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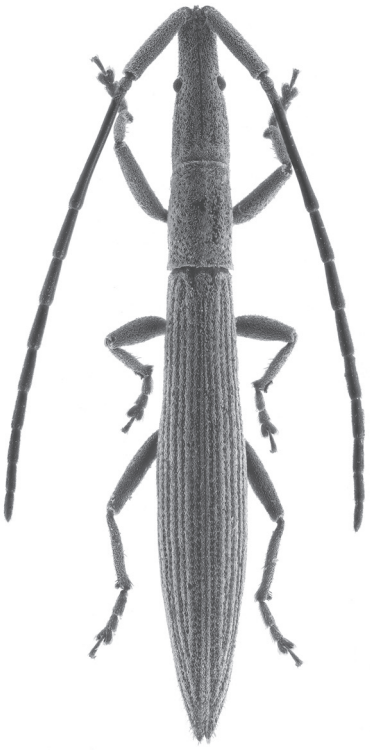

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Species composition and diversity of ant fauna (Hymenoptera: Formicidae) observed throughout a Yala season growing cycle of paddy fields in Gampaha District, Sri Lanka

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Abstract. Rice fields are inhabited by a great variety of fauna including ants. Species composition, proportional abundance and species diversity of ant fauna in two, similar rice fields in Mahadarawa, Gampaha District of Sri Lanka were investigated by honey baiting, hand collection and pitfall trapping conducted along four, 20 m transects throughout a Yala season growing cycle of paddy and 11 species in 11 genera of 4 subfamilies were observed in the two fields. Nine species were recorded during all stages of the rice fields whereas *Anochetus graeffei* Mayr, 1870 and *Monomorium floricola* (Jerdon, 1851) were not recorded in the seedling stage. The methods that caught species varied with the stage of the field. Overall, *Tapinoma melanocephalum* (Fabricius, 1793), *Anoplolepis gracilipes* (Smith, 1857) and *Camponotus compressus* (Fabricius, 1787) were observed in significantly higher proportions than other species. Shannon-Wiener Diversity Index ranged between 1.828–1.999 while Shannon-Wiener Equitability Index varied between 0.762–0.873 indicating a considerable diversity and less evenness in the ant communities recorded during the single growing cycle.

Key words: ants, paddy fields, Yala season growing cycle, wet zone, Sri Lanka.

Видовой состав и разнообразие муравьев (Hymenoptera: Formicidae) на рисовых полях на протяжении цикла выращивания риса в сезон Яла в округе Гампаха, Шри-Ланка

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Резюме. Рисовые поля отличаются высоким разнообразием фауны, в том числе и муравьев. В Махадараве, округ Гампаха, Шри-Ланка, были исследованы видовой состав, разнообразие и численность муравьев на двух аналогичных рисовых полях. Применялись медовые приманки, ручной сбор и почвенные ловушки вдоль четырех 20-метровых трансект в течение цикла выращивания риса в сезон Яла. На двух полях зарегистрировано 11 видов муравьев из 11 родов 4 подсемейств. Девять видов были собраны на всех стадиях выращивания риса, в то время как *Anochetus graeffei* Mayr, 1870 и *Monomorium floricola* (Jerdon, 1851) не были отмечены на стадии всходов. Методы отлова муравьев изменяли в зависимости от стадии поля. *Tapinoma melanocephalum* (Fabricius, 1793), *Anoplolepis gracilipes* (Smith, 1857) и *Camponotus compressus* (Fabricius, 1787) наблюдались в значительно более высоких пропорциях, чем другие виды. Индекс разнообразия Шеннона – Винера колебался в пределах 1.828–1.999, в то время как показатель выравненности Шеннона – Винера варьировался между 0.762 и 0.873, что указывает на значительное разнообразие и меньшую равномерность распределения видов в сообществах муравьев, зарегистрированных в течение одного цикла выращивания риса.

Ключевые слова: муравьи, рисовые поля, вегетационный цикл в сезон Яла, влажная зона, Шри-Ланка.

Introduction

Rice is the staple diet of people in Sri Lanka and occupies 34% (0.77 million ha) of the total cultivated area in this country [Rice cultivation, https://doa.gov.lk/rrdi/index.php?option=com_sppagebuilder&view=page&id=42&lang=en]. Based on the two major monsoon periods, paddy is cultivated in Yala (April to September) and Maha (October to March) seasons in Sri Lanka. On average, rice is cultivated in 560,000 ha of land during Maha season and 310,000 ha during Yala season [Department..., 2015]. Rice fields are inhabited by a great variety of fauna although often disturbed during tillage, application of pesticides and weedicides, and harvesting practices [Bambaradeniya et al., 1998].

So far, 341 valid species in 79 genera and 10 subfamilies of ants have been reported from Sri Lanka [Dias et al., 2020]. Multiple methods of sampling are very useful in collecting ants successfully within a given period and baiting, hand collection and pitfall trapping are among them [Dias, Peiris, 2015]. Ants that occupy rice fields in Sri Lanka are documented occasionally [Bambaradeniya et al., 1998] although they may feed upon rice seeds and seedlings, increase the incidence of diseases vectored by homopterans [Rice Knowledge..., http://www.knowledgebank.irri.org/training/fact-sheets/pest-management/insects/item/ants] and serve as the predators of rice insect pests [Way et al., 2002, 2009; Bambaradeniya, Edirisinghe, 2008]. In Philippine rice fields, at least 62 species of ants were caught by baits, notably on the bunds and many were relatively

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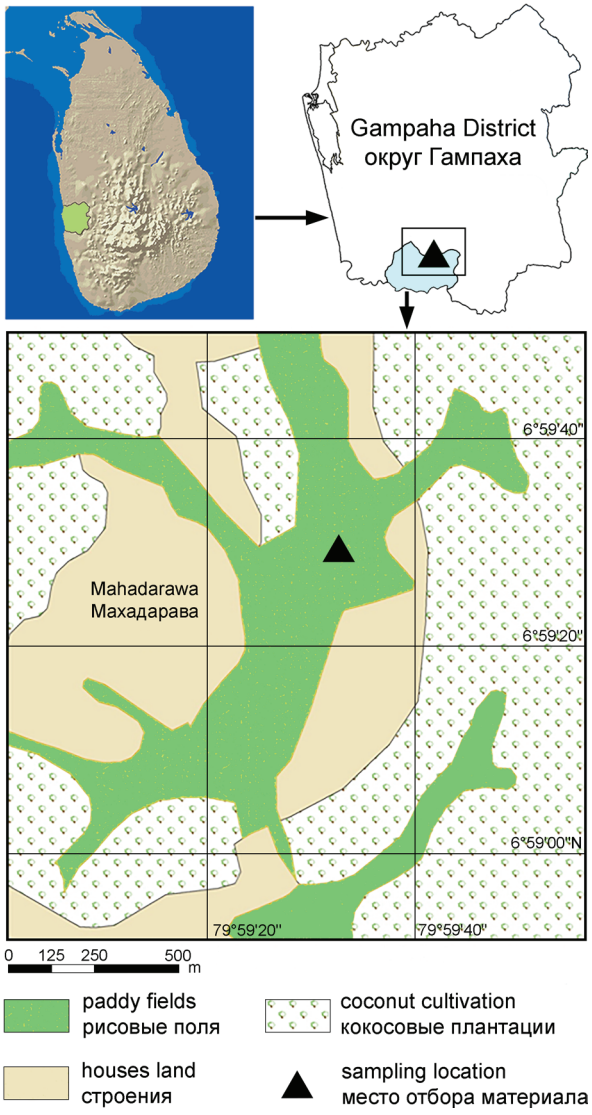

Fig. 1. Map showing the location of the two rice fields in Mahadarawa, Gampaha District, Sri Lanka.

Рис. 1. Местоположение обследованных рисовых полей в Махадараве, округ Гампаха, Шри-Ланка.

uncommon or localized while *Tapinoma* sp., predatory *Solenopsis geminata* (Fabricius, 1804) and *Pheidole* spp. were common among them [Way et al., 2009].

Species composition, proportional abundance and species diversity of ant fauna observed throughout a Yala season growing cycle in two, similar rice fields in Gampaha District of Sri Lanka are reported here.

Material and methods

Field and laboratory methods. Worker ants in two, rectangular rice fields of 18 m apart (18 × 20 m, 06°59.486′N / 79°59.545′E, 23.7 m a.s.l.) that lied in Mahadarawa, Gampaha District in Sri Lanka (Fig. 1), were surveyed from April to September in 2017 throughout a single growing cycle of paddy. Each field comprised of an area used for planting paddy and surrounding levees. The growing cycle included six stages of paddy, (1) post-harvest stage 1, (2) seedling stage, (3) tillering stage, (4) flowering stage, (5) mature grain stage and (6) post-harvest stage 2 ([Ricepedia, http://ricepedia.org]; personal communication, paddy field-owned farmer), in Yala season. Ants were sampled from 8:30 a.m. to 2:30 p.m. throughout the study period, by hand collection, honey baiting and pitfall trapping. Dates of sampling during each stage of paddy field and number of samples collected from each rice field by each method are presented in Table 1. The farmer applied Flubendiamide 20% (water dispersible granules) to the fields at the beginning of the seedling stage to control the leaf roller attacks.

Four 20 m transects which were 6 m apart from each other were laid in each rice field including the levee areas. Along each transect, 20 pieces of gauze (each of 5 × 5 cm) with a drop of honey were placed at 5 m intervals and collected after an hour. Twenty plastic cups (25 ml) half-filled with 50% ethanol were fixed to flush with the soil level at 5 m distance along a line which was parallel and 1 m right to each transect and collected after six hours. Worker ants observed along a line parallel and 3 m right to each transect at 15 points were collected; at each point, worker ants seen around the observer were collected for 10 minutes, using a pair of fine forceps and a paint brush. Collected ants were preserved in the Bijou bottles filled with 85% ethanol.

Identification of ants to the possible taxonomic levels was accomplished by observing each specimen under a low power, stereo microscope (Optika SZM-LED2) with reference to Bolton [1994], Fischer et al. [2014], Schmidt and Shattuck [2014], Fisher and Bolton [2016] and AntWeb [https://www.antweb.org/]. Number of workers of each species observed by each method was recorded.

Data analysis. Proportional abundance value (p_i = Total No of i^{th} species observed by three methods / Total No of all species) of each species was calculated for each rice field. Species richness per growth phase was calculated by counting the total number of ant species observed in each rice field. Shannon-Wiener Diversity Index ($H' = -\Sigma\ p_i \ln p_i$) and Shannon-Wiener Equitability Index ($J' = H' / \ln$ (Species richness)) [Magurran, 2004] were calculated using mean proportions observed in the two rice fields. Two Way ANOVA followed by Tukey's test was conducted to determine any significant differences between the proportions of ant species observed in the six phases of the rice fields.

Results

Species composition and proportional abundance of ants. Eleven species of ants in 11 genera of 4 subfamilies were observed in the two fields (Table 2). Nine species in Table 2 except *Anochetus graeffei* and *Monomorium floricola* were recorded during all stages of the rice fields. During the seedling stage, *Anochetus graeffei* and *Monomorium floricola* were not observed by any sampling method (Table 2). Among the methods that caught each species, honey baiting did not attract *Anochtus graeffei*, *Diacamma rugosum*, *Odontomachus simillimus* and *Tetramorium walshi*. The methods that caught other species varied with

Table 1. Dates of sampling during each stage of paddy field and number of samples collected from each rice field using each method (H – hand collection, B – honey baiting, P – pitfall trapping).

Таблица 1. Даты отбора проб на каждом этапе выращивания риса и количество проб, собранных с каждого рисового поля с использованием каждого метода отлова (Н – ручной сбор, В – медовые приманки, Р – почвенные ловушки).

	Stage of paddy field Стадия рисового поля	Date of sampling 2017 Дата отбора проб в 2017 году	Number of samples Количество проб					
			Field 1 / Поле 1			Field 2 / Поле 2		
			H	B	P	H	B	P
1	Post-harvest 1 / Послеуборочная 1	28 April / 28 апреля	15	20	20	15	20	20
2	Seedling / Всходы	18 May / 18 мая	15	20	20	15	20	20
3	Tillering / Кущение	15 June / 15 июня	15	20	20	15	20	20
4	Flowering / Цветение	3 August / 3 августа	15	20	20	15	20	20
5	Mature grain / Зрелое зерно	26 August / 26 августа	15	20	20	15	20	20
6	Post-harvest 2 / Послеуборочная 2	7 September / 7 сентября	15	20	20	15	20	20

Table 2. Subfamily, genera and species of ants observed during each phase of the two rice fields by hand picking (H), honey baiting (B) and pitfall trapping (P).

Таблица 2. Подсемейства, роды и виды муравьев, зарегистрированные на каждой стадии двух рисовых полей (Н – ручной сбор, В – медовые приманки, Р – почвенные ловушки).

Species Вид	Post-harvest stage I / Послеуборочная стадия – 1			Seedling stage Стадия всходов			Tillering stage Стадия кущения			Flowering stage Стадия цветения			Mature grain stage Стадия зрелого зерна			Post-harvest stage II / Послеуборочная стадия – 2		
	H	B	P	H	B	P	H	B	P	H	B	P	H	B	P	H	B	P
Dolichoderinae																		
Tapinoma melanocephalum (Fabricius, 1793)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Formicinae																		
Anoplolepis gracilipes (F. Smith, 1857)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Camponotus compressus Fabricius, 1787	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Paratrechina longicornis (Latrielle, 1802)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Myrmicinae																		
Carebara diversa (Jerdon, 1851)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Meranoplus bicolor (Guérin-Méneville, 1844)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Monomorium floricola (Jerdon, 1851)	+	+	+	–	–	–	+	+	+	+	+	+	+	+	+	+	+	+
Tetramorium walshi (Forel, 1890)	+	–	+	+	–	+	+	–	+	+	–	+	+	–	+	+	–	+
Anochetus graeffei Mayr, 1870	+	–	+	–	–	–	+	–	+	+	–	+	+	–	+	+	–	–
Diacamma rugosum (Le Guillou, 1842)	+	–	+	+	–	+	+	–	+	+	–	+	+	–	+	+	–	+
Odontomachus simillimus Smith, 1858	+	–	+	+	–	+	+	–	+	+	–	+	+	–	+	+	–	+

Table 3. Mean proportions of each ant species observed in each phase of the rice fields.
Таблица 3. Средние пропорции муравьев каждого вида, наблюдаемые на каждой фазе рисовых полей.

Species Вид	Mean proportion					
	Post-harvest stage I / Послеуборочная стадия – 1	Seedling stage Стадия всходов	Tillering stage Стадия кущения	Flowering stage Стадия цветения	Mature grain stage / Стадия зрелого зерна	Post-harvest stage II / Послеуборочная стадия – 2
Tapinoma melanocephalum (Fabricius, 1793)	0.451	0.084	0.185	0.306	0.269	0.353
Anoplolepis gracilipes (F. Smith, 1857)	0.094	0.174	0.157	0.186	0.268	0.208
Camponotus compressus Fabricius, 1787	0.143	0.307	0.281	0.185	0.143	0.138
Paratrechina longicornis (Latrielle, 1802)	0.042	0.077	0.081	0.129	0.068	0.039
Carebara diversa (Jerdon, 1851)	0.052	0.239	0.079	0.049	0.074	0.091
Meranoplus bicolor (Guérin-Méneville, 1844)	0.084	0.078	0.116	0.051	0.082	0.079
Monomorium floricola (Jerdon, 1851)	0.038	–	0.029	0.019	0.038	0.024
Tetramorium walshi (Forel, 1890)	0.018	0.017	0.026	0.024	0.017	0.018
Anochetus graeffei Mayr, 1870	0.011	–	0.006	0.007	0.004	0.001
Diacamma rugosum (Le Guillou, 1842)	0.035	0.035	0.027	0.025	0.023	0.022
Odontomachus simillimus Smith, 1858	0.032	0.035	0.014	0.019	0.014	0.029
Species richness in each field Видовое богатство на каждом поле	11	9	11	11	11	11
Shannon-Wiener Diversity Index (*H'*) Индекс разнообразия Шеннона – Винера	1.828	1.917	1.999	1.918	1.927	1.868
Shannon-Wiener Equitability Index (*J'*) Показатель выравненности Шеннона – Винера	0.762	0.873	0.834	0.799	0.804	0.779

the stage of the field. Table 3 presents the mean proportions of each species, species richness (9 and 11) and the values of Shannon-Wiener Diversity and Equitability Index for the rice fields. Considerable diversity is indicated by the diversity index values whereas less evenness is evident from the equitability values. *Tapinoma melanocephalum*, *Anoplolepis gracilipes* and *Camponotus compressus* were observed in significantly higher proportions ($p < 0.05$) than those of *Monomorium floricola*, *Tetramorium walshi*, *Anochetus graeffei*, *Diacamma rugosum* and *Odontomachus simillimus.*

Other observations. During the tillering stage, *Odontomachus simillimus* workers were observed attacking an oriental mole cricket and carrying it towards the nest. *Anoplolepis gracilipes* and *Camponotus compressus* frequently visited the inflorescences of the paddy plants. *Carebara diversa* workers carrying away paddy seeds in germination were also observed.

The range of air temperature and light intensity recorded during the survey were 32–36 °C and 14478–19983 Lux m^{-2}, respectively.

Discussion

In the rice fields, a considerable diversity of ants was observed throughout the cultivation period showing that the recorded species are not only terrestrial as known earlier but also semi-aquatic insects. In Sri Lanka, lack of information from similar surveys is a barrier for the comparison of our findings. Ants were predominantly observed on the levees but they were also present within the rice field during low water levels (personal observation). The absence of *Monomorium floricola* and *Anochetus graeffei* during the seedling stage could be due to their sensitivity to the insecticide, Flubendiamide 20% (water dispersible granules), applied at the beginning of that stage by the farmer. Further studies are required to find out how the other nine species were able to present in the rice fields despite the insecticide added to the paddy fields.

Ponerine ants, *Anochetus graeffei*, *Diacamma rugosum* and *Odontomachus simillimus* are known predators in the environment. According to the farmer's and second author's observations, it is learned that *Odontomachus simillimus* feeds upon certain rice pests and several ant species attend the honey-dew of homopterans. Singh and Singh [2014] stated that oriental mole cricket *Gryllotalpa orientalis* Burmeister, 1838 often makes burrows in the levees and is a noxious rice pest because its nymphs and adults feed on roots of paddy seedlings, causing the death of entire seedling in a severe attack. During this investigation, the presence of mole cricket was observed and *Odontomachus simillimus* appeared to be a natural enemy of this pest. Although Bambaradeniya et al. [2004] and Bambaradeniya and Edirisinghe [2008] reported predators of rice pests, *Solenopsis* spp., *Camponotus* spp. and *Odontomachus* spp., from the irrigated rice fields in intermediate zone of Sri Lanka, *Odontomachus simillimus* was only observed during this investigation.

Usually, *Tapinoma melanocephalum*, *Anoplolepis gracilipes* and *Camponotus compressus* are attracted to the

honey-dew of homopterans. In Philippines, it is reported that two ant species fed upon rice pests such as brown plant hopper and rice leaf folder [Way et al., 2002] but *Solenopsis geminata* and *Tapinoma indicum* were not recorded in the current fields. In Indonesia, *Anoplolepis gracilipes* was a predator of the rice pests [Abdullah et al., 2020]. *Carebara diversa* feeds on ungerminated and germinated rice seeds [Pathak, Khan, 1994]. A similar observation was made during the current study also. Hence, future studies should be focused on the ecological aspects of each ant species observed in the rice fields.

Feinsinger and Swarm [1978] reported that ants readily fed on floral nectar of several plant species in Trinidad. This was not given strong attention during this investigation but as *Anoplolepis gracilipes* and *Camponotus compressus* frequently visited paddy inflorescences the role played by the two ant species should be investigated further.

Eleven species of ants from 11 genera of 4 subfamilies reported for the first time from wet zone rice fields can be considered a preliminary inventory of rice field ant fauna in Yala season in Gampaha District, which is situated in the wet zone of Sri Lanka. Further investigations are encouraged in the two rice growing seasons in Sri Lanka for improving the current inventory.

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References

Abdullah T., Aminah S.N., Kuswinanti T., Nurariaty A., Gassa A., Nasruddin A., Fatahuddin F. 2020. The role of ants (Hymenoptera: Formicidae) in rice fields. *IOP Conference series: Earth and Environmental Science*. 486: 012167. DOI: 10.1088/1755-1315/486/1/012167

AntWeb. Available at: https://www.antweb.org/ (accessed 28 December 2020).

Bambaradeniya C.N.B., Edirisinghe J.P. 2008. Composition, structure and dynamics of arthropod communities in a rice agro-ecosystem. *Ceylon Journal of Science (Biological Sciences)*. 37(1): 23–48.

Bambaradeniya C.N.B., Edirisinghe J.P., de Silva D.N., Gunatilleke C.V.S., Ranawana K.B., Wijekoon S. 2004. Biodiversity associated with an irrigated rice agro-ecosystem in Sri Lanka. *Biodiversity and Conservation*. 13(9): 1715–1753. DOI: 10.1023/B:BIOC.0000029331.92656.de

Bambaradeniya C.N.B., Fonseka K.T., Ambagahawatte C.L. 1998. A preliminary study of fauna and flora of a rice field in Kandy, Sri Lanka. *Ceylon Journal of Science (Biological Sciences)*. 25: 1–22.

Bolton B. 1994. Identifcation guide to the ant genera of the world. Cambridge, Mass.: Harvard University Press. 222 p.

Department of agriculture, Government of Sri Lanka. 2015. Available at: https://doa.gov.lk (accessed 2 December 2020).

Dias R.K.S., Guénard B., Akbar S.A., Economo E.P., Udayakantha W.S., Wachkoo A.A. 2020. The Ants (Hymenoptera, Formicidae) of Sri Lanka: A taxonomic research summary and updated checklist. *ZooKeys*. 967: 1–142. DOI: 10.3897/zookeys.967.54432

Dias R.K.S., Peiris H.A.W.S. 2015. Ground-dwelling ant assemblages (Family: Formicidae) in six coconut (*Cocos nucifera* L. 1753) plantations in Sri Lanka. *Journal of Insect Biodiversity*. 3(14): 1–10. DOI: 10.12976/jib/2015.3.14

Feinsinger P., Swarm L.A. 1978. How common are ant-repellent nectars? *Biotropica*. 10(3): 238–239. DOI: 10.2307/2387911

Fischer G., Azorsa F., Fisher B. L. 2014. The ant genus *Carebara* Westwood (Hymenoptera, Formicidae): synonymisation of *Pheidologeton* Mayr under *Carebara*, establishment and revision of the *C. polita* species group. *ZooKeys*. 438: 57–122. DOI: 10.3897/zookeys.438.7922

Fisher B.L., Bolton B. 2016. Ants of Africa and Madagascar: A guide to the genera. Los Angeles: University of California Press. ix + 503 p.

Magurran A.E. 2004. Measuring biological Diversity. Madlen, USA: Blackwell. 256 p.

Pathak M.D., Khan Z.R. 1994. Insect pests of rice. Manila: International Rice Research Institute. 89 p.

Rice Knowledge Bank. Available at: http://www.knowledgebank.irri.org/training/fact-sheets/pest-management/insects/item/ants (accessed 12 January 2021).

Rice cultivation. *Rice Research and Development Institute, Department of Agriculture - Sri Lanka*. Available at: https://doa.gov.lk/rrdi/index.php?option=com_sppagebuilder&view=page&id=42&lang=en (accessed 10 December 2020).

Ricepedia. Available at: http://ricepedia.org (accessed 10 January 2021).

Schmidt C.A., Shattuck S.O. 2014. The higher classifcation of the ant subfamily Ponerinae (Hymenoptera: Formicidae), with a review of ponerine ecology and behavior. *Zootaxa*. 3817(1): 1–242. DOI: 10.11646/zootaxa.3817.1.1

Singh B.B., Singh R. 2014. Major rice insect pests in northeastern UP. *International Journal of Life Sciences, Biotechnology and Pharma Research*. 3(1): 124–143.

Way M.J., Islam Z., Heong K.L., Joshi R.C. 2009. Ants in tropical irrigated rice: distribution and abundance, especially of *Solenopsis geminata* (Hymenoptera: Formicidae). *Bulletin of Entomological Research*. 88: 467–476. DOI: 10.1017/S0007485300042218

Way M.J., Javier G., Heong K.L. 2002. The role of ants, especially the fire ant, *Solenopsis geminata* (Hymenoptera: Formicidae), in the biological control of tropical upland rice pests. *Bulletin of Entomological Research*. 92(5): 431–437.

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