Plant with Toxic Nectar Kills Native Honey Bees in SW China

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A plant with long-lived flowers, *Elsholtzia rugulosa*, produces copious nectar. Chinese honey bees, *A. cerana*, depend on food from this plant to overwinter. However, the nectar has been found to contain phenolics. Honey bees have suffered heavy losses in recent years. It was estimated that about 24.5% of SW Chinese colonies were lost during the florescence of the plant. Less honey storage and heavy losses of colonies strongly imply that the phenolics-containing nectar had increasing influences in the long- and short-term survival of honey bees. Both feral and domestic colonies are at risk from the nectar of this plant. The honey is harmless to people consuming it.

Introduction

Both wild and managed bees are disappearing at alarming rates (Watanabe, 1994; Kearns et al., 1998). These dramatic declines are believed to be the result of insecticides, reduced availability of nectar, parasites, destruction of habitat along migratory corridors, modern agricultural practices, grazing, and invasive species (Kearns et al., 1998). However, very little attention has been paid to potential food influences in the long- and short-term survival of pollinator populations.

It has been known that flora nectar, usually secreted from specialized glands within flowers, is utilized by honey bees for the energy-providing sugar that it contains. However, the phenolic compounds associated with resistance to herbivores (Haslam, 1988) is ubiquitously present in nectar (See ref. Adler, 2000). It has been estimated that more than 30% of the plant species secrete nectar with phenolics (Baker, 1977). The phenolics-containing nectar usually deters honey bees (Haglar and Buchmann, 1993).

A warming climate increases the herbivorous insect's food demand (Coley, 1999). Honey bees often take a risk to collect the alkaloids- and pheolics-containing nectar at a time when few flowers are available (Haglar and Buchmann 1993; Fægri and van der Pijl). Consequently, toxic nectar, referring to the nectar that contains secondary compounds (Adler, 2000), may be a potential threat to honey bees in a warming climate.

In the present study, we studied the nectar of *Elsholtzia rugulosa,* addressing the issue about the effect of food on honey bees.

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Materials and Methods

Study area

Yao'an is one of the reserve areas of Chinese honey bees, where the introduced species, *Apis mellifera*, is not permitted to immigrate. In winter, the bee flower available in the region is *Elsholtzia rugulosa* (Fig.1a), a widely distributed herbaceous plant with long-lived flowers (from Oct to Dec) (Xu, 1983). Chinese honey bees, *A. cerana*, depend on food from this plant to overwinter.

Detection of phenolics in nectar or honey

We collected nectar by pressing the honey stomachs of forager bees when they returned to the colony after foraging for nectar. Nectar drops were placed on Whatman #1 chromatography paper and dried rapidly. These samples were used subsequently to detect phenols after Baker and Baker (1975).

Relative astringency (RA) indicates the deterrence of phenolics to herbivores. Ten ml of nectar or capped honey was mixed with 20 ml methanol (70%), and was left at room temperature for 24 hr. The methanol-water elicited phenolics were centrifuged at 5000 r/m for 10 min. The 1 ml supernatant was diluted with sterile water to 10 ml. Its absorbancy at 280 nm was measured (A_0).

Another 1 ml of phenolics-containing supernatant was mixed with 1 ml glutin (1 mg/ml), and was diluted with sterile water to 10 ml. The mixture was incubated at room temperature for 24 hr., and was centrifuged at 10,000 r/m for 15 min. Its absorbancy at 280 nm was also measured (A_1). RA could be calculated according to $RA=(A_0-A_1)/A_0$ (Shi and Di, 2000).

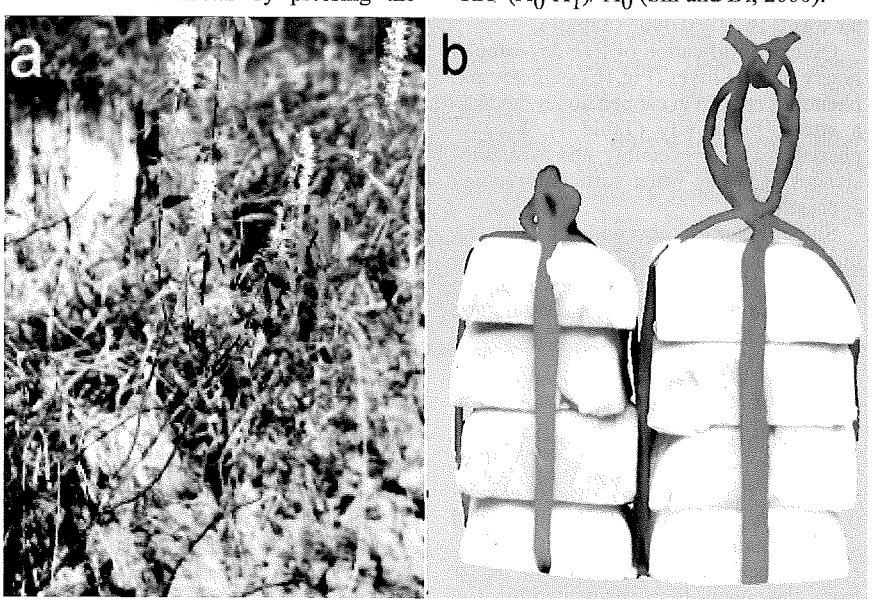

Figure 1. The plant, *E. rugulosa* (a), native to southwestern China, produces boundless nectar with phenolics. When the capped honey in combs is removed from hives, it quickly solidifies outside hives in two or three days. Local people carry the honey with a tie (b). The honey is non-toxic to people and is popular in the region where it is produced.

Table 1 The RA of fresh nectar and its capped honey of *E. rugulosa*

Sampling location	RA* of fresh nectar	RA of capped honey
Shizhong	0.1645	-
Daoun	0.1529	0.0438
Laizuozuo	0.1385	0.0592
Mimizuo	0.1744	0.0682
Cangputang	0.2157	0.0789
Average	0.1679±0.0467	0.0709±0.0177

*Relative astringency

Table 2 The percentage of colonies lost during flowering time of *E. rugulosa*

Year	No. of colonies at onset of flowering	No. of colonies lost during flowering		Percentage of lost colonies (%)
		Absconding	Death	
1996	2450	359	107	19.0
1997	1943	247	94	17.6
1998	1602	259	114	23.3
1999	1207	108	125	19.3
2000	972	126	107	24.0
2001	728	93	105	27.2
2002	530	79	81	30.2
2003	339	64	57	35.7
Average	-	-	-	24.5

Colony losses

In 1996, the local government introduced 2,450 colonies of Chinese honey bees into the area. The absconding and death of colonies during the 1996-2003 period were investigated.

Results

The plant frequently produces copious nectar. Both feral and domestic colonies actively collect nectar from this plant. However, the colonies had suffered from the nectar. The nectar was found to contain phenolics. The RA of the phenolics in nectar was 0.1679 ± 0.0467 (Table1).

Quick solidification of five-day-capped honey outside hives (Fig.1b) suggests that phenolics remain in capped honey, and has a strong bioactivity (Table 1), because phenolics can irreversibly mix with substances in honey when sufficient oxygen is present.

Some colonies absconded when the mass of flowers opened. Some colonies gradually dwindled and eventually died in winter. The percentage of absconding and death of colonies averaged 24.5% during 1996-2003 (Table 2).

Discussion

Although several plants flower in the region in winter, the plants such as *E. frnticosa*, *E. bodinieri*, *Rabdosia glaucocalyx*, *Mentha haplocalyx* were minor, and didn't sustain the honey bees' interests. Honey bees actively collect the nectar from this plant for over-wintering. The plant usually produces copious nectar. But, the nectar of *E. rugulosa* often poisons honey bees (Xu, 1983).

Here we first confirm that the nectar contains phenolics, which are ubiquitous defensive chemicals that are present in nectar. For honey bees, it is more common to first process nectar into palatable honey, instead of feeding on it directly (Winston 1987). The remaining phenolics in capped honey (Table 1) suggest that phenolics in nectar were not deactivated completely during the external inversion of nectar. The result indicates that colonies suffered from the antibiotic phenolics in nectar or honey.

Local people traditionally capture swarms of feral honey bees for honey production at the initial flowering of the plant. But few colonies have been captured in recent years. The widespread death of domestic colonies (Table 2) and less honey harvested in 1990's (Liu et al., 2004) strongly indicate that both feral and domestic colonies might be at risk from the toxic nectar.

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