Sociobiology 64(1): 14-17 (March, 2017) DOI: 10.13102/sociobiology.v64i1.1216

Sociobiology
An international journal on social insects

RESEARCH ARTICLE - ANTS

The use of light to enhance weaver ant *Oecophylla longinoda* Latreille (Hymenoptera: Formicidae) queen catches

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Article History

Edited by
Evandro Nascimento Silva, UEFS, Brazil
Received 18 October 2016
Initial acceptance 08 January 2017
Final acceptance 09 January 2017
Publication date 29 May 2017

Keywords
Light source, natural predator, founding queen, Tanzania.

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Abstract

Production of live weaver ant (*Oecophylla longinoda* and *O. smaragdina*) colonies is being developed as the ants provide several ecosystem services in agriculture and as they are used in education and research laboratories. Founding queens needed for colony production can be caught in artificial nests made of live leaves that are curled on trees. In this study we investigated if the catch rate of *O. longinoda* queens in artificial nests could be improved by attracting queens to trees with a light source (electric torches). We compared catch rates of 50 artificial nests on each of eight citrus trees, four of them with light and four without light. During two mating seasons covering 9 mating flights we caught a total of 178 queens. However, 3.8 times more queens were caught in the trees with light compared to trees without light. We conclude that queen catches can be highly improved by combining artificial nests with an attracting light source.

Introduction

Weaver ants (*O. longinoda* and *O. smaragdina*) are increasingly being utilized for human applications as they perform multiple valuable ecosystem services. Firstly, these ants are used as biological control agents against a number of pests in several tropical perennial crops (Way & Khoo, 1992; Peng & Christian, 2006), where they, in many cases, are as efficient in insect pest control as conventional chemical pesticides, and in some cases, are even more efficient (Offenberg, 2015). Secondly, they may also fertilize their host plants via their deposition of ant manure on the foliage; manure that contains N-rich urea that can be taken up by plants directly through the leaves (Pinkalski et al., 2015; Vidkjær et al., 2015; Vidkjær et al., 2016). Thirdly, the ants turn the pests and other prey they feed on into edible protein rich ant biomass which is easy to harvest and thus are being utilized as human food or animal feed (Césard, 2004; Offenberg, 2011; van Huis et al., 2013); a utilization that can be combined with the use of ants as biocontrol agents and thus provide double benefits (Offenberg & Wiwatwitaya, 2010). Fourthly, weaver ants are increasingly being investigated by researchers and are utilized in science education as a laboratory model organism (Van Mele, 2008; Offenberg, 2015).

Based on these applications there is an increasing needs to obtain founding weaver ant colonies. Such colonies can be used to stock ant nurseries that are culturing ants to farmers in order to facilitate implementation of weaver ant biocontrol programs and weaver ant mini-livestock productions (Ouagoussounon et al., 2013). Further they can be used to supply laboratories with colonies used in research and education. This is especially important as it is difficult to detect the single nest with the maternal queen(s) in weaver ant colonies as queen nests are small, placed high in the canopy,

ISSN: 0361-6525

and are one out of up to several hundred nests per colony (Peng et al., 1998; Van Itterbeeck et al., 2015)

Weaver ant queens disperse under their nuptial flight which takes place during rainy seasons (Nene et al., 2015; Nielsen et al., 2015; Rwegasira et al., 2015a; Rwegasira et al., 2015b). After mating they search for suitable nesting sites which under natural conditions are overlapping or curled leaves on host plants placed outside established weaver ant territories. During this process queen mortality is extremely high with probably less than 1 % of the queens surviving the first few days since good hiding places are in limited supply (Offenberg unpublished data). To arrest queens and increase their survival the application of artificially curled leaves have been used to ease the collection of founding queens. By providing such nests, collection success can be increased up to 100-fold compared to simple visual searches of plant foliage, and even with less time expenditures (Rwegasira et al., 2015a).

During recent studies on weaver ant mating flights it was observed that *O. longinoda* performed their nuptial flights at sunset (Nene et al., 2016). This is in contrast to *O. smaragdina*, which perform the flights at sunrise (Nielsen et al., 2015). Since *O. longinoda* perform flights just before nightfall, high numbers of queens are attracted to light sources right after the flight (Rwegasira et al., 2015a). Based on this, we hypothesized that a light source could be used to further increase the collection success of founding queens if combined with artificial nests. If trees with artificial nests are provided with a light source, queens may be attracted/lured to these trees where after it becomes easier for them to find and settle in the nests. In this study we compared queen catch frequencies in artificially nests on trees with and without a light source.

Methodology

Experiments were carried out at Naliendele Agricultural Research Institute, (10^0 21´ 22.49" S, 40^0 09´ 57.05" E and 140 Meters above sea level) about 10 km from Mtwara town in the southern part of Tanzania. The Mtwara region has a unimodal wet season, with regular rains from November/December to April/May. The annual rainfall ranges from 810 to 1090 mm. Weaver ant queens were trapped using artificially folded leaves as described by Peng et al., (2013). The study period covered two different mating seasons (December 2014 to February 2015 and December 2015 to February 2016).

Two different locations were selected, each with several small citrus trees (ranging between 3 and 5 m height) without weaver ants or other ant species in the canopy, in an area otherwise inhabited by mature *O. longinoda* colonies producing sexuals. On each site two pairs of the small ant-free trees were selected and 50 artificial nests were made in each tree. In each pair, one of the trees was mounted with two battery driven light torches (three volt each) attached to the canopy at a height between 2 and 3.5 m. The other tree in each pair was left without light. Whenever a mating flight was observed during each of the mating periods, the torches were turned on, on the evening of the flight between 6.45 and 7.00 PM. The same night they were switched off again between 8.30 and 9.00 PM, allowing the queens to search for nests during the rest of the night. On each morning following a flight (between 6.30 and and 7.30 AM) the presence of queens in the artificial nests was assessed and the number of queens caught in each tree was recorded. The caught queens were subsequently kept in match boxes for 60 days to test if they had mated before being attracted to the light. As successfully mated queens lay eggs that are able to hatch into larvae, queens were recorded as mated if they produced brood beyond the egg stage (Nene et al., 2015). As queens caught with light traps potentially could be harmed by flying into the torches, queen mortality was also recorded after the 60 day period.

To avoid pseudo-sampling the number of queens caught on each tree was summed for each season as more flights occurred per season. The effect of light on catch efficiency was tested by comparing the total number of queens caught per tree between trees with and without light with Wilcoxon one-way tests (Using JMP 11). Mortality was compared between treatments with a G-test. Furthermore, the total number of queen caught per tree per site in a season is illustrated in Fig 1.

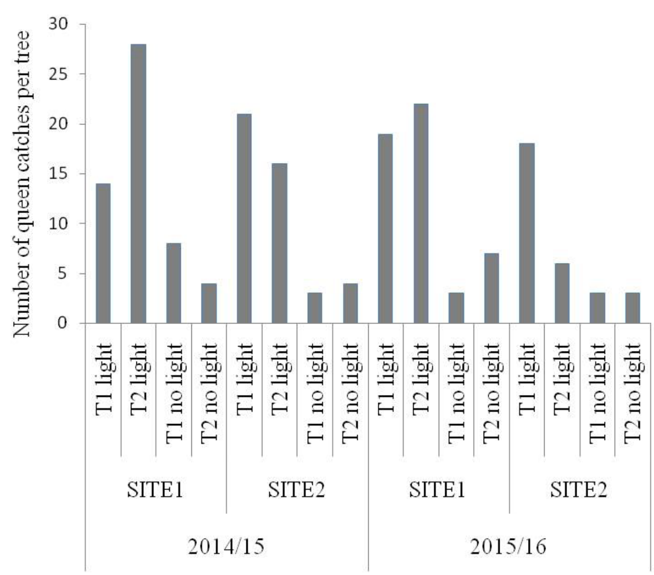

Fig 1. Number of *O. longinoda* queen catches per tree from two sites in 2014/15 and 2015/16 at Naliendele Agricultural Research Institute, Mtwara, Tanzania. Where: T1 and T2 are tree number 1 and 2 respectively.

Results

A total of nine flights were observed during the study with five flights in the 2014/15 season and four flights in the 2015/16 season. In the first season two and three flights (one was common for both sites) were observed at the two sites, whereas two flights were observed per site in the second season. In the first season a total of 91 queens were caught, with 72 of them being caught on trees with light traps and the remaining 19 caught on trees without light (Wilcoxon:

Chi square =5.5, P = 0.019). Five of the 72 queens in the light treatment died whereas 1 queen of the 19 queens from the trees without light died (G-test: G = 0.07, P = 0.80). In the second season a total of 87 queens were caught with 69 of them originating from trees with light and 18 from trees without light (Wilcoxon: Chisquare =5.4, P = 0.020). In this season all the queens survived. In total (pooling the two seasons) 3.8 times more queens were caught in the trees with light compared to the control trees without a light bulb. The average catch rate per tree (50 artificial nests) per mating flight was 7.8 (± 1.18 SE) and 2.1 (± 0.33 SE) queens in the light and control treatments, respectively.

All the queens from both seasons and treatments produced eggs that hatched to larvae and were thus expected to have been mated successfully prior to settling in the artificial nests.

Discussion

These results show that combining lights with artificial nests could successfully increase catch rates of *O. longinoda* queens almost four-fold compared to the use of artificial nests only. This may help researchers and ant nursery managers to reduce the costs associated to the collection of ant queens. Also the increased catch efficiency means that collectors may catch queens even after small flights and in this way the season of positive catches may be extended. This means higher security for collectors. Whether the method also works for *O. smaragdina* is questionable as this species make their nuptial flights in the morning (Nielsen et al., 2015). Thus, queens have most of the day available to find suitable nesting sites and are therefore likely to settle before nightfall. On the other hand, *O. smaragdina* queens have been caught at light sources in the night time in Thailand (Offenberg, unpublished data), suggesting that not all queens settle within the first day of the flight.

As queen mortality did not differ between the two treatments it is unlikely that the queens damaged themselves when flying into the light sources, in this case electric torches. This potential drawback of the method, thus, seems to be of no concern.

Another concern was that the queens could be attracted to the light before having had a chance to mate. This, however, was also not a problem in the present study, as all queens that were caught produced viable offspring. This means that mating takes place at least before the lights were turned off at no later than 9.00 PM, and probably much sooner. We therefore conclude that the mating takes no longer than two and a half hours and probably considerably less. This is the time from the beginning of the flights that does not take place earlier than 6.25 PM (Nene et al., 2016) until 9.00 PM, the latest at which lights were switched off. In comparison *O. smaragdina* in Darwin, Australia start their flights at sunrise and start to settle on foliage during the afternoon. However, when exactly their mating takes place and how long it takes is unknown (Nielsen et al., 2015).

Acknowledgement

We thank the Naliendele Agricultural Research Institute and farmers at Naliendele village for providing the fields for the experiments. Our sincere gratitude is to Mr. Hasan Libubulu for his assistance in data collection.

References

Césard, N. (2004) Harvesting and commercialisation of kroto (*Oecophylla smaragdina*) in the Malingpeng area, West Java, Indonesia. *Forest products, livelihoods and conservation. Case studies of non-timber product systems* (eds K. Kusters & B. Belcher), pp. 61-77. Center for International Forestry Research, Bogor.

Nene, W. A., Rwegasira, G. M., Nielsen, M. G., Mwatawala, M. & Offenberg, J. (2016). Nuptial flights behavior of the African weaver ant, *Oecophylla longinoda* Latreille (Hymenoptera: Formicidae) and weather factors triggering flights. Insectes Sociaux, 63: 243-248. doi: 10.1007/s00040-015-0456-9

Nene, W. A., Rwegasira, G. M., Offenberg, J., Mwatawala, M. & Nielsen, M. G. (2015). Mating behavior of the African weaver ant, oecophylla longinoda (Latreille) (Hymenoptera: Formicidae). Sociobiology, 62: 396-400. doi: 10.13102/sociobiology.v62i3.650

Nielsen, M.G., Peng, R., Offenberg, J. & Birkmose, D. (2015). Mating strategy of *Oecophylla smaragdina* (Hymenoptera: Formicidae) in northern Australia. Austral Entomology, 55: 261-267. doi: 10.1111/aen.12182

Offenberg, J. (2011). *Oecophylla smaragdina* food conversion efficiency: prospects for ant farming. Journal of Applied Entomology, 135: 575-581. doi: 10.1111/j. 1439-0418. 2010.01588.x

Offenberg, J. (2015). Ants as tools in sustainable agriculture. Journal of Applied Ecology, 52: 1197-1205. doi: 10.1111/1365-2664.12496

Offenberg, J. & Wiwatwitaya, D. (2010). Sustainable weaver ant (*Oecophylla smaragdina*) farming: harvest yields and effects on worker ant density. Asian Myrmecology, 3: 55-62. doi: 10.20362/am.003008

Ouagoussounon, I., Sinzogan, A., Offenberg, J., Adandonon, A., Vayssières, J. F. & Kossou, D. (2013). Pupae transplantation to boost early colony growth in the weaver ant *Oecophylla longinoda l*atreille (hymenoptera: Formicidae) pupae transplantation to boost early colony growth in the weaver ant oecophylla longinoda latreille (hymenoptera: Formicidae). Sociobiology, 60: 374-379. doi: 10.13102/sociobiology.v60i4.374-379

Peng, R., Nielsen, M. G., Offenberg, J. & Birkmose, D. (2013). Utilisation of multiple queens and pupae transplantation to boost early colony growth of weaver ants *Oecophylla smaragdina*. Asian Myrmecology, 5: 177-184.

Peng, R. K. & Christian, K. (2006). Effective control of Jarvis's fruit fly, *Bactrocera jarvisi* (Diptera : Tephritidae), by the weaver ant, *Oecophylla smaragdina* (Hymenoptera : Formicidae), in mango orchards in the Northern Territory of Australia. International Journal of Pest Management, 52: 275-282. doi: 10.1080/09670870600795989

Peng, R. K., Christian, K. & Gibb, K. (1998). Locating queen ant nests in the green ant, *Oecophylla smaragdina* (Hymenoptera, Formicidae). Insectes Sociaux, 45: 477-480. doi: 10.1007/s000400050103.

Pinkalski, C., Damgaard, C., Jensen, K. M.V., Peng, R. & Offenberg, J. (2015). Quantification of Ant Manure Deposition in a Tropical Agroecosystem: Implications for Host Plant Nitrogen Acquisition. Ecosystems, 18: 1373-1382. doi: 10.1007/s10021-015-9906-5

Rwegasira, R. G., Mwatawala, M., Rwegasira, G. M., Mogens, G. N. & Offenberg, J. (2015a) . Comparing different methods for trapping mated queens of weaver ants (*Oecophylla longinoda*; Hymenoptera: Formicidae). Biocontrol Science and Technology, 25: 503-512. doi: 10.1080/ 09583157.2014.992861

Rwegasira, R. G., Mwatawala, M., Rwegasira, G. M. & Offenberg, J. (2015b). Occurrence of sexuals of African weaver ant (*Oecophylla longinoda* Latreille) (Hymenoptera: Formicidae) under a bimodal rainfall pattern in eastern Tanzania. Bulletin of Entomological Research, 105: 182-186. doi: 10.1017/S0007485314000868

Van Huis, A., van Itterbeeck, J., Klunder, H., Mertens, E., Halloran, A., Muir, G. & Vantomme, P. (2013). Edible Insects: future prospects for food and feed security. pp. 201. FAO, Rome.

Van Itterbeeck, J., Sivongxay, N., Praxaysombath, B. & van Huis, A. (2015). Location and external characteristics of the *Oecophylla smaragdina* queen nest. Insectes Sociaux, 62: 351-356. doi: 10.1007/s00040-015-0411-9

Van Mele, P. (2008). A historical review of research on the weaver ant *Oecophylla* in biological control. Agricultural and Forest Entomology, 10: 13-22. doi: 10.1111/j.1461-9563. 2007.00350.x

Vidkjær, N. H., Wollenweber, B., Gislum, R., Jensen, K. M. V. & Fomsgaard, I. S. (2015). Are ant feces nutrients for plants? A metabolomics approach to elucidate the nutritional effects on plants hosting weaver ants. Metabolomics, 11: 1013-1028. doi: 10.1007/s11306-014-0757-4

Vidkjær, N. H., Wollenweber, B., Jensen, K. M.V., Ambus, P. L., Offenberg, J. & Fomsgaard, I. S. (2016). Urea in Weaver Ant Feces: Quantification and Investigation of the Uptake and Translocation of Urea in *Coffea arabica*. Journal of Plant Growth Regulation, 35: 1-12. doi: 10.1007/s00344-016-9586-1

Way, M. J. & Khoo, K. C. (1992). Role of ants in pest-management. Annual Review of Entomology, 37: 479-503. doi: 10.1146/annurev.en.37.010192.002403