

A revision of the genus *Munatia* Stål, 1875 (Orthoptera, Caelifera, Romaleidae, Romaleinae).

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A revision of the genus *Munatia* Stål, 1875 (Orthoptera, Caelifera, Romaleidae, Romaleinae). - The genus is redescribed. Keys to the genera of the Procolpini and to the species of *Munatia* are given. *M. punctata* Stål and *M. biolleyi* Carl are both redescribed, and a female allotype of the former designated. *M. decorata* Carl is synonymized with *M. punctata*. Lectotypes of both *M. decorata* Carl and *M. biolleyi* Carl are designated. Biological data on both valid species are provided. The younger larvae of at least *M. punctata* are gregarious and provided with a visually striking pattern.

Key-words: Orthoptera - Acridoidea - Romaleidae - Procolpini - taxonomy.

INTRODUCTION

The genus *Munatia* was created by STÅL (1875) with the new species *M. punctata* as the type. The same author later (1878) contrasted *Munatia* with his (1873) genus *Procolpia*, using the shape of the tips of the elytra and the prominence of the medial spine of the hind knee as distinguishing characters. REHN (1955) revised the genus *Procolpia*; he rejected Stål's discriminating characters while clarifying the distinction between the two genera on the basis of others, but did not revise or redescribe *Munatia*. REHN & GRANT (1959) included *Munatia* (along with *Procolpia* Stål, *Aeolacris* Scudder, *Prorhachis* Scudder and *Xomacris* Rehn) in a tribe Procolpini of the Romaleinae (a somewhat reduced successor to GIGLIO-TOS's (1898) group Procolpiae), which probably corresponds to a real clade.

Three further species of *Munatia* have been described since 1875. *Munatia australis* Bruner (1906) from Paraguay was synonymized with *Procolpia minor* Giglio-Tos, 1894 by REHN (1955). CARL (1916) erected two new species (*M. biolleyi* and *M. decorata*) on the basis of Costa Rican material, without discussing the characters of the genus. He effectively ignored Stål's *punctata*, noting only that it was too briefly described to provide a basis for comparison and in any case did not agree

with his *biolleyi*, and he did not examine the type specimen. Additionally, *Procolpia inclarata* (Walker) was treated by BRUNER (1907) in his text as *P. emarginata* (Serville) but figured as *Munatia inclarata*.

Specimens of *Munatia* from Costa Rica (Tucurrique, Turrialba, Juan Viñas and Carrillo) were referred, in part erroneously, to *punctata* Stål by REHN (1904) and BRUNER (1907), but since 1916 CARL's name *decorata* has mostly been used for Costa Rican material which does not agree with the description of *M. biolleyi*. REHN & GRANT (1959) examined and figured the male genitalia of *Munatia decorata* Carl but did not examine any other species of the genus.

Several orthopterists have indicated to me that they consider it likely that all three current species of *Munatia* represent the same taxon. With access to plentiful material and much field experience of the Costa Rican species I here show that *decorata* Carl is indeed a synonym of *punctata* Stål, but that *biolleyi* Carl is a valid species. In view of the inadequacy of previous descriptions, I also redescribe the genus and its two species and designate an allotype female of *M. punctata* Stål and lectotypes of both *M. decorata* Carl and *M. biolleyi* Carl.

Abbreviations of depositories: ANSP, Academy of Natural Sciences, Philadelphia, USA; INBio, Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica; MNHNP, Muséum National d'histoire naturelle, Paris, France; MHNG, Muséum d'histoire naturelle, Geneva, Switzerland; NRS, Naturhistoriska Rijksmuseum, Stockholm, Sweden; RC, the author's collection; UCR, Museo de Entomología, Universidad de Costa Rica, San José, Costa Rica; UMMZ, University of Michigan Museum of Zoology, Ann Arbor, USA.

KEY TO GENERA OF PROCOLPINI:

- 1 Medial carina of pronotum absent, lateral carinae present and decorated with granular points. At least the more proximal spines of hind tibia conspicuously flattened and dorsoventrally produced at their base. Male with large pale spots on elytron. *Aeolacris* Scudder
- Medial carina of pronotum present, lateral carinae absent. 2
- 2 Medial carina straight or simply arcuate, not incised by sulci. Elytra narrow with no costal lobe. *Munatia* Stål
- Medial carina incised by sulci, costal lobe present 3
3. Medial carina not produced dorsally to form large teeth. Lateral lobe not bearing a conspicuous lateral tubercle or spine. *Procolpia* Stål
- Medial carina divided into teeth in prozona; lateral lobe bearing a lateral spine or tubercle. 4
4. Medial carina anterior to first sulcus without prominent raised tooth. Lateral margins of fastigium spined. *Prorhachis* Scudder
- Medial carina of pronotum with three large teeth in prozona, the first one anterior to the first sulcus. Lateral margins of fastigium simple. *Xomacris* Rehn

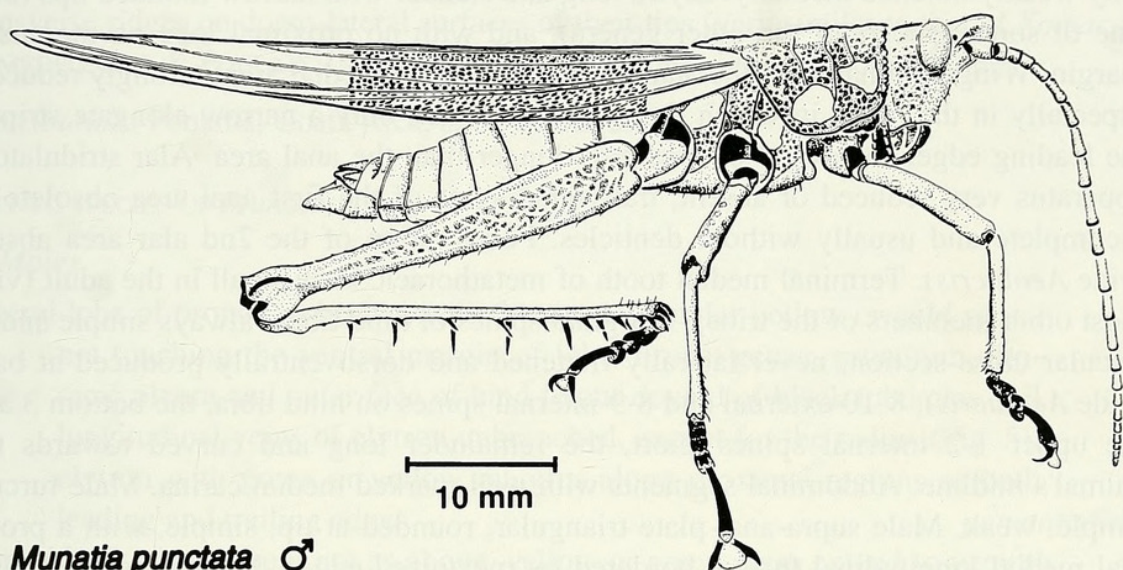


FIG. 1

M. punctata. Male, lateral view. Intersegmental membranes at base of legs are shown in black for clarity, but are pale brown in life.

***Munatia* Stål, 1875**

STÅL 1875: 28

Type species: *M. punctata* Stål, 1875.

REHN 1905: 404; BRUNER 1907: 223; KIRBY 1910: 366; REHN 1955b: 37-39; REHN & GRANT 1959: 239; UVAROV & DIRSH 1961: 158; AMÉDÉGNATO 1974: 198.

REDESCRIPTION OF GENUS

Displays the characters delimiting the tribe Procolpini as defined by REHN & GRANT (1959). The most obvious of these are generally elongate shape, ensiform antennae, well developed rostrum, fully developed wings and tympana, smoothly elongated male subgenital plate, and the inequality between the external and internal row of the hind tibial spines, the latter being notably long and curved. Additionally characterised and distinguished from the remaining genera of the tribe as follows (see also Key to Genera above):

Rostrum somewhat rounded in profile. Frontal ridge below medial ocellus absent (male) or obsolete (female) (vide *Procolpia* and *Xomacris*). Infra-ocular carinae weak or obsolete. Fastigium smooth-sided, without lateral processes (vide *Prorhachis*). Lateral carinae of pronotum absent (vide *Aeolacris*), medial carina well marked, in lateral view straight or forming a low curving crest, not incised by transverse sulci (vide *Procolpia*, *Prorhachis*, *Xomacris*), and not markedly higher in

prozona (vide *Xomacris* and *Prorhachis*) than elsewhere; anterior margin of pronotum only weakly notched medially. Elytra long and slender with narrow rounded tips (also true of some species of the other genera), and with no proximal lobe on the costal margin. Wing dominated by the anal region; radial and medial areas strongly reduced, especially in the male, in which the remigium forms only a narrow elongate strip at the leading edge, somewhat or markedly longer than the anal area. Alar stridulatory apparatus very reduced or absent, transverse veins of the first anal area obsolete or incomplete and usually without denticles. Fenestration of the 2nd alar area absent (vide *Aeolacris*). Terminal medial tooth of metathoracic knee small in the adult (vide most other members of the tribe). Marginal spines of hind tibiae always simple and of circular cross-section, never laterally flattened and dorsoventrally produced at base (vide *Aeolacris*); 8-10 external and 8-9 internal spines on hind tibia, the bottom 3 and the upper 1-2 internal spines short, the remainder long and curved towards the animal's midline. Abdominal segments with well-marked medial carina. Male furcula simple, weak. Male supra-anal plate triangular, rounded at tip, simple, with a proximal medial longitudinal furrow bordered by melanized edges. Male subgenital plate

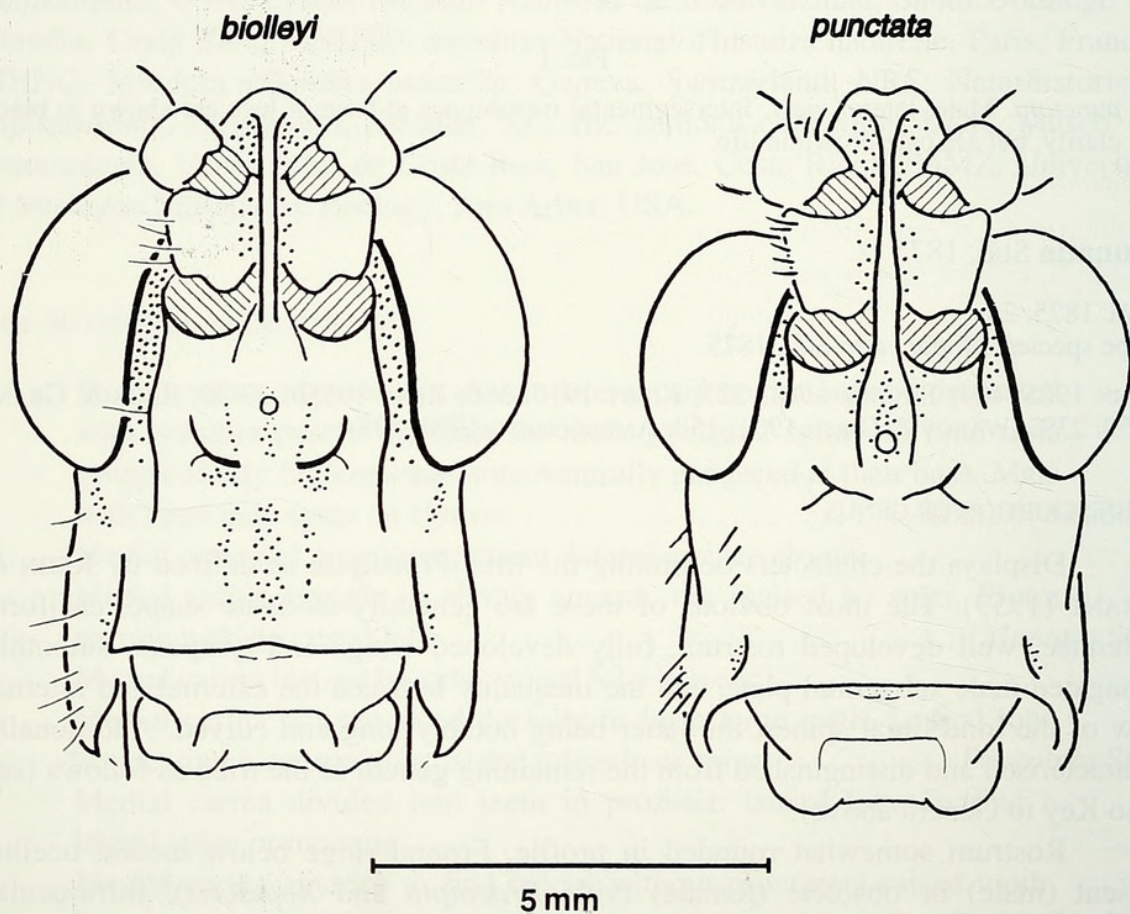


FIG. 2

Frontal view of head of males of *Munatia*. In *biolleyi* the eyes are more produced dorso-ventrally and the facial ridges more pronounced than in *punctata*.

twice as long as supra-anal plate (vide *Procolpia*, *Prorhachis*, *Xomacris*). Aedeagal valves with a weak subapical, latero-posteriorly directed process, and with weak transverse ridges on dorso-lateral surfaces of their tips (very similar to that of *Xomacris* (AMÉDÉGNATO & POULAIN 1986: Fig. 90)). Epiphallus with large pointed lophi.

Distribution: Panama, Costa Rica, and Nicaragua.

KEY TO SPECIES OF *Munatia*:

1) *Males*.

Lateral lobe of pronotum brown, with 2 pairs of circular yellow or gold spots, not touching the ventral margin of lobe. Frons, genae, pronotum, thoracic pleura and outer face of hind femur devoid of black tubercles. All longitudinal veins of elytron unbranched, except for the radius (Fig. 5); elytron with green or yellow margins along proximal regions of both leading and trailing edges *punctata* Stål

Lateral lobe of pronotum not as above, yellow or green areas extend to ventral margin and are often fused. Frons, genae, pronotum, thoracic pleura and outer face of hind femur with numerous small black tubercles. Radius, media and cubitus veins of elytron branched (Fig. 5); elytron with green or yellow margin along proximal region of trailing edge only *biolleyi* Carl

2) *Females*.

Medial carina of pronotum low and straight, not at all arcuate (Fig 4A). Distal medial surface of subgenital plate smooth and convex (Fig. 8B). Black tubercles absent and venation of elytron unbranched, as in male. . *punctata* Stål

Medial carina of pronotum raised and clearly arcuate (Fig 4C). Distal medial surface of subgenital plate bearing two minutely toothed ridges, separated by a deep medial groove (Fig. 8D). Black tubercles present and longitudinal elytral veins branched, as in male. *biolleyi* Carl

1. *Munatia punctata* Stål, 1875

Munatia punctata Stål, 1875: 28. Holotype male, Chiriquí, Panama (Boucard), no date, Naturhistoriska Rijksmuseum, Stockholm (examined).

PICTET & SAUSSURE 1887: 340.; REHN 1905: 405 (misidentification of *M. biolleyi*, as shown by figure of wing outlines); BRUNER 1907: 223 (in part misidentification of *M. biolleyi*, specimens examined).

Allotype female. Female, here designated. Costa Rica, Centr. Am. (P. Biolley), ANS Philadelphia. No other data; bears additional labels "*Munatia punctata* Stål", "Hebard Collection", "*M. decorata* Carl", "*Munatia punctata* Stål 1875 det. C.H.F. Rowell, 96041".

Munatia decorata Carl, 1916: 506, Fig. 12. Lectotype male, here designated (selected and labelled "Holotype" by C.S. CARBONELL 1966), Costa Rica (Prov. Cartago), Carrillo, 600 m; (Prov. Alajuela) Sarapiquí, Carablanco, 600 m (P. Biolley); paralectotype male (labelled "paratype" by C.S. CARBONELL 1966), no data, but considered by Carl to come from the other of the two localities indicated by Biolley on the label on lectotype male; both Muséum d'histoire naturelle, Geneva (examined). **Syn. n.**

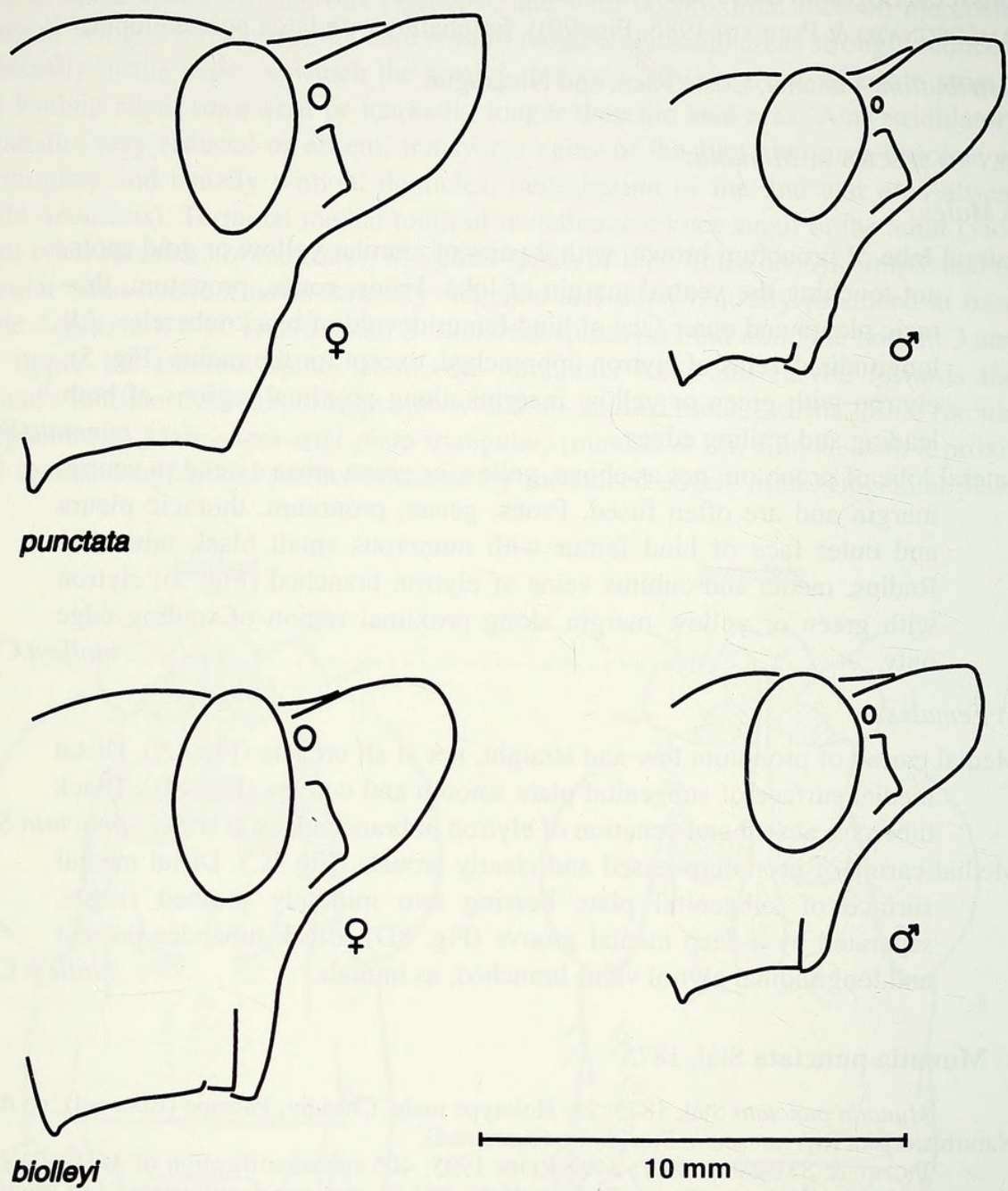


FIG. 3

Side view of head in *Munatia*. The rostrum is slightly longer and more pointed in *punctata*. In *biolleyi* there are also numerous small black tubercles on frons and genae (not shown).

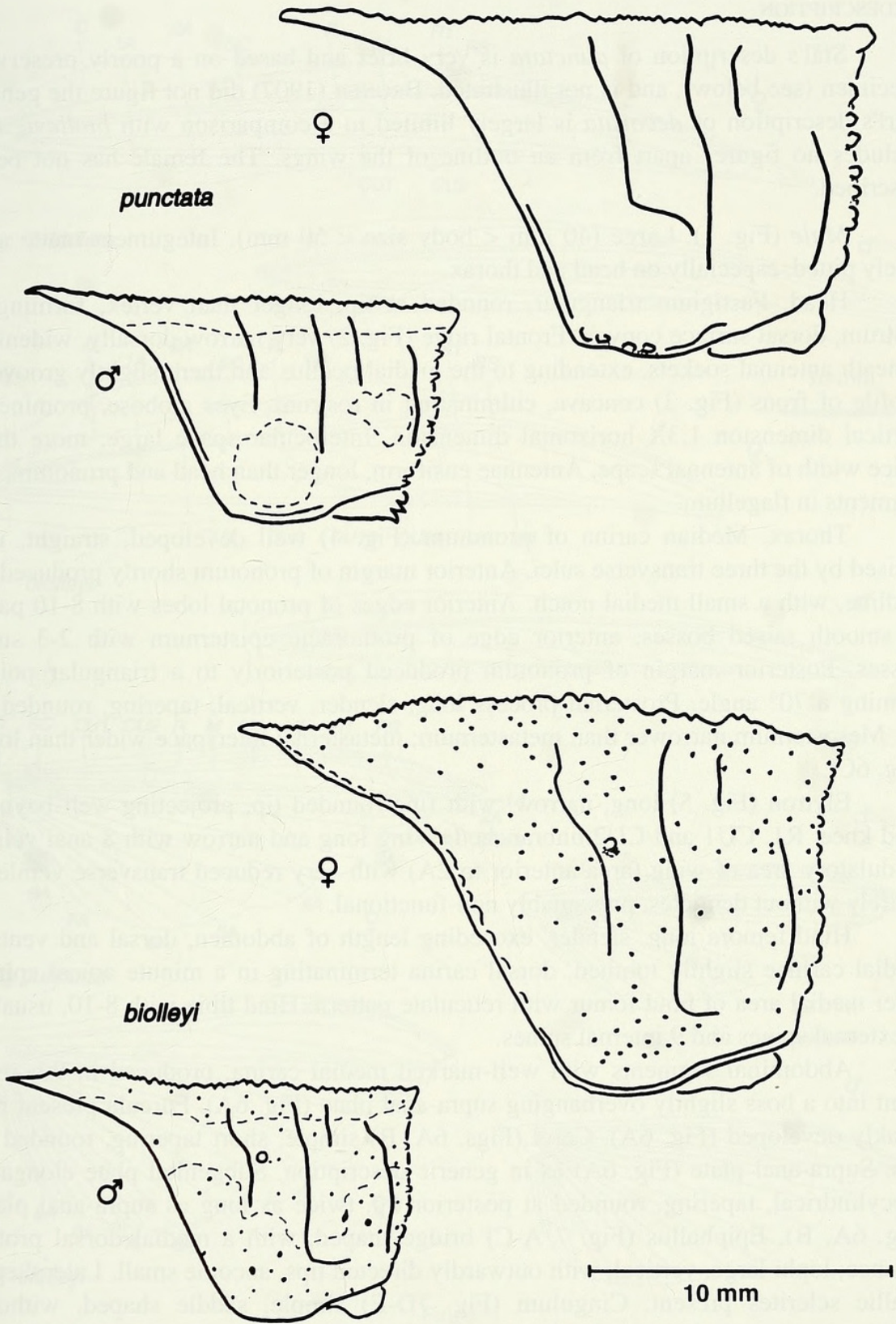


FIG. 4. Pronota of *Munatia*. In both sexes *biolleyi* is distinguished by having more numerous, smaller bosses along the anterior margin, the presence of a single raised pale tubercle laterally just anterior to the third sulcus (present but obscure in *punctata*), and numerous small black tubercles. Female *biolleyi* are additionally distinguished by the presence of a higher, arcuate crest, and males by a different distribution of pigment (dotted lines).

REDESCRIPTION

Stål's description of *punctata* is very brief and based on a poorly preserved specimen (see below), and is not illustrated. BRUNER (1907) did not figure the genus. Carl's description of *decorata* is largely limited to a comparison with *biolleyi*, and includes no figures apart from an outline of the wings. The female has not been described.

Male (Fig. 1). Large (40 mm < body size < 50 mm). Integument matte and finely pitted, especially on head and thorax.

Head. Fastigium triangular, rounded at tip, longer than vertex, forming a rostrum, dorsal surface convex. Frontal ridge (Fig. 2) very narrow dorsally, widening beneath antennal sockets, extending to the medial ocellus and there slightly grooved. Profile of frons (Fig. 3) concave, culminating in rostrum. Eyes globose, prominent, vertical dimension 1.3X horizontal dimension. Interocular space large, more than twice width of antennal scape. Antennae ensiform, longer than head and pronotum, 21 segments in flagellum.

Thorax. Median carina of pronotum (Fig. 4) well developed, straight, not incised by the three transverse sulci. Anterior margin of pronotum shortly produced in midline, with a small medial notch. Anterior edges of pronotal lobes with 8-10 pairs of smooth raised bosses, anterior edge of prothoracic episternum with 2-3 such bosses. Posterior margin of pronotum produced posteriorly to a triangular point, forming a 70° angle. Prosternal process long, slender, vertical, tapering, rounded at tip. Mesosternum narrower than metasternum; metasternal interspace wider than long (Fig. 6C).

Elytron (Fig. 5) long, narrow, with fine rounded tip, projecting well beyond hind knee. R1, CU1 and CU2 unbranched. Wing long and narrow with 8 anal veins; stridulatory area of wing (area anterior to 2A) with very reduced transverse veinlets, entirely without denticles, presumably non-functional.

Hind femora long, slender, exceeding length of abdomen, dorsal and ventral medial carinae slightly toothed, dorsal carina terminating in a minute apical spine; outer medial area of hind femur with reticulate pattern. Hind tibia with 8-10, usually 9, external spines and 9 internal spines.

Abdominal segments with well-marked medial carina, produced in 9th segment into a boss slightly overhanging supra-anal plate (Fig. 6A). Furcula present but weakly developed (Fig. 6A). Cerci (Figs. 6A, B) simple, short tapering, rounded at tips. Supra-anal plate (Fig. 6A) as in generic description. Subgenital plate elongate, subcylindrical, tapering, rounded at posterior tip, twice as long as supra-anal plate (Fig. 6A, B). Epiphallus (Fig. 7 A-C) bridge-shaped, with a medial dorsal protuberance; lophi large, vertical, with outwardly directed tips, ancorae small. Lateral epiphallic sclerites present. Cingulum (Fig. 7D-E) simple, saddle shaped, without anterior apodemes. Anterior apodemes of endophallus laterally flattened in form of two vertical concave plates, joined dorsally by a thin transparent chitinous plate (Fig. 7G, K). Aedeagal sclerites as in generic description.

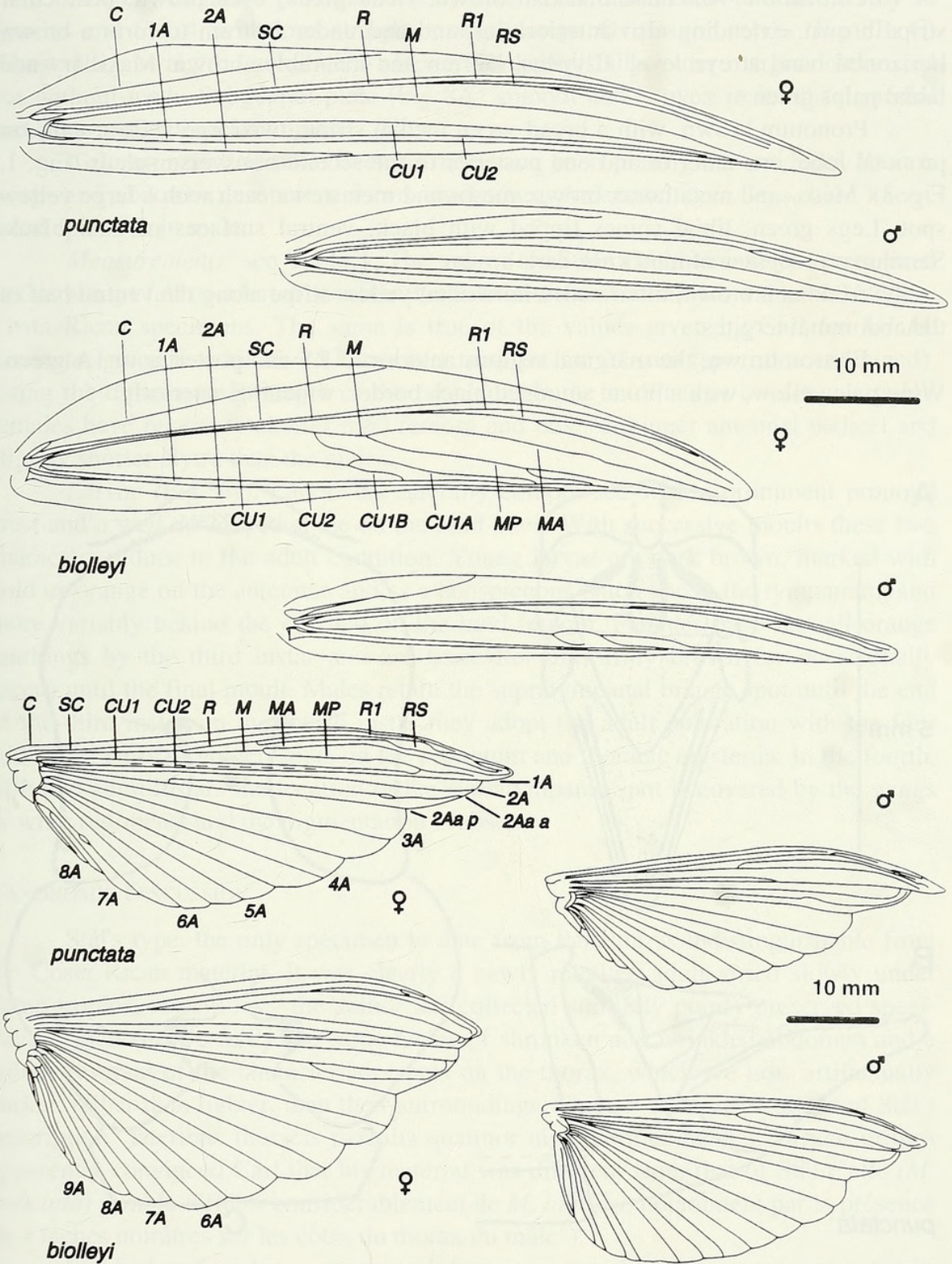


FIG. 5

A. Elytra and wings of female and male *M. punctata* and *M. biolleyi*. In *punctata* both the elytron and the wing are relatively narrower than in *biolleyi*, and this is associated with a reduction in the branching pattern of the longitudinal nerves of the elytron (especially in the male) and in the number of anal veins in the wing. Nomenclature of the venation and abbreviations after RAGGE (1955).

Coloration. Antennae blackish brown. Head green; eyes brown; postocular stripe brown, extending also anteriorly around and under rostrum to form a brown horizontal band at eye level. Clypeus, labrum and mandibles brown. Maxillary and labial palps green.

Pronotum brown, with a broad green medial stripe; two large yellow spots on pronotal lobe, one anterior and one posterior to the second transverse sulcus (Fig. 1, Fig. 3). Meso- and metathorax brown; meso- and metasterna each with a large yellow spot. Legs green, tibial spines tipped with black, ventral surfaces of tarsi black. Semilunar processes of hind knee dark brown.

Abdomen brown, often with a horizontal yellow stripe along the ventral half of the abdominal tergites.

Elytron brown, the marginal regions anterior to RS and posterior to 1A green. Wing pale yellow, with a broad smudged black border, widening anteriorly.

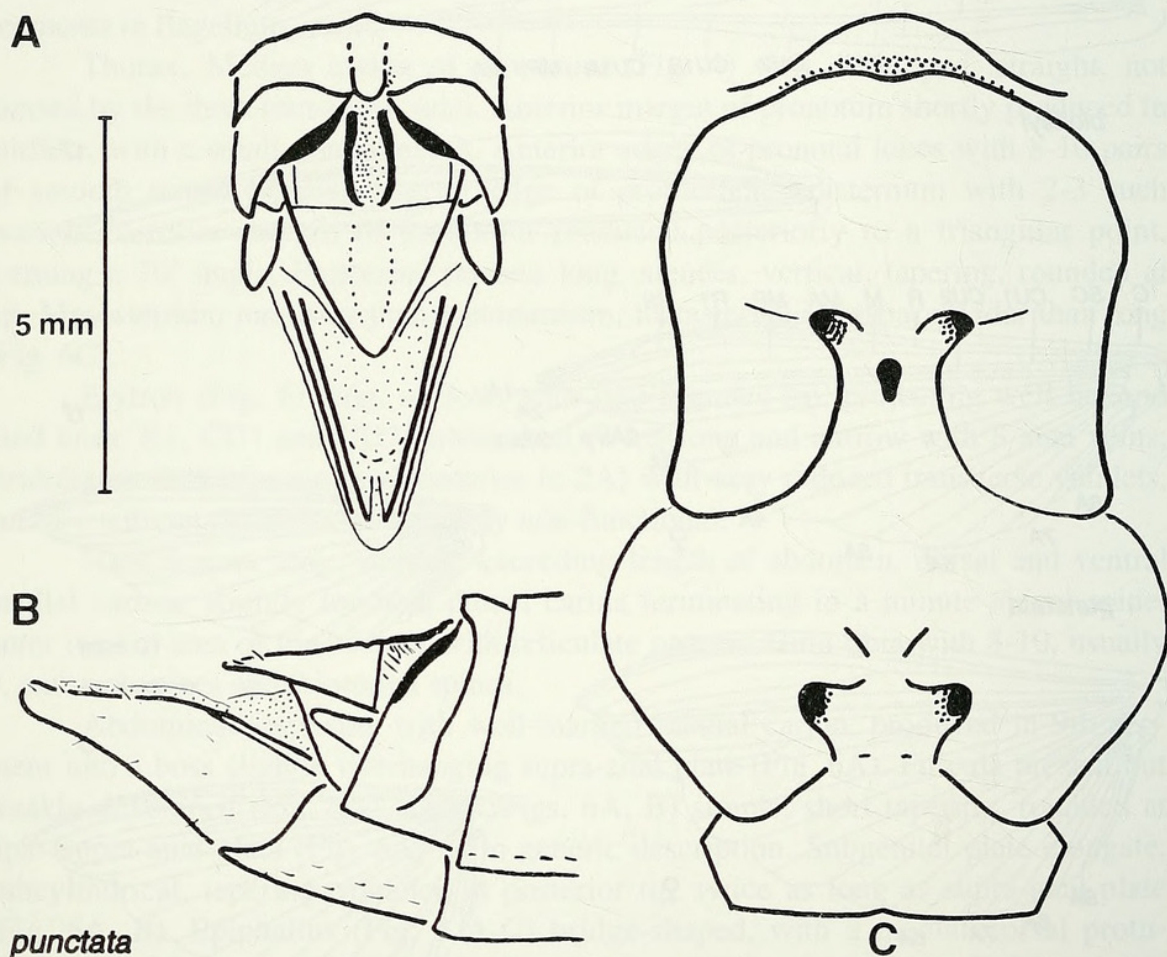


FIG. 6

M. punctata. A, B, extremity of male abdomen, A, dorsal view, B, lateral view. C. Male thoracic sternal plate.

Female. Gigantic (70 mm < body size < 80 mm). Pronotum as in Key to Species and Fig. 4, with low, straight, medial carina. Ovipositor valves (Fig 8B, C) robust, long, straight, in side view slightly hooked distally, outer margins melanized but without teeth. Subgenital plate (Fig 8A) smooth and convex in its distal medial part. Spermatheca not examined.

Coloration: all females seen to date have been plain green on head, thorax, wings and abdomen; no brown forms are known. Antennae, eyes, legs, hind knees, tarsal spines as in male.

Measurements: see Table 1. The values for Stål's Panamanian type (measured in this study) fall comfortably within the maximum and minimum values of modern Costa Rican specimens. The same is true of the values given by Carl for his *M. decorata*, given that his F = 17 mm is a misprint for 27 mm (specimen examined). Using the dimension P (length of the pronotum in the midline) as a reference point, females have relatively shorter hind femora and tarsi, a thinner antennal pedicel and slightly shorter elytra than the males.

Larvae (Fig 9A). Larvae are laterally compressed with a prominent pronotal crest and a well developed spine on the hind knee. With successive moults these two characters reduce to the adult condition. Young larvae are dark brown, marked with gold or orange on the antennae and as a conspicuous patch above the tympanum, and more variably behind the eye and on the hind femora. Females have lost all orange markings by the third instar and are thereafter uniformly brown (or occasionally green) until the final moult. Males retain the supratympanal orange spot until the end of the third instar; in the fourth instar they adopt the adult coloration with the four additional pairs of golden spots on the pronotum and thoracic episterna. In the fourth, fifth and adult instars the location of the supratympanal spot is covered by the wings or wing rudiments and the pigmentation is absent.

TAXONOMIC DISCUSSION

Stål's type, the only specimen to date from Panama, is indistinguishable from the Costa Rican material. It was clearly a newly moulted adult, dried slowly under damp tropical conditions - the author has collected similarly poorly preserved specimens which show exactly the same facies of shrunken and wrinkled abdomen and a colour reversal of the characteristic spots on the thorax, which are now artifactually darker, rather than lighter, than their surroundings. This reversal is the origin of Stål's description "lateribus thoracis maculis quattuor nigricantibus notatis", which in turn apparently convinced Carl that his material was different from that of Stål ("elle (*M. punctata*) semble différer considérablement de *M. biolleyi*, notamment par la présence de 4 taches noirâtres sur les côtés du thorax du mâle").

Stål had no female specimen, and there is no female specimen present in Carl's type series. For this reason an allotype female is designated. It is from the same collector and quite possibly the same locality as the lectotype of *M. decorata*.

MATERIAL EXAMINED. Type material of *punctata* Stål and *decorata* Carl as indicated above. Additionally:

TABLE 1. Dimensions of *M. punctata*

<i>Munatia punctata</i>	Mean	S.D.	Max	Min	N	Stål's type	Carl's values
Males							
Dimensions in millimetres:							
Hind femur (F)	28.45	2.35	31.32	24.06	9	28.77	17
Rostrum-subgen. plate (L)	47.22	4.43	55.23	40.26	10	41.00	45
Pronotum (midline) (P)	13.07	1.02	14.00	11.32	10	11.85	13
Pronotum longest	13.16	1.02	14.08	11.34	10	11.93	
Interocular space (IO)	2.22	0.13	2.43	1.95	10	1.90	
Antennal pedicel (width)	1.26	0.08	1.42	1.12	10	1.20	
Antenna (A)	29.23	2.61	34.70	26.10	8		
Antenna -> 11th. segment	19.31	2.09	22.60	17.00	6	17.25	
Hind tarsus 1st + 2nd segments	3.62	0.48	4.14	2.60	8	3.89	
Hind tarsus 3rd segment	3.95	0.27	4.18	3.46	8	3.89	
*Elytron length (E)	47.21	2.76	50.99	43.87	10	44.50	50
Rostrum, tip to eye	3.64	0.23	3.95	3.15	10	3.57	
Ratios							
F/P	2.16	0.06	2.26	2.11	9	2.43	
L/P	3.61	0.19	3.94	3.24	10	3.46	
IO/P	0.17	0.01	0.19	0.16	10	0.16	
IO/pedicel	1.76	0.13	1.96	1.56	10	1.58	
Tarsus 3/ Tarsus 1+2	1.05	0.16	1.50	1.01	8	1.00	
Tarsus 1+2+3/F	0.28	0.03	0.29	0.21	8	0.27	
Tarsus 1+2+3/P	0.60	0.05	0.64	0.46	8	0.66	
A/P	2.22	0.16	2.48	1.97	8		
*E/P	3.60	0.28	3.93	3.18	10	3.73	
*E/L	1.01	0.08	1.11	0.81	10		
Females							
Dimensions in millimetres:							
Hind femur (F)	39.01	2.38	41.57	36.20	4		
Rostrum-subgen. plate (L)	73.57	7.85	83.05	64.14	4		
Pronotum (midline) (P)	19.19	0.85	20.00	18.40	4		
Pronotum longest	19.32	0.77	20.00	18.63	4		
Interocular space (IO)	3.51	0.25	3.86	3.33	4		
Antennal pedicel (width)	1.51	0.04	1.55	1.45	4		
Antenna (A)	21.16	1.28	22.06	20.25	2		
Antenna -> 11th. segment	32.73	0.95	33.40	32.05	2		
Hind tarsus 1st + 2nd segments	5.06	0.44	5.37	4.75	2		
Hind tarsus 3rd segment	5.07	0.56	5.46	4.67	2		
*Elytron length (E)	62.44	4.97	67.27	57.10	4		
Rostrum, tip to eye	4.93	0.09	5.02	4.80	4		
Ratios							
F/P	2.03	0.05	2.09	1.97	4		
L/P	3.85	0.56	4.49	3.21	4		
IO/P	0.18	0.01	0.19	0.17	4		
IO/pedicel	2.33	0.17	2.57	2.19	4		
Tarsus 3/ Tarsus 1+2	1.00	0.02	1.02	0.98	2		
Tarsus 1+2+3/F	0.27	0.02	0.28	0.26	2		
Tarsus 1+2+3/P	0.55	0.05	0.59	0.51	2		
A/P	1.71	0.04	1.73	1.68	2		
*E/P	3.25	0.13	3.39	3.08	4		
*E/L	0.86	0.15	1.03	0.69	4		

* In many specimens the elytron tip is broken. Only the maximal values are meaningful.

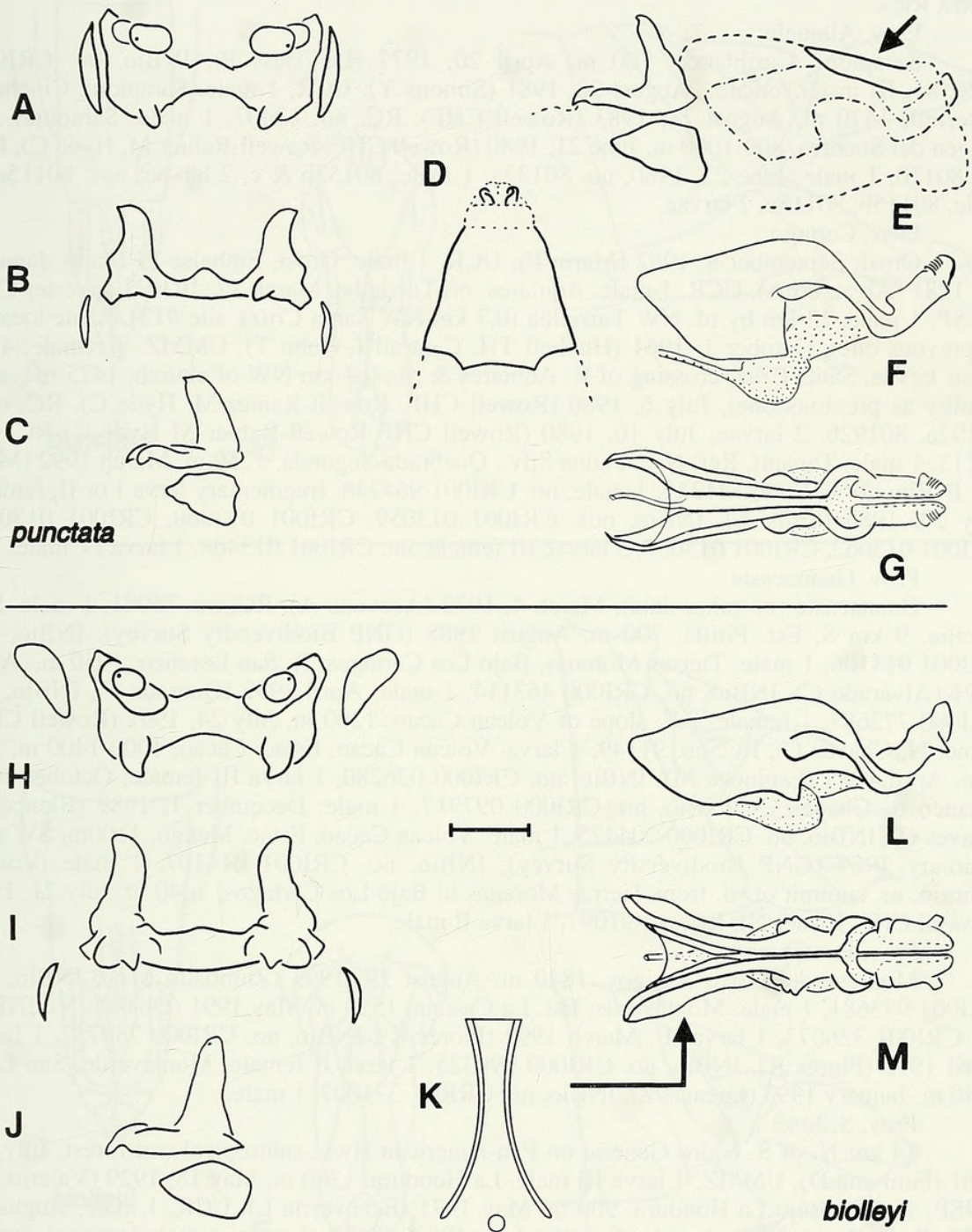


FIG. 7

Male genitalia. A-G, *M. punctata*; H-M, *M. biolleyi*. A-C, H-J, epiphallus, dorsal, axial and lateral views; D, dorsal view of posterior region of complete phallic complex (area indicated by arrow in E); E, Complete phallic complex, lateral view; F-G, L-M, endophallus, lateral and dorsal views; K, diagrammatic transverse section through M at the point indicated, to show relationships of anterior apodemes of endophallus, the dorsal plate joining them, and the ejaculatory duct. Scale bar 1 mm, except for D, E and K, not to scale.

COSTA RICA:

Prov. Alajuela:

Sarapiquí, Cariblanco, 700 m, April 20, 1977 (DeVriess P), INBio, no. CRI001 0130581, III instar female; August 28, 1981 (Simons Y), UCR, 1 male. Sarapiquí, Cinchona waterfall, 1470 m, August 24, 1983 (Rowell CHF), RC, no. 83407, 1 male. Sarapiquí, nr. Virgen del Socorro, 800-1000 m, June 21, 1980 (Rowell CHF, Rowell-Rahier M, Hyde C), RC, no. 80110, 1 male; June 22, 1980, no. 80132a, 1 male; 80132b & c, 2 larvae; nos. 80115a, 1 male, 80115b, 80115c, 2 larvae.

Prov. Cartago:

Orosí, September 9, 1982 (Marín F), UCR, 1 male. Orosí, Embalse El Llano, January 22, 1981 (Alvarado A), UCR, 1 male. Aquiares, nr. Turrialba, March 17, 1930 (Lankester CH), ANSP, 1 male. 13 km by rd. NW Turrialba (0.7 km NW Santa Cruz), site #131 (same locality as previous one), October 1, 1961 (Hubbell TH, Cantrall I, Cohn T), UMMZ, 1 female, 4 III instar larvae. Santa Cruz, crossing of R. Aquiares & rd., 0.7 km NW of church, 1475 m (same locality as previous one), July 6, 1980 (Rowell CHF, Rowell-Rahier M, Hyde C), RC, nos. 80192a, 80192b, 2 larvae; July 10, 1980 (Rowell CHF, Rowell-Rahier M, Hyde C), RC, no. 80213, 1 male. Tapantí, Ref. Nac. Fauna Silv., Quebrada Segunda, 1250 m, March 1992 (Mora G), INBio, no. CRI000 741239, 1 male; no. CRI001 964248, fragmentary larva I or II, female; July 20, 1985 (Solis A), INBio, nos. CRI001 013059, CRI001 013060, CRI001 013056, CRI001 013062, CRI001 013057, 5 larvae III female; no. CRI001 013408, 1 larva IV male.

Prov. Guanacaste:

Guanacaste (no other data), March 4, 1972 (Acevedo A), RC, no. 76001, 1 male. Sta. Cecilia, 9 km S, Est. Pitilla, 700 m, August 1988 (GNP Biodiversity Survey), INBio, no. CRI001 014106, 1 male. Tierras Morenas, Bajo Los Cartagos, R. San Lorenzo, 1050 m, April 1991 (Alvarado C), INBio, no. CRI000 463114, 1 male; April 1992 (Quesada F), INBio, no. CRI000 772687, 1 female. S.E. slope of Volcan Cacao, 1200 m, July 24, 1991 (Rowell CHF, Elsner N, Chavez C), RC, no. 91149, 1 larva. Volcan Cacao, Estac. Cacao, 1000-1400 m, SW side, April 1988 (Espinoza M), INBio, no. CRI000 036280, 1 larva III female; October 1989 (Blanco R, Chaves C), INBio, no. CRI000 097917, 1 male; December 1, 1989 (Blanco R, Chaves C), INBio, no. CRI000 204475, 1 male. Volcan Cacao, Estac. Mengo, 1100m, SW side February 1989 (GNP Biodiversity Survey), INBio, no. CRI001 014107, 1 male. Volcan Tenorio: nr. summit of rd. from Tierras Morenas to Bajo Los Cartagos, 1040 m, July 21, 1991 (Rowell CHF, Elsner N), RC, no. 91097, 1 larva II male.

Prov. Puntarenas:

Monteverde, Cerro Amigos, 1840 m, August 29, 1993 (Zumbado MA), INBio, no. CRI001 973681, 1 male. Monteverde, Est. La Casona, 1520 m, May 1991 (Obando N), INBio, no. CRI001 326073, 1 larva III; March 1992 (Flores K), INBio, no. CRI000 788757, 1 larva. April 1992 (Flores K), INBio, no. CRI000 990325, 1 larva II female. Monteverde, San Luís, 1040 m, January 1993 (Fuentes Z), INBio, no. CRI001 371007, 1 male.

Prov. S. José:

14 km N. of S. Isidro General on Pan-American Hwy, subtropical wet forest. July 19, 1961 (Futuyma D), UMMZ, 1 larva III male. La Hondura, 1300 m, May 18, 1929 (Valerio M), ANSP, 1 male. Bajo La Hondura. 900 m, May 1971 (Echeverría L), UCR, 1 male; August 9, 1978 (K. Paulsen), UCR, 1 male. Carrillo, June 1903, ANSP, 1 male, 4 male larvae, 1 female larva (Hebard Collection); August 1903, ANSP, 1 male; August-October 1903, ANSP, 1 male.

Parque Nacional Braulio-Carrillo, La Montura, 1100 m, April 26, 1980 (DeVriess P), RC, nos. 80282a, 80282b, 2 larvae. Pozo Azul de Pirrís, 325-550 ft (98-167 m) May-June 1903, ANSP, 1 larva.

Distribution. *M. punctata* is a characteristic and sometimes common species of lower montane rain forest in Costa Rica, replacing *M. biolleyi* as one ascends from the lowlands. Virtually all records come from between 600 and 1600 m altitude. The only certain record from a lower altitude is a single larva from Pozo Azul de Pirrís, 98-167 m, in 1903. The type of *punctata* from Chiriquí Province (Pacific slope, abutting the

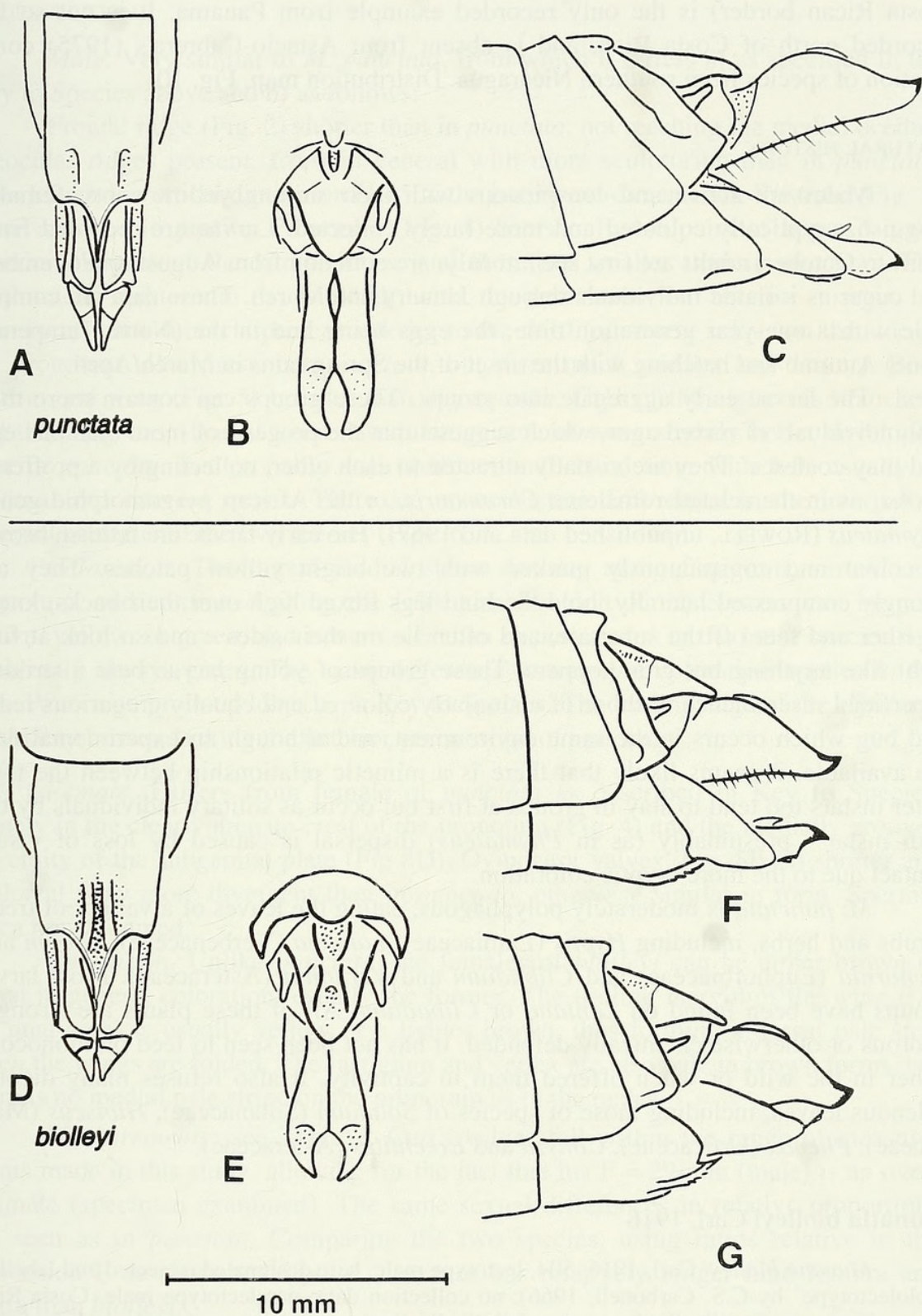


FIG. 8

Female genitalia. A-C, *M. punctata*; D-G, *M. biolleyi*. A, D, ventral view of subgenital plate and ventral ovipositor valves; B, E, dorsal view of supra-anal plate and dorsal ovipositor valves; C, F & G, lateral view.

Costa Rican border) is the only recorded example from Panama. It is not so far recorded north of Costa Rica, and is absent from Astacio-Cabrera's (1975) compilation of species from southern Nicaragua. Distribution map, Fig. 10.

NATURAL HISTORY

Males are active and conspicuous with their shining yellow spots, females sluggish, cryptically coloured and more rarely collected. Larvae are recorded from April to October; adults are first seen in July, are common from August to November, and occur as isolated individuals through January and March. These data are compatible with a one-year generation time, the eggs being laid in the (North Temperate Zone) Autumn and hatching with the onset of the Spring rains in March/April.

The larvae early aggregate into groups. These groups can contain more than 100 individuals of mixed ages, which suggests that the progeny of more than one egg pod may coalesce. They are visually attracted to each other, collecting by a proffered mirror, as in the related romaleine *Chromacris*, or the African pyrgomorphid genus *Phymateus* (ROWELL, unpublished data and 1967). The early larvae are reddish brown in colour and conspicuously marked with two bright yellow patches. They are strongly compressed laterally, hold the hind legs flexed high over their backs, knees together and feet off the substrate, and often lie on their sides - and so look at first sight like anything but grasshoppers. These groups of young larvae bear a striking superficial resemblance to those of a similarly coloured and equally gregarious reduviid bug which occurs in the same environment, and although no experimental data are available, it seems likely that there is a mimetic relationship between the two. Later instars too tend to stay in groups at first but occur as solitary individuals by the fifth instar - presumably (as in *Phymateus*) dispersal is caused by loss of visual contact due to the more cryptic coloration.

M. punctata is moderately polyphagous, eating the leaves of a variety of trees, shrubs and herbs, including *Hyptis* (Lamiaceae), *Lantana* (Verbenaceae), *Croton* and *Alchornia* (Euphorbiaceae) and *Clibadium* and *Vernonia* (Asteraceae). Most larval groups have been found on *Lantana* or *Clibadium*. All of these plants are strongly odorous or otherwise chemically defended. It has not been seen to feed on monocots, either in the wild or when offered them in captivity. It also refuses many dicotyledenous leaves, including those of species of *Solanum* (Solanaceae), *Hibiscus* (Malvaceae), *Phenax* (Urticaceae), *Conyza* and *Erechtites* (Asteraceae).

Munatia biolleyi Carl, 1916

Munatia biolleyi Carl, 1916: 504, lectotype male, here designated (selected and labelled "holotype" by C.S. Carbonell, 1966), no collection data; paralectotype male, Costa Rica (Prov. Cartago), Carrillo, herbes aux soleil (P. Biolley); paralectotype female (selected and labelled "allotype" by C.S. Carbonell, 1966), Costa Rica (label in Biolley's hand writing), no other collection data; all Muséum d'histoire naturelle, Geneva (examined). It is highly probable that all of Carl's type series were collected in Carrillo by Biolley.

REHN 1905: 405 (as *M. punctata*, but figured outline of wing indicates actually *biolleyi*); HEBARD 1924a: 100.

REDESCRIPTION

Male. Very similar to *M. punctata*, from which it differs a) as specified in the Key to Species above and b) as follows:

Frontal ridge (Fig. 2) shorter than in *punctata*, not reaching the medial ocellus. Preocular ridges present, frons in general with more sculpturing than in *punctata*. Eyes longer in vertical dimension (1.45 X the horizontal dimension). Rostrum (Fig. 3) more rounded in profile. Pronotum (Fig. 4) bears only 4-6 pairs of bosses on the anterior margins of the lateral lobes, and these are smaller than in *punctata*. The prothoracic episternum is rounded, with no decoration on anterior margin. A prominent white tubercle present anterior to the third transverse sulcus on the side of the pronotum (also present in *punctata*, but there much smaller and darker). Both elytron and wing (Fig. 5) broader than in *punctata*; CU1 of the elytron is branched, and the wing has 10 anal veins. Stridulatory area of wing slightly better developed than in *punctata*, but probably still nonfunctional. Hind tibia with 8-9, usually 8, external and internal spines. There are no consistent differences in the internal or external genitalia of the two species (Figs. 6, 7).

Coloration. The dorsal medial stripe running along fastigium, vertex, and pronotum, and continued along the folded anal region of the elytron, can be pale brown, yellow, or green, and is narrower than in *punctata* - in the latter species it is apparently always green. The same difference in range of coloration applies to the legs. Pattern on pronotal lobes as in Key to Species. The leading edge of the elytron is invariably brown, lacking the anterior green stripe of *punctata*.

Female. Differs from female of *punctata* as described in Key to Species, namely in the clearly arcuate crest of the pronotum (Fig. 4) and the medially grooved extremity of the subgenital plate (Fig 8D). Ovipositor valves (Fig. 8E-G) shorter and in dorsal view more divergent than in *punctata*, otherwise similar in form. Spermatheca not examined.

Coloration. Unlike *punctata*, the females of *biolleyi* can be either brown or green in general coloration, usually the former. The trailing margin of the wing (i.e. the anal area) is usually yellow or a lighter brown, thus forming a dorsal pale strip when the wings are folded. The fastigium and vertex are also pale in brown forms, but there is no medial pale stripe on the pronotum as in the males.

Measurements: see Table 2. Carl's values fall within the range of measurements made in this study, allowing for the fact that his F = 29 mm (male) is an overestimate (specimen examined). The same sexual differences in relative proportions are seen as in *punctata*. Comparing the two species, using ratios relative to the dimension P as a reference point, *punctata* has relatively longer hind femora and elytra than *biolleyi*.

Larvae (Fig 9B.) The morphological changes occurring in the larvae are similar to those described for *punctata*. Only the first instar however has orange markings, all others are cryptically coloured.

MATERIAL EXAMINED. Type material of *biolleyi* Carl as indicated above. Additionally:

TABLE 2. Dimensions of *M. biolleyi*

<i>Munatia biolleyi</i>	Mean	S.D.	Max	Min	N	
Males:						
Dimensions in millimetres:						Carl's values
Hind femur (F)	25.12	1.15	27.71	24.01	10	29
Rostrum-subgen. plate (L)	44.70	1.31	46.74	43.41	10	45
Pronotum (midline) (P)	12.02	0.58	13.24	11.21	10	12.5
Pronotum longest	12.11	0.58	13.35	11.31	10	
Interocular space (IO)	1.77	0.09	1.97	1.66	10	
Antennal pedicel (width)	1.13	0.07	1.23	1.00	10	
Antenna (A)	27.07	2.30	30.50	24.66	5	
Hind tarsus 1st + 2nd segments	3.53	0.28	4.10	3.13	10	
Hind tarsus 3rd segment	3.42	0.20	3.81	3.21	10	
Elytron length (E)	41.92	1.54	43.81	39.45	10	46
Rostrum, tip to eye	3.19	0.23	3.47	2.79	10	
Ratios						
F/P	2.11	0.08	2.24	2.00	9	
L/P	3.75	0.16	4.01	3.52	9	
IO/P	0.15	0.01	0.16	0.13	9	
IO/pedicel	1.58	0.14	1.85	1.43	9	
Tarsus 3/ Tarsus 1+2	0.99	0.05	1.06	0.91	9	
Tarsus 1+2+3/F	0.27	0.01	0.30	0.26	9	
Tarsus 1+2+3/P	0.58	0.02	0.60	0.55	9	
A/P	2.25	0.13	2.38	2.04	5	
E/P	3.49	0.17	3.72	3.22	9	
E/L	0.94	0.05	1.01	0.86	9	
Females:						
Dimensions in millimetres:						
Hind femur (F)	35.29	1.81	38.25	31.95	10	35
Rostrum-subgen. plate (L)	71.92	4.83	79.32	66.29	9	75
Pronotum (midline) (P)	19.73	0.96	21.50	18.03	10	20
Pronotum longest	19.90	0.94	21.70	18.30	10	
Interocular space (IO)	2.98	0.15	3.23	2.79	10	
Antennal pedicel (width)	1.40	0.07	1.50	1.31	9	
Antenna (A)	28.29	2.39	30.95	26.30	3	
Hind tarsus 1st + 2nd segments	4.51	0.58	5.42	3.16	10	
Hind tarsus 3rd segment	4.51	0.27	5.15	4.23	9	
Elytron length (E)	56.24	2.66	60.94	52.49	10	60
Rostrum, tip to eye	4.51	0.49	5.38	3.90	10	
Ratios						
F/P	1.79	0.09	1.98	1.66	10	
L/P	3.67	0.22	4.07	3.45	9	
IO/P	0.15	0.01	0.16	0.14	10	
IO/pedicel	2.15	0.17	2.43	1.86	9	
Tarsus 3/ Tarsus 1+2	0.92	0.35	1.38	0.00	10	
Tarsus 1+2+3/F	0.24	0.05	0.28	0.13	10	
Tarsus 1+2+3/P	0.44	0.08	0.50	0.22	10	
A/P	1.43	0.01	1.44	1.43	2	
E/P	2.85	0.12	3.11	2.70	10	
E/L	0.79	0.01	0.80	0.78	5	

PANAMA

Prov. Bocas del Toro: Bocas del Toro, July 1-10, 1908 (Robinson W), ANSP, 1 male.

COSTA RICA

Prov. Cartago:

2 mi SE Turrialba (grounds of Inst. Interamer. de Sci. Agrícolas), site #129, September 30, 1961 (Hubbell T, Cantrall I, Cohn T), UMMZ, 2 larvae III, 1 male; October 3, 1961 (Hubbell T, Cantrall I, Cohn T), UMMZ, 2 females, 1 male. Juan Viñas, March (no year given) (Bruner L), ANSP, 1 female.

Prov. Guanacaste:

Cerro El Hacha, 300 m, 12 km SE La Cruz, May 1988 (Espinoza M), INBio, no. CRI000 094299, 1 female. Sta. Cecilia, 9 km S, Est. Pitilla, 700 m, May 1988 (GNP Biodiversity Survey), INBio, no. CRI000 121179, 1 larva V female; July 1988, no. CRI001 014100, 1 larva V male; no. CRI001 014089, 1 male; no. CRI000 129732, 1 male; no. CRI000 129731, 1 male; no. CRI000 129446, 1 male; no. CRI000 088000, 1 male; no. CRI000 129797, 1 female; no. CRI000 088007, 1 female; no. CRI001 014121, 1 larva; August 1988, no. CRI001 014105, 1 larva III f.; no. CRI001 014090, 1 male; no. CRI001 014117, 1 female; September 1988, no. CRI001 013295, 1 male; November 1988, no. CRI001 014113, 1 larva V female; no. CRI000 136257, 1 male; April 6, 1989, no. CRI000 091743, 1 female; June 1989, no. CRI000 011236, 1 male; September 1989, no. CRI000 035769, 1 male; September 1989 (Moraga C, Rios P), INBio, no. CRI000 046485, 1 male; May 1990 (II Curso Parataxon.), INBio, no. CRI001 147678, 1 larva IV male, no. CRI000 241688, 1 larva V male.; no. CRI000 293438, 1 female; August 16, 1991 (Moraga C), INBio, no. CRI000 409548, 1 female; July 21, 1993 (Rios P), INBio, no. CRI001 767206, 1 male; December 10, 1993 (Moraga C), INBio, no. CRI001 948084, 1 female.

Prov. Heredia:

Parque Nacional Braulio-Carrillo, Est. Magsasay, June 1990 (Alvarado C), INBio, no. CRI000 272954, 1 female; Puerto Viejo, Finca La Selva. 40 m, September 3, 1975 (Rowell CHF), RC, nos. 75005 & 75006 1 male, 1 female, in cop.; August 13, 1976 (Waltz S, Rowell CHF), RC, nos. 76003 & 76004, 1 male, 1 female, in cop.; September 12, 1979 (Rowell CHF, Rowell-Rahier M), RC, no. 79246, 1 male; September 13 1979 (Rowell CHF, Rowell-Rahier M), RC, no. 79247, 1 male; July 10, 1980 (Braker HE), RC, no. 80018, 1 female; May 3, 1982 (Marquis B), ANSP, no. 82-106, 1 female; June 1982 (Braker HE), ANSP, no. 82-137, 82-138, 2 males; July 12, 1982 (Braker HE), ANSP, no. 82-140, 1 female; July 20, 1982 (Braker HE), ANSP, no. 82-143, 1 female; September 2, 1983 (Rowell CHF), RC, nos. 83447a & 83447b, 2 males; September 1, 1991 (Waltz S), RC, no. 75004, 1 male.

Prov. Limón:

5 km N. of Suretka, trail to Rio Uatsí, 200-220 m, September 20, 1983 (Rowell CHF), RC, nos. 83060a & 83060b, 1 male, 1 female, in cop.; Amubri, 70 m, August 23, 1992 (Gallardo G), INBio, no. CRI000 734414, 1 male; no. CRI000 734404, 1 female; May 14, 1994 (Gallardo G), INBio, no. CRI001 871114, 1 male; no. CRI001 871113, 1 male; Barra del Colorado, R.N.F.S., Rio Sardinas, 10 m, April 10, 1994 (Araya F), INBio, no. CRI001 848425, 1 larva; June 1994 (Araya F), INBio, no. CRI001 847939, 1 female; Parque Nacional Tortuguero, Est. Cuatro Esquinas, 0 m asl, June 1990 (Chavarria U), INBio, no. CRI000 272555, 1 female; June 1990 (Quesada E), INBio, no. CRI000 462818, 1 male; July 1990 (Chavarria U), INBio, no. CRI000 244702, 1 female; June 1990 (Chavarria U), INBio, no. CRI000 272558, 1 male. Río Segundo affl. Río. Banano, 500 m, April 27, 1985 (Solís A), INBio, no. CRI001 013052 to 013055, 4 larvae. Río Toro Amarillo, 7 km. W. of Guápiles, late second growth tropical wet forest, August 21, 1964 (Hubbell SP), UMMZ, 1 male, 1 female; Río Toro Amarillo, 10 km N of Guapiles, S of Quebrada Grande on trail to S. Valentino, 650 m, September 10, 1993 (Rowell CHF), RC, no. 93207, 1 male, 1 female, in cop.; Valle de la Estrella, Res. Biol. Hitoy Cerere, Est. Miramar, 500 m, July 1993 (Carballo G), INBio, no. CRI001 955534, 1 male; Est. Hitoy Cerere, 100 m, July 1991 (Carballo G), INBio, no. CRI000 585772, 1 larva V female; November 16, 1991 (Carballo G), INBio, no. CRI000 524119, 1 female.

Distribution. *M. biolleyi* is apparently confined to lowland rainforest of the Caribbean slope of northern Panama, Costa Rica, and southern Nicaragua (Nicaragua:

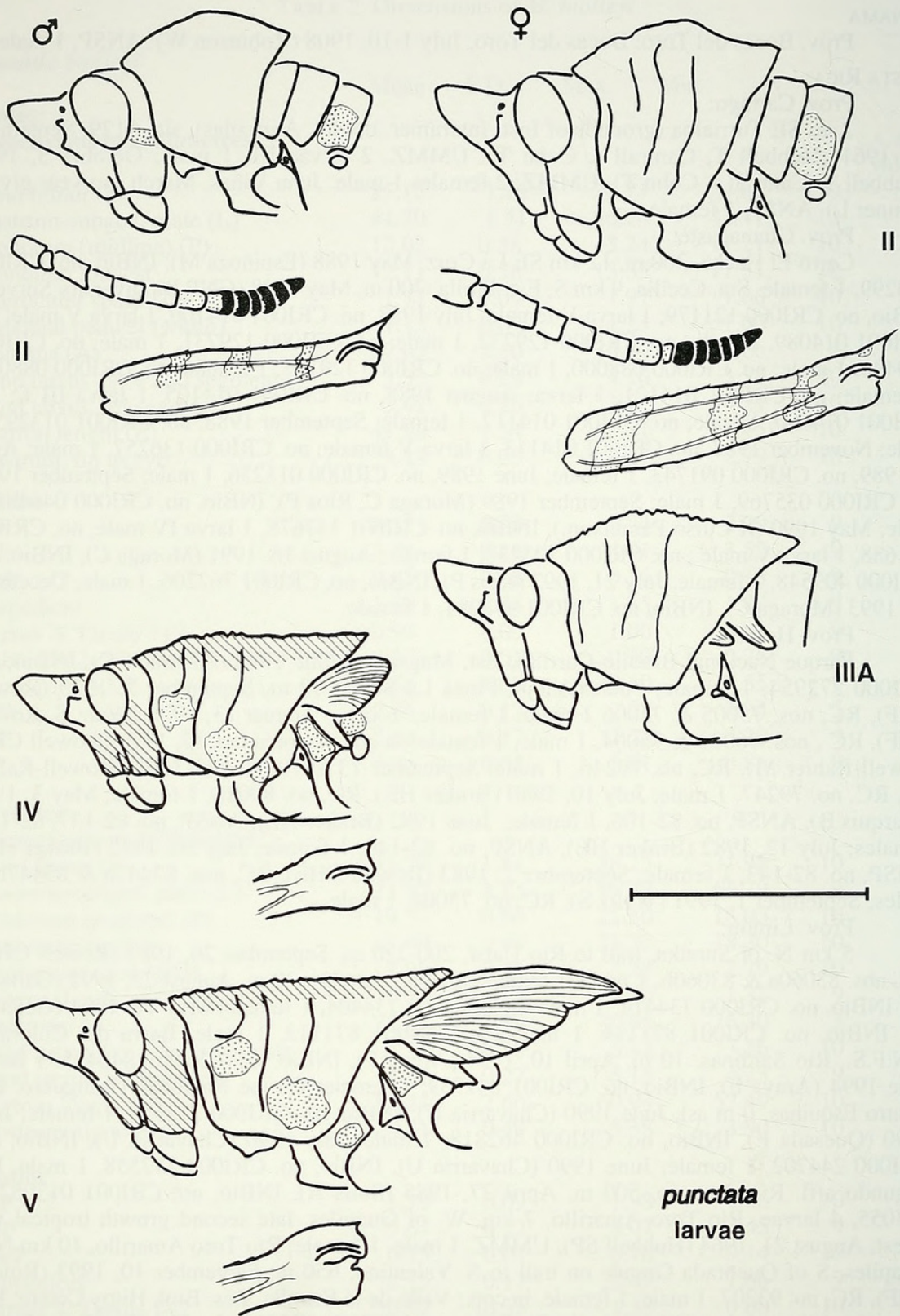
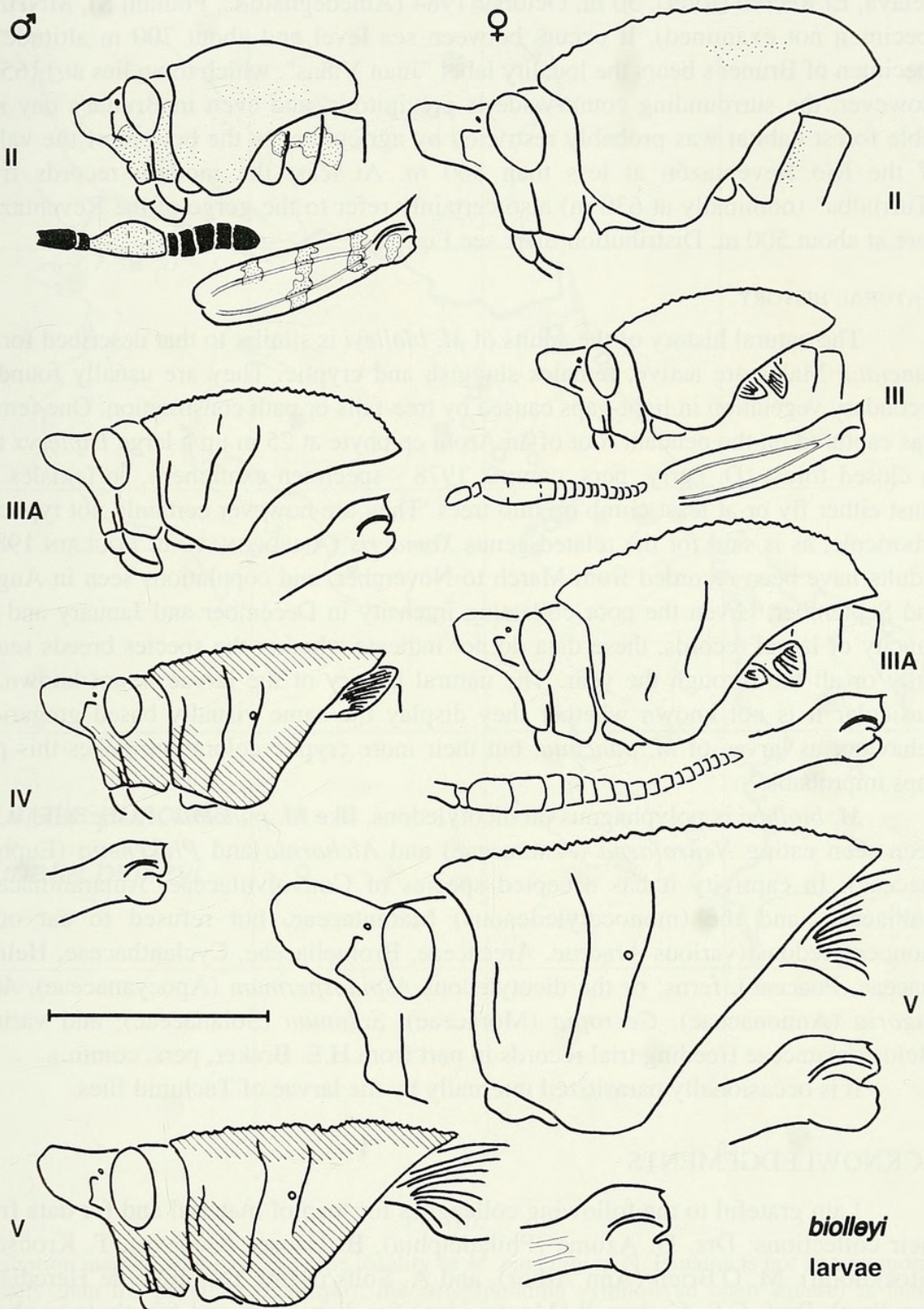


FIG. 9. Larvae of *Munatia*. A. *M. punctata*. B. *M. biolleyi*. Conventions applying to both diagrams: stippled areas, orange or gold; hatched areas, green or yellow, filled areas, black; open areas, dark brown. Scale 10 mm throughout, except for instar II larvae, where the scale is 5 mm. Both species show progressive reduction with age in the curvature of the pronotal crest and the



relative length of the spine on the hind knee, and similar changes in general coloration. They differ from each other throughout the larval instars in the more angular rostrum and pronotum of *punctata*, in the detail of colour patterning, especially on the antennae of young larvae and the pronota of older males, and in the presence in fourth and later instars of *biolleyi* of a conspicuous white tubercle in the centre of the pronotal lobe.

Zelaya, El Recreo (forêt), 30 m, October 1984 (Amedegnato C, Poulain S), MNHNP, specimen not examined). It occurs between sea level and about 700 m altitude. A specimen of Bruner's bears the locality label "Juan Viñas", which town lies at 1165 m. However, the surrounding countryside is precipitous, and even in Bruner's day suitable forest habitat was probably restricted by agriculture to the bottom of the valley of the Río Reventazón at less than 800 m. At least the modern records from "Turrialba" (nominally at 630 m) also certainly refer to the gorge of the Reventazón, here at about 500 m. Distribution map: see Fig. 10.

NATURAL HISTORY

The natural history of the adults of *M. biolleyi* is similar to that described for *M. punctata*. Males are active, females sluggish and cryptic. They are usually found in secondary vegetation in light-gaps caused by tree-falls or path construction. One female was captured on the pendant root of an Aroid epiphyte at 25 m up a large *Dipteryx* tree in closed forest (D. Perry, pers. comm., 1978 - specimen examined), so females too must either fly or at least climb up into trees. They are however certainly not typically arboricole, as is said for the related genus *Xomacris* (AMÉDÉGNATO & POULAIN 1986). Adults have been recorded from March to November, and copulations seen in August and September. Given the poor collecting intensity in December and January and the paucity of larval records, these data do not indicate whether the species breeds seasonally or all the through the year. The natural history of the larvae is not known. In particular it is not known whether they display the same visually based gregarious behaviour as larvae of *M. punctata*, but their more cryptic coloration makes this perhaps improbable.

M. biolleyi is polyphagous on dicotyledons, like *M. punctata*. In the wild it has been seen eating *Neurolaena* (Asteraceae) and *Alchornea* and *Plukenetia* (Euphorbiaceae). In captivity it has accepted species of Convolvulaceae, Amaranthaceae, Rubiaceae, and the (monocotyledenous) Marantaceae, but refused to eat other monocotyledons (various Araceae, Arecaceae, Bromeliaceae, Cyclanthaceae, Heliconiaceae, Poaceae), ferns, or the dicotyledons *Aspidospermum* (Apocyanaceae), *Anaxagoria* (Annonaceae), *Cecropia* (Moraceae), *Solanum* (Solanaceae), and various Melostomataceae (feeding trial records in part from H.E. Braker, pers. comm.).

It is occasionally parasitized internally by the larvae of Tachinid flies.

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FIG. 10

Distribution map of *Munatia*. The type locality of *M. punctata* in N. Panama is not known more precisely than the province (Chiriquí); the corresponding symbol (an open square) is here placed arbitrarily between Cerro Punto and Boquete. A further locality (not shown) for *M. biolleyi* is known in E. Nicaragua at 12°10' N, 84°19' W. The map includes sight records of the present author not listed in "Material examined". All localities for *biolleyi* are in the Caribbean lowlands or in the floor of river valleys draining into them. The localities for *punctata* are all in the highlands near the Pacific/Caribbean watershed, with one exception (Pozo Azul de Pirrís in the Pacific lowlands).

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