ENTOMOLOGICAL Communications

Entomological Communications, 6, 2024: ec06034
doi: 10.37486/2675-1305.ec06034
e-ISSN: 2675-1305
Open Access Full Text Article

Scientific Note

Observations of the scoliid wasp *Campsomeriella annulata annulata* (Fabricius, 1793) foraging on fallen *Firmiana simplex* (L.) W.F.Wight (Malvaceae) flowers

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Edited by: Daniell R. R. Fernandes

Received: November 18, 2024. Accepted: December 07, 2024. Published: December 23, 2024.

Abstract. A scoliid wasp, *Campsomeriella annulata annulata* (Fabricius, 1793) (Hymenoptera: Scoliidae), was observed foraging on *Firmiana simplex* (L.) W.F.Wight (Malvaceae) flowers that had fallen onto shrubs in an urban park in central Japan. The wasp inserted its glossa into the tubular corolla of eight different fallen male flowers within five minutes before flying away. This finding suggests that scoliid wasps may engage in atypical flower visitation, or that foraging from fallen flowers could reduce interspecific competition for floral resources.

Keywords: flower visitors, foraging behavior, Scoliidae, solitary wasp.

Angiosperm trees characteristically bloom in their canopy, shedding flowers that temporarily cover the understory and ground, and are used by various arthropods as a source of food (Feinstein et al. 2007; Whigham et al. 2013). Larvae of many Lepidoptera, Coleoptera and Diptera feed on fallen decaying flowers to complete their development (Sakai 2002; Feinstein et al. 2007; 2008; Yoshimoto et al. 2018), and bees and wasps occasionally forage on fallen unspoiled flowers from which they obtain nectar and pollen (Mohammed & Starr 1999). Although visitation of fresh, attached flowers by hymenopterans generally contributes to pollination and subsequent fruit set, foraging from fallen flowers, which does not involve contact with receptive stigmas, offers no pollination benefit to plants. From the standpoint of bees and wasps, fallen flowers can supplement their diet, particularly when flowers in bloom are scarce, or competition with other flower-visitors is intense.

Scoliid wasps, comprising ca. 560 species in the world, are ectoparasitoids of scarabaeid larvae, and to a lesser extent, some curculionid larvae, that live in the soil and rotten wood (O'Neill 2001; Eaton 2021). Scoliid wasps have been studied for use as biological control agents of scarabaeid pests (Clausen et al. 1932; Abbate et al. 2018), and as pollinators of plants, such as climbers, agricultural crops, sexually deceptive orchids, and coastal plants (Ayasse et al. 2001; Inoue & Endo 2006; Tanaka et al. 2006; Campbell et al. 2016; Nagasaki 2021). However, the flower foraging behavior of Scoliidae is poorly understood. Indeed, unusual foraging behaviors of wasps and bees are rarely described in scientific literature (e.g., Herrera 1990; Requier & Leonhardt 2020; Meiners et al. 2017). The author observed a scoliid wasp foraging on fallen flowers in an urban park in central Japan. Here, the behavior of the wasp is described and its implications are examined within the context of foraging tactics and learning abilities of scoliids.

The observation took place at Nagai Park (34°36'52.23"N, 135°31'23.14"E, 7.3 m above sea level) in Osaka City, central Japan, on July 8, 2023. Approximately 20 Chinese parasol trees *Firmiana simplex* (L.) W.F.Wight (Malvaceae), ranging from five to eight m in height, are located in the northern part of the park. The author visited the park to survey flower-visiting insects on trees that were in bloom at the time. While *F. simplex* is native to southern Japan, China, Taiwan, and Indochina, it is also widely cultivated in warm regions. This monoecious species bears numerous male and female flowers on large inflorescences in summer (Nakagawa 2000; Upson & Cullen 2012). Although the pollination biology of *F. simplex* has not been detailed, its flowers produce nectar and pollen to attract pollinators such as the Japanese large carpenter bee *Xylocopa appendiculata circumvolans* Smith, 1873 (Hymenoptera: Apidae), as well as medium-sized and smaller bees (Ichikawa et al. 2011; Yamazaki 2022). While the flowers lack petals, sepals of both male and female flowers change color from yellow to red, which likely serves as a visual cue for pollinators (Upson & Cullen 2012; Ohashi et al. 2015). Numerous old male flowers and a small number of aborted female flowers were observed scattered on the ground and on shrubs below *F. simplex* trees at the observation site.

At 14:56, a female scoliid wasp was observed approaching a fallen male *F. simplex* flower on an azalea shrub, *Rhododendron* × *pulchrum* Sweet (Ericaceae), which was not in bloom. The wasp was identified as *Campsomeriella annulata annulata* (Fabricius, 1793) (Hymenoptera: Scoliidae) based on the dark color of the forewing tips, the paucity of hairs on the mesonotum and the white hairs on the posterior edge of the abdominal terga, using the taxonomic key of Japanese Scoliidae (Terayama & Nagase 2016). The wasp was observed inserting its mouthparts between the red sepals and the coalesced filaments that resemble a thick stamen. It moved between eight different fallen flowers in approximately five minutes before disappearing. The wasp employed two distinct foraging tactics to utilize these spatially isolated, unstable resources. When the fallen flowers were wedged between stems and leaves, it positioned itself on a leaf and extended its mouthparts toward the flowers. Conversely, when a flower was positioned on a leaf, the wasp grasped the flower with its forelegs and probed the flower to extract the nectar. Several *Formica japonica* Motschoulsky, 1866 (Hymenoptera: Formicidae) worker ants were also observed to forage on the fallen flowers.

Campsomeriella annulata is a common scoliid species that is widely distributed in Japan, China, Korea, Southeast and South Asia. The species is an important natural enemy of scarabaeid pests, including *Anomala* and *Popillia* spp. (Miyagi 1960; Nagamine 1980) and plays a role in pollinating a variety of herbaceous, climber, and shrub flowers (Inoue & Endo 2006; Tanaka et al. 2006).

The present observations may be interpreted in several ways. One possibility is that the flowers were misidentified as a food resource,

with the wasp accidentally landing on the fallen flowers in search of fresh herbaceous flowers and then subsequently foraging on these suboptimal resources. After foraging in this way on eight fallen flowers for five minutes, the wasp may have adapted its foraging behavior in response to the low profitability of the resource and flew away. Such 'mistaken visits' are important for pollen transfer in rewardless flowers, which do not offer nectar or pollen to pollinators (Renner 2006). However, since discriminating between rewarding and rewardless flowers can be difficult for foragers, pollinators visit both flower types and inadvertently pollinate rewardless flowers (Lichtenberg et al. 2020). The present observation may provide insights into potential trial-and-error foraging behavior in scoliid wasps.

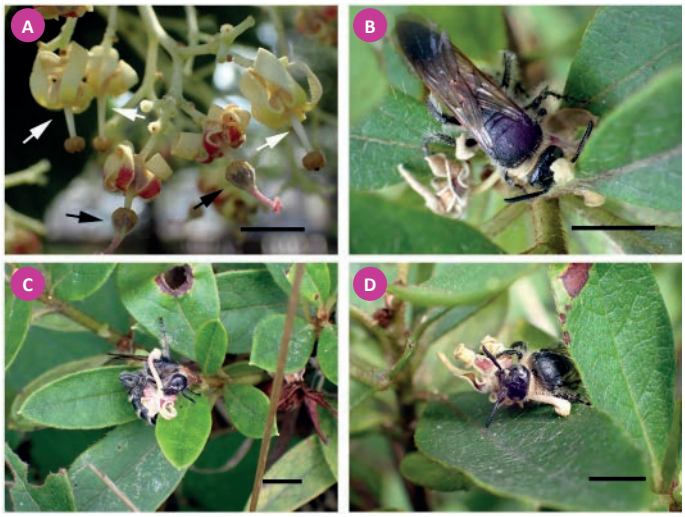

Figure 1. Utilization of fallen *Firmiana simplex* flowers by *Campsomeriella annulata*. (A) *Firmiana simplex* flowers in the canopy, with black and white arrows indicating female and male flowers, respectively; (B) *Campsomeriella annulata* inserting its glossa into an *F. simplex* flower that was wedged between a stem and a leaf; (C) *Campsomeriella annulata* holding a fallen *F. simplex* flower on a leaf while feeding; (D) Close-up view of nectar consumption from a fallen *F. simplex* flower by *C. annulata*. Scale bars: 10 mm.

Scoliid wasps possess a well-developed capacity for site fidelity and homing behavior, which facilitates efficient searching for belowground host grubs by gravid females and competitive mating with virgin females emerging from the ground by males (Tani & Ueno 2013; Alcock 2016). Thus, the atypical foraging behavior described here may represent an unusual case. An intensive field study of the flower-visiting behavior of scoliid wasps in Japan did not report the use of fallen flowers (Nagasaki 2021), although fallen flowers seem to be ignored in pollination studies. Alternatively, the wasp may actively utilize fallen flowers to avoid competition with other flower visitors for floral resources, as various bees and wasps were actively foraging at the observation site, and flowers of deciduous trees and shrubs are dominated by foraging Asian honeybees in summer in central Japan (Fujiwara & Washitani 2017). The abundant secretion of nectar in active flowers on *F. simplex* tress (Son et al. 2023) and the presence of ants foraging on the fallen flowers suggests that residual amounts of nectar may remain in fallen flowers. To test this idea, it is necessary to compare the amount of nectar and sugar concentration between active and fallen flowers. Utilizing fallen flowers may facilitate coexistence among flower-visiting species to some extent (Mohammed & Starr 1999). Additionally, the wasp might be responding to non-nectar components in the fallen flowers. Although foraging from fallen flowers by bees and wasps is infrequently reported, further research could elucidate its causes and consequences in relation to the foraging tactics employed by pollinators and interspecific competition among flower visitors.

Acknowledgment

The author thanks Dr. Pedro Reck Bartholomay and an anonymous reviewer for their valuable comments on this manuscript. Dr. Rikio Matsumoto kindly confirmed the identification of the scoliid wasp. Thanks are also due to FORTE Science Communications (https://www.forte-science.co.jp/) for English language editing.

Funding Information

This study was supported by JSPS KAKENHI Grant Number JP 24K08962.

Conflict of Interest Statement

The author declares that there are no conflicts of interest regarding the publication of this manuscript.

References

Abbate, A.; Campbell, J.; Bremer, J.; Kern, W. H. (2018) The introduction and establishment of *Campsomeris dorsata* (Hymenoptera: Scoliidae) in Florida. *Florida Entomologist*, 101(3): 543-545. doi: 10.1653/024.101.0334

Alcock, J. (2016) The scramble competition mating system of *Scolia dubia* (Hymenoptera: Scoliidae). *Journal of the Kansas Entomological Society*, 89(2): 168-173. doi: 10.2317/JKES155009.1

Ayasse, M.; Paxton, R. J.; Tengö, J. (2001) Mating behavior and chemical communication in the order Hymenoptera. *Annual Review of Entomology*, 46: 31-78. doi: 10.1146/annurev.ento.46.1.31

Campbell, J. W.; Irvin, A.; Irvin, H.; Stanley-Stahr, C.; Ellis, J. D. (2016) Insect visitors to flowering buckwheat, *Fagopyrum esculentum* (Polygonales: Polygonaceae), in north-central Florida. *Florida Entomologist*, 99(2): 264-268. doi: 10.1653/024.099.0216

Clausen, C. P.; Gardner, T. R.; Sato, K. (1932) Biology of some Japanese and Chosenese grub parasites (Scoliidae). *United States Department of Agriculture Technical Bulletin*, 308: 1-26.

Eaton, E. R. (2021) *Wasps: The Astonishing Diversity of a Misunderstood Insect*. Princeton: Princeton University Press.

Feinstein, J.; Mori, S.; Berkov, A. (2007) Saproflorivory: a diverse insect community in fallen flowers of Lecythidaceae in French Guiana. *Biotropica*, 39(4): 549-554. doi: 10.1111/j.1744-7429.2007.00279.x

Feinstein, J.; Purzycki, K. L.; Mori, S.; Hequet, V.; Berkov, A. (2008) Neotropical soldier flies (Stratiomyidae) reared from *Lecythis poiteaui* in French Guiana: Do bat-pollinated flowers attract saprophiles? *Journal of the Torrey Botanical Society*, 135(2): 200-207. doi: 10.3159/07-RA-033.1

Fujiwara, A.; Washitani, I. (2017) Dependence of Asian honeybee on deciduous woody plants for pollen resource during spring to mid-summer in northern Japan. *Entomological Science*, 20(1): 96-99. doi: 10.1111/ens.12228

Herrera, C. M. (1990) Bumble bees feeding on non-plant food sources. *Bee World*, 71(2): 67-69. doi: 10.1080/0005772x.1990.11099039

Ichikawa, T.; Kurahashi, T.; Ikudome, S. (2011) Flower-visiting bees collected in Kagawa Prefecture, Japan and the possibility of unusual pollination by the large carpenter bee (Hymenoptera: Apoidea). *Technical Bulletin of Faculty of Agriculture, Kagawa University*, 63: 43-59.

Inoue, M.; Endo, T. (2006) Spatiotemporal distribution and resource use of scoliid wasps (Hymenoptera) in coastal sand dunes. *Entomological Science*, 9(4): 359-371. doi: 10.1111/j.1479-8298.2006.00182.x

Lichtenberg, E. M.; Heiling, J. M.; Bronstein, J. L.; Barker, J. L. (2020) Noisy communities and signal detection: why do foragers visit rewardless flowers? *Philosophical Transactions of the Royal Society B*, 375(1802): 20190486. doi: 10.1098/rstb.2019.0486

Meiners, J. M.; Griswold, T. L.; Harris, D. J.; Ernest, S. K. M. (2017) Bees without flowers: Before peak bloom, diverse native bees find insect-produced honeydew sugars. *American Naturalist*, 190(2): 281-291. doi: 10.1086/692437

Miyagi, I. (1960) Ecological studies of some Japanese species of Scoliidae (Hymenoptera). *Transactions of the Shikoku Entomological Society*, 6: 104-120.

Mohammed, F.; Starr, C. K. (1999) Comparative foraging of the sympatric stingless bees *Trigona nigra* and *Partamona nigrior*

(Apidae: Meliponini). *Proceedings of the section Experimental and Applied Entomology of the Netherlands Entomological Society*, 10: 195-202.

Nagamine, M. (1980) Biology and habits of *Campsomeris annulata* (Hymenoptera: Scoliidae), a monoparasitic ectoparasite of a sugarcane white grub, *Anomala albopilosa* (Coleoptera: Rutelidae). *Bulletin of Okinawa Agricultural Experiment Station*, 5: 45-51.

Nagasaki, O. (2021) Functional specialization for pollination by scoliid wasps and solitary bees of *Ampelopsis glandulosa* (Vitaceae). *Flora*, 284: 151921. doi: 10.1016/j.flora.2021.151921

Nakagawa, S. (2000) *Firminia simplex*. In: Mogi, T. (Photos), Takahashi, H.; Katsuyama, T. (Supervised), *Woody Plants of Japan: Choripetalae 2*, pp. 554-555, Tokyo: Yamakei.

Ohashi, K.; Makino, T.; Arikawa, K. (2015) Floral colour change in the eyes of pollinators: testing possible constraints and correlated evolution. *Functional Ecology*, 19(9): 1144-1155. doi: 10.1111/1365-2435.12420

O'Neill, K. M. (2001) *Solitary Wasps: Behavior and Natural History*. Ithaca, New York: Cornell University Press.

Renner, S. S. (2006) Rewardless flowers in the angiosperms and the role of insect cognition in their evolution. In: Waser, N. M.; Ollerton, J. (Eds.), *Plant-Pollinator Interactions: from Specialization to Generalization*, pp. 123-144. Chicago: University of Chicago Press.

Requier, F.; Leonhardt, S. D. (2020) Beyond flowers: including non-floral resources in bee conservation schemes. *Journal of Insect Conservation*, 24: 5-16. doi: 10.1007/s10841-019-00206-1

Sakai, S. (2002) *Aristolochia* spp. (Aristolochiaceae) pollinated by flies breeding on decomposing flowers in Panama. *American Journal of Botany*, 89(3): 527-534. doi: 10.3732/ajb.89.3.527

Son, M. W.; Lee, K. H.; Jung, C. E. (2023) Analysis of floral nectar secretion and plant-pollinator interactions based on flower characteristics of 18 honey plant species. *Journal of Apiculture*, 38(3): 255-266. doi: 10.17519/apiculture.2023.09.38.3.255

Tani, S.; Ueno, T. (2013) Site fidelity and long-distance homing by males of solitary parasitic wasps (Hymenoptera: Scoliidae). *Canadian Entomologist*, 145(3): 333-337. doi: 10.4039/tce.2012.108

Tanaka, H.; Hatano, T.; Kaneko, N.; Kawachino, S.; Kitamura, O.; Suzuki, Y.; Tada, T.; Yaoi, Y. (2006) Andromonoecious sex expression of flowers and pollinia delivery by insects in a Japanese milkweed *Metaplexis japonica* (Asclepiadaceae), with special reference to its floral morphology. *Plant Species Biology*, 21(3): 193-199. doi: 10.1111/j.1442-1984.2006.00165.x

Terayama, M.; Nagase, H. (2016) Scolioidea. In: Terayama, M.; Suda, H. (Eds.), *A Guide to the Aculeate Wasps of Japan*, pp. 248-259. Hiratsuka: Tokai University Press.

Upson, T. M.; Cullen, J. (2012) *Firmiana simplex* Malvaceae. *Curtis's Botanical Magazine*, 29(2): 170-181. doi: 10.1111/j.1467-8748.2012.01783.x

Whigham, A. E.; Baxt, A.; Berkov, A. (2013) Senescent Neotropical flowers (Lecythidaceae) offer a rich nutrient source to ground-foraging arthropods. *Journal of the Torrey Botanical Society*, 140(1): 31-40. doi: 10.3159/torrey-d-12-00028.1

Yamazaki, K. (2022) Insects associated with extrafloral nectaries of *Firmiana simplex* trees and their possible role. In: Miyatake, Y. (Ed.) *Insecta Shiyakeana, a Special Publication from the Entomological Laboratory, Osaka Museum of Natural History, in Commemoration of the Retirement of Shigehiko Shiyake*, pp. 113-117. Otsu: Sokeisha.

Yoshimoto, J.; Powell, G. S.; Cline, A. R. (2018) Flower-inhabiting sap beetles (Coleoptera: Nitidulidae: Carpophilinae) in Guatemala. *The Coleopterists Bulletin*, 74(4): 762-766. doi: 10.1649/0010-065X-72.4.762