

NECTAR SUGAR PRODUCTION AND FLOWER VISITORS OF THE BRAMBLE, *RUBUS ELLIPTICUS* SMITH (ROSACEAE), AT SOLAN, INDIA

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SUMMARY

Nectar sugar production in flowers of *Rubus ellipticus* averaged 6.93 mg/flower at 24 h and the accumulation of the sugar in the bagged flowers occurred only during the first 24 h of flower opening. The amount remained unchanged up to 72 h and then the flowers began to wither. Nectarivores collected about 80 per cent of the total nectar secreted. The concentration of solutes as determined from the honey sac contents of foraging *Apis mellifera*, ranged from 65.3 to 71.3 %. Honey bees (*A. mellifera* and *A. cerana indica*) were the prominent nectar foragers on the bloom. Other Hymenoptera, various Diptera and Lepidoptera were the other visitors.

INTRODUCTION

In the organization of a good food base for honey bees it is extremely important to know the available food resources and their nectar properties. Although much work has been done on the various aspects of nectar production in other parts of the world (PERCIVAL, 1946, 65 ; SHUEL, 1975 ; SIMIDCHIEV, 1976 ; NUÑEZ, 1977 ; CORBET, 1978 ; ROBERTS, 1979 a,b ; PLEASANTS, 1983 ; CORBET and DELFOSSE, 1984), negligible data are available on the nectar properties in flowering plants of India (SHARMA, 1958 ; WAKHLE *et al.*, 1981 ; GUPTA *et al.*, 1984). In our program on the evaluation of different bee forage, the present paper deals with bramble, *Rubus ellipticus* Smith (Fam., Rosaceae). It is a wild prickly shrub and bears white flowers, 0.84 to 1.27 cm in diameter, crowded in axillary and terminal panicles. It flowers from January-March and grows throughout the Himalayas at an altitude varying between 610 to 2140 meters above sea level. The fruit has the flavor of raspberry and is good to eat (COLLETT, 1921).

MATERIALS AND METHODS

The present studies were undertaken in the vicinity of an apiary (containing 30 colonies of *A. mellifera* and only 2 colonies of *A. cerana indica*) during February, 1985 at Nauni, Solan, India, situated at 30.33 °N latitude, 70.7 °E longitude and 1200 meters above sea level. Atmospheric temperature at different day hours was recorded using a simple Celsius thermometer.

Nectar

Nectar sugar concentration : Since it was not possible to collect the viscous nectar from the flowers using microcapillaries, honey stomach contents of the honey bees foraging constantly on the nectar of *R. ellipticus*, were used to determine the solute concentration. A bee that had collected nectar from the flowers for at least five minutes was captured and its honey sac contents were immediately pressed out on the prismatic surface of a hand refractometer (Erma-Tokyo-Japan, no. 2867, range 58-92 %). Twenty honeybees (*A. mellifera*) were sampled during 1000-1200 h and then during 1400-1600 h for determination of sugar concentration of their honey sac contents.

Rate of nectar secretion/accumulation : The amount of sugar present in the flowers of different age was estimated by enclosing the floral buds in nylon net cages (25 × 15 cm, 16 cm mesh size) on three different bushes. Freshly opened flowers were marked at the base of pedicel. Sampling was made at 24 h intervals till the flowers began withering. Each time ten flowers were individually rinsed in 5 ml distilled water in a capped vial for 45 minutes. After removing the flower, sugar was analysed in the rinsate following the method of ROBERTS (1979 a).

For determining the possible amount of nectar sugar harvested by the nectarivores, a parallel set of floral buds was marked and left open. The flowers were sampled after 0 (freshly opened flowers), 24, 48 and 72 h and their dry sugar contents determined. The difference between the average sugar content of bagged and unprotected flowers gave the approximate amount of sugar harvested by insects.

Insect visitors : Observations on the number and types of insects visiting each of the five quadrats of 1 m² of flowering bushes (containing at least 50 % opened flowers) per five minutes, from 1100 to 1700 h, at 2 h intervals, were made. Such counts were continued for 3 sunny days and the average values represented the activity of insects at different hours of the day.

The data were analyzed statistically by using factorial randomized block design (PANSE and SUKHATME, 1978).

RESULTS AND DISCUSSION

Nectar

Nectar sugar concentration : Nectar solute concentration did not vary significantly with time of day from 65.3 to 71.3 %. Average sugar concentrations of nectar in other species of *Rubus* have been reported to range between 38.1 and 46.6 % in blackberry (*R. fruticosus*) and 38 to 59 % in raspberry (*R. idaeus*) (SIMIDCHIEV, 1976).

Rate of nectar secretion : Average weight of nectar sugar present in bagged (Group I) and unprotected (Group II) flowers of different ages is shown in Table 1. Sugar content in the flowers of Group I represents the amount secreted and resorbed by the nectaries. Freshly opened flowers of Group I

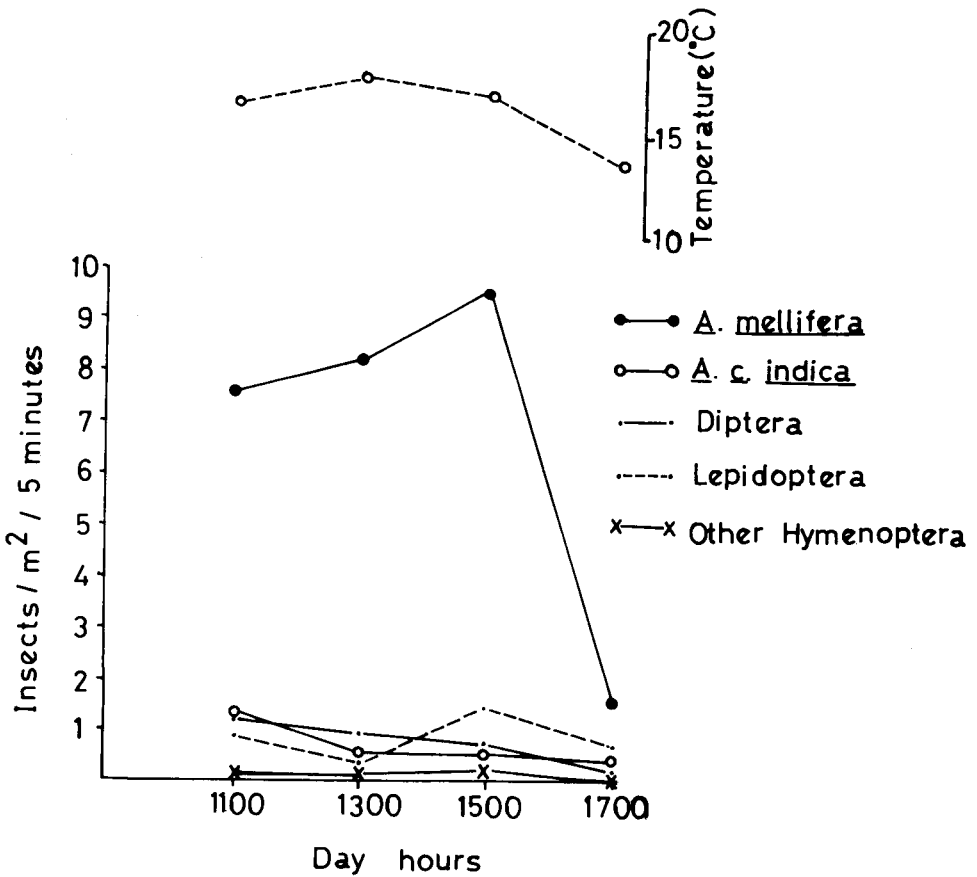


FIG. 1. — Activity of honeybees and other insect visitors on *R. ellipticus* flowers at different hours of the day.

TABLE 1. — Nectar sugar production in bagged and unprotected flowers of *R. ellipticus* at 24-hour intervals after flower opening (Feb., 1985).

Sampling period (hours after flower opening)	Mean (SE _m) nectar sugar, mg / flower	
	Bagged flowers	Unprotected flowers
0 (Freshly opened)	1.33 (0.291)	1.25 (0.125)
24	6.93 (0.646)	1.86 (0.320)
48	7.20 (0.783)	1.13 (0.068)
72	8.57 (0.597)	0.39 (0.108)
Mean	6.01	1.16

C.D. (P = 0.05) : Sugar contents in bagged or unprotected flowers = 0.613
 Interaction (hoursXnectar sugar) = significant
 For any pair of combination = 0.867

contained 1.33 mg sugar/flower. The amount increased significantly after 24 h. However, there was no significant addition to the amount of nectar sugar in 48 and 72 h old flowers. This indicates that significant nectar secretion occurred only during the first 24 h of flower opening. Nectar production rate of a plant is of importance for the insect visitors. The 24 h value (amount of sugar accumulated in a flower in 24 h after its opening) is commonly used to explain the attractiveness of different species of pollinators although the validity of this measure is still in question (PLEASANTS, 1983) particularly in those plants where resorption of nectar takes place. However, there was no apparent resorption (i.e. decrease in sugar content with the age of the flower) of nectar sugar in the flowers of *R. ellipticus* even after 72 h of flower opening. The 24 h sugar value in the present studies was 6.93 mg/flower as compared to 1.9-6.7 mg in *R. idaeus* (PETER, 1977) and 1.9-3.4 mg in *R. fruticosus* (MAURIZIO and GRAFL, 1982). The flowers of *R. ellipticus* started showing signs of withering after 72 h. The present observations revealed that the nectar secretion decreased with increase in age of the flower. SIMIDCHIEV (1976) also reported that the rate of nectar secretion of raspberry (*Rubus idaeus*) and blackberry (*R. fruticosus*) decreased with increase in age of the flowers. Average sugar content in a flower during a day (irrespective of flower age) which would be available to the nectarivores was 6.01 mg.

Nectar sugar content in the unprotected flowers represents the standing crop of nectar after being harvested by nectarivores and/or resorbed. This amount also indicated the amount of sugar available to the nectarivores during a particular day-hour. There was no significant accumulation of sugar in flowers of different ages and varied between 0.39 to 1.86 mg/flower. This might be due to quick removal of sugar by frequent insect visits. ROBERTS (1979 b) observed that in the cranberry (*Vaccinium* sp.) flowers, bee visits were so frequent that sugar did not accumulate in the unprotected flowers. The probable amount of sugar harvested by nectarivores from a flower of *R. ellipticus*, as calculated from the difference between the average amount of sugar in bagged and unprotected flowers, was to the extent of 80.7 % of the total sugar produced.

Insect visitors

The honey bee, *Apis mellifera*, was the principal nectar forager on the flowers of *R. ellipticus* during a day constituting about 73.0 % of the total insect visits. Respective values for *A. cerana indica*, other Hymenoptera, Diptera and Lepidoptera were 7.7, 1.6, 8.5 and 9.2 % respectively.

Flowering of *R. ellipticus* takes place at a time of the year (i.e. during late winter and early spring) when other good bee forages are scarce. Honey bees took full advantage of the flora for spring build up thereby constituting about

80 % (both *A. mellifera* and *A. c. indica*) of the total population of nectar foragers. Moreover, during this period, the requirements of the colonies are also high due to the start of brood rearing.

A. mellifera showed good activity during most of the day hours (Fig. 1). However, the activity was quite low in the evening when the bee count was only 1.5 bees/5 min. The low activity was apparently due to the drop in temperature. Most of the honey bees foraged only for nectar. However, some of them were also seen packing pollen incidentally collected while foraging for nectar.

It is evident from the present studies that the bushes of *R. ellipticus* provided good energetic rewards to honey bees. Each flower presented at least 8.6 mg sugar during its flowering. The concentration of sugar in nectar was also quite high (65.1 to 71.3 %), well in the range of flower preference of honey bees and bumble bees (10 to 74 %) as classified by PERCIVAL (1965). All these characteristics make *R. ellipticus* a very useful forage for honey bees.

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RÉSUMÉ

PRODUCTION DE NECTAR ET INSECTES VISITANT LA RONCE, *RUBUS ELLIPTICUS* SMITH (ROSACEAE) A SOLAN, INDE

L'étude a été menée en février 1985 à proximité d'un rucher composé de colonies d'*Apis mellifica* et d'*Apis cerana indica*, à Nauni (Solan, Inde) à 1 200 m d'altitude.

Pour déterminer la concentration en sucre du nectar, on a capturé des abeilles en train de butiner les fleurs de *Rubus ellipticus* et déterminé la concentration du contenu du jabot. La quantité de sucre dans les fleurs d'âge divers a été estimée par spectrophotométrie en enfermant les boutons floraux dans des sacs grillagés en nylon et en prélevant des échantillons toutes les 24 heures jusqu'à ce que les fleurs commencent à se faner. On a également comparé la teneur en sucre des fleurs engagées et non engagées afin de connaître la quantité de sucre récoltable par les nectarivores. L'activité des insectes a été enregistrée sur les fleurs (carrés de 1 m²) pendant 5 mn toutes les 2 heures de 11 h à 17 h.

Les résultats montrent que la concentration au sucre du nectar de *R. ellipticus* varie de façon non significative entre 65,3 et 71,3 %. Les fleurs (engagées) qui viennent de s'épanouir renferment 1,33 mg de sucre/fleur (Tabl. 1) ; cette teneur augmente jusqu'à 6,93 mg/fleur au bout de 24 h. Par la suite elle ne s'accroît pas significativement et les fleurs commencent à se flétrir au bout de 72 h. Chez les fleurs non protégées, qui représentent la récolte de nectar fixe, la quantité de sucre dans le nectar varie de façon non significative entre 0,39 et 1,86 mg/fleur, ce qui implique un prélèvement rapide du nectar sécrété. On a calculé que la quantité probable de sucre récoltée par les nectarivores sur une fleur de *R. ellipticus* avoisinait 80,7 % de la quantité totale de sucre produit.

Apis mellifica est le principal insecte visitant les fleurs (6,73 abeilles/5 min/m²), avec 73,0 % de l'ensemble des visites (Fig. 1). La faible activité de l'abeille *Apis cerana indica* (représentant 7,7 % des visites globales) est attribuée à la présence de 2 colonies seulement dans le rucher par rapport à 30 colonies d'*Apis mellifica*. Les autres insectes butineurs sont d'« autres Hyménoptères », divers Diptères et Lépidoptères, représentant 1,62, 8,45 et 9,21 % des visites respectivement.

La floraison de *R. ellipticus* a lieu à une période de l'année (fin de l'hiver, début du printemps), où les bonnes ressources en nectar sont rares, ce qui augmente d'autant son importance pour les abeilles.

ZUSAMMENFASSUNG

DIE PRODUKTION VON NEKTAR UND DIE BLÜTENBESUCHER DER BROMBEERE,
RUBUS ELLIPTICUS SMITH (ROSACEAE), IN SOLAN, INDIEN

Die vorliegenden Untersuchungen wurden im Februar 1985 in der Nähe eines Bienenstandes mit Völkern sowohl von *Apis mellifera* wie *Apis cerana indica* in Nauri, Solan, Indien (Seehöhe 1200 m) durchgeführt.

Um die Zuckerkonzentration des Nektars zu bestimmen, wurden Sammelbienen von den Blüten von *Rubus ellipticus* abgefangen und die Konzentration des Inhalts der Honigblase bestimmt. Mit spektrophotometrischen Methoden wurde der Zuckergehalt von Blüten verschiedenen Alters dadurch bestimmt, indem man Blütenstände mit Nylonnetz umschloß und in Abständen von 24 h bis zum Verwelken der Blüten Proben entnahm. Außerdem wurde der Zuckergehalt von freien und eingeschlossenen Blüten verglichen, um die Menge des von den blütenbesuchenden Insekten geernteten Nektars zu schätzen. Die Aktivität der Insekten auf den Blüten wurde in Quadranten von 1 m² zwischen 11.00 und 17.00 h fünf min lang in Abständen von zwei Stunden protokolliert.

Die Ergebnisse zeigten, daß der Zuckergehalt des Nektars von *R. ellipticus* in nicht-signifikanter Weise zwischen 65,3 und 71,3 % schwankte. Frisch geöffnete, umhüllte Blüten enthielten 1,3 mg Zucker (Tab. 1) ; diese Menge stieg nach 24 h auf 6,93 mg/Blüte. Nachher war keine signifikante Änderung der Menge des Nektarzuckers in den Blüten zu beobachten. Nach 72 h zeigten die Blüten Zeichen des Verwelkens. In ungeschützten Blüten, die ständig zur Ernte zur Verfügung standen, schwankte die Menge des Nektarzuckers nicht-signifikant zwischen 0,39 und 1,86 mg/Blüte, ein Hinweis auf das rasche Einsammeln des abgeschiedenen Nektars. Es wurde berechnet, daß die Zuckermenge, die wahrscheinlich von den besuchenden Insekten von einer Brombeerenblüte eingesammelt wird, etwa 80,7 % des gesamten produzierten Zuckers beträgt.

Apis mellifera war der wichtigste unter den Blütenbesuchern (Abb. 1 ; 6,73 Bienen/5 min/m²), deren Anteil 73,0 % aller besuchenden Insekten ausmachte. Die schwache Aktivität der Indischen Honigbiene *Apis cerana indica*, die nur 7,70 % aller besuchenden Insekten ausmachte, ist auf die geringe Zahl von nur zwei Völkern dieser Art gegenüber 30 Völkern von *Apis mellifera* zurückzuführen. Während des Versuches wurden die *cerana*-Völker durch das « Thai Sackbrutvirus » beinahe bis zur völligen Vernichtung verheert. Andere Blütenbesucher waren andere Hautflügler, verschiedene Fliegen und Schmetterlinge, die nur 1,62, 8,45 und 9,21 % der Insektenbesucher ausmachten.

Es soll in dieser Arbeit besonders betont werden, daß bestehende Brombeer-Büsche erhalten bleiben und daß weitere auf Ödland, in Schutzzonen, auf Flächen von geringem landwirtschaftlichen Wert und als Hecken um Felder angebaut werden sollten. *Rubus ellipticus* ist eine gute Trachtpflanze der Wildflora, die zu einer sehr günstigen Zeit (im Spätwinter und zeitigen Frühjahr) blüht, wenn andere Trachtpflanzen selten sind und ihr Wert für die Honigbienen besonders groß ist.

REFERENCES

- COLLETT H., 1921. — *Flora Simlensis. A hand book of flowering plants of Simla and neighbourhood.* II. Impression.
- CORBET S.A., 1978. — A bee's view of nectar. *Bee Wld.*, **59**, 25-32.
- CORBET S.A., DELFOSSE E.S., 1984. — Honeybees and nectar of *Echium plantagineum* L. in South-eastern Australia. *Aust. J. Ecol.*, **9**, 125-139.
- GUPTA J.K., MISHRA R.C., KUMAR J., 1984. — *Plectranthus* as a forage for *Apis c. indica* and *A. mellifera*. *Apidologie*, **115**, 75-82.
- MAURIZIO A., GRAFL I., 1982. — *Das Trachtpflanzenbuch. Nektar und Pollen — die wichtigsten Nahrungsquellen der Honigbiene.* — München (German Federal Republic), Ehrenwirth Verlag.

- NUÑEZ J., 1977. — Nectar flow by melliferous flora and gathering flow by *Apis mellifera ligustica*. *J. Insect Physiol.*, **23**, 265-275.
- PANSE V.G., SUKHATME P.V., 1978. — *Statistical methods for agricultural workers*. ICAR, New Delhi. III. Edition.
- PERCIVAL M.S., 1946. — Observations on the flowering and nectar secretion of *Rubus fruticosus* (Agg.). *New Phytol.*, **45**, 111-123.
- PERCIVAL M.S., 1965. — *Floral Biology*. Pergamon press, Oxford.
- PETER J., 1977. — Importance of crops, fruit trees and ornamental shrubs for apiculture. In : *Honey plants, basis of apiculture*, Int. Symp. melliferous flora, Budapest, Sep., 1976.
- PLEASANTS J.M., 1983. — Nectar production in *Ipomopsis aggregata* (Polemoniaceae). *Am. J. Bot.*, **70**, 1468-1475.
- ROBERTS R.B., 1979 a. — Spectrophotometric analysis of sugar produced by plants and harvested by insects. *J. Apic. Res.*, **18**, 191-195.
- ROBERTS R.B., 1979 b. — Energetics of Cranberry pollination. In : *Proc. IV Int. Symp. Pollination, Md Agric. Exp. Stn. Spec. Misc. Publ.*, **1**, 431-440.
- SHARMA P.L., 1958. — Sugar concentration of nectar of some Punjab honey plants. *Indian Bee J.*, **20**, 86-91.
- SHUEL R.W., 1975. — The production of nectar. In : *The Hive and the Honey bee*, Dadant and Sons ed., Hamilton, Illinois.
- SIMIDCHIEV T., 1976. — Studies of nectar and honey production in raspberry (*Rubus idaeus* L.) and blackberry (*Rubus fruticosus* L.). *Gradinar. Lozar. Nauk.*, **13**, 42-49.
- WAKLE D.M., NAIR K.S., RAMESH B., 1981. — Sugar composition in nectar of certain plants. *Indian Bee J.*, **43**, 6-8.