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# Contribution of wet zone coconut plantations and non-agricultural lands to the conservation of ant communities (Hymenoptera: Formicidae) in Sri Lanka

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***Abstract.*** Agricultural practices are blamed for the reduction of ant diversity on earth. Contribution of four coconut plantations (CP) and four non-agricultural lands (NL) for sustaining diversity and relative abundance of ground-dwelling and ground-foraging ants was investigated by surveying them from May to October, 2018, in a CP and a NL in Minuwangoda, Mirigama, Katana and Veyangoda in Gampaha District that lies in the wet zone, Sri Lanka. Worker ants were surveyed by honey baiting and soil sifting along two transects at three, 50 m$^2$ plots in each type of land. Workers were identified using standard methods and frequency of each ant species observed by each method was recorded. Percentage frequency of occurrence observed by each method, mean percentage frequency of occurrence of each ant species and proportional abundance of each species in each ant community were calculated. Species richness recorded by both methods at each CP was 14–19 whereas that recorded at each NL was 17–23. Shannon-Wiener Diversity Index values (*H′*, CP: 2.06–2.36; NL: 2.11–2.56) and Shannon-Wiener Equitability Index values (*J′*, CP: 0.73–0.87; NL: 0.7–0.88) showed a considerable diversity and evenness of ant communities at both types of lands. Four coconut plantations had 29 species in 23 genera of 5 subfamilies, Dolichoderinae, Dorylinae, Formicinae, Myrmicinae and Ponerinae. Four NLs consisted of 36 species in 26 genera of 7 subfamilies including additional Leptanillinae and Pseudomyrmecinae. Several species were restricted to coconut or non-agricultural lands while many species were common to both types of land.

***Key words:*** impact of agricultural practices, non-agricultural lands, coconut plantation, ant diversity.

**Значение кокосовых плантаций и несельскохозяйственных земель влажной зоны для сохранения сообществ муравьев (Hymenoptera: Formicidae) на Шри-Ланке**

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***Резюме.*** Сельскохозяйственная деятельность является одной из причин сокращения разнообразия муравьев на Земле. С мая по октябрь 2018 года были исследованы разнообразие и относительная численность муравьев на четырех кокосовых плантациях и четырех участках несельскохозяйственных земель в Минувангоде, Миригаме, Катане и Вейангоде в округе Гампаха, который находится во влажной зоне Шри-Ланки. Изучение рабочих особей проводили с помощью ловли на медовую приманку и просеивания почвы на трех участках по 50 м$^2$ на двух трансектах в каждом типе земель. Муравьев идентифицировали стандартными методами, частоту встречаемости каждого вида регистрировали при использовании обоих методов ловли. Были рассчитаны процент частоты встречаемости, наблюдаемой при каждом методе ловли, средний процент частоты встречаемости каждого вида муравьев и пропорциональная численность каждого вида в каждом сообществе муравьев. На кокосовых плантациях при обоих методах ловли зарегистрировано 14–19 видов, на несельскохозяйственных землях – 17–23 вида. Значения индекса разнообразия Шеннона –Винера (*H′*, кокосовые плантации: 2.06–2.36; несельскохозяйственные земли: 2.11–2.56) и показателя выравненности Шеннона –Винера (*J′*, кокосовые плантации: 0.73–0.87; несельскохозяйственные земли: 0.7–0.88) продемонстрировали значительное разнообразие и равномерность распределения сообществ муравьев на обоих типах земель. На четырех кокосовых плантациях насчитывалось 29 видов из 23 родов 5 подсемейств: Dolichoderinae, Dorylinae, Formicinae, Myrmicinae и Ponerinae. На четырех участках несельскохозяйственных земель зарегистрировано 36 видов из 26 родов 7 подсемейств, включая, кроме вышеупомянутых, Leptanillinae и Pseudomyrmecinae. Некоторые виды обитают только на кокосовых плантациях или только на несельскохозяйственных землях, в то время как многие были общими для обоих типов земель.

***Ключевые слова:*** влияние сельскохозяйственной деятельности, несельскохозяйственные земли, кокосовые плантации, разнообразие муравьев.

## Introduction

Any considerable disturbance to an ecosystem caused by agriculture may provoke an impact on its animal and plant communities such as reduction of species richness or diversity of communities. Being a dominant and successful component of tropical ecosystems by generally constituting the largest fraction of the animal biomass, ants could be indicators of the well-being of an ecosystem because of their sensitivity to environmental changes, ease of sampling, sorting and identification, and occupying different trophic levels in the food webs. Ants are a group of major predators in tropical agroforestry ecosystems. Moreover, sampling protocols for ground-dwelling ant species have been

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established and available for ant surveys [Alonso, 2000; Delabie et al., 2009].

Coconut (Cocos nucifera L.) is a rain fed perennial crop important in Sri Lankan culture, food consumption and the economy. The coconut tree benefits the people of Sri Lanka in numerous ways due to its multiple uses. Coconut plantations occupy about 20% of the arable lands (almost 400,000 ha) in the island [Department..., 2002]. Contribution of coconut to Sri Lankan GDP is 1.1% [Central Bank..., 2013] and the contribution to Sri Lankan export earnings is nearly 4% [Coconut..., 2012; Pathiraja et al., 2015]. Clearing of land for planting coconut initially and anthropogenic activities such as weeding, adding manure, pest control, cattle feeding, harvesting practices and collection of fallen coconut fronds regularly as firewood may highly disturb the natural biodiversity in coconut plantations. Six coconut plantations located at arid and intermediate zones were surveyed by Dias and Peiris [2015] and a diverse ant assemblage, 19–29 species, was reported from each plantation. Forty-eight species of 27 genera in five subfamilies were recorded from the six plantations [Dias, Peiris, 2015]. Surveys on the ant diversity of well-established coconut plantations in the wet zone of the country are scarce.

Also, non-agricultural lands, which have never been currently used for agricultural purposes or are abandoned after planting some trees, approximated to 5620 ha [Land Use..., 2007] have been observed in the country. Those lands are the property of the government or owned by the general public. Presence of vegetation and other decomposing matter in such lands also may favour survival of diverse ants and contribute to the conservation of biodiversity. Hence, species diversity, percentage frequency of occurrence and mean percentage frequency of occurrence of each ant species and, proportional abundance of each species in each ant community observed at four coconut plantations and four non-agricultural lands are presented in this paper.

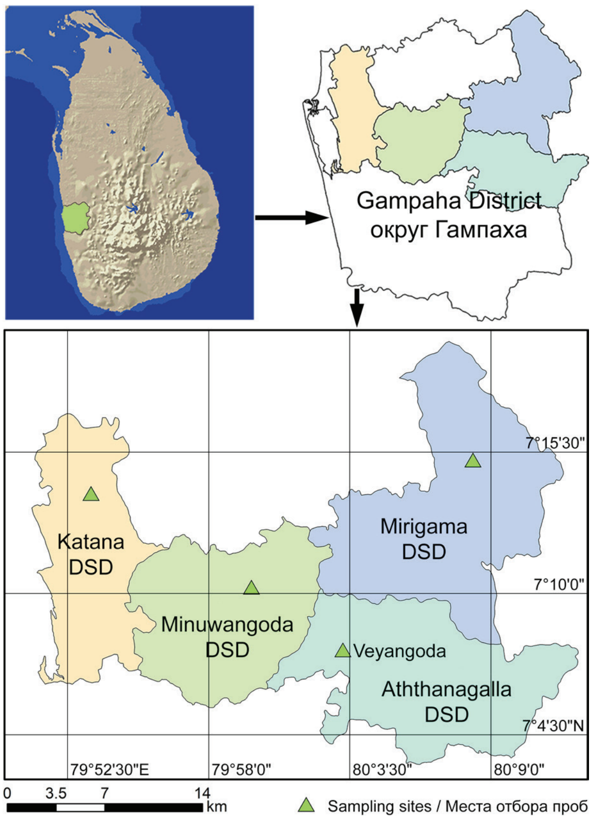


Fig. 1. Map showing the locations of coconut plantations and non-agricultural lands in Gampaha District, Sri Lanka.

Рис. 1. Расположение кокосовых плантаций и несельскохозяйственных земель в округе Гампаха, Шри-Ланка.

## Material and methods

**Description of localities** (Fig. 1). Ant fauna were surveyed at a coconut plantation and a non-agricultural land in each Minuwangoda (CP1: 7°10′19″N / 79°59′44″E; NL1: 7°12′2″N / 79°59′32″E), Mirigama (CP2: 7°15′6″N / 80°8′8″E; NL2: 7°14′57″N / 80°7′54″E), Katana (CP3: 7°13′41″N / 79°53′22″E; NL3: 7°15′19″N / 79°54′42″E) and Veyangoda (CP4: 7°8′41″N / 80°3′48″E; NL4: 7°8′33″N / 80°3′46″E) in Gampaha District that lies in the wet zone of Sri Lanka. Each coconut plantation consisted of mature and young coconut trees. Chemical fertilizer mixed urea or ash was usually applied to the base of the trees by the land owners annually. Many weed species covered the floor of each plantation. Fallen coconut fronds, immature coconuts and related parts were observed throughout the plantation floor. Non-agricultural lands were not subjected to any agricultural practices and the lands were covered with one or two weed species, Cynodon dactylon L., Axonopus compressus (Sw.), Gliricidia sepium (Jacq.) and Echinochloa colona L. Several tall tree species were observed in NL2 and NL4.

**Field and laboratory methods.** Table 1 presents the weather existed on the dates of sampling and number of samples collected by honey baiting (HB) and soil sifting (SS) conducted at each land. Three, 50 $m^2$ plots were demarcated in each land while leaving a 10 m distance between any two plots. Worker ants were sampled from 17 May to 12 October in 2018 during the day time.

Two transects were laid while joining the opposite corners of each 50 $m^2$ plot. Twenty pieces of gauze, each of 2 × 2 cm with a drop of honey, were placed at 1 m interval along the two transects. The pieces of gauze with ants attended were collected after one hour into the Bijou bottles filled with 85% ethanol. Another two transects were laid parallel to the length of each plot and 20 soil samples (each of 5 × 5 × 5 $cm^3$) taken at 1 m distance along each transect were sifted through a mesh into a white tray. Worker ants fallen to the white tray kept underneath were collected into the Bijou bottles filled with 85% ethanol.

Collected ants were identified to the possible taxonomic levels using a low power stereo-microscope (Optika SZM-LED2) with reference to Bolton [1994], Brady et al. [2014], Dias [2014], Fischer et al. [2014], Schmidt and Shattuck [2014], Hita Garcia et al. [2015], Fisher and Bolton [2016], Marek [2016], Agavekar et al. [2017]. Number of workers of each species observed by each method was recorded.

Table 1. Weather, date of sampling and number of samples collected by honey baiting (HB) and soil sifting (SS).
Таблица 1. Погода, дата отбора проб и количество проб, собранных с помощью медовой приманки и просеивания почвы (обозначения участков см. в разделе «Материал и методы»).

| Locality and weather<br>Местность и погода | Land<br>Участок | Date of sampling 2018<br>Дата отбора проб в 2018 году | No of samples<br>Количество проб | |
|---|---|---|---|---|
| | | | HB<br>Медовая приманка | SS<br>Просеивание почвы |
| Minuwangoda, rainy<br>Минувангода, дождливо | CP1 | 17 May / 17 мая | 60 | 60 |
| | NL1 | 18 May / 18 мая | 60 | 60 |
| Mirigama, dry<br>Миригама, сухо | CP2 | 21 June / 21 июня | 60 | 60 |
| | NL2 | 22 June / 22 июня | 60 | 60 |
| Katana, dry<br>Катана, сухо | CP3 | 20 July / 20 июля | 60 | 60 |
| | NL3 | 21 July / 21 июля | 60 | 60 |
| Veyangoda, rainy<br>Вейангода, дождливо | CP4 | 11 October / 11 октября | 60 | 60 |
| | NL4 | 12 October / 12 октября | 60 | 60 |

**Estimation of mean percentage frequency of occurrence and diversity.** Percentage frequency of occurrence values (FO%) of each ant species observed by each method was calculated (e.g. No of honey baits with the focal species / 20) and mean percentage frequency of occurrence (MFO%) (= FO% recorded at Plot 1 + Plot 2 + + Plot 3 by each method / 3) observed by each method was calculated for each species.

Proportional abundance value ($p_i$ = Total No of $i^{th}$ species observed by both methods / Total No of all species) of each species was calculated for each land. Species richness per land was calculated by counting the total number of ant species observed in each CP and NL. Shannon-Wiener Diversity Index ($H' = -\sum p_i \ln p_i$) and Shannon-Wiener Equitability Index ($J' = H'$ / ln (Species richness)) [Magurran, 2004] were calculated for each land.

Multi-Dimensional Scale Analysis (MDS) was conducted to investigate the degree of similarity and dissimilarity of observed ant communities at the eight lands using Primer software 2002, Version 5.2.9.

**Environmental parameters.** Each parameter was measured at three representative points in each plot and mean values were calculated. Air and soil temperature were measured by a mercury and soil thermometers, respectively. Two soil samples from each plot were collected into polythene bags; a known weight of soil from each sample was dried in an oven at 105 °C until a steady dry weight was observed, and moisture content was calculated according to Brower et al. [1998]. Oven dried samples were kept in Muffle Furnace for 24 hours and soil organic matter content was calculated according to "Ecological Census Techniques" [2006]. Soil pH was measured using a pH meter (HANNA Direct soil pH meter, HI 99121) and soil texture was investigated according to Huddleston and Kling [2007]. Mean or percentage value of each parameter (as appropriate) was calculated for each 50 $m^2$ area and land. One-Way Analysis of Variance followed by Tukey's pairwise comparisons in Minitab 14.0 was conducted to test any significant differences between mean values of environmental parameters observed at the eight lands.

## Results

At the four coconut plantations (Table 2), species richness of 11–15 by HB and 5–13 by SS was recorded. By both methods, pooled species richness of 14–19 was recorded. The lowest species richness, 14, was observed at Veyangoda coconut plantation (CP4) while 19 species were observed at Minuwangoda plantation (CP1). Overall, 29 species belong to 23 genera of 5 subfamilies, Dolichoderinae, Dorylinae, Formicinae, Myrmicinae and Ponerinae were recorded (Table 2). Shannon-Wiener Diversity Index and Shannon-Wiener Equitability Index calculated for the ant community observed at each coconut plantation ranged from 2.06–2.36 and 0.73–0.87, respectively.

At each non-agricultural land (Table 2), 12–14 and 6–14 of species richness was recorded by HB and SS, respectively. By both methods, pooled species richness of 17–23 was recorded. Overall, 36 species in 26 genera of 7 subfamilies, Dolichoderinae, Dorylinae, Formicinae, Leptanillinae, Myrmicinae, Ponerinae and Pseudomyrmecinae were observed at non-agricultural lands. Shannon-Wiener Diversity Index and Shannon-Wiener Equitability Index calculated for the ant community observed at each non-agricultural land ranged from 2.11–2.56 and 0.70–0.88, respectively.

Proportional abundance values indicated that *Tapinoma melanocephalum* was dominant at Minuwangoda coconut plantation (CP1) whereas *Pheidole indica* was dominant at NL1 (Table 2); *Anoplolepis gracilipes* was dominant at both types of land (CP2 and NL2) in Mirigama. In Katana (CP3 and NL3), *Myrmicaria brunnea* or *Tapinoma melanocephalum* was dominant at coconut plantation and non-agricultural land, respectively. At Veyangoda coconut plantation (CP4), *Technomyrmex albipes* and *Myrmicaria brunnea* were dominant while NL4 was dominated by *Pheidole indica*. *Nylanderia yerburyi*, *Camponotus rufoglaucus*, *Polyrhachis* sp. and *Leptogenys processionalis* were restricted to coconut plantations whereas *Paratrechina longicornis*, *Carebara* sp., *Solenopsis geminata*, *Anochetus graffei* and *Tetraponera* sp. were recorded from non-agricultural

Table 2. Mean frequency% of each species recorded by each method, proportional abundance of each species observed by both methods, species richness, Shannon-Wiener Diversity index and Equitability Index values observed at coconut plantations (CP) and non-agricultural lands (NL).
Таблица 2. Средний процент встречаемости каждого вида, зарегистрированный с помощью каждого из методов сбора, пропорциональная численность каждого вида, наблюдаемая обоими методами, видовое богатство, индекс разнообразия Шеннона – Винера и показатель выравненности Шеннона – Винера, наблюдаемые на кокосовых плантациях (CP) и несельскохозяйственных землях (NL).

| Subfamily Подсемейство | Species Вид | Mean percentage frequency of occurrence (MFO%) and proportional abundance values (PA) / Средний процент частоты встречаемости (MFO%) и значения пропорциональной численности (PA) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CP1 | | NL1 | | CP2 | | NL2 | | CP3 | | NL3 | | CP4 | | NL4 | |
| | | HB | SS | HB | SS | HB | SS | HB | SS | HB | SS | HB | SS | HB | SS | HB | SS |
| 1. Dolichoderinae | 1. *Tapinoma melanocephalum* (Fabricius, 1793) | 11.7 | 6.7 | – | – | – | 13.3 | – | – | 16.7 | 11.7 | 1.7 | 23.3 | – | – | 1.7 | – |
| | | 0.24 | | – | | 0.049 | | – | | 0.072 | | 0.23 | | – | | 0.005 | |
| | 2. *Technomyrmex albipes* (F. Smith, 1861) | – | – | – | – | – | – | – | – | – | 10 | 3.3 | – | 8.3 | – | – | – |
| | | – | | – | | – | | – | | 0.006 | | 0.02 | | 0.168 | | – | |
| 2. Dorylinae | 3. *Aenictus pachycerus* (F. Smith, 1858) | – | – | – | – | – | – | – | – | 1.7 | – | – | – | – | – | – | – |
| | | – | | – | | – | | – | | 0.003 | | – | | – | | – | |
| | 4. *Ooceraea biroi* (Forel, 1907) | – | 1.7 | – | 1.7 | – | – | – | – | – | 1.7 | – | – | – | – | – | 1.7 |
| | | 0.009 | | 0.009 | | – | | – | | 0.003 | | – | | – | | 0.005 | |
| 3. Formicinae | 5. *Anoplolepis gracilipes* (F. Smith, 1857) | – | – | 21.7 | – | 13.3 | – | 21.7 | – | 3.3 | – | 13.3 | – | 1.7 | – | 8.3 | – |
| | | – | | 0.181 | | 0.215 | | 0.298 | | 0.063 | | 0.083 | | 0.079 | | 0.067 | |
| | 6. *Camponotus irritans* (F. Smith, 1857) | 1.7 | – | – | – | 16.7 | – | 5 | – | 8.3 | – | 3.3 | – | 1.7 | – | 3.3 | – |
| | | 0.006 | | – | | 0.027 | | 0.009 | | 0.05 | | 0.03 | | 0.011 | | 0.01 | |
| | 7. *Camponotus barbatus* Roger, 1863 | 5 | – | – | – | 18.3 | – | – | – | – | – | – | 1.7 | – | – | 1.7 | 3.3 |
| | | 0.011 | | – | | 0.032 | | – | | – | | 0.013 | | – | | 0.005 | |
| | 8. *Camponotus* sp. 3 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1.7 | – |
| | | – | | – | | – | | – | | – | | – | | – | | 0.005 | |
| | 9. *Camponotus* sp. 4 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1.7 | – |
| | | – | | – | | – | | – | | – | | – | | – | | 0.005 | |
| | 10. *Camponotus rufoglaucus* (Jerdon, 1851) | 1.7 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | 0.005 | | – | | – | | – | | – | | – | | – | | – | |
| | 11. *Lepisiota* sp. | – | – | – | 1.7 | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | | 0.003 | | – | | – | | – | | – | | – | | – | |
| | 12. *Lepisiota capensis* (Mayr, 1862) | 25 | 1.7 | 15 | – | – | – | 1.7 | – | 3.3 | – | 5 | – | – | – | – | – |
| | | 0.105 | | 0.086 | | – | | 0.024 | | 0.013 | | 0.03 | | – | | – | |
| | 13. *Nylanderia yerburyi* (Forel, 1894) | – | 3.3 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | 0.009 | | – | | – | | – | | – | | – | | – | | – | |
| | 14. *Oecophylla smaragdina* (Fabricius, 1775) | – | – | – | – | 1.7 | – | 5 | – | 1.7 | – | 13.3 | – | 1.7 | – | – | – |
| | | – | | – | | 0.027 | | 0.046 | | 0.038 | | 0.05 | | 0.047 | | – | |
| | 15. *Paratrechina longicornis* (Latrielle, 1802) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 8.3 | 1.7 |
| | | – | | – | | – | | – | | – | | – | | – | | 0.036 | |
| | 16. *Polyrhachis exercita* (Walker, 1859) | – | – | – | – | 1.7 | – | – | – | – | – | – | – | – | – | – | – |
| | | – | | – | | 0.002 | | – | | – | | – | | – | | – | |
| | 17. *Polyrhachis* sp. | – | – | – | – | 1.7 | – | – | – | – | – | – | – | – | – | – | – |
| | | – | | – | | 0.002 | | – | | – | | – | | – | | – | |

Table 2 (continuation).
Таблица 2 (продолжение).

| Subfamily Подсемейство | Species Вид | Mean percentage frequency of occurrence (MFO%) and proportional abundance values (PA) / Средний процент частоты встречаемости (MFO%) и значения пропорциональной численности (PA) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CP1 | | NL1 | | CP2 | | NL2 | | CP3 | | NL3 | | CP4 | | NL4 | |
| | | HB | SS | HB | SS | HB | SS | HB | SS | HB | SS | HB | SS | HB | SS | HB | SS |
| 4. Leptanillinae | 18. *Leptanilla besucheti* Baroni Urbani, 1977 | – | – | – | – | – | – | – | 1.7 | – | – | – | – | – | – | – | – |
| | | – | | – | | – | | 0.003 | | – | | – | | – | | – | |
| 5. Myrmicinae | 19. *Carebara diversa* (F. Smith, 1858) | – | 3.3 | – | 1.7 | – | – | – | 1.7 | – | – | – | – | – | 3.3 | 5 | 10 |
| | | 0.009 | | 0.004 | | – | | 0.003 | | – | | – | | 0.016 | | 0.098 | |
| | 20. *Carebara* sp. | – | – | – | – | – | – | – | 1.7 | – | – | – | 16.7 | – | – | 1.7 | 5 |
| | | – | | – | | – | | 0.003 | | – | | 0.036 | | – | | 0.052 | |
| | 21. *Crematogaster biroi* Mayr, 1897 | – | 15 | – | – | – | – | 5 | – | – | – | – | – | – | 1.7 | – | 1.7 |
| | | 0.027 | | – | | – | | 0.006 | | – | | – | | 0.016 | | 0.005 | |
| | 22. *Crematogaster dohrni* Mayr, 1879 | – | 5 | 1.7 | 11.7 | 3.3 | – | 1.7 | – | – | – | – | – | – | – | – | – |
| | | 0.027 | | 0.032 | | 0.009 | | 0.006 | | – | | – | | – | | – | |
| | 23. *Crematogaster rogenhoferi* Mayr, 1879 | – | – | – | – | – | – | – | – | 1.7 | 5 | 13.3 | – | – | – | – | – |
| | | – | | – | | – | | – | | 0.032 | | 0.039 | | – | | – | |
| | 24. *Lophomyrmex quadrispinosus* (Jerdon, 1851) | – | 10 | 5 | 18.3 | 5 | 13.3 | 10 | 11.7 | 1.7 | 8.3 | 10 | – | 6.7 | – | – | 3.3 |
| | | 0.054 | | 0.122 | | 0.076 | | 0.049 | | 0.028 | | 0.063 | | 0.042 | | 0.021 | |
| | 25. *Meranoplus bicolor* (Guerin-Meneville, 1844) | 8.3 | 5 | 8.3 | – | 8.3 | 1.7 | 15 | 1.7 | 21.7 | 23.3 | 10 | – | 15 | – | 15 | – |
| | | 0.096 | | 0.092 | | 0.174 | | 0.178 | | 0.195 | | 0.139 | | 0.1 | | 0.124 | |
| | 26. *Myrmicaria brunnea* Saunders, 1915 | 26.7 | 10 | – | – | 5 | – | 8.3 | – | 13.3 | – | 1.7 | – | 8.3 | – | 6.7 | – |
| | | 0.195 | | – | | 0.072 | | 0.172 | | 0.368 | | 0.05 | | 0.168 | | 0.093 | |
| | 27. *Pheidole indica* Mayr, 1879 | 11.7 | 15 | 30 | 11.7 | 15 | 38.3 | 11.7 | 6.7 | 11.7 | 31.7 | – | 21.7 | 1.7 | 1.7 | 23.3 | 5 |
| | | 0.083 | | 0.223 | | 0.174 | | 0.068 | | 0.079 | | 0.117 | | 0.068 | | 0.197 | |
| | 28. *Pheidole latinoda* Roger, 1863 | – | – | 3.3 | 20 | – | 5 | – | – | – | – | – | – | – | – | – | – |
| | | – | | 0.068 | | 0.007 | | – | | – | | – | | – | | – | |
| | 29. *Recurvidris recurvispinosa* (Forel, 1890) | – | – | 1.7 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | | 0.003 | | – | | – | | – | | – | | – | | – | |
| | 30. *Solenopsis geminata* (Fabricius, 1804) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 6.7 |
| | | – | | – | | – | | – | | – | | – | | – | | 0.04 | |
| | 31. *Strumigenys* sp. | – | – | – | 1.7 | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | | 0.003 | | – | | – | | – | | – | | – | | – | |
| | 32. *Tetramorium bicarinatum* (Nylander, 1846) | 3.3 | 1.7 | – | 1.7 | 10 | 5 | 15 | 1.7 | 1.7 | 8.3 | – | 13.3 | – | – | – | 1.7 |
| | | 0.011 | | 0.003 | | 0.078 | | 0.068 | | 0.016 | | 0.013 | | – | | 0.01 | |
| | 33. *Tetramorium smithi* Mayr, 1879 | – | – | – | 3.3 | – | – | – | – | – | – | – | – | – | – | – | – |
| | | – | | 0.012 | | – | | – | | – | | – | | – | | – | |
| | 34. *Tetramorium walshi* (Forel, 1890) | 3.3 | – | 1.7 | – | 6.7 | 3.3 | – | 6.7 | – | – | – | 15 | 1.7 | 1.7 | – | 1.7 |
| | | 0.02 | | 0.025 | | 0.031 | | 0.024 | | – | | 0.018 | | 0.011 | | 0.021 | |
| | 35. *Trichomyrmex destructor* (Jerdon, 1851) | – | 3.3 | 3.3 | 3.3 | 3.3 | 1.7 | – | – | – | – | – | – | – | – | – | – |
| | | 0.005 | | 0.036 | | 0.009 | | – | | – | | – | | – | | – | |

Table 2 (completion).
Таблица 2 (окончание).

| Subfamily<br>Подсемейство | Species<br>Вид | Mean percentage frequency of occurrence (MFO%) and proportional abundance values (PA) / Средний процент частоты встречаемости (MFO%) и значения пропорциональной численности (PA) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CP1 | | NL1 | | CP2 | | NL2 | | CP3 | | NL3 | | CP4 | | NL4 | |
| | | HB | SS | HB | SS | HB | SS | HB | SS | HB | SS | HB | SS | HB | SS | HB | SS |
| 6. Ponerinae | 36. *Anochetus graffei* Mayr, 1870 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1.7 |
| | | – | | – | | – | | – | | – | | – | | – | | 0.01 | |
| | 37. *Bothroponera sulcata* Forel, 1900 | – | – | – | – | – | – | 1.7 | – | 1.7 | – | – | – | – | – | – | – |
| | | – | | – | | – | | 0.003 | | 0.003 | | – | | – | | – | |
| | 38. *Diacamma rugosum* Forel, 1911 | 20 | – | 10 | – | 6.67 | – | 8.3 | – | 8.3 | – | 3.3 | – | 5 | – | 23.3 | – |
| | | 0.054 | | 0.042 | | 0.016 | | 0.04 | | 0.028 | | 0.023 | | 0.079 | | 0.057 | |
| | 39. *Hypoponera confinis* (Roger, 1960) | – | – | – | – | – | – | – | – | – | – | – | – | – | 5 | – | 3.3 |
| | | – | | – | | – | | – | | – | | – | | 0.142 | | 0.005 | |
| | 40. *Leptogenys processionalis* (Jerdon, 1851) | – | – | – | – | – | – | – | – | 1.7 | – | – | – | – | – | – | – |
| | | – | | – | | – | | – | | 0.003 | | – | | – | | – | |
| | 41. *Odontomachus simillimus* F. Smith, 1858 | 5 | – | 16.7 | – | – | – | – | – | – | – | 15 | – | 20 | – | 28.3 | – |
| | | 0.009 | | 0.056 | | – | | – | | – | | 0.046 | | 0.053 | | 0.124 | |
| 7. Pseudomyrmecinae | 42. *Tetraponera* sp. | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1.7 |
| | | – | | – | | – | | – | | – | | – | | – | | 0.005 | |
| Species richness / Видовое богатство | | 12 | 13 | 12 | 11 | 15 | 8 | 13 | 8 | 15 | 8 | 12 | 6 | 11 | 5 | 14 | 14 |
| Species richness (by both methods) / Видовое богатство (с использованием двух методов сбора) | | 19 | | 18 | | 17 | | 17 | | 17 | | 17 | | 14 | | 23 | |
| Shannon-Wiener Diversity Index (*H'*) Индекс разнообразия Шеннона – Винера | | 2.36 | | 2.32 | | 2.30 | | 2.11 | | 2.06 | | 2.49 | | 2.29 | | 2.56 | |
| Shannon-Wiener Equitability Index (*J'*) / Показатель выравненности Шеннона – Винера | | 0.79 | | 0.70 | | 0.81 | | 0.75 | | 0.73 | | 0.88 | | 0.87 | | 0.82 | |

Table 3. Mean air and soil temperature, soil moisture content%, soil organic matter content% and soil pH at each CP and NL during May-October, 2018.
Таблица 3. Средняя температура воздуха и почвы, влажность почвы, содержание органического вещества в почве и pH почвы для каждого участка в период с мая по октябрь 2018 года (обозначения участков см. в разделе «Материал и методы»).

| Parameter<br>Параметр | Locality<br>Местонахождение | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Minuwangoda<br>Минувангода | | Mirigama<br>Миригама | | Katana<br>Катана | | Veyangoda<br>Вейангода | |
| | CP1 | NL1 | CP2 | NL2 | CP3 | NL3 | CP4 | NL4 |
| Air T, °C<br>Температура воздуха, °C | 29.7 ± 0.58 | 25.3 ± 0.6 | 29.7 ± 0.6 | 25.3 ± 0.6 | 29.7 ± 0.6 | 31.0 ± 0 | 30.7 ± 2.5 | 29.7 ± 1.5 |
| Soil T, °C<br>Температура почвы, °C | 30.7 ± 0.86 | 31.1 ± 0.8 | 29.0 ± 0.8 | 28.3 ± 0.8 | 30.7 ± 1.7 | 33.3 ± 0.6 | 30.7 ± 2.0 | 30.3 ± 2.1 |
| Soil moisture content, %<br>Влажность почвы, % | 12.4 ± 1.08 | 11.9 ± 2.9 | 15.8 ± 2.4 | 16.3 ± 2.5 | 12.5 ± 0.7 | 10.8 ± 2.5 | 13.1 ± 2.5 | 14.9 ± 2.0 |
| Soil organic matter content, % / Содержание органического вещества в почве, % | 16.0 ± 11.5 | 4.0 ± 1.6 | 5.7 ± 0.4 | 6.0 ± 0.9 | 5.0 ± 0.8 | 4.4 ± 1.5 | 19.3 ± 1.5 | 17.5 ± 3.2 |
| Soil pH<br>pH почвы | 6.5 ± 0.34 | 6.6 ± 0.3 | 6.4 ± 0.6 | 6.0 ± 0.5 | 6.2 ± 0.6 | 7.1 ± 0.5 | 6.4 ± 0.85 | 6.0 ± 0.7 |

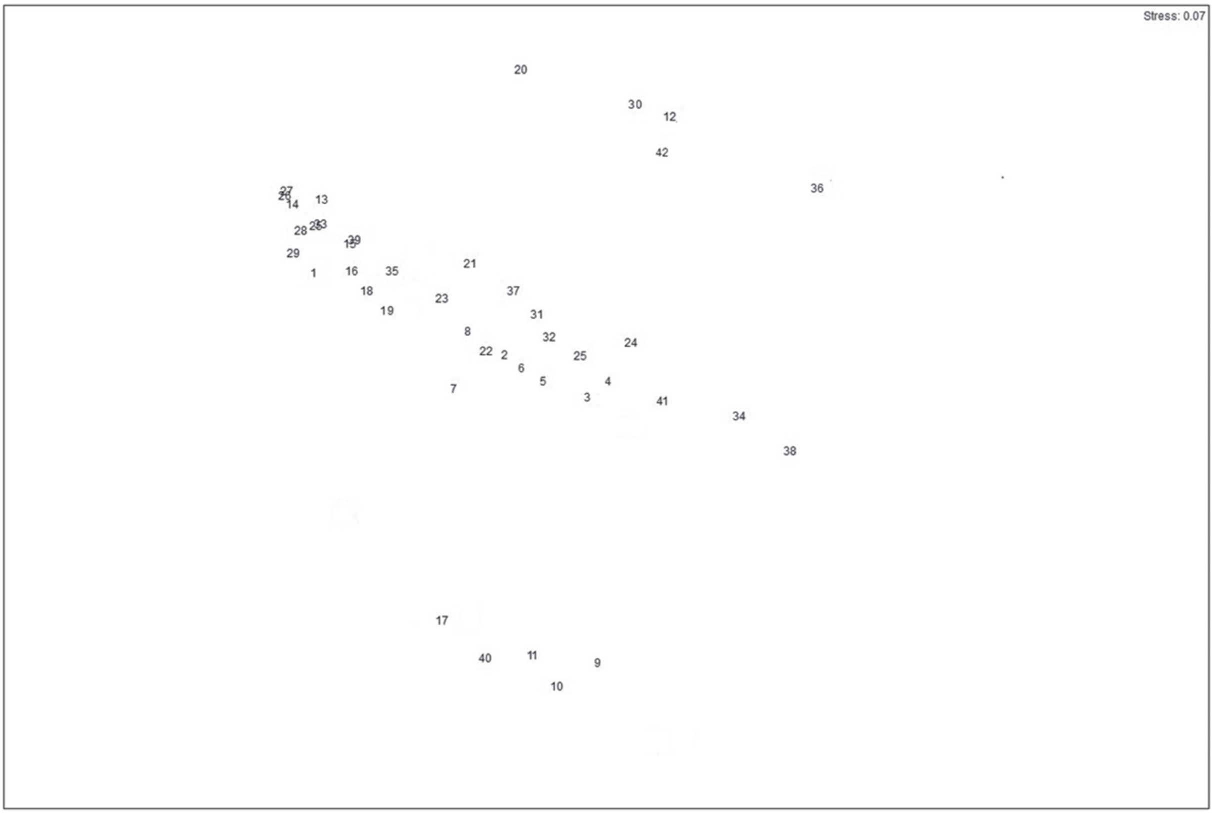


Fig. 2. Multi-Dimensional Scale plot (MDS) (0.07) showing ant species restricted or common at each type of land.

Рис. 2. Многомерное шкалирование (MDS) (Stress value: 0.07), показывающее виды муравьев, ограниченные только кокосовыми плантациях или только несельскохозяйственными землями и общие для обоих типов земель.

1 – *Tapinoma melanacephallum*; 2 – *Technomyrmex albipes*; 3 – *Oocerea biroi*; 4 – *Aenictus pachycerus*; 5 – *Camponotus irritans*; 6 – *Camponotus barbatus*; 7 – *Camponotus* sp. 3; 8 – *Camponotus* sp. 4; 9 – *Camponotus rufoglaucus*; 10 – *Polyrhachis exercita*; 11 – *Polyrhachis* sp.; 12 – *Paratrechina longicornis*; 13 – *Anoplolepis gracilipes*; 14 – *Lepisiota capensis*; 15 – *Lepisiota* sp.; 16 – *Oecophylla smaragdina*; 17 – *Nylanderia yerburyi*; 18 – *Leptanilla besucheti;* 19 – *Carebara diversa*; 20 – *Carebara* sp.; 21 – *Crematogaster biroi*; 22 – *Crematogaster dohrni*; 23 – *Crematogaster rogenhoferi*; 24 – *Lophomyrmex quadrispinosus*; 25 – *Meranoplus bicolor*; 26 – *Myrmicaria brunnea*; 27 – *Pheidole indica*; 28 – *Pheidole latinoda*; 29 – *Recurvidris recurvispinosa*; 30 – *Solenopsis geminata*; 31 – *Strumigenys* sp.; 32 – *Tetramorium bicarinatum*; 33 – *Tetramorium smithi*; 34 – *Tetramorium walshi*; 35 – *Trichomyrmex destructor*; 36 – *Anochetus graffei*; 37 – *Bothroponera sulcata*; 38 – *Diacamma rugosum*; 39 – *Hypoponera confinis*; 40 – *Leptogenys processionalis*; 41 – *Odontomachus simillimus*; 42 – *Tetraponera* sp.

lands only (Fig. 2). Other species were common to both types of lands.

Significant differences were not evident among the values of environmental parameters (Table 3) recorded at each coconut plantation and non-agricultural land ($p > 0.05$, ANOVA).

## Discussion

The first attempt to characterize the diversity and community composition of ant fauna at coconut plantations and non-agricultural lands in the wet zone of Sri Lanka showed a considerably higher ant richness at coconut plantations although with many disturbing, agricultural practices. Ant survey conducted by Dias and Peiris [2015] at six coconut plantations in dry and intermediate zones reported 48 species in 25 genera of 5 subfamilies and each of those coconut plantation had higher proportional abundance of formicines and myrmicines. Similarly, diverse ant communities in same subfamilies (currently valid Dorylinae instead of former Cerapachyinae) with higher proportional abundance of formicines and myrmicines were recorded in the current survey. According to Dias and Rajapaksa [2016], 73 species of ants in 63 genera and 11 subfamilies have been recorded from the wet zone of Sri Lanka. Twenty-three out of the 63 genera, *Tapinoma* Foerster, 1850, *Technomyrmex* Mayr, 1872, *Aenictus* Shuckard, 1840, *Cerapachys* Smith, 1857, *Anoplolepis* Santschi, 1914, *Camponotus* Mayr, 1861, *Lepisiota* Santschi, 1926, *Nylanderia* Emery, 1906, *Oecophylla* Smith, 1860, *Polyrhachis* Smith, 1857, *Carebara* Westwood, 1840, *Crematogaster* Lund, 1831, *Lophomyrmex* Emery, 1892, *Meranoplus* Smith, 1853, *Myrmicaria* Saunders, 1842, *Pheidole* Westwood, 1839, *Tetramorium* Mayr, 1855, *Trichomyrmex* Mayr, 1865, *Bothroponera* Mayr, 1862, *Diacamma* Mayr, 1862, *Hypoponera* Santschi, 1938, *Leptogenys* Roger, 1861 and *Odontomachus* Latreille, 1804 in 5 out of 11 subfamilies were observed at the current coconut plantations.

Higher proportional abundance and frequency of occurrence values are useful to explain community structure based on dominant species. Hence, *Camponotus irritans*, *Lophomyrmex quadrispinosus*, *Meranoplus bicolor*, *Myrmicaria brunnea*, *Pheidole indica* and

*Diacamma rugosum* observed with higher values of frequency of occurrence at four coconut plantations (Table 2) could be the dominant species of those ant communities. Also, they can be considered as generalists of coconut plantations. Coconut plantations may provide suitable conditions for ant communities such as food, microhabitats, mating and breeding grounds. They are well-suited to environment with disturbances such as agricultural practices and they may have an ability to tolerate wide range of harsh conditions at the coconut plantations [Conceição et al., 2014]. Similarly, *Anoplolepis gracilipes*, *Tetramorium bicarinatum* and *Tetramorium walshi* can be considered the dominant species at the non-agricultural land ant communities. Specialists, *Bothroponera sulcata* and *Leptogenys processionalis* [Ant Ecology, 2010] at coconut plantations were recorded in lower proportions. Typically, they feed on other invertebrates such as termites and collembolans. Also, dorylomorph ants, *Aenictus pachycerus* and *Ooceraea biroi*, were observed in lower proportions only at Katana and Mirigama coconut plantations. Brady et al. [2014] reported that those ants have nomadic behaviour and also they are highly specialized predators.

The presence of medically important myrmicines, *Meranoplus bicolo*r, *Myrmicaria brunnea* and *Pheidole indica* and the ponerine, *Diacamma rugosum*, [Dias, 2011] observed in coconut plantations can be a major risk to human life because labourers and other people frequently wander in those lands. *Odontomachus simillimus*, which caused fatal anaphylaxis [Ratnatilaka et al., 2011] was observed only at two out of four coconut plantations. *Leptogenys processionalis* is another medically important ponerine [Dias, 2011] that is occasionally seen in human habitations. Medically important *Solenopsis geminata* [Dias, 2011] was observed in lower proportions only at the Veyangoda non-agricultural land.

The list of ants provided in the Table 2 can be considered the preliminary inventory of species observed at the coconut plantations and non-agricultural lands in Gampaha District, Sri Lanka. Similar surveys in large scale are encouraged in other wet zone districts in Sri Lanka to improve the knowledge on the impact of agricultural plantations and abandoned/uncultivated lands on the ant communities of such lands in the wet zone of Sri Lanka.

## Conclusion

Species richness of 14–19 was recorded by honey baiting and soil sifting at each coconut plantation and 29 ant species in 23 genera of 5 subfamilies, Dolichoderinae, Dorylinae, Formicinae, Myrmicinae and Ponerinae were recorded from the four plantations. At each non-agricultural land, species richness of 17–23 was recorded by both methods and 36 species in 26 genera of 7 subfamilies, including additional Leptanillinae and Pseudomyrmecinae were observed at the four non-agricultural lands. Many species were common to both types of land whereas few were restricted to coconut or non-agricultural lands. Few medically important ant species were also recorded.

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