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ON THE OCCURRENCE OF AROLIA IN ANT FEET

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Abstract

Female ants of the genus *Rhytidoponera* Mayr lack pretarsal arolia, but their brothers possess arolia. A brief survey indicates that arolia are universally present in ants outside the subfamilies Ponerinae and Leptanillinae. Some ponerine groups possess arolia, while others do not. We briefly discuss the evolutionary functional, behavioural and systematic implications of these findings.

Introduction

Ants of the genus *Rhytidoponera* are some of the most abundant insects in Australia, and occur in all major habitat types. This large genus, of well over 50 species, also exhibits a gradient of social structure, from species with the usual ant reliance on differentiated queens as reproductives to species in which mated workers fulfil the egg-laying role (Haskins and Whelden 1965; Crozier 1977).

Given the ecological significance, species richness and sociobiological characteristics of *Rhytidoponera*, it is not surprising that species in this genus have been the subjects of a number of recent studies (Imai *et al.* 1977; Hölldobler and Haskins 1977; Ward 1978, 1980; Crozier 1981). The ants are easy to keep and study in the laboratory because the females, unlike those of most ants, cannot easily climb glass or plastic. *Rhytidoponera* males, however, climb these substances with the ease normal for ants. We were struck by this lack of an apparently universal ant ability in *Rhytidoponera* females, and we here provide a proximate explanation for it and briefly discuss the functional and systematic significance of our findings.

Techniques and findings

Grip marks

If a drop of 1 M sucrose solution, or other bait, is suspended over a slide coated with carbon using Hangartner's (1969) technique, ants will tug at it, attempting to grip the slide surface. When the slide is placed in a photographic enlarger, reverse prints can be made of the grip marks made by the ants' feet; when the ants lay trails, traces of these are also left.

We elicited grip marks (Figs 1-5) from workers of *Camponotus discors*, *Dolichoderus scabridus*, *Podomyrma gratiosa*, and *Rhytidoponera metallica*, and from *R. metallica* males. All these ants were collected in the Sydney region, and all except the *Rhytidoponera* workers yielded three-groove grip marks. Marks made by *Rhytidoponera* workers lack the third, inner, groove probably made by the arolium. These results are consistent with an arolium being absent from the pretarsi of *Rhytidoponera* workers.

Microscopy

Examination under a dissecting microscope confirmed that *Rhytidoponera* workers, but not males, lack an arolium. We next killed ants of various species using 2% acetic acid in 70% ethanol, air-dried them, and mounted whole ants or isolated legs on stubs for sputter-coating with gold. We examined and photographed the legs using a Stereoscan S4-10 scanning electron microscope in the UNSW Electron Microscope Unit.

Workers of *Podomyrma gratiosa* (Fig. 8), *Camponotus discors* (Fig. 6), and *Dolichoderus scabridus* (Fig. 7) clearly possess an arolium, whereas those of *Rhytidoponera metallica* (Fig. 9) lack a functional arolium, although there is an indeterminate structure between the claws that might represent a vestigial arolium. Males of *R. metallica*, unlike the workers, have an arolium in the pretarsus (Fig. 10).

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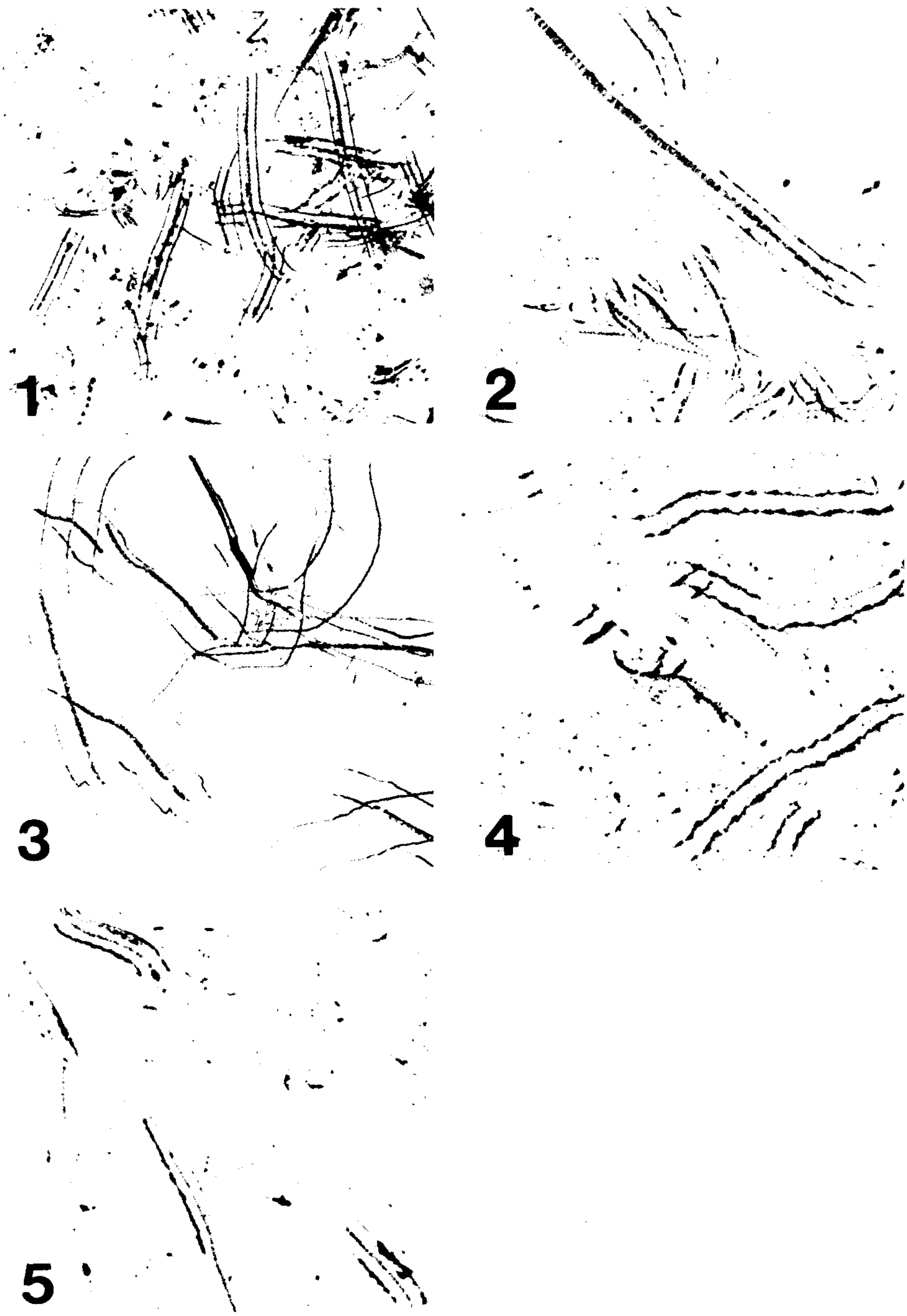
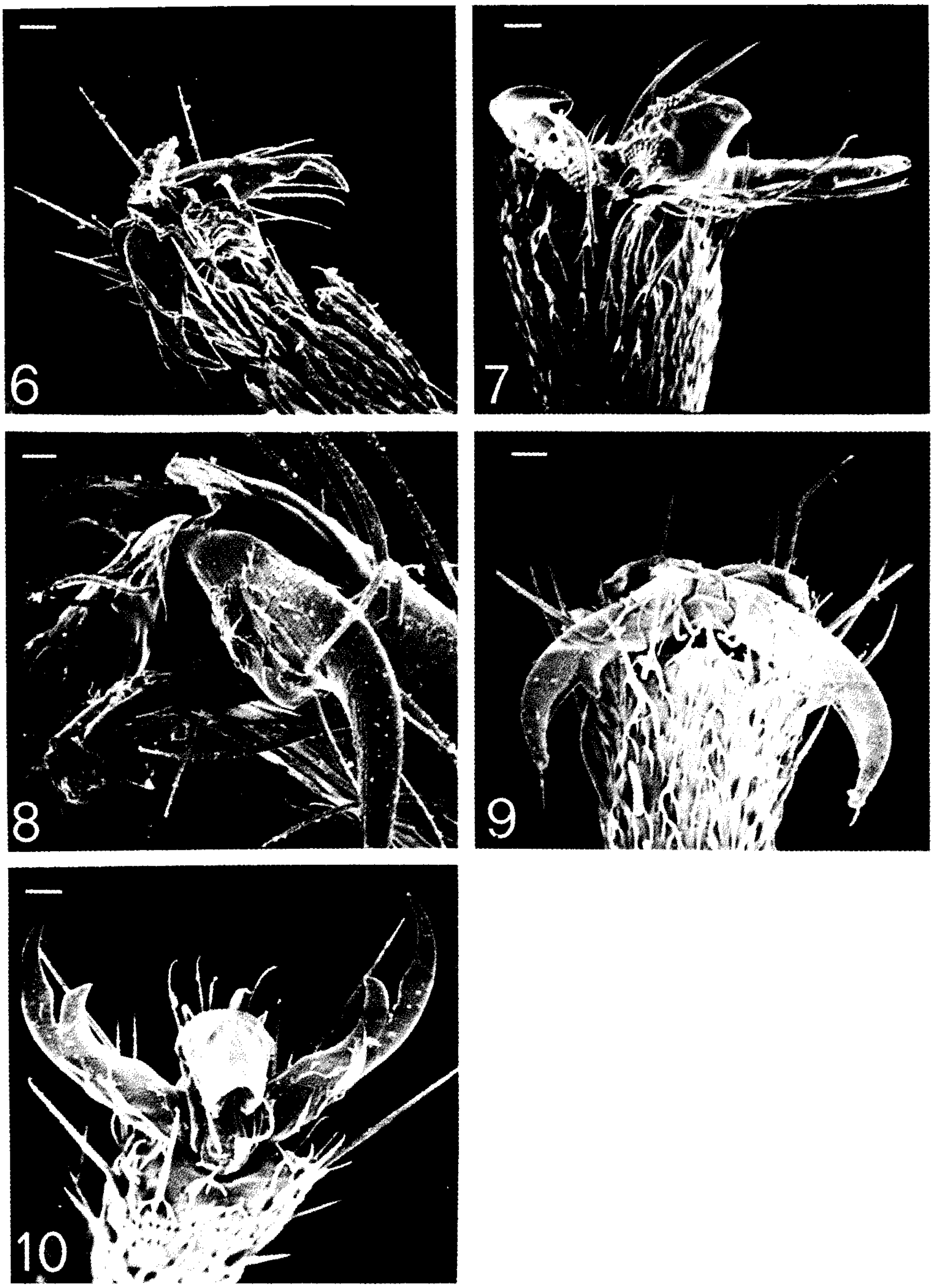
The structure of the ant arolium seems to be similar to that described for the honeybee *Apis mellifera* L. by Snodgrass (1956), in that the details seen in our Fig. 8 are similar to those in his Fig. 40.



FIGS **1-5**—Grip marks of various ants, elicited by allowing them to tug at a sugar bait suspended over a soot-coated slide: workers of **(1)** *Camponotus discors* (AAWI-1); **(2)** *Dolichoderus scabridus* (AAWH-1); **(3)** *Podomyrma gratiosa* (AAWK-1); **(4)** *Rhutidoponera metallica* (AAWF-1); **(5)** males of *Rytidoponera metallica* (AAWF)-1). The grip marks are characterized by 3 grooves cut into the soot, the middle groove probably being cut by the extended arolium. Marks of *Rhytidoponera* workers lack the middle groove. Collection accession codes are given in parentheses.



FIGS **6-10**—Views of the arolium region: workers of **(6)** *Camponotus discors* (AAWI-1); **(7)** *Dolichoderus scabridus* (AAWH-1); **(8)** *Podomyrma gratiosa* (AAWK-1); **(9)** *Rhytidoponera metallica* (AAWF-1); male of **(10)** *Rhytidoponera metallica* (AAWF-1). Scale bars represent 20 μm.

Systematic survey

We surveyed a number of species, drawn from all major ant groups, for the presence or absence of arolia. As can be seen from Table 1, the presence of an arolium in the worker pretarsus is widespread. Species lacking arolia were found by us only in the subfamilies Ponerinae and Leptanillinae. All *Amblyopone* species surveyed, the giant South American ectatommine *Paraponera clavata*, and *Diacamma ?rugosum* possess arolia whereas all other ponerines lack worker arolia. *Amblyopone* species vary in whether arolia occur on all worker pretarsi, or only on the front feet.

The ectatommine *Aulacopone relicta* Arnoldi lacks arolia in the queen, the only caste known (Taylor 1979).

Although species names are given, where present knowledge allows, many ant "species" are actually superspecies (Crozier 1981).

Discussion

Our systematic survey indicates that the presence or absence of arolia may be a useful systematic character at the level of the genus or above. But it was not our intention to provide a definitive statement on the detailed distribution of arolia among ants, and a much larger survey would be required for that.

TABLE 1

PRESENCE (+) OR ABSENCE (—) OF AROLIA IN MAJOR ANT GROUPS. WORKERS (☿) WERE EXAMINED FOR EACH SPECIES, AND IN SOME INSTANCES QUEENS (♀) AND MALES (♂) AS WELL. ANIC: SPECIMENS FROM THE AUSTRALIAN NATIONAL INSECT COLLECTION, DIVISION OF ENTOMOLOGY, CSIRO, CANBERRA. RHC: SPECIMENS IN THE COLLECTION OF RHC, SCHOOL OF ZOOLOGY, UNSW. COLLECTION ACCESSION CODES ARE GIVEN WHERE KNOWN.

Taxon	Code	Colln	Locality	Arolium ☿	♀	♂	Remarks
ANEURETINAE							
Aneuretus simoni Emery	—	ANIC	Ratnapura, Sri Lanka	+			small arolia on all feet.
CERAPACHYINAE							
Cerapachyini							
Cerapachys brevis (Clark)	AAGZ-1	RHC	Fowler's Gap NSW	+			
Sphinctomyrmini							
Sphinctomyrmex steinheili Forel	AAGT-16	RHC	Leumeah, NSW	+			
DOLICHODERINAE							
Dolichoderini							
Dolichoderus scabridus Roger	AAWH-1	RHC	Menai, NSW	+			
Leptomyrmini							
Leptomyrmex erythrocephalus (F.)	AAHC-1	RHC	Vittoria, NSW	+			
Tapimomini							
Iridomyrmex sp., *purpureus* (Fr. Smith) gp. (blue form)	AAGL-6	RHC	Kanapa, SA	+			
DORYLINAE							
Aenictini							
Aenictus ceylonicus Mayr	—	RHC	Ho Chi Minh City, Vietnam	+			
Dorylini							
Dorylus fulvus (Westwood)	Leston-439	ANIC	Tafo, Ghana	+			
Ecitonini							
Neivamyrmex nigrescens (Cresson)	—	ANIC	Laurel, Miss.	+			
FORMICINAE							
Camponotini							
Camponotinus discors Forel	AAWI-1	RHC	Como, NSW	+			
Formicini							
Paratrechina sp. 1 (ANIC)	AAGR-9	RHC	Leumeah, NSW	+			
Melophorini							
Melophorus sp.	AAGW-22	RHC	Kudgee, NSW	+			
LEPTANILLINAE							
Leptanilla escheri (Kutter)	—	ANIC	Travancore, India	—			part of type series for *Leptomesites escheri*

TABLE 1—continued

Taxon	Code	Colln	Locality	Arolium ♀	☿	♂	Remarks
MYRMECIINAE							
Myrmecia gulosa (F.)	AAGT-1	RHC	Leumeah, NSW	+			
MYRMICINAE							
Crematogastrini							
Crematogaster sp. 1 (ANIC)	AAGR-10	RHC	Leumeah, NSW	+			
Dacetini							
Orectognathus versicolor Donisthorpe	AAGF-1	RHC	Roy. Nat. Pk., NSW	+			
Meranoplini							
Meranoplus sp. 4 (ANIC)	AAGR-22	RHC	Leumeah, NSW	+			
Myrmicini							
Podomyrma gratiosa (Fr. Smith)	AAWK-1	RHC	Milperra, NSW	+			
NOTHOMYRMECIINAE							
Nothomyrmecia macrops Clark	—	ANIC	Ceduna, SA	+	+	+	
PONERINAE							
Amblyponini							
Amblyopone australis Erichson	AAFU-14	RHC	Blue Mts., Nat. Pk., NSW	+		+	All ♂ but only ♀ fore-tarsi with arolia
Amblyopone exigua Clark	—	ANIC	Kallista, V.	+			Small arolia on all tarsi, fore-tarsal ones largest
Amblyopone longidens Forel	—	ANIC	Pine I., ACT	+			arolia on front feet only
Amblyopone pallipes (Haldeman)	—	ANIC	Slaterville, NY	+			small arolia, on front feet only
Amblyopone sp. (*reclinata* Mayr gp.)	—	ANIC	Baguio, Luzon	+			arolia on all tarsi, fore-tarsal ones largest
Ectatommini							
Acanthoponera minor Forel	—	ANIC	Caracas, Venezeula	—			
Ectatomma ruidum Roger	—	ANIC	Cerro Campana Panama	—			
Heteroponera imbellis (Emery)	353	ANIC	Crater Nat. Pk., Q.	—			
Heteroponera relicta (Wheeler)	318	ANIC	Mt. Lewis, Q.	—			
Paraponera clavata (F.)	RWTP81	ANIC	Barro Colorado, Canal Zone	+		+	arolia small and hairy, present on all feet of both sexes
Rhytidoponera aspera (Roger)	AAXB-2	RHC	Smith's Lake, NSW	—			
Rhytidoponera metallica (Fr. Smith)	AAQQ-1	RHC	Roy. Nat. Pk., NSW		—		
Rhytidoponera metallica (Fr. Smith)	AAWF-1	RHC	Como, NSW	—		+	all ♂ tarsi have arolia
Odontomachini							
Odontomachus sp. 1 (ANIC)	AAGX-7	RHC	Coombah, NSW	–			
Ponerini							
Bothroponera sp. 2 (ANIC)	AAHA-5	RHC	Fowler's Gap, NSW	—			
Brachyponera lutea (Mayr)	AAFU-2	RHC	Blue Mts., Nat. Pk., NSW	—	—		
Diacamma ?rugosum (Le Guillou)	AAZZ-1	RHC	Raub, Malaysia	+			small arolia
PSEUDOMYRMECINAE							
Tetraponera rufoniger (Jerdon)	AAZX-1	RHC	Kuala Lumpur, Malaysia	+			

The lack of arolia in many species, especially species of *Rhytidoponera*, raises functional, ecological, and behavioural questions. It is tempting to suggest that modern ponerines arose from hypogeaic ancestors in which arolia were not particularly useful and so were lost. But this evolutionary hypothesis faces the difficulty that the most hypogeaic living group examined, *Amblyopone*, has retained arolia, whereas these are lacking in some epigeaic forms, such as the totally arboreal *Rhytidoponera aspera*.

The lack of worker arolia in arboreal species such as *Rhytidoponera aspera* is intriguing. Our experience with *Rhytidoponera* in the laboratory indicates that these ants should have difficulty climbing on such smooth surfaces as many leaves, especially on windy days. Do foragers of such species, in fact, confine themselves only to the trunks and stems of trees foraged over? The presence of arolia in *Paraponera clavata* is noteworthy in this connection: workers of this species wound the petioles of certain of the plants on which they forage, and collect the sap exuded (Young 1977).

Finally, there is the presence of arolia on *Rhytidoponera* males to consider. Two hypotheses can be proposed to explain this inter-caste difference. Firstly, hymenopteran males, especially those of ants, are usually morphologically relatively conservative compared with the females, and the presence of arolia may then simply represent evolutionary inertia. Secondly, the males do have to grip a relatively smooth surface, the body of the females, during copulation, and it is tempting to suggest that the males need arolia to complete courtship. This second hypothesis is, in principle, open to test.

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