doi: 10.31674/book.2024scibe.004

Distribution of Invasive Ant Species across Various Locations in and around the Indian Sunderbans

Damayanti Bakra

Department of Zoology, Vidyasagar Metropolitan College, Kolkata, West Bengal, India

Corresponding Author's E-mail: *damayanti.zoology@gmail.com*

Abstract

Ants, a keystone species of the order Hymenoptera, play a crucial role in ecosystems, serving essential functions like pollination, tillage and aeration of the soil, and suppressing insect populations of various crops. However, some species that harm crops, contribute to pests, destroy pollen grains, and threaten biodiversity. Invasive ant species are among the supreme threats to ecosystems. These species disrupt native species, leading to habitat loss, competition, hybridization, fragmentation, and foraging behavior. High densities of invasive species can have devastating effects on indigenous communities and ecosystems, disrupting community structure and disrupting ecosystem functions by replacing native species. The Sunderbans, the largest mangrove ecosystem in the world, are under threat from various invasive ant species. This article described the status of invasive ant species in different study sites of the Indian Sunderbans. The invasive species of ants were collected from different locations of Sunderbans during pre-monsoon and post monsoon seasons using honey bait, pitfall trap methods and hand collection techniques. A total of 7 invasive species, comprising 22.847% of total abundance, were distributed in the Sunderbans. Those were *Paratrechina longicornis*, *Tapinoma melanocephalum*, *Monomorium floricola*, *Technomyrmex albipes*, *Solenopsis geminata*, *Trichomyrmex destructor* and *Anoplolepis gracilipes*. *Paratrechina longicornis* had the highest abundance (13.8%). Invasive species pose a serious threat to the native species of agricultural lands of Sagar Island. Early detection of invasion and rapid management are significant for controlling these species.

Keywords: *Ants; Invasive; Keystone Species; Sunderbans*

Introduction

Invasive species are among the most serious threats to native communities and biodiversity (Mack *et al*., 2000; Rodriguez, 2006; Gentili *et al*., 2021). It has been well documented that the invasion caused massive and rapid losses of community structure and biodiversity (Charles & Dukes 2007; Kehoe *et al*., 2020; Zina *et al*., 2020; Farahat *et al*., 2021). Invasive species have ecological implications such as predation, hybridization, and competition with native species, which alter ecosystem processes due

to biodiversity loss and pest infestation (Bruno *et al*., 2005; Crooks, 2002; Grosholz, 2002; Mack *et al*., 2000; Peh, 2010). Generalist non-native species may effectively become the ecologically dominant species, leading to trophic popularization (Kehoe *et al.*, 2020). Invasive species may out-compete native species, causing disruptions to ecological processes and communities (Peh, 2010). Certain alien species' direct and indirect influences can be so widespread and strong that they can reorganize entire communication networks and trigger abrupt changes in bio networks (Maron *et al*., 2006; Linders *et al*., 2019). Invasive species naturally have an impact on native species through resource competition, predation, and habitat deterioration (King & Tschinkel, 2008).

Among invasive species, ants are a particularly prominent group. More than 200 exotic species were recorded (Suarez *et al*., 2010), 19 are recognized as very invasive by listed by the IUCN Invasive Species Specialist Group (IUCN SSC Invasive Species Specialist Group 2012) and five are even on the IUCN ‘‘100 of the world’s worst invasive species’’ list (Lowe *et al*., 2000). Invasive ants are often highly aggressive, dominant competitors that displace many native species, through either direct or indirect competition, i.e. interference or exploitation competition (Holway, 2005; Rowles & O’Dowd, 2007; Carpintero, Reyes-Lo´pez & Arias de Reyna, 2005). Invasive ant species create major risks to local biodiversity, particularly native ants in some areas (Holway *et al*., 2002). Invasive ants can colonize human-modified habitats, such as urban environments. (Gibb & Hochuli, 2002), ability to nest in human structure (Schultz & McGlynn, 2000) and are easily spread by humans. Invasive ants can monopolize existing resources in an ecosystem and can get rid of existing native species (Eyer *et al*., 2018).

This research aims to determine the invasive ant diversity and function in Indian Sunderbans.

Methodology

Study Area

The Sunderbans, located between 21°31′00″ N and 22°30′00″ N latitude and 88°10′00″ E and 89°51′00″ E longitude, are among the world's largest mangrove forests. It was designated as a Sundarbans Biosphere Reserve (1989), a National Park (1984), and a World Heritage Site (1985). The Ganges, Brahmaputra, and Meghna Rivers confluence in the Bay of Bengal and create the delta that contains the mangrove region known as the Sundarbans. A total of five locations were selected for ant sampling, which is spread across the districts of North and South 24-Parganas in the state of West Bengal. Specimens were collected from five different sites of the Sunderbans.

Site 1: Sagar Island (21°43'01''N/88°03'27''E). Sagar Island is the westernmost island of the Ganges- Brahmaputra delta of West Bengal.

Site 2: Bakkhali (21°34'59''N/88°16'16''E).Bakkhaliis located in the South 24 Parganas district of West Bengal, India, which is a coastal region.

Site 3: Patharpratima (21°47'15''N/88°21'46''E). Patharpratima, the most remote block in South 24 Parganas district, comprises thirteen islands criss-crossed by numerous tidal rivers.

Site 4: Gosaba (22°7'51''N/88°50'10''E), is situated in the south 24 Parganas district and central region of the Sundarbans.

Site 5: Hingalganj (22°21'1''N/88°59'8''E), is located in the eastern Sundarbans which is located in the north 24 Parganas district.

Ant sampling

Ant sampling was conducted in 2019 during the pre and post monsoon seasons using honey bait, pitfall trap methods and hand collection. A cotton ball moistened with 20% honey and 80% water solution on transparent plastic plates was placed in each subplot. After 60 min, visual counts of all ants at the baits were completed and identifications were recorded to morphospecies. The ants were also collected using pitfall traps made of plastic cups and filled with water and detergent. After 24 hours, ants were collected and categorized in a laboratory for counting and analysis. Hand collections of ants using forceps were also carried out.

Identification

The identification of insects was conducted at the Central Entomological Laboratory, Zoological Survey of India, Kolkata. Morphological identification was performed using existing literature such as Bolton (1994) and Bingham (1903) and various keys available on antwiki.org.

Identification was carried out using Leica EZ4 stereo zoom microscope.

Results

A total of 2880 ants were sampled of which invasive species were 658 or 22.847% of the overall ant population. Among the 64 ant species encountered, seven are commonly classified as invasive species (as per Global Invasive Species Database: https://www.iucngisd.org/gisd/). Those were *Paratrechina longicornis*, *Tapinoma melanocephalum*, *Monomorium floricola*, *Technomyrmex albipes*, *Solenopsis geminata*, *Trichomyrmex destructor*, and *Anoplolepis gracilipes*. The *Paratrechina longicornis* of subfamily Formicinae had the highest abundance (13.8%), followed by *Tapinoma melanocephalum* (3.9%), *Monomorium floricola* (3%),*Technomyrmex albipes* (1.2%),*Solenopsis geminate* (0.5%), *Trichomyrmex destructor* (0.2%) and *Anoplolepis gracilepis* (0.07%).

In Sagar Island (Site-1), during the pre-monsoon, the abundance of *Paratrechina longicornis* was 4.87%, followed by *Trichomyrmex destructor* (1.8%), *Tapinoma melanocephalum* (0.75%), and *Solenopsis geminata*(0.37%). In post-monsoon collections, the abundance of *Technomyrmex albipes* (20.8%) became the highest, followed by *Tapinoma melanocephalum* (2.38%) and *Paratrechina longicornis* (1.78%).

In Bokkhali (Site-2), the ant species *P. longicornis* (5.7%), *M. floricola* (4.4%), *T. melanocephalum* (1.333%), and *S. geminata* (0.444%) were the most abundant during the premonsoon. In the postmonsoon period, *T. melanocephalum* (4.4%), *M. floricola* (15.66%), and *P. longicornis* (25.7%).

In Patharpratima (Site-3) during pre-monsoon, *P. longicornis* (8.6%), *T. melanocephalum*(2.4%), *S. geminata* (0.4%) were abundant while during post-monsoon, *Paratrechina longicornis*(5.7%)and *Tapinoma melanocephalum* (0.598%).

Gosaba (Site-4) has *Paratrechin*a (16%) and *Tapinoma* (10%) during pre-monsoon, *Paratrechin*a (15%), *Tapinoma* (11.67%) and *Solenopsis* (4.01%) during post-monsoon, and Hingalganj (Site-5) has *Paratrechina* (22.29%), *Anoplolepis* (0.6%), and *Solenopsis* (4%) (Table 1).

While comparing the abundance of native ant species, viz., *Camponotus compressus*, *Monomorium indicum, and Crematogaster rogenhoferi,* it is found that the abundance of *Camponotus compressus* (11.86%) was much higher than *Paratrechina longicornis*(10%) during pre-monsoon. But after monsoon, abundance of *Paratrechina longicornis* was higher (17.7%) than *Camponotus compressus* (6.9%). In the post-monsoon season, the abundance of *Monomorium floricola* (5.4%) was near that of *Monomorium indicum* (6.7%), *Crematogaster rogenhoferi* (4%), and *Tapinoma melanocephalum* (4.1%) (Figure1).

Table 1*: Relative Abundance of Invasive Ants during Pre-Monsoon and Post Monsoon Seasons in Different Locations of Indian Sunderbans*

Location	**Sagar**		**Bokkhali**		**Patharpratima**		**Gosaba**		**Hingalganj**	
Ant species	Pre monsoon	Post monsoon	Pre monsoon	Post monsoon	Pre monsoon	Post monsoon	Pre monsoon	Post monsoon	Pre monsoon	Post monsoon
Paratrechina longicornis	9.3	1.785	5.77	25.7	8.6	5.98	16	14.598		22.29
Trichomyrmex destructor	1.865		0.888							
Tapinoma melanocephalum	0.75	2.38	1.333	4.4	2.459	0.598	10.5	11.678	0.3	
Monomorium. floricola			4.4	15.66						
Solenopsis geminata	0.373		0.444		0.4			4.01		0.3
Technomyrmex albipes		20.8								
Anoplolepis gracilipes										0.6

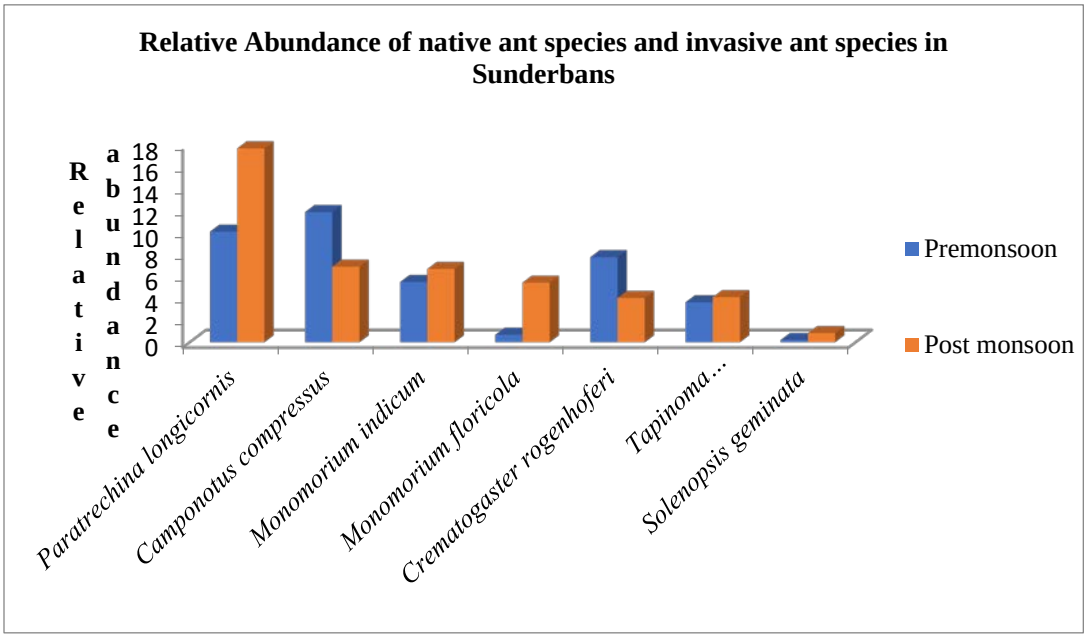

Figure 1: Relative Abundance of Native Ants and Invasive Ant Species During Pre-Monsoon and Post Monsoon Seasons in Sunderbans

Discussion

The abundance of ant species in a particular area is greatly affected by environmental changes, and ants respond to environmental disturbances or soil disruptions as they serve as their habitats (Andersen, 2019). In the present study, total seven invasive ant species were recorded during pre-monsoon and post monsoon seasons i.e. *Anoplolepis gracilipes, Paratrechina longicornis*, and *Solenopsis geminata*, *Tapinoma melanocephalum*, *Trichomyrmex destructo*r, *Technomyrmex albipes* and *Monomorium floricola*. The ant species *Paratrechina longicornis, Tapinoma melanocephalum* and *Solenopsis geminate* were found in all study sites, whereas *Trichomyrmex destructo*r found from Site-1 and Site-2*, Technomyrmex albipes* only in Site-1*, Monomorium floricola* only in Site-2 and *A. gracilipes* was only found in the Site-5. Abundance of invasive ant species, including *Paratrechina longicornis*, *Trichomyrmex destructor*, *Tapinoma melanocephalum*, and *Solenopsis geminata*, in Sagar Island, Bokkhali, Patharpratima, Gosaba, and Hingalganj, varies during the pre-monsoon and post-monsoon periods. Figure 1 showing that invasive antscompetewith native ant species and become dominant during post monsoon season**.** Another finding, Site-1 (Sagar Island) consists of a higher population of invasive ant species than other sites. Whereas Site-3, Site-4 and Site-5 are located near Reserve Forest and with low human disturbances have very few invasive ants.

While comparing the ant functional groups in Indian Sunderbans, it is found that *Paratrechina longicornis*, popularly known as crazy ants, are opportunistic omnivores that can adapt to various environments by feeding on insects, seeds, honeydew, fruits, and plant exudates. *Trichomyrmex destructor* is a tropical climate specialist and known to consume seeds and was viewed as a potential competitor for seed resources. Another most significant household ant species in the tropics is the ghost ant, *Tapinoma melanocephalum* (Lee & Robinson, 2001). *Tapinoma melanocephalum* is an opportunist and typical pest in residential areas in Malaysia (Lee 2002). The tropical fire ant, *Solenopsis geminata* is hot climate specialist, this species can well adapt in habitat such as settlement area, forest edge, and agriculture area (Ness & Bronstein 2004) and also regarded as an environmental and commercial pest that significantly affects the ecological balances of ecosystems (Risch & Carroll 1982; Plentovich, Hebshi & Conant 2009), and it is one of the most harmful and widespread introduced species (Holway *et al.*, 2002).

Conclusion

Invasive ants are easily dispersed by humans. They have a rapid adaptation mechanism and great competitive capacity, which has a negative impact on the survival of local ants. Studies of invasive ant diversity of Sunderbans will provide valuable insights into the health and functioning of mangrove forest ecosystems. Since early management actions are more practical and successful, early detection of invasive species, pests, and pathogens is essential for preventing damage. Therefore, their role in novel habitats should be addressed, and the factors that encourage their occurrence that have a severe impact on native species should be explored. These factors and processes are essential to control the expansion of invasive ant species, enhance their management, and conserve native species in the future.

Acknowledgement

The author expresses her sincere gratitude her supervisors, Dr**.** Sheela S., Scientist-E, Zoological Survey of India, Kolkata and Dr. Silanjan Bhattacharyya**,** Professor, Department of Zoology, West Bengal State University, for their guidance, support, and encouragement. The author is also grateful to the Department of Science & Technology and Biotechnology, Govt. of West Bengal for financial support.

References

Andersen, A. N. (2019). Responses of ant communities to disturbance: Five principles for understanding the disturbance dynamics of a globally dominant faunal group. *Journal of Animal Ecology*, *88*(3), 350-362. https://doi.org/10.1111/1365-2656.12907

Bingham, C. T. 1903. *The Fauna of British India, including Ceylon and Burma*. *Hymenoptera, 2. Ants and Cuckoo-Wasps.* Taylor and Francis, London. https://doi.org/10.5962/bhl.title.106780

Bolton B. 1994. Identification Guide to the Ant Genera of The World. Harvard University Press, Cambridge, MA. https://www.cabidigitallibrary.org/doi/full/10.5555/19951102914

Bruno, J. F., Fridley, J. D., Bromberg, K. D., & Bertness, M. D. (2005). Insights into biotic interactions from studies of species invasions. *Species invasions: insights into ecology, evolution, and biogeography*, 13-40.

Carpintero, S., Reyes-López, J., & Arias de Reyna, L. (2005). Impact of Argentine ants (Linepithema humile) on an arboreal ant community in Donana National Park, Spain. *Biodiversity & Conservation*, *14*, 151-163. https://doi.org/10.1007/s10531-005-3947-6

Charles, H., & Dukes, J. S. (2007). Impacts of invasive species on ecosystem services. *Biological Invasions*, 217-237. https://doi.org/10.1007/978-3-540-36920-2_13

Crooks, J. A. (2002). Characterizing ecosystem-level consequences of biological invasions: the role of ecosystem engineers. *Oikos*, *97*(2), 153-166. https://doi.org/10.1034/j.1600-0706.2002.970201.x

Eyer, P. A., McDowell, B., Johnson, L. N., Calcaterra, L. A., Fernandez, M. B., Shoemaker, D., ... & Vargo, E. L. (2018). Supercolonial structure of invasive populations of the tawny crazy ant Nylanderia fulva in the US. *BMC evolutionary biology*, *18*, 1-14. https://doi.org/10.1186/s12862-018-1336-5

Farahat, E. A., Mahmoud, W. F., Fahmy, G. M., Farrag, H. F., & Awad, H. E. (2021). Impact of the invasive species Vossia cuspidata (Roxb.) Griff. on the diversity and temporal changes of the native flora of the River Nile in Egypt. *Taeckholmia*, *41*(1), 1-17. https://doi.org/10.21608/taec.2021.62873.1029

Gentili, R., Schaffner, U., Martinoli, A., & Citterio, S. (2021). Invasive alien species and biodiversity: Impacts and management. *Biodiversity*, *22*(1-2), 1-3. https://doi.org/10.1080/14888386.2021.1929484

Gibb, H., & Hochuli, D. F. (2003). Colonisation by a dominant ant facilitated by anthropogenic disturbance: effects on ant assemblage composition, biomass and resource use. *Oikos*, *103*(3), 469-478. https://doi.org/10.1034/j.1600-0706.2003.12652.x

GISD, 2021. Global Invasive Species Database (GISD). https://www.iucngisd.org/gisd/

Grosholz, E. (2002). Ecological and evolutionary consequences of coastal invasions. *Trends in ecology & evolution*, *17*(1), 22-27. https://doi.org/10.1016/S0169-5347(01)02358-8

Holway, D. A. (2005). Edge effects of an invasive species across a natural ecological boundary. *Biological Conservation*, *121*(4), 561-567. https://doi.org/10.1016/j.biocon.2004.06.005

Holway, D. A., Lach, L., Suarez, A. V., Tsutsui, N. D., & Case, T. J. (2002). The causes and consequences of ant invasions. *Annual review of ecology and systematics*, *33*(1), 181-233. https://doi.org/10.1146/annurev.ecolsys.33.010802.150444

Kehoe, R., Frago, E., & Sanders, D. (2021). Cascading extinctions as a hidden driver of insect decline. *Ecological Entomology*, *46*(4), 743-756. https://doi.org/10.1111/een.12985

King, J. R., & Tschinkel, W. R. (2008). Experimental evidence that human impacts drive fire ant invasions and ecological change. *Proceedings of the National Academy of Sciences*, *105*(51), 20339-20343. https://doi.org/10.1073/pnas.0809423105

Lee, C. Y. (2002, July). Tropical household ants: pest status, species diversity, foraging behavior and baiting studies. In *Proceedings of Fourth International Conference on Urban Pests (SC Jones, J. Zhai & WH Robinson, eds), Pocahontas Press, Blacksburg, Virginia, USA,* 3-18.

Lee, C. Y., & Robinson, W. H. (2001). *Handbook of Malaysian household and structural pests*. Pest Control Association of Malaysia.

Linders, T. E. W., Schaffner, U., Eschen, R., Abebe, A., Choge, S. K., Nigatu, L., ... & Allan, E. (2019). Direct and indirect effects of invasive species: Biodiversity loss is a major mechanism by which an invasive tree affects ecosystem functioning. *Journal of Ecology*, *107*(6), 2660-2672. https://doi.org/10.1111/1365-2745.13268

Lowe, S., Browne, M., Boudjelas, S., & De Poorter, M. (2000). *100 of the world's worst invasive alien species: a selection from the global invasive species database* (Vol. 12). Auckland: Invasive Species Specialist Group.

Mack, R. N., Simberloff, D., Mark Lonsdale, W., Evans, H., Clout, M., & Bazzaz, F. A. (2000). Biotic invasions: causes, epidemiology, global consequences, and control. *Ecological applications*, *10*(3), 689-710. https://doi.org/10.1890/1051-0761(2000)010[0689:BICEGC]2.0.CO;2

Maron, J. L., Estes, J. A., Croll, D. A., Danner, E. M., Elmendorf, S. C., & Buckelew, S. L. (2006). An introduced predator alters Aleutian Island plant communities by thwarting nutrient subsidies. *Ecological Monographs*, *76*(1), 3-24. https://doi.org/10.1890/05-0496

Ness, J. H., & Bronstein, J. L. (2004). The effects of invasive ants on prospective ant mutualists. *Biological Invasions*, *6*, 445-461. https://doi.org/10.1023/B:BINV.0000041556.88920.dd

Peh, K. S. H. (2010). Invasive species in Southeast Asia: the knowledge so far. *Biodiversity and Conservation*, *19*, 1083-1099. https://doi.org/10.1007/s10531-009-9755-7

Plentovich, S., Hebshi, A., & Conant, S. (2009). Detrimental effects of two widespread invasive ant species on weight and survival of colonial nesting seabirds in the Hawaiian Islands. *Biological Invasions*, *11*(289-298). https://doi.org/10.1007/s10530-008-9233-2

Risch, S. J., & Carroll, C. R. (1982). Effect of a keystone predaceous ant, Solenopsis geminata, on arthropods in a tropical agroecosystem. *Ecology*, 1979-1983. https://doi.org/10.2307/1940138

Rodriguez, L. F. (2006). Can invasive species facilitate native species? Evidence of how, when, and why these impacts occur. *Biological invasions*, *8*, 927-939. https://doi.org/10.1007/s10530-005-5103-3

Rowles, A. D., & O'Dowd, D. J. (2007). Interference competition by Argentine ants displaces native ants: implications for biotic resistance to invasion. *Biological invasions*, *9*, 73-85. https://doi.org/10.1007/s10530-006-9009-5

Schultz, T. R., & McGlynn, T. P. (2000). *The interactions of Ants with other organisms. Di dalam: Agosti D, Majer JD, Alonso LE*. Schultz TR, editor. Ants: Standard Methods for Measuring and Monitoring.

Suarez, A. V., McGlynn, T. P., & Tsutsui, N. D. (2010). Biogeographic and taxonomic patterns of introduced ants. *Ant Ecology*, 233-244. https://antssouthafrica.com/wp-content/uploads/2021/04/Ant-Ecology-by-Lori-Lach-Catherine-Parr-Kirsti-Abbott-z-lib.org-compressed.pdf#page=252

Zina, V., Branco, M., & Franco, J. C. (2020). Impact of the invasive Argentine ant in citrus agroecosystems: Effects on the diversity and frequency of native ant species foraging on tree canopy. *Insects*, *11*(11), 785. https://doi.org/10.3390/insects11110785