

NECTAR SECRETION, AMOUNT AND TYPE OF NECTAR SUGARS AND INSECT FORAGING IN *WOODFORDIA FLORIBUNDA* SALISB.

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SUMMARY

Woodfordia floribunda flowers secreted 126.4 μ l of nectar in 3 days. Nectar-sugar concentration was 10.65-12.2 %. Only fructose and glucose were present in nectar as were analysed by paper chromatography and total sugars were 12.5 mg/flower. *Apis dorsata*, *A. cerana indica*, wasps, ants and flies visited the flowers for nectar.

INTRODUCTION

Woodfordia floribunda Salisb. (Lythraceae) commonly called « Dhain », a shrub with long spreading branches is found in lower hills up to 1500 m. elevation. Its flowers are numerous, clustered, short stalked and bright red in colour and are used for dyeing silk. This shrub flowers during hot summer months (May-June) and is visited by insects for nectar. There is no information available on the utilization of this flora by bees vis-a-vis other insects. Therefore, an attempt was made to evaluate *W. floribunda* as bee forage.

MATERIALS AND METHODS

Studies were carried out during May, 1982 at S.N.S. Nagar, Solan (1400 m. elevation). Five branches with floral buds on each five plants were enclosed in nylon net (16 mesh) cages separately to avoid the removal of nectar by insects. All opened flowers were removed before caging. Observations were made on the (i) duration a flower continues to secrete nectar, (ii) total volume of nectar secreted per flower, (iii) sugar concentration of nectar in caged and uncaged flowers, (iv) types of sugars in the nectar and (v) insect activity during different hours of the day.

Freshly opened flowers on the caged branches were marked every day. Total number of flowers observed for nectar secretion varied from 9 to 16 per branch of the five plants (total, 59 flowers). Averages for a branch on a plant were computed. Amount of nectar secreted by a flower was collected and measured daily at 1100 and 1500 h with a graduated microcapillary pipette for the period until nectar secretion ceased. Nectar-sugar concentration was measured with hand refractometer (0.32%). Nectar was qualitatively analysed by using descending paper chromatography with butanol + benzene + pyridine + water (5 : 1 : 3 : 3) as solvent and aniline phthalate as developer. Developed spots were eluted in 5 ml of ethanol (50 %) for one hour and absorbance of the unknown was read at 379 nm. Since only two spots, comparable to fructose and glucose were developed, the final chromatogram was run with a standard of these (3 spots of 10, 20, 30 μ l of 500 mg/10 ml of each) sugars. Spots of standard sugars were eluted for preparing standard curves and the value of the unknown was read from the standard curves. Frequency of different insect foragers was recorded at 1000, 1200 and 1500 h for each flowering shrub for 5 min for 15 days and averages were computed. Three shrubs were observed at each hour every day.

RESULTS

Data on nectar secretion (Table 1) indicated that each flower secreted 126.46 μ l nectar. *W. floribunda* flowers secreted nectar for three days after opening. The maximum amount of nectar was secreted on second day (64.86 μ l/flower). But on the first and third day it was 19.8 and 41.80 μ l/flower. Nectar was drawn from the flowers at 1100 and 1500 h and there was little nectar secretion i.e. 0, 7.1 and 2.4 μ l on 1st, 2nd and 3rd day, respectively between these hours. Concentration of nectar of caged and uncaged flowers was 10.65 and 12.2 per cent, respectively. Amount of dry nectar sugars calculated from the volume of nectar secreted and the sugar concentration of nectar, was 13.47 mg per flower.

Qualitative analysis of *W. floribunda* nectar revealed that it contained only two sugars, fructose and glucose, in the ratio of 1 : 1.04. Amount of total sugars determined by elution of spots and measuring absorbance in spectrophotometer, was 12.5 mg/flower.

TABLE 1. — Amount of nectar secreted (μ l) by *W. floribunda* flowers during three days of nectar secretion

Day after flower opening	Avg. nectar per flower					Mean
	1	2	3	4	5	
1st	23.8	22.2	15.3	31.2	6.5	19.8
2nd	76.9	90.6	56.6	53.2	47.0	64.86
3rd	49.0	53.6	26.0	27.0	53.4	41.80
	149.7	166.4	97.9	111.4	106.9	124.46

The corolla of the flowers was 1.7 cm long but not narrow and different insects were able to reach the base. Insect foragers (Table 2) on *W. floribunda* were *Apis dorsata*, *A. cerana indica*, ants wasps (*Vespa* sp. and *Polistis* sp.) and flies. *Apis mellifera* was not observed, though some colonies were present in the vicinity. *A. dorsata* (3.0/shrub/5 min.), *A. c. indica* (2.67) and ants (3.56) did not differ from each other with respect to their frequency of visits. Dipteran flies (2.00) and wasps were lower in number than other insect foragers. Insects availing nectar were greater in number in the morning (0900 h) ; their activity declined at 1200 h and furthermore at 1500 h.

TABLE 2. — Activity of insects on Woodfordia flowers during different hours (per 5 minutes)

Name of Insect	Time of observation (hours)			Mean
	0900	1200	1500	
1. <i>A. dorsata</i>	2.67 (1.91) *	4.67 (2.41)	1.67 (1.62)	3.00 (1.98)
2. <i>A.c. indica</i>	5.00 (2.44)	2.00 (1.71)	1.00 (1.38)	2.67 (1.84)
3. Ants	6.00 (2.67)	2.67 (1.91)	2.00 (1.66)	3.56 (2.08)
4. Wasps	1.33 (1.47)	1.67 (1.58)	1.00 (1.38)	1.33 (1.48)
5. Flies	4.00 (2.24)	1.00 (1.38)	1.00 (1.33)	2.00 (1.65)
	3.80 (2.15)	2.40 (1.80)	1.33 (1.47)	2.51 (1.81)

* Figures in parentheses are $\sqrt{n + 1}$ transformation

CD_{0.5} Insect visitor = 0.32
 Time = 0.25
 Interaction = 0.55
 (insect visitors
 × time)

DISCUSSION AND CONCLUSION

Woodfordia floribunda flowers during summer and produces abundant nectar (126.46 µl/flower), though nectar sugar concentration is low (10.65 %), but even poor forages are valuable when available during dearth period. Though bees prefer forages with higher nectar sugar concentrations, honeybees are known to collect dilute nectar of fruit crops with as low as 6 % sugars (ZAURALOV, 1983). Sugar concentration of *Melaleuca leucadendron* nectar is 8 % (ZMARLICKI, 1980) but the forage has been reported to be a good source of surplus honey (GOODACRE, 1947 ; CRANE, 1973). *Bombax ceiba* is also a major (NAIM and PHADKE, 1976) to medium (CHAUBAL and KOTMIRE, 1980) source of surplus honey and the nectar sugar concentration in this case is as low as 6 % (ZAMARLICKI, 1980). The amount of nectar produced varies to a

great extent in different plants. One flower of rape secretes 0.17 to 0.35 μ l (SZABO, 1982), *Robinia* 38.4 mg (HOWES, 1979) and *Ochroma lagopus* 1800 mg (HEINRICH, 1975) of nectar. *W. floribunda* has been found to secrete a moderately high amount (126.47 μ l) of nectar. Sugar value of *W. floribunda* nectar was 12 mg/flower which is higher than for many of the important bee forages varying between 0.92 mg (*Trifolium*) to 5.4 mg in *Tilia* (CRANE, 1979).

Qualitative analysis of nectar indicated the presence of only two sugars, fructose and glucose. The amount of nectar sugars determined spectrophotometrically was 12.5 mg as compared to 13.47 mg calculated from the total volume of nectar secreted and the concentration of nectar determined by using hand refractometer. This discrepancy of about 8 % can be explained since INOUE *et al.* (1980) reported that it is not precise to estimate nectar sugars using a refractometer calibrated in percentage sucrose concentration, as the refractive indices of nonsugar components interferes with measurements of sugar concentration and results in overestimates of 8-13 %. From these close estimates of nectar sugars by two methods, it is also inferred that the nectar contains only two sugars. Though most of the nectars contain more than two sugars including fructose and glucose, WAKHLE *et al.* (1981) have found that *Schefflera* and *Gravillea* nectar contained only glucose and fructose. VAN HANDEL *et al.* (1972) also observed no sucrose and only fructose and glucose in *Callistemon* and cultivated *Hibiscus* nectars. Fructose to glucose ratio of 1.04 in the present studies received support from ROWLEY (1976) who reported fructose/glucose ratio to be 1.0 or more in 26 and less than 1.0 in 14 common Philippine nectars.

Activity of insect foragers was high in the morning hours (0900) and declined significantly during later hours. This is attributed to the fact that no or very little nectar (0-7.1 μ l/flower) was secreted from 1100 to 1500 h and it showed that most of the nectar was secreted in the evening or morning hours and hence much insect foraging activity in the morning. *W. floribunda* flower has a tubular corolla and changes in the volume of nectar are known to influence accessibility of nectar in tubular corollas (CORBET, 1978). During the day the volume of nectar in the flower is also reduced because of evaporation as the nectar-sugar concentration varies from 8.2 % in the morning and 12.5 % during evening hours and reduced nectar collection by insects is expected from morning through evening.

It appears probable that high nectar — water content in *W. floribunda* also satisfies water requirements of bees in the hives during hot summer — dearth period besides being a sugar energy source.

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RÉSUMÉ

SECRETION NECTARIFÈRE, QUANTITÉ ET TYPES DE SUCRES DU NECTAR
ET VISITE PAR LES INSECTES DE *WOODFORDIA FLORIBUNDA* SALISB.

Woodfordia floribunda Salisb. fleurit abondamment pendant la période sèche (mai-juin). La sécrétion nectarifère (volume et durée), la quantité et les types de sucres du nectar et les insectes butineurs ont été étudiés à Solan dans la province d'Himachal Pradesh (1400 m d'altitude). Le nectar a été prélevé chaque jour à 11 h et 15 h à l'aide de microcapillaires gradués dans des fleurs placées sous cages insect-proof. Les types de sucres ont été déterminés par chromatographie sur papier et la quantité de sucres a été estimée par élution des taches. Les insectes butineurs ont été comptés sur chaque arbuste à 10 h, 12 h et 15 h pendant 15 jours et les moyennes calculées.

Chaque fleur a secrété 126,46 µl de nectar en 3 jours de floraison (Tabl. 1). La concentration en sucres du nectar a été de 10,65 dans les fleurs engagées et de 12,20 dans les fleurs non engagées. Le nectar ne renferme que du fructose et du glucose, comme c'est le cas pour d'autres plantes (cf. VAN HANDLE *et al.*, 1972; WAKHLE *et al.*, 1981). *Apis dorsata*, *A. cerana indica*, des fourmis, des guêpes et des mouches visitent les fleurs pour le nectar (Tabl. 2), mais on n'a pas observé d'abeille domestique (*Apis mellifica*). Le nectar de *Woodfordia* a une faible concentration en sucres mais il est récolté par les abeilles et d'autres insectes. De nombreuses autres sources de nectar avec une faible concentration en sucres sont utilisées par les abeilles (GOODACRE, 1947; CRANE, 1973; NAIM et PHADKE, 1976). En plus de l'énergie fournie par les sucres, le nectar de *W. floribunda* satisfait probablement les besoins en eau des colonies d'abeilles en été.

ZUSAMMENFASSUNG

NEKTARSEKRETION, MENGE UND ART DER NEKTARZUCKER
UND INSEKTENBESUCH BEI *WOODFORDIA FLORIBUNDA* SALISB.

Woodfordia floribunda Salisb. blüht überreich während der Trockenperiode (Mai-Juni). In Solan, H.P. (1400 m NN) wurden die Nektarabscheidung (Menge und Dauer) sowie die Menge und Art der Nektarzucker und die besuchenden Insekten studiert. Täglich wurde mit Meßkapillaren um 11.00 Uhr und um 16.00 Uhr Nektar aus mit Nylonnetzen umhüllten Blüten gesammelt. Die Zuckertypen wurden mittels Papierchromatographie bestimmt und zur quantitativen Schätzung aus den entwickelten Flecken herausgelöst. Die Insektenbesucher pro Strauch wurden durch 15 Tage jeweils um 10, 12 und 15 Uhr beobachtet und anschließend wurden Mittelwerte berechnet.

Jede Blüte schied 126,46 µl Nektar in den drei Tagen ihre Blühzeit aus (Tabl. 1). Die Nektarkonzentration betrug 10,65 % in gekäfigten und 12,20 % in ungekäfigten Blüten. Der Nektar enthielt nur Fructose und Glukose, entsprechend den Befunden an bestimmten anderen Blüten (siehe VAN HANDLE *et al.*, 1972; WAKHLE *et al.*, 1981). *Apis dorsata*, *A. cerana indica*, Ameisen, Wespen und Fliegen sammelten an den Blüten Nektar (Tab. 2), aber *A. mellifera* wurde nicht beobachtet. *Woodfordia*-Nektar besitzt eine niedrige Zuckerkonzentration, aber er wird von Bienen und anderen Insekten gesammelt; viele andere Nektarquellen mit niedriger Zuckerkonzentration (ZMARLICKI, 1980) werden von Bienen genutzt (GOODACRE, 1947; CRANE, 1973; NAIM und PADHKE, 1976). Der *W. floribunda*-Nektar befriedigt wahrscheinlich neben der Beistellung von Zuckerenergie den Wasserbedarf der Bienenvölker im Sommer.

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