**Title**

Catch a free ride with me: A report on ant hitchhiking on vehicles in Taiwan and its ecological implications

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**Abstract**

Human transportation can facilitate long-distance dispersal of organisms, allowing them to colonize new areas and thus increasing the probability of biological invasions. Here, we report on 41 cases of ant hitchhiking on vehicles (cars and scooters) in Taiwan collected from the social media platform between 2017 and 2022. Among the eight hitchhiking ant species, six were invasive and constituted 93% (*n* = 38) of the cases. Moreover, about half of the cases (*n* = 22) were from the invasive species *Dolichoderus thoracicus*. The ants colonized the vehicles within a day in 60% of the cases (*n* = 25), while a few colonizations took over a month (*n* = 4). The hitchhiking events occurred more frequently during summer (June to September, *n* = 26) compared to spring (March to May, *n* = 10) or fall/winter (October to December, *n* = 5). To our knowledge, this is among the first studies of ant hitchhiking on vehicles. Further research on the factors underlying ant hitchhiking behavior and colonization attempts will provide useful implications for ant invasion management.

**Keywords**

ant colonization, biological invasions, citizen science, exotic species, human-mediated long-distance dispersal, species hitchhiking

**Introduction**

The definition of species hitchhiking and the importance of species hitchhiking for biological invasions.

Several species have been observed to hitchhike on vehicles and the past studies and their impacts.

Most reported cases were passive hitchhikers, but in Taiwan over the past few years, there have been anecdotal observations of an active hitchhiking by ants, and we were particularly interested in this behavior. In this study, we reported on cases of ant hitchhiking in Taiwan collected via citizen science efforts.

**Materials and Methods**

*Data collection*

We collected cases of ant hitchhiking on vehicles between 2017 and 2023 via citizen science by distributing relevant information on a social media platform Facebook. When an observer responded, we asked the person for the parking date and location of the vehicles, the parking duration, and vehicle type, the weather conditions and surrounding environment, the intended destination, and a photo of the ants for species identification. All recorded cases and the associated variables were provided in the Supplementary Data.

**Results**

In total, we collected 45 cases of ant hitchhiking on cars (*n* = 39) and scooters (*n* = 6) between 2017 and 2023, with the majority of them from central and northern Taiwan (Fig. 1). Eight species were recorded, among which two were native and six were exotic (Table 1). Seven species were arboreal ants (Table 1). One species, the black cocoa ant (*Dolichoderus thoracicus*), constituted over half of the reported cases (*n* = 26). The duration of ant colonization of vehicles ranged from several hours to a month, with around 65% (*n* = 28) of the cases taking place within a day. There were more cased reported in spring (March–May) and summer (June–August) compared to fall (September–November) and winter (December–February) (χ2 = 16.78, *df* = 3, *P* < 0.001; Fig. 2).

**Discussion**

Ant hitchhiking on vehicles can be a potential pathway for the spread of exotic species (Table 1). In some cases, the travel distance between the parking location and the intended destination can be as long as a few hundred kilometers (from Nantou County in central Taiwan to PingTung County in southern Taiwan), which largely exceeds the dispersal distance achievable through natural movements. Furthermore, hitchhiking events can take place within several hours, during which the workers would carry the queen, the eggs, and the larvae to the vehicles, suggesting that such hitchhiking is not a foraging behavior but rather a colonization attempt, potentially driven by high population pressure. In fact, the most reported hitchhiking species, the black cocoa ant (*D*. *thoracicus*), has high local densities, which may stimulate the dispersal and colonization of artificial structures.

A successful ant hitchhiking event involves various steps (Fig. 3). First, ants need to encounter vehicles, which depends largely on their searching activities. Ants are generally more active under warmer conditions (Parr and Bishop 2022), potentially leading to more hitchhiking cases in spring and summer compared to fall and winter (Fig. 2). Moreover, species with different habitat associations may differ in the probability of encountering vehicles. Arboreal ants often nest in drier habitats with fewer resources, which facilitate their searching activities and thus they are more likely to encounter vehicles (citation). In contrast, ground-dwelling ants often nest in wetter habitats with more resources and consequently engage less in searching (citation). Interestingly, rubber odor could be an important chemical cue for ants to locate vehicles since the tires are the only part of the vehicles directly connected to the ground.

Second, ants need to climb onto the vehicles after locating them. The metallic paint of vehicle surface could present a slippery barrier to ants, and only species with good climbing abilities are able to overcome this hurdle. The climbing performance of ants is determined by the morphological characteristics of the leg segments (Beutel et al. 2020). For instance, the fine hair arrays on the tarsus can increase the friction for vertical climbing (Endlein and Federle 2015). Arboreal ants have hooked pretarsal claws, well-developed adhesive pads, and fine tarsal hairs, allowing them to walk on smooth vertical substrates. On the other hand, ground-dwelling ants have straight pretarsal claws and lack adhesive pads as well as tarsal hairs, and therefore they are less capable of moving on smooth vertical surfaces (Orivel et al. 2001, Billen et al. 2017).

Third, ants need to be capable of colonizing the vehicles after moving onto them. The thermal tolerance of species plays a critical role in this because ants have to tolerate the high temperature of the vehicle surface and interior before arriving at the destination and dispersing to new areas. Arboreal ants are more drought-tolerant than ground-dwelling ants and thus are more likely to utilize artificial structures and hitchhike on vehicles (citation). Furthermore, car color may influence the ants’ colonization attempt and success as it affects the temperature of the vehicles, particularly under exposure to sunlight.

To our knowledge, this is the first report on ant hitchhiking on vehicles via citizen science. Despite limited reported cases, our results still reveal interesting patterns in ant hitchhiking, and we have endeavored to engage the wider community in such citizen science data collection efforts. We also encourage future studies to examine the behavioral, morphological, physiological, and ecological traits of exotic species versus their native relatives to better understand the determinants underlying the success of hitchhiking events, and to develop management strategies for preventing biological invasions of ants.

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**Conflict of interest**

The author declares no conflict of interest regarding this manuscript.

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**Tables and Figures**

Table 1. The status, habitat association, and the number of reported hitchhiking cases of the ant species in this study

|  |  |  |  |
| --- | --- | --- | --- |
| Species | Status | Habitat association | Cases |
| *Polyrhachis dives* | Native | Arboreal | 2 |
| *Nylanderia* sp. | Native | Ground-dwelling | 1 |
| *Dolichoderus thoracicus* | Exotic | Arboreal | 26 |
| *Tapinoma melanocephalum* | Exotic | Arboreal/  Ground-dwelling | 5 |
| *Paratrechina longicornis* | Exotic | Arboreal/  Ground-dwelling | 4 |
| *Technomyrmex albipes* | Exotic | Arboreal | 4 |
| *Technomyrmex brunneus* | Exotic | Arboreal | 2 |
| *Anoplolepis gracilipes* | Exotic | Arboreal/  Ground-dwelling | 1 |

Figure 1. (a) A map of the ant hitchhiking cases in Taiwan and (b–c) example photos of ant hitchhiking on vehicles.

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Season_barplot

Figure 2. The number of ant hitchhiking cases in each season (spring: March–May; summer: June–August; fall: September–November; winter: December–February).

Figure 3. The determinants of a successful ant hitchhiking event.