

SHORT COMMUNICATION

Oviposition of *Minstrellus grandis* (Lepidoptera: Riodinidae) in a harmful ant-plant symbiosis

Lucas A. KAMINSKI¹ , Eduardo CARNEIRO², Diego R. DOLIBAINA², Mirna M. CASAGRANDE², Olaf H. H. MIELKE²

¹ Universidade Federal do Rio Grande do Sul, Instituto de Biociências, Departamento de Zoologia, Av. Bento Gonçalves 9500, 91501-970, Porto Alegre, RS, Brazil

² Universidade Federal do Paraná, Departamento de Zoologia, Laboratório de Estudos de Lepidoptera Neotropical, Avenida Cel. Francisco H. dos Santos, 100, 81531-980, Curitiba, Paraná, Brazil

* Corresponding author: lucaskaminski@yahoo.com.br;  <https://orcid.org/0000-0002-6468-0960>

ABSTRACT

The oviposition behavior of the rare butterfly *Minstrellus grandis* (Callaghan, 1999) (Lepidoptera: Riodinidae) is recorded for the first time. Two females laid eggs on the old leaves of an unidentified *Triplaris* Loeffl. ex L. (Polygonaceae), a myrmecophytic plant typically known as ‘Triplaria’ or ‘novice’ tree, inhabited by aggressive ‘taxi’ ants of the genus *Pseudomyrmex* Lund, 1831 (Hymenoptera: Formicidae). These observations suggest that *M. grandis* caterpillars live associated with one of the most harmful types of Amazon ant-plant symbiosis.

KEYWORDS: Carnivory, myrmecophily, host plant selection, Pachythytonina, social parasitism

Ovipoção de *Minstrellus grandis* (Lepidoptera: Riodinidae) em uma perigosa simbiose formiga-planta

RESUMO

O comportamento de ovipoção da rara borboleta *Minstrellus grandis* (Lepidoptera: Riodinidae) é registrado pela primeira vez. Duas fêmeas depositaram ovos sobre folhas velhas de uma *Triplaris* (Polygonaceae) não identificada, uma planta mirmecofítica conhecida popularmente como ‘pau-formiga’ ou ‘novateiro’, habitadas por formigas ‘taxi’ agressivas do gênero *Pseudomyrmex* (Hymenoptera: Formicidae). Estas observações sugerem que as lagartas de *M. grandis* vivem associadas com um dos mais perigosos tipos de simbiose formiga-planta da Amazônia.

PALAVRAS-CHAVE: Carnívoros, mirmecofilia, seleção de planta hospedeira, Pachythytonina, parasitismo social

The systematics of Riodinidae has advanced in recent years, and robust phylogenetic hypotheses supported by fossil-calibrated dating are now available (Seraphim *et al.* 2018). This backbone is essential to understand the evolutionary history of this remarkable group of butterflies (Kaminski *et al.* 2013). The main impediment for the advancement on the knowledge on this family, however, is the lack of information on natural history of species in this group, especially for rare and/or restricted species (DeVries 1997). This is the case for members of the subtribe Pachythytonina (Nymphidiini), which comprises 33 species in five genera (Callaghan and Lamas 2004; Hall 2007, 2018; Dias *et al.* 2015; Gallard 2017; Gallard and Fernandez 2017). Only recently, the first life cycle information for this lineage was revealed, indicating that their caterpillars are myrmecophilous (i.e., live associated with ants), present armored larval morphology and are carnivorous (Medina 2014; Mota *et al.* 2020). During a collection expedition to the

Serra do Divisor National Park [Parque Nacional da Serra do Divisor (PNSD)], in the western Amazon region (state of Acre, Brazil), we observed, for the first time, the female reproductive behavior of the poorly known riodinid *Minstrellus grandis* (Callaghan, 1999). This Pachythytonina species is rare, known from only five localities in the western Amazon region in Brazil, Bolivia and Peru (Callaghan 1999; Hall 2007). Here we describe its oviposition behavior.

The observations were made in the riparian forest on the right margin of the Moa River, in a frontier-protection deployment area of the Brazilian military forces (Destacamento Especial de Fronteira de São Salvador, 61º Batalhão de Infantaria de Selva) (7°24'47.72"S, 73°12'46.55"W, 200 m), about 8 km east of the border of the PNSD. This region is characterized by a high biological diversity, including riodinid butterflies (Brown and Freitas 2002; Dolibaina *et al.* 2012, 2015, 2016). Our behavioral observations were

CITE AS: Kaminski, L.A.; Carneiro, E.; Dolibaina, D.R.; Casagrande, M.M.; Mielke, O.H.H. 2020. Oviposition of *Minstrellus grandis* (Lepidoptera: Riodinidae) in a harmful ant-plant symbiosis. *Acta Amazonica* 50: 256-259.

made on June 19, 2013, between 13:50 and 14:15 h, when two females of *M. grandis* were observed inspecting a *Triplaris* Loeffl. ex L. (Polygonaceae) myrmecophytic plant inhabited by *Pseudomyrmex* Lund, 1831 ants (Hymenoptera: Formicidae). The females flew slowly and walked along the plant branches, at a height of about three meters from the ground, without attracting the attention of ants (Figure 1a,b). Three oviposition events were observed in both the abaxial and adaxial surfaces of old leaves (Figure 1c). The adult butterflies were collected and are deposited (DZ 51.398 and DZ 51.408) in the collection of the Department of Zoology of Universidade Federal do Paraná, Curitiba, Paraná, Brazil (DZUP). Due to the ant aggressiveness (see Haddad *et al.* 2009), we were unable to search the *Triplaris* plant to find possible caterpillars, nor were the eggs and ant vouchers collected. The ants were identified based on behavior, photographs and taxonomist opinion (see Acknowledgments).

Our observations confirm that *M. grandis* uses the myrmecophytic *Triplaris* plant as oviposition substrate. Although we cannot confirm whether *M. grandis* caterpillars are myrmecophilous, nor whether the type of interaction with ants is commensal, mutualistic or parasitic, the observed

behavior suggests a unique life cycle, which may represent the first known case of butterfly caterpillars specialized in *Pseudomyrmex* ants (Pseudomyrmecinae). These large-eyed arboreal ants have stingers and are quite aggressive, especially those that live associated with myrmecophytes, such as those of the *Pseudomyrmex triplarinus* (Weddell, 1850) group (*sensu* Chomicki *et al.* 2015), that are specialized on *Triplaris* (Benson 1985; Ward 1999; Chomicki *et al.* 2015; Sanchez 2015). Known associations between myrmecophilous caterpillars and *Pseudomyrmex* ants are rare and facultative or antagonistic (Fiedler 2001; Kaminski *et al.* 2012).

The *Triplaris*-*Pseudomyrmex* ant-plant symbiosis is widely distributed in the Neotropical lowland forests, but the hotspot for these associations is the western part of the Amazon Basin (Sanchez 2015). Interestingly, the four species of *Minstrellus* Hall, 2007 are also restricted to the western Amazon (Hall 2007). Although some species of *Triplaris* and *Pseudomyrmex* are widely distributed, others have restricted distribution ranges (Ward 1999; Sanchez 2015). Thus, the precise identification of *Triplaris*-*Pseudomyrmex* associations is essential to understand their evolutionary history and their relationship with the distribution range and apparent rarity

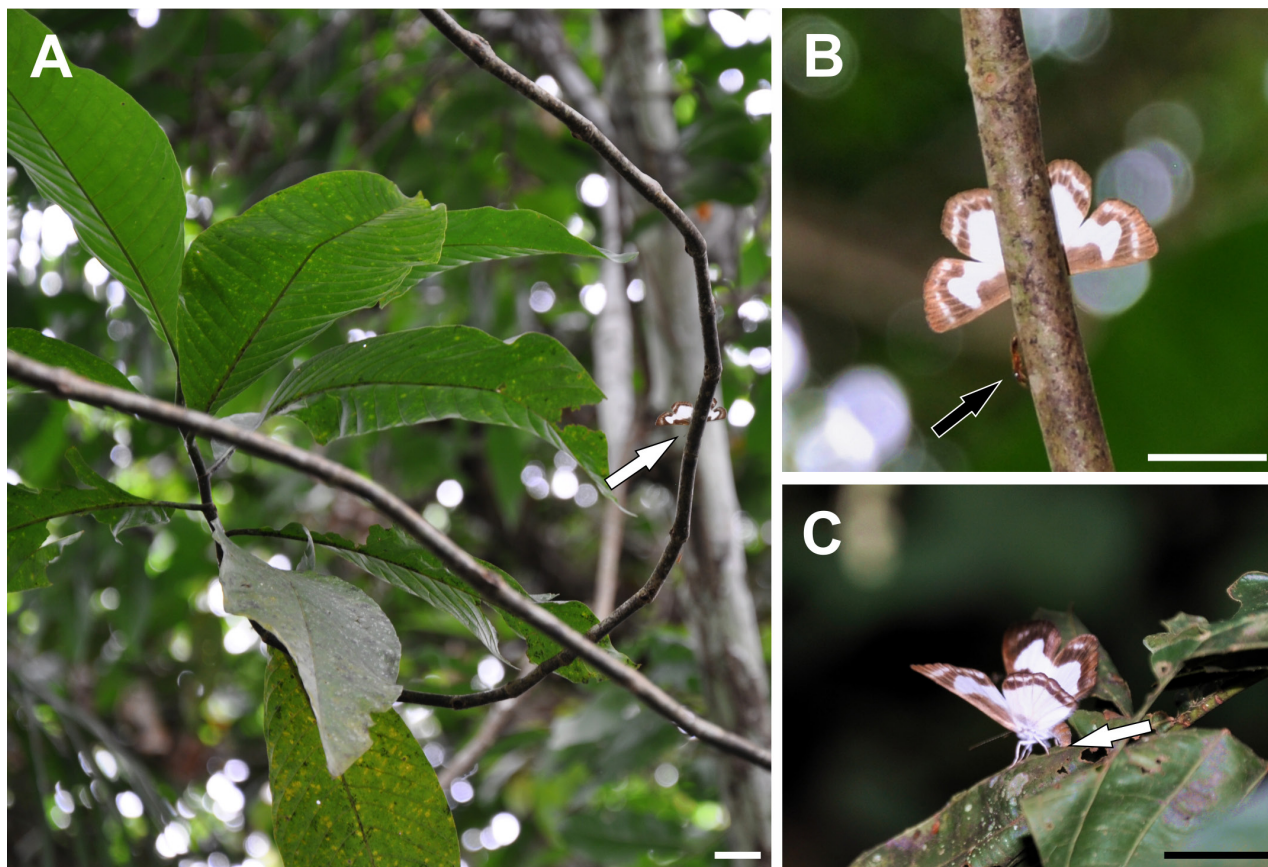


Figure 1. Female behavior of *Minstrellus grandis* (Lepidoptera: Riodinidae) on a *Triplaris* (Polygonaceae) plant inhabited by *Pseudomyrmex* ants by the Moa River, Mâncio Lima, Acre, Brazil. A – host plant, showing female walking on *Triplaris* branch (arrow); B – detail of female on a branch of the host plant near an ant worker (arrow); C – female laying eggs on an old leaf of the host plant (arrow). Scale bars = 1.5 cm. This figure is in color in the electronic version.

of *Minstrellus* species. It is worth mentioning this was our only record of *M. grandis* in a total of four expeditions to the PNSD, totaling 35 days of sampling effort in September 2011, June 2013, August 2014, and October 2018. This suggests that the occurrence of *M. grandis* may be seasonal, with adults flying for a short period, as reported for some social parasitic species (Fiedler 1998).

Myrmecophilous caterpillars that exploit ant-plant symbiosis are known to exist (Maschwitz *et al.* 1984). For instance, *Triplaris* trees inhabited by *Azteca* Forel, 1878 (Dolichoderinae) ants are attacked by *Theope pieridoides* C. Felder & R. Felder, 1865 (Riodinidae) caterpillars (Kaminski *et al.* 2013). In general, myrmecophilous caterpillars are herbivorous and receive protective benefits from ant partners by inhabiting an enemy-free space (e.g., Kaminski *et al.* 2010). From herbivorous ancestors, however, some species evolved caterpillars with carnivorous habit and even social parasitism, when caterpillars directly exploit the ants' resources (Pierce *et al.* 2002). In Pachythinina, it is known that caterpillars of *Pachythone xanthe* H. Bates, 1868 and *Pachythone gigas* Godman & Salvin, 1878 are predators of scale insects associated with aggressive *Azteca* ants (Medina 2014; Mota *et al.* 2020). In common, the caterpillars have an armored morphology, perforated cupola organs and tentacular nectary organs with possible appeasing function (Mota *et al.* 2020). These morphological traits can be preadaptations to live with aggressive ants (see Fiedler 1998; Dupont *et al.* 2016).

Therefore, it would not be unlikely that *M. grandis* caterpillars are also able to exploit resources from the harmful *Triplaris-Pseudomyrmex* ant-plant symbiosis. Confirming this hypothesis may add another piece to understand the evolution of carnivory and social parasitism in Pachythinina. Thus, we hope that our report will encourage future fearless efforts to reveal the life cycle of this rare Amazon butterfly.

ACKNOWLEDGMENTS

We are grateful to former and current PNSD staff, Paulo Oliveira de Sousa, Cleide Rezende de Souza, Diogo Mitsuru Koga and Aécio Silva dos Santos; to Argemiro Oliveira Magalhães (Miro) for his receptivity and support during fieldwork; to Rodrigo Feitosa and Phillip S. Ward for help with ant identification; to Gabriela Pérez-Lachaud, André V. L. Freitas and one anonymous reviewer for their helpful comments on the manuscript; and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) (LAK: PNPd-CAPES), National Geographic Society (#WW-224R-17) (LAK), and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) (DRD: 171177/2017-7; OHHM: 304639/2014-2; MMC: 302084/2017-7) for the research fellowships granted to the authors.

REFERENCES

- Benson, W.W. 1985. Amazon ant-plants. In: Prance, G.; Lovejoy, T.E. (Eds.). *Amazonia*. Pergamon Press, New York, p.239–266.
- Brown, K.S.; Freitas, A.V.L. 2002. Diversidade Biológica no Alto Juruá: avaliação, causas e manutenção. In: Carneiro da Cunha, M.M.; Almeida, M.B. (Eds.). *Enciclopédia da Floresta. O Alvo Juruá: Prática e conhecimentos das populações*. Companhia das Letras, São Paulo, p.33–42.
- Callaghan, C.J. 1999. New taxa of Neotropical Riodinidae (Lepidoptera). *Revista Brasileira de Zoologia*, 16: 1045–1064.
- Callaghan, C.J.; Lamas, G. 2004. Riodinidae. In: Lamas, G. (Ed.). *Atlas of Neotropical Lepidoptera, Checklist. Part 4A. Hesperioidea—Papilionoidea*. Scientific Publishers, Gainesville, p.141–170.
- Chomicki, G.; Ward, P.S.; Renner, S.S. 2015. Macroevolutionary assembly of ant/plant symbioses: *Pseudomyrmex* ants and their ant-housing plants in the Neotropics. *Proceedings of the Royal Society B*, 282: 20152200.
- DeVries, P.J. 1997. *The Butterflies of Costa Rica and Their Natural History. Vol. II: Riodinidae*. Princeton University Press, Princeton, 288p.
- Dias, F.M.S.; Dolibaina, D.R.; Mielke, C.G.C.; Mielke, O.H.H.; Casagrande, M.M. 2015. Description of two new species of *Pheles* Herrich-Schäffer, [1853] and the taxonomic position of two species hitherto included in the genus (Riodinidae: Riodininae). *Zootaxa*, 3981: 275–283.
- Dolibaina, D.R.; Leite, L.A.R.; Dias, F.M.S.; Mielke, O.H.H.; Casagrande, M.M. 2012. An annotated list of *Symmachia* Hübner, [1819] (Lepidoptera: Riodinidae: Symmachiini) from Parque Nacional da Serra do Divisor, Acre, Brazil, with the description of a new species. *Insecta Mundi*, 249: 1–11.
- Dolibaina, D.R.; Dias, F.M.S.; Mielke, O.H.H.; Casagrande, M.M. 2015. *Argyrogrammana* Strand (Lepidoptera: Riodinidae) from Parque Nacional da Serra do Divisor, Acre, Brazil, with the description of four new species. *Zootaxa*, 4028: 227–245.
- Dolibaina, D.R.; Dias, F.M.S.; Mielke, O.H.H.; Casagrande, M.M. 2016. *Mesene* Doubleday (Lepidoptera: Riodinidae) from Parque Nacional da Serra do Divisor, Acre, Brazil, with taxonomic notes and the description of a new species. *Zootaxa*, 4175: 463–472.
- Dupont, S.T.; Zemeitat, D.S.; Lohman, D.J.; Pierce, N.E. 2016. The setae of parasitic *Liphya brassolis* butterfly larvae form a flexible armour for resisting attack by their ant hosts (Lycaenidae: Lepidoptera). *Biological Journal of the Linnean Society*, 117: 607–619.
- Fiedler, K. 2001. Ants that associate with Lycaeninae butterfly larvae: diversity, ecology and biogeography. *Diversity and Distributions*, 7: 45–60.
- Fiedler, K. 1998. Lycaenid-ant interactions of the *Maculinea* type: tracing their historical roots in a comparative framework. *Journal of Insect Conservation*, 2: 3–14.
- Gallard, J.-Y. 2017. *Les Riodinidae de Guyane*. Tezida, Bulgaria, 191p.
- Gallard, J.-Y.; Fernandez, S. 2017. Des postes territoriaux des Riodinides en Guyane: découverte de deux nouvelles espèces (Lepidoptera, Riodinidae). *Bulletin de la Société entomologique de France*, 122: 429–436.

- Haddad Jr., V.; Bicudo, L.R.H.; Fransozo, A. 2009. The *Triplaris* tree (*Triplaris* spp) and *Pseudomyrmex* ants: a symbiotic relationship with risks of attack for humans. *Revista da Sociedade Brasileira de Medicina Tropical*, 42: 727–729.
- Hall, J.P.W. 2007. Phylogenetic revision of the new neotropical riodinid genus *Minstrellus* (Lepidoptera: Riodinidae). *Annals of the Entomological Society of America*, 100: 773–786.
- Hall, J.P.W. 2018. *A Monograph of the Nymphidiina (Lepidoptera: Riodinidae: Nymphidiini): Phylogeny, Taxonomy, Biology, and Biogeography*. Entomological Society of Washington, Washington DC., 990p.
- Kaminski, L.A.; Freitas, A.V.L.; Oliveira, P.S. 2010. Interaction between mutualisms: ant-tended butterflies exploit enemy-free space provided by ant-treehopper associations. *American Naturalist*, 176: 322–334.
- Kaminski, L.A.; Mota, L.L.; Freitas, A.V.L.; Moreira, G.R.P. 2013. Two ways to be a myrmecophilous butterfly: natural history and comparative immature-stage morphology of two species of *Theope* (Lepidoptera: Riodinidae). *Biological Journal of the Linnean Society*, 108: 844–870.
- Kaminski, L.A.; Rodrigues, D.; Freitas, A.V.L. 2012. Immature stages of *Parrhasius polibetes* (Lepidoptera: Lycaenidae): host plants, tending ants, natural enemies, and morphology. *Journal of Natural History*, 46: 645–667.
- Maschwitz, U.; Schroth, M.; Hänel, H.; Pong, T.Y. 1984. Lycaenids parasitizing symbiotic plant–ant partnerships. *Oecologia*, 64: 78–80.
- Medina, R.M. 2014. *Pachythone gigas* (Riodinidae). (<https://www.acguanacaste.ac.cr/paginas-de-especies/insectos/111-riodinidae/581-i-pachythone-gigas-i-riodinidae>). Accessed on 14 May 2020.
- Mota, L.L.; Kaminski, L.A.; Freitas, A.V.L. 2020. The tortoise caterpillar: carnivory and armored larval morphology of the metalmark butterfly *Pachythone xanthe* (Lepidoptera: Riodinidae). *Journal of Natural History*, 54: 309–319.
- Pierce, N.E.; Braby, M.F.; Heath, A.; Lohman, D.J.; Mathew, J.; Rand, D.B.; Travassos, M.A. 2002. The ecology and evolution of ant association in the Lycaenidae (Lepidoptera). *Annual Review of Entomology*, 47: 733–71.
- Seraphim, N.; Kaminski, L.A.; DeVries, P.J.; Penz, C.M.; Callaghan, C.J.; Wahlberg, N.; Silva-Brandão, K.L.; Freitas, A.V.L. 2018. Molecular phylogeny and higher systematics of the metalmark butterflies (Lepidoptera: Riodinidae). *Systematic Entomology*, 43: 407–425.
- Sanchez, A. 2015. Fidelity and promiscuity in an ant-plant mutualism: a case study of *Triplaris* and *Pseudomyrmex*. *PLoS ONE*, 10: e0143535.
- Ward, P.S. 1999. Systematics, biogeography and host plant associations of the *Pseudomyrmex viduus* group (Hymenoptera: Formicidae), *Triplaris*- and *Tachigali*-inhabiting ants. *Zoological Journal of the Linnean Society*, 126: 451–540.

RECEIVED: 14/05/2020

ACCEPTED: 22/06/2020

ASSOCIATE EDITOR: Juliana Hipólito de Sousa

ERRATA

On page 256, where it reads:

“*Triplaris* sp.” and “*Pseudomyrmex* sp.”

Please read as:

“*Triplaris* Loeffl. ex L.” and “*Pseudomyrmex* Lund, 1831”

On page 257, where it reads:

“, when they occur (Fiedler 2001)”

Please read as:

“or antagonistic (Fiedler 2001; Kaminski *et al.* 2012)”

On page 258, where it reads:

“Dolibaina, D.R.; Dias, F.M.S.; Mielke, O.H.H.; Casagrande, M.M. 2015. *Mesene* Doubleday (Lepidoptera: Riodinidae) from Parque Nacional da Serra do Divisor, Acre, Brazil, with taxonomic notes and the description of a new species. *Zootaxa*, 4175: 463–472.”

Please read as:

“Dolibaina, D.R.; Dias, F.M.S.; Mielke, O.H.H.; Casagrande, M.M. 2016. *Mesene* Doubleday (Lepidoptera: Riodinidae) from Parque Nacional da Serra do Divisor, Acre, Brazil, with taxonomic notes and the description of a new species. *Zootaxa*, 4175: 463–472.”

On page 258, in the References, after Kaminski *et al.* 2013, please add:

“Kaminski, L.A.; Rodrigues, D.; Freitas, A.V.L. 2012. Immature stages of *Parrhasius polibetes* (Lepidoptera: Lycaenidae): host plants, tending ants, natural enemies, and morphology. *Journal of Natural History*, 46: 645–667.”

Acta Amazonica 50(4): 368-368



This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.