DOI : 10.5958/0974-4576.2020.00078.X

©MPH J. ent. Res., 44 (3) : 469-474 (2020)

Altitudinal gradients of ant species diversity (Hymenoptera: Formicidae) in Mount Talang, West Sumatra, Indonesia

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ABSTRACT

The present study adds a novel perspective on Sumatran ant fauna by providing the information on its diversity across an altitudinal gradient in Mount Talang, a mountain in West Sumatra Province. A standardized sampling method of Quadra Protocol was applied at three altitudes (1,500, 2,000 and 2,500 m elevation). A total of 408 ant individuals collected in the study were identified to belong to 27 species in 19 genera of nine tribes and five subfamilies. Myrmicinae was the subfamily with the largest number of species collected (14 species), followed by Formicinae (six species), Dolichoderinae, and Ponerinae (three species in each), and a single species of an army ant from subfamily Dorylinae. The number of ant species decreases with altitude inclination; 19 species were recorded at 1,500 m elevation, ten at 2,000 m, and only three at 2,500 m.

Key words : Altitudinal gradient, ants, diversity, Mount Talang, West Sumatra.

INTRODUCTION

Ants are abundant in most terrestrial ecosystems and play various ecological roles, such as predators (Brady *et al*., 2014), decomposers (Ramón and Donoso, 2015) and herbivores (Holldobler and Wilson, 1990). They inhabit various habitats in different altitudes, from lowland to highland. Highland habitats are generally limited by abiotic factors such as temperature and humidity, and subsequently by biotic factors, mainly the vegetation. Ant communities are structurally and functionally affected by their ability to respond to environmental stresses, which may limit their productivity, as well as to disturbances that possibly reduce their environmental biomass. The primary stressors (e.g., temperature, nest site availability, and food supply) structurally influence ant communities the most (Andersen, 2007). Altitudinal gradients, with different environmental stressors, will also affect the structure of certain ant communities.

Ants as biotic components in mountainous areas have been reported across the globe, such as from Mt. Espinchaco in Brazil (Araujo and Fernandes, 2013), Mt. Kinabalu in Borneo Island (Bruhl *et al*., 1999) and the Himalayas (Bharti *et al*., 2013). Sumatra Island in Indonesia has many high mountains, and with its mountainous ant fauna as prominent research objects. The studies on Sumatran ants have been so far undertaken to those in banana plantation (Herwina, *et al*., 2013) and those in the campus of Universitas Andalas (Satria *et al*., 2015; Herwina, *et a*l., 2018) and at Conservation forest and oil palm plantation (Herwina, *et al*., 2020). The present study will add a novel perspective to Sumatran ant fauna by providing the information on ant diversity across an altitudinal gradient in Mount Talang, one among several high mountains in West Sumatra (Fig. 1).

MATERIALS AND METHODS

The field research was conducted at Mount Talang (0.98°S 100.68°E, 2,597 m elevation) in Solok Regency, West Sumatra Province, Indonesia. The samplings were performed on 18 and 19 February 2017 along the hiking trail from Aia Batumbuak Village up to the summit. The sampling sites were set at 1,500 m elevation (1.02°S*,* 100.67°E*)*, 2,000 m elevation (1.99°S*,* 100.68°E*)* and 2,500 m elevation (1.98°S*,* 100.67°E*)* along the trail. Vegetation, temperature, and humidity were recorded at the sampling of ants (Table 2; Fig. 2).

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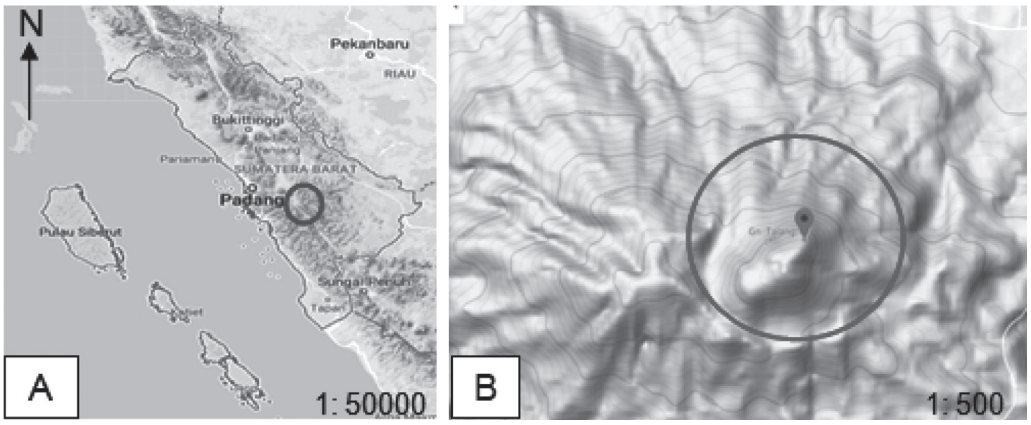

Fig. 1. Study site at Mt. Talang, West Sumatra Province: (A) West Sumatra, (B): Mt. Talang (Google Maps, 2018).

The sampling site at 1,500 m elevation was an agricultural area, mainly produces onion, radish, and tea; it has been severely affected by frequent human interferences within the agricultural process. The sampling site at 2,000 m elevation was a moist tropical mountainous forest composed of trees mainly identified from Euphorbiaceae (*Macaranga* spp.), Moraceae (*Ficus* spp.) and Myrtaceae (*Syzigium* spp.) (Mukhti *et al*., 2012); it receives less human interferences by having only been used as a shelter for mountain hikers. The sampling site at the highest elevation (2,500 m) was the summit area which comprised of limestones covered with lichens and mosses and interspersed with dense grasses and *Anaphalis* wildflowers. The area is mild to moderately affected by human interference through camping activity, especially during holiday seasons.

Ant Sampling : Ants were sampled using the standardized Quadra Protocol (Yamane and Hashimoto, 2001), which consists of the following four methods: honey-baited trapping, soil sampling, leaf litter sifting, and hand collecting (Hashimoto *et al*., 2001). The protocol was deployed through 180 m, the line transect established in each sampling site. Each transect was purposely divided into three equal 60 m sub-transects to accommodate the sampling on rough mountainous terrain.

Ant identification : Ant specimen was brought to the Laboratory of Animal Taxonomy at Universitas Andalas, where the identification was guided using proper references, such as Bolton (1994), Bolton (2016), and Hashimoto (2003). Specimen collection in the Universitas Andalas Repository curated by the first author (Henny Herwina) was also used to assist the identification. The generic name followed by specific code (given as “sp. of HH”) was deployed whenever the identification is uncertain or vague.

Data analysis : The Shannon-Wiener index (*H’*) was used to calculate the ant diversity index (Magguran, 2004):

$$H' = -\sum_{i=1}^{n} pi \ln pi$$

where

p_i = proportion of individuals belong to species *i*.

RESULTS AND DISCUSSION

A total of 408 ant individuals collected in this study were identified into 27 species of 18 genera in five

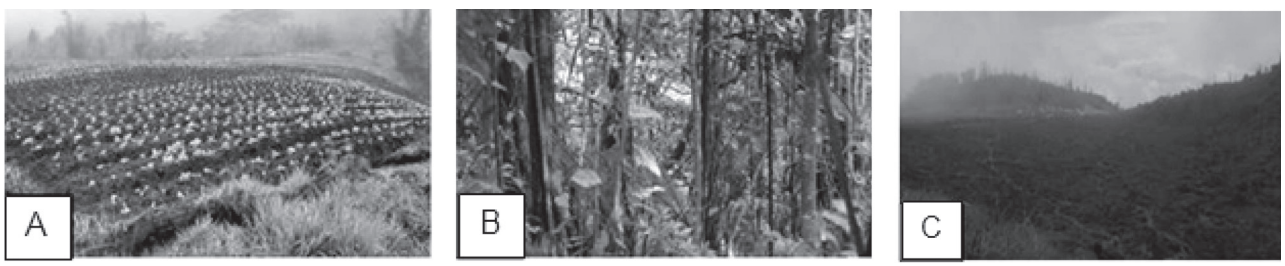

Fig. 2. Habitat at sampling sites in three different elevations of Mt. Talang West Sumatra: (A) 1,500 m a.s.l. horticulture area, (B) 2,000 m a.s.l. forest area, (C) 2,500 m a.s.l. rocky area.

subfamilies (Table 1). Myrmicinae was subfamily with the largest number of species collected (14 species, 52% of the total number of species), followed by Formicinae (six species, 22%), Dolichoderinae (three species, 11%) and Ponerinae (three species, 11%) while Dorylinae only represented by one species, *Dorylus laevigatu*s that was collected at 1,500 m. The subfamily Myrmicinae is known as the taxon with numerous members with vast distribution ranges (Shattuck, 1999; Bolton, 2016; Antwiki, 2017). On the present knowledge, this subfamily has been massively recorded (individual or species number) in the Himalayas (Bharti *et al*., 2013), Bogor Botanical Gardens in Bogor, Java (Herwina and Nakamura, 2007), South Maninjau Nature Reserve, West Sumatra (Septriani *et al*., 2016). Due to its subterranean habit that forages underground (Weissflog *et al*., 2000), Dorylinae was collected only by leaf lifter sifting and soil core method within the Quadra Protocol. At the genus level, some genera such as *Pheidole* (Myrmicinae) and *Nylanderia* (Formicidae), were represented with only five and three species, respectively. Albeit, these two genera are known for their vast distribution across geographical and altitudinal boundaries, as well as inhabit various habitats (Bruhl *et al*., 1999; Bharti *et al*., 2013).

Among the study sites, the highest species diversity was observed at the site 1,500 m elevation (*H'* = 2.37), seconded by 2,000 m elevation (*H'* = 1.03) and 2,500 m (*H'* = 0.53). The number of recorded species

Table 1. Species, subfamily and number of individuals of ants (Formicidae) collected at three different elevations in Mt. Talang, West Sumatra.

Species	Number of ant individuals collected							
	Total	At each elevation (m)			In each sampling method*			
		1,500	2,000	2,500	BT	HC	LS	SS
Subfam. Dolichoderinae	15	6	9			12	3	
Tribe Dolichoderini	10	1	9			7	3	
Dolichoderus tuberifer Emery, 1887	7	1	6			4	3	
Dolichoderus sp. 3 of HH	3		3			3		
Tribe Tapinomini	5	5				5		
Tapinoma melanocephalum (Fabricius, 1793)	5	5				5		
Subfam. Dorylinae	4	4					2	2
Tribe Dorylini	4	4					2	2
Dorylus laevigatus (F. Smith, 1857)	4	4					2	2
Subfam. Formicinae	175	33	1	141	157	12	4	2
Tribe Camponotini	3	3				3		
Camponotus odiosus (Forel, 1886)	1	1				1		
Polyrhachis abdominalis F. Smith, 1858	1	1				1		
Polyrhachis dives F. Smith, 1857	1	1				1		
Tribe Plagiolepidini	172	30	1	141	157	9	4	2
Nylanderia sp. 1 of HH	2	2			2			
Nylanderia sp. 2 of HH	1		1		1			
Nylanderia sp. 8 of HH	169	28		141	154	9	4	2
Subfam. Myrmicinae	208	105	78	25	177	7	9	15
Tribe Attini	144	69	75		136	1	4	3
Pheidole plagiaria F. Smith, 1860	1	1					1	
Pheidole quadrensis Forel, 1900	123	53	70		118	1	1	3
Pheidole sp. 3 of HH	2	2					2	
Pheidole sp. 17 of HH	5		5		5			
Pheidole sp. 18 of HH	13	13			13			

Contd...

Table 1 contd...

Species	Number of ant individuals collected							
	Total	At each elevation (m)			In each sampling method*			
		1,500	2,000	2,500	BT	HC	LS	SS
Tribe Crematogastrini	55	27	3	25	32	6	5	12
Carebara cf. *affinis* (Forel, 1915)	7	7					2	5
Crematogaster modiglianii Emery, 1900	13	13			7	6		
Myrmecina sp. 1 of HH	5		1	4	4			1
Myrmecina sp. 3 of HH	1		1					1
Lophomyrmex bedoti Eemery, 1983								
Tetramorium lanuginosum Mayr, 1870	22		1	21	21			1
Tribe Paratopulini	1	1			1			
Paratopula sp. 1 of HH	1	1			1			
Tribe Solenopsidini	8	8			8			
Monomorium florica (Jerdon, 1851)	1	1			1			
Myrmicaria brunnea Saunders, 1842	7	7			7			
Subfam. Ponerinae	6	1	5			3		3
Tribe Ponerini	6	1	5			3		3
Leptogenys parvula Emery, 1900	3		3					3
Odontomachus latidens Mayr, 1867	1	1				1		
Ponera sp. 2 of HH	2		2			2		

*Sampling method: BT= honey bait trap, HC = hand collection, LS = leaf litter sifting, SS = soil core method.

Table 2. Recorded biotic and abiotic factors during ant sampling at three different elevations in Mt. Talang, West Sumatra.

Elevation (m, a.s.l)	Coordinate	Temperature (°C)	Humidity (%)	Dominant vegetation
1500	100.67 E, 1.02 S	24	83	Commercial crops such as onion, radish, tea, mixed with shrubs and ferns (Pteridophyts).
2000	100.68 E, 1.99 S	20	94	Trees from Euphorbiaceae (*Macaranga* spp.), Moraceae (*Ficus* spp.), and Myrtaceae (*Syzigium* spp.)
2500	100.67 E, 1.98 S	17	89	Mixed shrubs, comprised mainly from mosses (Bryophyt), grasses (Gramminae) and wild flowers *Anaphalis* spp.

decreased with the increasing of elevation; 19 species were collected at 1,500 m elevations before decreased to ten at 2,000 m and continued to a significant reduction of three species at 2,500 m elevation. These results are in concordance with previous observation at the Himalayas (Bharti *et al.*, 2013), where the harsher condition at the higher elevation of a mountain area potent to lower the diversity of ants. Species composition was somewhat unique to each site, with few species such as *Nylanderia* sp. 8 and *Pheidole quadrensis* were abundantly occurred at two sites. Fifteen species were recorded only at 1,500 m elevation (Table 1). This site was rich with horticultural plants, such as onion, radish, tea, and other commercial crops; all together with favorable abiotic factors, microhabitats, and human interferences, created a variety of habitats suitable for diverse ant species. Species composition within certain habitat correlates to abiotic factors, availability of food source and nesting sites, in addition to the existence of mutualist or competitor species (Crist, 2009).

Lophomyrmex bedoti, *Monomorium floricola*, *Myrmicaria brunnea* and *Tapinoma melanocephalum*, (observed in this study) were previously recorded at 500 - 1,000 m a.s.l elevation in the Himalayas (Bharti *et al*., 2013). Although the geo-historical processes for the establishment of such disjunct of ant distribution pattern need further studies, from an ecological standpoint, similar environmental conditions such as climate,

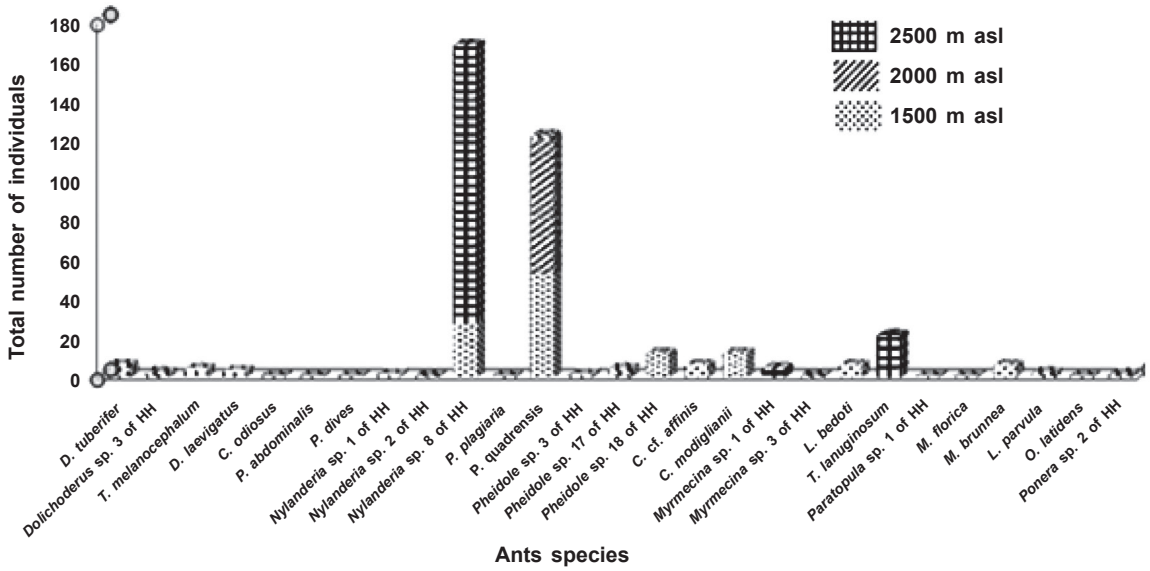

Fig. 3. Distribution of ant individual collected with Quadra Protocol at three different elevations in Mt. Talang, West Sumatra.

altitude, and type of substrates between two separated areas, along with ant species adaptability to specific altitudes may allow such species to occur in both areas. *Tapinoma* and *Monomorium* are an indicator of the ongoing disturbance in the habitats (Narendra *et al*., 2011; Bharti *et al*., 2013). *Nylanderia* sp. 8 was found at both 1,500 m and 2,500 m elevation while *Pheidole quadrensis* observed at 1,500 m and 2,000 m elevation. *Myrmecina* sp. 1 and *Tetramorium lanuginosum*, were collected from 2,000 m and 2,500 m elevation. Variability of vegetation and microhabitat conditions in a given elevation, mixed with the adaptability of ant species to a wider range of environmental conditions, might result in species occurrence across different elevational sites.

Nylanderia sp. 8 of HH, with its 169 individuals collected, became the most abundant species in Mt. Talang, either at 1,500 m (28 individuals) or at 2,500 m elevation (141 individuals) (Fig. 3). This observation may indicate that this species more dominates at higher elevations. *Nylanderia* ants are thought to be adaptive to various habitats, including plantation, urban, and forest areas, as it has been always recorded in these habitats (Herwina, unpubl data, 2018). Five ant species were collected only at 2,000 m, *i.e. Dolichoderus* sp. 3, *Leptogenys parvula*, *Myrmecina* sp. 3, *Nylanderia* sp. 2 and *Pheidole* sp. 17. *Tetramorium lanuginosum*, which occurred at 2,000 m and 2,500 m elevation was previously recorded at similar altitudes in the Himalayas (Bharti *et al*., 2013). This finding may similarly, from an ecological standpoint, have a similar explanation with phenomena observed at the 1,500 m elevation. Honey-baited trapping collected 12 species while the hand collecting, soil sampling, and leaf lifter sifting obtained respectively 11, nine and eight species. The Quadra protocol is effective to study diversity and species composition of ants (Hashimoto *et al*., 2001; Eguchi and Yamane, 2003; Fukumoto *et al*., 2014). Each method in the protocol contributes to collecting the diverse habits of ant species while also complementing each other's shortage; this was confirmed in the present study, as quite a few species (such as those from Formicinae and Ponerinae) were collected only through one of the four methods. The two most abundant species were collected by all the methods in the Quadra Protocol (*Nylanderia* sp. 8 of HH and *Pheidole quadrensis*).

ACKNOWLEDGEMENTS

This research was financed by collaborative grants from 1) The Minister of Research, Technology, and Higher Education of the Republic of Indonesia through the International Collaboration and Publication Project year 2016 to 2018 with contract no: 050/SP2H/LT/DPRM2018,2) Universitas Andalas Research Funding with contract no: T/16/UN.16.17/PP.OK-KRP2GB/LPPM/2019 (Team Leader: Henny Herwina) and 3) the Program of Scheme of Academic Mobility and Exchange (SAME) 2019 at Ibaraki University (Host partner: Junichi Kojima).

REFERENCES

Andersen, A.N. 2007. Ant diversity in arid Australia: a systematic overview. ***In***: Snelling, R.R., Fisher B.L. and Ward, P.S. (Eds). *Advances in ant systematics*

(*Hymenoptera: Formicidae*): *homage to Wilson EO-50 years of contributions*. Memoirs of the American Entomological Institute, **80**: 19-51.

Antwiki. 2017. Antwiki at: http://www.antwiki.org/wiki/Indonesia/ downloaded on 28 of November 2017.

Araujo, M.L. and Fernandes, G.W. 2003. Altitudinal patterns in a tropical ant assemblage and variation in species richness between habitats. *Lundiana,* **4**: 103-109.

Bharti, H., Sharma, Y.P., Bharti, M. and Pfeiffer, M. 2013. Ant species richness, endemicity and functional groups, along an elevational gradient in the Himalayas. *Asian Myrmecology*, **5**: 79-101.

Bolton, B. 1994. *Identification guide to the genera of the World*. Harvard University Press, London.

Bolton, B. 2016. *AntCat.org:an online catalog of the ants of the world* at http://antwiki.org/ downloaded on 26 of October 2017.

Brady, S.G., Fisher, B.L., Schultz, T.R. and Ward, P.S. 2014. The rise of army ants and their relatives: diversification of specialized predatory doryline ants. *BMC Evol. Biol.*, **14**: 93. https://bmcevolbiol.biomedcentral.com/articles/10.1186/1471-2148-14-93

Bruhl, C.A., Mohamed, M. and Linsenmair, K.E. 1999. Altitudinal distribution of leaf litter ants along a transect in primary forests on Mount Kinabalu, Sabah, Malaysia. *J. Trop. Eco.*, **15**: 265-77.

Crist, T.O. 2009. Biodiversity, species interactions, and functional roles of ants (Hymenoptera: Formicidae) in fragmented landscapes: a review. *Myrmecological News,* **12**: 3-13.

Eguchi, K. and Yamane, S. 2003. Species diversity of ants (Hymenoptera, Formicidae) in a lowland rainforest, Northwestern Borneo. *New Entomol.*, **52**: 49-59.

Fukumoto, S., Satria, R., Maeda T. and Yamane, S. 2014. Ant fauna of Gaja-jima, Tokara Islands, southwestern Japan. *Nature of Kagoshima*, **40**: 127-31 (in Japanese).

Google Maps. 2018. Location of Talang Mountain. Downloaded from *https://www.google.co.id/maps/place/Gn.+Talang/@-0.9800467,100.6815933,491m/data=!3m1!1e3!4m5!3m4!1s0x2e2b4c6da50bd541:0x3f6bd78d294269f5!8m2!3d-0.9761111!4d100.6838889!5m1!1e4* on 29 of August 2018.

Hashimoto, Y. 2003. Identification guide to the ant subfamily of Borneo*, Tools for monitoring soil biodiversity in the ASEAN region*. Darwin Initiative, UK.

Hashimoto, Y., Yamane, S. and Mohamed, M. 2001. How to design an inventory method for ground-level ants in Tropical Forest. *Nature and Human Activities*, **6**: 25-30.

Herwina, H. and Nakamura, K. 2007. Ant species diversity using pitfall traps in a small yard in Bogor Botanic Garden, West Java, Indonesia. *Treubia,* **35**: 1-141.

Herwina, H., Nasir, N., Jumjunidang and Yaherwandi. 2013. The composition of ant species on banana plants with Banana Bunchy-top Virus (BBTV) symptoms in West Sumatra, Indonesia. *Asian Myrmecology*, **5**: 151-61.

Herwina, H., Satria, R., Yaherwandi and Sakamaki Y. 2018. Subterranean ant species diversity (Hymenoptera: Formicidae) in Educational and Biological Research Forest of Universitas Andalas, Indonesia. *J. Ent. and Zool. Stud.*, **6**: 1720-24.

Herwina, H, Sakamaki, Y., Satria, R. and Janra, M.N. 2020. Ground-dwelling ant species diversity (Hymenoptera: Formicidae) at conservation forest and oil-palm plantation in Sumatra, Indonesia. *J. ent. Res.*, **44**: 11-19.

Holldobler, B. and Wilson, E. 1990. *The Ants*. Belknap Press. Harvard University Cambridge.

Magguran, A.E. 2004. *Measuring Biological Diversity*. Blackwell Science Ltd., UK.

Mukhti, R.P., Syamsuardi and Chairul. 2012. Species of Balanophoraceae in West Sumatra. *J. Bio. UA*, **1**: 15-22.

Narendra, A., Gibb, H. and Ali, T.M. 2011. Structure of ant assemblages in Western Ghats, India: role of habitat, disturbance and introduced species. *Insect Conserv. and Divers.,* **4:** 132-141

Ramón, G. and Donoso, D.A. 2015. The role of ants (Hymenoptera: Formicidae) in forensic entomology. *REMCB,* **36**: 19-26.

Satria, R., Kurushima, H., Herwina, H., Yamane, S. and Eguchi, K. 2015. The trap-jaw ant genus *Odontomachus Latreille* (Hymenoptera: Formicidae) from Sumatra, with a new species description. *Zootaxa.,* **4048**: 1-36.

Septriani, S., Herwina, H. and dan Mairawita. 2016. Ant subfamily Myrmicinae at maninjau utara selatan natural reserve, Agam district, West Sumatra. *J. Bio. UA*, **4**: 91-95.

Shattuck, S.O. 1999. *Australian ants: Their biology and identification.* CSIRO publishing, Australia.

Weissflog, A., Sternheim, E., Dorow, W.H.O., Berghoff, S. and Maschwitz, U. 2000. How to study subterranean army ants: a novel method for locating and monitoring field populations of the South East Asian army ant *Dorylus* (*Dichthadia*) *laevigatus* Smith, 1857 (Formicidae, Dorylinae) with observations on their ecology. *Insectes Socia ux,* **47**: 317-24.

Yamane, S. and Hashimoto, Y. 2001. Standardised sampling methods: the Quadra Protocol. *Ant Newslett.,* **3**: 16-17.

(Received : March 20, 2020; Accepted : July 30, 2020)