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ORIGINAL ARTICLE

Pollination ecology of *Acacia gerrardii* Benth. (Fabaceae: Mimosoideae) under extremely hot-dry conditions



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Abstract Talh trees (*Acacia gerrardii* Benth.) are acacias that are native to the arid and semiarid Africa and west Asia. We investigated the flowering biology, pod set and flower visitors of Talh and discussed the role of these visitors in pollen transfer. The Talh trees blossomed laterally on the nodes of one-year-old twigs. Each node produced 21 flower buds seasonally. Each flower bud opened to a flower head (FH) of 60 florets. The bagged FHs podded significantly ($p \leq 0.05$) less than did the unbagged FHs. The FHs were visited by 31 insect species (25 genera, 16 families and 5 orders). The major taxa were honeybees, megachilids, butterflies, ants, beetles and thrips. Each of honeybees, megachilids and beetles showed a significant ($p \leq 0.05$) hourly pattern, while each of butterflies, ants and thrips had no hourly pattern ($p > 0.05$). Furthermore, some birds and mammals touched the Talh FHs. Talh trees evolved a mass flowering behavior to face pre- and post-flowering obstacles. Megachilids seemed to play the major effort of zoophily because of their relatively high numbers of individuals and species and their effective movement behavior on the FH surface. Nevertheless, honeybees and other insects and vertebrate taxa also contributed to the pollen transfer. These results greatly contribute to our understanding of the pollination ecology of acacias, especially Arabian acacias.

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1. Introduction

Acacias are woody flora that are spread throughout Africa, Australia, Asia, and America and have been introduced into Europe. Acacias are key components in arid and semi-arid environments (Ross, 1981) and produce timber, fruits, fodder and some plant secondary compounds (Midgely and

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Turnbull, 2003). Acacias are used in traditional medicine worldwide (Ross, 1981), contribute to biomass and support the diversity of invertebrate and vertebrate herbivores (Kruger and McGavin, 1998).

Approximately 16 acacia species are indigenous to the Arabian Peninsula, and other species have been introduced from Australia and Mexico. Acacias are used as animal forage, fodder, and honeybee forage among others (Aref et al., 2003) and are considered the most successful survivors in arid regions (Ibrahim and Aref, 2000).

Talh trees (*Acacia gerrardii*) are native to the subtropical environments in Africa and west Asia (Dharani, 2007). These trees are considered among the most widespread acacias in the Arabian Peninsula (at least in the Saudi area) and provide people with shade and fodder, provide domestic animals with feed, and provide honeybees with nectar and pollen (Aref et al., 2003). From the flowers of *A. gerrardii*, honeybees produce one of the most desirable honeys in Saudi Arabia (Al-Khalifa and Al-Arif, 1999). Talh is the Arabic name for *A. gerrardii* and was used in this study (Bahaffi and Al-Lihaibi, 2005). Talh honey is one of the most consumed honeys in Saudi Arabia. Many beekeepers collect Talh honey from late July-early August each year.

The pollination ecology of acacias has been relatively well studied in Australia (Ford and Forde, 1976; Bernhardt and Walker, 1984; Bernhardt et al., 1984; Knox et al., 1985; Bernhardt, 1987; Vanstone and Paton, 1988; Sedgley et al., 1992; Sedgley and Harbard, 1993; Jusaitis et al., 2009; Gibson et al., 2011) and somewhat in Africa (Tybrik, 1989, 1993; Kruger and McGavin, 1998; Stone et al., 1996; Stone et al., 1998; Fleming et al., 2006, 2007) and America (Baranelli et al., 1995). However, this ecology has either been sparsely or not at all studied elsewhere (Stone et al., 2003). Although acacias are the major flora species in the Arabian Peninsula, their pollination ecology, flowering biology, pod set and flower visitors have not been explored.

The aim of this study was to investigate the flowering biology, pod set and flower visitors of Talh trees. This study is part of a research project that explores the nectar secretion dynamics and pollination ecology of Talh trees and the interaction of these trees with honeybees.

2. Materials and methods

2.1. Study region

Field investigations were performed in Rawdhat-Khoraim oasis, a naturally preserved area in central Saudi Arabia. This lies approximately 25°32' North and 47°17' East and is 1817 feet above sea level. This region is extremely hot-dry during the summer and is relatively cold during the winter. Talh (*A. gerrardii*) trees constitute a prime tree population among many tree species. In general, the plant cover is rich compared to the surrounding desert (Alfarhan, 2001). Talh trees in the study region depend on surrounding estuaries during the autumn, winter and spring. The field investigations were repeated in 2011 and 2012 to generate more realistic general mean values. Laboratory tasks were performed in the labs and museum of the Plant Protection Department, King Saud University, Riyadh, Saudi Arabia.

2.2. Tested plants

Five random Talh trees, all of reproductive age, were randomly selected. These trees were studied for two years. The selected trees were labeled with plastic tags that were fixed onto their trunks. These trees were unprotected and therefore reachable to all potential flower visitors.

2.3. Flowering biology

Fifteen nodes were randomly selected from each selected tree in April 2011 and 2012. The nodes were selected from one-year-old twigs because Talh trees blossoms on twigs of this age. The nodes were labeled using small plastic tags that were fixed with a piece of metallic thread and were observed weekly from April-August 2011 and 2012. The flower buds that budded on the selected nodes were counted, documented and cut. The total number of yearly flower buds of each selected flowering node was calculated. The described methods were improved from those of Baranelli et al. (1995) and Adgaba et al. (2012).

Twenty flower heads (FHs) were selected and cut from each selected tree during the mid-bloom season (July) in 2011 and 2012. The florets of each selected FH were counted to document the number of florets per FH (Baranelli et al., 1995; Fleming et al., 2007). Each counted floret was immediately removed to avoid double counting because the FH of Talh is composed of very condensed florets.

2.4. Pod set

Two flowering twigs (one-year-old) were randomly selected from each selected tree in late April when the first flower buds appeared. The selected twigs were at least three meters above ground to be unreachable by camels (Fleming et al., 2007), which are common in the study area during the flowering season. From each selected twig, 10 flowering nodes were selected, and the remaining nodes were removed using a sharp cutter. One of the two selected twigs at each selected tree was bagged using pollination bags (made of bridal veil), while the other was unbagged. The purpose of this procedure is to compare the pollinator-accessed (unbagged) and the pollinator-unaccessed (bagged) twigs. The selected pollinator-unaccessed (P-unaccessed) and pollinator-accessed (P-accessed) twigs were labeled using small plastic tags that were bound with metallic threads. The selected twigs were checked weekly to ensure that no damage occurred, and the bags did not directly touch the FHs. After the bloom season in late August, the number of pods at each selected node were counted and documented. The ratios of the pods/flowering node and pods/FH were calculated. The average ratio of buds per node of each selected tree was treated as the number of FHs per each selected node of the same tree. This procedure was used assuming that all the flower buds opened and produced FHs.

The described procedures were applied twice: in 2011 and 2012. These procedures were modified from those previously described (Sedgley et al., 1992; Baranelli et al., 1995; Raju and Rao, 2002; Jusaitis et al., 2009). Generally, these experiments were designed to document the pod set percentage of Talh FHs and to compare the percentages of each P-accessed

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