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Original article

Pollen analysis of some *Apis cerana* Fabr honeys from Andhra Pradesh, India

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Summary — Pollen analyses of 6 apiary (extracted) honey samples collected during March and June, 1982 from 3 districts, Vishakhapatnam (2), East Godavari (1) and Guntur (3) of Andhra Pradesh in the southern part of India, showed that these honeys come from 2 discrete floristic regimes: deciduous forest (Vishakhapatnam and East Godavari) and agricultural tracts (Guntur). The East Godavari honey was unifloral with *Anogeissus latifolia* (48.67%) as the predominant pollen type. The remaining samples were multifloral. *Lagerstroemia parviflora*, *Crotalaria juncea* and *Schleichera oleosa* constitute the chief nectar sources of the forest area of Vishakhapatnam during late summer. *Borassus flabellifer*, *Hygrophila* sp, *Crotalaria juncea*, *Cucumis* sp, *Phylla nodiflora* and *Momordica charantia*, however, represent the main bee plants of the agricultural tracts of the Guntur district during the summer.

***Apis cerana* / honey / pollen analysis / nectar plant / India**

INTRODUCTION

Pollen analysis of honeys encompassing qualitative and quantitative methodology is of great significance in apiculture. Identification of bee plants from diverse geographic areas and floristic communities helps immensely in the development of bee-keeping industry. Melittopalynological studies have received to date only marginal attention in various parts of India and particularly so in Andhra Pradesh, a major state in south India.

Nair (1964), Seethalakshmi (1980) and Chanda and Ganguly (1981) carried out pollen analysis of a few honey samples from

Andhra Pradesh. During the last decade, serious efforts have been made in pollen analytical studies of honeys from this state. Jhansi and Ramanujam (1986, 1987, 1990) provided pollen analysis of some extracted and squeezed honeys from various parts of Andhra Pradesh. Kalpana and Ramanujam (1989, 1991) and Kalpana *et al* (1990) carried out detailed qualitative and quantitative pollen analytical studies of squeezed honeys of *Apis florea* Fabr and *A. cerana* Fabr from the Ranga Reddy and Hyderabad districts.

The present contribution forms part of a more comprehensive study of pollen analysis of diverse apiary and squeezed honeys from different parts of Andhra Pradesh. It

is aimed mainly at recognizing and screening the key bee plants from 2 varied floristic regimes: deciduous forest and agricultural tracts of 3 districts to help promote the bee-keeping industry at these places.

MATERIALS AND METHODS

Six apiary honey samples (500 g each) of *A cerana*, the Indian hive bee, were collected from 3 districts of Andhra Pradesh in 1982 (fig 1). The districts from which the samples were collected include Vishakhapatnam (2 samples, CHE-2 and CHE-4), East Godavari (1 sample, CHE-9) and Guntur (3 samples, CHE-12, CHE-13 and CHE-16) (table I). The samples CHE-2, CHE-4, CHE-9, CHE-12 and CHE-13 were collected in June (late summer) whereas CHE-16 was collected in March (early summer). The samples CHE-2, CHE-4 and CHE-9 are from a deciduous forest area and CHE-12, CHE-13 and CHE-16 are from an agricultural area.

Honey (1 ml) was dissolved in 10 ml distilled water and centrifuged. The recovered sediment was treated with 5 ml glacial acetic acid and the mixture was subjected to acetolysis (Erdtman, 1960). Three pollen slides were prepared for each sample. The recovered pollen types were identified with the help of reference slide collection of

local flora and relevant literature. As far as possible, the pollen types were identified to the generic and specific levels. In some cases, however, only family identification was possible. A few types that could not be identified even in terms of family were designated 'unknown'.

For determining the frequency classes of pollen types, 300 pollen grains were counted (100 per slide). As recommended by the International Commission for Bee Botany (Louveaux *et al*, 1978), 4 frequency classes were recognized: predominant pollen type (> 45%); secondary pollen types (16–45%); important minor pollen types (3–15%); and minor pollen types (< 3%).

Unacetolysed honey samples were examined in order to calculate the ratio between honeydew elements (fungal spores and hyphae, algae and wax particles of honeydew-producing insects) and pollen grains (Louveaux *et al*, 1978). The method recommended by Suryanarayana *et al* (1981) was employed to determine the absolute pollen counts (APC) of honey samples.

RESULTS AND DISCUSSION

Altogether 51 pollen types (49 of nectar-yielding and 2 of non-nectar-yielding taxa) referable to 36 families (34 of nectar-yielding and 2 of non-nectar-yielding taxa) were

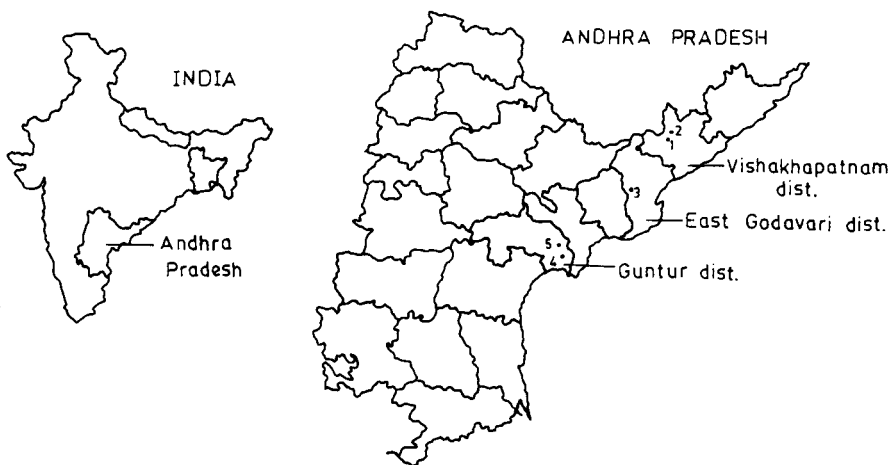


Fig 1. Location sites of honey samples. 1: Chinthapally (CHE-2); 2: Lothugadda (CHE-4); 3: Bommuru (CHE-9); 4: Dandamudi (CHE-12; CHE-13); 5: Tenali (CHE-16).

Table 1. Inventory, colour, moisture content (%) and absolute pollen count (APC) of honey samples.

Sample No	Place of collection	Date of collection	Colour	Moisture content (%)	APC
CHE-2	Chinthapally area of Vishakhapatnam district	June, 1982	Dark-amber	23.1	500 000 G-III
CHE-4	Lothugadda area of Vishakhapatnam district	June, 1982	Dark-amber	24.6	300 000 G-III
CHE-9	Near Bommaru area in East Godavari district	June, 1982	Dark-amber	25.0	676 190 G-IV
CHE-12	Dandamudi village of Guntur district	June, 1982	Amber	21.6	20 830 G-II
CHE-13	Dandamudi village of Guntur district	June, 1982	Yellow	21.8	90 000 G-II
CHE-16	Tenali area of Guntur district	March, 1982	Light-amber	21.2	25 000 G-II

recorded in the samples studied. Sample CHE-2 from Vishakhapatnam district had the maximum number of pollen types (28), whereas CHE-12 from Guntur district had the minimum number (9). Samples from the forest area of Vishakhapatnam district, CHE-2 (28) and CHE-4 (26), had more pollen types than those from agricultural area of Guntur district, CHE-12 (9), CHE-13 (13) and CHE-16 (16). The honey from East Godavari (CHE-9) had intermediate number of pollen types, *ie* 16 (fig 2).

The sample CHE-9, obtained from East Godavari district, was found to be unifloral with *Anogeissus latifolia* (48.67%) as the predominant pollen type. *Phyllanthus* L sp (35.67%) constitutes the secondary pollen type of this sample. The rest of the samples, CHE-2 and CHE-4 from Vishakhapatnam district and CHE-12, CHE-13 and CHE-16 from Guntur district, were all multifloral.

Lagerstroemia parviflora Roxb, *Crotalaria juncea* L, *Schleichera oleosa* (Lour)

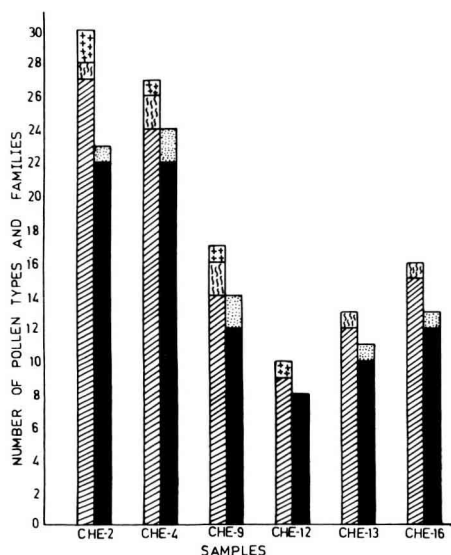


Fig 2. Number of pollen types and families encountered in honey samples. ▨ nectar-yielding taxa; ■ nectar-yielding families; ▤ non-nectar-yielding taxa; ▥ non-nectar-yielding families; ▦ unknown pollen.

Oken, *Merremia* Dennst ex Endl sp, *Chenopodium album* L, *Capparis grandis* L, *Albizia lebbbeck* L, *Tridax procumbens* L, *Syzygium cumini* (L) Skeels, *Grewia* L sp, *Medicago sativa* L and *Jasminum* L sp are the significant bee plants of Vishakhapatnam district. Those of East Godavari district are *Anogeissus latifolia* (DC) Wallicher Guillemin and Perrottet, *Phyllanthus* sp, *Schleichera oleosa* and *Terminalia* L sp. The important nectar-yielding bee plants of the Guntur district are *Borassus flabellifer* L, *Hygrophila* R Br sp, *Crotalaria juncea*, *Cucumis* L sp, *Phyla nodiflora* (L) E Greene, *Momordica charantia* L, *Citrus limon* (L) Burm, *Brassica nigra* Koch, *Tridax procumbens* L, *Sphaeranthus indicus* L and *Cocos nucifera* L.

The degree of similarity in any pair of honey samples collected during the same period can also be quantified by using a similarity index, calculated using the for-

mula $2c/(a + b)$, where *a* and *b* represent the number of pollen types in each of the samples and *c* represents the number of pollen types common to both the samples. An index value of more than 0.5 represents a close degree of similarity between the samples. The lower the similarity index, the more the diversity between samples. Table II shows the similarity index values between the multifloral honey samples from the deciduous forest area of Vishakhapatnam and agricultural tracts of Guntur districts, all collected in the month of June. Honey samples from the same floristic region provide high index values compared with those from different regions.

Cyperus rotundus and Gramineae represent the pollen types of anemophilous (non-nectar-yielding) taxa in the present study. The presence of these pollen types in low percentages could be due to contamination

Table II. Similarity index of multifloral honeys collected in June.

Sample No	Total No of pollen types	No of pollen types common to both samples	Similarity index
CHE-2 and CHE-4	28 26	22	$2 \times 22/28 + 26 = 0.815$
CHE-12 and CHE-13	9 13	6	$2 \times 6/9 + 13 = 0.545$
CHE-2 and CHE-12	28 9	2	$2 \times 2/28 + 9 = 0.108$
CHE-2 and CHE-13	28 13	2	$2 \times 2/28 + 13 = 0.098$
CHE-4 and CHE-12	26 9	2	$2 \times 2/26 + 9 = 0.114$
CHE-4 and CHE-13	26 13	2	$2 \times 2/26 + 13 = 0.103$

by bees themselves (Iwama and Melhem, 1979).

Fungal spores (*Drechslera* and *Nygrospora*) and shreds of hyphae are the honeydew elements recorded in the samples analysed. HDE/P ratio ranged from 0.003–0.01 and can thus be compared with the 'practically none' group (Louveaux *et al*, 1978).

Based upon the absolute pollen counts, the honey samples CHE–2 and CHE–4 were referred to group III, and CHE–9 to group IV. The remaining 3 samples were placed in group II.

The colour of the samples from visual observation ranged from yellow to dark amber. The moisture content of the samples varied from 21.2 to 25.0%. The samples with moisture content of 23–25% represent 'unripe' honeys (table I).

Photographs of some of the significant pollen types are shown in figure 3.

Lagerstroemia parviflora, *Crotalaria juncea* and *Schleichera oleosa* are the chief nectar sources in the deciduous forest areas (*Chinthapally* and *Lothugadda*) of Vishakhapatnam district during late summer. *Merremia* sp, *Chenopodium album*, *Capparis grandis*, *Albizia lebbek*, *Tridax procumbens*, *Grewia* sp, *Syzygium cumini*, *Medicago sativa* and *Jasminum* sp serve as other useful sources of nectar in these areas. In a more recent study involving the pollen analysis of a forest honey sample from this district Jhansi and Ramanujam (1990) also considered *Lagerstroemia* and *Syzygium* as useful sources of nectar.

Anogeissus latifolia, *Phyllanthus* sp, *Schleichera oleosa* and *Terminalia* sp appear to be important nectar sources near Bomuru in East Godavari district. In the agricultural tracts of Guntur district (Dandamudi and Tenali), however, *Borassus flabellifer*, *Hygrophila* sp, *Crotalaria juncea*, *Cucumis* sp, *Phyla nodiflora* and *Momordica charantia* are the chief nectar-yielding plants during

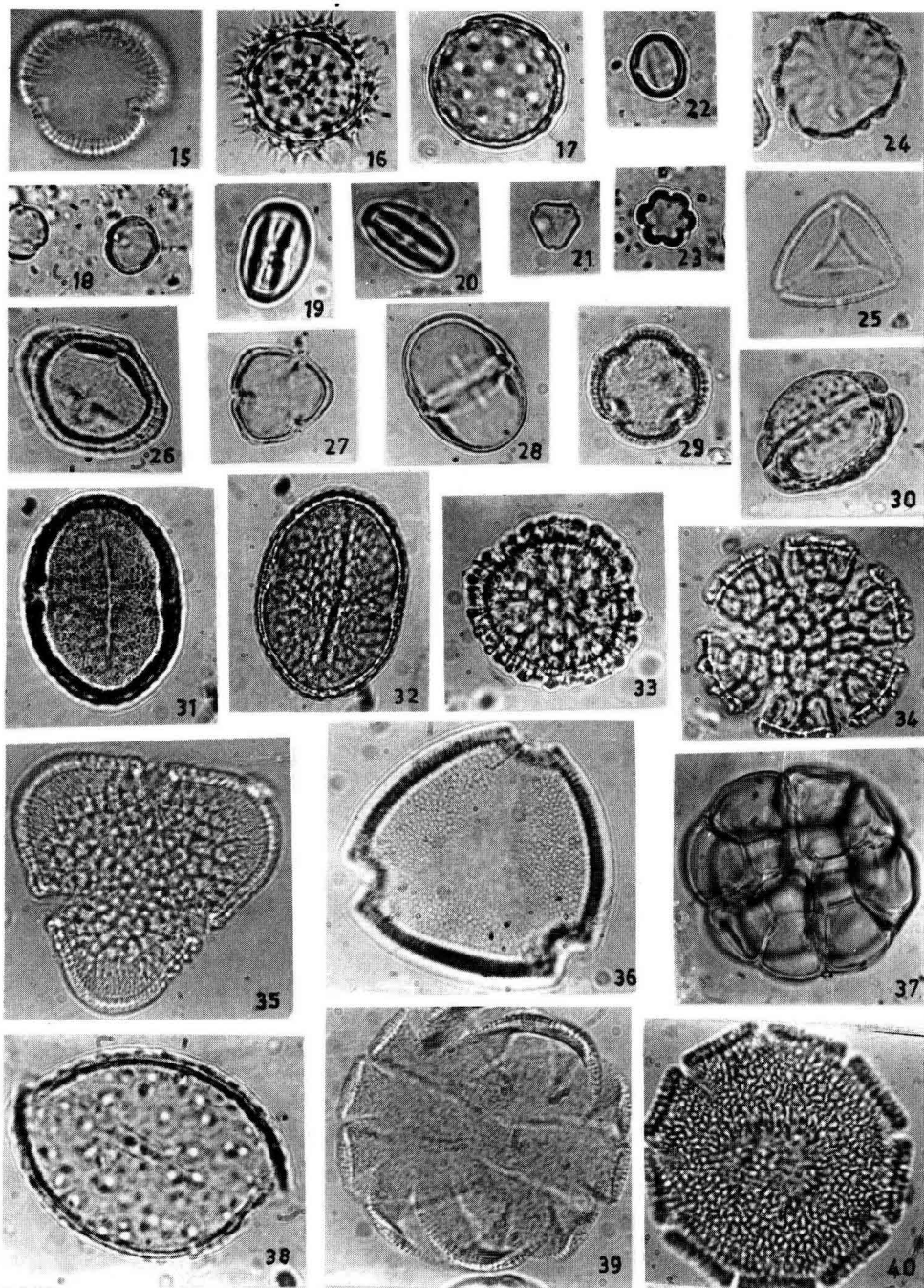
summer, and *Citrus limon*, *Brassica nigra*, *Tridax procumbens*, *Sphaeranthus indicus* and *Cocos nucifera* also serve as useful nectar sources. In an earlier study (Seethalakshmi, 1980), *Borassus*, *Phyla* and *Hygrophila* were recognized as significant bee-forage plants in the agricultural tracts of Guntur district. Further, Jhansi and Ramanujam (1986, 1990) also highlighted *Borassus*, *Hygrophila* (which they identified as *Asteracantha*) along with *Citrus* as reliable nectar sources for the honey bees of this district.

The present work thus facilitates recognition of honeys from deciduous forest and agricultural areas of the coastal belt of Andhra Pradesh.

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Résumé — Analyse pollinique de quelques miels d'*Apis cerana* Fabr de l'Andhra Pradesh, Inde. L'analyse pollinique porte sur 6 échantillons de miel prélevés dans des ruchers en mars et juin 1982 dans 3 districts de l'Andhra Pradesh dans le sud de l'Inde (fig 1). Les échantillons provenaient de 2 régions floristiques différentes : forêt à feuilles caduques (Vishakhapatnam et East Godavari) et région agricole (Guntur). Ils ont été analysés selon la méthode proposée par Louveaux *et al* (1978). On a déterminé un total de 51 types polliniques (dont 2 de plantes non nectarifères, parmi lesquelles *Cyperus rotundus*) se rapportant à 36 familles (dont 2 familles de plantes non nectarifères, Gramineae et Cyperaceae). La figure 2 donne le nombre de taxons et de familles de plantes nectarifères et non nectarifères pour chacun des échantillons. Le miel du district d'East Goda-



vari était monofloral avec *Anogeissus latifolia* comme pollen prédominant et *Phyllanthus* sp comme pollen secondaire. Les autres échantillons étaient des miels toutes fleurs. *Lagerstroemia parviflora*, *Crotalaria juncea* L et *Schleichera oleosa* sont les principales sources de nectar à la fin de l'été dans les forêts à feuilles caduques du district de Vishakhapatnam et *Borassus flabellifer*, *Hygrophila* sp, *Crotalaria juncea*, *Cucumis* sp, *Phyllanthus nodiflora* et *Momordica charantia* les principales plantes nectarifères de l'été dans la zone agricole du district de Guntur. Le tableau I donne les caractéristiques des échantillons : couleur, teneur en eau, teneur absolue en pollen (calculée d'après Suryanarayana *et al*, 1981). La figure 3 regroupe des microphotographies de quelques pollens importants. Le degré de similitude entre miels pris 2 à 2 peut être mesuré par la formule $2c/a+b$, où a et b représentent le nombre de types polliniques dans chacun des 2 échantillons et c le nombre de types polliniques communs aux 2 échantillons. Le tableau II donne la valeur de l'indice des 6 paires de miels toutes fleurs récoltés en juin. Les échantillons provenant d'une même région floristique ont un indice de similarité élevé. D'après la teneur absolue en pollen, les échantillons appartiennent aux groupes II, III et IV. Le rapport HDE/P (indicateur de miellat) est pratiquement nul pour tous les échantillons. L'étude permet de reconnaître facilement les miels de diverses régions floristiques.

Apis cerana / miel / analyse pollinique / plante mellifère / Inde

Zusammenfassung — Pollenanalyse einiger Honige von *Apis cerana* Fabr aus Andhra Pradesh, Indien. Diese Arbeit berichtet über die eingehende Pollenanalyse von sechs Honigproben, gesammelt im März und Juni 1982 in drei Distrikten von Andhra Pradesh, Südindien, und zwar: Vishakhapatnam, 2 Proben (CHE-2, CHE-4); East Godavari, 1 Probe (CHE-9); und Guntur, 3 Proben (CHE-12, CHE-13, CHE-16) (Abb 1). Die Proben stammten aus zwei floristisch verschiedenen Regionen, Laubwald (Vishakhapatnam und East Godavari) und einem landwirtschaftlich genutzten Gebiet (Guntur). Die Proben wurden nach der von Louveaux *et al* vorgeschlagenen Methode analysiert. Insgesamt wurden in den analysierten Honigen 51 Pollentypen (49 von Nektarpflanzen und 2 von nektarlosen Taxa) aus 36 Familien (davon 34 mit nektarabscheidenden Pflanzen) beobachtet. Gramineae und *Cyperus rotundus* stellten die beiden nektarlosen Gruppen. Die Anzahl der Taxa und Familien mit Nektar- und nektarlosen Pflanzen ist aus Abbildung 2 ersichtlich. Die Honigprobe aus East Godavari (CHE-9) war unifloral mit *Anogeissus latifolia* als Leitpollen und *Phyllanthus* sp als Begleitpollen. Alle übrigen Proben waren multifloral. *Lagerstroemia parviflora*, *Crotalaria juncea* und *Schleichera oleosa* bilden in dem Waldgebiet von Vishakhapatnam im Spätsommer die wichtigsten Nektarquellen. Hingegen stellen im Kulturland von Guntur im Sommer *Borassus flabellifer*, *Hygrophila* sp, *Crotalaria juncea*, *Cucumis* sp, *Phyllanthus nodiflora* und *Momordica charantia* die wichtigsten Bienenpflanzen.

Fig 3. Some significant pollen types recorded in the present study (unless otherwise mentioned all magnified x 500). Photograph No 15 = *Merremia* sp; No 16 = *Tridax procumbens*; No 17 = *Chenopodium album*; No 18 = *Phyllanthus* sp; No 19 and 20 = *Crotalaria juncea*; No 21 = *Syzygium cumini*; No 22 and 23 = *Anogeissus latifolia*; No 24 = *Hygrophila* sp; No 25 = *Schleichera oleosa*; No 26 and 27 = *Lagerstroemia parviflora*; No 28 = *Phyllanthus nodiflora*; No 29 = *Citrus limon*; No 30 = *Barringtonia acutangula*; No 31 and 32 = *Grewia* sp; No 33 = *Jasminum* sp; No 34 = *Ocimum* sp; No 35 = *Bombax ceiba*; No 36 = *Cucumis* sp; No 37 = *Albizia lebbek* (x 450); No 38 = *Borassus flabellifer*; No 39 = *Sesamum orientale*; No 40 = *Chrozophora* sp.

zen. Die Charakterisierung der Honigproben, wie Farbe, Wassergehalt (%) und Gesamtpollengehalt sind in Tabelle I zusammengestellt. Abbildung 3 zeigt Mikrophotographien einiger signifikanter Pollentypen. Der Ähnlichkeitsgrad zwischen zwei beliebigen Honigproben kann nach der Formel $2c/a+b$ quantifiziert werden, wobei a und b die Anzahl der Pollentypen in jedem der beiden Honige darstellt, und c die Zahl der in beiden Proben gemeinsam vorkommenden Typen. Tabelle II zeigt die Indexwerte von sechs Paaren im Juni gesammelter multifloraler Honige. Proben aus derselben floristischen Region zeigten einen hohen Ähnlichkeitsindex. Auf der Basis der absoluten Pollenzahlen, bestimmt nach dem Verfahren von Suryanarayana *et al* (1981) könnten die Proben den Gruppen II, III and IV zugeordnet werden. HDE/P wurde in allen Proben als 'praktisch Null' bestimmt. Diese Studie erleichtert die Erkennung von Honigen aus verschiedenen floristischen Regionen.

***Apis cerana* / Honig / Pollenanalyse / Nektarpflanze / Indien**

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