Circumgastric depression present. Surface tuberculate, tubercles obscure on rim; arranged in longitudinal rows of 6-7 tubercles each from anterior margin to *c*-row of setae, tubercles posterior to *c*-row arranged in circles of 6-10 tubercles each. Notogastral setae short (length of *da* approximately 1/2 distance between insertion of *da* and insertion of *dm*), leaf-like, spiculate; 15 pairs present: four pairs in medial row (c_1, *da*, *dm*, *dp*), five pairs in lateral row (c_2, *lm*, *lp*, h_1, h_2), two pairs on shoulder (c_3, *la*), and four pairs along posterior edge



FIGS. 1-2: *Yoshiobodes irmayi* (Balogh and Mahunka), adult, gnathosoma and legs removed.
1. — Dorsal aspect. 2. — Ventral aspect. See text for abbreviations. Scale bars in micrometers.

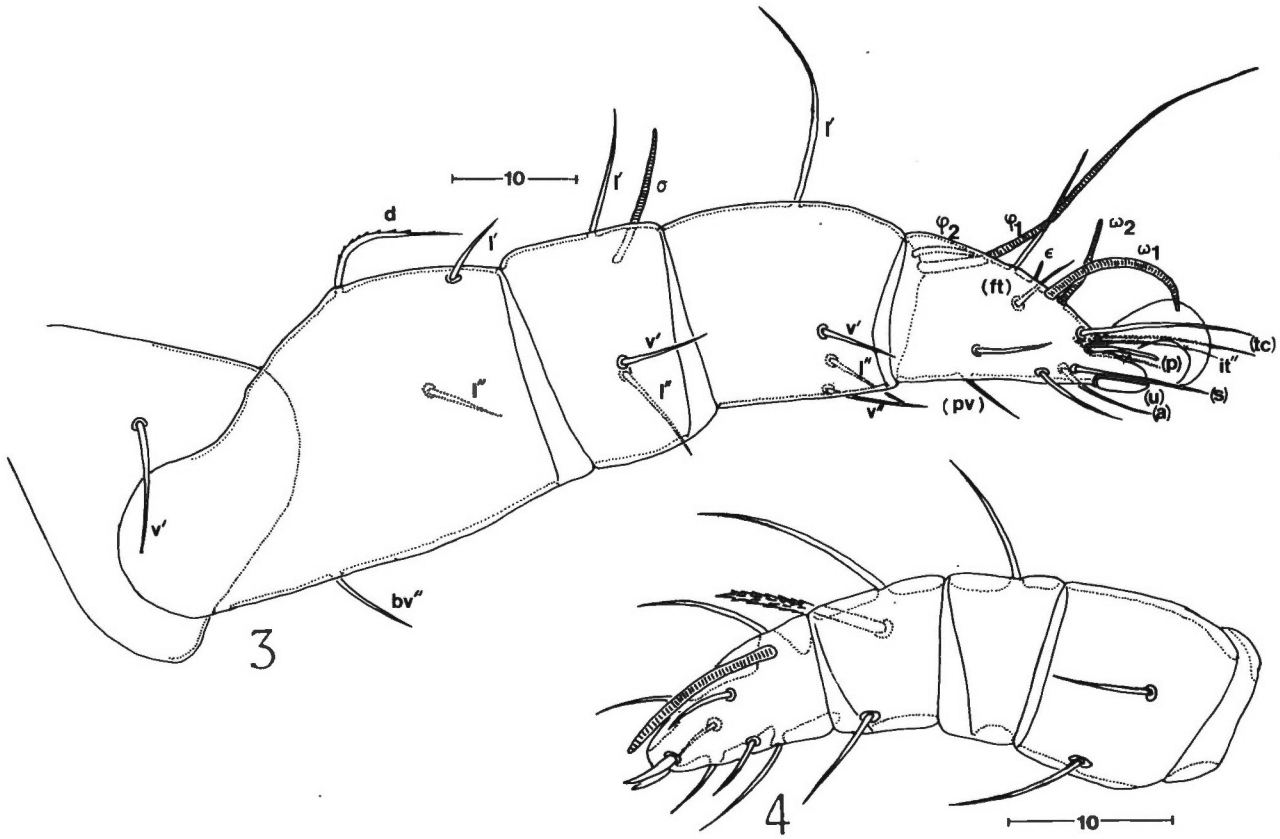
(p_{1-3}, h_3), seta c_3 shortest, *la*, p_{1-3}, and h_3 approximately 1/2 as long as central notogastral setae.

Gnathosoma. Mentum granulate. Palp setal formula 0-2-1-3-9(1).

Ventral surface (Figs. 2, 13, 15). Surface foveate-reticulate on epimera and lateral to genital plates; genital and anal plates foveate; ventral plate tuberculate, size and arrangement of tubercles like those on central area of notogaster. Epimeral setae short, spiniform, formula 3-1-3-3. Genitoanal region formula 4-1-2-3. Genital, aggenital (*ag*) and anal setae short, spiniform; adanal setae (ad_{1-3}) similar to notogastral setae but shorter, ad_3 inserted anterior to anal plate. Lyrifissure *iad* in lateral position.

Lateral surface. Surface below lamellae and bothridium, anterior to ventral plate, and above pedotecta I-IV with minute tubercles.

Legs. Abaxial surfaces of femora I and II and trochanters and femora III and IV foveate. Femur III and trochanter and femur IV with ventral keel. Setation of legs I-IV (solenidia in parentheses): trochanters 1-1-2-1, femora 4-4-3-2, genua 3(1)-3(1)-1(1)-2, tibiae 4(2)-3(1)-2(1)-2(1), tarsi 15(2)-15(2)-15-12. Setae (*u*) of all tarsi short, scale-like. See Table 1 for setal designations.



FIGS. 3-4: *Yoshiobodes irmayi* (Balogh and Mahunka), tritonymph.
3. — Leg I (at slight angle). 4. — Palpus. Scale bars in micrometers.

IMMATURES

Measurements. Total length: larva (n=2) 178 (165-190), protonymph (n=8) 208 (180-235), deutonymph (n=5) 242 (220-260), tritonymph (n=10) 300 (270-335). Width: larva (n=2) 110 (100-120), protonymph (n=8) 119 (100-135), deutonymph (n=5) 134 (120-145), tritonymph (n=10) 162 (155-180).

Integument. Unsclerotized, clear.

Prodorsum (Figs. 5, 7). All immatures except larva with scalloped edged depression on central area behind insertion of lamellar setae. Rostral, lamellar and interlamellar setae long, setiform. Sensillus short, setiform, arising from small, pocket-like bothridium. Exobothridial setae (*ex*) short, spiniform.

Gastronotic region (Figs. 5, 7). All setae setiform, setae h_3, p_1, p_2, and p_3 added in protonymph, adanal setae added in deutonymph.

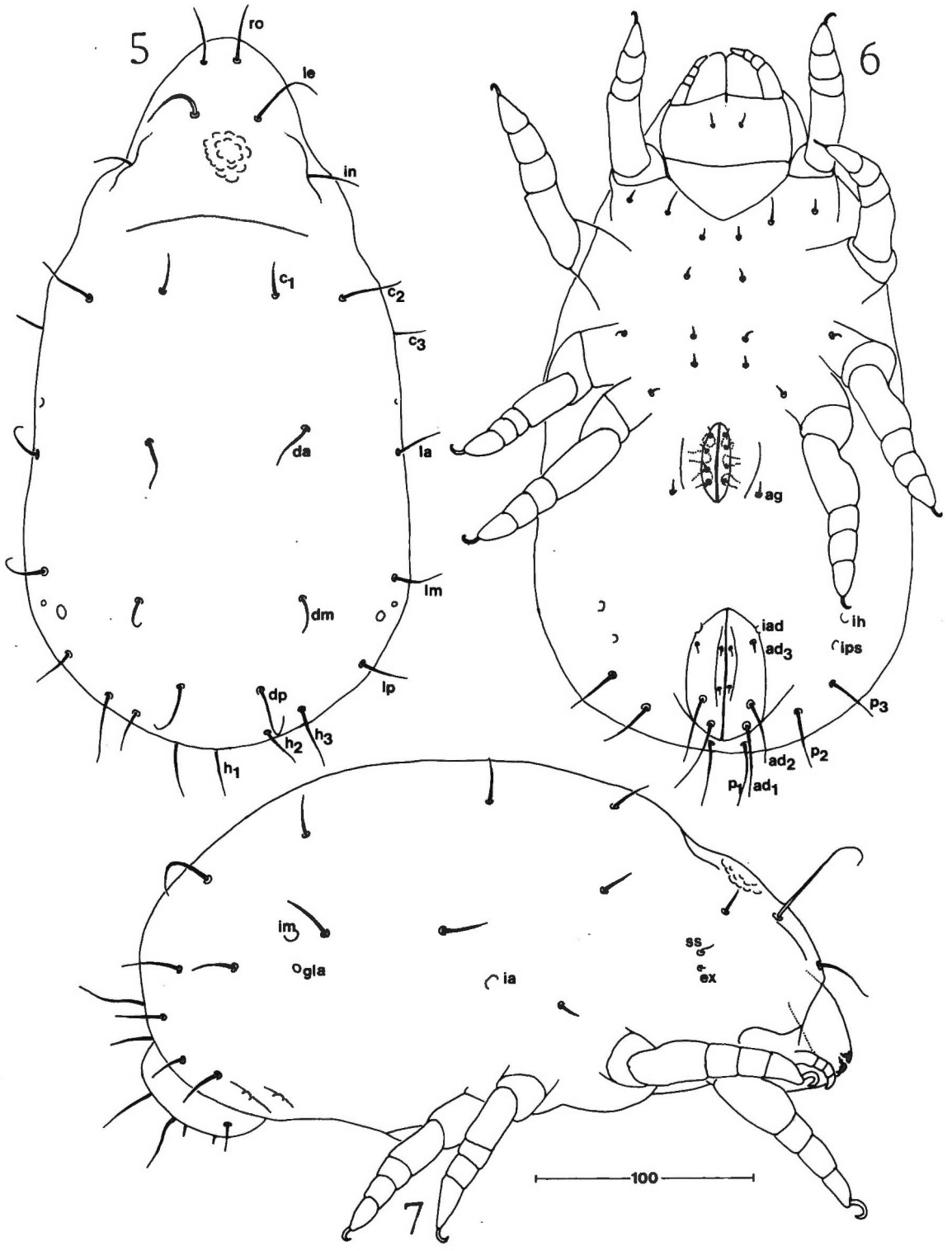
Gnathosoma (Fig. 4). Ventral seta of femur of palpus added in deutonymph.

Ventral region (Fig. 6). Setal formulae (larva to tritonymph) for epimera 2-1-2, 3-1-2-1, 3-1-2-2, 3-1-2-2; genital 0, 1, 2, 4; aggenital 0, 0, 0, 1; anal 0, 0, 0, 2.

Legs (Fig. 3). Setal ontogeny for the legs of larvae to adults given in Table 1.

MATERIAL EXAMINED

Holotype and paratypes (neither seen) of *Y. irmayi* are from Bolivia and Brazil and deposited in the Hungarian Natural History Museum, Budapest. Observed was one specimen on loan from the Hungarian Natural History Museum collected from St. Lucia, Antilles. The nearly 900 specimens of this species examined were collected from Oklahoma (Latimer Co.), Texas (Aransas, Bastrop, Blanco and



FIGS. 5-7: *Yoshiobodes irmayi* (Balogh and Mahunka), tritonymph (lyrifissure *ip* not illustrated).
5. — Dorsal aspect. 6. — Ventral aspect. 7. — Lateral aspect. Scale bar in micrometers.

	Trochanter	Femur	Genu	Tibia	Tarsus
Leg I					
L	0	*d, bv″*	*(l), σ*	*(l), v′, φ₁*	*(pv), s, (a), (u), (p), (tc), (ft), ε, ω₁*
PN	0	—	—	—	*ω₂*
DN	0	*l′*	—	*φ₂*	—
TN	*v′*	*l″*	*v′*	*v″*	*it″*
A	—	—	—	—	—
Leg II					
L	0	*d, bv″*	*(l), σ*	*l′, v′, φ*	*(pv), s, (a), (u), (p), (tc), (ft), ω₁*
PN	0	—	—	—	—
DN	0	*l′*	—	—	*ω₂*
TN	*v′*	*l″*	*v′*	*v″*	*(it)*
A	—	—	—	—	—
Leg III					
L	0	*d, ev′*	*l′, σ*	*v′, φ*	*(pv), s, (a), (u), (p), (tc), (ft)*
PN	0	—	—	—	—
DN	0	—	—	—	—
TN	*l′*	*l′*	—	*v″*	*(it)*
A	*v′*	—	—	—	—
Leg IV					
PN	0	0	0	0	*(pv), (u), (p), ft″*
DN	0	*d, ev′*	*d, l′*	d, *v′, φ*	*s, (a), (tc)*
TN	0	—	—	*v″*	—
A	*v′*	—	—	(*d* lost)	—

Table 1: Development of setae and solenidia in larvae (L), protonymphs (PN), deutonymphs (DN), tritonymphs (TN) and adults (A) of *Yoshiobodes irmayi* (Balogh and Mahunka).

Tyler Cos.), Louisiana (Calcasieu Co.), Mississippi (Adams and Harrison Cos.), Alabama (Baldwin and Conecuh Cos.), Florida (Baker, Calhoun, Dade and Monroe Cos.), Georgia (Jones, Morgan and Putnam Cos.), South Carolina (Abbeville, Charleston, Edgefield, McCormick and Newbury Cos.), and North Carolina (Jones Co.) (Fig. 16). I have also seen specimens from Chichen Itza, Yucatan, Mexico.

Most of the specimens (44%) examined from North America were collected from hardwood leaf litter, 11% from rat nests, 8% from conifer leaf litter, 6% from tree holes, and 4% from rotten wood.

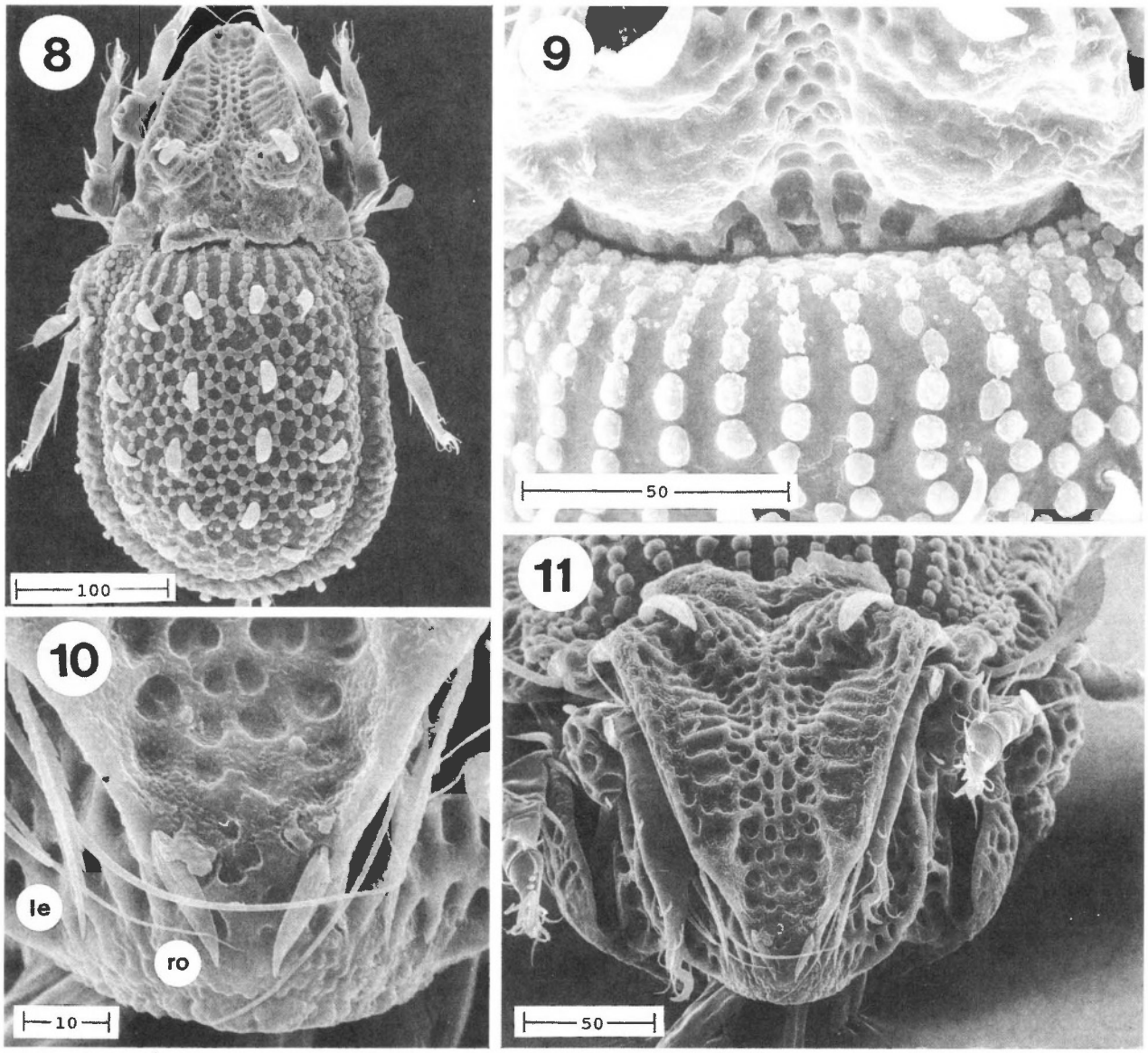
Voucher specimens will be deposited in the National Museum of Natural History, Washington, DC; Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; Canadian National Insect Collection, Centre for land and Biological Resources Research, Ottawa, Ontario, Canada; and the personal collections of R. A. NORTON and the author.

REMARKS

North American specimens of *Y. irmayi* are similar to the specimen from St. Lucia and to figures in BALOGH & MAHUNKA (1969) and MAHUNKA (1986, 1987) except that the rostral and lamellar setae on North American specimens appear longer. This species differs from all other North American Carabodidae in the presence of 15 pairs of notogastral setae, the form of the interlamellar and notogastral setae, and the arrangement of tubercles on the notogaster.

The scalloped edged depression on the prodorsum of protonymphs, deutonymphs and tritonymphs appears similar to the foveate sclerite found in immatures described by BELLIDO (1978) of *Carabodes willmanni* Bernini. The addition of the ventral seta on the femur of the palp differs in each species so far studied. In *Y. irmayi* it first appears in the deutonymph, in *Carabodes polyporetes* Reeves in the protonymph (REEVES 1991), in *C. willmanni* Bernini in the tritonymph, and in *Carabodes erectus* Reeves it is present in all immatures (REEVES, 1992). The setation of the legs differs from species so far studied as follows: trochanters with seta *v′* of legs III and IV added in adult rather than in tritonymph as in *C. polyporetes* and *C. erectus*, femora with seta *l′* of legs I and II added in deutonymph rather than tritonymph as in *C. polyporetes* and *C. willmanni*, tibiae with seta *l″* of leg II absent as in *C. erectus* and *C. willmanni* but not in *C. polyporetes*, seta *v″* of legs III and IV added in tritonymph as in *C. erectus* and *C. willmanni* rather than in deutonymph as in *C. polyporetes*, seta *v′* of leg IV added in deutonymph as in *C. polyporetes* and *C. erectus* rather than in tritonymph as in *C. willmanni*, and tarsus with seta *ft′* of leg III present in all immatures as in *C. polyporetes* and *C. erectus*, *ft′* absent from leg III in *C. willmanni*.

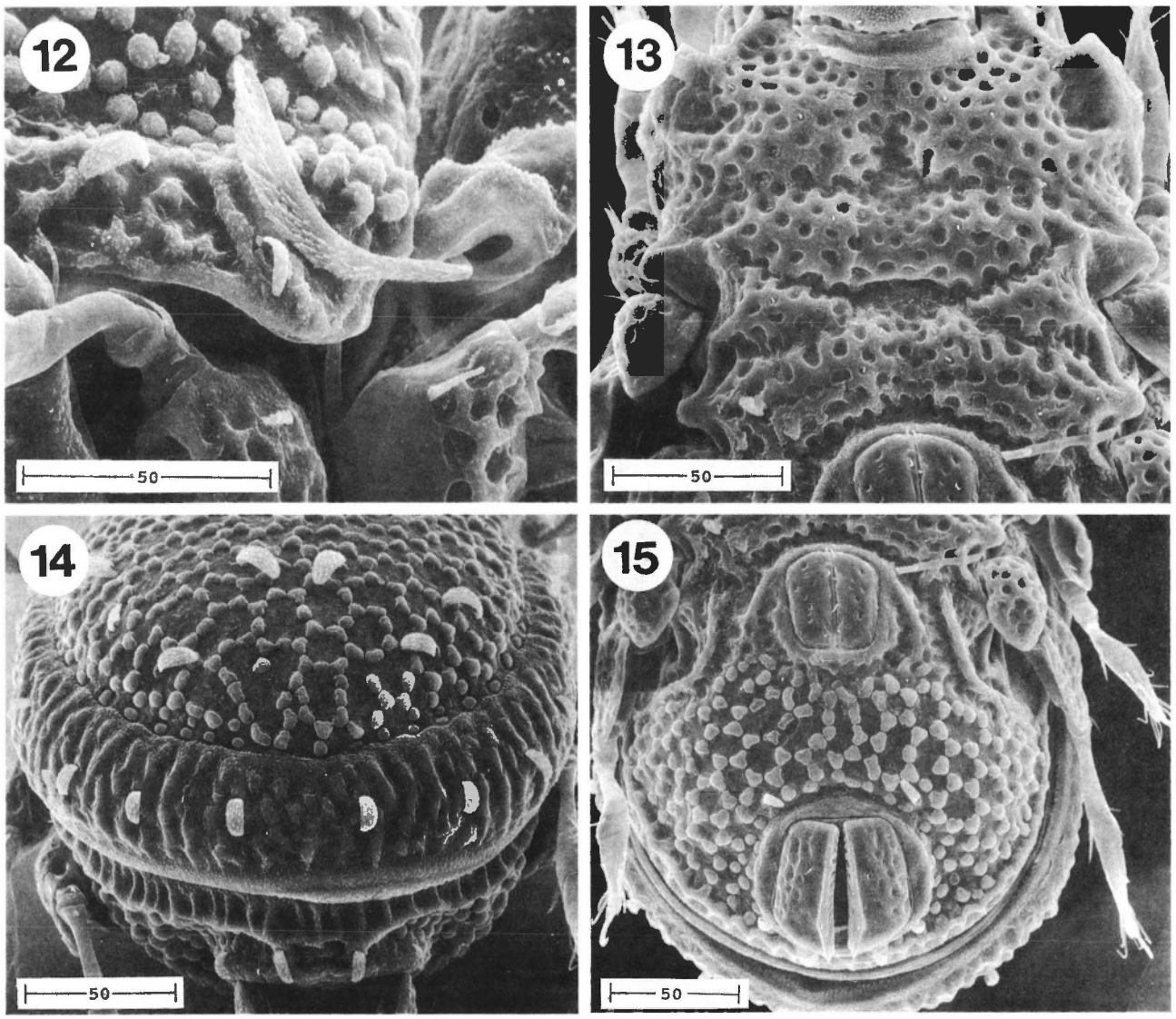
All adult specimens observed, both field collected and from cultures, were females, suggesting that this is the third species in the family Carabodidae that is thelytokus. Thelytoky is suspected in *Carabodes granulatus* Banks and *C. pentasetosus* Reeves (REEVES, 1992). The former is the most widely distributed cara-



FIGS. 8-11: *Yoshiobodes irmayi* (Balogh and Mahunka), adult.
8. — Dorsal aspect. 9. — Dorsosejugal region. 10. — Rostral region. 11. — Prodorsum, anterior view. Scale bars in micrometers.

bodid species in eastern North America (REEVES, 1992) and, since publication of its distribution, I have seen additional specimens from South Dakota and California. The latter species is most abundant in low, wet forested areas along the Atlantic and Gulf coastal plains of eastern United States. Only in four recent collections from southern Alabama have I found male:female ratios approximately equal, suggesting that thelytoky may be an important factor in colonization of this species.

NORTON & PALMER (1991), in their discussion of characteristics of thelytokus mites, suggested that small size, preference for disclimaxes, a broadly adapted genome, and tolerance of habitats that are regularly flooded are important and provide a distinct colonization advantage. They cite *Rostrozetes ovulum* (Berlese) as an example of a thelytokus species in both Neotropical and Nearctic regions. *Yoshiobodes irmayi* is small in comparison to most other Carabodidae, its body length (344) is less than the thelytokus species *C. granulatus* (430) and *C. pentasetosus* (374). Its presence in tropical South America and eastern



FIGS. 12-15: *Yoshiobodes irmayi* (Balogh and Mahunka), adult.
12. — Sensillus and humeral region, lateral view. 13. — Epimeral region. 14. — Notogaster, posterior view. 15. — Genitoanal region. Scale bars in micrometers.

United States indicates a relatively broad tolerance of climatic conditions. The effects of disclimaxes and flooding could not be determined from the available collection information.

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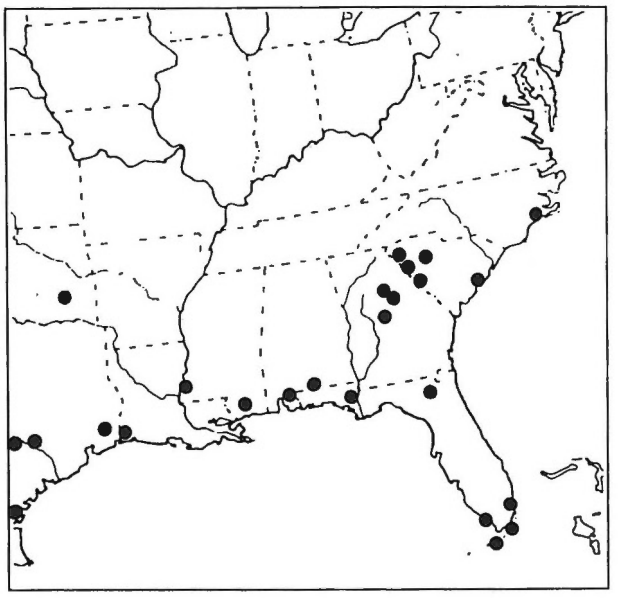

FIG. 16. Collection locations of *Yoshiobodes irmayi* (Balogh and Mahunka) in North America.

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