Myrmecological News

myrmecologicalnews.org

Myrmecol. News 29

Digital supplementary material

Digital supplementary material to

ALCANTARA, M.J.M., MODI, S., LING, T.C., MONKAI, J., XU, H., HUANG, S. & NAKAMURA, A. 2019: Differences in geographic distribution of ant species (Hymenoptera: Formicidae) between forests and rubber plantations: a case study in Xishuangbanna, China, and a global meta-analysis. – Myrmecological News 29: 135-145.

Supplementary Results

Meta-analysis of geographic distribution of ant species from papers published in SCI-listed journals

We found eight papers published in SCI-listed journals and whose taxonomic identifications were done or validated by taxonomist/s. A total of 242 described species were used in the analysis, 175 from primary forests, 41 from secondary forests and 125 from rubber plantations. Primary and secondary forest species had significantly smaller geographic distribution, and rubber plantation species had the largest ($F_{(2,338)}$ = 7.59, $P < 0.001$; Tab. S6). The results of subsampling 125 species from rubber plantations and primary forests showed significant differences in geographic distribution between primary forests and rubber plantations ($P = 0.001$). The number of ant species became smaller when only habitat specialist species were included in the analysis (94 species in primary forests, 9 in secondary forests, and 57 in rubber plantations). Species restricted to primary forests had the smallest range, followed by the secondary forest specialists and rubber plantation specialists ($F_{(2,157)} = 11.5$, $P < 0.001$; Tab. S6). The results of subsampling 57 species from rubber plantations and primary forests returned significant differences in ant distributions ($P = 0.001$).

A total of 207 species, 154 from primary forests, 39 from secondary forests, and 92 from rubber plantations were used for the analysis excluding exotic species (as classified in antmaps.org). Ninety-three species were restricted only within primary forests, nine in secondary forests only and 43 in rubber plantations only. For both all species and habitat specialist species datasets, primary forest ants had the smallest geographic distribution, followed by secondary forest ants and rubber plantation ants ($P = 0.045$, 0.007, respectively; Tab. S6). However, subsampling equal number of ant species from primary forests and rubber plantations showed no significant difference in ant geographic distribution for both datasets ($P_{(\text{all species})} = 0.323$; $P_{(\text{specialists})} = 0.180$; Tab. S6).

Five studies were used for the Old World region dataset. A total of 169 species were documented, 135 in primary forests, 30 in secondary forests and 95 in rubber plantations. Primary and secondary forest species had significantly narrower geographic distributions than rubber plantation species ($F_{(2,257)} = 7.77$, $P < 0.001$; Tab. S6). The results of subsampling 95 species from two habitat types still showed significant differences in geographic distribution between primary forests and rubber plantations ($P = 0.006$). When we analyzed only habitat specialist species, primary forests still had the highest number of species (59 species) followed by rubber plantations (31 species) and secondary forests (3 species). Habitat specialist species from primary forests had narrower geographic distributions than species from rubber plantations ($F_{(1,88)} = 15.3$, $P < 0.001$; Tab. S6). Subsampling 31 species also showed that primary forest ants have significantly smaller geographic distributions than rubber plantation ants ($P = 0.003$).

When we analyzed only native species, we found a total of 142 species for the Old World regions, 116 from primary forests, 29 from secondary forests and 69 from rubber plantations. Ant species from the three habitats had similar geographic distributions ($P = 0.06$) and subsampling the same number of species from rubber plantations and primary forests did not show significant difference in ant geographic distribution ($P = 0.541$; Tab. S6). We found 58 native species restricted in the primary forests, only three secondary forests and 23 in rubber plantations. Primary forest ants had smaller geographic distribution than rubber plantation ant species ($P = 0.04$; Tab. S6). Subsampling equal number of species from the two habitats did not show significant differences in ant geographic distribution ($P = 0.57$; Tab. S6).

Meta-analysis of geographic distribution of ground ants

We used 15 papers which conducted sampling in the ground stratum only. A total of 311 described species were used in the analysis, 210 from primary forests, 73 from secondary forests and 159 from rubber plantations. Primary forest had significantly smaller geographic distribution than secondary forest and rubber plantation species ($F_{(2,439)} = 6.79$, $P = 0.001$; Tab. S6). The results of subsampling 159 species from rubber plantations and primary forests showed revealed wider geographic distributions of rubber plantation ants ($P < 0.001$). A total of 212 habitat specialists (118 in primary forests, 17 in secondary forests, and 77 in rubber plantations) were found. Species restricted to primary forests had the smallest range, followed by the secondary forest specialists and rubber plantation specialists ($F_{(2,209)} = 8.062$, $P < 0.001$; Tab. S6). The results of subsampling 77 species from rubber plantations and primary forests returned significant differences in ant distributions ($P < 0.001$).

Similar patterns were observed for the Old World dataset. A total of 246 species were documented, 173 in primary forests, 66 in secondary forests and 132 in rubber plantations from 13 studies. Primary forest species had smallest geographic distribution, followed by secondary forest and rubber plantation ants ($F_{(2,368)} = 5.28$, $P = 0.005$; Tab. S6). Habitat specialist ants from primary forests also had smallest distribution, followed by secondary forest and rubber plantations ants ($F_{(2,147)} = 5.538$, $P = 0.005$; Tab. S6). Subsampling equal number of ants from primary forests and rubber plantations also showed wider distribution of rubber plantation ants ($P_{(\text{all species})} = 0.005$; $P_{(\text{specialists})} = 0.021$; Tab. S6).

However, when only native species were analyzed, no difference in ant geographic distributions was detected regardless of the dataset (all vs habitat specialists; all geographic areas vs Old World only). Subsampling using only native species also did not detect differences in ant geographic distributions (see Tab. S6).

Supplementary Tables

Tab. S1: Comparisons of the mean number of regions occupied by ants from different microhabitats (arboreal vs ground) in Xishuangbanna Tropical Botanical Garden (XTBG). Mean number of occupied regions are shown for two classes of ants: all species and habitat specialist species only. Superscript letters indicate results of Tukey's post-hoc test when ANOVA results returned significant *P* values (in bold). Total numbers of ant species are shown enclosed in parentheses.

Dataset	Mean number of regions occupied by ants			ANOVA results (*P* value)
Arboreal ants only	Rainforest	Limestone forest	Rubber plantation	
All species (10 spp.)	19.8 (5 spp.) [a]	18.0 (2 spp.) [a]	114.5 (4 spp.) [b]	**0.007**
Habitat specialists (9 spp.)	17.0 (4 spp.) [a]	15.3 (1 spp.) [a]	114.5 (4 spp.) [b]	**0.002**
Ground ants only	Rainforest	Limestone forest	Rubber plantation	
All species (36 spp.)	17.3 (26 spp.)	25.6 (18 spp.)	45.6 (10 spp.)	0.218
Habitat specialists (22 spp.)	13.0 (13 spp.)	39.0 (4 spp.)	64.0 (5 spp.)	0.124

Tab. S2: Summary of the published studies from which data was extracted for the meta-analysis of ant geographic distribution patterns. The list shows where (locality, habitat types and microhabitats) and how (sampling methods) the studies were conducted. Quality of the data and key findings of each study are also shown.
# indicates that the paper was written in Chinese.
* unless clearly stated, all 'forest' sites were classified as primary forests.
† "OK" indicates that the paper was published in an SCI-listed journal and taxonomic identification was validated by taxonomists, "Grey" indicates that the paper was published in a non-SCI listed journal, and "ID?" indicates that the taxonomic identification was not validated by taxonomists.

Article	Country, Location	Habitat types*			Microhabitat		Methods				Data quality†	Key findings
		Rubber plantation	Secondary forest	Primary forest	Ground	Arboreal	Winkler	Pitfall	Hand	Bait		
Zhang *et al.* 2015. *Chinese J. of Ecology* #	China, Chengmai County, Hainan	Yes	No	No	No	Yes	No	No	Yes	No	Grey ID?	Competition between two dominant ant species drives aggregated distribution patterns of arboreal ant species.
Song *et al.* 2014. *J. of West China Forestry Science* #	China, Nangun River Nature Reserve	Yes	No	Yes	Yes	No	No	No	Yes	No	Grey	Comparable number of ant species in rubber plantation but different dominant species from natural forests.
Zhang *et al.* 2013 *Acta Entomologica Sinica* #	China, Luchun County	Yes	Yes	No	Yes	No	Yes	No	No	No	Grey ID?	Reduced richness and abundance and different assemblage composition in rubber.
Meng & Gao 2007 *Chinese J. of Ecology* #	China, Bubeng, Yunnan	No	No	Yes	Yes	No	No	Yes	No	No	Grey ID?	Different community structure of ants among the different habitat types.
Yang *et al.* 2001. *Acta Ecol. Sin.* #	China, Xishuangbanna	No	No	Yes	Yes	No	No	Yes	No	No	Grey ID?	Lower ant diversity in fragmented (they are protected for religious

												reasons) compared with continuous forests.
Zhang *et al.* 2000. *Zool. Res.* [#]	China, Xishuangbanna	No	No	Yes	Yes	No	No	Yes	No	Yes	Grey ID?	Different common ant species among the rainforests at different locations.
Xu *et al.* 1999a. *Zool. Res. 20:2* [#]	China, Xishuangbanna	Yes	No	Yes	Yes	Small trees	No	No	Yes	No	Grey	Highest ant species diversity in primary forests and lowest in tea plantation.
Xu *et al.* 1999b. *Zool. Res. 20:4* [#]	China, Xishuangbanna	No	No	Yes	Yes	Small trees	No	No	Yes	No	Grey	Significant effects of isolation on ant communities of fragmented forests.
Xu *et al.* 1999c. *Zool. Res. 20:5* [#]	China, Xishuangbanna	No	Yes	Yes	Yes	Small trees	No	No	Yes	No	Grey	Lower species richness in secondary forests than primary forests.
Xu *et al.* 1999d. *Zool. Res. 20:6* [#]	China, Xishuangbanna	Yes	No	Yes	Yes	Small trees	No	No	Yes	No	Grey	Estimated the biomass of ants in Xishuangbanna. Lower ant density in rubber plantation than other habitats.
Liu *et al*. 2016. *Ecol. Monogr.*	China, Xishuangbanna	Yes	No	Yes	Yes	No	Yes	No	No	No	OK	Reduced species richness and simplified assemblage in rubber.
Liu *et al*. 2015. *ZooKeys*	China, Xishuangbanna	Yes	Yes	Yes	Yes	Lower vegetation and tree trunks	Yes	No	Yes	No	OK	Only inventory, no analysis conducted.
Shen *et al.* unpublished	China, Xishuangbanna	Yes	No	Yes	Yes	No	Yes	No	No	No	Grey ID?	Reduced species richness and different assemblages in rubber.

Thongphak & Kulsa 2014. *IJERD*	Thailand, Chulaborn Dam, Chaiyaphum	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Grey ID?	Reduced species richness and different assemblages in rubber.
Watanasit & Nhu-eard 2011. *Songklanakarin J. Sci. and Technol.*	Thailand, Songkhla Province	Yes	No	No	Yes	No	Yes	No	Yes	Yes	Grey	Lower species richness in homogeneous than heterogeneous rubber plantations but both sites dominated by *Pheidole* and *Crematogaster* spp.
Bickel & Watanasit 2005. *Songklanakarin J. Sci. and Technol.*	Thailand, Songkhla Province	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Grey	Reduced overall species richness in rubber; native species replaced by tramps.
Hosoishi *et al.* 2013. *Asian Myrmecol*	Cambodia, Kampong Cham	Yes	No	No	Yes	Understory vegetation at 0.5 to 2.0 m above ground	Yes	No	Yes	No	OK	Overall species richness similar in young, mid-aged and old rubber. *Oecophylla smaragdina* found in 50% of the samples. Rare occurrences of cryptic species in old plantations.
Rubiana *et al.* 2015. *Asian Myrmecol*	Indonesia, Jambi province, Sumatra	Yes	No	Yes	Yes	Tree trunks	No	No	Yes	Yes	OK	Similar species richness but different assemblages between jungle rubber and rubber plantations.
Room 1975 *Aust. J. Zool.*	Northern Papua New Guinea, Popondetta	Yes	No	Yes	Yes	No	No	No	No	Yes	OK	Similar species richness and assemblages.
Paul *et al.* 2016. *Bull. Env.*	India, Machad region, Kerala state	Yes	No	No	Yes	No	No	Yes	Yes	Yes	Grey	Low overall richness in rubber.

Pharmacol. Life Sci.												
Thomas & Aswathi 2012. *J. Biopest*	India, Calicut	Yes	No	No	Yes	No	No	Yes	No	Yes	Grey	Low species richness and abundance in rubber.
Resende *et al.* 2013. *Sociobiology*	Brazil, Michelin Ecological Reserve, Bahia	Yes	Yes	Yes	No	Tree trunks	No	No	No	Yes	OK	Similar species richness but different assemblages in mixed coffee-rubber systems.
Silva *et al.* 2007. *For. Ecol. Manage*.	Brazil, Southern Atlantic Forest	No	No	Yes	Yes	No	Yes	No	No	Yes	OK	Loss of species and distinct assemblages in secondary versus primary forest. Most species in secondary forests were generalists.
Sanabria *et al.* 2014. *Appl. Soil Ecol.*	Eastern Colombia, Meta	Yes	No	No	Yes	No	modified "tropical soil biology and fertility" protocol (Anderson and Ingram 1993)				OK	Lower abundance and species richness than improved pasture and savanna ecosystems, similar with that of oil palm plantations.

Full publication details of the articles used in the meta-analysis (excluding the unpublished data of SHEN & al.)

1. BICKEL, T.O. & WATANASIT, S. 2005: Diversity of leaf litter ant communities in Ton Nga Chang Wildlife Sanctuary and nearby rubber plantations, Songkhla, Southern Thailand. – Songklanakarin Journal of Science and Technology 27: 943–955.
2. HOSOISHI, S., NGOC, A.L., YAMANE, S. & OGATA, K. 2013: Ant diversity in rubber plantations (*Hevea brasiliensis*) of Cambodia. – Asian Myrmecology 5: 69-77.
3. LIU, C., GUENARD, B., BLANCHARD, B., PENG, Y-Q. & ECONOMO, E.P. 2016: Reorganization of taxonomic, functional, and phylogenetic ant biodiversity after conversion to rubber plantation. – Ecological Monographs 86: 215–227.
4. LIU, C., GUENARD, B., GARCIA, F.H., YAMANE, S., BLANCHARD, B., YANG, D-R. & ECONOMO, E.P. 2015: New records of ant species from Yunnan, China. – ZooKeys 477: 17–78.
5. MENG, L-Z. & GAO, X-X. 2007: Species diversity of rat and ant at different habitats and sites in Xishuangbanna. – Chinese Journal of Ecology 26: 802-809.
6. PAUL, N., JOHN, P., JOB, B. & MENON, P.L.D. 2016: Comparison of ant (Hymenoptera: Formicidae) diversity in different habitats of Machad Region of Thrissur. – Bulletin of Environment, Pharmacology and Life Sciences 5: 28-33.

7. RESENDE, J.J., PEIXOTO, P.E.C., DA SILVA, E.N., DELABIE, J.H.C. & SANTOS, G.M.M. 2013: Arboreal ant assemblages respond differently to food source and vegetation physiognomies: a study in the Brazilian Atlantic rain forest. – Sociobiology 60: 174-182.
8. ROOM, P.M. 1975: Diversity and organization of the ground foraging ant faunas of forest, grassland and tree crops in Papua New Guinea. – Australian Journal of Zoology 23: 71-89.
9. RUBIANA, R., RIZALI, A., DENMEAD, L.H., ALAMSARI, W., HIDAYAT, P., PUDJIANTO, HINDAYANA, D., CLOUGH, Y., TSCHARNTKE, T. & BUCHORI, D. 2015: Agricultural land use alters species composition but not species richness of ant communities. – Asian Myrmecology 7: 73-85.
10. SANABRIA, C., LAVELLE, P. & FONTE, S.J. 2014: Ants as indicators of soil-based ecosystem services in agroecosystems of the Colombian Llanos. – Applied Soil Ecology 84: 24-30.
11. SILVA, R.R, MACHADO FEITOSA, R.S. & EBERHARDT, F. 2007: Reduced ant diversity along a habitat regeneration gradient in the southern Brazilian Atlantic Forest. – Forest Ecology and Management 240: 61-69.
12. SONG, Y., XU, Z-H., LI, C-L., HAO, Y-Q. & LI, H-B. 2014: Ant communities of Nangun River Nature Reserve in Yunnan. – Journal of West China Forestry Science 43: 93-100.
13. THOMAS, S.K. & ASWATHI, P. 2012: Potential of rubber litter dwelling ants as biocontrol agent of home invading nuisance pest, *Luprops tristis*. – Journal of Biopesticides 5: 188-191.
14. THONGPHAK, D. & KULSA, C. 2014: Diversity and community composition of ants in the mixed deciduous forest, the pine forest and the para rubber plantation at Chulaborn Dam, Chaiyaphum Province, the Northeastern Thailand. – International Journal of Environmental and Rural Development 5: 72–76.
15. WATANASIT, S. & NHU-EARD, T. 2011: Diversity of ants (Hymenoptera: Formicidae) in two rubber plantations in Songkhla Province, Southern Thailand. – Songklanakarin Journal of Science and Technology 33: 151-161.
16. XU, Z-H., ZENG, G., LIU, T-Y. & HE, Y-F. 1999a: A study on communities of Formicidae ants in different subtypes of vegetation in Xishuangbanna district of China. – Zoological Research 20(2): 118-125.
17. XU, Z-H., YANG, B-L. & HU, G. 1999b: Formicidae ant communities in fragments of montane rain forest in Xishuangbanna, China. – Zoological Research 20(4): 288-293.
18. XU, Z-H., LIU, T-Y., HE, Y-F. & ZENG, G. 1999c: A comparative study on the ant communities in primeval and secondary forests of four vegetation subtypes in Xishuangbanna. – Zoological Research, 20(5): 360-364.
19. XU, Z-H., HU, G., & YU, X-W. 1999d: Biomass and ecological function of ant communities in the tropical rain forest of Xishuangbanna, China. – Zoological Research 20(6): 441-445.
20. YANG, X-D., SHE, Y-P., ZHANG, Z-Y., CAO, M., & DENG, X-B. 2001: Studies on structure and diversity of ant groups in the fragmentary tropical rainforests of 'Holy Hills' of Dai nationality in Xishuangbanna. – Acta Ecologica Sinica 21: 1321-1328.
21. ZHANG, Z-Y., CAO, M., YANG, X-D., DENG, X-B. & SHE, Y-P. 2000: A study on species diversity of ant in fragments of seasonal rain forest of Xishuangbanna, China. – Zoological Research, 21: 70-75.
22. ZHANG, L-H., ZHOU, X., CHEN, T-L., ZHANG, B. & WANG, Y-B. 2015: The spatial distribution patterns of two kinds of ants on rubber trees and the determination of aggressive ability. – Chinese Journal of Ecology 34: 3424-3429.
23. ZHANG, N-N., CHEN, Y-Q., LU, Z-X., ZHANG, W. & LI, K-L. 2013: Species diversity, community structure and indicator species of leaf-litter ants in rubber plantations and secondary natural forests in Yunnan, southwestern, China. – Acta Entomologica Sinica, 56: 1314-1323.

Tab. S3: Comparisons of the mean number of regions occupied by ants from different habitat types for the 16 additional datasets generated for the meta-analysis. Mean number of occupied regions are shown for two classes of ants: all species and habitat specialist species only. Superscript letters indicate results of Tukey's post-hoc test when ANOVA results returned significant *P* values (in bold). * denotes that comparisons were made between only the primary forest and rubber plantation ants due to relatively low number of species in secondary forests (see the Methods for more details). Total numbers of ant species are shown enclosed in parentheses.

Dataset	Mean number of regions occupied by ants			ANOVA results (*P* value)	
SCI papers only Global scale (8 studies)	Primary forest	Secondary forest	Rubber plantation	Normal analysis	Subsampling*
All species	20.3 (175 spp.) [a]	19.1 (41 spp.) [a]	33.6 (125 spp.) [b]	**<0.001**	**0.001**
Habitat specialists	12.9 (94 spp.) [a]	28.3 (9 spp.) [ab]	35.8 (57 spp.) [b]	**<0.001**	**0.001**
All species (natives only)	12.4 (154 spp.) [a]	15.4 (39 spp.) [ab]	18.0 (92 spp.) [b]	**0.045**	0.323
Habitat specialists (natives only)	12.3 (93 spp.) [a]	28.3 (9 spp.) [ab]	22.9 (43 spp.) [b]	**0.007**	0.180
Old World only (5 studies)					
All species	18.9 (135 spp.) [a]	8.5 (30 spp.) [ab]	30.8 (95 spp.) [b]	**<0.001**	**0.006**
Habitat specialists	9.7 (59 spp.) [a]	3.7 (3 spp.) [ab]	33.3 (31 spp.) [b]	**<0.001**	**0.003**
All species (natives only)	9.8 (116 spp.)	7.5 (29 spp.)	13.1 (69 spp.)	0.060	0.541
Habitat specialists (natives only)	8.6 (58 spp.) [a]	3.7 (3 spp.) [ab]	15.3 (23 spp.) [b]	**0.040**	0.570

Ground ants only Global scale (15 studies)	Primary forest	Secondary forest	Rubber plantation	Normal analysis	Subsampling*
All species	19.6 (210 spp.) [a]	29.9 (73 spp.) [b]	31.5 (159 spp.) [b]	**0.001**	**<0.001**
Habitat specialists	13.0 (118 spp.) [a]	16.2 (17 spp.) [ab]	31.6 (77 spp.) [b]	**<0.001**	**<0.001**
All species (natives only)	12.4 (184 spp.)	16.3 (56 spp.)	15.9 (116 spp.)	0.122	0.814
Habitat specialists (natives only)	11.8 (115 spp.)	15.3 (16 spp.)	16.9 (57 spp.)	0.276	0.882
Old World scale (13 studies)					
All species	19.3 (173 spp.) [a]	28.2 (66 spp.) [ab]	29.4 (132 spp.) [b]	**0.005**	**0.005**
Habitat specialists	11.3 (85 spp.) [a]	11.7 (13 spp.) [ab]	28.7 (52 spp.) [b]	**0.004**	**0.021**
All species (natives only)	11.2 (150 spp.)	15.2 (51 spp.)	13.1 (97 spp.)	0.138	0.890
Habitat specialists (natives only)	9.59 (82 spp.)	9.83 (12 spp.)	10.4 (38 spp.)	0.580	0.991

Tab. S4: Abundance of ant species collected by litter extraction and baiting methods from the different sites in Xishuangbanna Tropical Botanical Garden (rainforest, limestone forest, and rubber plantation). Morphospecies with quotation marks were referenced from an online pictorial record of ants in Xishuangbanna (https://congliu0514.wordpress.com/ants-in-xishuangbanna/) but were not verified by taxonomists.

Species name	Rainforest	Limestone forest	Rubber plantation	Total
Anochetus myops	1	15	0	16
Anoplolepis gracilipes	0	0	3	3
Aphaenogaster beccarii	14	0	0	14
Aphaenogaster feae	0	3	0	3
Brachyponera luteipes	9	30	6	45
Camponotus mitis	1	0	0	1
Cardiocondyla wroughtonii	0	5	0	5
Carebara "sp. 9"	6	2	3	11
Carebara sp. 1	15	38	60	113
Crematogaster binghamii	16	0	0	16
Crematogaster dohrni	5	0	0	5
Discothyrea clavicornis	2	0	0	2
Discothyrea kamiteta	2	0	0	2
Ectomomyrmex "sp. 1"	2	1	0	3
Ectomomyrmex "sp. 2"	1	0	0	1
Ectomomyrmex astutus	0	5	0	5
Ectomomyrmex leeuwenhoeki	3	2	0	5
Gauromyrmex sp. 1	617	0	0	617
Gnamptogenys bicolor	2	4	22	28
Gnamptogenys costata	0	1	0	1
Hypoponera sp. 2	18	65	2	85
Hypoponera sp. 3	0	3	0	3
Hypoponera sp. 4	19	2	1	22
Monomorium sp. 1	19	23	2	44
Monomorium sp. 2	28	25	0	53
Monomorium sp. 4	1	0	0	1
Monomorium sp. 5	38	139	254	431
Monomorium sp. 6	3	0	0	3
Monomorium sp. 7	0	0	105	105
Myrmecina curvispina	4	1	0	5
Myrmoteras binghamii	0	0	4	4

Myrmoteras cuneonodum	2	0	0	2
Nylanderia "sp. 5"	0	0	6	6
Nylanderia "sp. 6"	0	0	5	5
Nylanderia emmae	17	0	0	17
Nylanderia sp. 1	62	195	192	449
Nylanderia sp. 2	80	0	0	80
Nylanderia sp. 3	38	26	0	64
Odontomachus sp. 1	7	2	32	41
Odontoponera denticulata	38	61	125	224
Oecophylla smaragdina	0	0	794	794
Paraparatrechina "sp. 3"	76	0	0	76
Paraparatrechina sp. 1	1	0	0	1
Paraparatrechina sp. 2	0	0	144	144
Pheidole planifrons	253	104	0	357
*Pheidole rabo*_cf	0	6	2	8
Pheidole sp. 1	331	77	2	410
Pheidole sp. 2	25	263	0	288
Pheidole sp. 3	6	0	99	105
Pheidole sp. 4	4	109	0	113
Pheidole sp. 5	1	0	53	54
Pheidole sp. 7	39	28	5	72
Pheidole sp. 9	27	0	0	27
Pheidole sp. 10	1	0	25	26
Pheidole sp. 11	0	23	10	33
Pheidole sp. 12	0	0	11	11
Pheidole sp. 13	50	89	22	161
Pheidole sp. 14	0	412	0	412
*Pheidole tjibodana*_cf	1	0	0	1
Pheidole vieti	1	0	0	1
Polyrhachis armata	1	0	0	1
Ponera menglana	4	18	0	22
Prenolepis naoroji	6	0	0	6
Pristomyrmex hamatus	1	5	0	6
Strumigenys "sp. 5"	1	11	0	12
Strumigenys "sp. 6"	0	3	0	3
Strumigenys "sp. 8"	0	0	1	1
Strumigenys feae	0	0	5	5

*Strumigenys lyroessa*_nr.	2	0	0	2
Strumigenys mitis	8	0	0	8
Strumigenys nanzanensis	0	0	3	3
Strumigenys rallarhina	139	12	14	165
Strumigenys sp. 1	30	20	0	50
Strumigenys sp. 7	0	2	0	2
Strumigenys strygax	6	123	0	129
Tapinoma melanocephalum	0	0	4292	4292
Technomyrmex albipes	0	0	126	126
Technomyrmex horni	49	12	3	64
Technomyrmex sp. 1	0	0	6	6
Technomyrmex sp. 2	3901	131	4127	8159
Technomyrmex sp. 3	0	8	0	8
Technomyrmex sp. 4	0	3	0	3
Tetramorium flavipes	3	142	0	145
Tetramorium kheperra	35	20	0	55
Tetramorium nipponense	49	54	0	103
Tetramorium parvispinum	2	0	0	2
*Vollenhovia emeryi*_nr	3	16	35	54
Vollenhovia sp. 1	0	5	0	5
Vombisidris sp. 1	1	0	0	1
Total abundance	**6127**	**2492**	**10453**	**19072**

Tab. S5: Identified ant species in three habitat types within XTBG. Numbers in the cell correspond to the number of regions that species occupies (based on antmaps.org). Names in bold indicate that the species were found in only one habitat type (i.e., habitat specialists).

	Habitat type		
Species	Rainforest	Limestone forest	Rubber plantation
Anochetus myops	11	11	
Anoplolepis gracilipes			90
Aphaenogaster beccarii	19		
Aphaenogaster feae		15	
Brachyponera luteipes	60	60	60
Camponotus mitis	43		
Cardiocondyla wroughtonii		90	
Crematogaster binghamii	10		
Crematogaster dohrni	14		
Discothyrea clavicornis	10		
Discothyrea kamiteta	4		
Ectomomyrmex astutus		37	
Ectomomyrmex leeuwenhoeki	23	23	
Gnamptogenys bicolor	23	23	23
Gnamptogenys coxalis		14	
Myrmecina curvispina	2	2	
Myrmoteras binghamii			4
Myrmoteras cuneonodum	4		
Nylanderia emmae	9		
Odontoponera denticulata	31	31	31
Oecophylla smaragdina			57
Pheidole planifrons	4	4	
Pheidole vieti	2		
Polyrhachis armata	21		
Ponera menglana	2	2	
Prenolepis naoroji	25		
Pristomyrmex hamatus	1	1	
Strumigenys feae			5
Strumigenys mitis	18		
Strumigenys nanzanensis			29
Strumigenys rallarhina	4	4	4

Strumigenys strygax	3	3		
Tapinoma melanocephalum			225	
Technomyrmex albipes			86	
Technomyrmex horni	18	18	18	
Tetramorium flavipes	5	5		
Tetramorium kheperra	14	14		
Tetramorium nipponense	30	30		
Tetramorium parvispinum	6			
Total number of species:	28	19	12	Grand total: 39

Tab. S6: Number of regions occupied by each species (based on antmaps.org) found in different habitat types according to 25 different studies used for the meta-analysis of ant geographic distributions. Names in bold indicate that the species were found in only one habitat type (i.e., habitat specialists). * specifies that the species is classified as exotic ("exotic" and "indoor introduced" according to antmaps.org.).

	Habitat type		
Species	Primary forest	Secondary forest	Rubber plantation
Acanthognathus ocellatus	27		
Acanthognathus rudis	10		
Acanthomyrmex luciolae	2		
Acanthostichus sanchezorum			1
Acropyga acutiventris		34	
Acropyga nipponensis		14	14
Aenictus artipus	3	3	3
Aenictus changmaianus			3
Aenictus hodgsoni	13	13	
Aenictus laeviceps			27
Aenictus maneerati	3	3	
Aenictus paradentatus	4		
Aenictus thailandianus	5	5	5
*Anochetus graeffei**	62		62
Anochetus mixtus	2		
Anochetus myops	11		11
Anochetus subcoecus		2	
*Anoplolepis gracilipes**	90		90
Aphaenogaster beccarii	19		
Aphaenogaster dromedaria	2		
Aphaenogaster exasperata	8		
Aphaenogaster feae	15		15
Aphaenogaster perplexa	1		1
Aphaenogaster schurri	9	9	9
Basiceros disciger	19		
Brachymyrmex coactus		12	
Brachyponera chinensis*			76
Brachyponera croceicornis	4		4
*Brachyponera luteipes**	60	60	60
Buniapone amblyops	14		
Camponotus angusticollis			18

*Camponotus mitis**	43	43	43
Camponotus nicobarensis	22		
Camponotus parius	30	30	
Camponotus rufoglaucus			28
Camponotus sericeus*			60
Camponotus singularis	15		
Camponotus variegatus somnificus			5
Cardiocondyla nuda*			12
Cardiocondyla paradoxa			2
*Cardiocondyla wroughtonii**	90		90
*Carebara affinis**	44	44	44
Carebara altinoda	3		
Carebara bruni	1		
*Carebara diversa**	38	38	38
Carebara melasolena	8		
Carebara pilosa	4		
Cataulacus horridus			4
Centromyrmex brachycola			16
Centromyrmex feae			20
Cephalotes atratus		62	
Cerapachys sulcinodis	24		
Colobopsis conithorax			3
Colobopsis leonardi	15		15
Crematogaster binghamii	10		
Crematogaster biroi	23	23	
Crematogaster dohrni	14		
Crematogaster ferrarii	17	17	17
Crematogaster longispina			20
Crematogaster modiglianii			11
Crematogaster nigropilosa			38
Crematogaster obscurata*			19
Crematogaster osakensis	33	33	
Crematogaster politula	14		
Crematogaster rochai			48
Crematogaster rogenhoferi	41		41
Crematogaster rothneyi	22		

Crematogaster treubi	15		15
Cryptopone motschulskyi	2		
Diacamma ceylonense			6
*Diacamma rugosum**	43		43
Dilobocondyla fouqueti	9		
Dinomyrmex gigas	6		6
Discothyrea banna		1	
Discothyrea clavicornis	10	10	10
Discothyrea diana		1	
Discothyrea kamiteta	4	4	
Discothyrea neotropica	13		
Discothyrea sexarticulata	25		
Dolichoderus affinis	21		21
Dolichoderus incisus	3		
Dolichoderus laotius		3	
Dolichoderus squamanodus	1		
*Dolichoderus thoracicus**	37	37	37
Dolichoderus tricornis	2		
Dorylus laevigatus			12
Dorylus orientalis	46		
Dorymyrmex goeldii			10
Echinopla cherapunjiensis		7	
Ectatomma brunneum		56	
Ectatomma ruidum*			58
Ectatomma tuberculatum	75	75	75
Ectomomyrmex aciculatus	1		1
Ectomomyrmex annamitus	17	17	
Ectomomyrmex astutus	37		
Ectomomyrmex javanus	36		
Ectomomyrmex leeuwenhoeki	23	23	23
Ectomomyrmex lobocarenus	3		3
Ectomomyrmex sauteri	11	11	
Ectomomyrmex zhengi	2	2	
Emeryopone melaina	1		1
Erromyrma latinodis*	42		
Fulakora elongata	18		
Gesomyrmex kalshoveni	3		

Gnamptogenys bicolor	23	23	23
Gnamptogenys continua	34		
Gnamptogenys coxalis	14		
Gnamptogenys rastrata	12		
Gnamptogenys reichenspergeri	8		
*Gnamptogenys striatula**	76	76	
Gnamptogenys treta	2	2	2
Harpegnathos venator	25		
Heteroponera dentinodis	11		
Heteroponera mayri	14		
Hylomyrma reitteri	16	16	
Hypoponera ceylonensis	2		
*Hypoponera confinis**		41	41
Hypoponera creola			2
Hypoponera ergatandria*		31	
Hypoponera opacior*			69
Hypoponera punctatissima*			150
Hypoponera sauteri		30	
Hypoponera sororcula			2
Kartidris ashima	1		
Kartidris nyos	3		
Kartidris sparsipila			1
Labidus praedator			81
Lachnomyrmex plaumanni	9		
Lepisiota reticulata	3	3	
Lepisiota rothneyi			19
Leptanilloides sculpturata			1
Leptogenys birmana	12		12
Leptogenys chinensis			23
Leptogenys crassicornis	6		
Leptogenys diminuta			44
Leptogenys kitteli	30		
Leptogenys lucidula	7		
Leptogenys mengzii	2		
Leptogenys yerburyi	3		
Leptogenys zhuangzii	1		
Leptomyrmex fragilis	4		4

Leptomyrmex niger			3
Linepithema neotropicum			34
Liometopum sinense	18		
Lophomyrmex quadrispinosus	20	20	20
Lordomyrma idianale	1		
Mayaponera constricta			49
Megalomyrmex drifti	40		
Megalomyrmex goeldii	9		
Meranoplus bicolor*			46
Meranoplus laeviventris	6	6	
Monomorium chinense	42	42	42
Monomorium floricola*			162
*Monomorium pharaonis**	292	292	292
Mycetophylax olitor	13		
Mycetophylax plaumanni	5		
Mycetophylax strigatus	7		
Mycocepurus smithii			53
Myopias hania	1		
Myrmecina curvispina	2	2	2
Myrmecina guangxiensis	3	3	
Myrmica smythiesi			5
Myrmicaria brunnea			30
Myrmoteras binghamii	4	4	4
Myrmoteras cuneonodum	4		
Mystrium camillae	14		
Neivamyrmex punctaticeps			38
Neocerapachys splendens	23		
Neoponera apicalis	63		
Neoponera bucki	13		
Neoponera venusta		9	9
Neoponera villosa			90
Nylanderia birmana	28		28
Nylanderia bourbonica*	76		
Nylanderia emmae	9		
Nylanderia flaviabdominis	7		
Nylanderia flavipes*	55		
Nylanderia fulva*			54

Nylanderia indica	20		
Nylanderia taylori	22		
Nylanderia vividula*			95
Octostruma rugifera	48		
Octostruma stenognatha	10		
Odontomachus affinis		10	
Odontomachus chelifer		64	
Odontomachus circulus	2	2	
Odontomachus haematodus*			87
Odontomachus nigriceps	2		2
Odontomachus rixosus			21
*Odontomachus simillimus**	52		52
Odontomachus tensus			1
Odontomachus yucatecus			16
Odontoponera denticulata	31	31	31
Odontoponera transversa	9	9	9
*Oecophylla smaragdina**	57	57	57
Orectognathus velutinus	1		
Oxyepoecus plaumanni	4		
Oxyepoecus rastratus	7		
Pachycondyla harpax	85		
Pachycondyla striata		40	
Parasyscia fossulata	4		
Paratrechina longicornis*			249
Pheidole aglae			8
Pheidole annexa			4
Pheidole aristotelis			7
Pheidole butteli			5
Pheidole cariniceps	5	5	5
Pheidole elongicephala	1		1
Pheidole fervens*			59
Pheidole fervida	29		
Pheidole gatesi	6		
Pheidole hongkongensis	8	8	8
Pheidole hortensis	7	7	7
Pheidole impressiceps	5		5
*Pheidole indica**	98		98

Pheidole inversa			3
Pheidole jucunda	11		
Pheidole longipes	1	1	
Pheidole multidens			5
*Pheidole nodus**	56	56	56
Pheidole pieli	31	31	31
Pheidole plagiaria	17		17
Pheidole planifrons	4	4	4
Pheidole plinii			4
Pheidole rabo	8	8	
Pheidole rugithorax	4	4	
Pheidole sagei	7		7
Pheidole sauberi			7
Pheidole scalaris			10
Pheidole smythiesii	23	23	
Pheidole spathifera	19		
Pheidole subarmata			42
Pheidole tandjongensis			5
Pheidole tjibodana			9
Pheidole tumida	9	9	9
Pheidole vallifica			10
Pheidole vieti	2	2	
Pheidole watsoni	18	18	18
Pheidole yeensis	12	12	12
Pheidole zoceana	4	4	4
Platythyrea clypeata	4		
Polyrhachis armata	21		
Polyrhachis bihamata	21		
Polyrhachis furcata	13		13
Polyrhachis halidayi			11
Polyrhachis hippomanes	11		
Polyrhachis illaudata	49		49
Polyrhachis proxima			22
Ponera baka		2	
Ponera chiponensis	2		
Ponera menglana	2		2
Ponera nangongshana	1		

Prenolepis melanogaster	11		
Prenolepis naoroji	25		
Pristomyrmex brevispinosus	17		17
Pristomyrmex hamatus	1	1	
*Pristomyrmex punctatus**	52		52
Proceratium deelemani	4		
Proceratium longigaster	3		
Pseudolasius cibdelus	8		
Pseudolasius emeryi	13		
Pseudolasius familiaris	20	20	20
Pseudolasius silvestrii	6	6	6
Pseudoneoponera rufipes		36	36
Recurvidris kemneri	5	5	5
Recurvidris nuwa		2	2
Recurvidris recurvispinosa	30	30	30
Rhopalomastix umbracapita		2	
Rhytidoponera araneoides			7
Rogeria curvipubens*			22
Solenopsis jacoti	12	12	12
Sphinctomyrmex stali	5		
Stegomyrmex vizottoi	8		
Stigmatomma scrobiceps		1	
Strumigenys ailaoshana			1
Strumigenys appretiata	12		
Strumigenys crassicornis	25		
Strumigenys dyschima	2		
Strumigenys exilirhina	33	33	33
Strumigenys feae	5		5
Strumigenys kichijo			8
*Strumigenys lewisi**		37	37
Strumigenys lopotyle	1		
*Strumigenys louisianae**	78		78
Strumigenys lygatrix	2		
Strumigenys lyroessa	13	13	13
Strumigenys membranifera*			85
Strumigenys mitis	18	18	18
Strumigenys mutica	20	20	

Strumigenys nanzanensis	29		29
Strumigenys nepalensis	14	14	14
Strumigenys rallarhina	4	4	4
Strumigenys rugithorax	5		
Strumigenys sauteri	8	8	
Strumigenys sisyrata	1		
Strumigenys strygax	3	3	3
Strumigenys wallacei	1		
Syllophopsis australica*			19
Syllophopsis sechellensis*			30
Syscia typhla	5		
Tapinoma geei			10
Tapinoma indicum	25	25	
*Tapinoma melanocephalum**	225	225	225
*Technomyrmex albipes**	86	86	86
Technomyrmex antennus	8		8
Technomyrmex bicolor			8
Technomyrmex butteli			6
Technomyrmex elatior*			18
Technomyrmex horni	18		18
Technomyrmex modiglianii			10
Technomyrmex pratensis	13	13	
Tetramorium aptum	5		
Tetramorium ciliatum	3	3	
Tetramorium cuneinode		3	
Tetramorium difficile	4	4	
Tetramorium flavipes	5	5	
Tetramorium inglebyi		10	
*Tetramorium kheperra**	14	14	14
*Tetramorium kraepelini**	24	24	24
Tetramorium laparum	5	5	
Tetramorium melleum	5		5
Tetramorium nipponense	30		30
Tetramorium pacificum*			54
Tetramorium parvispinum	6	6	6
Tetramorium polymorphum	3		
Tetramorium smithi*	42		

*Tetramorium tonganum**	37	37	37	
Tetramorium wroughtonii		59	59	
Tetraponera allaborans*			51	
Tetraponera amargina	2			
Tetraponera attenuata		21	21	
Tetraponera microcarpa	8			
Tetraponera nigra	30			
Tetraponera nitida			26	
Trachymyrmex zeteki	6			
Tranopelta gilva			42	
Typhlomyrmex major	10			
Typhlomyrmex pusillus	38			
*Vollenhovia emeryi**	21		21	
*Wasmannia auropunctata**	106	106	106	
Total number of species:	231	106	179	Grand total: 340

Tab. S7: Within habitat comparisons of geographic distribution (mean number of occupied regions) of ants with and without exotic species. Significant differences in mean number of occupied regions of between all and only native species are shown in bold.

		Global		Old World	
Habitat type	With or without exotics	All species	Habitat specialists	All species	Habitat specialists
Primary forest	With exotics	20	14.5	18.9	12.6
	Without exotics	12.9	13	11.3	10.3
	P	**0.030**	0.660	**0.030**	0.560
Secondary forest	With exotics	24.6	19.5	21.9	9.8
	Without exotics	14.8	18.9	12.2	8
	P	0.070	0.880	0.070	0.750
Rubber plantations	With exotics	29	30.9	27.6	27.8
	Without exotics	15.8	17.3	12.8	11
	P	**0.001**	**0.04**	**0.001**	**0.026**