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Nest density dynamics and worker occurrence of *Aneuretus simoni* Emery, 1893 (Formicidae: Aneuretinae) and associated ant taxa in a Forest Reserve in Kegalle District, Sri Lanka

Динамика плотности гнезд и численность рабочих особей *Aneuretus simoni* Emery, 1893 (Formicidae: Aneuretinae) и обитающих совместно с ним муравьев в лесном заповеднике округа Кегалле, Шри-Ланка

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Key words: Formicidae, Aneuretinae, Sri Lankan relict ant, *Aneuretus*, habitats, forest ants, ant sampling methods.
Ключевые слова: Formicidae, Aneuretinae, *Aneuretus*, реликтовый муравей Шри-Ланки, места обитания, лесные муравьи, методы сбора муравьев.

Abstract. Lenagala Forest Reserve in Kegalle District of Sabaragamuwa Province, Sri-Lanka, was reported a habitat of Endangered, island-endemic, *Aneuretus simoni* Emery, 1893 recently and a detailed report on the repeated sampling and the findings are presented here. *Aneuretus simoni* was among the 14 resident species and its overall mean nest density, 0.12 m^{-2}, had the 6th rank while that of *Anoplolepis gracilipes* (Smith, 1857) ($p < 0.05$) and *Odontomachus simillimus* (Smith, 1858) ($p < 0.05$) had the 1st and 2nd rank among that of other species. Significant difference among its mean nest density values of four occasions or between that calculated for the dry and wet months was not evident ($p < 0.05$). No significant difference was observed between its mean frequency of nest occurrence, 11.3%, and that of each dominant species. Significantly lower mean percentage frequency of worker occurrence ($p < 0.05$) of the species than that of *A. gracilipes*, *O. simillimus* and *Technomyrmex albipes* (Smith, 1861) was observed. Fifty-six species in 32 genera of 6 subfamilies listed here can be considered an updated ant inventory of the study region.

Резюме. Лесной заповедник Ленагала в округе Кегалле провинции Сабарагамува, Шри-Ланка, – место обитания находящегося под угрозой исчезновения островного эндемика *Aneuretus simoni Emery*, 1893. Представлены результаты изучения экологических особенностей сообщества муравьев заповедника: средняяплотностьгнезд,средняячастотавстречаемости гнезд и рабочих особей каждого зарегистрированного вида и благоприятные условия обитания. Средняя плотность гнезд *Aneuretus simoni* составила 0.12 $м^{-2}$ и заняла шестую позицию, тогда как *Anoplolepis gracilipes* (Smith, 1857) ($p < 0,05$) и *Odontomachus simillimus* (Smith, 1858) ($p < 0,05$) заняли первое и второе места. Значимые различия между значениями средней плотности гнезд в четырех исследованных случаях или между значениями, рассчитанными для влажного (сентябрь и ноябрь 2016 года) и сухих (февраль и август 2017 года) периодов, не были очевидными ($p < 0,05$). Не было обнаружено существенных различий между средней частотой встречаемости гнезд (11,3%) и частотой встречаемости каждого доминирующего вида. Наблюдалась значительно более низкая средняя процентная частота встречаемости рабочих особей *Aneuretus simoni* ($p < 0,05$), чем у *Anoplolepis gracilipes*, *Odontomachus simillimus* и *Technomyrmex albipes* (Smith, 1861). Представлен обновленный список муравьев для региона исследования –56 видов из 32 родов 6 подсемейств.

Introduction

Among the nine provinces, Sabaragamuwa Province in Sri Lanka includes two districts, Ratnapura and Kegalle, in the wet zone. Several forests in Ratnapura District were reported as the habitats of endangered *Aneuretus simoni* Emery, 1893 (Aneuretinae) [Dias et al., 2012], the island-endemic Sri Lankan Relict ant, earlier [Wilson et al., 1956; Udayakantha, Dias, 2018] and hence, ant communities in Kegalle District forests were of special interest.

Salgala Forest Reserve known since 1817 in Kegalle District was renamed as Lenagala Forest Reserve in February 2009 (gazette No. 1589/16). It is an evergreen tropical rainforest of 128 ha, located in Galapitamada. The forest consists of a central hill and a southern hill with the slope of the terrain varying between 5–45 degrees. The

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forest floor mainly consists of Red Yellow Podsolic soil and the leaf litter. Mean annual temperature fluctuates between 25–27 °C and the forest receives 2000–4000 mm of average annual rainfall. The forest is surrounded by rubber plantations, home gardens and paddy fields. Higher floristic richness, 37 and 38, at the elevation range of 221–260 m and 261–300 m of the forest has been reported while Aporosa lindleyana (Wight) Baill. and Humboldtia laurifolia M. Vahl. were common with many endemic species in the plant community [Chandrasekera, 2013]. Invertebrate communities of the forest are not well documented but 51 species of ants in 32 genera of 6 subfamilies, Aneuretinae, Dolichoderinae, Dorylinae, Formicinae, Myrmicinae and Ponerinae and mean nest density of *A. simoni* observed at each locality on each of the four occasions have been very briefly documented by Dias and Udayakantha [2018]. In this paper, ecological features of the ant community in a selected region of Lenagala Forest Reserve, (a) mean nest density and its rank, (b) mean percentage frequency of nest occurrence and (c) mean percentage frequency of worker occurrence of each ant species recorded from both Locality A and Locality B at two elevations and favourable mean environmental conditions are presented in detail. In addition, an updated ant inventory for the study region is provided.

Material and methods

Two localities at each 255 m and 280 m elevations in the southern mountain region of Lenagala Forest Reserve were surveyed for ants in September and November, 2016 (wet months) and February and August, 2017 (dry months). Locality A consisted of a clay floor, a canopy with irregularly scattered tall trees, a sub canopy and a layer of grasses. Locality B also composed of a clay floor with stones and boulders and a taller continuous canopy, a sub canopy and poorly developed grasses. The forest floor of each locality was usually covered with a dense leaf litter layer and decaying parts of fallen trees. Nests of the ant species were surveyed using the quadrat method while workers were collected by pitfall trapping, simultaneously. Dates of sampling, elevation of each Locality A and Locality B, GPS coordinates of each plot and number of quadrats laid are shown in Table 1. Also, soil sifting alone was conducted once during 23–25, June in 2017.

Quadrat sampling of ant nests and calculation of mean nest density. Twenty, 1 × 1 m^2 quadrats were laid within each plot at each elevation, at least 1 m apart from each other, by fixing four pegs and connecting them with a cord. Nests of ants were searched by checking leaf litter and other materials and breaking fallen plant parts within each quadrat. Number of nests of each species within each quadrat was recorded and three worker ants from each nest were preserved in glass bottles (7 ml) filled with 80% ethanol with appropriate labels. Collected ants were identified using a Low Power Stereo-microscope with reference to Bingham [1903], Bolton [1994, 2003], Eguchi [2001], Dias [2014], Hita Garcia, Fisher [2014], Schmidt, Shattuck [2014], Sarnat et al., [2015], AntWeb [http://www.antweb.org] and AntCat [http://www.antcat.org]. Species richness of ant community at the study region was estimated by pooling the data collected from both localities on the four occasions and updating that with the findings of the soil sifting. Mean nest density (MND) in Locality A and Locality B of each species was calculated first (MND = number of nests of the species per locality / sum of the quadrat areas (= 20 + 20 = 40 m^2)) and MND for the study region observed on each occasion was calculated by the addition of the two values (MND on each occasion = MND Locality A + MND Locality B). Overall mean nest density (OMND) of each ant species at the study region from all occasions was calculated by totalling four calculated MND values of each species (MND September and November, 2016 + MND February and August, 2017) and dividing that value by 4 and the OMND values of all species were ranked. One Way Analysis of Variance followed by Tukey's test (Minitab 14.0) was conducted to test any significant difference among four mean nest density values of *A. simoni*. In addition, mean nest density values of *A. simoni* for the study region in wet and dry months was calculated by totalling the MND values observed in September and November, 2016 (wet months) and February and August, 2017 (dry months). Student t-test was conducted to test significant difference between the mean nest density of the species in wet and dry occasions.

Table 1. Number of quadrats laid at each plot and number of pitfall traps fixed outside each plot.
Таблица 1. Количество квадратов, заложенных на каждом участке, и ловушек, установленных вне площадок.

Date Дата	Locality A (255 m) Участок А (255 м н.у.м.)			Locality B (280 m) Участок Б (280 м н.у.м.)		
	plot A_1 площадка $А_1$ 7°07′33.6″N / 80°14′54.2″E	plot A_2 площадка $А_2$ 7°07′32.5″N / 80°14′54.8″E	pitfall traps (outside) / ловушки вне площадок	plot B_1 площадка $Б_1$ 7°07′18.0″N / 80°14′59.2″E	plot B_2 площадка $Б_2$ 7°07′16.2″N / 80°15′01.1″E	pitfall traps (outside) / ловушки вне площадок
17–20 September, 2016 17–20 сентября 2016	20	20	50	20	20	50
26–28 November, 2016 26–28 ноября 2016	20	20	50	20	20	50
16–18 February, 2017 16–18 февраля 2017	20	20	50	20	20	50
23–25 August, 2017 23–25 августа 2017	20	20	50	20	20	50

Also, for Locality A and Locality B, frequency of nest occurrence (FNO%) of each species was calculated (FNO Locality A% or FNO Locality B% = number of quadrats with nests of the focal species / total number of quadrats laid (= 40) × 100). Next, those two values observed for each occasion were added together to calculate FNO% for each occasion. Mean percentage FNO of each species for the study region was calculated by dividing the total of those four values by 4. One Way Analysis of Variance (Minitab 14.0) was applied to test any significant difference among Arcsine-transformed FNO proportions and if necessary, Tukey's test was conducted to test any significant difference between mean FNO% of *A. simoni* and selected species.

Pitfall trapping and calculation of mean percentage frequency of worker occurrence. At each elevation, four, 100 m transects were laid outside of each 100 m^2 plot that was marked for laying the quadrats and honey-baited pitfall traps (diameter = 7.5 cm, volume = 80 ml) were set at 4 m distance along each of them. All pitfall traps were collected after 6 hours and collected ants were preserved and identified to the furthest possible taxonomic levels as described in the previous section. Frequency of worker occurrence of each species on each occasion (FWO% = number of pitfall traps with the focal species / total number of pitfall traps (= 200) × 100) was calculated. Mean FWO% for the study region was calculated by totalling the four values of the four occasions and dividing the total by 4. One Way Analysis of Variance (Minitab 14.0) was applied to test any significant difference among Arcsine-transformed FWO proportions and if necessary, Tukey's test was conducted to test any significant difference between mean FWO% of *A. simoni* and that of a selected species.

Soil sifting and calculation of mean percentage worker occurrence. One hundred soil samples (each of 10 × 10 × 10 cm), that were taken at 1 m interval along a 100 m transect laid at each elevation were sifted using a sieve and a white tray and worker ants fallen to the white tray were preserved in 80% ethanol. Collected ants were identified to the possible taxonomic levels according to the previously described procedure. Frequency of worker occurrence of each species in the soil samples that were taken from each elevation (FWOss% of Locality A or Locality B = number of soil samples that had the focal species / total number of soil samples (= 100)) was calculated. Mean percentage frequency of worker occurrence of each species for the study region was calculated by totalling the two values calculated for each elevation and dividing the total by 2. One Way Analysis of Variance (Minitab 14.0) was applied to test any significant difference among Arcsine-transformed FWOss proportions and if necessary, Tukey's test was conducted to test any significant difference between mean FWOss% of *A. simoni* and that of a selected species.

Measurement of environmental parameters and data analysis. Monthly rainfall for the region was obtained from Meteorological Department in Colombo. Air and soil temperature, depth of leaf litter, soil moisture content and soil organic matter content were measured at three representative places at each locality and mean values were calculated. Air and soil temperature were measured using a mercury thermometer. The depth of leaf litter was measured using a ruler. Three soil samples from each plot were collected into polythene bags and a known weight of soil from each sample was dried in an oven at 105 °C until a steady dry weight was observed. Percentage of soil moisture was calculated [Brower et al., 1998]. Oven-dried soil samples were kept in a muffle furnace at 450 °C for 24 hours and percentage of soil organic matter was calculated according to Ecological Census Techniques [2006]. Any significant difference among the values of each environmental parameter recorded on the four occasions was analyzed using One Way ANOVA followed by Tukey's test in Minitab 14.0. Pearson's correlation analysis was used to test any association between the nest density of *A. simoni* (and log transformed nest density) and the values (and log transformed values) of soil temperature or soil moisture content or soil organic matter content and monthly mean rainfall recorded on the four occasions.

Results

Mean nest density and mean percentage frequency of nest occurrence of ant taxa. Table 2 shows the mean nest density observed on each occasion at both elevations, overall MND for the study region and its rank and, mean percentage frequency of nest occurrence observed on each occasion and the four occasions for each taxon. Nests of *A. simoni* were detected at both Locality A and Locality B. Its MND fluctuated between 0.11 and 0.12 on the four occasions and overall MND had the 6th rank. Overall MND of each *Anoplolepis gracilipes* (Smith, 1857), *Odontomachus simillimus* (Smith, 1858) and *Technomyrmex albipes* (Smith, 1861) with the 1st, 2nd and 3rd rank, respectively among all species was significantly higher ($p < 0.05$) than that of *Aneuretus simoni* in September and November in 2016. Overall MND of *A. simoni* was significantly lower ($p < 0.05$) than that of *Anoplolepis gracilipes*, *Odontomachus simillimus* and *Technomyrmex albipes* in February and *Anoplolepis gracilipes* and *Odontomachus simillimus* in August, 2017. No significant difference was evident ($p > 0.05$) between MND of *Aneuretus simoni* calculated for the rainy (0.115 m^{-2}) and dry (0.115 m^{-2}) occasions.

Percentage frequency of nest occurrence of *A. simoni* varied between 11 and 12 on the four occasions and a considerable mean FNO% was observed for the species at the study region (Table 2). Although the highest mean FNO% was apparent for *Anoplolepis gracilipes* significant differences were not evident ($p > 0.05$) between those values of selected taxa.

Mean percentage frequency of worker occurrence in the pitfall traps or soil samples. Workers of *Aneuretus simoni* were found in the pitfall traps fixed at both localities on each occasion. Mean FWO of *A. simoni* observed for the study region was lower than that of *Anoplolepis gracilipes* ($p < 0.05$). *Camponotus carin* Emery, 1889, *Dilobocondyla* sp. 1, *Crematogaster* sp. 1 and *Leptogenys kraepelini* Forel, 1905 were observed in the pitfall traps only (Table 2).

Aneuretus simoni workers were observed in soil samples of both Locality A and Locality B. Significantly lower mean FWOss of *A. simoni* (6.5%) than that of *Anoplolepis gracilipes* or *Odontomachus simillimus*

Table 2. Species and mean nest density (MND), mean percentage frequency of nest occurrence (FNO%) and mean percentage frequency of worker occurrence observed by pitfall trapping (FWO%) and soil sifting (FWOss%) of each species observed at the study region (both Locality A and Locality B) of Lenagala Forest Reserve.

Таблица 2. Виды муравьев, средняя плотность гнезд (MND), средняя частота встречаемости гнезд (FNO%) и средняя частота встречаемости рабочих особей в ловушках (FWO%) и при просеивании почвы (FWOss%) в исследуемом районе лесного заповедника Ленагала.

	Species Вид	Quadrat sampling Квадраты										Pitfall trapping Ловушки					Soil sifting Просеивание почвы
		MND, m^{-2}					Mean FNO%					Mean FWO%					Mean FWOss%
		September 2016 Сентябрь 2016	November 2016 Ноябрь 2016	February 2017 Февраль 2017	August 2017 Август 2017	Overall Среднее значение	September 2016 Сентябрь 2016	November 2016 Ноябрь 2016	February 2017 Февраль 2017	August 2017 Август 2017	Overall Среднее значение	September 2016 Сентябрь 2016	November 2016 Ноябрь 2016	February 2017 Февраль 2017	August 2017 Август 2017	Overall Среднее значение	June 2017 Июнь 2017
1	*Aneuretus simoni* Emery, 1893	0.12 ± 0.02	0.11 ± 0.03	0.12 ± 0.04	0.11 ± 0.03	0.12[6] ± 0.03	12	11	12	11	11.3	12	7	14	16	12.3	6.5
2	*Technomyrmex albipes* (F. Smith, 1861)	0.11 ± 0.03	0.09 ± 0.01	0.21 ± 0.03	0.24 ± 0.11	0.17[3] ± 0.02	9	21	17	24	11	11	10	24	30	18.8	7.5
3	*Technomyrmex bicolor* Emery, 1893	0.17 ± 0.03	0.17 ± 0.02	0.11 ± 0.03	0.09 ± 0.04	0.14[4] ± 0.02	17	11	14	9	17	20	14	20.5	13	18.2	3.5
4	*Tapinoma melanocephalum* (Fabricius, 1793)	0.02 ± 0.03	–	0.02 ± 0.02	–	0.04[11] ± 0.04	–	2	4	–	–	0.5	–	1.5	–	0.5	–
5	*Ooceraea biroi* (Forel, 1907)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.5
6	*Anoplolepis gracilipes* (Smith, 1857)	0.27 ± 0.02	0.28 ± 0.0	0.21 ± 0.03	0.15 ± 0.07	0.23[1] ± 0.16	28	21	23	15	27	29.5	27	18	33	26.9	14.5
7	*Camponotus* (*Tanaemyrmex*) cf. *carin* Emery, 1889	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5	0.2	–
8	*Camponotus compressus* (Fabricius, 1787)	0.02 ± 0.03	0.02 ± 002	0.02 ± 0.02	–	0.07[8] ± 0.01	2	2	1.5	–	2	–	0.5	–	–	0.2	–
9	*Camponotus* (*Myrmamblys*) *rufoglaucus* (Jerdon, 1851)	–	–	–	0.04 ± 0.0	0.01[13] ± 0.01	–	–	1	4	–	0.5	–	–	–	0.2	–
10	*Camponotus* sp. 1	–	–	0.03 ± 0.03	–	0.01[13] ± 0.01	–	3	0.5	–	–	1	–	–	–	0.3	–
11	*Nylanderia yerburyi* (Forel, 1894)	–	–	0.11 ± 0.03	0.02 ± 0.02	0.03[12] ± 0.0	–	11	3	2	–	–	–	7.5	–	1.9	2.5
12	*Nylanderia* sp. 1	–	0.02 ± 0.02	–	0.11 ± 0.05	0.03[12] ± 0.0	2	–	3	11	–	–	–	–	4.5	1.2	0.5
13	*Paratrechina longicornis* (Latreille, 1802)	0.03 ± 0.0	0.02 ± 0.02	–	–	0.02[13] ± 0.01	2	–	1.5	–	3	1.5	1.5	–	–	0.8	–
14	*Polyrhachis bugnioni* Forel, 1908	0.03 ± 0.03	0.03 ± 0.05	–	–	0.01[14] ± 0.0	3	–	1	–	3	–	–	–	–	–	–

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

	Species Вид	Quadrat sampling Квадраты										Pitfall trapping Ловушки					Soil sifting Просеивание почвы
		MND, m^{-2}					Mean FNO%					Mean FWO%					Mean FWOss%
		September 2016 Сентябрь 2016	November 2016 Ноябрь 2016	February 2017 Февраль 2017	August 2017 Август 2017	Overall Среднее значение	September 2016 Сентябрь 2016	November 2016 Ноябрь 2016	February 2017 Февраль 2017	August 2017 Август 2017	Overall Среднее значение	September 2016 Сентябрь 2016	November 2016 Ноябрь 2016	February 2017 Февраль 2017	August 2017 Август 2017	Overall Среднее значение	June 2017 Июнь 2017
15	*Acanthomyrmex luciolae* Emery, 1893		0.03 ± 0.03	–	–	0.01[14] ± 0.0	3	–	0.5	–			0.5	–	–	0.2	–
16	*Cardiocondyla nuda* (Mayr, 1866)	0.02 ± 0.02	–	–	–	0.01[14] ± 0.01	–	–	1	–	2	2	–	–	2	1	–
17	*Carebara diversa* (Jerdon, 1851)	0.04 ± 0.02	0.03 ± 0.0	–	–	0.02[13] ± 0.0	3	–	2	–	4	7	3	–	–	2.7	–
18	*Carebara* sp. 1	–	–	–	–	0.01[14] ± 0.0	–	–	1	–	–	–	–	–	1	0.8	–
19	*Cataulacus taprobanae* Smith, 1853	0.02 ± 0.02	0.02 ± 0.0	–	–	0.01[14] ± 0.01	2	–	1	–	2	0.5	3.5	–	–	1	–
20	*Cryptopone testacea* Emery, 1893	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5
21	*Dilobocondyla* sp. 1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	0.3	–
22	*Crematogaster* sp. 1	–	–	–	–	–	–	–	–	–	–	–	–	0.5	1	0.4	–
23	*Meranoplus bicolor* Guérin-Méneville, 1844	0.07 ± 0.02	0.09 ± 0.02	–	0.12 ± 0.06	0.07[8] ± 0.02	9	–	7	12	7	13	12	–	6	7.8	–
24	*Monomorium floricola* (Jerdon, 1851)	0.03 ± 0.02	0.05 ± 0.01	0.08 ± 0.05	–	0.03[12] ± 0.01	5	8	2.5	–	3	0.5	1.5	2	–	0.5	0.5
25	*Monomorium* sp. 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5
26	*Pheidole noda* Smith, 1874	0.21 ± 0.03	0.22 ± 0.04	0.12 ± 0.02	0.13 ± 0.07	0.17[3] ± 0.04	22	12	17	13	21	20	15	10	2.5	10.7	4.5
27	*Pheidole fervens* Smith, 1858	0.08 ± 0.04	0.06 ± 0.04	0.14 ± 0.04	0.23	0.13[5] ± 0.04	6	14	13	23	8	5.5	5	9	7	6.7	1.5
28	*Pheidole* sp. 1	0.07 ± 0.05	–	0.12 ± 0.04	0.05 ± 0.01	0.06[9] ± 0.02	–	12	5.5	5	7	–	–	2.5	0.5	0.8	–
29	*Pheidole* sp. 2	0.08 ± 0.04	0.07 ± 0.04	0.19 ± 0.04	0.04	0.10[7] ± 0.02	7	19	9.5	4	8	3	12	1.5	1	4.3	1.5

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

	Species Вид	Quadrat sampling Квадраты										Pitfall trapping Ловушки					Soil sifting Просеивание почвы
		MND, m^{-2}					Mean FNO%					Mean FWO%					Mean FWOss%
		September 2016 Сентябрь 2016	November 2016 Ноябрь 2016	February 2017 Февраль 2017	August 2017 Август 2017	Overall Среднее значение	September 2016 Сентябрь 2016	November 2016 Ноябрь 2016	February 2017 Февраль 2017	August 2017 Август 2017	Overall Среднее значение	September 2016 Сентябрь 2016	November 2016 Ноябрь 2016	February 2017 Февраль 2017	August 2017 Август 2017	Overall Среднее значение	June 2017 Июнь 2017
30	*Pheidole* sp. 3	0.10 ± 0.06	0.04 ± 0.01	0.07 ± 0.02	0.05 ± 0.03	0.10^{7} ± 0.03	4	7	10	5	10	15	14	1	5.5	8.9	1.5
31	*Pheidole* sp. 4	0.02 ± 0.01	0.17 ± 0.02	0.04 ± 0.01	0.05 ± 0.01	0.07^{8} ± 0.01	17	4	6.5	5	2	1	13	–	0.5	3.5	–
32	*Pheidole* sp. 5	–	–	0.05 ± 0.0	0.04	0.02^{13} ± 0.01	–	5	2	4	–	–	–	10	2	3	–
33	*Pheidole* sp. 6	–	–	–	0.03 ± 0.04	0.01^{14} ± 0.01	–	–	1	2	–	1	–	–	–	–	–
34	*Pheidole* sp. 7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
35	*Recurvidris recurvispinosa* (Forel, 1890)	0.06 ± 0.04	–	0.04 ± 0.01	–	0.02^{13} ± 0.0	–	4	2	–	6	2	–	–	1.5	0.9	2
36	*Solenopsis* sp. 1	0.02 ± 0.01	0.03 ± 0.0	0.07 ± 0.02	0.03 ± 0.03	0.13^{5} ± 0.11	3	7	3.5	3	2	2.5	2.5	4.5	0.5	2.5	2
37	*Strumigenys emmae* (Emery, 1890)	–	–	–	0.15 ± 0.12	0.01^{14} ± 0.01	–	–	0.5	15	–	–	–	–	–	–	1.5
38	*Tetramorium bicarinatum* (Nylander, 1846)	–	0.04 ± 0.01	0.03 ± 0.03	0.03 ± 0.02	0.02^{13} ± 0.01	4	3	2	3	–	–	4	–	3.5	1.9	–
39	*Tetramorium lanuginosum* Mayr, 1870	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5
40	*Tetramorium pacificum* Mayr, 1870	–	–	0.02 ± 0.02	0.09 ± 0.04	0.03^{12} ± 0.01	–	2	2.5	9	–	–	–	–	2	0.6	2.5
41	*Tetramorium pilosum* Emery, 1893	0.06 ± 0.04	0.02 ± 0.02	0.06 ± 0.03	0.07 ± 0.05	0.05^{10} ± 0.01	2	6	4.5	7	6	5	2.5	0.5	0.5	2.2	1.5
42	*Tetramorium walshi* (Forel, 1890)	0.05 ± 0.0	0.07 ± 0.02	0.05 ± 0.0	0.05 ± 0.01	0.06^{9} ± 0.01	7	5	5.5	5	5	7	3.5	–	–	2.7	–
43	*Tetramorium* sp. 1	–	–	0.02 ± 0.02	0.07 ± 0.02	0.02^{13} ± 0.0	–	2	2	7	–	–	–	–	2	0.4	0.5

Таблица 1 (окончание).
Table 1 (completion).

	Species Вид	Quadrat sampling Квадраты										Pitfall trapping Ловушки					Soil sifting Просеивание почвы
		MND, m^{-2}					Mean FNO%					Mean FWO%					Mean FWOss%
		September 2016 Сентябрь 2016	November 2016 Ноябрь 2016	February 2017 Февраль 2017	August 2017 Август 2017	Overall Среднее значение	September 2016 Сентябрь 2016	November 2016 Ноябрь 2016	February 2017 Февраль 2017	August 2017 Август 2017	Overall Среднее значение	September 2016 Сентябрь 2016	November 2016 Ноябрь 2016	February 2017 Февраль 2017	August 2017 Август 2017	Overall Среднее значение	June 2017 Июнь 2017
44	*Vollenhovia* sp. 1	–	–	–	0.04 ± 0.01	0.01^{14} ± 0.0	–	–	1	4	–	–	–	–	20	2.9	–
45	*Anochetus longifossatus* Mayr, 1897	0.04 ± 0.02	0.06 ± 0.03	–	–	0.04^{11} ± 0.01	6	–	4	–	4	1.5	1.5	–	–	0.8	1.5
46	*Anochetus madaraszi* Mayr, 1897	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
47	*Brachyponera luteipes* (Mayr, 1862)	0.03 ± 0.0	0.04 ± 0.01	0.05 ± 0.0	0.12 ± 0.07	0.04^{11} ± 0.03	4	5	4	12	3	5	5	–	4	3.7	–
48	*Diacamma rugosum* (Le Guillou, 1842)	–	–	–	0.04 ± 0.03	0.01^{14} ± 0.0	–	–	1	4	–	–	–	–		–	–
49	*Hypoponera confinis* (Roger, 1860)	–	–	0.09 ± 0.01	–	0.03^{12} ± 0.01	–	9	2.5	–	–	–	–	–	1.5	0.4	3.5
50	*Hypoponera* sp. 1	–	–	–	0.15 ± 0.0	0.01^{14} ± 0.01	–	–	1	15	–	–	–	–	0.5	0.5	–
51	*Leptogenys chinensis* (Mayr, 1870)	0.02 ± 0.02	0.02 ± 0.02	–	0.05 ± 0.0	0.03^{12} ± 0.01	2	–	2.5	5	2	1	0.5	–	–	0.5	–
52	*Leptogenys kraepelini* Forel, 1905	–	–	–	–	–	–	–	–	–	–	–	–	–	1	0.3	–
53	*Leptogenys* sp. 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
54	*Mesoponera melanaria* (Emery, 1893)	–	0.03 ± 0.0	0.06 ± 0.03	–	0.03^{12} ± 0.01	3	6	2.5	–	–	–	3.5	1.5	–	1.3	–
55	*Odontomachus simillimus* (Smith 1858)	0.21 ± 0.04	0.24 ± 0.04	0.25 ± 0.0	0.24 ± 0.15	0.22^{2} ± 0.07	24	25	22	24	21	25.5	23	20	7.5	21.5	7.5
56	*Ponera* sp. 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5

Note. Numbers given in superscripts with the Overall MND values show the rank of the mean nest density of each species.
Примечание. Числа, приведенные верхним индексом со средними значениями MND, показывают ранг вида по средней плотности гнезд.

was observed. Workers of *Anochetus madaraszi* Mayr, 1897, *Cryptopone testacea* Mayr, 1893, *Leptogenys* sp. 1, *Oocerea biroi* Forel, 1907, *Pheidole* sp. 7, *Ponera* sp. 1 and *Tetramorium lanuginosum* Mayr, 1870 were collected by the soil sifting only (Table 2).

Species richness and updated inventory of ants. Overall species richness observed by the quadrat method rose to 44 after pooling the ant taxa observed on the four occasions. Pitfall traps collected 19–29 species on each occasion and species richness recorded by the two methods was 48. Soil sifting alone resulted 28 species in 15 genera and 6 subfamilies. The updated preliminary inventory, 56 species in 32 genera of 6 subfamilies, Aneuretinae, Dolichoderinae, Dorylinae, Formicinae, Myrmicinae and Ponerinae, resulted from the survey is presented in Table 2.

Mean environmental conditions. Table 3 shows that mean values of environmental parameters slightly fluctuated throughout the study period. Higher soil temperature ($p < 0.05$), lower soil humidity ($p < 0.05$) and lower soil organic matter content ($p < 0.05$) than that observed on the other occasions were observed in February 2017. No significant association was evident ($p > 0.05$) between MND of *A. simoni* and each environmental parameter given in Table 3.

Discussion

The discovery of *A. simoni* nests in Lenagala Forest Reserve extends its distribution to Kegalle District in the Sabaragamuwa Province of Sri Lanka for the first time. The nest density of the species recorded at the study region of Lenagala Forest Reserve was higher than that recorded from Gilimale Forest [Jayasuriya, Traniello, 1985] and Indikada Mukalana Forest Reserve [Udayakantha, Dias, 2018] but lower than those observed at Kirikanda Forest [Dias et al., 2013], Kalugala Proposed Forest Reserve, Kuluna Kanda Proposed Forest Reserve, Wilpita "Aranya Kele" [Dias, Ruchirani, 2014] and Meethirigala Forest Reserve [Dias, Udayakantha, 2016]. Considerable MND values of the species observed throughout the study period had higher ranks among other ant species showing that it was a major component of the ant community in the study region.

The mean annual rainfall of Lenagala Forest Reserve, 2000–4000 mm lies within the range recorded by Jayasuriya and Traniello [1985] and that of its other habitats mentioned earlier. The range of elevation recorded for the species was 57 m [Dias, Udayakantha, 2016] to 592 m [Karunarathna, Karunaratne, 2013] and both Locality A (255 m) and Locality B (280 m) of Lenagala Forest Reserve are located within that range.

Values of air and soil temperature, litter depth and soil moisture content observed at Lenagala Forest Reserve (Table 3) were comparable with those recorded in Gilimale Forest Reserve [Dias, Perera, 2011], Sinharaja Forest Reserve [Perera et al., 2006], Kirikanda Forest [Dias et al., 2013], Meethirigala Forest Reserve [Dias, Udayakantha, 2016] and Indikada Mukalana Forest Reserve [Udayakantha, Dias, 2018] and lie within previously recorded range of each favourable parameter for *A. simoni* survival, above 2,000 mm annual rainfall, 21–30.2 °C air temperature, 20–28.3 °C soil temperature, 11.9–69% soil humidity and 0–6.5 cm of leaf litter depth [Udayakantha, Dias, 2018] although a higher soil organic matter content, 28.4%, than the favourable highest value reported earlier [24.9%, Udayakantha, Dias, 2018] was recorded at Lenagala Forest Reserve in August, 2017 and this finding extends the favourable 4.3–24.9% range to 4.3–28.4%.

Although similar types of microhabitats to that reported in other habitats of *A. simoni* such as hollow cavities of decaying fallen twigs, leaf litter, bark of rotting logs and superficial layer of soil [Wilson et al., 1956; Jayasuriya, Traniello, 1985; Dias, 2014; Udayakantha, Dias, 2018] and flat rock surfaces [Dias, Ruchirani, 2014] were observed at the region, a nest of the species was discovered at about 15 cm depth in the soil. The twigs of very small diameter, 0.3 mm, and decaying stems of Gyrinops walla Gaertn should also be added to the list of its nesting substrates.

Species observed throughout the study period at Lenagala Forest Reserve and common to the recently

Table 3. Mean value ± S.D. of each environmental parameter recorded at the selected region in Lenagala Forest Reserve on each sampling occasion.
Таблица 3. Среднее значение ± стандартное отклонение параметров окружающей среды, измеренных в изученном районе лесного заповедника Ленагала в каждый из периодов исследования.

Environmental parameter Параметр окружающей среды	September, 2016 Сентябрь 2016	November, 2016 Ноябрь 2016	February, 2017 Февраль 2017	August, 2017 Август 2017
Air temperature, °C Температура воздуха, °C	29 ± 0.0	28 ± 1.0	28 ± 0.0	28 ± 0.1
Soil temperature, °C Температура почвы, °C	23.3 ± 0.3	22.7 ± 0.7	25.5 ± 0.3	22.7 ± 0.7
Depth of leaf litter, cm Глубина листовой подстилки, см	3 ± 0.0	6 ± 0.0	5 ± 1.0	6 ± 0.0
Soil moisture% Влажность почвы, %	28.6 ± 5.6	36.9 ± 7.8	18.4 ± 3.8	36.9 ± 8.3
Soil organic matter content, % Содержание органических веществ в почве, %	21.2 ± 1.1	21.2 ± 1.2	15.1 ± 3.3	21.2 ± 7.2
Monthly rainfall (mm)* Среднемесячные осадки, мм*	221	331	11.5	173

Note. * – data from Meteorological Department, Colombo, Sri Lanka.
Примечание. * – данные Метеорологического департамента, Коломбо, Шри-Ланка.

reported habitats of *A. simoni*, Indikada Mukalana Forest Reserve in Colombo District of the Western Province and Lenagala Forest Reserve in Kegalle District of Sabaragamuwa Province, *Technomyrmex albipes*, *T. bicolor* Emery, 1893, *Pheidole noda* Smith, 1894, *Ph. fervens* Smith, 1858, *Solenopsis* sp. 1, *Strumigenys emmae* Emery, 1890, *Tetramorium pilosum* Emery, 1893, *T. walshi* Forel, 1890, *Brachyponera luteipes* (Mayr, 1862) and *Odontomachus simillimus*, were permanent inhabitants that coexisted with *Aneuretus simoni* in the study region. The other species observed on all occasions at Lenagala Forest Reserve, *Anoplolepis gracilipes*, can be considered a permanent inhabitant at the forest but it was never observed in Sinharaja Forest Reserve [Perera et al., 2006] or Indikada Mukalana Forest Reserve [Udayakantha, Dias, 2018], two previously recorded *Aneuretus simoni* habitats. Soil sifting was useful for sampling workers of *Anochetus madaraszi*, *Cryptopone testacea*, *Leptogenys* sp. 1, *Oocerea biroi*, *Pheidole* sp. 7, *Ponera* sp. 1 and *Tetramorium lanuginosum* whereas pitfall traps were useful in collecting *Camponotus carin*, *Dilobocondyla* sp. 1, *Crematogaster* sp. 1 and *Leptogenys kraepelini* that were not collected by other two methods. Fifty-six ant species including dominant *Anoplolepis gracilipes* and *Odontomachus simillimus* in 33 genera of 6 subfamilies recorded at the selected region of Lenagala Forest Reserve can be considered the first updated ant inventory of the forest.

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